# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

column C1, Floor 1

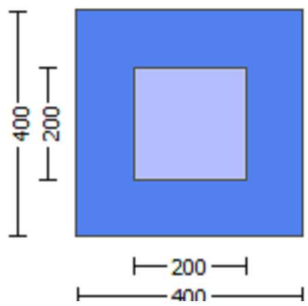
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

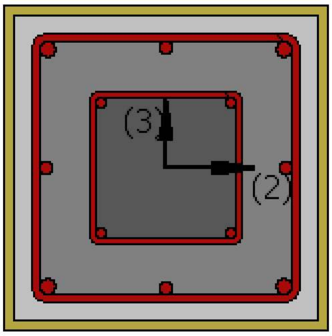
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.7258E+007
Shear Force, Va = -5750.847
EDGE -B-
Bending Moment, Mb = 0.00815737
Shear Force, Vb = 5750.847
BOTH EDGES
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 505466.139
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 505466.139

VCol = 505466.139
knl = 1.00
displacement_ductility_demand = 0.02169271
---------------------------------------------------------------
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 = 1.7258E+007
Vu = 5750.847
d = 0.8*h = 320.00
Nu = 5974.507
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
---------------------------------------------------------------

---------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00028349
θy = (My*Ls/3)/EIeff = 0.01306853 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.88
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

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

Calculation of Yielding Moment My

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

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

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
 with fy = 555.56
 d = 357.00
 ξy = 0.280262
 A = 0.01881926
 B = 0.01057612
 with pt = 0.00796398
 pc = 0.00796398
 pv = 0.00281599
 N = 5974.507
 b = 400.00
 δ" = 0.12044818
Φy_comp = 2.3130541E-005
 with fc* (12.3, (ACI 440)) = 34.65043
 fc = 33.00
 fl = 0.93147527
 b = 400.00
 h = 400.00
 Ag = 160000.00
 From (12.9), ACI 440: ka = 0.56518315
 ρg = pt + pc + pv = 0.01874396
 rc = 40.00
 Ae/Ac = 0.56518315
 Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
 effective strain from (12.5) and (12.12), efe = 0.004
 εfu = 0.01
 Ef = 64828.00
 Ec = 26999.444
 ξy = 0.27975145
 A = 0.0186534
 B = 0.01050082
 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

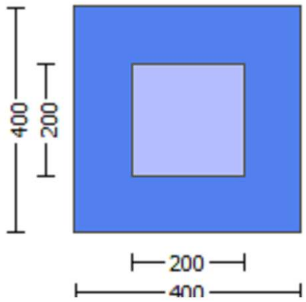
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

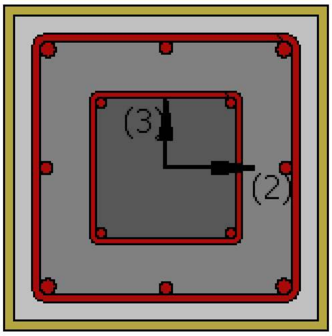
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
######################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
######################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
------------------------------------------------------------

Stepwise Properties
------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
------------------------------------------------------------
------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119

λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

-------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508

bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce  = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc  = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------

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

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
---------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
---------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
---------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
---------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
---------------------------------------------------------------------

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections

wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
----------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

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

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

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

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##############################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##############################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031

EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
--------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00

effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119

λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00

Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
----------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008

φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
----------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47

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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
Bending Moment, M = 2.1072102E-010
Shear Force, V2 = -5750.847
Shear Force, V3 = -1.0642330E-013
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01153235
θu = θy + θp = 0.01153235

-------------------------------------------------------------
- Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))

My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013

---

---

Calculation of Yielding Moment My

---

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

---

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ" = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534
B = 0.01050082
with Es = 200000.00

---

Calculation of ratio lb/ld

---

Adequate Lap Length: lb/ld >= 1

---

- Calculation of θp -

---

From table 10-8: θp = 0.005
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00

s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.507
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00
---------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

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

## Calculation No. 3

column C1, Floor 1

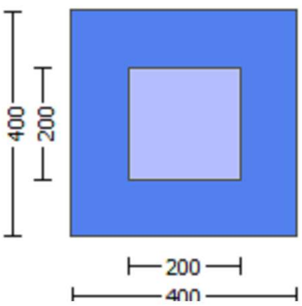
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

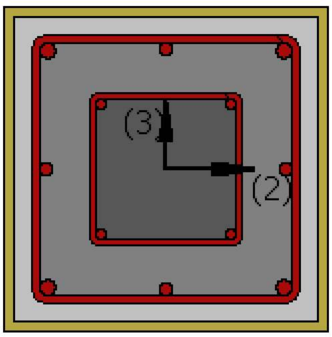
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)



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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 2.1072102E-010
Shear Force, Va = -1.0642330E-013
EDGE -B-
Bending Moment, Mb = 1.0860180E-010
Shear Force, Vb = 1.0642330E-013
BOTH EDGES
Axial Force, F = -5974.507

Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.827
VCol = 585777.827
knl = 1.00
displacement_ductility_demand = 0.00
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 2.1072102E-010
Vu = 1.0642330E-013
d = 0.8*h = 320.00
Nu = 5974.507
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
-----------------------------------------------------------------

-----------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)
-----------------------------------------------------------------
From analysis, chord rotation θ = 2.9773643E-021
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Yielding Moment My
-----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
-----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534
B = 0.01050082
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

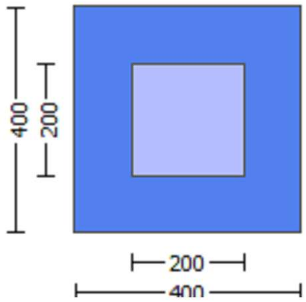
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

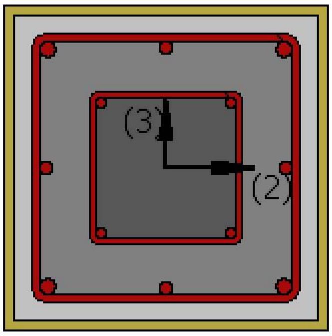
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
######################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
######################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00

Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 =  Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

------------------------------------------------------------------------------
Calculation of Mu1+
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119

λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00

Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

-------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008

φu = φsu (4.1) = 0.00010712
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:

d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:

total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

-----------------------------------------------------------------------------
Calculation of Mu1+
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-----------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00

effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------

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

Calculation of Mu1-

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

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

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008

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

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

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

ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

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

ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

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

R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

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

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

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

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
R = 40.00

Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00

d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00

s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
-------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440

with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-------------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-------------------------------------------------------------------
-------------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
Bending Moment, M = -1.7258E+007
Shear Force, V2 = -5750.847
Shear Force, V3 = -1.0642330E-013
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01806853
θu = θy + θp = 0.01806853

-----------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.01306853 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.88
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Yielding Moment My
-----------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
-----------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534
B = 0.01050082
with Es = 200000.00
-----------------------------------------------------------

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

-----------------------------------------------------------
- Calculation of θp -
-----------------------------------------------------------
From table 10-8: θp = 0.005
with:

- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 0.35962554
  d = d_external = 357.00
  s = s_external = 0.00
  ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
  jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
    Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
    h1 = 400.00
    s1 = 100.00
  core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
    Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
    h2 = 200.00
    s2 = 250.00
  The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
  where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
  All these variables have already been given in Shear control ratio calculation.
  For the normalisation fs of jacket is used.
   NUD = 5974.507
   Ag = 160000.00
   f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
   fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
   fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
  b = 400.00
  d = 357.00
   f'cE = 33.00

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

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

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

## Calculation No. 5

column C1, Floor 1

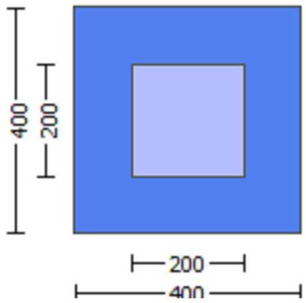
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

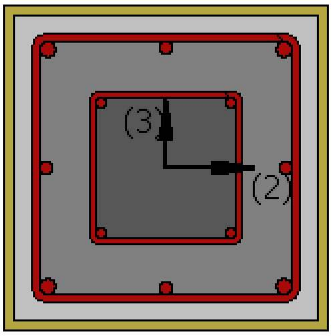
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1

Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.7258E+007
Shear Force, Va = -5750.847
EDGE -B-
Bending Moment, Mb = 0.00815737
Shear Force, Vb = 5750.847
BOTH EDGES
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.827
VCol = 585777.827
knl = 1.00
displacement_ductility_demand = 0.11465513
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.00815737
Vu = 5750.847
d = 0.8*h = 320.00
Nu = 5974.507
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,

as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
-----------------------------------------------------------------

-----------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)
-----------------------------------------------------------------
From analysis, chord rotation θ = 0.00014979
θy = (My*Ls/3)/EIeff = 0.00130647 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Yielding Moment My
-----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
-----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534

B = 0.01050082
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

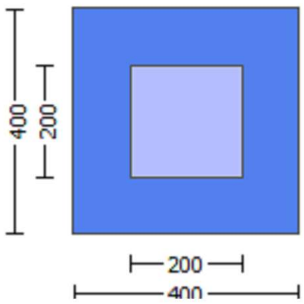
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

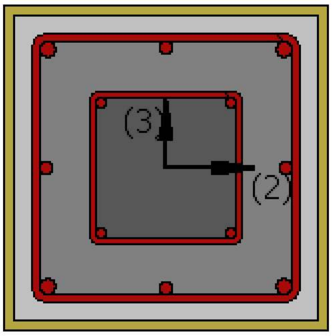
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----------------------------------------------------------------------------
Calculation of Mu1+
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
----------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333

b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------------

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

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

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00

ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00

d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc  = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00

Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:

d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 =  Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

--------------------------------------------------------------------------------
Calculation of Mu1+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831

N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45

fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
--------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc  = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333

b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00

s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
--------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440

with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
----------------------------------------------------------------
----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
----------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
----------------------------------------------------------------

Stepwise Properties
----------------------------------------------------------------
Bending Moment, M = 1.0860180E-010
Shear Force, V2 = 5750.847
Shear Force, V3 = 1.0642330E-013
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01153235
θu = θy + θp = 0.01153235

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444

$\xi y = 0.27975145$
A = 0.0186534
B = 0.01050082
with Es = 200000.00
-------------------------------------------------------------

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

-------------------------------------------------------------
- Calculation of θp -
-------------------------------------------------------------
From table 10-8: θp = 0.005
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.507
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00
-------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (b)

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

## Calculation No. 7

column C1, Floor 1

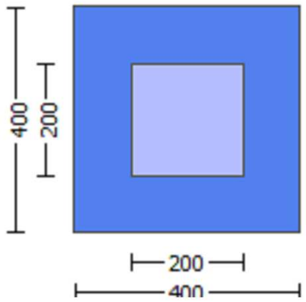
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

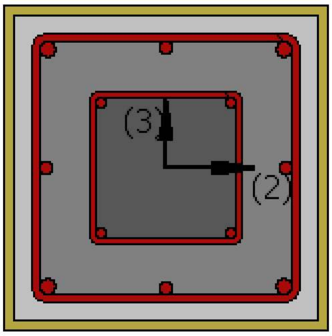
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 2.1072102E-010
Shear Force, Va = -1.0642330E-013
EDGE -B-
Bending Moment, Mb = 1.0860180E-010
Shear Force, Vb = 1.0642330E-013
BOTH EDGES
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.827
VCol = 585777.827
knl = 1.00
displacement_ductility_demand = 0.00
-------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.0860180E-010
Vu = 1.0642330E-013
d = 0.8*h = 320.00
Nu = 5974.507
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125

Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
----------------------------------------------------------------

----------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)
----------------------------------------------------------------
From analysis, chord rotation θ = 4.3619512E-023
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00

h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534
B = 0.01050082
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

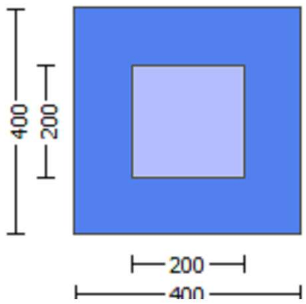
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

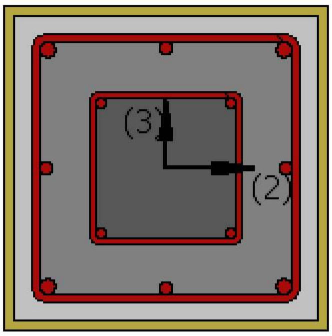
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)




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

Section Type: rcjrs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##############################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##############################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: Aslt = 0.00
 -Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: Asl,ten = 1137.257
 -Compression: Asl,com = 1137.257
 -Middle: Asl,mid = 402.1239

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

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

-------------------------------------------------------------------------------
Calculation of Mu1+
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00

Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce  = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc  = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------

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

-------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008

φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

---------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------

ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
----------------------------------------------------------------------------------
----------------------------------------------------------------------------------
----------------------------------------------------------------------------------
----------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47

-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032

d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
--------------------------------------------------------------
--------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
--------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##############################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 =  Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

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

Calculation of Mu1+
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

---------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00

Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00

d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00

s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

Calculation of ratio lb/ld

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

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008

---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00

ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:

Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148

ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00
----------------------------------------------------------------

Stepwise Properties
----------------------------------------------------------------
Bending Moment, M = 0.00815737
Shear Force, V2 = 5750.847
Shear Force, V3 = 1.0642330E-013
Axial Force, F = -5974.507
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00630647
θu = θy + θp = 0.00630647

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00130647 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.507
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810812E-005
with fy = 555.56
d = 357.00
ξy = 0.280262
A = 0.01881926
B = 0.01057612
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.507
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130541E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00

fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975145
A = 0.0186534
B = 0.01050082
with Es = 200000.00

---

Calculation of ratio lb/ld

---

Adequate Lap Length: lb/ld >= 1

---

- Calculation of θp -

---

From table 10-8: θp = 0.005
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.507
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00

---

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

---

# Calculation No. 9

column C1, Floor 1

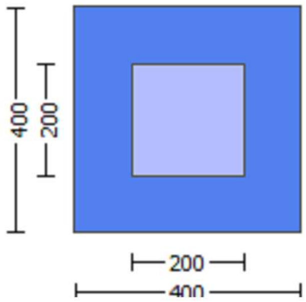
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

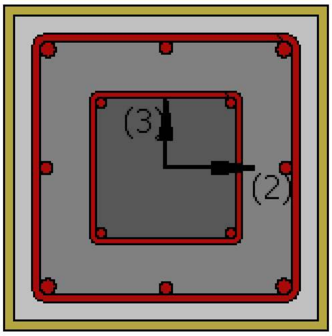
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56

#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.3810E+007
Shear Force, Va = -4601.921
EDGE -B-
Bending Moment, Mb = 0.00652766
Shear Force, Vb = 4601.921
BOTH EDGES
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 505466.184
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 505466.184
VCol = 505466.184
knl = 1.00
displacement_ductility_demand = 0.01735885
-----------------------------------------------------------------
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 = 1.3810E+007
Vu = 4601.921
d = 0.8*h = 320.00
Nu = 5974.966
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412

where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
---------------------------------------------------------------

---------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00022685
θy = (My*Ls/3)/Eleff = 0.01306853 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.88
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
---------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599

N = 5974.966
b = 400.00
δ" = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339
B = 0.01050082
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

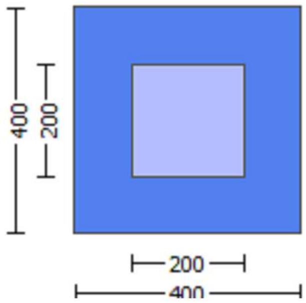
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

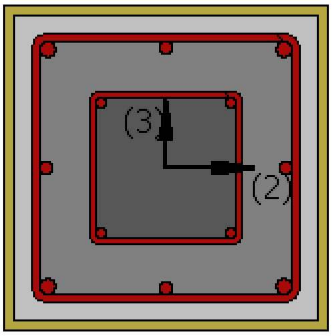
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00

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

Stepwise Properties
-----------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

-----------------------------------------------------------------------------
Calculation of Mu1+
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-----------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244

-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
---------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
---------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
---------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
---------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
---------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
--------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016

fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00

v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01

From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288

bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

-----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
------------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333

b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47

Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808

Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
Bending Moment, M = 1.6663953E-010
Shear Force, V2 = -4601.921
Shear Force, V3 = -8.5161640E-014
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05698684
θu = θy + θp = 0.05698684

-------------------------------------------------------------
- Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Yielding Moment My
-------------------------------------------------------------

Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ" = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339
B = 0.01050082
with Es = 200000.00
----------------------------------------------------------------

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

----------------------------------------------------------------
- Calculation of θp -
----------------------------------------------------------------
From table 10-8: θp = 0.05045449
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.966
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein =

555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00
-----------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 2
Integration Section: (a)

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

## Calculation No. 11

column C1, Floor 1

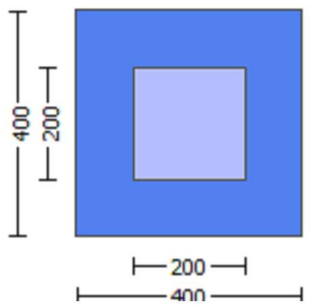
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

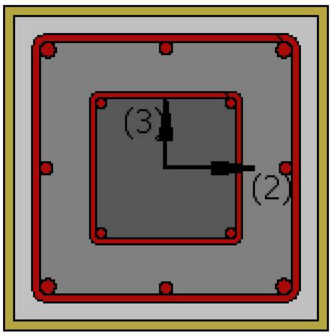
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)




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

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00

New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 1.6663953E-010
Shear Force, Va = -8.5161640E-014
EDGE -B-
Bending Moment, Mb = 8.8887759E-011
Shear Force, Vb = 8.5161640E-014
BOTH EDGES
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.918

Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.918
VCol = 585777.918
knl = 1.00
displacement_ductility_demand = 0.00
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.6663953E-010
Vu = 8.5161640E-014
d = 0.8*h = 320.00
Nu = 5974.966
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
---------------------------------------------------------------

---------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 2.3825350E-021
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966

Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
---------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339
B = 0.01050082
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

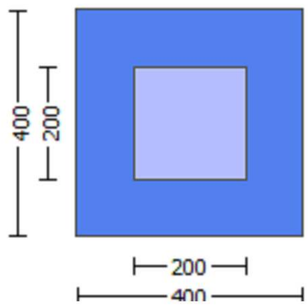
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

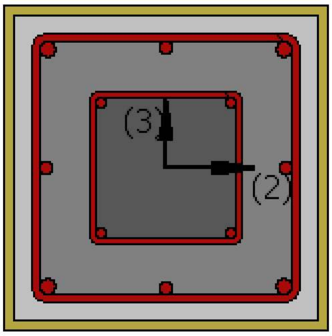
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

--------------------------------------------------------------------------
Calculation of Mu1+
--------------------------------------------------------------------------

--------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119

$\lambda c$ = confinement factor = 1.13212
$\varepsilon y1$ = 0.0025
$\varepsilon sh1$ = 0.008
ft1 = 833.34
fy1 = 694.45
$\varepsilon su1$ = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
$\varepsilon su1$ = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and $\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
$\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,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
$\varepsilon y2$ = 0.0025
$\varepsilon sh2$ = 0.008
ft2 = 833.34
fy2 = 694.45
$\varepsilon su2$ = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
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
$\varepsilon su2$ = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and $\varepsilon y2$,$\varepsilon sh2$,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
$\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,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
$\varepsilon yv$ = 0.0025
$\varepsilon shv$ = 0.008
ftv = 833.34
fyv = 694.45
$\varepsilon suv$ = 0.032
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 1.00
$\varepsilon suv$ = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and $\varepsilon yv$,$\varepsilon shv$,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
$\varepsilon y1$,$\varepsilon sh1$,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,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
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.16759354
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.16759354
$\omega v$ = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
$\varepsilon cc$ (5A.5, TBDY) = 0.00332119
$\lambda c$ = confinement factor = 1.13212
$\omega 1$ = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
$\omega 2$ = Asl,com/(b*d)*(fs2/fc) = 0.21525776
$\omega v$ = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
$\delta'$ satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508

bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------

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

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections

wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

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

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

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

Constant Properties
------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
------------------------------------------------------------

Stepwise Properties
------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031

EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

--------------------------------------------------------------------------------
Calculation of Mu1+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00

effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

---------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119

λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------

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

--------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00

Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce  = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc  = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008

φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
--------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------
--------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47

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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
Bending Moment, M = -1.3810E+007
Shear Force, V2 = -4601.921
Shear Force, V3 = -8.5161640E-014
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1137.257
-Compression: Aslc = 1539.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.06352302
θu = θy + θp = 0.06352302

-----------------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/Eleff = 0.01306853 ((4.29),Biskinis Phd))

My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3000.88
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
---------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ" = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339
B = 0.01050082
with Es = 200000.00
---------------------------------------------------------------

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

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-8: θp = 0.05045449
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00

s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.966
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00
---------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (a)

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

## Calculation No. 13

column C1, Floor 1

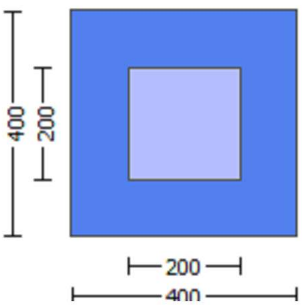
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

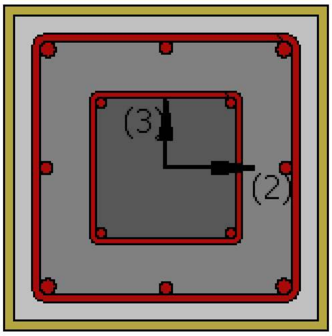
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)



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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###############################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###############################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.3810E+007
Shear Force, Va = -4601.921
EDGE -B-
Bending Moment, Mb = 0.00652766
Shear Force, Vb = 4601.921
BOTH EDGES
Axial Force, F = -5974.966

Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.918
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.918
VCol = 585777.918
knl = 1.00
displacement_ductility_demand = 0.09174886
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.00652766
Vu = 4601.921
d = 0.8*h = 320.00
Nu = 5974.966
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
-----------------------------------------------------------------

-----------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00011987
θy = (My*Ls/3)/EIeff = 0.00130647 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
---------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339
B = 0.01050082
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

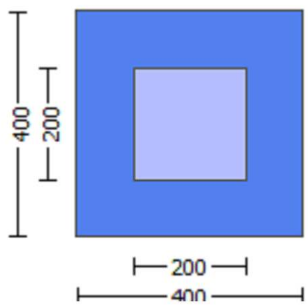
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

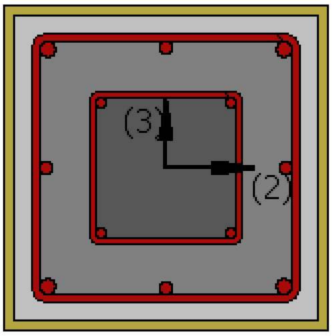
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
#################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00

Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------

with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119

λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00

Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc  = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008

φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:

d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:

total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1

Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

------------------------------------------------------------------------------
Calculation of Mu1+
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00

effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

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

Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617

ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00

Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00

d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00

s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776

ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440

with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-----------------------------------------------------------------
-----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
Bending Moment, M = 8.8887759E-011
Shear Force, V2 = 4601.921
Shear Force, V3 = 8.5161640E-014
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05698684
θu = θy + θp = 0.05698684

-------------------------------------------------------------
 - Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
  My = 2.2575E+008
  Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
  From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
    factor = 0.30
      Ag = 160000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
      N = 5974.966
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Yielding Moment My
-------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
-------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
 with fy = 555.56
    d = 357.00
    ξy = 0.28026208
    A = 0.01881927
    B = 0.01057613
     with pt = 0.00680078
        pc = 0.00796398
        pv = 0.00281599
        N = 5974.966
        b = 400.00
        δ'' = 0.12044818
Φy_comp = 2.3130538E-005
 with fc* (12.3, (ACI 440)) = 34.65043
    fc = 33.00
    fl = 0.93147527
    b = 400.00
    h = 400.00
    Ag = 160000.00
    From (12.9), ACI 440: ka = 0.56518315
      ρg = pt + pc + pv = 0.01874396
      rc = 40.00
      Ae/Ac = 0.56518315
      Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
    effective strain from (12.5) and (12.12), efe = 0.004
    εfu = 0.01
    Ef = 64828.00
    Ec = 26999.444
    ξy = 0.27975148
    A = 0.01865339
    B = 0.01050082
     with Es = 200000.00
-------------------------------------------------------------

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

-------------------------------------------------------------
 - Calculation of θp -
-------------------------------------------------------------
From table 10-8: θp = 0.05045449
with:

- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.966
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00

---

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

---

## Calculation No. 15

column C1, Floor 1

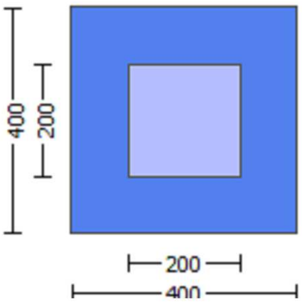
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

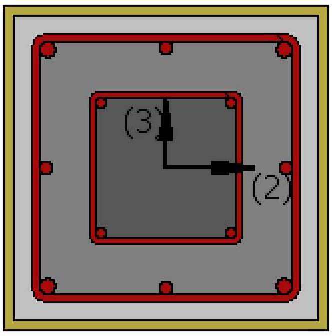
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##################################################################
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min = lb/ld >=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1

Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 1.6663953E-010
Shear Force, Va = -8.5161640E-014
EDGE -B-
Bending Moment, Mb = 8.8887759E-011
Shear Force, Vb = 8.5161640E-014
BOTH EDGES
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.80
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 585777.918
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 585777.918
VCol = 585777.918
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 = 8.8887759E-011
Vu = 8.5161640E-014
d = 0.8*h = 320.00
Nu = 5974.966
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 251327.412
where:
Vs1 = 251327.412 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,

as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 425154.451
bw = 400.00
----------------------------------------------------------------

----------------------------------------------------------------
displacement_ductility_demand is calculated as θ/θy

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)
----------------------------------------------------------------
From analysis, chord rotation θ = 3.4905038E-023
θy = (My*Ls/3)/EIeff = 0.00653235 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
----------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00796398
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ'' = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444
ξy = 0.27975148
A = 0.01865339

B = 0.01050082
with Es = 200000.00
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
---------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

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

## Calculation No. 16

column C1, Floor 1

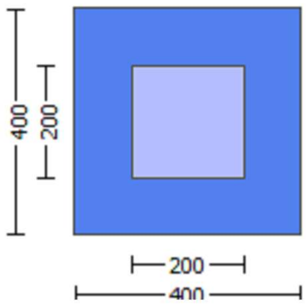
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

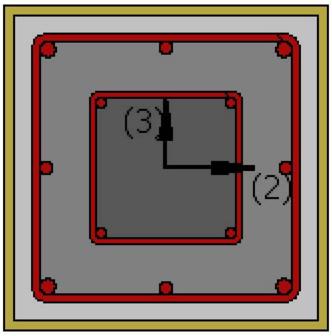
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)




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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = 5.2204734E-032
EDGE -B-
Shear Force, Vb = -5.2204734E-032
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 = Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

---------------------------------------------------------------------------
Calculation of Mu1+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

---------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
---------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
-------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333

b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
------------------------------------------------------------

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

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

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00

ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00

d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc  = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
------------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
------------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00

Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00

---

---

Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
knl = 1 (zero step-static loading)

---

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

---

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.9249344E-012
Vu = 5.2204734E-032
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:

d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 3

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

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

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 0.80
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
################################################################
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.13212
Element Length, L = 3000.00
Secondary Member

Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lo/lou,min>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi:  0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = -4.7900285E-031
EDGE -B-
Shear Force, Vb = 4.7900285E-031
BOTH EDGES
Axial Force, F = -5976.808
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.35962554
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 230997.004
with
Mpr1 =  Max(Mu1+ , Mu1-) = 3.4650E+008
Mu1+ = 3.4650E+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- = 3.4650E+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-) = 3.4650E+008
Mu2+ = 3.4650E+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- = 3.4650E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

--------------------------------------------------------------------------------
Calculation of Mu1+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831

N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45

fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture

δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
----------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
--------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
--------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00

psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
-------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
--------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
-----------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333

b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------

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

-------------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 0.00010712
Mu = 3.4650E+008
-------------------------------------------------------------------------------
with full section properties:
b = 400.00
d = 357.00
d' = 43.00
v = 0.00126831
N = 5976.808
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01506636
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01506636
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.08361288
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
----------------------------------------------------------------------
ωfx = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
ωfy = 0.07683125
af = 0.57333333
b = 400.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00508
bw = 400.00
effective stress from (A.35), ff,e = 870.5244
----------------------------------------------------------------------
R = 40.00
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
fu,f = 1055.00
Ef = 64828.00
εu,f = 0.015
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.24250288
ase1 = 0.24250288
bo_1 = 340.00
ho_1 = 340.00
Σbi2_1 = 462400.00
ase2 = Max(ase1,ase2) = 0.24250288
bo_2 = 192.00
ho_2 = 192.00
Σbi2_2 = 147456.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 3.07617
Expression ((5.4d), TBDY) for psh,min*Fywe has been miltiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)
----------------------------------------------------------------------
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531

No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.07617
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00050265
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----------------------------------------------------------------------
Asec = 160000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00332119
λc = confinement factor = 1.13212
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) = 0.16759354
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.16759354
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.05925959
and confined core properties:
b = 340.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 37.35991
εcc (5A.5, TBDY) = 0.00332119
λc = confinement factor = 1.13212
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.21525776
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.21525776
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.07611324
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16321971
Mu = MRc (4.14) = 3.4650E+008
φu = φsu (4.1) = 0.00010712
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Adequate Lap Length: lb/ld >= 1
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 642326.47
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 642326.47
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00

s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440
with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
---------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 642326.47
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 642326.47
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 = 1.3318154E-012
Vu = 4.7900285E-031
d = 0.8*h = 320.00
Nu = 5976.808
Ag = 160000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 279254.914
where:
Vs1 = 279254.914 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.3125
Vs2 = 0.00 is calculated for core, with:
d = 160.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 0.00
s/d = 1.5625
Vf ((11-3)-(11.4), ACI 440) = 188111.148
ψf = 0.95, for fully-wrapped sections
wf/sf = 1 (FRP strips adjacent to one another).
In (11.3) sinα + cosα is replaced with (cotθ+cota)sina which is more a generalised expression,
where θ is the angle of the crack direction (see KANEPE).
This later relation, considered as a function Vf(θ,α), is implemented for every different fiber orientation ai,
as well as for 2 crack directions, θ=45° and θ=-45° to take into consideration the cyclic seismic loading.
orientation 1: α1 = b1 + 90° = 90.00
Vf = Min(|Vf(45,α1)|,|Vf(-45,a1)|), with:
total thickness per orientation, tf1 = NL*t/NoDir = 1.016
dfv = d (figure 11.2, ACI 440) = 357.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
εfe = 0.004, from (11.6a), ACI 440

with εfu = 0.01
From (11-11), ACI 440: Vs + Vf <= 488465.275
bw = 400.00
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column JC1 of floor 1
At local axis: 2

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

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

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 0.80
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 400.00
Internal Height, H = 200.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Adequate Lap Length (lb/ld>=1)
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
Bending Moment, M = 0.00652766
Shear Force, V2 = 4601.921
Shear Force, V3 = 8.5161640E-014
Axial Force, F = -5974.966
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 2676.637
Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: Asl,ten = 1137.257
-Compression: Asl,com = 1137.257
-Middle: Asl,mid = 402.1239
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 = 307.8761
-Compression: Asl,com,core = 307.8761
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.80
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05176096
θu = θy + θp = 0.05176096

-------------------------------------------------------------
- Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00130647 ((4.29),Biskinis Phd))
My = 2.2575E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.7280E+013
factor = 0.30
Ag = 160000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 5974.966
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 5.7599E+013
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Yielding Moment My
-------------------------------------------------------------
Calculation of Φy and My according to Annex 7A - ΚΑΝΕΠΕ
-------------------------------------------------------------
Φy = Min(Φy_ten,Φy_com)
Φy_ten = 1.0810813E-005
with fy = 555.56
d = 357.00
ξy = 0.28026208
A = 0.01881927
B = 0.01057613
with pt = 0.00680078
pc = 0.00796398
pv = 0.00281599
N = 5974.966
b = 400.00
δ" = 0.12044818
Φy_comp = 2.3130538E-005
with fc* (12.3, (ACI 440)) = 34.65043
fc = 33.00
fl = 0.93147527
b = 400.00
h = 400.00
Ag = 160000.00
From (12.9), ACI 440: ka = 0.56518315
ρg = pt + pc + pv = 0.01874396
rc = 40.00
Ae/Ac = 0.56518315
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
effective strain from (12.5) and (12.12), efe = 0.004
εfu = 0.01
Ef = 64828.00
Ec = 26999.444

$\xi y$ = 0.27975148
A = 0.01865339
B = 0.01050082
with Es = 200000.00
-----------------------------------------------------------------

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

-----------------------------------------------------------------
- Calculation of θp -
-----------------------------------------------------------------
From table 10-8: θp = 0.05045449
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.35962554
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00680078
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 400.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00050265
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 200.00
s2 = 250.00
The term 2*tf/bw*(ffe/fs) is implemented to account for FRP contribution
where ρf = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises ρf to steel strength
All these variables have already been given in Shear control ratio calculation.
For the normalisation fs of jacket is used.
NUD = 5974.966
Ag = 160000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*Area_ext_Trans_Reinf+fy_int_Trans_Reinf*Area_int_Trans_Reinf)/Area_Tot_Trans_Rein = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01874396
b = 400.00
d = 357.00
f'cE = 33.00
-----------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column JC1 of floor 1
At local axis: 3
Integration Section: (b)

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