Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

column C1, Floor 1

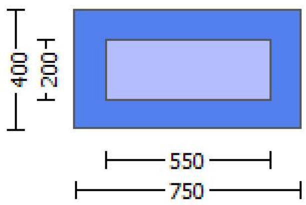
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

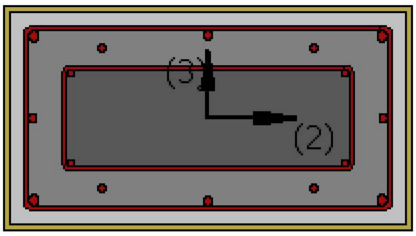
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00

Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = -1.1557E+007
Shear Force, Va = -3329.889
EDGE -B-
Bending Moment, Mb = 1.5598E+006
Shear Force, Vb = 3329.889
BOTH EDGES
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 948716.502
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 948716.502

VCol = 948716.502
knl = 1.00
displacement_ductility_demand = 0.01748594

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 = 1.1557E+007
Vu = 3329.889
d = 0.8*h = 600.00
Nu = 15599.353
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 559706.147
where:
Vs1 = 471238.898 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 88467.249 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 797164.595
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 = 5.7479514E-005
θy = (My*Ls/3)/EIeff = 0.00328719 ((4.29),Biskinis Phd))
My = 3.2365E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3470.659
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8638188E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.2314711
A = 0.01181936
B = 0.00635234
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 15599.353
b = 400.00
δ" = 0.06082037
Φy_comp = 1.3708970E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22894859
A = 0.01151782
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 2

column C1, Floor 1

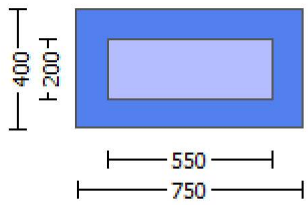
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

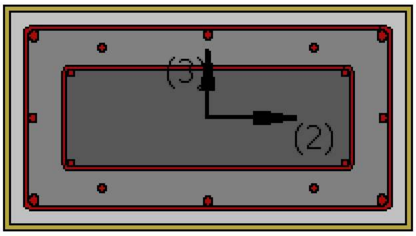
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888

λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933

bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030

EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167

fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----

with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888

λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00

Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814

ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008

φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006

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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = 5.3474414E-010
Shear Force, V2 = -3329.889
Shear Force, V3 = -1.2056938E-013
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0024982
θu = θy + θp = 0.0024982

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.0024982 ((4.29),Biskinis Phd))

My = 1.6188E+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 = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7673866E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24425049
A = 0.01248371
B = 0.00707601
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 15599.353
b = 750.00
δ" = 0.12044818
Φy_comp = 2.5704181E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.2418176
A = 0.01216523
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.18775615
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00362708
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.0020944
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) = 0.00026808
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 = 15599.353
Ag = 300000.00
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*ps1+fy_int_Trans_Reinf*ps2)/(ps1+ps2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.0122965
b = 750.00
d = 357.00
f'cE = 33.00

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

Calculation No. 3

column C1, Floor 1

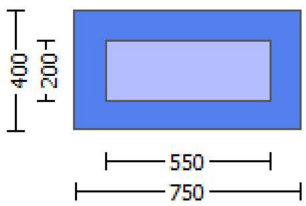
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

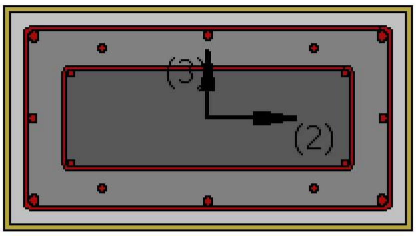
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = 5.3474414E-010
Shear Force, Va = -1.2056938E-013
EDGE -B-
Bending Moment, Mb = -1.7170468E-010
Shear Force, Vb = 1.2056938E-013
BOTH EDGES
Axial Force, F = -15599.353

Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 733136.818
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 733136.818
VCol = 733136.818
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 = 5.3474414E-010
Vu = 1.2056938E-013
d = 0.8*h = 320.00
Nu = 15599.353
Ag = 300000.00
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 <= 797164.595
bw = 750.00

----
displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 1.0392954E-020
θy = (My*Ls/3)/EIeff = 0.0024982 ((4.29),Biskinis Phd))
My = 1.6188E+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 = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7673866E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24425049
A = 0.01248371
B = 0.00707601
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 15599.353
b = 750.00
δ'' = 0.12044818
Φy_comp = 2.5704181E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.2418176
A = 0.01216523
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 4

column C1, Floor 1

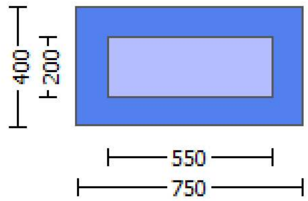
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

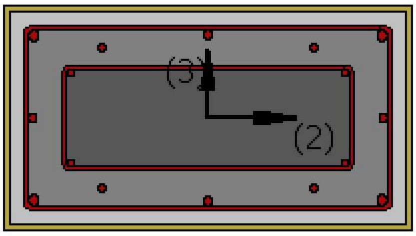
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00

Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008

----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833

εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00

ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044

εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254

Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062

ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933

bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*ρf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), ρf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
From EC8 A4.4.3(6), ρf = 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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008

----

with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00

d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = -1.1557E+007
Shear Force, V2 = -3329.889
Shear Force, V3 = -1.2056938E-013
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00328719
θu = θy + θp = 0.00328719

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00328719 ((4.29),Biskinis Phd))
My = 3.2365E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3470.659
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8638188E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.2314711
A = 0.01181936
B = 0.00635234
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 15599.353
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3708970E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22894859
A = 0.01151782
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.24663717
d = d_external = 707.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00703535
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 750.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00073723
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 550.00
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 = 15599.353
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01164211
b = 400.00
d = 707.00
f'cE = 33.00

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

Calculation No. 5

column C1, Floor 1

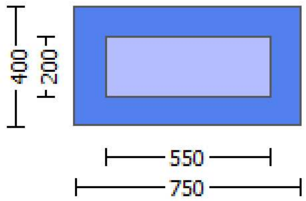
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

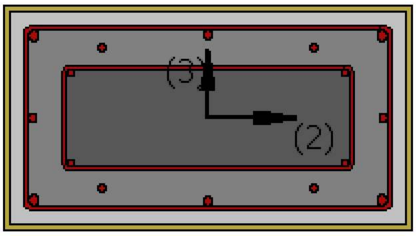
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = -1.1557E+007
Shear Force, Va = -3329.889
EDGE -B-
Bending Moment, Mb = 1.5598E+006
Shear Force, Vb = 3329.889
BOTH EDGES
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.1003E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.1003E+006
VCol = 1.1003E+006
knl = 1.00
displacement_ductility_demand = 0.04311998

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 = 1.5598E+006
Vu = 3329.889
d = 0.8*h = 600.00
Nu = 15599.353
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 559706.147
where:
Vs1 = 471238.898 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 88467.249 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 797164.595
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 = 1.9130925E-005
θy = (My*Ls/3)/Eleff = 0.00044367 ((4.29),Biskinis Phd))
My = 3.2365E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 468.4306
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8638188E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.2314711
A = 0.01181936
B = 0.00635234
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 15599.353
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3708970E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22894859
A = 0.01151782

B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 6

column C1, Floor 1

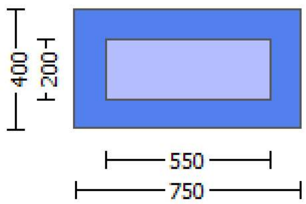
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

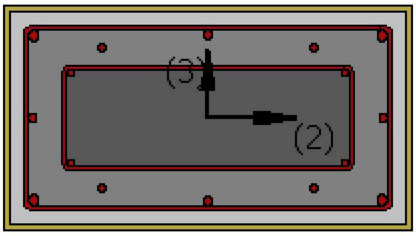
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





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

Constant Properties

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

Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment

direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065

af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:

b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00

Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00

v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00

Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814

ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036

af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00

Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = -1.7170468E-010
Shear Force, V2 = 3329.889
Shear Force, V3 = 1.2056938E-013
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389

Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0024982
θu = θy + θp = 0.0024982

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.0024982 ((4.29),Biskinis Phd))
My = 1.6188E+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 = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7673866E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24425049
A = 0.01248371
B = 0.00707601
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 15599.353
b = 750.00
δ'' = 0.12044818
Φy_comp = 2.5704181E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.2418176
A = 0.01216523
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.18775615
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00362708
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.0020944
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) = 0.00026808
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 = 15599.353
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.0122965
b = 750.00
d = 357.00
f'cE = 33.00

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

Calculation No. 7

column C1, Floor 1

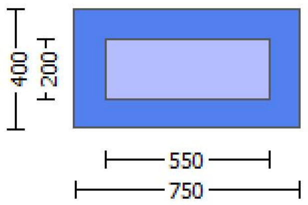
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

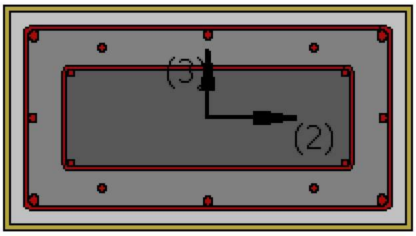
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member

Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = 5.3474414E-010
Shear Force, Va = -1.2056938E-013
EDGE -B-
Bending Moment, Mb = -1.7170468E-010
Shear Force, Vb = 1.2056938E-013
BOTH EDGES
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 733136.818
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 733136.818
VCol = 733136.818
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 = 1.7170468E-010
Vu = 1.2056938E-013
d = 0.8*h = 320.00
Nu = 15599.353
Ag = 300000.00
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 <= 797164.595
bw = 750.00

----
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 = 4.1109882E-021
θy = (My*Ls/3)/EIeff = 0.0024982 ((4.29),Biskinis Phd))
My = 1.6188E+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 = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7673866E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24425049
A = 0.01248371
B = 0.00707601
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 15599.353
b = 750.00
δ'' = 0.12044818
Φy_comp = 2.5704181E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00

h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.2418176
A = 0.01216523
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 8

column C1, Floor 1

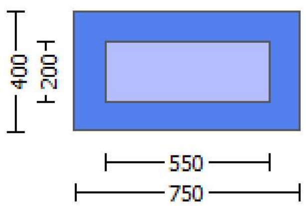
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

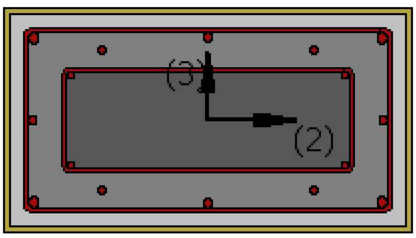
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





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

(Bending local axis: 2)
Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133

-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00

ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044

εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254

Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062

ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered

characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013

Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

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

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00

d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038

bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694

where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182

Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = 1.5598E+006
Shear Force, V2 = 3329.889
Shear Force, V3 = 1.2056938E-013
Axial Force, F = -15599.353
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00044367
θu = θy + θp = 0.00044367

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00044367 ((4.29),Biskinis Phd))
My = 3.2365E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 468.4306
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 15599.353
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8638188E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.2314711
A = 0.01181936
B = 0.00635234
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 15599.353
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3708970E-005
with fc* (12.3, (ACI 440)) = 33.28469

fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22894859
A = 0.01151782
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.00
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.24663717
d = d_external = 707.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00703535
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 750.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00073723
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 550.00
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 = 15599.353
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01164211
b = 400.00
d = 707.00
f'cE = 33.00

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

Calculation No. 9

column C1, Floor 1

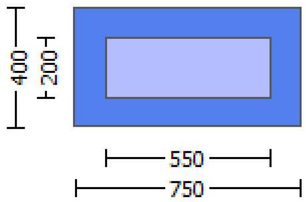
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

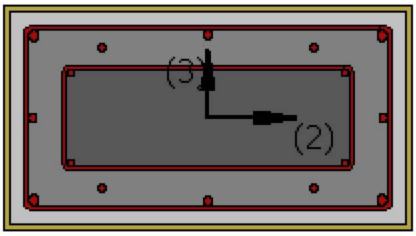
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00

New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = -7.3927E+006
Shear Force, Va = -2130.057
EDGE -B-
Bending Moment, Mb = 997783.867
Shear Force, Vb = 2130.057
BOTH EDGES
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 948554.766
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 948554.766
VCol = 948554.766
knl = 1.00
displacement_ductility_demand = 0.01120223

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 = 7.3927E+006
Vu = 2130.057
d = 0.8*h = 600.00
Nu = 13966.133
Ag = 300000.00

From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 559706.147
where:
Vs1 = 471238.898 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 88467.249 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 797164.595
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 = 3.6768391E-005
θy = (My*Ls/3)/EIeff = 0.00328224 ((4.29),Biskinis Phd))
My = 3.2316E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3470.659
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8625842E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.23113964
A = 0.0118008
B = 0.00633378
with pt = 0.00511009
pc = 0.00511009

ρv = 0.00142194
N = 13966.133
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3713175E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = ρt + ρc + ρv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22887838
A = 0.01153083
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 10

column C1, Floor 1

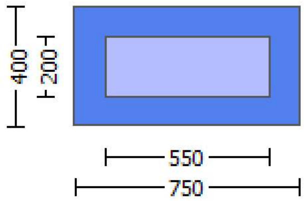
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

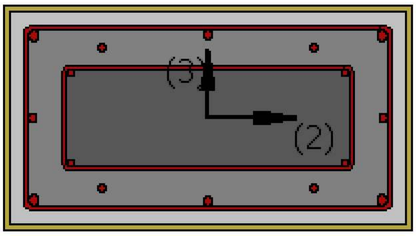
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----

Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008

----

with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered

characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699

Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524

```
   ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
   b = 690.00
   d = 327.00
   d' = 13.00
   fcc (5A.2, TBDY) = 34.2833
   εcc (5A.5, TBDY) = 0.00238888
      λc  = confinement factor = 1.03889
   ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
   ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
   ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----------------------------------------------------------------------------
with full section properties:
   b = 750.00
   d = 357.00
   d' = 43.00
   v = 0.00125249
      N = 11066.684
   fc = 33.00
   εco (5A.5, TBDY) = 0.002
   Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
      The Shear_factor is considered equal to 1 (pure moment strength)
      From (5.4b), TBDY: εcu = 0.01055215
      ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
      where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
      --------------------------------------------------------------------
      ωfx = 0.0292036
         af = 0.38744444
            b = 750.00
            h = 400.00
         From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
            bw = 750.00
         effective stress from (A.35), ff,e = 918.0757
      --------------------------------------------------------------------
      ωfy = 0.05192065
         af = 0.38744444
            b = 400.00
            h = 750.00
         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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00

v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
  VCol0 = 804840.539
  knl = 1 (zero step-static loading)

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

  λ = 1 (normal-weight concrete)
  Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
  M/Vd = 2.00
    Mu = 4.5539906E-013
    Vu = 8.2514216E-031
  d = 0.8*h = 320.00
  Nu = 11066.684
  Ag = 300000.00
  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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038

bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139

εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444

b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006

Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684

Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00

Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = 3.4222825E-010
Shear Force, V2 = -2130.057
Shear Force, V3 = -7.7125599E-014
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02600675
θu = θy + θp = 0.02600675

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00249427 ((4.29),Biskinis Phd))
My = 1.6163E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7648986E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24392432
A = 0.01246411
B = 0.0070564
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 13966.133
b = 750.00
δ'' = 0.12044818
Φy_comp = 2.5712066E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.24174344
A = 0.01217897
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.02351248
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.18775615
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00362708
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.0020944
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) = 0.00026808
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 = 13966.133
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00

fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
ρl = Area_Tot_Long_Rein/(b*d) = 0.0122965
b = 750.00
d = 357.00
f'cE = 33.00

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

Calculation No. 11

column C1, Floor 1

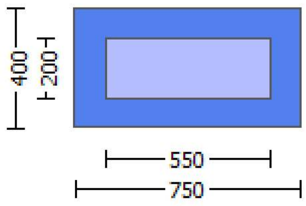
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

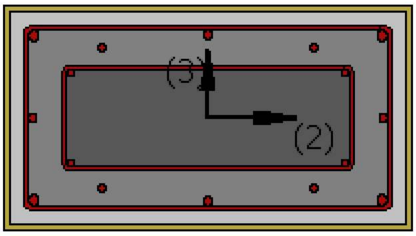
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00

New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = 3.4222825E-010
Shear Force, Va = -7.7125599E-014
EDGE -B-
Bending Moment, Mb = -1.0999983E-010
Shear Force, Vb = 7.7125599E-014
BOTH EDGES
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 732813.346

Vn ((10.3), ASCE 41-17) = knl*VCol0 = 732813.346
VCol = 732813.346
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 = 3.4222825E-010
Vu = 7.7125599E-014
d = 0.8*h = 320.00
Nu = 13966.133
Ag = 300000.00
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 <= 797164.595
bw = 750.00

----
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 = 6.6481460E-021
θy = (My*Ls/3)/Eleff = 0.00249427 ((4.29),Biskinis Phd))
My = 1.6163E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133

Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7648986E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24392432
A = 0.01246411
B = 0.0070564
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 13966.133
b = 750.00
δ" = 0.12044818
Φy_comp = 2.5712066E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.24174344
A = 0.01217897
B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 12

column C1, Floor 1

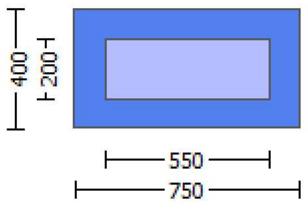
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

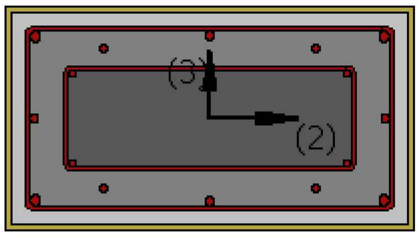
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002

Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888

λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933

bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030

EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167

fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----

with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888

λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00

Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215

ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814

ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008

φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006

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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket

New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = -7.3927E+006
Shear Force, V2 = -2130.057
Shear Force, V3 = -7.7125599E-014
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03328224
θu = θy + θp = 0.03328224

- Calculation of θy -

θy = (My*Ls/3)/Eleff = 0.00328224 ((4.29),Biskinis Phd))

My = 3.2316E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3470.659
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8625842E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.23113964
A = 0.0118008
B = 0.00633378
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 13966.133
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3713175E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22887838
A = 0.01153083
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.03
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.24663717
d = d_external = 707.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00703535
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction

h1 = 750.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00073723
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 550.00
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 = 13966.133
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01164211
b = 400.00
d = 707.00
f'cE = 33.00

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

Calculation No. 13

column C1, Floor 1

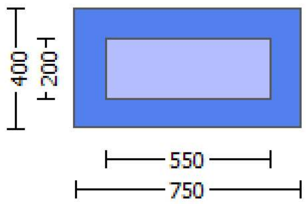
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

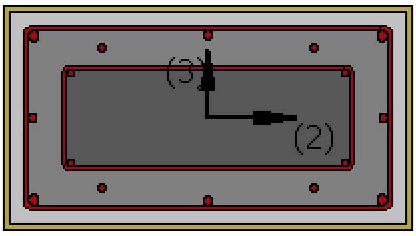
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = -7.3927E+006
Shear Force, Va = -2130.057
EDGE -B-
Bending Moment, Mb = 997783.867
Shear Force, Vb = 2130.057
BOTH EDGES
Axial Force, F = -13966.133

Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 1.0999E+006
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 1.0999E+006
VCol = 1.0999E+006
knl = 1.00
displacement_ductility_demand = 0.02762447

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 = 997783.867
Vu = 2130.057
d = 0.8*h = 600.00
Nu = 13966.133
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 559706.147
where:
Vs1 = 471238.898 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 500.00
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 88467.249 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 500.00
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 797164.595
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 = 1.2237635E-005
θy = (My*Ls/3)/EIeff = 0.000443 ((4.29),Biskinis Phd))
My = 3.2316E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 468.4306
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8625842E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.23113964
A = 0.0118008
B = 0.00633378
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 13966.133
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3713175E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22887838
A = 0.01153083
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 14

column C1, Floor 1

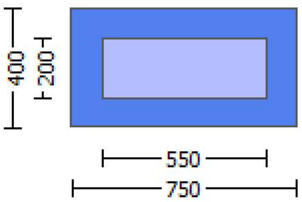
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

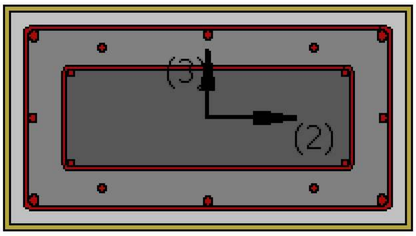
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)





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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00

Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008

----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00

h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833

εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00

ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044

εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254

Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062

ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933

bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00

d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00

s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016

ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Section Type: rcjrs

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = -1.0999983E-010
Shear Force, V2 = 2130.057
Shear Force, V3 = 7.7125599E-014
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.02600675
θu = θy + θp = 0.02600675

 - Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.00249427 ((4.29),Biskinis Phd))
  My = 1.6163E+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 = 3.2399E+013
    factor = 0.30
      Ag = 300000.00
      Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
      N = 13966.133
    Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7648986E-006
 with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
    d = 357.00
    ξy = 0.24392432
    A = 0.01246411
    B = 0.0070564
    with pt = 0.00539732
      pc = 0.00539732
      pv = 0.00150186
      N = 13966.133
      b = 750.00
      δ'' = 0.12044818
Φy_comp = 2.5712066E-005
 with fc* (12.3, (ACI 440)) = 33.28451
    fc = 33.00
    fl = 0.61990822
    b = 750.00
    h = 400.00
    Ag = 300000.00
    From (12.9), ACI 440: ka = 0.14639905
      ρg = pt + pc + pv = 0.0122965
      rc = 40.00
      Ae/Ac = 0.51468416
      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 = 0.24174344
    A = 0.01217897
    B = 0.0068888
    with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

 - Calculation of θp -

From table 10-8: θp = 0.02351248
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.18775615
d = d_external = 357.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00362708
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.0020944
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) = 0.00026808
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 = 13966.133
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.0122965
b = 750.00
d = 357.00
f'cE = 33.00

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

Calculation No. 15

column C1, Floor 1

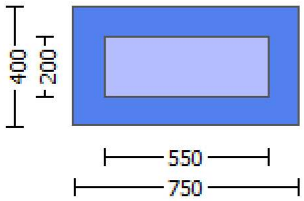
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

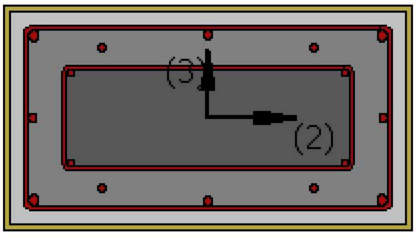
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)





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

Constant Properties

Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fc_lower_bound = 25.00
New material of Secondary Member: Steel Strength, fs = fs_lower_bound = 500.00
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of θy for displacement ductility demand,
the expected (mean value) strengths are used (7.5.1.3, ASCE 41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE 41-17).
Jacket
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
Existing Column
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min =lb/ld = 0.30
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 = 3.4222825E-010
Shear Force, Va = -7.7125599E-014
EDGE -B-
Bending Moment, Mb = -1.0999983E-010
Shear Force, Vb = 7.7125599E-014
BOTH EDGES
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Mean Diameter of Tension Reinforcement, DbL,ten = 16.00

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 732813.346
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 732813.346
VCol = 732813.346
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 = 1.0999983E-010
Vu = 7.7125599E-014
d = 0.8*h = 320.00
Nu = 13966.133
Ag = 300000.00
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 <= 797164.595
bw = 750.00

----
displacement_ductility_demand is calculated as θ/θy

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

From analysis, chord rotation θ = 2.6297094E-021
θy = (My*Ls/3)/Eleff = 0.00249427 ((4.29),Biskinis Phd))
My = 1.6163E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 3.2399E+013
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 1.0800E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 5.7648986E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 357.00
ξy = 0.24392432
A = 0.01246411
B = 0.0070564
with pt = 0.00539732
pc = 0.00539732
pv = 0.00150186
N = 13966.133
b = 750.00
δ'' = 0.12044818
Φy_comp = 2.5712066E-005
with fc* (12.3, (ACI 440)) = 33.28451
fc = 33.00
fl = 0.61990822
b = 750.00
h = 400.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14639905
ρg = pt + pc + pv = 0.0122965
rc = 40.00
Ae/Ac = 0.51468416
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 = 0.24174344
A = 0.01217897

B = 0.0068888
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

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

Calculation No. 16

column C1, Floor 1

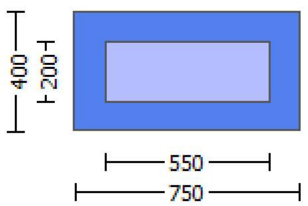
Limit State: Life Safety (data interpolation between analysis steps 1 and 2)

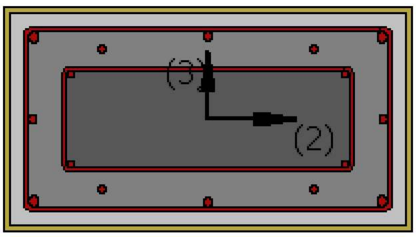
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)





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

Constant Properties

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

Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
##
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
##
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 8.2514216E-031
EDGE -B-
Shear Force, Vb = -8.2514216E-031
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.18775615
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 151113.764
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2667E+008
Mu1+ = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 2.2667E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment

direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2667E+008
Mu2+ = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 2.2667E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796

No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065

af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00

h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:

b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 1.7449757E-005
Mu = 2.2667E+008
----
with full section properties:
b = 750.00
d = 357.00
d' = 43.00
v = 0.00125249
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*psh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30

εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06362524
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06362524
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01770442
and confined core properties:
b = 690.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07550263
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07550263
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02100943
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.17811254
Mu = MRc (4.14) = 2.2667E+008
φu = φsu (4.1) = 1.7449757E-005

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 804840.539

Calculation of Shear Strength at edge 1, Vr1 = 804840.539
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

Calculation of Shear Strength at edge 2, Vr2 = 804840.539
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 804840.539
knl = 1 (zero step-static loading)

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

λ = 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.5539906E-013
Vu = 8.2514216E-031
d = 0.8*h = 320.00
Nu = 11066.684
Ag = 300000.00
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 <= 915872.391
bw = 750.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
###
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 694.45
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 694.45
###
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.03889
Element Length, L = 3000.00

Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lo/lou,min = 0.30
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 = 1.9721523E-030
EDGE -B-
Shear Force, Vb = -1.9721523E-030
BOTH EDGES
Axial Force, F = -11066.684
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239

Calculation of Shear Capacity ratio , Ve/Vr = 0.24663717
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 311441.684
with
Mpr1 = Max(Mu1+ , Mu1-) = 4.6716E+008
Mu1+ = 4.6716E+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- = 4.6716E+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-) = 4.6716E+008
Mu2+ = 4.6716E+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- = 4.6716E+008, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

----
Calculation of Mu1+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00

v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00

fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413

Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu1-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00

Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814

ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2+

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036

af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Mu2-

Calculation of ultimate curvature φu according to 4.1, Biskinis/Fardis 2013:
φu = 8.6604793E-006
Mu = 4.6716E+008
----
with full section properties:
b = 400.00
d = 707.00
d' = 43.00
v = 0.00118583
N = 11066.684
fc = 33.00
εco (5A.5, TBDY) = 0.002
Final value of εcu: εcu* = shear_factor * Max(εcu,εcc) = 0.01055215
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: εcu = 0.01055215
ωwe ((5.4c), TBDY) = ase*ρsh,min*fywe/fce+Min(ωfx, ωfy) = 0.03108301
where ωf = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

ωfx = 0.0292036
af = 0.38744444
b = 750.00
h = 400.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.00270933
bw = 750.00
effective stress from (A.35), ff,e = 918.0757

ωfy = 0.05192065
af = 0.38744444
b = 400.00
h = 750.00
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 = 0.12601038
ase1 = 0.12601038
bo_1 = 690.00
ho_1 = 340.00
Σbi2_1 = 1.1834E+006
ase2 = Max(ase1,ase2) = 0.12601038
bo_2 = 542.00
ho_2 = 192.00
Σbi2_2 = 661256.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.64062
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 = 1.64062
ps1 (external) = (Ash1*h1/s1)/Asec = 0.0020944
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00026808

Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 3.23907
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00392699
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 750.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00073723
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 550.00

Asec = 300000.00
s1 = 100.00
s2 = 250.00
fywe1 = 694.45
fywe2 = 694.45
fce = 33.00
From ((5.A5), TBDY), TBDY: εcc = 0.00238888
λc = confinement factor = 1.03889
εy1 = 0.00140044
εsh1 = 0.0044814
ft1 = 466.8167
fy1 = 389.0139
εsu1 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsu1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and εy1,εsh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
εy2 = 0.00140044
εsh2 = 0.0044814
ft2 = 466.8167
fy2 = 389.0139
εsu2 = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.30
εsu2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and εy2,εsh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
εyv = 0.00140044
εshv = 0.0044814
ftv = 466.8167
fyv = 389.0139
εsuv = 0.00512
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.30
εsuv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and εyv,εshv,ftv,fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
εy1,εsh1,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 = 389.0139
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.06023925
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.06023925
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.01676222
and confined core properties:
b = 340.00
d = 677.00
d' = 13.00
fcc (5A.2, TBDY) = 34.2833
εcc (5A.5, TBDY) = 0.00238888
λc = confinement factor = 1.03889
ω1 = Asl,ten/(b*d)*(fs1/fc) = 0.07401016
ω2 = Asl,com/(b*d)*(fs2/fc) = 0.07401016
ωv = Asl,mid/(b*d)*(fsv/fc) = 0.02059413
Case/Assumption: Unconfinesd full section - Steel rupture
δ' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
ξsu (4.9) = 0.16380297
Mu = MRc (4.14) = 4.6716E+008
φu = φsu (4.1) = 8.6604793E-006

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 1.2628E+006

Calculation of Shear Strength at edge 1, Vr1 = 1.2628E+006
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00

Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

Calculation of Shear Strength at edge 2, Vr2 = 1.2628E+006
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 1.2628E+006
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 = 1.0300657E-011
Vu = 1.9721523E-030
d = 0.8*h = 600.00
Nu = 11066.684
Ag = 300000.00
From (11.5.4.8), ACI 318-14: Vs = Vs1 + Vs2 = 621900.694
where:
Vs1 = 523602.964 is calculated for jacket, with:
d = 600.00
Av = 157079.633
fy = 555.56
s = 100.00
Vs1 is multiplied by αCol1 = 1.00
s/d = 0.16666667
Vs2 = 98297.73 is calculated for core, with:
d = 440.00
Av = 100530.965
fy = 555.56
s = 250.00
Vs2 is multiplied by αCol2 = 1.00
s/d = 0.56818182
Vf ((11-3)-(11.4), ACI 440) = 372533.843
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) = 707.00
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 <= 915872.391
bw = 400.00

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

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

Constant Properties

Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
Existing Column
New material of Secondary Member: Concrete Strength, fc = fcm = 33.00
New material of Secondary Member: Steel Strength, fs = fsm = 555.56
Concrete Elasticity, Ec = 26999.444
Steel Elasticity, Es = 200000.00
External Height, H = 400.00
External Width, W = 750.00
Internal Height, H = 200.00
Internal Width, W = 550.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Inadequate Lap Length with lb/ld = 0.30
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 = 997783.867
Shear Force, V2 = 2130.057
Shear Force, V3 = 7.7125599E-014
Axial Force, F = -13966.133
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3292.389

Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1445.133
-Compression: Asl,com = 1445.133
-Middle: Asl,mid = 402.1239
Longitudinal External Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,jacket = 1291.195
-Compression: Asl,com,jacket = 983.3185
-Middle: Asl,mid,jacket = 402.1239
Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten,core = 153.938
-Compression: Asl,com,core = 461.8141
-Middle: Asl,mid,core = 0.00
Mean Diameter of Tension Reinforcement, DbL = 16.00

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.030443
θu = θy + θp = 0.030443

- Calculation of θy -

θy = (My*Ls/3)/EIeff = 0.000443 ((4.29),Biskinis Phd))
My = 3.2316E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 468.4306
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.1390E+014
factor = 0.30
Ag = 300000.00
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 33.00
N = 13966.133
Ec*Ig = Ec_jacket*Ig_jacket + Ec_core*Ig_core = 3.7968E+014

Calculation of Yielding Moment My

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

Φy = Min(Φy_ten,Φy_com)
Φy_ten = 2.8625842E-006
with ((10.1), ASCE 41-17) fy = Min(fy, 1.25*fy*(lb/ld)^2/3) = 311.2112
d = 707.00
ξy = 0.23113964
A = 0.0118008
B = 0.00633378
with pt = 0.00511009
pc = 0.00511009
pv = 0.00142194
N = 13966.133
b = 400.00
δ'' = 0.06082037
Φy_comp = 1.3713175E-005
with fc* (12.3, (ACI 440)) = 33.28469
fc = 33.00
fl = 0.61990822
b = 400.00
h = 750.00
Ag = 300000.00
From (12.9), ACI 440: ka = 0.14649045
ρg = pt + pc + pv = 0.01164211
rc = 40.00
Ae/Ac = 0.51500549
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 = 0.22887838
A = 0.01153083
B = 0.00617509
with Es = 200000.00

Calculation of ratio lb/ld

Inadequate Lap Length with lb/ld = 0.30

- Calculation of θp -

From table 10-8: θp = 0.03
with:
- Columns controlled by inadequate development or splicing along the clear height because lb/ld < 1
shear control ratio VyE/VCol0E = 0.24663717
d = d_external = 707.00
s = s_external = 0.00
ρt = ρs1 + ρs2 + 2*tf/bw*(ffe/fs) = 0.00703535
jacket: ρs1 = Av1*h1/(s1*Ag) = 0.00392699
Av1 = 157.0796, is the total area of all stirrups parallel to loading (shear) direction
h1 = 750.00
s1 = 100.00
core: ρs2 = Av2*h2/(s2*Ag) = 0.00073723
Av2 = 100.531, is the total area of all stirrups parallel to loading (shear) direction
h2 = 550.00
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 = 13966.133
Ag = 300000.00
f'cE = (fc_jacket*Area_jacket+fc_core*Area_core)/section_area = 33.00
fylE = (fy_ext_Long_Reinf*Area_ext_Long_Reinf+fy_int_Long_Reinf*Area_int_Long_Reinf)/Area_Tot_Long_Rein = 555.56
fytE = (fy_ext_Trans_Reinf*ρs1+fy_int_Trans_Reinf*ρs2)/(ρs1+ρs2) = 555.56
pl = Area_Tot_Long_Rein/(b*d) = 0.01164211
b = 400.00
d = 707.00
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)
