# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

column C1, Floor 1

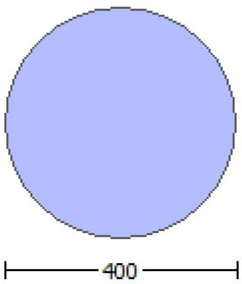
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

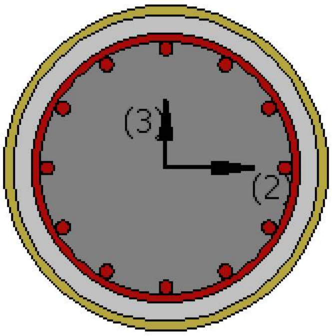
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.4289E+007
Shear Force, Va = -4761.318
EDGE -B-
Bending Moment, Mb = 0.07626496
Shear Force, Vb = 4761.318
BOTH EDGES
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 330216.711
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 330216.711
VCol = 330216.711
knl = 1.00
displacement_ductility_demand = 0.02275042
-----------------------------------------------------------------
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00
Mu = 1.4289E+007
Vu = 4761.318
d = 0.8*D = 320.00

Nu = 4769.328
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------

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

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)
----------------------------------------------------------------
From analysis, chord rotation θ = 0.00038437
θy = (My*Ls/3)/Eleff = 0.01689505 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.151
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
----------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274

with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00

---

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)

---

## Calculation No. 2

column C1, Floor 1

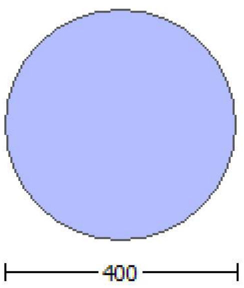
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

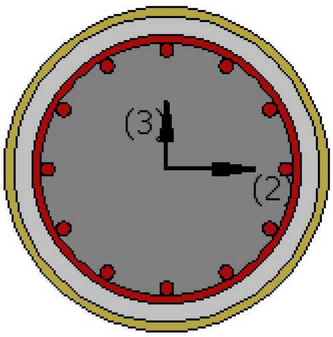
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties

---

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

Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

---

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

---

---

Calculation of Mu1-

---

---

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

---

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

---

---

Calculation of Mu2+

---

---

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

---

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

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

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

Calculation of Mu2-

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

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

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

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

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

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

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786

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

Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031

d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
---------------------------------------------------------------

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

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233

Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125

Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rccs

Constant Properties
----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 8.0591947E-010
Shear Force, V2 = -4761.318
Shear Force, V3 = -2.5218259E-013

Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00844428
θu = θy + θp = 0.00844428

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00844428 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

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

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

- Calculation of θp -

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

From table 10-9: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
  shear control ratio VyE/VCol0E = 0.27446066
  d = 0.00
  s = 0.00
  ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
  Av = 78.53982, is the area of the circular stirrup
  dc = D - 2*cover - Hoop Diameter = 340.00
  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.
    NUD = 4769.328
    Ag = 125663.706
    f'cE = 33.00
    fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
    f'cE = 33.00

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

End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)

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

## Calculation No. 3

column C1, Floor 1

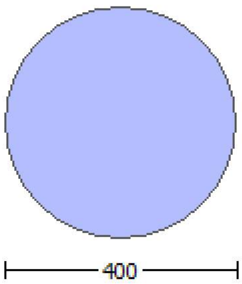
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

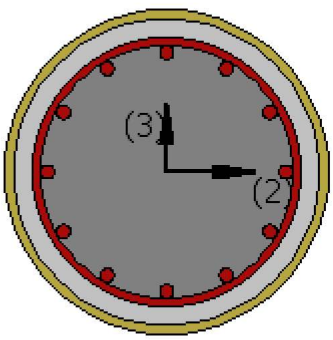
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1

At local axis: 3
Integration Section: (a)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 8.0591947E-010
Shear Force, Va = -2.5218259E-013
EDGE -B-
Bending Moment, Mb = -4.9031316E-011
Shear Force, Vb = 2.5218259E-013
BOTH EDGES
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393301.001
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393301.001

VCol = 393301.001
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 8.0591947E-010
Vu = 2.5218259E-013
d = 0.8*D = 320.00
Nu = 4769.328
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------

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

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 2.3857092E-020
θy = (My*Ls/3)/Eleff = 0.00844428 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729

error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)

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

## Calculation No. 4

column C1, Floor 1

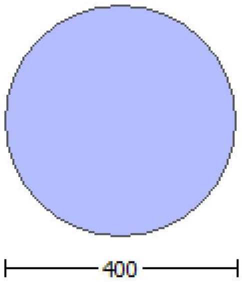
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

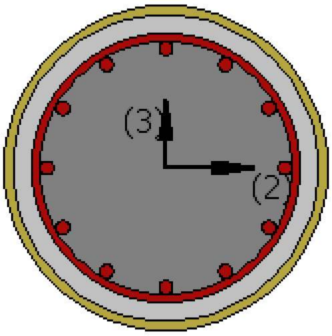
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406

fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233

Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-----------------------------------------------------------------
-----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

Calculation of ratio lb/ld

---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00

Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.4289E+007
Shear Force, V2 = -4761.318
Shear Force, V3 = -2.5218259E-013
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01689505
θu = θy + θp = 0.01689505

-------------------------------------------------------------
- Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.01689505 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.151
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Yielding Moment My
-------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
-------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541

with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00

---

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

- Calculation of θp -

---

From table 10-9: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4769.328
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00

---

End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)

---

## Calculation No. 5

column C1, Floor 1

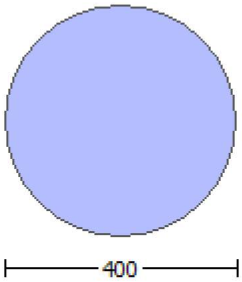
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

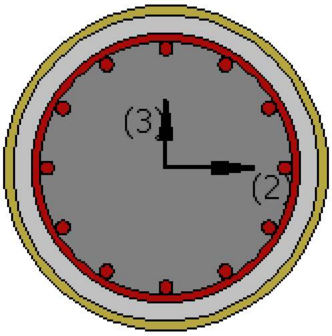
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.4289E+007
Shear Force, Va = -4761.318
EDGE -B-
Bending Moment, Mb = 0.07626496
Shear Force, Vb = 4761.318
BOTH EDGES
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393301.001
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393301.001
VCol = 393301.001
knl = 1.00
displacement_ductility_demand = 0.12467619
-----------------------------------------------------------------
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 0.07626496
Vu = 4761.318
d = 0.8*D = 320.00
Nu = 4769.328
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772

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

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

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00021056
θy = (My*Ls/3)/EIeff = 0.00168886 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)

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

## Calculation No. 6

column C1, Floor 1

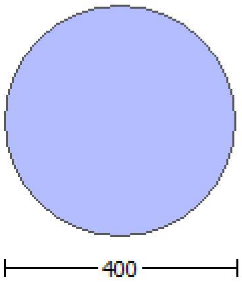
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

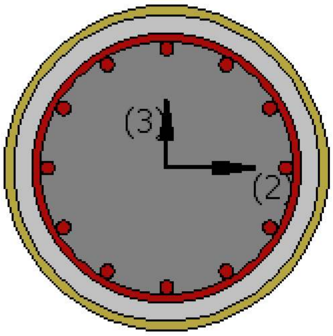
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties

----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

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

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

Calculation of Mu1-

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

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

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

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

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

Calculation of Mu2+

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

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

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

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

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

Calculation of Mu2-

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

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
##############################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00

From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56

s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---

---

Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---

---

End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

---

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -4.9031316E-011
Shear Force, V2 = 4761.318
Shear Force, V3 = 2.5218259E-013
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00844428
θu = θy + θp = 0.00844428

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/Eleff = 0.00844428 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.0179E+013

factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

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

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-9: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4769.328
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
---------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1

At local axis: 2
Integration Section: (b)

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

## Calculation No. 7

column C1, Floor 1

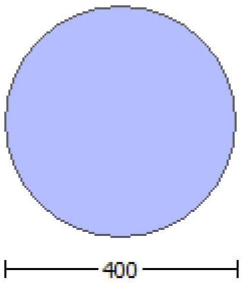
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

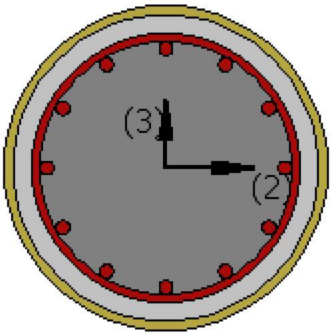
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rccs

Constant Properties
-----------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 8.0591947E-010
Shear Force, Va = -2.5218259E-013
EDGE -B-
Bending Moment, Mb = -4.9031316E-011
Shear Force, Vb = 2.5218259E-013
BOTH EDGES
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393301.001
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393301.001
VCol = 393301.001
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.9031316E-011
Vu = 2.5218259E-013
d = 0.8*D = 320.00
Nu = 4769.328
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------

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

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)
---------------------------------------------------------------
From analysis, chord rotation θ = 1.2586936E-020
θy = (My*Ls/3)/EIeff = 0.00844428 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)

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

## Calculation No. 8

column C1, Floor 1

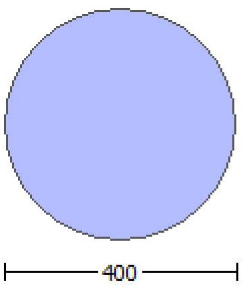
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

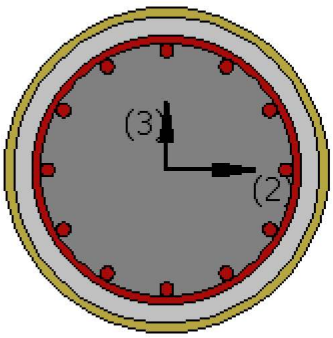
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################

Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------------
φ = 0.90757121

φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu1-
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

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

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00

v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134

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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2

(Bending local axis: 3)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Mu1-
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
---------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rccs

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 0.07626496
Shear Force, V2 = 4761.318
Shear Force, V3 = 2.5218259E-013
Axial Force, F = -4769.328
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
-------------------------------------------------------------

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

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00168886
θu = θy + θp = 0.00168886

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00168886 ((4.29),Biskinis Phd))
My = 1.7190E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4769.328
Ec*Ig = 3.3929E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
----------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7190E+008
Φy = 8.8237314E-006
My_ten (8c) = 1.7190E+008
Φ_ten (7c) = 67.12729
error of function (7c) = 0.00132754
My_com (8d) = 4.6746E+008
Φ_com (7d) = 67.1564
error of function (7d) = -0.00265541
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00102217
N = 4769.328
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
----------------------------------------------------------------
----------------------------------------------------------------

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

----------------------------------------------------------------
- Calculation of θp -
----------------------------------------------------------------
From table 10-9: θp = 0.00
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00

Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4769.328
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
----------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)

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

# Calculation No. 9

column C1, Floor 1

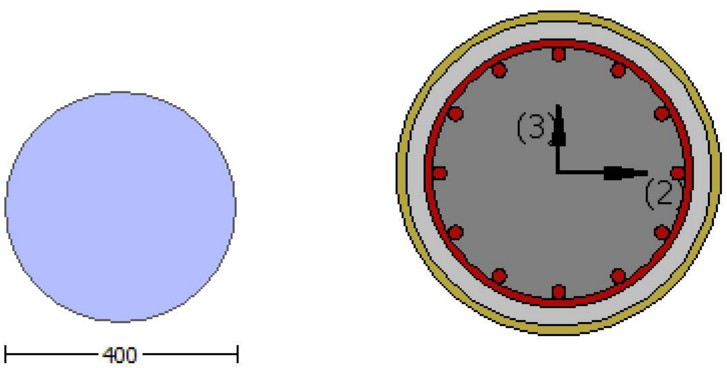
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rccs

Constant Properties
----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:

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, ASCE41-17) because bending is considered as Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.5697E+007
Shear Force, Va = -5225.405
EDGE -B-
Bending Moment, Mb = 13966.10
Shear Force, Vb = 5225.405
BOTH EDGES
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 330223.332
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 330223.332
VCol = 330223.332
knl = 1.00
displacement_ductility_demand = 0.02751181
-----------------------------------------------------------------
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 4.00

Mu = 1.5697E+007
Vu = 5225.405
d = 0.8*D = 320.00
Nu = 4836.048
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------

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

- Calculation of θ/θy for END A -
for rotation axis 3 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00046528
θy = (My*Ls/3)/EIeff = 0.01691187 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3003.978
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647

N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00

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

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)

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

## Calculation No. 10

column C1, Floor 1

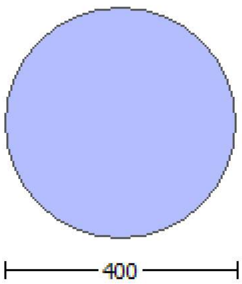
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

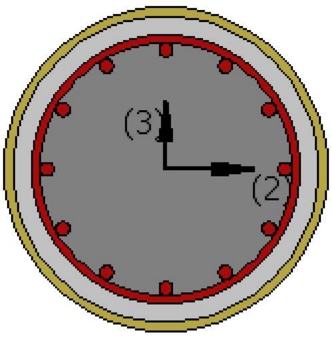
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties

---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
###############################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction

which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
------------------------------------------------------------

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

---

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

---

---

Calculation of Mu2-

---

---

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008

---

φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

---

Calculation of ratio lb/ld

---

Inadequate Lap Length with lb/ld = 0.30

---

---

---

---

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786

---

Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)

M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

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

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

Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876

-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00

R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
--------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56

s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-----------------------------------------------------------------
-----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 9.5835045E-010
Shear Force, V2 = -5225.405
Shear Force, V3 = -3.1652758E-013
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05044474
θu = θy + θp = 0.05044474

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00844474 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld

---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-9: θp = 0.042
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4836.048
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
---------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (a)

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

## Calculation No. 11

column C1, Floor 1

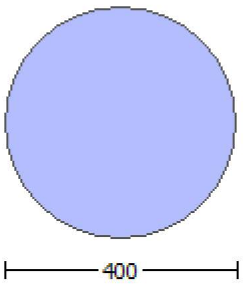
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

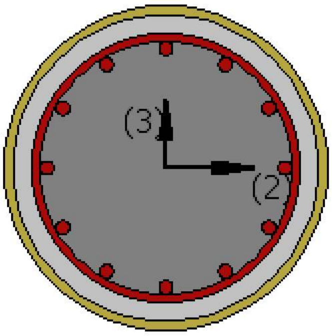
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
###############################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 9.5835045E-010
Shear Force, Va = -3.1652758E-013
EDGE -B-
Bending Moment, Mb = -8.4741565E-012
Shear Force, Vb = 3.1652758E-013
BOTH EDGES
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393314.244
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393314.244
VCol = 393314.244
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 9.5835045E-010
Vu = 3.1652758E-013
d = 0.8*D = 320.00
Nu = 4836.048
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------

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

- Calculation of θ/θy for END A -
for rotation axis 2 and integ. section (a)
---------------------------------------------------------------
From analysis, chord rotation θ = 2.0496434E-020
θy = (My*Ls/3)/EIeff = 0.00844474 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008

Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
----------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)

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

# Calculation No. 12

column C1, Floor 1

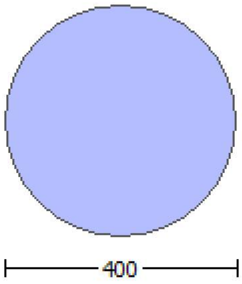
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

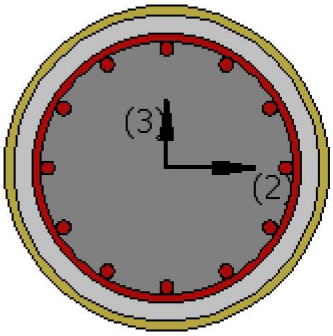
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)






Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406

fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld

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

Inadequate Lap Length with lb/ld = 0.30

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

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786

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

Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

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

Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233

Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------
-------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld

-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

-------------------------------------------------------------------
----------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------------
-------------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)
Section Type: rccs

Constant Properties
-------------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00

Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.5697E+007
Shear Force, V2 = -5225.405
Shear Force, V3 = -3.1652758E-013
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1272.345
-Compression: Aslc = 1781.283
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05891187
θu = θy + θp = 0.05891187

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.01691187 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3003.978
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
----------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433

with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
-------------------------------------------------------------
-------------------------------------------------------------

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

-------------------------------------------------------------
- Calculation of θp -
-------------------------------------------------------------
From table 10-9: θp = 0.042
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4836.048
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
-------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (a)

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

## Calculation No. 13

column C1, Floor 1

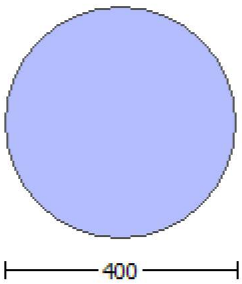
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

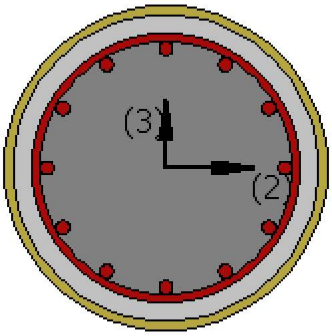
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
######################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -1.5697E+007
Shear Force, Va = -5225.405
EDGE -B-
Bending Moment, Mb = 13966.10
Shear Force, Vb = 5225.405
BOTH EDGES
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393314.244
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393314.244
VCol = 393314.244
knl = 1.00
displacement_ductility_demand = 0.13717225
----------------------------------------------------------------
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 13966.10
Vu = 5225.405
d = 0.8*D = 320.00
Nu = 4836.048
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772

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

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

- Calculation of θ/θy for END B -
for rotation axis 3 and integ. section (b)
---------------------------------------------------------------
From analysis, chord rotation θ = 0.00023168
θy = (My*Ls/3)/EIeff = 0.00168895 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)

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

# Calculation No. 14

column C1, Floor 1

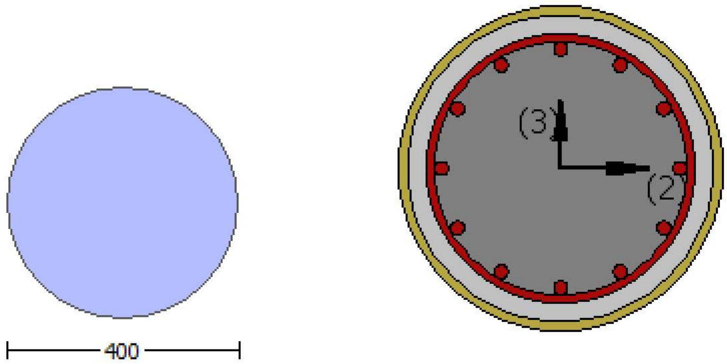
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties
-------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302

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

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
----------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rccs

Constant Properties
----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Mu1-
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
---------------------------------------------------------------

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

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00

From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56

s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---

---

Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772

---

---

End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

---

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 2
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -8.4741565E-012
Shear Force, V2 = 5225.405
Shear Force, V3 = 3.1652758E-013
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.05044474
θu = θy + θp = 0.05044474

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00844474 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013

factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Yielding Moment My
----------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
----------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
----------------------------------------------------------------
----------------------------------------------------------------

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

----------------------------------------------------------------
- Calculation of θp -
----------------------------------------------------------------
From table 10-9: θp = 0.042
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00
Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4836.048
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
ρl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
----------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1

At local axis: 2
Integration Section: (b)

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

## Calculation No. 15

column C1, Floor 1

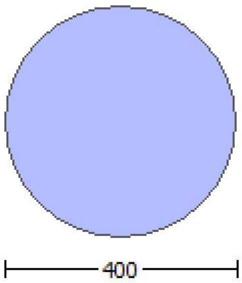
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

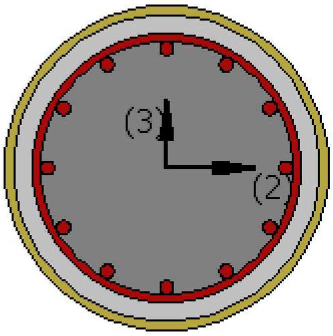
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE41-17.
Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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, ASCE41-17) because bending is considered as
Deformation-Controlled Action (Table C7-1, ASCE41-17).
New material: Concrete Strength, fc = fcm = 33.00
New material: Steel Strength, fs = fsm = 555.56
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00

Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 9.5835045E-010
Shear Force, Va = -3.1652758E-013
EDGE -B-
Bending Moment, Mb = -8.4741565E-012
Shear Force, Vb = 3.1652758E-013
BOTH EDGES
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL,ten = 18.00
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 393314.244
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 393314.244
VCol = 393314.244
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)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 8.4741565E-012
Vu = 3.1652758E-013
d = 0.8*D = 320.00
Nu = 4836.048
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 197392.088
Av = π/2*A_stirrup = 123370.055
fy = 500.00
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 267132.42
bw*d = π*d*d/4 = 80424.772
-------------------------------------------------------------

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

- Calculation of θ/θy for END B -
for rotation axis 2 and integ. section (b)
-------------------------------------------------------------
From analysis, chord rotation θ = 1.3796523E-020
θy = (My*Ls/3)/EIeff = 0.00844474 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 1500.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Yielding Moment My
-------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
-------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------
End Of Calculation of Shear Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)

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

## Calculation No. 16

column C1, Floor 1

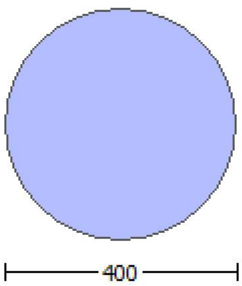
Limit State: Collapse Prevention (data interpolation between analysis steps 2 and 3)

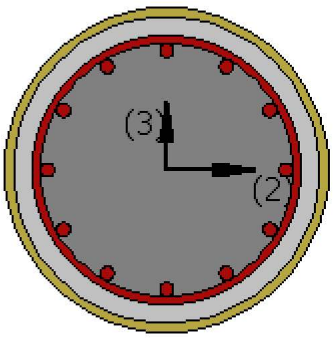
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 3
(Bending local axis: 2)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################

Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 1.1167452E-031
EDGE -B-
Shear Force, Vb = -1.1167452E-031
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr  =  0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 =  Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination
Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 =  Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121

φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00

v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

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

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
--------------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134

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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 1.5353150E-011
Vu = 1.1167452E-031
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
----------------------------------------------------------------
----------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 3

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

Start Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At Shear local axis: 2

(Bending local axis: 3)
Section Type: rccs

Constant Properties
-----------------------------------------------------------------
Knowledge Factor, κ = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
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
New material: Steel Strength, fs = 1.25*fsm = 694.45
#################################################################
Diameter, D = 400.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.56406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = -6.8378665E-048
EDGE -B-
Shear Force, Vb = 6.8378665E-048
BOTH EDGES
Axial Force, F = -4771.233
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27446066
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 123981.505
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.8597E+008
Mu1+ = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction which is defined for the static loading combination

Mu1- = 1.8597E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 1.8597E+008
Mu2+ = 1.8597E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the the static loading combination
Mu2- = 1.8597E+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 Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
---------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
------------------------------------------------------------

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

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
--------------------------------------------------------------

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

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.8597E+008
-----------------------------------------------------------------------------
φ = 0.90757121
φ' = 0.80580716
error of function (3.68), Biskinis Phd = 62663.77
From 5A.2, TBDY: fcc = fc*λc = 51.61391
conf. factor λc = 1.56406
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 389.0139
lb/ld = 0.30
d1 = 44.00
R = 200.00
v = 0.00101663
N = 4771.233
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.25311302
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Inadequate Lap Length with lb/ld = 0.30
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 451727.786
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 451727.786
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 2, Vr2 = 451727.786
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 451727.786
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)
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 5.4715235E-012
Vu = 6.8378665E-048
d = 0.8*D = 320.00
Nu = 4771.233
Ag = 125663.706
From (11.5.4.8), ACI 318-14: Vs = 219326.297
Av = π/2*A_stirrup = 123370.055
fy = 555.56
s = 100.00
Vs is multiplied by αCol = 0.00
s/d = 0.3125
Vf ((11-3)-(11.4), ACI 440) = 194961.134
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) = 370.00
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 <= 306911.784
bw*d = π*d*d/4 = 80424.772
---------------------------------------------------------------
---------------------------------------------------------------
End Of Calculation of Shear Capacity ratio for element: column CC1 of floor 1
At local axis: 2

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

Start Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rccs

Constant Properties
---------------------------------------------------------------
Knowledge Factor, κ = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
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
Diameter, D = 400.00
Cover Thickness, c = 25.00
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
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 = 13966.10
Shear Force, V2 = 5225.405
Shear Force, V3 = 3.1652758E-013
Axial Force, F = -4836.048
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3053.628
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1017.876
-Compression: Asl,com = 1017.876
-Middle: Asl,mid = 1017.876
Mean Diameter of Tension Reinforcement, DbL = 18.00
---------------------------------------------------------------

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

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.04368895
θu = θy + θp = 0.04368895

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00168895 ((4.29),Biskinis Phd))
My = 1.7191E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4836.048
Ec*Ig = 3.3929E+013
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of Yielding Moment My
---------------------------------------------------------------
Calculation of Φy and My according to (7) - (8) in Biskinis and Fardis
---------------------------------------------------------------
My = Min(My_ten,My_com) = 1.7191E+008
Φy = 8.8239433E-006
My_ten (8c) = 1.7191E+008
Φ_ten (7c) = 67.12916
error of function (7c) = 0.00132593
My_com (8d) = 4.6745E+008
Φ_com (7d) = 67.15694
error of function (7d) = -0.00265433
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.45 ((9c) in Biskinis and Fardis for FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00103647
N = 4836.048
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.36359274
with fc* ((12.3), ACI 440) = 37.12975
fc = 33.00
fl = 1.3173
kα = 1
Effective FRP thickness, tf = NL*t*Cos(b1) = 1.016
efe ((12.5) and (12.7)) = 0.004
εfu = 0.01
Ef = 64828.00
---------------------------------------------------------------
---------------------------------------------------------------

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

---------------------------------------------------------------
- Calculation of θp -
---------------------------------------------------------------
From table 10-9: θp = 0.042
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VColOE = 0.27446066
d = 0.00
s = 0.00
ρt = 2*Av/(dc*s) + 4*tf/D*(ffe/fs) = 0.00

Av = 78.53982, is the area of the circular stirrup
dc = D - 2*cover - Hoop Diameter = 340.00
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.
NUD = 4836.048
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0243
f'cE = 33.00
-----------------------------------------------------------------
End Of Calculation of Chord Rotation Capacity for element: column CC1 of floor 1
At local axis: 3
Integration Section: (b)

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