# Detailed Member Calculations

**Units: N&mm**

**Regulation: ASCE 41-17**

## Calculation No. 1

column C1, Floor 1

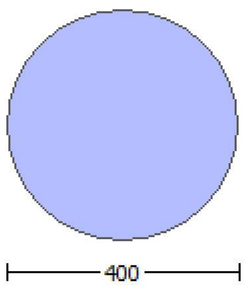
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

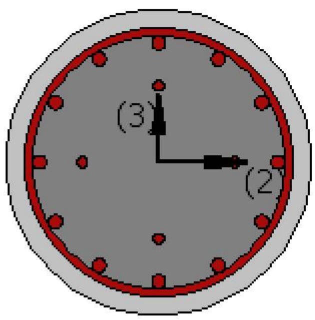
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column 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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.3539E+007
Shear Force, Va = -4511.31
EDGE -B-
Bending Moment, Mb = 0.00056226
Shear Force, Vb = 4511.31
BOTH EDGES
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 260481.339
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 260481.339
VCol = 260481.339
knl = 1.00
displacement_ductility_demand = 0.02450249
-----------------------------------------------------------------
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 = 1.3539E+007
Vu = 4511.31
d = 0.8*D = 320.00
Nu = 4819.304
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) = 0.00
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 = 0.00036158
θy = (My*Ls/3)/EIeff = 0.01475688 ((4.29),Biskinis Phd))
My = 1.5015E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.155
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------

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

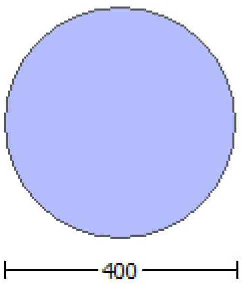
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

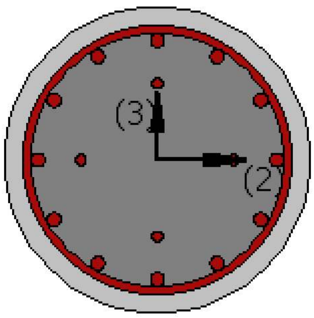
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column 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 = 1.3629
Element Length, L = 3000.00
Secondary Member

Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
-------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu1-
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--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

Calculation of Mu2+

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Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008

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φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987

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Calculation of ratio lb/ld

---

Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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Calculation of Mu2-

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Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008

---

φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987

---

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
--------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00

Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
----------------------------------------------------------------

Stepwise Properties
----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127

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

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu1-
------------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Mu2+
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld

---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu2-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
--------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
Bending Moment, M = 5.0135224E-011
Shear Force, V2 = -4511.31
Shear Force, V3 = -2.7001176E-014
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0073756
θu = θy + θp = 0.0073756

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.0073756 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616

My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

---------------------------------------------------------------
- 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 = 0.27772678
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 = 4819.304
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

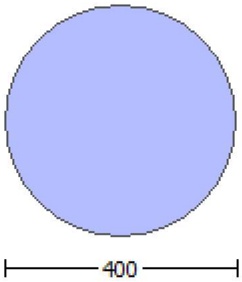
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

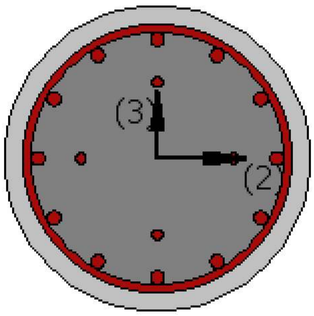
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: Start

Local Axis: (3)




Start Of Calculation of Shear Capacity for element: column 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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping

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

Stepwise Properties
-------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 5.0135224E-011
Shear Force, Va = -2.7001176E-014
EDGE -B-
Bending Moment, Mb = 3.0782901E-011
Shear Force, Vb = 2.7001176E-014
BOTH EDGES
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323570.589
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323570.589
VCol = 323570.589
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 = 5.0135224E-011
Vu = 2.7001176E-014
d = 0.8*D = 320.00
Nu = 4819.304
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) = 0.00
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 = 5.8979492E-021
θy = (My*Ls/3)/Eleff = 0.0073756 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4819.304

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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------
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

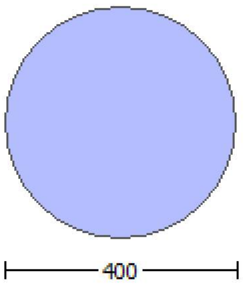
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

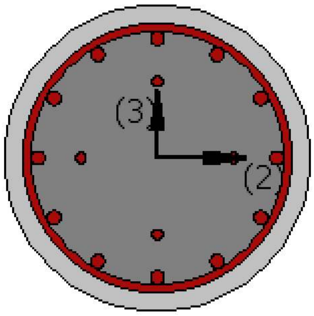
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: Start

Local Axis: (3)




Start Of Calculation of Shear Capacity ratio for element: column 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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Mu1-
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Mu2+
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Mu2-
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
----------------------------------------------------------------

Stepwise Properties
----------------------------------------------------------------
Bending Moment, M = -1.3539E+007
Shear Force, V2 = -4511.31
Shear Force, V3 = -2.7001176E-014
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.01475688
θu = θy + θp = 0.01475688

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.01475688 ((4.29),Biskinis Phd))
My = 1.5015E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3001.155
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of ratio lb/ld

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

Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

- 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 = 0.27772678
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 = 4819.304
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

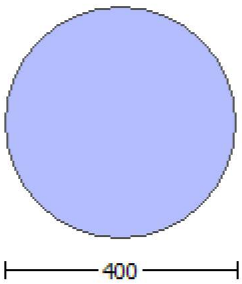
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

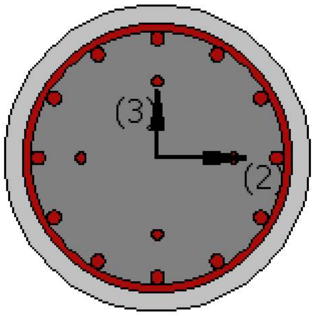
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity for element: column 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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.3539E+007
Shear Force, Va = -4511.31

EDGE -B-
Bending Moment, Mb = 0.00056226
Shear Force, Vb = 4511.31
BOTH EDGES
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323570.589
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323570.589
VCol = 323570.589
knl = 1.00
displacement_ductility_demand = 0.13524615
---------------------------------------------------------------
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 = 0.00056226
Vu = 4511.31
d = 0.8*D = 320.00
Nu = 4819.304
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) = 0.00
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 = 0.0001995
θy = (My*Ls/3)/Eleff = 0.00147512 ((4.29),Biskinis Phd))
My = 1.5015E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 300.00
From table 10.5, ASCE 41_17: Eleff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------
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

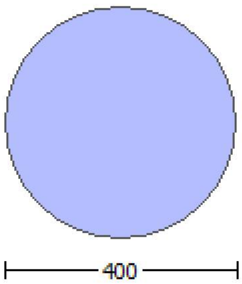
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

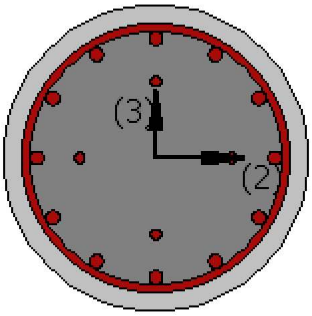
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (2)




Start Of Calculation of Shear Capacity ratio for element: column 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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
-------------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-----------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Mu2-
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
--------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
Bending Moment, M = 3.0782901E-011
Shear Force, V2 = 4511.31
Shear Force, V3 = 2.7001176E-014
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0073756
θu = θy + θp = 0.0073756

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.0073756 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

---------------------------------------------------------------
- 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 = 0.27772678
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 = 4819.304
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

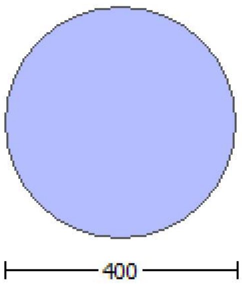
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

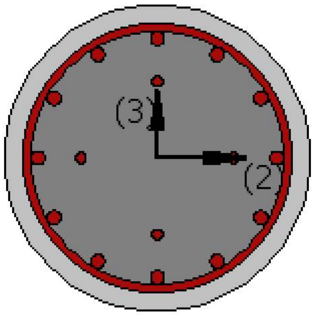
Analysis: Uniform +X

Check: Shear capacity VRd

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity for element: column 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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 5.0135224E-011
Shear Force, Va = -2.7001176E-014

EDGE -B-
Bending Moment, Mb = 3.0782901E-011
Shear Force, Vb = 2.7001176E-014
BOTH EDGES
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323570.589
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323570.589
VCol = 323570.589
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 = 3.0782901E-011
Vu = 2.7001176E-014
d = 0.8*D = 320.00
Nu = 4819.304
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) = 0.00
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 = 2.1497967E-022
θy = (My*Ls/3)/EIeff = 0.0073756 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------
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

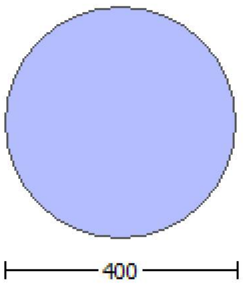
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

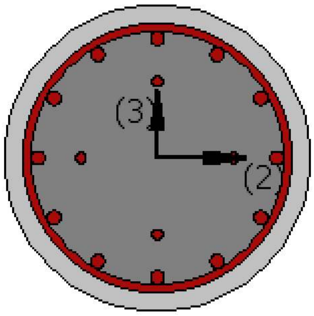
Analysis: Uniform +X

Check: Chord rotation capacity (θu)

Edge: End

Local Axis: (3)




Start Of Calculation of Shear Capacity ratio for element: column 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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu2-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
Bending Moment, M = 0.00056226
Shear Force, V2 = 4511.31
Shear Force, V3 = 2.7001176E-014
Axial Force, F = -4819.304
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
-------------------------------------------------------------
-------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.00147512
θu = θy + θp = 0.00147512

-------------------------------------------------------------
- Calculation of θy -
-------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00147512 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4819.304
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) = 1.5015E+008
Φy = 6.5188016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46139
error of function (7c) = 0.00036616
My_com (8d) = 4.7857E+008
Φ_com (7d) = 69.1237
error of function (7d) = -0.00032574
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116215
N = 4819.304
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of ratio lb/ld

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

Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

- 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 = 0.27772678
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 = 4819.304
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

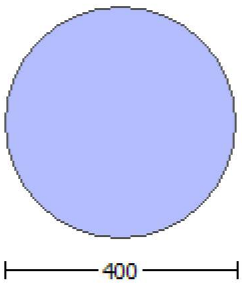
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

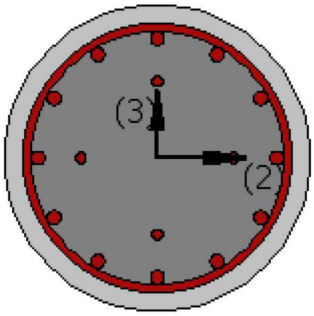
Analysis: Uniform +X

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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.5505E+007
Shear Force, Va = -5163.801

EDGE -B-
Bending Moment, Mb = 7305.744
Shear Force, Vb = 5163.801
BOTH EDGES
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 260484.457
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 260484.457
VCol = 260484.457
knl = 1.00
displacement_ductility_demand = 0.02963851
---------------------------------------------------------------
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 = 1.5505E+007
Vu = 5163.801
d = 0.8*D = 320.00
Nu = 4850.731
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) = 0.00
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 = 0.0004376
θy = (My*Ls/3)/EIeff = 0.01476472 ((4.29),Biskinis Phd))
My = 1.5015E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3002.653
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------
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

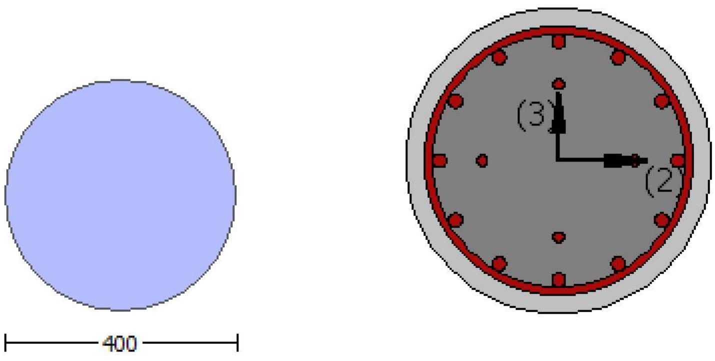
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Calculation of Mu2-
------------------------------------------------------------------------------

------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-----------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-----------------------------------------------------------
-----------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
Bending Moment, M = 6.0800665E-011
Shear Force, V2 = -5163.801
Shear Force, V3 = -3.3698040E-014
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03684577
θu = θy + θp = 0.03684577

-----------------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00737584 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of ratio lb/ld
--------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

--------------------------------------------------------------
- Calculation of θp -
--------------------------------------------------------------
From table 10-9: θp = 0.02946994
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27772678
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 = 4850.731
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

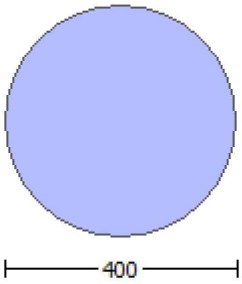
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

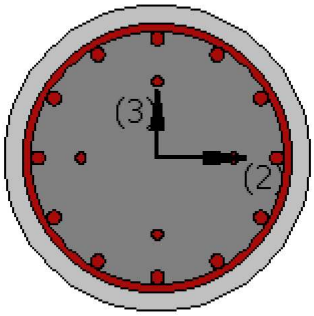
Analysis: Uniform +X

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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 6.0800665E-011
Shear Force, Va = -3.3698040E-014

EDGE -B-
Bending Moment, Mb = 4.0166836E-011
Shear Force, Vb = 3.3698040E-014
BOTH EDGES
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323576.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323576.827
VCol = 323576.827
knl = 1.00
displacement_ductility_demand = 0.00
---------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
---------------------------------------------------------------
λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 6.0800665E-011
Vu = 3.3698040E-014
d = 0.8*D = 320.00
Nu = 4850.731
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) = 0.00
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 = 8.5678757E-021
θy = (My*Ls/3)/EIeff = 0.00737584 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------
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

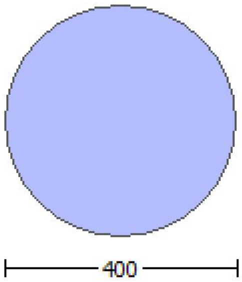
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

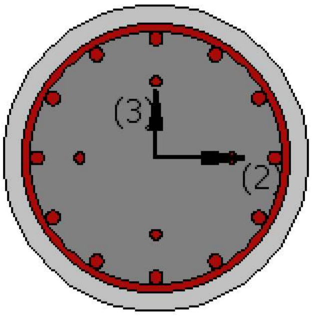
Analysis: Uniform +X

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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
Calculation of Mu2-
-------------------------------------------------------------------------------

-------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
Bending Moment, M = -1.5505E+007
Shear Force, V2 = -5163.801
Shear Force, V3 = -3.3698040E-014
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 1426.283
-Compression: Aslc = 2243.097
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.04423466
θu = θy + θp = 0.04423466

-----------------------------------------------------------------
- Calculation of θy -
-----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.01476472 ((4.29),Biskinis Phd))
My = 1.5015E+008
Ls = M/V (with Ls >0.1*L and Ls < 2*L) = 3002.653
From table 10.5, ASCE 41_17: EIeff = factor*Ec*Ig = 1.0179E+013
factor = 0.30
Ag = 125663.706
fc' = 33.00
N = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
$\lambda$ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
$\psi t$ = 1.00
$\psi s$ = 0.80
$\psi e$ = 1.00
cb = 25.00
Ktr = 3.08425
Atr = $\pi$/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

-----------------------------------------------------------------
- Calculation of $\theta p$ -
-----------------------------------------------------------------
From table 10-9: $\theta p$ = 0.02946994
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27772678
d = 0.00
s = 0.00
$\rho t$ = 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 $\rho f$ = 2*tf/bw is FRP ratio (EC8 - 3, A.4.4.3(6)) and ffe/fs normalises $\rho f$ to steel strength
All these variables have already been given in Shear control ratio calculation.
NUD = 4850.731
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

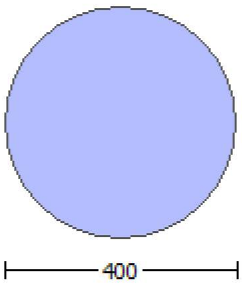
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

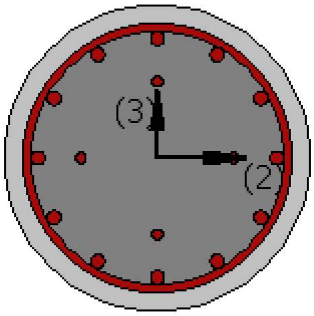
Analysis: Uniform +X

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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = -1.5505E+007
Shear Force, Va = -5163.801

EDGE -B-
Bending Moment, Mb = 7305.744
Shear Force, Vb = 5163.801
BOTH EDGES
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323576.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323576.827
VCol = 323576.827
knl = 1.00
displacement_ductility_demand = 0.15501198
----------------------------------------------------------------
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 = 7305.744
Vu = 5163.801
d = 0.8*D = 320.00
Nu = 4850.731
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) = 0.00
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 = 0.00022867
θy = (My*Ls/3)/EIeff = 0.00147517 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------
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

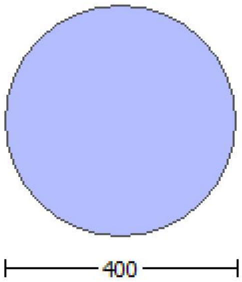
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

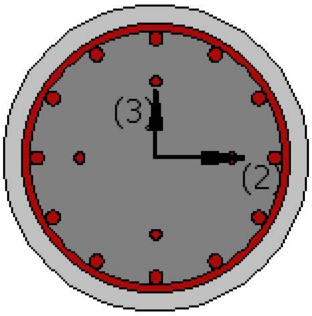
Analysis: Uniform +X

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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu1-
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
----------------------------------------------------------------------------
----------------------------------------------------------------------------
----------------------------------------------------------------------------
Calculation of Mu2+
----------------------------------------------------------------------------

----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-----------------------------------------------------------------

Stepwise Properties
-----------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-----------------------------------------------------------------
-----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2+
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Mu2-
-----------------------------------------------------------------------------

-----------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
-----------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-------------------------------------------------------------

Calculation of ratio lb/ld
-------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
-----------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
----------------------------------------------------------------

Stepwise Properties
----------------------------------------------------------------
Bending Moment, M = 4.0166836E-011
Shear Force, V2 = 5163.801
Shear Force, V3 = 3.3698040E-014
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
----------------------------------------------------------------
----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.03684577
θu = θy + θp = 0.03684577

----------------------------------------------------------------
- Calculation of θy -
----------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00737584 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of ratio lb/ld

---

Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

---

- Calculation of θp -

---

From table 10-9: θp = 0.02946994
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27772678
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 = 4850.731
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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

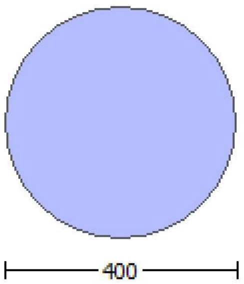
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

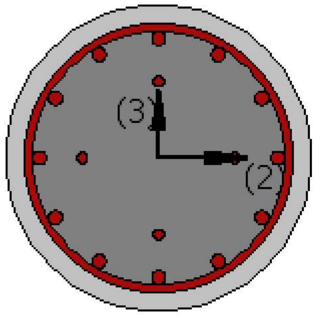
Analysis: Uniform +X

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
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
EDGE -A-
Bending Moment, Ma = 6.0800665E-011
Shear Force, Va = -3.3698040E-014

EDGE -B-
Bending Moment, Mb = 4.0166836E-011
Shear Force, Vb = 3.3698040E-014
BOTH EDGES
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL,ten = 17.33333
-----------------------------------------------------------------
-----------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final Shear Capacity VR = 1.0*Vn = 323576.827
Vn ((10.3), ASCE 41-17) = knl*VCol0 = 323576.827
VCol = 323576.827
knl = 1.00
displacement_ductility_demand = 0.00
-----------------------------------------------------------------
NOTE: In expression (10-3) 'Vs = Av*fy*d/s' is replaced by 'Vs+ψf*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).
-----------------------------------------------------------------
λ = 1 (normal-weight concrete)
fc' = 25.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
M/Vd = 2.00
Mu = 4.0166836E-011
Vu = 3.3698040E-014
d = 0.8*D = 320.00
Nu = 4850.731
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) = 0.00
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 = 2.8452640E-022
θy = (My*Ls/3)/Eleff = 0.00737584 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld
---------------------------------------------------------------
Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------
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

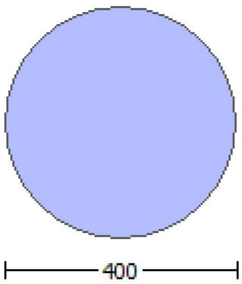
Limit State: Life Safety (data interpolation between analysis steps 2 and 3)

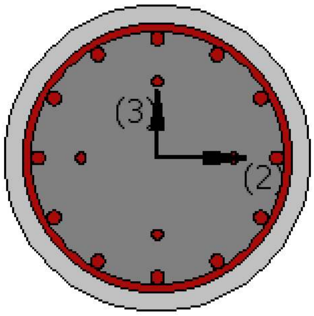
Analysis: Uniform +X

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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
At local axis: 3
EDGE -A-
Shear Force, Va = -7.7548325E-031
EDGE -B-
Shear Force, Vb = 7.7548325E-031

BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
----------------------------------------------------------------
----------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
----------------------------------------------------------------

Calculation of ratio lb/ld
----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00

Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

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

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

Calculation of Mu1-

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008

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

φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987

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

Calculation of ratio lb/ld

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

Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

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

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

Calculation of Mu2+

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

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008

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

φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635

d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Calculation of Mu2-
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
--------------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
-----------------------------------------------------------------

Calculation of ratio lb/ld
-----------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00

cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208
---------------------------------------------------------------------------
Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.2118694E-011
Vu = 7.7548325E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 1.3629
Element Length, L = 3000.00
Secondary Member
Smooth Bars
Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
No FRP Wrapping
-------------------------------------------------------------

Stepwise Properties
-------------------------------------------------------------
At local axis: 2
EDGE -A-
Shear Force, Va = 1.6678553E-031
EDGE -B-
Shear Force, Vb = -1.6678553E-031
BOTH EDGES
Axial Force, F = -4821.109
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
-------------------------------------------------------------
-------------------------------------------------------------

Calculation of Shear Capacity ratio , Ve/Vr = 0.27772678
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln = 101134.82
with
Mpr1 = Max(Mu1+ , Mu1-) = 1.5170E+008
Mu1+ = 1.5170E+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- = 1.5170E+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-) = 1.5170E+008
Mu2+ = 1.5170E+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- = 1.5170E+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 = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu1-
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00

v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00
---------------------------------------------------------------------------
---------------------------------------------------------------------------
---------------------------------------------------------------------------
Calculation of Mu2+
---------------------------------------------------------------------------

---------------------------------------------------------------------------
Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008
---------------------------------------------------------------------------
φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987
------------------------------------------------------------

Calculation of ratio lb/ld
------------------------------------------------------------
Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425

Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

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

Calculation of Mu2-

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

Calculation of ultimate Moment Strength ((3.67), Biskinis Phd), Mu
Mu = 1.5170E+008

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

φ = 0.89011792
φ' = 0.79054747
error of function (3.68), Biskinis Phd = 49090.089
From 5A.2, TBDY: fcc = fc*λc = 44.97572
conf. factor λc = 1.3629
fc = 33.00
From 10.3.5, ASCE41-17, Final value of fy: fy*Min(1,1.25*(lb/ld)^2/3) = 261.9797
lb/ld = 0.16579635
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4821.109
Ac = 125663.706
ω = ω*Min(1,1.25*(lb/ld)^2/3) = 0.18544987

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

Calculation of ratio lb/ld

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

Lap Length: lb/ld = 0.16579635
lb = 300.00
ld = 1809.449
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 694.45
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

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

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

Calculation of Shear Strength Vr = Min(Vr1,Vr2) = 364152.208

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

Calculation of Shear Strength at edge 1, Vr1 = 364152.208
Vr1 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031

d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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 = 364152.208
Vr2 = VCol ((10.3), ASCE 41-17) = knl*VCol0
VCol0 = 364152.208
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 = 1.1494811E-011
Vu = 1.6678553E-031
d = 0.8*D = 320.00
Nu = 4821.109
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) = 0.00
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
Smooth Bars

Ductile Steel
With Detailing for Earthquake Resistance (including stirrups closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lb = 300.00
No FRP Wrapping
---------------------------------------------------------------

Stepwise Properties
---------------------------------------------------------------
Bending Moment, M = 7305.744
Shear Force, V2 = 5163.801
Shear Force, V3 = 3.3698040E-014
Axial Force, F = -4850.731
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 0.00
-Compression: Aslc = 3669.38
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 1223.127
-Compression: Asl,com = 1223.127
-Middle: Asl,mid = 1223.127
Mean Diameter of Tension Reinforcement, DbL = 17.33333
---------------------------------------------------------------
---------------------------------------------------------------

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity θu,R = 1.0*θu = 0.0309451
θu = θy + θp = 0.0309451

---------------------------------------------------------------
- Calculation of θy -
---------------------------------------------------------------
θy = (My*Ls/3)/EIeff = 0.00147517 ((4.29),Biskinis Phd))
My = 1.5015E+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 = 4850.731
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) = 1.5015E+008
Φy = 6.5189016E-006
My_ten (8c) = 1.5015E+008
Φ_ten (7c) = 71.46244
error of function (7c) = 0.00036671
My_com (8d) = 4.7856E+008
Φ_com (7d) = 69.12394
error of function (7d) = -0.00032556
with ((10.1), ASCE 41-17) ey = Min(ey, 1.25*ey*(lb/ld)^2/3) = 0.0027778
eco = 0.002
apl = 0.35 ((9a) in Biskinis and Fardis for no FRP Wrap)
d1 = 44.00
R = 200.00
v = 0.00116972
N = 4850.731
Ac = 125663.706
((10.1), ASCE 41-17) ω = Min(ω, 1.25*ω*(lb/ld)^2/3) = 0.49158642
with fc = 33.00
---------------------------------------------------------------
---------------------------------------------------------------

Calculation of ratio lb/ld

---

Lap Length: ld/ld,min = 0.20724543
lb = 300.00
ld = 1447.559
Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
ld,min from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
λ = 1
db = 17.00
Mean strength value of all re-bars: fy = 555.56
fc' = 33.00, but fc^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
ψt = 1.00
ψs = 0.80
ψe = 1.00
cb = 25.00
Ktr = 3.08425
Atr = π/2 * Area of stirrup = 123.3701
s = 100.00
n = 16.00

---

- Calculation of θp -

---

From table 10-9: θp = 0.02946994
with:
- Columns not controlled by inadequate development or splicing along the clear height because lb/ld >= 1
shear control ratio VyE/VCol0E = 0.27772678
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 = 4850.731
Ag = 125663.706
f'cE = 33.00
fytE = fylE = 555.56
pl = Area_Tot_Long_Rein/(Ag) = 0.0292
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)

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