

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

beam B1, Floor 1

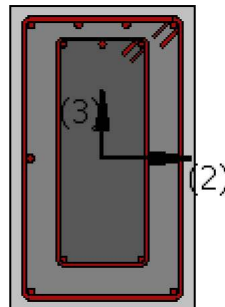
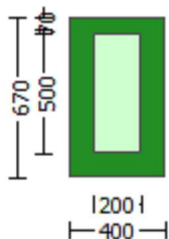
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Primary 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 $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -1.7163466E-011$
 Shear Force, $V_a = -7.6321477E-015$
 EDGE -B-
 Bending Moment, $M_b = -5.8922949E-012$
 Shear Force, $V_b = 7.6321477E-015$
 BOTH EDGES
 Axial Force, $F = -5285.801$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 911.0619$
 -Compression: $A_{sl,com} = 911.0619$
 -Middle: $A_{sl,mid} = 556.0619$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 320963.76$
 $V_n ((22.5.1.1), \text{ACI } 318-14) = 320963.76$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 153412.152$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 20.00$, but $f'_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 1.7163466E-011$
 $V_u = 7.6321477E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 2

beam B1, Floor 1

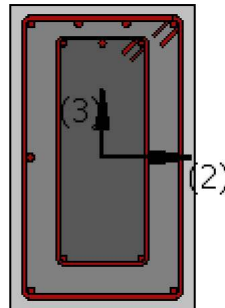
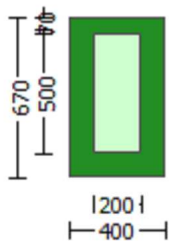
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

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Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, fs = 1.25*fsm = 781.25
Existing Column
New material: Steel Strength, fs = 1.25*fsm = 781.25
#####
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.04251
Element Length, L = 3000.00
Primary 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
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Stepwise Properties
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At local axis: 3
EDGE -A-
Shear Force, Va = 9840.634
EDGE -B-
Shear Force, Vb = 9840.632
BOTH EDGES
Axial Force, F = -2287.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: Aslt = 709.9999
-Compression: Aslc = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: Asl,ten = 709.9999
-Compression: Asl,com = 1266.062
-Middle: Asl,mid = 402.1239
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Calculation of Shear Capacity ratio , Ve/Vr = 0.26808017
Member Controlled by Flexure (Ve/Vr < 1)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 Ve = (Mpr1 + Mpr2)/ln ± vu*ln/2 = 158880.346
with
Mpr1 = Max(Mu1+ , Mu1-) = 2.2356E+008
Mu1+ = 1.1381E+008, is the ultimate moment strength at the edge 1 of the member in the actual moment direction
which is defined for the static loading combination
Mu1- = 2.2356E+008, is the ultimate moment strength at the edge 1 of the member in the opposite moment
direction which is defined for the static loading combination
Mpr2 = Max(Mu2+ , Mu2-) = 2.2356E+008
Mu2+ = 1.1381E+008, is the ultimate moment strength at the edge 2 of the member in the actual moment direction
which is defined for the the static loading combination
Mu2- = 2.2356E+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
and
± vu*ln = (|V1| + |V2|)/2
with

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V1 = 9840.634, is the shear force acting at edge 1 for the the static loading combination
V2 = 9840.632, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 5.6034793E-006$$

$$M_u = 1.1381E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi_{co} \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00684112$$

$$\phi_{we} \text{ (5.4c)} = 0.00697692$$

$$\phi_{ase} \text{ ((5.4d), TBDY)} = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.41645$$

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 2.53374$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{psh2} * F_{ywe2} = 1.41645$$

$$\phi_{psh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{psh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$s_{h1} = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

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su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02582354
2 = Asl,com/(b*d)*(fs2/fc) = 0.04604817
v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0319073
2 = Asl,com/(b*d)*(fs2/fc) = 0.05689664
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20240787
Mu = MRc (4.14) = 1.1381E+008
u = su (4.1) = 5.6034793E-006

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Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, \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)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_1 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 5.7880076E-006$

$\mu = 2.2356E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00030396$

$N = 2287.027$

$f_c = 30.00$

α_0 (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha_0) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu = 0.00684112$

w_e (5.4c) = 0.00697692

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.41645$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirups, $n_{s_1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirups, $n_{s_2} = 2.00$

$h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirups, $n_{s_1} = 2.00$

$h_1 = 400.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$

Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 781.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514

c = confinement factor = 1.04251

y1 = 0.0008757

sh1 = 0.00280225

ft1 = 328.3881

fy1 = 273.6568

su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
 characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757

sh2 = 0.00280225

ft2 = 328.3881

fy2 = 273.6568

su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757

shv = 0.00280225

ftv = 328.3881

fyv = 273.6568

suv = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
 For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
 characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568

with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.04604817

2 = Asl,com/(b*d)*(fs2/fc) = 0.02582354

v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572

and confined core properties:

b = 340.00

d = 597.00


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d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05689664
2 = Asl,com/(b*d)*(fs2/fc) = 0.0319073
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22783602
Mu = MRc (4.14) = 2.2356E+008
u = su (4.1) = 5.7880076E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 5.6034793E-006
Mu = 1.1381E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.00030396
N = 2287.027
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00684112
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00684112
we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

```

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 781.25$

$fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$

$c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$

$sh1 = 0.00280225$

$ft1 = 328.3881$

$fy1 = 273.6568$

$su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket * Asl, ten, jacket + fs_core * Asl, ten, core) / Asl, ten = 273.6568$

with $Es1 = (Es_jacket * Asl, ten, jacket + Es_core * Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0008757$

$sh2 = 0.00280225$

$ft2 = 328.3881$

$fy2 = 273.6568$

$su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/lb, min = 0.14834034$

$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket * Asl, com, jacket + fs_core * Asl, com, core) / Asl, com = 273.6568$

with $Es2 = (Es_jacket * Asl, com, jacket + Es_core * Asl, com, core) / Asl, com = 200000.00$

$yv = 0.0008757$

$shv = 0.00280225$

$ftv = 328.3881$

$fyv = 273.6568$

$suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

$\text{Shear_factor} = 1.00$
 $\text{lb}/\text{ld}, \text{min} = \text{lb}/\text{ld} = 0.14834034$
 $\text{suv} = 0.4 * \text{esuv_nominal} ((5.5), \text{TBDY}) = 0.032$
 From table 5A.1, TBDY: $\text{esuv_nominal} = 0.08$,
 considering characteristic value $\text{fsyv} = \text{fsv}/1.2$, from table 5.1, TBDY
 For calculation of esuv_nominal and yv , shv , ftv , fyv , it is considered
 characteristic value $\text{fsyv} = \text{fsv}/1.2$, from table 5.1, TBDY.
 y1 , sh1 , ft1 , fy1 , are also multiplied by $\text{Min}(1, 1.25 * (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.
 with $\text{fsv} = (\text{fsjacket} * \text{Asl}, \text{mid}, \text{jacket} + \text{fs}, \text{mid} * \text{Asl}, \text{mid}, \text{core}) / \text{Asl}, \text{mid} = 273.6568$
 with $\text{Esv} = (\text{Esjacket} * \text{Asl}, \text{mid}, \text{jacket} + \text{Es}, \text{mid} * \text{Asl}, \text{mid}, \text{core}) / \text{Asl}, \text{mid} = 200000.00$
 $1 = \text{Asl}, \text{ten} / (\text{b} * \text{d}) * (\text{fs1} / \text{fc}) = 0.02582354$
 $2 = \text{Asl}, \text{com} / (\text{b} * \text{d}) * (\text{fs2} / \text{fc}) = 0.04604817$
 $v = \text{Asl}, \text{mid} / (\text{b} * \text{d}) * (\text{fsv} / \text{fc}) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $\text{fcc} (5A.2, \text{TBDY}) = 31.27541$
 $\text{cc} (5A.5, \text{TBDY}) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = \text{Asl}, \text{ten} / (\text{b} * \text{d}) * (\text{fs1} / \text{fc}) = 0.0319073$
 $2 = \text{Asl}, \text{com} / (\text{b} * \text{d}) * (\text{fs2} / \text{fc}) = 0.05689664$
 $v = \text{Asl}, \text{mid} / (\text{b} * \text{d}) * (\text{fsv} / \text{fc}) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $\text{su} (4.9) = 0.20240787$
 $\text{Mu} = \text{MRc} (4.14) = 1.1381\text{E}+008$
 $u = \text{su} (4.1) = 5.6034793\text{E}-006$

Calculation of ratio lb/ld

Lap Length: $\text{lb}/\text{ld} = 0.14834034$
 $\text{lb} = 300.00$
 $\text{ld} = 2022.376$
 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)
 $= 1$
 $\text{db} = 15.23077$
 Mean strength value of all re-bars: $\text{fy} = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $\text{cb} = 25.00$
 $\text{Ktr} = 2.64216$
 $n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 5.7880076\text{E}-006$
 $\text{Mu} = 2.2356\text{E}+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $\text{fc} = 30.00$

$co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00684112$
 $we (5.4c) = 0.00697692$
 $ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = Max(ase1,ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh,min*Fywe = Min(psh,x*Fywe, psh,y*Fywe) = 1.41645$

$psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374$
 $ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645$
 $ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298$
 $Ash1 = Astir_1*ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008$
 $Ash2 = Astir_2*ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = confinement\ factor = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou,min = lb/ld = 0.14834034$

$su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568$

with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 273.6568$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $su_v = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04604817$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.02582354$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05689664$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0319073$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22783602$

$Mu = MRc (4.14) = 2.2356E+008$

$u = su (4.1) = 5.7880076E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 592659.827$

Calculation of Shear Strength at edge 1, $V_{r1} = 592659.827$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area_jacket} + f'_{c_core} \cdot \text{Area_core}) / \text{Area_section} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.1092E+006$

$V_u = 9840.634$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$d/2 = 400.00$

$A_v = 100530.965$

$f_y = 625.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area_jacket} + f'_{c_core} \cdot \text{Area_core}) / \text{Area_section} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 1.00$

$M_u = 1.1092E+006$

$V_u = 9840.632$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 625.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$d/2 = 400.00$

$A_v = 100530.965$

$f_y = 625.00$

$s = 300.00$

Vs2 has been multiplied by 2(1-s/d) (s>d/2, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

$V_f((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.04251

Element Length, $L = 3000.00$

Primary 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 $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 8.9541895E-015$

EDGE -B-

Shear Force, $V_b = -8.9541895E-015$

BOTH EDGES

Axial Force, $F = -2287.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 911.0619$

-Compression: $A_{sl,com} = 911.0619$

-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio , $V_e/V_r = 0.15088696$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 59951.954$ with

$M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 8.9928E+007$

$M_{u1+} = 8.9928E+007$, 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

$M_{u1-} = 8.9928E+007$, 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

$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 8.9928E+007$

$M_{u2+} = 8.9928E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$M_{u2-} = 8.9928E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = 8.9541895E-015$, is the shear force acting at edge 1 for the static loading combination

$V_2 = -8.9541895E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.0089632E-005$

$M_u = 8.9928E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00031872$

$N = 2287.027$

$f_c = 30.00$

$\phi_{co} (5A.5, \text{TBDY}) = 0.002$

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_{co}) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) $= 0.00697692$

$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$

$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$

$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirups, $n_{s_1} = 2.00$

$h_1 = 670.00$

$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 781.25

fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514

c = confinement factor = 1.04251

y1 = 0.0008757

sh1 = 0.00280225

ft1 = 328.3881

fy1 = 273.6568

su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757

sh2 = 0.00280225

ft2 = 328.3881

fy2 = 273.6568

su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757

shv = 0.00280225

ftv = 328.3881

fyv = 273.6568

suv = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Esv = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0347448$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0347448$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02120631$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 31.27541
 cc (5A.5, TBDY) = 0.00242514
 c = confinement factor = 1.04251
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04166345$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04166345$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02542907$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs_{y2}$ - LHS eq.(4.5) is satisfied
 --->
 su (4.9) = 0.22203037
 $Mu = MRc$ (4.14) = 8.9928E+007
 $u = su$ (4.1) = 1.0089632E-005

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$
 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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

 Calculation of $Mu1$ -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.0089632E-005$
 $Mu = 8.9928E+007$

 with full section properties:
 $b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $fc = 30.00$
 co (5A.5, TBDY) = 0.002
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00684112$
 we (5.4c) = 0.00697692
 ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$

$bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.41645$

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.53374$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $\text{No stirups, } ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $\text{No stirups, } ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $\text{No stirups, } ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $\text{No stirups, } ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $fce = 30.00$

$\text{From } ((5.A5), \text{ TBDY}), \text{ TBDY: } cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

$\text{using (30) in Biskinis/Fardis (2013) multiplied with shear_factor}$
 $\text{and also multiplied by the shear_factor according to 15.7.1.4, with}$
 $\text{Shear_factor} = 1.00$

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_nominal ((5.5), \text{ TBDY}) = 0.032$

$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08,$

$\text{For calculation of } esu1_nominal \text{ and } y1, sh1, ft1, fy1, \text{ it is considered}$
 $\text{characteristic value } fsy1 = fs1 / 1.2, \text{ from table 5.1, TBDY.}$

$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$

$\text{with } fs1 = (fs, jacket * Asl, ten, jacket + fs, core * Asl, ten, core) / Asl, ten = 273.6568$

$\text{with } Es1 = (Es, jacket * Asl, ten, jacket + Es, core * Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

$\text{using (30) in Biskinis/Fardis (2013) multiplied with shear_factor}$
 $\text{and also multiplied by the shear_factor according to 15.7.1.4, with}$
 $\text{Shear_factor} = 1.00$

$lo/lou, min = lb/lb, min = 0.14834034$

$su2 = 0.4 * esu2_nominal ((5.5), \text{ TBDY}) = 0.032$

$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08,$

$\text{For calculation of } esu2_nominal \text{ and } y2, sh2, ft2, fy2, \text{ it is considered}$
 $\text{characteristic value } fsy2 = fs2 / 1.2, \text{ from table 5.1, TBDY.}$

$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$

$$\text{with } fs_2 = (fs_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + fs_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 273.6568$$

$$\text{with } Es_2 = (Es_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + Es_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 200000.00$$

$$yv = 0.0008757$$

$$shv = 0.00280225$$

$$ftv = 328.3881$$

$$fyv = 273.6568$$

$$suv = 0.00280225$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$$lo/lo_{\text{min}} = lb/ld = 0.14834034$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{\text{nominal}}$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 273.6568$$

$$\text{with } Es_v = (Es_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + Es_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 200000.00$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.0347448$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.0347448$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.02120631$$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, \text{TBDY}) = 31.27541$
 $cc (5A.5, \text{TBDY}) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.04166345$
 $2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.04166345$
 $v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$

$lb = 300.00$

$ld = 2022.376$

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)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu_{2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.0089632E-005$

$$\mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi = 0.00684112$$

$$\phi (5.4c) = 0.00697692$$

$$A_{se} ((5.4d), \text{TB DY}) = (A_{se1} * A_{ext} + A_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$A_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$A_{se2} = \text{Max}(A_{se1}, A_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.41645$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.53374$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.41645$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / l_d = 0.14834034$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1_{\text{nominal}} = 0.08,$$

For calculation of esu_1_{nominal} and y_1, sh_1, ft_1, fy_1 , it is considered

characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.14834034
lb = 300.00
lb = 2022.376
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
lb,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)
= 1
db = 15.23077

```

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 1.0089632E-005$$

$$\mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\alpha (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00684112$$

$$\mu (5.4c) = 0.00697692$$

$$\alpha_e ((5.4d), TBDY) = (\alpha_1 * A_{ext} + \alpha_2 * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_1 = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i_1} = 975400.00$$

$$\alpha_2 = \text{Max}(\alpha_1, \alpha_2) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i_2} = 557856.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.41645$$

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.53374$$

$$\mu_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.41645$$

$$\mu_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

From (5A.5, TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.14834034$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu1_nominal = 0.08$,
 For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568$
 with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.14834034$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568$
 with $Es_v = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631$
 and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

---->

$$su(4.9) = 0.22203037$$

$$Mu = MRc(4.14) = 8.9928E+007$$

$$u = su(4.1) = 1.0089632E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14834034$$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,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)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 397330.256$

Calculation of Shear Strength at edge 1, $V_{r1} = 397330.256$

$$V_{r1} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '

where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$

$= 1$ (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / Mu < 1 = 0.00$$

$$Mu = 4.3946131E-012$$

$$Vu = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 780103.388$$

Calculation of Shear Strength at edge 2, $V_{r2} = 397330.256$

$$V_{r2} = V_n \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f^*V_f$ '

where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 3.1257229E-011$
 $V_u = 8.9541895E-015$
 From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 $V_f ((11-3)-(11.4), ACI 440) = 0.00$
 From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
 At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (a)
 Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$
 Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
 Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 Jacket
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 5.1787\text{E}+006$

Shear Force, $V2 = -7.6321477\text{E}-015$

Shear Force, $V3 = 4767.522$

Axial Force, $F = -5285.801$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{c,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 402.1239$

-Compression: $As_{c,com,jacket} = 804.2477$

-Middle: $As_{c,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,core} = 307.8761$

-Compression: $As_{c,com,core} = 461.8141$

-Middle: $As_{c,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01058881$

$u = y + p = 0.01058881$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00058881$ ((4.29), Biskinis Phd))

$M_y = 1.2591\text{E}+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 1086.241

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.7425\text{E}+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 2.4988631\text{E}-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (I_b / I_d)^{2/3}) = 254.0405$

$d = 627.00$

$y = 0.18929495$

$A = 0.00956536$

$B = 0.00411677$

with $p_t = 0.00283094$

$p_c = 0.00504809$

$p_v = 0.00160336$

$N = 5285.801$

$b = 400.00$

$\epsilon = 0.06858054$

$y_{comp} = 1.7835268\text{E}-005$

with $f_c = 30.00$

$E_c = 25742.96$

$y = 0.18758068$

$A = 0.00943216$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/l_{d,min} = 0.18542542$

$l_b = 300.00$

$l_d = 1617.901$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

$(l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.26808017$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)

$= 5.0826101E-005$

- Stirrup Spacing $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

- Strength provided by hoops $V_s < 3/4 \times \text{design Shear}$

$V_s = 434586.984$, already given in calculation of shear control ratio

design Shear = 4767.522

- $(\rho' - \rho)/\rho_{bal} = -0.29412606$

$= A_{st}/(b_w \times d) = 0.00283094$

Tension Reinf Area: $A_{st} = 709.9999$

$\rho' = A_{sc}/(b_w \times d) = 0.00665146$

Compression Reinf Area: $A_{sc} = 1668.186$

From (B-1), ACI 318-11: $\rho_{bal} = 0.01298939$

$f_c = (f_{c,jacket} \times \text{Area}_{jacket} + f_{c,core} \times \text{Area}_{core}) / \text{section_area} = 30.00$

$f_y = f_{y,jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: $\beta_1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = cb/dt = 0.003/(0.003 + \gamma) = 0.48979592$

$\gamma = 0.003125$

- $V/(b_w \times d \times f_c^{0.5}) = 0.04179533$, NOTE: units in lb & in

$b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 3

beam B1, Floor 1

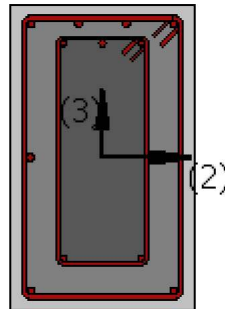
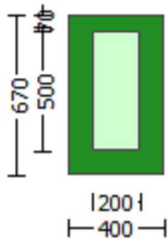
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 5.1787E+006$

Shear Force, $V_a = 4767.522$

EDGE -B-

Bending Moment, $M_b = 1.0041E+007$

Shear Force, $V_b = 14913.744$

BOTH EDGES

Axial Force, $F = -5285.801$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{mid} = 402.1239$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 473527.293$
 V_n ((22.5.1.1), ACI 318-14) = 473527.293

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 159368.028$
= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c,jacket} \cdot Area_{jacket} + f'_{c,core} \cdot Area_{core}) / Area_{section} = 20.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.4934446$

$M_u = 5.1787E+006$

$V_u = 4767.522$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 4

beam B1, Floor 1

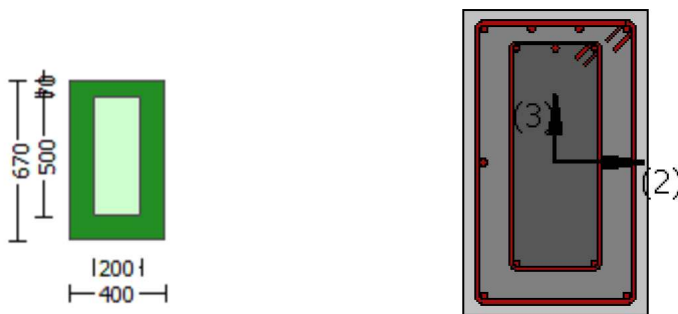
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.04251
 Element Length, $L = 3000.00$
 Primary 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 $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.634$
 EDGE -B-
 Shear Force, $V_b = 9840.632$
 BOTH EDGES
 Axial Force, $F = -2287.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 709.9999$
 -Compression: $A_{sc} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 709.9999$
 -Compression: $A_{sc,com} = 1266.062$
 -Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26808017$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 158880.346$
 with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 2.2356E+008$
 $\mu_{u1+} = 1.1381E+008$, 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
 $\mu_{u1-} = 2.2356E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 2.2356E+008$
 $\mu_{u2+} = 1.1381E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 2.2356E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6034793E-006$
 $\mu_u = 1.1381E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$


```

fc = 30.00
cc (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00684112
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00684112
we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645
-----
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00
-----
psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00
-----
Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251
y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

```

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 273.6568$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 273.6568$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.02582354$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.04604817$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.0319073$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.05689664$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.20240787$

$Mu = MRc (4.14) = 1.1381E+008$

$u = su (4.1) = 5.6034793E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu1-

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 5.7880076E-006$$

$$M_u = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi_{co} (5A.5, TBDY) = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu} = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00684112$$

$$\phi_{we} (5.4c) = 0.00697692$$

$$\phi_{ase} ((5.4d), TBDY) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh, min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.41645$$

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.53374$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.41645$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } \phi_{cc} = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu_{1,nominal} = 0.08$,
For calculation of $esu_{1,nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_1 = (fs_{jacket} * A_{sl,ten,jacket} + fs_{core} * A_{sl,ten,core}) / A_{sl,ten} = 273.6568$
with $Es_1 = (Es_{jacket} * A_{sl,ten,jacket} + Es_{core} * A_{sl,ten,core}) / A_{sl,ten} = 200000.00$
 $y_2 = 0.0008757$
 $sh_2 = 0.00280225$
 $ft_2 = 328.3881$
 $fy_2 = 273.6568$
 $su_2 = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_2, sh_2, ft_2, fy_2 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 273.6568$
with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 273.6568$
with $Esv = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04604817$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.02582354$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01462572$
and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.05689664$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.0319073$
 $v = A_{sl,mid} / (b * d) * (fsv / fc) = 0.01807139$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,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)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$\mu = 5.6034793E-006$

$\mu = 1.1381E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00030396$

$N = 2287.027$

$f_c = 30.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu = 0.00684112$

w_e (5.4c) = 0.00697692

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$

$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$

$ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h1 = 670.00$

$ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

$h2 = 500.00$

$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.41645$

$ps1$ (external) = $(A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$

$A_{sh1} = A_{stir_1} * ns_1 = 157.0796$

No stirups, $ns_1 = 2.00$

$h1 = 400.00$

$ps2$ (internal) = $(A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$

$A_{sh2} = A_{stir_2} * ns_2 = 100.531$

No stirups, $ns_2 = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } cc = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1 \text{ nominal} = 0.08,$$

For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$$

$$\text{with } Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.0008757$$

$$sh_2 = 0.00280225$$

$$ft_2 = 328.3881$$

$$fy_2 = 273.6568$$

$$su_2 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.14834034$$

$$su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_2 \text{ nominal} = 0.08,$$

For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$$

$$\text{with } Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.0008757$$

$$sh_v = 0.00280225$$

$$ft_v = 328.3881$$

$$fy_v = 273.6568$$

$$su_v = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$su_v = 0.4 * esuv \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv \text{ nominal} = 0.08,$$

considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY
For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 273.6568$$

$$\text{with } Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02582354$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04604817$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01462572$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc \text{ (5A.2, TB DY)} = 31.27541$$

```

cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0319073
2 = Asl,com/(b*d)*(fs2/fc) = 0.05689664
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20240787
Mu = MRc (4.14) = 1.1381E+008
u = su (4.1) = 5.6034793E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 5.7880076E-006
Mu = 2.2356E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.00030396
N = 2287.027
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00684112
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00684112
we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799

```

Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 670.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
 ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
 Ash1 = Astir_1*ns_1 = 157.0796
 No stirups, ns_1 = 2.00
 h1 = 400.00
 ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
 Ash2 = Astir_2*ns_2 = 100.531
 No stirups, ns_2 = 2.00
 h2 = 200.00

Asec = 268000.00
 s1 = 150.00
 s2 = 300.00
 fywe1 = 781.25
 fywe2 = 781.25
 fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514
 c = confinement factor = 1.04251

y1 = 0.0008757
 sh1 = 0.00280225
 ft1 = 328.3881
 fy1 = 273.6568
 su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
 characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
 sh2 = 0.00280225
 ft2 = 328.3881
 fy2 = 273.6568
 su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
 characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (\text{lb}/\text{ld})^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
 shv = 0.00280225
 ftv = 328.3881
 fyv = 273.6568
 suv = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 273.6568$
 with $Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04604817$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.02582354$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01462572$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.05689664$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.0319073$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01807139$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vsy2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

 Calculation of ratio lb/ld

 Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$
 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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

 Calculation of Shear Strength $Vr = Min(Vr1, Vr2) = 592659.827$

 Calculation of Shear Strength at edge 1, $Vr1 = 592659.827$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

 NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f * Vf$ '
 where Vf is the contribution of FRPs (11.3), ACI 440).

 From Table (22.5.5.1), ACI 318-14: $Vc = 199960.745$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc_jacket * Area_jacket + fc_core * Area_core) / Area_section = 30.00$, but $fc'^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $pw = As / (bw * d) = 0.00331157$
 As (tension reinf.) = 709.9999
 $bw = 400.00$
 $d = 536.00$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1092E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From (11-11), ACI } 440: V_s + V_f \leq 780103.388$$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI } 318-14: V_c = 199960.745$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 30.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI } 318-14)$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1092E+006$$

$$V_u = 9840.632$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From (11-11), ACI } 440: V_s + V_f \leq 780103.388$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.04251
Element Length, $L = 3000.00$
Primary 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 $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = 8.9541895E-015$
EDGE -B-
Shear Force, $V_b = -8.9541895E-015$
BOTH EDGES
Axial Force, $F = -2287.027$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 911.0619$
-Compression: $A_{sl,com} = 911.0619$
-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15088696$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 59951.954$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 8.9928E+007$
 $\mu_{u1+} = 8.9928E+007$, 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
 $\mu_{u1-} = 8.9928E+007$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 8.9928E+007$

$Mu_{2+} = 8.9928E+007$, 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

$Mu_{2-} = 8.9928E+007$, 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
and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

$V1 = 8.9541895E-015$, is the shear force acting at edge 1 for the the static loading combination

$V2 = -8.9541895E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$Mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$fc = 30.00$$

$$co(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00684112$$

$$we(5.4c) = 0.00697692$$

$$ase((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh, min*Fywe = \text{Min}(psh, x*Fywe, psh, y*Fywe) = 1.41645$$

$$psh_x*Fywe = psh1*Fywe1 + ps2*Fywe2 = 2.53374$$

$$ps1(\text{external}) = (Ash1*h1/s1)/Asec = 0.00261799$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2*h2/s2)/Asec = 0.00062519$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y*Fywe = psh1*Fywe1 + ps2*Fywe2 = 1.41645$$

$$ps1(\text{external}) = (Ash1*h1/s1)/Asec = 0.00156298$$

$$Ash1 = Astir_1*ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2*h2/s2)/Asec = 0.00025008$$

$$Ash2 = Astir_2*ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 781.25$$

```

fce = 30.00
From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251
y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $\mu_u (4.9) = 0.22203037$
 $\mu_u = M_{Rc} (4.14) = 8.9928E+007$
 $u = \mu_u (4.1) = 1.0089632E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$
 $l_b = 300.00$
 $l_d = 2022.376$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d ,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)
 $= 1$
 $d_b = 15.23077$
 Mean strength value of all re-bars: $f_y = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.0089632E-005$
 $\mu_u = 8.9928E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $f_c = 30.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.00684112$
 $\mu_u (5.4c) = 0.00697692$
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$
 $p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirrups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirrups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $\text{No stirups, } ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $\text{No stirups, } ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 781.25$

$fce = 30.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00242514$

$c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$

$sh1 = 0.00280225$

$ft1 = 328.3881$

$fy1 = 273.6568$

$su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket * Asl, ten, jacket + fs_core * Asl, ten, core) / Asl, ten = 273.6568$

with $Es1 = (Es_jacket * Asl, ten, jacket + Es_core * Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0008757$

$sh2 = 0.00280225$

$ft2 = 328.3881$

$fy2 = 273.6568$

$su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/lb, min = 0.14834034$

$su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket * Asl, com, jacket + fs_core * Asl, com, core) / Asl, com = 273.6568$

with $Es2 = (Es_jacket * Asl, com, jacket + Es_core * Asl, com, core) / Asl, com = 200000.00$

$yv = 0.0008757$

$shv = 0.00280225$

$ftv = 328.3881$

$fyv = 273.6568$

$suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/ld = 0.14834034$

$suv = 0.4 * esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket * Asl, mid, jacket + fs_mid * Asl, mid, core) / Asl, mid = 273.6568$

with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0347448$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0347448$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02120631$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 31.27541$$

$$c_c (5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04166345$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04166345$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.22203037$$

$$\mu_u = M_{Rc} (4.14) = 8.9928E+007$$

$$u = s_u (4.1) = 1.0089632E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.14834034$

$$l_b = 300.00$$

$$d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{b,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{u2+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$\mu_u = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, c_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00684112$$

$$w_e (5.4c) = 0.00697692$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_o_1 = 340.00$$

$$h_o_1 = 610.00$$


```

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

```

```

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

```

From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

```

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

```

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

```

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005
-----

Calculation of ratio lb/ld
-----

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.0089632E-005
Mu = 8.9928E+007
-----

```

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi = 0.00684112$$

$$\phi_e (5.4c) = 0.00697692$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.41645$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.53374$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.41645$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / d = 0.14834034$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{1_nominal} = 0.08,$$

For calculation of $esu_{1_nominal}$ and y_1 , sh_1 , ft_1 , fy_1 , it is considered

characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{sjacket} * A_{sl, ten, jacket} + f_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 273.6568$$

$$\text{with } Es_1 = (E_{sjacket} * A_{sl, ten, jacket} + E_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$$

```

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154

```

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 397330.256$

Calculation of Shear Strength at edge 1, $V_{r1} = 397330.256$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 30.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.3946131\text{E-}012$
 $V_u = 8.9541895\text{E-}015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

Calculation of Shear Strength at edge 2, $V_{r2} = 397330.256$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + f'_c_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 30.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 3.1257229\text{E-}011$
 $V_u = 8.9541895\text{E-}015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 625.00$

$s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -1.7163466\text{E-}011$

Shear Force, $V_2 = -7.6321477\text{E-}015$

Shear Force, $V_3 = 4767.522$

Axial Force, $F = -5285.801$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_{lt} = 709.9999$

-Compression: $As_{lc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten,jacket} = 603.1858$

-Compression: $Asl,com,jacket = 603.1858$

-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$

-Compression: $Asl,com,core = 307.8761$

-Middle: $Asl,mid,core = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.0066567$

$u = y + p = 0.0066567$

- Calculation of y -

$y = (My*Ls/3)/Eleff = 0.0016567 ((4.29),Biskinis Phd)$

$My = 9.1438E+007$

$Ls = M/V$ (with $Ls > 0.1*L$ and $Ls < 2*L$) = 1500.00

From table 10.5, ASCE 41_17: $Eleff = 0.3*Ec*Ig = 2.7596E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 4.6125528E-006$

with ((10.1), ASCE 41-17) $fy = \text{Min}(fy, 1.25*fy*(lb/d)^{2/3}) = 254.0405$

$d = 357.00$

$y = 0.22862898$

$A = 0.01002965$

$B = 0.00565711$

with $pt = 0.00380895$

$pc = 0.00380895$

$pv = 0.00232477$

$N = 5285.801$

$b = 670.00$

$" = 0.12044818$

$y_{comp} = 2.5858904E-005$

with $fc = 30.00$

$Ec = 25742.96$

$y = 0.22722543$

$A = 0.00988999$

$B = 0.00557012$

with $Es = 200000.00$

Calculation of ratio lb/d

Lap Length: $ld/d,min = 0.18542542$

$lb = 300.00$

$ld = 1617.901$

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)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$

with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.15088696$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $\gamma = 7.7109583E-022$
- Stirrup Spacing $\leq d/2$
 $d = d_{\text{external}} = 357.00$
 $s = s_{\text{external}} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 242949.832$, already given in calculation of shear control ratio
design Shear = $7.6321477E-015$
- ($\rho_t - \rho_c$)/ $\rho_{\text{bal}} = -0.30840259$
 $\rho_t = A_{st}/(b_w \cdot d) = 0.00296835$
Tension Reinf Area: $A_{st} = 709.9999$
 $\rho_c = A_{sc}/(b_w \cdot d) = 0.00697431$
Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $\rho_{\text{bal}} = 0.01298939$
 $f_c = (f_{c_jacket} \cdot \text{Area}_{\text{jacket}} + f_{c_core} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 30.00$
 $f_y = f_{y_jacket_bars} = 625.00$
From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b/d_t = 0.003 / (0.003 + \gamma) = 0.48979592$
 $\gamma = 0.003125$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 7.0156248E-020$, NOTE: units in lb & in
 $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

beam B1, Floor 1

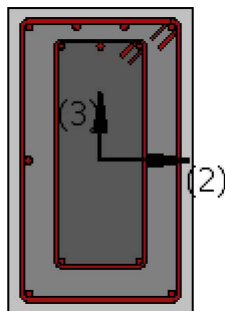
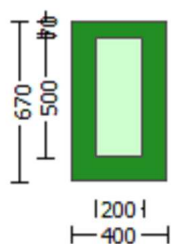
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -1.7163466E-011$

Shear Force, $V_a = -7.6321477E-015$

EDGE -B-

Bending Moment, $M_b = -5.8922949E-012$

Shear Force, $V_b = 7.6321477E-015$

BOTH EDGES

Axial Force, $F = -5285.801$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $Asl_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $DbL_{ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 320963.76$
 $V_n ((22.5.1.1), ACI 318-14) = 320963.76$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 153412.152$
 $= 1$ (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 20.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = As / (bw \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

$bw = 670.00$

$d = 320.00$

$V_u \cdot d / M_u < 1 = 0.00$

$M_u = 5.8922949E-012$

$V_u = 7.6321477E-015$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 0.00$ is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)

$V_f ((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 6

beam B1, Floor 1

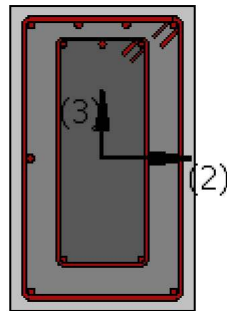
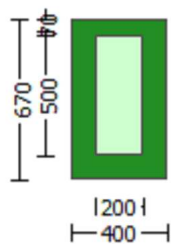
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.04251

Element Length, $L = 3000.00$

Primary 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 $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2287.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{c,com} = 1266.062$
 -Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26808017$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 158880.346$
 with
 $M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 2.2356E+008$
 $\mu_{1+} = 1.1381E+008$, 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
 $\mu_{1-} = 2.2356E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 2.2356E+008$
 $\mu_{2+} = 1.1381E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{2-} = 2.2356E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
 and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
 with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{1+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 5.6034793E-006$
 $M_u = 1.1381E+008$

with full section properties:
 $b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $f_c = 30.00$
 ϕ_c (5A.5, TBDY) = 0.002
 Final value of ϕ_c : $\phi_c^* = \text{shear_factor} \cdot \text{Max}(\phi_c, \phi_c) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_c = 0.00684112$
 w_e (5.4c) = 0.00697692
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int})/A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh,min} \cdot F_{ywe} = \text{Min}(p_{sh,x} \cdot F_{ywe}, p_{sh,y} \cdot F_{ywe}) = 1.41645$
 $p_{sh,x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.53374$
 p_{s1} (external) = $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$

No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

From ((5.A.5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket*Asl_mid,jacket + fs_mid*Asl_mid,core)/Asl_mid = 273.6568$
 with $Esv = (Es_jacket*Asl_mid,jacket + Es_mid*Asl_mid,core)/Asl_mid = 200000.00$
 $1 = Asl_ten/(b*d)*(fs1/fc) = 0.02582354$
 $2 = Asl_com/(b*d)*(fs2/fc) = 0.04604817$
 $v = Asl_mid/(b*d)*(fsv/fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 31.27541
 cc (5A.5, TBDY) = 0.00242514
 c = confinement factor = 1.04251
 $1 = Asl_ten/(b*d)*(fs1/fc) = 0.0319073$
 $2 = Asl_com/(b*d)*(fs2/fc) = 0.05689664$
 $v = Asl_mid/(b*d)*(fsv/fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

---->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied

---->
 su (4.9) = 0.20240787
 $Mu = MRc$ (4.14) = 1.1381E+008
 $u = su$ (4.1) = 5.6034793E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 5.7880076E-006$
 $Mu = 2.2356E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $fc = 30.00$
 co (5A.5, TBDY) = 0.002
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00684112$
 The $Shear_factor$ is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.00684112$
 w_e (5.4c) = 0.00697692
 a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.41645$

$p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 2.53374$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{s2} \cdot F_{ywe2} = 1.41645$
 p_{s1} (external) = $(A_{sh1} \cdot h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 p_{s2} (internal) = $(A_{sh2} \cdot h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} \cdot n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$

$s_1 = 150.00$

$s_2 = 300.00$

$f_{ywe1} = 781.25$

$f_{ywe2} = 781.25$

$f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $c_c = 0.00242514$

c = confinement factor = 1.04251

$y_1 = 0.0008757$

$sh_1 = 0.00280225$

$ft_1 = 328.3881$

$fy_1 = 273.6568$

$su_1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 0.14834034$

$su_1 = 0.4 \cdot esu_{1_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1 , sh_1 , ft_1 , fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + f_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 273.6568$

with $Es_1 = (E_{s, \text{jacket}} \cdot A_{s, \text{ten, jacket}} + E_{s, \text{core}} \cdot A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0008757$

$sh_2 = 0.00280225$

$ft_2 = 328.3881$

$fy_2 = 273.6568$

$su_2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_{b, \min} = 0.14834034$

$su_2 = 0.4 \cdot esu_{2_nominal}$ ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $es_{u2_nominal} = 0.08$,
 For calculation of $es_{u2_nominal}$ and y_2 , sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 273.6568$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $s_{uv} = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/d = 0.14834034$
 $s_{uv} = 0.4 \cdot es_{uv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $es_{uv_nominal} = 0.08$,
 considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $es_{uv_nominal}$ and y_v , sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.
 y_1 , sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.04604817$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.02582354$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten}/(b \cdot d) \cdot (fs_1/f_c) = 0.05689664$
 $2 = Asl_{com}/(b \cdot d) \cdot (fs_2/f_c) = 0.0319073$
 $v = Asl_{mid}/(b \cdot d) \cdot (fs_v/f_c) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio lb/d

Lap Length: $lb/d = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

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)

$= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6034793E-006$$

$$\mu = 1.1381E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00684112$$

$$\omega_e (5.4c) = 0.00697692$$

$$\alpha_{se} ((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.41645$$

$$\text{psh}_x * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.53374$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_y * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.41645$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 0.14834034$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 273.6568$
with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 273.6568$
with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 273.6568$
with $Es_v = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.02582354$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.04604817$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.0319073$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.05689664$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.20240787$
 $Mu = MRc (4.14) = 1.1381E+008$
 $u = su (4.1) = 5.6034793E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.7880076E-006$$

$$\mu = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi_0 \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \phi_0) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00684112$$

$$\mu_e \text{ (5.4c)} = 0.00697692$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o,1} = 340.00$$

$$h_{o,1} = 610.00$$

$$b_{i,1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o,2} = 192.00$$

$$h_{o,2} = 492.00$$

$$b_{i,2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$$

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$$

$$\text{No stirups, } n_{s,1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$$

$$\text{No stirups, } n_{s,2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645$$

$$p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$$

$$\text{No stirups, } n_{s,1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$$

$$\text{No stirups, } n_{s,2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$s_2 = 300.00$
 $fy_{we1} = 781.25$
 $fy_{we2} = 781.25$
 $f_{ce} = 30.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $y_1 = 0.0008757$
 $sh_1 = 0.00280225$
 $ft_1 = 328.3881$
 $fy_1 = 273.6568$
 $su_1 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.14834034$
 $su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.0008757$
 $sh_2 = 0.00280225$
 $ft_2 = 328.3881$
 $fy_2 = 273.6568$
 $su_2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.14834034$
 $su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 * esuv \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 273.6568$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.04604817$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.02582354$
 $v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01462572$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 31.27541$
 $cc \text{ (5A.5, TBDY)} = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.05689664$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.0319073$

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.01807139$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.22783602$$

$$\mu = M_{Rc}(4.14) = 2.2356E+008$$

$$u = s_u(4.1) = 5.7880076E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, 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)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 592659.827$

Calculation of Shear Strength at edge 1, $V_{r1} = 592659.827$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '

where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} * \text{Area}_{jacket} + f'_c_{core} * \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u * d / \mu < 1 = 1.00$$

$$\mu = 1.1092E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 780103.388$$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.1092E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 41887.902$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.04251
Element Length, L = 3000.00
Primary 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 l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, V_a = 8.9541895E-015
EDGE -B-
Shear Force, V_b = -8.9541895E-015
BOTH EDGES
Axial Force, F = -2287.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: A_{st} = 709.9999
-Compression: A_{sc} = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten}$ = 911.0619
-Compression: $A_{sc,com}$ = 911.0619
-Middle: $A_{st,mid}$ = 556.0619

Calculation of Shear Capacity ratio , V_e/V_r = 0.15088696
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 59951.954$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 8.9928E+007$
 $\mu_{u1+} = 8.9928E+007$, 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
 $\mu_{u1-} = 8.9928E+007$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 8.9928E+007$
 $\mu_{u2+} = 8.9928E+007$, 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
 $\mu_{u2-} = 8.9928E+007$, 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
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 8.9541895E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = -8.9541895E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.0089632E-005$
 $\mu_u = 8.9928E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $fc = 30.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00684112$
 $w_e(5.4c) = 0.00697692$
 $ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = Max(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.41645$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$
 $ps1(external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2(internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$
 $ps1(external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2(internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$

$fywe1 = 781.25$
 $fywe2 = 781.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_nominal((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, jacket * A_{sl, ten, jacket} + fs, core * A_{sl, ten, core}) / A_{sl, ten} = 273.6568$

with $Es1 = (Es, jacket * A_{sl, ten, jacket} + Es, core * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0008757$


```

sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lo,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$u = 1.0089632E-005$
 $Mu = 8.9928E+007$

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00031872
N = 2287.027

fc = 30.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) = 0.00697692

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.41645$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 781.25

fce = 30.00

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00242514$

c = confinement factor = 1.04251

y1 = 0.0008757

```

sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.14834034
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14834034
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
    c = confinement factor = 1.04251
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037

```

$$\begin{aligned} \mu &= M/R_c (4.14) = 8.9928E+007 \\ u &= s_u (4.1) = 1.0089632E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

$$\begin{aligned} \text{Lap Length: } l_b/l_d &= 0.14834034 \\ l_b &= 300.00 \\ l_d &= 2022.376 \end{aligned}$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d ,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)

$$\begin{aligned} &= 1 \\ db &= 15.23077 \\ \text{Mean strength value of all re-bars: } f_y &= 781.25 \\ t &= 1.16154 \\ s &= 0.80 \\ e &= 1.00 \\ cb &= 25.00 \\ K_{tr} &= 2.64216 \\ n &= 13.00 \end{aligned}$$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\begin{aligned} u &= 1.0089632E-005 \\ \mu &= 8.9928E+007 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 670.00 \\ d &= 357.00 \\ d' &= 43.00 \\ v &= 0.00031872 \\ N &= 2287.027 \\ f_c &= 30.00 \\ c_o (5A.5, TBDY) &= 0.002 \\ \text{Final value of } c_u: c_u &= \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00684112 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } c_u &= 0.00684112 \\ w_e (5.4c) &= 0.00697692 \\ a_{se} ((5.4d), TBDY) &= (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895 \\ a_{se1} &= 0.14776895 \\ b_{o_1} &= 340.00 \\ h_{o_1} &= 610.00 \\ b_{i_1} &= 975400.00 \\ a_{se2} &= \text{Max}(a_{se1}, a_{se2}) = 0.14776895 \\ b_{o_2} &= 192.00 \\ h_{o_2} &= 492.00 \\ b_{i_2} &= 557856.00 \\ p_{sh,min} * F_{ywe} &= \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645 \end{aligned}$$

$$\begin{aligned} p_{sh,x} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374 \\ p_{s1} \text{ (external)} &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirups, } n_{s_1} &= 2.00 \\ h_1 &= 670.00 \\ p_{s2} \text{ (internal)} &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirups, } n_{s_2} &= 2.00 \\ h_2 &= 500.00 \end{aligned}$$

$$\begin{aligned} p_{sh,y} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645 \\ p_{s1} \text{ (external)} &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \end{aligned}$$

No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fyw1 = 781.25$
 $fyw2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es_jacket \cdot Asl, \text{ten}, \text{jacket} + Es_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 273.6568$

with $Es2 = (Es_jacket \cdot Asl, \text{com}, \text{jacket} + Es_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$

$yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket \cdot Asl, \text{mid}, \text{jacket} + fs_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 273.6568$

with $Esv = (Es_jacket \cdot Asl, \text{mid}, \text{jacket} + Es_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0347448$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0347448$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02120631$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 31.27541$$

$$cc(5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04166345$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04166345$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su(4.9) = 0.22203037$$

$$\mu_u = MR_c(4.14) = 8.9928E+007$$

$$u = su(4.1) = 1.0089632E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{u2} -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$\mu_u = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00684112$$

$$w_e(5.4c) = 0.00697692$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi_2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb,min)^ 2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568

$$suv = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 0.14834034$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and yv , shv , ftv , fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 273.6568$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.0347448$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.0347448$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02120631$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 31.27541$$

$$cc (5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04166345$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04166345$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.22203037$$

$$Mu = MRc (4.14) = 8.9928E+007$$

$$u = su (4.1) = 1.0089632E-005$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.14834034$$

$$lb = 300.00$$

$$ld = 2022.376$$

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)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $fy = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 397330.256$

Calculation of Shear Strength at edge 1, $V_{r1} = 397330.256$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI 318-14: } V_c = 187890.746$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 30.00, \text{ but } fc'^{0.5} \leq 8.3$$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 4.3946131E-012$$

$$Vu = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$

$Vs1 = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

Calculation of Shear Strength at edge 2, $Vr2 = 397330.256$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f*Vf$ '
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 187890.746$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 30.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 3.1257229E-011$$

$$Vu = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$

$Vs1 = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.0041E+007$

Shear Force, $V_2 = 7.6321477E-015$

Shear Force, $V_3 = 14913.744$

Axial Force, $F = -5285.801$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{l,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 402.1239$

-Compression: $As_{l,com,jacket} = 804.2477$

-Middle: $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,core} = 307.8761$

-Compression: $As_{l,com,core} = 461.8141$

-Middle: $As_{l,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.01036495$

$u = y + p = 0.01036495$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00036495 ((4.29), \text{Biskinis Phd})$

$M_y = 1.2591E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) $= 673.2661$

From table 10.5, ASCE 41-17: $E_{eff} = 0.3 \cdot E_c \cdot I_g = 7.7425E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 2.4988631E-006$
with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b/I_d)^{2/3}) = 254.0405$
 $d = 627.00$
 $y = 0.18929495$
 $A = 0.00956536$
 $B = 0.00411677$
with $p_t = 0.00283094$
 $p_c = 0.00504809$
 $p_v = 0.00160336$
 $N = 5285.801$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7835268E-005$
with $f_c = 30.00$
 $E_c = 25742.96$
 $y = 0.18758068$
 $A = 0.00943216$
 $B = 0.0040338$
with $E_s = 200000.00$

Calculation of ratio I_b/I_d

Lap Length: $I_d/I_{d,min} = 0.18542542$
 $I_b = 300.00$
 $I_d = 1617.901$
Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 15.23077$
Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.01$

with:

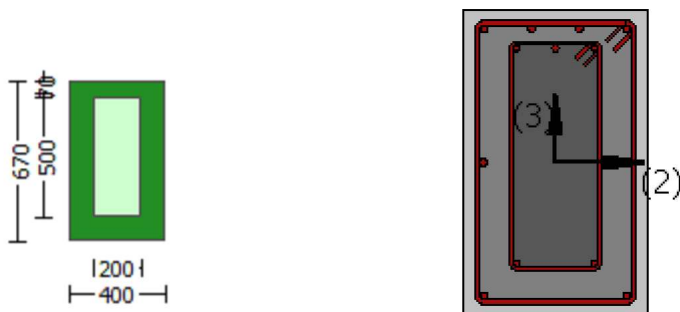
- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($I_b/I_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.26808017$
- Transverse Reinforcement: C
- Stirrup Spacing $\leq d/3$
- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)
 $= -4.4998439E-007$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 627.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 434586.984$, already given in calculation of shear control ratio
 design Shear = 14913.744
 $- (- ') / \text{ bal} = -0.29412606$
 $= A_{st}/(b_w*d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $' = A_{sc}/(b_w*d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
 From (B-1), ACI 318-11: $\text{ bal} = 0.01298939$
 $f_c = (f_{c_jacket}*Area_jacket + f_{c_core}*Area_core)/section_area = 30.00$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/dt = 0.003/(0.003 + y) = 0.48979592$
 $y = 0.003125$
 $- V/(b_w*d*f_c^{0.5}) = 0.130744$, NOTE: units in lb & in
 $b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (b)

Calculation No. 7

beam B1, Floor 1
 Limit State: Operational Level (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity VR_d
 Edge: End
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (b)
 Section Type: rcjars
 Constant Properties

Knowledge Factor, $\phi = 1.00$
 Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 Jacket
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Primary 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 $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 5.1787E+006$
 Shear Force, $V_a = 4767.522$
 EDGE -B-
 Bending Moment, $M_b = 1.0041E+007$
 Shear Force, $V_b = 14913.744$
 BOTH EDGES
 Axial Force, $F = -5285.801$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{l,com} = 1266.062$
 -Middle: $As_{l,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41-17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 477180.574$
 V_n ((22.5.1.1), ACI 318-14) = 477180.574

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 163021.308$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 20.00$, but $f'_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 0.79611908$

$$Mu = 1.0041E+007$$

$$Vu = 14913.744$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 314159.265$

$Vs1 = 280648.944$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 500.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 33510.322$ is calculated for core, with:

$$d = 400.00$$

$$Av = 100530.965$$

$$fy = 500.00$$

$$s = 300.00$$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$Vf ((11-3)-(11.4), ACI 440) = 0.00$$

$$\text{From } (11-11), ACI 440: Vs + Vf \leq 636951.749$$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)

Calculation No. 8

beam B1, Floor 1

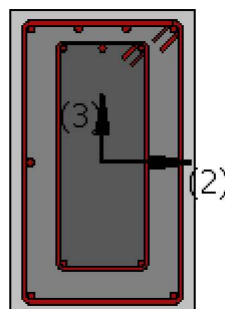
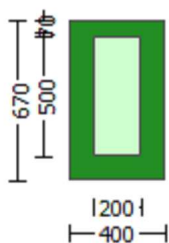
Limit State: Operational Level (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Jacket
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
 New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 #####
 Note: Especially for the calculation of moment strengths,
 the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
 Jacket
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
 Existing Column
 New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
 #####
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.04251
 Element Length, $L = 3000.00$
 Primary 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 $l_o = 300.00$
 No FRP Wrapping

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 9840.634$
 EDGE -B-
 Shear Force, $V_b = 9840.632$
 BOTH EDGES
 Axial Force, $F = -2287.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 709.9999$
 -Compression: $As_{l,com} = 1266.062$
 -Middle: $As_{l,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26808017$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 158880.346$
 with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 2.2356E+008$
 $M_{u1+} = 1.1381E+008$, 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
 $M_{u1-} = 2.2356E+008$, 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

$$M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 2.2356\text{E}+008$$

$M_{u2+} = 1.1381\text{E}+008$, 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

$M_{u2-} = 2.2356\text{E}+008$, 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

$$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$$

with

$V_1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination

$V_2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$\phi_u = 5.6034793\text{E}-006$$

$$M_u = 1.1381\text{E}+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi_{co} (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.00684112$$

$$\omega_{se} (5.4c) = 0.00697692$$

$$\phi_{ase} ((5.4d), \text{TBDY}) = (\phi_{ase1} * A_{ext} + \phi_{ase2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{ase1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{ase2} = \text{Max}(\phi_{ase1}, \phi_{ase2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{psh, \min} * F_{ywe} = \text{Min}(\phi_{psh, x} * F_{ywe}, \phi_{psh, y} * F_{ywe}) = 1.41645$$

$$\phi_{psh, x} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 2.53374$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{psh, y} * F_{ywe} = \phi_{psh1} * F_{ywe1} + \phi_{ps2} * F_{ywe2} = 1.41645$$

$$\phi_{ps1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{ps2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$


```

fywe2 = 781.25
fce = 30.00
From ((5A.5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251
y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02582354
2 = Asl,com/(b*d)*(fs2/fc) = 0.04604817
v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0319073
2 = Asl,com/(b*d)*(fs2/fc) = 0.05689664
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfinedsd full section - Steel rupture

```

satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

μ_u (4.9) = 0.20240787

$\mu_u = M_{Rc}$ (4.14) = 1.1381E+008

$u = \mu_u$ (4.1) = 5.6034793E-006

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,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)

= 1

$d_b = 15.23077$

Mean strength value of all re-bars: $f_y = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$u = 5.7880076E-006$

$\mu_u = 2.2356E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00030396$

$N = 2287.027$

$f_c = 30.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu_u = 0.00684112$

we (5.4c) = 0.00697692

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$

$a_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$

$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$

p_{s1} (external) = $(A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$

No stirrups, $n_{s_1} = 2.00$

$h_1 = 670.00$

p_{s2} (internal) = $(A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$

$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$

No stirrups, $n_{s_2} = 2.00$

$$h2 = 500.00$$

$$\begin{aligned} psh_y * Fywe &= psh1 * Fywe1 + ps2 * Fywe2 = 1.41645 \\ ps1 \text{ (external)} &= (Ash1 * h1 / s1) / Asec = 0.00156298 \\ Ash1 &= Astir_1 * ns_1 = 157.0796 \\ \text{No stirups, } ns_1 &= 2.00 \\ h1 &= 400.00 \\ ps2 \text{ (internal)} &= (Ash2 * h2 / s2) / Asec = 0.00025008 \\ Ash2 &= Astir_2 * ns_2 = 100.531 \\ \text{No stirups, } ns_2 &= 2.00 \\ h2 &= 200.00 \end{aligned}$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 781.25$$

$$fce = 30.00$$

$$\text{From } ((5.A.5), \text{ TBDY}), \text{ TBDY: } cc = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y1 = 0.0008757$$

$$sh1 = 0.00280225$$

$$ft1 = 328.3881$$

$$fy1 = 273.6568$$

$$su1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$su1 = 0.4 * esu1_nominal ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1, ft1, fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = (fs_jacket * Asl, \text{ten, jacket} + fs_core * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$$

$$\text{with } Es1 = (Es_jacket * Asl, \text{ten, jacket} + Es_core * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0008757$$

$$sh2 = 0.00280225$$

$$ft2 = 328.3881$$

$$fy2 = 273.6568$$

$$su2 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.14834034$$

$$su2 = 0.4 * esu2_nominal ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2, ft2, fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = (fs_jacket * Asl, \text{com, jacket} + fs_core * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$$

$$\text{with } Es2 = (Es_jacket * Asl, \text{com, jacket} + Es_core * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0008757$$

$$shv = 0.00280225$$

$$ftv = 328.3881$$

$$fyv = 273.6568$$

$$suv = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$suv = 0.4 * esuv_nominal ((5.5), \text{ TBDY}) = 0.032$$

From table 5A.1, TBDY: esuv_nominal = 0.08,

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv, ftv, fyv, it is considered

characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

y1, sh1, ft1, fy1, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

```

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04604817
2 = Asl,com/(b*d)*(fs2/fc) = 0.02582354
v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572

```

and confined core properties:

```

b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.05689664
2 = Asl,com/(b*d)*(fs2/fc) = 0.0319073
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139

```

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

v < vs,y2 - LHS eq.(4.5) is satisfied

--->

```

su (4.9) = 0.22783602
Mu = MRc (4.14) = 2.2356E+008
u = su (4.1) = 5.7880076E-006

```

Calculation of ratio lb/d

Lap Length: lb/d = 0.14834034

lb = 300.00

ld = 2022.376

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)

= 1

db = 15.23077

Mean strength value of all re-bars: fy = 781.25

t = 1.16154

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.64216

n = 13.00

Calculation of Mu2+

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

u = 5.6034793E-006

Mu = 1.1381E+008

with full section properties:

b = 400.00

d = 627.00

d' = 43.00

v = 0.00030396

N = 2287.027

fc = 30.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.00684112

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: cu = 0.00684112

we (5.4c) = 0.00697692

ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895

ase1 = 0.14776895

bo_1 = 340.00

$ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min * Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.41645$

$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.53374$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $\text{No stirups, } ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $\text{No stirups, } ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $\text{No stirups, } ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $\text{No stirups, } ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, \text{jacket} * Asl, \text{ten, jacket} + fs, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es, \text{jacket} * Asl, \text{ten, jacket} + Es, \text{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 0.14834034$
 $su2 = 0.4 * esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs, \text{jacket} * Asl, \text{com, jacket} + fs, \text{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$

$$\text{with } Es_2 = (Es_{\text{jacket}} \cdot Asl_{\text{com,jacket}} + Es_{\text{core}} \cdot Asl_{\text{com,core}}) / Asl_{\text{com}} = 200000.00$$

$$y_v = 0.0008757$$

$$sh_v = 0.00280225$$

$$ft_v = 328.3881$$

$$fy_v = 273.6568$$

$$suv = 0.00280225$$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$lo/lo_{\text{min}} = lb/ld = 0.14834034$$

$$suv = 0.4 \cdot esuv_{\text{nominal}} ((5.5), \text{TBDY}) = 0.032$$
 From table 5A.1, TBDY: $esuv_{\text{nominal}} = 0.08$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{\text{nominal}}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + fs_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 273.6568$$

$$\text{with } Es_v = (Es_{\text{jacket}} \cdot Asl_{\text{mid,jacket}} + Es_{\text{mid}} \cdot Asl_{\text{mid,core}}) / Asl_{\text{mid}} = 200000.00$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.02582354$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.04604817$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.01462572$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TBDY}) = 31.27541$$

$$cc (5A.5, \text{TBDY}) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = Asl_{\text{ten}} / (b \cdot d) \cdot (fs_1 / fc) = 0.0319073$$

$$2 = Asl_{\text{com}} / (b \cdot d) \cdot (fs_2 / fc) = 0.05689664$$

$$v = Asl_{\text{mid}} / (b \cdot d) \cdot (fsv / fc) = 0.01807139$$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->

$$v < v_{s,y2} - \text{LHS eq. (4.5) is satisfied}$$
 --->

$$su (4.9) = 0.20240787$$

$$Mu = MRc (4.14) = 1.1381E+008$$

$$u = su (4.1) = 5.6034793E-006$$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$

$$lb = 300.00$$

$$ld = 2022.376$$
 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)

$$= 1$$

$$db = 15.23077$$
 Mean strength value of all re-bars: $fy = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.7880076E-006$$

$$Mu = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi = 0.00684112$$

$$\phi_e (5.4c) = 0.00697692$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o1} = 340.00$$

$$h_{o1} = 610.00$$

$$b_{i21} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o2} = 192.00$$

$$h_{o2} = 492.00$$

$$b_{i22} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.41645$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.53374$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.41645$$

$$\phi_{sh1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{sh2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / d = 0.14834034$$

$$su_1 = 0.4 * esu_1_{\text{nominal}} ((5.5), \text{TB DY}) = 0.032$$

From table 5A.1, TB DY: $esu_1_{\text{nominal}} = 0.08$,

For calculation of esu_1_{nominal} and y_1 , sh_1 , ft_1 , fy_1 , it is considered

characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs_1 = (fs_{\text{jacket}} * A_{sl, \text{ten, jacket}} + fs_{\text{core}} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 273.6568$$

with $E_{s1} = (E_{sjacket} \cdot A_{s1,ten,jacket} + E_{s,core} \cdot A_{s1,ten,core}) / A_{s1,ten} = 200000.00$
 $y_2 = 0.0008757$
 $sh_2 = 0.00280225$
 $ft_2 = 328.3881$
 $fy_2 = 273.6568$
 $su_2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 \cdot esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fs_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot A_{s1,com,jacket} + fs_{core} \cdot A_{s1,com,core}) / A_{s1,com} = 273.6568$
 with $E_{s2} = (E_{sjacket} \cdot A_{s1,com,jacket} + E_{s,core} \cdot A_{s1,com,core}) / A_{s1,com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 \cdot esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} \cdot A_{s1,mid,jacket} + fs_{mid} \cdot A_{s1,mid,core}) / A_{s1,mid} = 273.6568$
 with $E_{sv} = (E_{sjacket} \cdot A_{s1,mid,jacket} + E_{s,mid} \cdot A_{s1,mid,core}) / A_{s1,mid} = 200000.00$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.04604817$
 $2 = A_{s1,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.02582354$
 $v = A_{s1,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01462572$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = A_{s1,ten} / (b \cdot d) \cdot (fs_1 / f_c) = 0.05689664$
 $2 = A_{s1,com} / (b \cdot d) \cdot (fs_2 / f_c) = 0.0319073$
 $v = A_{s1,mid} / (b \cdot d) \cdot (fs_v / f_c) = 0.01807139$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$
 $l_b = 300.00$
 $l_d = 2022.376$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$

t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 592659.827$

Calculation of Shear Strength at edge 1, $V_{r1} = 592659.827$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1092E+006$
 $V_u = 9840.634$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 41887.902$ is calculated for jacket, with:
 $d_2 = 400.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 1.00$
 $M_u = 1.1092E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$

fy = 625.00

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 41887.902 is calculated for jacket, with:

d = 400.00

Av = 100530.965

fy = 625.00

s = 300.00

Vs2 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.04251

Element Length, $L = 3000.00$

Primary 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 $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 2

EDGE -A-

Shear Force, $V_a = 8.9541895E-015$
EDGE -B-
Shear Force, $V_b = -8.9541895E-015$
BOTH EDGES
Axial Force, $F = -2287.027$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{c,com} = 911.0619$
-Middle: $As_{mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15088696$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n / 2 = 59951.954$
with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 8.9928E+007$
 $Mu_{1+} = 8.9928E+007$, 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
 $Mu_{1-} = 8.9928E+007$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 8.9928E+007$
 $Mu_{2+} = 8.9928E+007$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $Mu_{2-} = 8.9928E+007$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 8.9541895E-015$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = -8.9541895E-015$, is the shear force acting at edge 2 for the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.0089632E-005$
 $M_u = 8.9928E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $f_c = 30.00$
 ϕ_c (5A.5, TBDY) = 0.002
Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00684112$
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: $\phi_u = 0.00684112$
 w_e (5.4c) = 0.00697692
 ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh_{min} \cdot F_{ywe} = \text{Min}(psh_x \cdot F_{ywe}, psh_y \cdot F_{ywe}) = 1.41645$

$psh_x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.53374$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 781.25$

$fce = 30.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00242514$

$c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$

$sh1 = 0.00280225$

$ft1 = 328.3881$

$fy1 = 273.6568$

$su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1$, $sh1$, $ft1$, $fy1$, it is considered
characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl, ten, jacket + fs_core \cdot Asl, ten, core) / Asl, ten = 273.6568$

with $Es1 = (Es_jacket \cdot Asl, ten, jacket + Es_core \cdot Asl, ten, core) / Asl, ten = 200000.00$

$y2 = 0.0008757$

$sh2 = 0.00280225$

$ft2 = 328.3881$

$fy2 = 273.6568$

$su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$lo/lou, min = lb/lb, min = 0.14834034$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2$, $sh2$, $ft2$, $fy2$, it is considered
characteristic value $fsy2 = fs2 / 1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, com, jacket + fs_core \cdot Asl, com, core) / Asl, com = 273.6568$

with $Es2 = (Es_jacket \cdot Asl, com, jacket + Es_core \cdot Asl, com, core) / Asl, com = 200000.00$

$yv = 0.0008757$

$shv = 0.00280225$

$ftv = 328.3881$

$fyv = 273.6568$

$suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 273.6568$
with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.0347448$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.0347448$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02120631$
and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.04166345$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04166345$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02542907$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$
 $l_b = 300.00$
 $l_d = 2022.376$
Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d,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)
 $= 1$
 $db = 15.23077$
Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 1.0089632E-005$
 $Mu = 8.9928E+007$

with full section properties:
 $b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00684112$
 $w_e (5.4c) = 0.00697692$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.41645$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645$
 $p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 200.00$

$A_{sec} = 268000.00$
 $s_1 = 150.00$
 $s_2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 781.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY): $c_c = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y_1 = 0.0008757$
 $sh_1 = 0.00280225$
 $ft_1 = 328.3881$
 $fy_1 = 273.6568$
 $su_1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, \min} = l_b / l_d = 0.14834034$
 $su_1 = 0.4 * esu_{1_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu_{1_nominal} = 0.08$,

For calculation of $esu_{1_nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TBDY.

y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_1 = (f_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + f_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 273.6568$

with $Es_1 = (E_{s, \text{jacket}} * A_{s, \text{ten, jacket}} + E_{s, \text{core}} * A_{s, \text{ten, core}}) / A_{s, \text{ten}} = 200000.00$

$y_2 = 0.0008757$
 $sh_2 = 0.00280225$
 $ft_2 = 328.3881$
 $fy_2 = 273.6568$
 $su_2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * A_{sl,com,jacket} + fs_{core} * A_{sl,com,core}) / A_{sl,com} = 273.6568$
 with $Es_2 = (Es_{jacket} * A_{sl,com,jacket} + Es_{core} * A_{sl,com,core}) / A_{sl,com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * A_{sl,mid,jacket} + fs_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 273.6568$
 with $Es_v = (Es_{jacket} * A_{sl,mid,jacket} + Es_{mid} * A_{sl,mid,core}) / A_{sl,mid} = 200000.00$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.0347448$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.0347448$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.02120631$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = A_{sl,ten} / (b * d) * (fs_1 / fc) = 0.04166345$
 $2 = A_{sl,com} / (b * d) * (fs_2 / fc) = 0.04166345$
 $v = A_{sl,mid} / (b * d) * (fs_v / fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.22203037$

$Mu = MRc (4.14) = 8.9928E+007$

$u = su (4.1) = 1.0089632E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu2+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$Mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } c_u: c_u = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00684112$$

$$w_e \text{ (5.4c)} = 0.00697692$$

$$a_{se} \text{ ((5.4d), TBDY)} = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$$

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$$

$$p_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.41645$$

$$p_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14834034$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568$
with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568$
with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14834034$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568$
with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631$
and confined core properties:
 $b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $l_b/l_d = 0.14834034$
 $l_b = 300.00$
 $l_d = 2022.376$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $f_y = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 1.0089632E-005$
 $\mu = 8.9928E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $f_c = 30.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu = 0.00684112$
 $\mu_e (5.4c) = 0.00697692$
 $\alpha_e ((5.4d), TBDY) = (\alpha e_1 * A_{ext} + \alpha e_2 * A_{int}) / A_{sec} = 0.14776895$
 $\alpha e_1 = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i_1} = 975400.00$
 $\alpha e_2 = \text{Max}(\alpha e_1, \alpha e_2) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.41645$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.41645$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$

$$h2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } cc = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y1 = 0.0008757$$

$$sh1 = 0.00280225$$

$$ft1 = 328.3881$$

$$fy1 = 273.6568$$

$$su1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$su1 = 0.4 * esu1_{nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu1_{nominal} = 0.08,$$

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TB DY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$$

$$\text{with } Es1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y2 = 0.0008757$$

$$sh2 = 0.00280225$$

$$ft2 = 328.3881$$

$$fy2 = 273.6568$$

$$su2 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.14834034$$

$$su2 = 0.4 * esu2_{nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu2_{nominal} = 0.08,$$

For calculation of $esu2_{nominal}$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TB DY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$$

$$\text{with } Es2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$yv = 0.0008757$$

$$shv = 0.00280225$$

$$ftv = 328.3881$$

$$fyv = 273.6568$$

$$suv = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$suv = 0.4 * esuv_{nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv_{nominal} = 0.08,$$

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TB DY

For calculation of $esuv_{nominal}$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TB DY.

$$y1, sh1, ft1, fy1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fsv = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 273.6568$$

$$\text{with } Esv = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs1 / f_{ce}) = 0.0347448$$

$$2 = Asl, \text{com} / (b * d) * (fs2 / f_{ce}) = 0.0347448$$

$$v = Asl, \text{mid} / (b * d) * (fsv / f_{ce}) = 0.02120631$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TB DY}) = 31.27541$$

$cc(5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = As_{l,ten}/(b*d)*(fs1/fc) = 0.04166345$
 $2 = As_{l,com}/(b*d)*(fs2/fc) = 0.04166345$
 $v = As_{l,mid}/(b*d)*(fsv/fc) = 0.02542907$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.22203037$
 $Mu = MRc(4.14) = 8.9928E+007$
 $u = su(4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$
 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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 397330.256$

Calculation of Shear Strength at edge 1, $Vr1 = 397330.256$
 $Vr1 = Vn$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 187890.746$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 30.00$, but $fc'^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $pw = As/(bw*d) = 0.00331157$
 As (tension reinf.) = 709.9999
 $bw = 670.00$
 $d = 320.00$
 $Vu*d/Mu < 1 = 0.00$
 $Mu = 4.3946131E-012$
 $Vu = 8.9541895E-015$
 From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$
 $Vs1 = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $Av = 157079.633$
 $fy = 625.00$
 $s = 150.00$
 $Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $Vs2 = 0.00$ is calculated for jacket, with:
 $d2 = 160.00$
 $Av = 100530.965$
 $fy = 625.00$
 $s = 300.00$
 $Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 780103.388

Calculation of Shear Strength at edge 2, Vr2 = 397330.256
Vr2 = Vn ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: Vc = 187890.746
= 1 (normal-weight concrete)
Mean concrete strength: fc' = (fc'_jacket*Area_jacket + fc'_core*Area_core)/Area_section = 30.00, but fc'^0.5 <= 8.3 MPa (22.5.3.1, ACI 318-14)
pw = As/(bw*d) = 0.00331157
As (tension reinf.) = 709.9999
bw = 670.00
d = 320.00
Vu*d/Mu < 1 = 0.00
Mu = 3.1257229E-011
Vu = 8.9541895E-015
From (11.5.4.8), ACI 318-14: Vs1 + Vs2 = 209439.51
Vs1 = 209439.51 is calculated for jacket, with:
d = 320.00
Av = 157079.633
fy = 625.00
s = 150.00
Vs1 has been multiplied by 1 (s<d/2, according to ASCE 41-17,10.3.4)
Vs2 = 0.00 is calculated for jacket, with:
d = 160.00
Av = 100530.965
fy = 625.00
s = 300.00
Vs2 is considered 0 (s>d, according to ASCE 41-17,10.3.4)
Vf ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: Vs + Vf <= 780103.388

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
At local axis: 3
Integration Section: (b)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00
Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.
Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17
Consequently:
Jacket
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
Existing Column
New material of Primary Member: Concrete Strength, fc = fcm = 30.00
New material of Primary Member: Steel Strength, fs = fsm = 625.00
Concrete Elasticity, Ec = 25742.96
Steel Elasticity, Es = 200000.00
External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00

Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Primary 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 $l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -5.8922949E-012$
 Shear Force, $V_2 = 7.6321477E-015$
 Shear Force, $V_3 = 14913.744$
 Axial Force, $F = -5285.801$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 709.9999$
 -Compression: $As_c = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 911.0619$
 -Compression: $As_{l,com} = 911.0619$
 -Middle: $As_{l,mid} = 556.0619$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,jacket} = 603.1858$
 -Compression: $As_{l,com,jacket} = 603.1858$
 -Middle: $As_{l,mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten,core} = 307.8761$
 -Compression: $As_{l,com,core} = 307.8761$
 -Middle: $As_{l,mid,core} = 153.938$
 Mean Diameter of Tension Reinforcement, $Db_L = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.0066567$
 $u = y + p = 0.0066567$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.0016567 ((4.29), \text{Biskinis Phd})$
 $M_y = 9.1438E+007$
 $L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) $= 1500.00$
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 2.7596E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 4.6125528E-006$
 with $((10.1), \text{ASCE 41-17})$ $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 254.0405$
 $d = 357.00$
 $y = 0.22862898$
 $A = 0.01002965$
 $B = 0.00565711$
 with $pt = 0.00380895$
 $pc = 0.00380895$
 $pv = 0.00232477$
 $N = 5285.801$
 $b = 670.00$
 $" = 0.12044818$

$y_{comp} = 2.5858904E-005$
 with $f_c = 30.00$
 $E_c = 25742.96$
 $y = 0.22722543$
 $A = 0.00988999$
 $B = 0.00557012$
 with $E_s = 200000.00$

Calculation of ratio l_b/l_d

Lap Length: $l_d/l_{d,min} = 0.18542542$
 $l_b = 300.00$
 $l_d = 1617.901$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.005$
 with:

- Condition iv occurred
Beam controlled by inadequate embedment into beam-column joint:
($l_b/l_d < 1$ and With Lapping in the Vicinity of the End Regions)
- Condition i occurred
Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.15088696$
- Transverse Reinforcement: NC
- Stirrup Spacing $> d/3$
- Low ductility demand, $\lambda / y < 2$ (table 10-6, ASCE 41-17)
 $= 2.9463220E-022$
- Stirrup Spacing $\leq d/2$
 $d = d_{external} = 357.00$
 $s = s_{external} = 150.00$
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$
 $V_s = 242949.832$, already given in calculation of shear control ratio
 design Shear = $7.6321477E-015$
- ($\lambda - \lambda'$)/ $bal = -0.30840259$
 $= A_{sl}/(b_w \cdot d) = 0.00296835$
 Tension Reinf Area: $A_{sl} = 709.9999$
 $\lambda' = A_{sc}/(b_w \cdot d) = 0.00697431$
 Compression Reinf Area: $A_{sc} = 1668.186$
- From (B-1), ACI 318-11: $bal = 0.01298939$
 $f_c = (f_{c,jacket} \cdot \text{Area}_{jacket} + f_{c,core} \cdot \text{Area}_{core}) / \text{section_area} = 30.00$
 $f_y = f_{y,jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = cb/dt = 0.003 / (0.003 + \lambda) = 0.48979592$
 $y = 0.003125$
- $V / (b_w \cdot d \cdot f_c^{0.5}) = 7.0156248E-020$, NOTE: units in lb & in
 $b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (b)

Calculation No. 9

beam B1, Floor 1

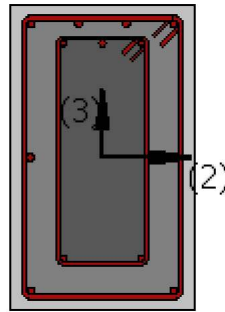
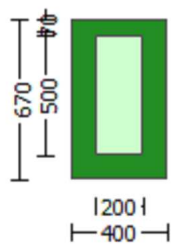
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_o = l_b = 300.00$
No FRP Wrapping

Stepwise Properties

EDGE -A-
Bending Moment, $M_a = -2.4081400E-011$
Shear Force, $V_a = -1.6618325E-014$
EDGE -B-
Bending Moment, $M_b = -2.6019235E-011$
Shear Force, $V_b = 1.6618325E-014$
BOTH EDGES
Axial Force, $F = -6910.482$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 709.9999$
-Compression: $As_c = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 911.0619$
-Compression: $As_{c,com} = 911.0619$
-Middle: $As_{mid} = 556.0619$
Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 320963.76$
 V_n ((22.5.1.1), ACI 318-14) = 320963.76

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 153412.152$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_c_{jacket} \cdot Area_{jacket} + f'_c_{core} \cdot Area_{core}) / Area_{section} = 20.00$, but $f'_c^{0.5} \leq 8.3$
MPa ((22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 2.4081400E-011$
 $V_u = 1.6618325E-014$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$
 $V_{s1} = 167551.608$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 500.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 0.00$ is calculated for core, with:
 $d = 160.00$
 $A_v = 100530.965$
 $f_y = 500.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 10

beam B1, Floor 1

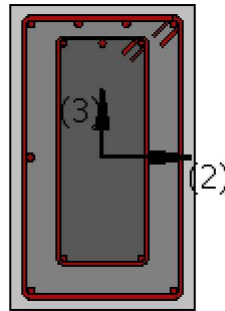
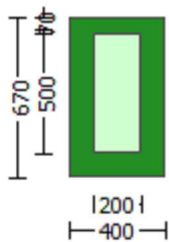
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.04251
Element Length, L = 3000.00
Primary 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 l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, V_a = 9840.634
EDGE -B-
Shear Force, V_b = 9840.632
BOTH EDGES
Axial Force, F = -2287.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t}$ = 709.9999
-Compression: $A_{sl,c}$ = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten}$ = 709.9999
-Compression: $A_{sl,com}$ = 1266.062
-Middle: $A_{sl,mid}$ = 402.1239

Calculation of Shear Capacity ratio , V_e/V_r = 0.26808017
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 158880.346$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 2.2356E+008$
 $\mu_{u1+} = 1.1381E+008$, 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
 $\mu_{u1-} = 2.2356E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 2.2356E+008$
 $\mu_{u2+} = 1.1381E+008$, 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
 $\mu_{u2-} = 2.2356E+008$, 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
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 5.6034793E-006$
 $\mu_u = 1.1381E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $fc = 30.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00684112$
 $w_e(5.4c) = 0.00697692$
 $ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = Max(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, min * F_{ywe} = Min(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.41645$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$
 $ps1(external) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2(internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$
 $ps1(external) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2(internal) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$

$fywe1 = 781.25$
 $fywe2 = 781.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou, min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_nominal((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, jacket * A_{sl, ten, jacket} + fs, core * A_{sl, ten, core}) / A_{sl, ten} = 273.6568$

with $Es1 = (Es, jacket * A_{sl, ten, jacket} + Es, core * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0008757$

```

sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14834034
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.02582354
2 = Asl,com/(b*d)*(fs2/fc) = 0.04604817
v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0319073
2 = Asl,com/(b*d)*(fs2/fc) = 0.05689664
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20240787
Mu = MRc (4.14) = 1.1381E+008
u = su (4.1) = 5.6034793E-006

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.14834034
lb = 300.00
lb = 2022.376
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
lb,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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

u = 5.7880076E-006
Mu = 2.2356E+008

with full section properties:

b = 400.00
d = 627.00
d' = 43.00
v = 0.00030396
N = 2287.027

fc = 30.00

co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) = 0.00697692

ase ((5.4d), TBDY) = $(\text{ase1} * \text{Aext} + \text{ase2} * \text{Aint}) / \text{Asec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(\text{ase1}, \text{ase2}) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$\text{psh}_{\min} * \text{Fywe} = \text{Min}(\text{psh}_x * \text{Fywe}, \text{psh}_y * \text{Fywe}) = 1.41645$

$\text{psh}_x * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 2.53374$

ps1 (external) = $(\text{Ash1} * \text{h1} / \text{s1}) / \text{Asec} = 0.00261799$

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(\text{Ash2} * \text{h2} / \text{s2}) / \text{Asec} = 0.00062519$

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 500.00

$\text{psh}_y * \text{Fywe} = \text{psh1} * \text{Fywe1} + \text{ps2} * \text{Fywe2} = 1.41645$

ps1 (external) = $(\text{Ash1} * \text{h1} / \text{s1}) / \text{Asec} = 0.00156298$

Ash1 = $\text{Astir}_1 * \text{ns}_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(\text{Ash2} * \text{h2} / \text{s2}) / \text{Asec} = 0.00025008$

Ash2 = $\text{Astir}_2 * \text{ns}_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 781.25

fce = 30.00

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00242514$

c = confinement factor = 1.04251

y1 = 0.0008757

```

sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.14834034
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14834034
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04604817
2 = Asl,com/(b*d)*(fs2/fc) = 0.02582354
v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572
and confined core properties:
b = 340.00
d = 597.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
    c = confinement factor = 1.04251
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.05689664
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0319073
    v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22783602

```

$$\begin{aligned} \mu &= MRC(4.14) = 2.2356E+008 \\ u &= su(4.1) = 5.7880076E-006 \end{aligned}$$

Calculation of ratio l_b/l_d

$$\begin{aligned} \text{Lap Length: } l_b/l_d &= 0.14834034 \\ l_b &= 300.00 \\ l_d &= 2022.376 \end{aligned}$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d ,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)

$$\begin{aligned} &= 1 \\ db &= 15.23077 \\ \text{Mean strength value of all re-bars: } f_y &= 781.25 \\ t &= 1.16154 \\ s &= 0.80 \\ e &= 1.00 \\ cb &= 25.00 \\ K_{tr} &= 2.64216 \\ n &= 13.00 \end{aligned}$$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\begin{aligned} u &= 5.6034793E-006 \\ \mu &= 1.1381E+008 \end{aligned}$$

with full section properties:

$$\begin{aligned} b &= 400.00 \\ d &= 627.00 \\ d' &= 43.00 \\ v &= 0.00030396 \\ N &= 2287.027 \\ f_c &= 30.00 \\ c_o(5A.5, TBDY) &= 0.002 \\ \text{Final value of } c_u: c_u &= \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00684112 \\ \text{The Shear_factor is considered equal to 1 (pure moment strength)} \\ \text{From (5.4b), TBDY: } c_u &= 0.00684112 \\ w_e(5.4c) &= 0.00697692 \\ a_{se}((5.4d), TBDY) &= (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895 \\ a_{se1} &= 0.14776895 \\ b_{o_1} &= 340.00 \\ h_{o_1} &= 610.00 \\ b_{i_1} &= 975400.00 \\ a_{se2} &= \text{Max}(a_{se1}, a_{se2}) = 0.14776895 \\ b_{o_2} &= 192.00 \\ h_{o_2} &= 492.00 \\ b_{i_2} &= 557856.00 \\ p_{sh,min} * F_{ywe} &= \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645 \end{aligned}$$

$$\begin{aligned} p_{sh,x} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374 \\ p_{s1}(\text{external}) &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \\ \text{No stirups, } n_{s_1} &= 2.00 \\ h_1 &= 670.00 \\ p_{s2}(\text{internal}) &= (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519 \\ A_{sh2} &= A_{stir_2} * n_{s_2} = 100.531 \\ \text{No stirups, } n_{s_2} &= 2.00 \\ h_2 &= 500.00 \end{aligned}$$

$$\begin{aligned} p_{sh,y} * F_{ywe} &= p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645 \\ p_{s1}(\text{external}) &= (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298 \\ A_{sh1} &= A_{stir_1} * n_{s_1} = 157.0796 \end{aligned}$$

No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fyw1 = 781.25$
 $fyw2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es_jacket \cdot Asl, \text{ten}, \text{jacket} + Es_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 273.6568$

with $Es2 = (Es_jacket \cdot Asl, \text{com}, \text{jacket} + Es_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$

$yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket \cdot Asl, \text{mid}, \text{jacket} + fs_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 273.6568$

with $Es_v = (Es_jacket \cdot Asl, \text{mid}, \text{jacket} + Es_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.02582354$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04604817$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.01462572$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 31.27541$$

$$cc(5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.0319073$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.05689664$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.01807139$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.20240787$$

$$\mu_u = M_{Rc}(4.14) = 1.1381E+008$$

$$u = s_u(4.1) = 5.6034793E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{u2} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.7880076E-006$$

$$\mu_u = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\alpha(5A.5, TBDY) = 0.002$$

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\mu_u = 0.00684112$

$$\mu_u(5.4c) = 0.00697692$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568

$$suv = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lo_{u,min} = lb/ld = 0.14834034$$

$$suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$$

From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_{nominal}$ and yv , shv , ftv , fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 273.6568$$

$$\text{with } Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04604817$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.02582354$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01462572$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, TBDY) = 31.27541$$

$$cc (5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.05689664$$

$$2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.0319073$$

$$v = Asl_{mid} / (b * d) * (fsv / fc) = 0.01807139$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$su (4.9) = 0.22783602$$

$$Mu = MRc (4.14) = 2.2356E+008$$

$$u = su (4.1) = 5.7880076E-006$$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$

$$lb = 300.00$$

$$ld = 2022.376$$

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)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $fy = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$Ktr = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 592659.827$

Calculation of Shear Strength at edge 1, $V_{r1} = 592659.827$

$$V_{r1} = V_n ((22.5.1.1), ACI 318-14)$$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'

where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$

= 1 (normal-weight concrete)

$$\text{Mean concrete strength: } fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 30.00, \text{ but } fc'^{0.5} \leq 8.3$$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.1092E+006$$

$$Vu = 9840.634$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 392699.082$

$Vs1 = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 41887.902$ is calculated for jacket, with:

$$d2 = 400.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

Calculation of Shear Strength at edge 2, $Vr2 = 592659.827$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f*Vf$ ' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 199960.745$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * \text{Area}_{\text{jacket}} + fc'_{\text{core}} * \text{Area}_{\text{core}}) / \text{Area}_{\text{section}} = 30.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 400.00$$

$$d = 536.00$$

$$Vu*d/Mu < 1 = 1.00$$

$$Mu = 1.1092E+006$$

$$Vu = 9840.632$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 392699.082$

$Vs1 = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 41887.902$ is calculated for jacket, with:

$$d = 400.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

```

(Bending local axis: 3)
Section Type: rcjars

Constant Properties
-----
Knowledge Factor,   = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 30.00$ 
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 625.00$ 
Concrete Elasticity,  $E_c = 25742.96$ 
Steel Elasticity,  $E_s = 200000.00$ 
Existing Column
New material of Primary Member: Concrete Strength,  $f_c = f_{cm} = 30.00$ 
New material of Primary Member: Steel Strength,  $f_s = f_{sm} = 625.00$ 
Concrete Elasticity,  $E_c = 25742.96$ 
Steel Elasticity,  $E_s = 200000.00$ 
#####
Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 781.25$ 
Existing Column
New material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 781.25$ 
#####
External Height,  $H = 670.00$ 
External Width,  $W = 400.00$ 
Internal Height,  $H = 500.00$ 
Internal Width,  $W = 200.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.04251
Element Length,  $L = 3000.00$ 
Primary 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  $l_o = 300.00$ 
No FRP Wrapping
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 8.9541895E-015$ 
EDGE -B-
Shear Force,  $V_b = -8.9541895E-015$ 
BOTH EDGES
Axial Force,  $F = -2287.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $As_t = 709.9999$ 
  -Compression:  $As_c = 1668.186$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $As_{t,ten} = 911.0619$ 
  -Compression:  $As_{l,com} = 911.0619$ 
  -Middle:  $As_{l,mid} = 556.0619$ 
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.15088696$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 59951.954$ 
with
 $M_{pr1} = \text{Max}(Mu_{1+} , Mu_{1-}) = 8.9928E+007$ 

```

Mu1+ = 8.9928E+007, 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- = 8.9928E+007, 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-) = 8.9928E+007

Mu2+ = 8.9928E+007, 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- = 8.9928E+007, 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

and

$\pm v_u \cdot l_n = (|V1| + |V2|)/2$

with

V1 = 8.9541895E-015, is the shear force acting at edge 1 for the the static loading combination

V2 = -8.9541895E-015, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu1+

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 1.0089632E-005$

Mu = 8.9928E+007

with full section properties:

b = 670.00

d = 357.00

d' = 43.00

v = 0.00031872

N = 2287.027

fc = 30.00

co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) = 0.00697692

ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = Max(ase1, ase2) = 0.14776895

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$p_{sh, min} \cdot F_{ywe} = \text{Min}(p_{sh, x} \cdot F_{ywe}, p_{sh, y} \cdot F_{ywe}) = 1.41645$

 $p_{sh, x} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 2.53374$

ps1 (external) = $(A_{sh1} \cdot h1 / s1) / A_{sec} = 0.00261799$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(A_{sh2} \cdot h2 / s2) / A_{sec} = 0.00062519$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 500.00

$p_{sh, y} \cdot F_{ywe} = p_{sh1} \cdot F_{ywe1} + p_{sh2} \cdot F_{ywe2} = 1.41645$

ps1 (external) = $(A_{sh1} \cdot h1 / s1) / A_{sec} = 0.00156298$

Ash1 = Astir_1 * ns_1 = 157.0796

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(A_{sh2} \cdot h2 / s2) / A_{sec} = 0.00025008$

Ash2 = Astir_2 * ns_2 = 100.531

No stirups, ns_2 = 2.00

h2 = 200.00

```

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00
From ((5.A.5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251
y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251

```


$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04166345$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04166345$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.22203037$$

$$M_u = M_{Rc}(4.14) = 8.9928E+007$$

$$u = s_u(4.1) = 1.0089632E-005$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of M_{u1} -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$M_u = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00684112$$

$$w_e(5.4c) = 0.00697692$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$$

$$p_{sh_x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$$

$$p_{s1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh_y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es_jacket \cdot Asl, \text{ten}, \text{jacket} + Es_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 273.6568$

with $Es2 = (Es_jacket \cdot Asl, \text{com}, \text{jacket} + Es_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$

$yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY
For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered
characteristic value $f_{sv} = f_{sv}/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $f_{sv} = (f_{s,jacket} \cdot A_{s,mid,jacket} + f_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 273.6568$

with $E_{sv} = (E_{s,jacket} \cdot A_{s,mid,jacket} + E_{s,mid} \cdot A_{s,mid,core}) / A_{s,mid} = 200000.00$

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0347448$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0347448$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02120631$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

f_{cc} (5A.2, TBDY) = 31.27541

cc (5A.5, TBDY) = 0.00242514

c = confinement factor = 1.04251

$1 = A_{s,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04166345$

$2 = A_{s,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04166345$

$v = A_{s,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

su (4.9) = 0.22203037

$\mu_u = MR_c$ (4.14) = 8.9928E+007

$u = su$ (4.1) = 1.0089632E-005

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $f_y = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of μ_{u2+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$u = 1.0089632E-005$

$\mu_u = 8.9928E+007$

with full section properties:

$b = 670.00$

$d = 357.00$

$d' = 43.00$

$v = 0.00031872$

$N = 2287.027$

$f_c = 30.00$

co (5A.5, TBDY) = 0.002

Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00684112$

```

we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

```

```

Asec = 268000.00

```

```

s1 = 150.00

```

```

s2 = 300.00

```

```

fywe1 = 781.25

```

```

fywe2 = 781.25

```

```

fce = 30.00

```

```

From ((5.A5), TBDY), TBDY: cc = 0.00242514

```

```

c = confinement factor = 1.04251

```

```

y1 = 0.0008757

```

```

sh1 = 0.00280225

```

```

ft1 = 328.3881

```

```

fy1 = 273.6568

```

```

su1 = 0.00280225

```

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

```

lo/lou,min = lb/lb = 0.14834034

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08,

```

```

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

```

```

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.

```

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

```

```

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

```

```

y2 = 0.0008757

```

```

sh2 = 0.00280225

```

```

ft2 = 328.3881

```

```

fy2 = 273.6568

```

```

su2 = 0.00280225

```

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

```

lo/lou,min = lb/lb,min = 0.14834034

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08,

```

For calculation of $es_{u2_nominal}$ and y_2 , sh_2 , ft_2 , fy_2 , it is considered characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_2 = (fs_{jacket} \cdot A_{sl,com,jacket} + fs_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 273.6568$

with $Es_2 = (Es_{jacket} \cdot A_{sl,com,jacket} + Es_{core} \cdot A_{sl,com,core}) / A_{sl,com} = 200000.00$

$y_v = 0.0008757$

$sh_v = 0.00280225$

$ft_v = 328.3881$

$fy_v = 273.6568$

$s_{uv} = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor and also multiplied by the shear_factor according to 15.7.1.4, with Shear_factor = 1.00

$l_o/l_{ou,min} = l_b/l_d = 0.14834034$

$s_{uv} = 0.4 \cdot es_{uv_nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $es_{uv_nominal} = 0.08$, considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY

For calculation of $es_{uv_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.

y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs_v = (fs_{jacket} \cdot A_{sl,mid,jacket} + fs_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 273.6568$

with $Es_v = (Es_{jacket} \cdot A_{sl,mid,jacket} + Es_{mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.0347448$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0347448$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02120631$

and confined core properties:

$b = 610.00$

$d = 327.00$

$d' = 13.00$

$fcc (5A.2, TBDY) = 31.27541$

$cc (5A.5, TBDY) = 0.00242514$

$c = \text{confinement factor} = 1.04251$

$1 = A_{sl,ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04166345$

$2 = A_{sl,com} / (b \cdot d) \cdot (fs_2 / fc) = 0.04166345$

$v = A_{sl,mid} / (b \cdot d) \cdot (fs_v / fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22203037$

$Mu = MRc (4.14) = 8.9928E+007$

$u = su (4.1) = 1.0089632E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu_2 -

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$Mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00684112$$

$$w_e (5.4c) = 0.00697692$$

$$a_{se} ((5.4d), \text{TBDY}) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.41645$$

$$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 2.53374$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{sh2} * F_{ywe2} = 1.41645$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / d = 0.14834034$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TBDY}) = 0.032$$

$$\text{From table 5A.1, TBDY: } esu_{1_nominal} = 0.08,$$

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = (fs_{jacket} \cdot Asl_{ten,jacket} + fs_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 273.6568$
 with $Es1 = (Es_{jacket} \cdot Asl_{ten,jacket} + Es_{core} \cdot Asl_{ten,core}) / Asl_{ten} = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 273.6568$
 with $Es2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0347448$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0347448$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02120631$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.04166345$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs2 / fc) = 0.04166345$
 $v = Asl_{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

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)

$$= 1$$

$$db = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 397330.256$

Calculation of Shear Strength at edge 1, $V_{r1} = 397330.256$

$V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 4.3946131E-012$$

$$V_u = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

$V_{s1} = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 0.00$ is calculated for jacket, with:

$$d_2 = 160.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

Calculation of Shear Strength at edge 2, $V_{r2} = 397330.256$

$V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf' where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 670.00$$

$$d = 320.00$$

$$V_u \cdot d / M_u < 1 = 0.00$$

$$M_u = 3.1257229E-011$$

$$V_u = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$

Vs1 = 209439.51 is calculated for jacket, with:

d = 320.00

Av = 157079.633

fy = 625.00

s = 150.00

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

d = 160.00

Av = 100530.965

fy = 625.00

s = 300.00

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

Vf ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: Vs + Vf <= 780103.388

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, H = 670.00

External Width, W = 400.00

Internal Height, H = 500.00

Internal Width, W = 200.00

Cover Thickness, c = 25.00

Element Length, L = 3000.00

Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, M = 8.5853E+006

Shear Force, V2 = -1.6618325E-014

Shear Force, V3 = 2019.001

Axial Force, F = -6910.482

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: Aslt = 709.9999

-Compression: Aslc = 1668.186

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl_{ten} = 709.9999$
 -Compression: $Asl_{com} = 1266.062$
 -Middle: $Asl_{mid} = 402.1239$
 Longitudinal External Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,jacket} = 402.1239$
 -Compression: $Asl_{com,jacket} = 804.2477$
 -Middle: $Asl_{mid,jacket} = 402.1239$
 Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten,core} = 307.8761$
 -Compression: $Asl_{com,core} = 461.8141$
 -Middle: $Asl_{mid,core} = 0.00$
 Mean Diameter of Tension Reinforcement, $DbL = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.03231317$
 $u = y + p = 0.03231317$

- Calculation of y -

$y = (My * Ls / 3) / E_{eff} = 0.00231317$ ((4.29), Biskinis Phd))
 $My = 1.2635E+008$
 $Ls = M/V$ (with $Ls > 0.1 * L$ and $Ls < 2 * L$) = 4252.274
 From table 10.5, ASCE 41_17: $E_{eff} = 0.3 * E_c * I_g = 7.7425E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$
 $y_{ten} = 2.5007389E-006$
 with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 * f_y * (l_b / d)^{2/3}) = 254.0405$
 $d = 627.00$
 $y = 0.18990306$
 $A = 0.00959086$
 $B = 0.00414227$
 with $pt = 0.00283094$
 $pc = 0.00504809$
 $pv = 0.00160336$
 $N = 6910.482$
 $b = 400.00$
 $" = 0.06858054$
 $y_{comp} = 1.7827067E-005$
 with $fc = 30.00$
 $E_c = 25742.96$
 $y = 0.18766697$
 $A = 0.00941672$
 $B = 0.0040338$
 with $E_s = 200000.00$

Calculation of ratio l_b / d

Lap Length: $l_d / d_{min} = 0.18542542$
 $l_b = 300.00$
 $l_d = 1617.901$
 Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $f_y = 625.00$
 $t = 1.16154$

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

- Calculation of p -

From table 10-7: $p = 0.03$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$
shear control ratio $V_p/V_o = 0.26808017$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\phi_y < 2$ (table 10-6, ASCE 41-17)
 $= 6.6685376E-005$

- Stirrup Spacing $\leq d/2$

$d = d_{\text{external}} = 627.00$

$s = s_{\text{external}} = 150.00$

- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 434586.984$, already given in calculation of shear control ratio
design Shear = 2019.001

- ($\phi - \phi'$)/ $\phi_{\text{bal}} = -0.29412606$

$= A_{\text{sl}}/(b_w \cdot d) = 0.00283094$

Tension Reinf Area: $A_{\text{sl}} = 709.9999$

$\phi' = A_{\text{sc}}/(b_w \cdot d) = 0.00665146$

Compression Reinf Area: $A_{\text{sc}} = 1668.186$

From (B-1), ACI 318-11: $\phi_{\text{bal}} = 0.01298939$

$\phi_c = (\phi_{\text{jacket}} \cdot \text{Area}_{\text{jacket}} + \phi_{\text{core}} \cdot \text{Area}_{\text{core}}) / \text{section_area} = 30.00$

$\phi_y = \phi_{y_{\text{jacket_bars}}} = 625.00$

From 10.2.7.3, ACI 318-11: $\phi_1 = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + \phi_y) = c_b/d_t = 0.003/(0.003 + \phi_y) = 0.48979592$
 $\phi_y = 0.003125$

- $V/(b_w \cdot d \cdot \phi_c^{0.5}) = 0.01769993$, NOTE: units in lb & in

$b_w = 400.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 11

beam B1, Floor 1

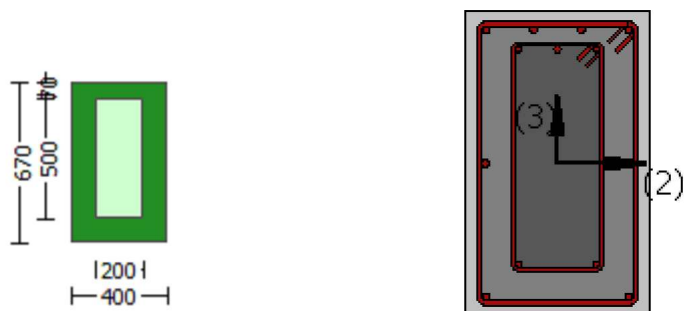
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.5853E+006$

Shear Force, $V_a = 2019.001$

EDGE -B-

Bending Moment, $M_b = 1.4880E+007$

Shear Force, $V_b = 17662.265$

BOTH EDGES

Axial Force, $F = -6910.482$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{st} = 709.9999$

-Compression: $A_{sc} = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{st,ten} = 709.9999$

-Compression: $A_{sc,com} = 1266.062$

-Middle: $A_{st,mid} = 402.1239$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 469092.843$

V_n ((22.5.1.1), ACI 318-14) = 469092.843

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 154933.577$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} \cdot Area_{jacket} + f'_c_{core} \cdot Area_{core}) / Area_{section} = 20.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$\rho_w = A_s / (b_w \cdot d) = 0.00331157$

A_s (tension reinf.) = 709.9999

$b_w = 400.00$

$d = 536.00$

$V_u \cdot d / M_u < 1 = 0.12605019$

$M_u = 8.5853E+006$

$V_u = 2019.001$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$d = 536.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$ is calculated for core, with:

$d = 400.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.50$

V_f ((11-3)-(11.4), ACI 440) = 0.00

From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 12

beam B1, Floor 1

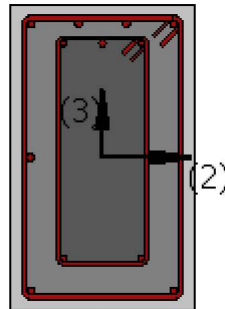
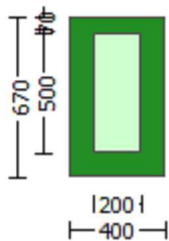
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ)

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.04251
Element Length, $L = 3000.00$
Primary 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 $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 3
EDGE -A-
Shear Force, $V_a = 9840.634$
EDGE -B-
Shear Force, $V_b = 9840.632$
BOTH EDGES
Axial Force, $F = -2287.027$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{st} = 709.9999$
-Compression: $A_{sc} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten} = 709.9999$
-Compression: $A_{sc,com} = 1266.062$
-Middle: $A_{sl,mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26808017$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 158880.346$
with
 $M_{pr1} = \max(\mu_{u1+}, \mu_{u1-}) = 2.2356E+008$
 $\mu_{u1+} = 1.1381E+008$, 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
 $\mu_{u1-} = 2.2356E+008$, 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
 $M_{pr2} = \max(\mu_{u2+}, \mu_{u2-}) = 2.2356E+008$
 $\mu_{u2+} = 1.1381E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination
 $\mu_{u2-} = 2.2356E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination
and
 $\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination
 $V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 5.6034793E-006$
 $\mu_u = 1.1381E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$

$f_c = 30.00$
 $c_o (5A.5, TBDY) = 0.002$
 Final value of c_u : $c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $c_u = 0.00684112$
 $w_e (5.4c) = 0.00697692$
 $a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $a_{se1} = 0.14776895$
 $b_o_1 = 340.00$
 $h_o_1 = 610.00$
 $b_{i2_1} = 975400.00$
 $a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$
 $b_o_2 = 192.00$
 $h_o_2 = 492.00$
 $b_{i2_2} = 557856.00$
 $psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.41645$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$
 $ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h2 = 500.00$

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$
 $ps1 \text{ (external)} = (A_{sh1} * h1 / s1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (A_{sh2} * h2 / s2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $f_{ywe1} = 781.25$
 $f_{ywe2} = 781.25$
 $f_{ce} = 30.00$

From ((5.A5), TBDY): $c_c = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00

$l_o / l_{ou, min} = l_b / l_d = 0.14834034$
 $su1 = 0.4 * esu1_{nominal} ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08$,

For calculation of $esu1_{nominal}$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (l_b / l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (f_{s, jacket} * A_{sl, ten, jacket} + f_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 273.6568$

with $Es1 = (E_{s, jacket} * A_{sl, ten, jacket} + E_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.14834034$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08$,
 For calculation of $esu_{2,nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl_{com,jacket} + fs_{core} * Asl_{com,core}) / Asl_{com} = 273.6568$
 with $Es_2 = (Es_{jacket} * Asl_{com,jacket} + Es_{core} * Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.14834034$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Es_v = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.02582354$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.04604817$
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b * d) * (fs_1 / fc) = 0.0319073$
 $2 = Asl_{com} / (b * d) * (fs_2 / fc) = 0.05689664$
 $v = Asl_{mid} / (b * d) * (fs_v / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

---->

$v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied

---->

$su (4.9) = 0.20240787$

$Mu = MRc (4.14) = 1.1381E+008$

$u = su (4.1) = 5.6034793E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.14834034$

$l_b = 300.00$

$l_d = 2022.376$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

Calculation of Mu1-

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.7880076E-006$$

$$Mu = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o(5A.5, TBDY) = 0.002$$

$$\text{Final value of } \mu: \mu = \text{shear_factor} * \text{Max}(\mu_c, \mu_o) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu_c = 0.00684112$$

$$\mu_o(5.4c) = 0.00697692$$

$$\mu_{se}((5.4d), TBDY) = (\mu_{se1} * A_{ext} + \mu_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\mu_{se2} = \text{Max}(\mu_{se1}, \mu_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\mu_{psh, \min} * F_{ywe} = \text{Min}(\mu_{psh, x} * F_{ywe}, \mu_{psh, y} * F_{ywe}) = 1.41645$$

$$\mu_{psh, x} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 2.53374$$

$$\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\mu_{psh, y} * F_{ywe} = \mu_{psh1} * F_{ywe1} + \mu_{psh2} * F_{ywe2} = 1.41645$$

$$\mu_{psh1}(\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\mu_{psh2}(\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A.5), TBDY), TBDY: } c_c = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14834034$
 $su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1,ft1,fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568$
with $Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2,ft2,fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568$
with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lou,min = lb/ld = 0.14834034$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv,ftv,fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1,ft1,fy1$, are also multiplied by $Min(1,1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568$
with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04604817$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.02582354$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01462572$
and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.05689664$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0319073$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio lb/ld

Lap Length: $l_b/l_d = 0.14834034$
 $l_b = 300.00$
 $l_d = 2022.376$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 l_d, \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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $f_y = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:
 $\mu = 5.6034793E-006$
 $\mu = 1.1381E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $f_c = 30.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu_c, \mu_{cc}) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_c = 0.00684112$
 $\mu_{cc} (5.4c) = 0.00697692$
 $\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$
 $\alpha_{se1} = 0.14776895$
 $b_{o_1} = 340.00$
 $h_{o_1} = 610.00$
 $b_{i2_1} = 975400.00$
 $\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$
 $b_{o_2} = 192.00$
 $h_{o_2} = 492.00$
 $b_{i2_2} = 557856.00$
 $p_{sh, \min} * F_{ywe} = \text{Min}(p_{sh, x} * F_{ywe}, p_{sh, y} * F_{ywe}) = 1.41645$

$p_{sh, x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 670.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$
 $h_2 = 500.00$

$p_{sh, y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645$
 $p_{s1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$
 $A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$
 No stirups, $n_{s_1} = 2.00$
 $h_1 = 400.00$
 $p_{s2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$
 $A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$
 No stirups, $n_{s_2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From } ((5.5), \text{TB DY}), \text{TB DY: } cc = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$su_1 = 0.4 * esu_1 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_1 \text{ nominal} = 0.08,$$

For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$$

$$\text{with } Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$$

$$y_2 = 0.0008757$$

$$sh_2 = 0.00280225$$

$$ft_2 = 328.3881$$

$$fy_2 = 273.6568$$

$$su_2 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/lb, \min = 0.14834034$$

$$su_2 = 0.4 * esu_2 \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_2 \text{ nominal} = 0.08,$$

For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$$

$$\text{with } Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$$

$$y_v = 0.0008757$$

$$sh_v = 0.00280225$$

$$ft_v = 328.3881$$

$$fy_v = 273.6568$$

$$suv = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$lo/lou, \min = lb/ld = 0.14834034$$

$$suv = 0.4 * esuv \text{ nominal } ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esuv \text{ nominal} = 0.08,$$

considering characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY
For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
characteristic value $fsy_v = fs_v/1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (lb/ld)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 273.6568$$

$$\text{with } Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$$

$$1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.02582354$$

$$2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.04604817$$

$$v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01462572$$

and confined core properties:

$$b = 340.00$$

$$d = 597.00$$

$$d' = 13.00$$

$$fcc (5A.2, \text{TB DY}) = 31.27541$$

```

cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0319073
2 = Asl,com/(b*d)*(fs2/fc) = 0.05689664
v = Asl,mid/(b*d)*(fsv/fc) = 0.01807139
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20240787
Mu = MRc (4.14) = 1.1381E+008
u = su (4.1) = 5.6034793E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu2-

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 5.7880076E-006
Mu = 2.2356E+008

```

with full section properties:

```

b = 400.00
d = 627.00
d' = 43.00
v = 0.00030396
N = 2287.027
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00684112
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00684112
we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645
psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799

```

$Ash1 = Astir_1 * ns_1 = 157.0796$
 $No\ stirups, ns_1 = 2.00$
 $h1 = 670.00$
 $ps2\ (internal) = (Ash2 * h2 / s2) / Asec = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $No\ stirups, ns_2 = 2.00$
 $h2 = 500.00$

$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.41645$
 $ps1\ (external) = (Ash1 * h1 / s1) / Asec = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 $No\ stirups, ns_1 = 2.00$
 $h1 = 400.00$
 $ps2\ (internal) = (Ash2 * h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 $No\ stirups, ns_2 = 2.00$
 $h2 = 200.00$

$Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou,min = lb/ld = 0.14834034$
 $su1 = 0.4 * esu1_nominal\ ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs,jacket * Asl,ten,jacket + fs,core * Asl,ten,core) / Asl,ten = 273.6568$

with $Es1 = (Es,jacket * Asl,ten,jacket + Es,core * Asl,ten,core) / Asl,ten = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4 * esu2_nominal\ ((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs,jacket * Asl,com,jacket + fs,core * Asl,com,core) / Asl,com = 273.6568$

with $Es2 = (Es,jacket * Asl,com,jacket + Es,core * Asl,com,core) / Asl,com = 200000.00$

$yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$

$lo/lou,min = lb/ld = 0.14834034$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket * Asl_mid_jacket + fs_mid * Asl_mid_core) / Asl_mid = 273.6568$
 with $Esv = (Es_jacket * Asl_mid_jacket + Es_mid * Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.04604817$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.02582354$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_ten / (b * d) * (fs1 / fc) = 0.05689664$
 $2 = Asl_com / (b * d) * (fs2 / fc) = 0.0319073$
 $v = Asl_mid / (b * d) * (fsv / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < vsy2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$
 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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of Shear Strength $Vr = Min(Vr1, Vr2) = 592659.827$

Calculation of Shear Strength at edge 1, $Vr1 = 592659.827$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f * Vf$ '
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 199960.745$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_jacket * Area_jacket + fc'_core * Area_core) / Area_section = 30.00$, but $fc'^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $pw = As / (bw * d) = 0.00331157$
 As (tension reinf.) = 709.9999
 $bw = 400.00$
 $d = 536.00$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1092E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From (11-11), ACI } 440: V_s + V_f \leq 780103.388$$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$

$$V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

$$\text{From Table (22.5.5.1), ACI } 318-14: V_c = 199960.745$$

$$= 1 \text{ (normal-weight concrete)}$$

$$\text{Mean concrete strength: } f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00, \text{ but } f'_c^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI } 318-14)$$

$$p_w = A_s / (b_w \cdot d) = 0.00331157$$

$$A_s \text{ (tension reinf.)} = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u \cdot d / M_u < 1 = 1.00$$

$$M_u = 1.1092E+006$$

$$V_u = 9840.632$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$$

$$\text{From (11-11), ACI } 440: V_s + V_f \leq 780103.388$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 2

(Bending local axis: 3)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

External Height, $H = 670.00$
External Width, $W = 400.00$
Internal Height, $H = 500.00$
Internal Width, $W = 200.00$
Cover Thickness, $c = 25.00$
Mean Confinement Factor overall section = 1.04251
Element Length, $L = 3000.00$
Primary 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 $l_o = 300.00$
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, $V_a = 8.9541895E-015$
EDGE -B-
Shear Force, $V_b = -8.9541895E-015$
BOTH EDGES
Axial Force, $F = -2287.027$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 709.9999$
-Compression: $A_{sl,c} = 1668.186$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 911.0619$
-Compression: $A_{sl,com} = 911.0619$
-Middle: $A_{sl,mid} = 556.0619$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.15088696$
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 59951.954$
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 8.9928E+007$
 $M_{u1+} = 8.9928E+007$, 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
 $M_{u1-} = 8.9928E+007$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 8.9928E+007$

$Mu_{2+} = 8.9928E+007$, 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

$Mu_{2-} = 8.9928E+007$, 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
and

$$\pm wu*ln = (|V1| + |V2|)/2$$

with

$V1 = 8.9541895E-015$, is the shear force acting at edge 1 for the the static loading combination

$V2 = -8.9541895E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$Mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$fc = 30.00$$

$$co(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00684112$$

$$we(5.4c) = 0.00697692$$

$$ase((5.4d), TBDY) = (ase1*Aext + ase2*Aint)/Asec = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

$$bi2_2 = 557856.00$$

$$psh, \min Fywe = \text{Min}(psh, x * Fywe, psh, y * Fywe) = 1.41645$$

$$psh_x * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 2.53374$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00261799$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 670.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00062519$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 500.00$$

$$psh_y * Fywe = psh1 * Fywe1 + ps2 * Fywe2 = 1.41645$$

$$ps1(\text{external}) = (Ash1 * h1 / s1) / Asec = 0.00156298$$

$$Ash1 = Astir_1 * ns_1 = 157.0796$$

$$\text{No stirups, } ns_1 = 2.00$$

$$h1 = 400.00$$

$$ps2(\text{internal}) = (Ash2 * h2 / s2) / Asec = 0.00025008$$

$$Ash2 = Astir_2 * ns_2 = 100.531$$

$$\text{No stirups, } ns_2 = 2.00$$

$$h2 = 200.00$$

$$Asec = 268000.00$$

$$s1 = 150.00$$

$$s2 = 300.00$$

$$fywe1 = 781.25$$

$$fywe2 = 781.25$$

```

fce = 30.00
From ((5.A.5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251
y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu1_nominal = 0.08,
For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esu2_nominal = 0.08,
For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.14834034
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
From table 5A.1, TBDY: esuv_nominal = 0.08,
considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

```

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005

```

Calculation of ratio lb/l_d

```

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

```

Calculation of Mu1-

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

```

u = 1.0089632E-005
Mu = 8.9928E+007

```

with full section properties:

```

b = 670.00
d = 357.00
d' = 43.00
v = 0.00031872
N = 2287.027
fc = 30.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.00684112
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.00684112
we (5.4c) = 0.00697692
ase ((5.4d), TBDY) = (ase1*Aext+ase2*Aint)/Asec = 0.14776895
ase1 = 0.14776895
bo_1 = 340.00
ho_1 = 610.00
bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

```

```

Asec = 268000.00

```

```

s1 = 150.00

```

```

s2 = 300.00

```

```

fywe1 = 781.25

```

```

fywe2 = 781.25

```

```

fce = 30.00

```

```

From ((5.A5), TBDY), TBDY: cc = 0.00242514

```

```

c = confinement factor = 1.04251

```

```

y1 = 0.0008757

```

```

sh1 = 0.00280225

```

```

ft1 = 328.3881

```

```

fy1 = 273.6568

```

```

su1 = 0.00280225

```

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

```

lo/lou,min = lb/lb = 0.14834034

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08,

```

```

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

```

```

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

```

```

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

```

```

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

```

```

y2 = 0.0008757

```

```

sh2 = 0.00280225

```

```

ft2 = 328.3881

```

```

fy2 = 273.6568

```

```

su2 = 0.00280225

```

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

```

lo/lou,min = lb/lb,min = 0.14834034

```

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esu2_nominal = 0.08,

```

```

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

```

```

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

```

```

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

```

```

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

```

```

yv = 0.0008757

```

```

shv = 0.00280225

```

```

ftv = 328.3881

```

```

fyv = 273.6568

```

```

suv = 0.00280225

```

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

```

```

lo/lou,min = lb/lb = 0.14834034

```

```

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

```

```

From table 5A.1, TBDY: esuv_nominal = 0.08,

```

```

considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.

```

```

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

```

```

with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568

```

with $E_{sv} = (E_{sjacket} \cdot A_{sl,mid,jacket} + E_{s,mid} \cdot A_{sl,mid,core}) / A_{sl,mid} = 200000.00$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.0347448$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.0347448$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02120631$$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 31.27541$$

$$c_c (5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = A_{sl,ten} / (b \cdot d) \cdot (f_{s1} / f_c) = 0.04166345$$

$$2 = A_{sl,com} / (b \cdot d) \cdot (f_{s2} / f_c) = 0.04166345$$

$$v = A_{sl,mid} / (b \cdot d) \cdot (f_{sv} / f_c) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.22203037$$

$$\mu_u = M_{Rc} (4.14) = 8.9928E+007$$

$$u = s_u (4.1) = 1.0089632E-005$$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.14834034$

$$l_b = 300.00$$

$$d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{b,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{u2+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$\mu_u = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} \cdot \text{Max}(c_u, c_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00684112$$

$$w_e (5.4c) = 0.00697692$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{ext} + a_{se2} \cdot A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_o_1 = 340.00$$

$$h_o_1 = 610.00$$

```

bi2_1 = 975400.00
ase2 = Max(ase1,ase2) = 0.14776895
bo_2 = 192.00
ho_2 = 492.00
bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

```

```

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

```

```

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

```

```

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

```

From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

```

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

```

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00


```

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
    2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
    c = confinement factor = 1.04251
    1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
    2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
    v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005
-----

Calculation of ratio lb/ld
-----

Lap Length: lb/ld = 0.14834034
lb = 300.00
ld = 2022.376
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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00
-----

Calculation of Mu2-
-----

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 1.0089632E-005
Mu = 8.9928E+007
-----

```

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi (5A.5, \text{TB DY}) = 0.002$$

$$\text{Final value of } \phi: \phi^* = \text{shear_factor} * \text{Max}(\phi, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TB DY: } \phi = 0.00684112$$

$$\phi_e (5.4c) = 0.00697692$$

$$\phi_{se} ((5.4d), \text{TB DY}) = (\phi_{se1} * A_{ext} + \phi_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\phi_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\phi_{sh, \min} * F_{ywe} = \text{Min}(\phi_{sh, x} * F_{ywe}, \phi_{sh, y} * F_{ywe}) = 1.41645$$

$$\phi_{sh, x} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 2.53374$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\phi_{sh, y} * F_{ywe} = \phi_{sh1} * F_{ywe1} + \phi_{sh2} * F_{ywe2} = 1.41645$$

$$\phi_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\phi_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TB DY), TB DY: } \phi_c = 0.00242514$$

$$\phi_c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$ft_1 = 328.3881$$

$$fy_1 = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with

$$\text{Shear_factor} = 1.00$$

$$l_o / l_{ou, \min} = l_b / d = 0.14834034$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TB DY}) = 0.032$$

$$\text{From table 5A.1, TB DY: } esu_{1_nominal} = 0.08,$$

For calculation of $esu_{1_nominal}$ and y_1 , sh_1 , ft_1 , fy_1 , it is considered

characteristic value $fsy_1 = fs_1 / 1.2$, from table 5.1, TB DY.

$$y_1, sh_1, ft_1, fy_1, \text{ are also multiplied by } \text{Min}(1, 1.25 * (l_b / d)^{2/3}), \text{ from 10.3.5, ASCE 41-17.}$$

$$\text{with } fs_1 = (f_{sjacket} * A_{sl, ten, jacket} + f_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 273.6568$$

$$\text{with } Es_1 = (E_{sjacket} * A_{sl, ten, jacket} + E_{s, core} * A_{sl, ten, core}) / A_{sl, ten} = 200000.00$$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/lb,min = 0.14834034$
 $su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esu2_nominal = 0.08$,
 For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568$
 with $Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.14834034$
 $suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568$
 with $Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < vs, y2$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$

$lb = 300.00$

$ld = 2022.376$

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)

= 1

$db = 15.23077$

Mean strength value of all re-bars: $fy = 781.25$

$t = 1.16154$

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 397330.256$

Calculation of Shear Strength at edge 1, $V_{r1} = 397330.256$
 $V_{r1} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 4.3946131\text{E-}012$
 $V_u = 8.9541895\text{E-}015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 0.00$ is calculated for jacket, with:
 $d_2 = 160.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)
 V_f ((11-3)-(11.4), ACI 440) = 0.00
From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

Calculation of Shear Strength at edge 2, $V_{r2} = 397330.256$
 $V_{r2} = V_n$ ((22.5.1.1), ACI 318-14)

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 187890.746$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f'_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 670.00$
 $d = 320.00$
 $V_u \cdot d / M_u < 1 = 0.00$
 $M_u = 3.1257229\text{E-}011$
 $V_u = 8.9541895\text{E-}015$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 209439.51$
 $V_{s1} = 209439.51$ is calculated for jacket, with:
 $d = 320.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$

Vs1 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

Vs2 = 0.00 is calculated for jacket, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 625.00$

$s = 300.00$

Vs2 is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcjars

Constant Properties

Knowledge Factor, $= 1.00$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = -2.4081400E-011$

Shear Force, $V_2 = -1.6618325E-014$

Shear Force, $V_3 = 2019.001$

Axial Force, $F = -6910.482$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{c,com} = 911.0619$

-Middle: $As_{l,mid} = 556.0619$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten,jacket} = 603.1858$

-Compression: $Asl,com,jacket = 603.1858$

-Middle: $Asl,mid,jacket = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $Asl,ten,core = 307.8761$

-Compression: $Asl,com,core = 307.8761$

-Middle: $Asl,mid,core = 153.938$

Mean Diameter of Tension Reinforcement, $DbL = 15.20$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u,R = 1.0^*$ $u = 0.03166131$

$u = y + p = 0.03166131$

- Calculation of y -

$y = (My*Ls/3)/Eleff = 0.00166131$ ((4.29),Biskinis Phd))

$My = 9.1693E+007$

$Ls = M/V$ (with $Ls > 0.1*L$ and $Ls < 2*L$) = 1500.00

From table 10.5, ASCE 41_17: $Eleff = 0.3*Ec*Ig = 2.7596E+013$

Calculation of Yielding Moment My

Calculation of y and My according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 4.6156757E-006$

with ((10.1), ASCE 41-17) $fy = \text{Min}(fy, 1.25*fy*(lb/d)^{2/3}) = 254.0405$

$d = 357.00$

$y = 0.22915089$

$A = 0.01005639$

$B = 0.00568385$

with $pt = 0.00380895$

$pc = 0.00380895$

$pv = 0.00232477$

$N = 6910.482$

$b = 670.00$

$" = 0.12044818$

$y_{comp} = 2.5848208E-005$

with $fc = 30.00$

$Ec = 25742.96$

$y = 0.22731946$

$A = 0.0098738$

$B = 0.00557012$

with $Es = 200000.00$

Calculation of ratio lb/d

Lap Length: $ld/d,min = 0.18542542$

$lb = 300.00$

$ld = 1617.901$

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)

$= 1$

$db = 15.23077$

Mean strength value of all re-bars: $fy = 625.00$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$Ktr = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.03$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:
($l_b/d < 1$ and With Lapping in the Vicinity of the End Regions)

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.15088696$

- Transverse Reinforcement: NC

- Stirrup Spacing $> d/3$

- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)

$= 1.2489173E-021$

- Stirrup Spacing $\leq d/2$

$d = d_{\text{external}} = 357.00$

$s = s_{\text{external}} = 150.00$

- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 242949.832$, already given in calculation of shear control ratio

design Shear = $1.6618325E-014$

- (ρ_t)/ $\rho_{bal} = -0.30840259$

$= A_{st}/(b_w \cdot d) = 0.00296835$

Tension Reinf Area: $A_{st} = 709.9999$

$\rho_c = A_{sc}/(b_w \cdot d) = 0.00697431$

Compression Reinf Area: $A_{sc} = 1668.186$

From (B-1), ACI 318-11: $\rho_{bal} = 0.01298939$

$f_c = (f_{c_jacket} \cdot \text{Area}_{jacket} + f_{c_core} \cdot \text{Area}_{core}) / \text{section_area} = 30.00$

$f_y = f_{y_jacket_bars} = 625.00$

From 10.2.7.3, ACI 318-11: $\lambda = 0.65$

From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000/(87000 + f_y) = c_b/d_t = 0.003/(0.003 + \gamma) = 0.48979592$
 $\gamma = 0.003125$

- $V/(b_w \cdot d \cdot f_c^{0.5}) = 1.5275901E-019$, NOTE: units in lb & in

$b_w = 670.00$

End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

beam B1, Floor 1

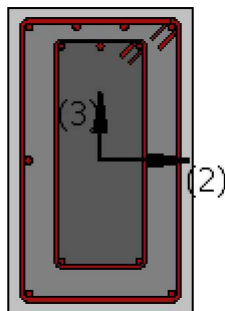
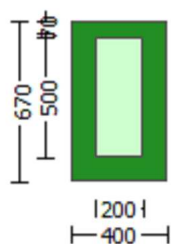
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.

Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$

New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_o = l_b = 300.00$

No FRP Wrapping

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -2.4081400E-011$

Shear Force, $V_a = -1.6618325E-014$

EDGE -B-

Bending Moment, $M_b = -2.6019235E-011$

Shear Force, $V_b = 1.6618325E-014$

BOTH EDGES

Axial Force, $F = -6910.482$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 911.0619$

-Compression: $As_{l,com} = 911.0619$

-Middle: $Asl_{mid} = 556.0619$

Mean Diameter of Tension Reinforcement, $DbL_{ten} = 15.20$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $VR = 1.0 \cdot V_n = 320963.76$
 $V_n ((22.5.1.1), ACI 318-14) = 320963.76$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f'V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 153412.152$
 $= 1$ (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{jacket} \cdot Area_{jacket} + fc'_{core} \cdot Area_{core}) / Area_{section} = 20.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$p_w = As / (bw \cdot d) = 0.00331157$

As (tension reinf.) = 709.9999

$bw = 670.00$

$d = 320.00$

$V_u \cdot d / Mu < 1 = 0.00$

$Mu = 2.6019235E-011$

$V_u = 1.6618325E-014$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 167551.608$

$V_{s1} = 167551.608$ is calculated for jacket, with:

$d = 320.00$

$A_v = 157079.633$

$f_y = 500.00$

$s = 150.00$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 0.00$ is calculated for core, with:

$d = 160.00$

$A_v = 100530.965$

$f_y = 500.00$

$s = 300.00$

V_{s2} is considered 0 ($s > d$, according to ASCE 41-17, 10.3.4)

$V_f ((11-3)-(11.4), ACI 440) = 0.00$

From (11-11), ACI 440: $V_s + V_f \leq 636951.749$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Calculation No. 14

beam B1, Floor 1

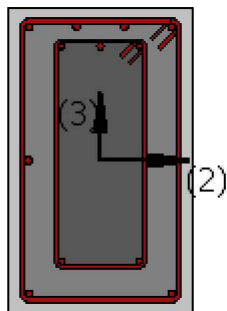
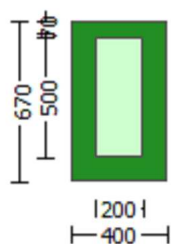
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (ϕ_r)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\gamma = 1.00$

Mean strength values are used for both shear and moment calculations.

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

#####

Note: Especially for the calculation of moment strengths,

the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14

Jacket

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

Existing Column

New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.04251

Element Length, $L = 3000.00$

Primary 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 $l_o = 300.00$

No FRP Wrapping

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 9840.634$

EDGE -B-

Shear Force, $V_b = 9840.632$

BOTH EDGES

Axial Force, $F = -2287.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{c,com} = 1266.062$

-Middle: $As_{mid} = 402.1239$

Calculation of Shear Capacity ratio, $V_e/V_r = 0.26808017$

Member Controlled by Flexure ($V_e/V_r < 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u \cdot l_n/2 = 158880.346$ with

$M_{pr1} = \text{Max}(\mu_{1+}, \mu_{1-}) = 2.2356E+008$

$\mu_{1+} = 1.1381E+008$, 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

$\mu_{1-} = 2.2356E+008$, 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

$M_{pr2} = \text{Max}(\mu_{2+}, \mu_{2-}) = 2.2356E+008$

$\mu_{2+} = 1.1381E+008$, is the ultimate moment strength at the edge 2 of the member in the actual moment direction which is defined for the static loading combination

$\mu_{2-} = 2.2356E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the static loading combination

and

$\pm w_u \cdot l_n = (|V_1| + |V_2|)/2$

with

$V_1 = 9840.634$, is the shear force acting at edge 1 for the static loading combination

$V_2 = 9840.632$, is the shear force acting at edge 2 for the static loading combination

Calculation of μ_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$\phi_u = 5.6034793E-006$

$M_u = 1.1381E+008$

with full section properties:

$b = 400.00$

$d = 627.00$

$d' = 43.00$

$v = 0.00030396$

$N = 2287.027$

$f_c = 30.00$

ϕ_c (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} \cdot \text{Max}(\phi_u, \phi_c) = 0.00684112$

The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) = 0.00697692

ϕ_{se} ((5.4d), TBDY) = $(\phi_{se1} \cdot A_{ext} + \phi_{se2} \cdot A_{int})/A_{sec} = 0.14776895$

$\phi_{se1} = 0.14776895$

$b_{o_1} = 340.00$

$h_{o_1} = 610.00$

$b_{i2_1} = 975400.00$

$\phi_{se2} = \text{Max}(\phi_{se1}, \phi_{se2}) = 0.14776895$

$b_{o_2} = 192.00$

$h_{o_2} = 492.00$

$b_{i2_2} = 557856.00$

$\phi_{sh,min} \cdot F_{ywe} = \text{Min}(\phi_{sh,x} \cdot F_{ywe}, \phi_{sh,y} \cdot F_{ywe}) = 1.41645$

$\phi_{sh,x} \cdot F_{ywe} = \phi_{sh1} \cdot F_{ywe1} + \phi_{sh2} \cdot F_{ywe2} = 2.53374$

ϕ_{s1} (external) = $(A_{sh1} \cdot h_1/s_1)/A_{sec} = 0.00261799$

$A_{sh1} = A_{stir_1} \cdot n_{s_1} = 157.0796$

No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

From ((5.A.5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/ld = 0.14834034

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25*(lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_jacket*Asl_mid,jacket + fs_mid*Asl_mid,core)/Asl_mid = 273.6568$
 with $Esv = (Es_jacket*Asl_mid,jacket + Es_mid*Asl_mid,core)/Asl_mid = 200000.00$
 $1 = Asl_ten/(b*d)*(fs1/fc) = 0.02582354$
 $2 = Asl_com/(b*d)*(fs2/fc) = 0.04604817$
 $v = Asl_mid/(b*d)*(fsv/fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 fcc (5A.2, TBDY) = 31.27541
 cc (5A.5, TBDY) = 0.00242514
 c = confinement factor = 1.04251
 $1 = Asl_ten/(b*d)*(fs1/fc) = 0.0319073$
 $2 = Asl_com/(b*d)*(fs2/fc) = 0.05689664$
 $v = Asl_mid/(b*d)*(fsv/fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

---->
 $v < vsy2$ - LHS eq.(4.5) is satisfied

---->
 su (4.9) = 0.20240787
 $Mu = MRc$ (4.14) = 1.1381E+008
 $u = su$ (4.1) = 5.6034793E-006

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 5.7880076E-006$
 $Mu = 2.2356E+008$

with full section properties:

$b = 400.00$
 $d = 627.00$
 $d' = 43.00$
 $v = 0.00030396$
 $N = 2287.027$
 $fc = 30.00$
 co (5A.5, TBDY) = 0.002
 Final value of cu : $cu^* = shear_factor * Max(cu, cc) = 0.00684112$
 The $Shear_factor$ is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $cu = 0.00684112$
 we (5.4c) = 0.00697692
 ase ((5.4d), TBDY) = $(ase1 \cdot A_{ext} + ase2 \cdot A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min \cdot Fywe = \text{Min}(psh, x \cdot Fywe, psh, y \cdot Fywe) = 1.41645$

$psh, x \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 2.53374$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y \cdot Fywe = psh1 \cdot Fywe1 + ps2 \cdot Fywe2 = 1.41645$
 $ps1 \text{ (external)} = (Ash1 \cdot h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 \cdot ns_1 = 157.0796$
 No stirups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$

$s1 = 150.00$

$s2 = 300.00$

$fywe1 = 781.25$

$fywe2 = 781.25$

$fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$

$c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$

$sh1 = 0.00280225$

$ft1 = 328.3881$

$fy1 = 273.6568$

$su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, \min = lb/ld = 0.14834034$

$su1 = 0.4 \cdot esu1_{\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_{\text{nominal}} = 0.08$,

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, \text{jacket} \cdot Asl, \text{ten, jacket} + fs, \text{core} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es, \text{jacket} \cdot Asl, \text{ten, jacket} + Es, \text{core} \cdot Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$

$sh2 = 0.00280225$

$ft2 = 328.3881$

$fy2 = 273.6568$

$su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with

Shear_factor = 1.00

$lo/lou, \min = lb/lb, \min = 0.14834034$

$su2 = 0.4 \cdot esu2_{\text{nominal}} \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $es_{u2_nominal} = 0.08$,
 For calculation of $es_{u2_nominal}$ and y_2 , sh_2 , ft_2 , fy_2 , it is considered
 characteristic value $fs_{y2} = fs_2/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} \cdot Asl_{com,jacket} + fs_{core} \cdot Asl_{com,core}) / Asl_{com} = 273.6568$
 with $Es_2 = (Es_{jacket} \cdot Asl_{com,jacket} + Es_{core} \cdot Asl_{com,core}) / Asl_{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $s_{uv} = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou_{min} = lb/d = 0.14834034$
 $s_{uv} = 0.4 \cdot es_{uv_nominal} ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $es_{uv_nominal} = 0.08$,
 considering characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $es_{uv_nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered
 characteristic value $fs_{yv} = fs_v/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} \cdot Asl_{mid,jacket} + fs_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Es_v = (Es_{jacket} \cdot Asl_{mid,jacket} + Es_{mid} \cdot Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.04604817$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.02582354$
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.01462572$

and confined core properties:

$b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b \cdot d) \cdot (fs_1 / fc) = 0.05689664$
 $2 = Asl_{com} / (b \cdot d) \cdot (fs_2 / fc) = 0.0319073$
 $v = Asl_{mid} / (b \cdot d) \cdot (fs_v / fc) = 0.01807139$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$su (4.9) = 0.22783602$
 $Mu = MRc (4.14) = 2.2356E+008$
 $u = su (4.1) = 5.7880076E-006$

Calculation of ratio lb/d

Lap Length: $lb/d = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

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)

$= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.64216$
 $n = 13.00$

Calculation of Mu_{2+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$$u = 5.6034793E-006$$

$$\mu = 1.1381E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\alpha (5A.5, \text{TBDY}) = 0.002$$

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \phi_u = 0.00684112$$

$$\omega_e (5.4c) = 0.00697692$$

$$\alpha_{se} ((5.4d), \text{TBDY}) = (\alpha_{se1} * A_{ext} + \alpha_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\alpha_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$\alpha_{se2} = \text{Max}(\alpha_{se1}, \alpha_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$\text{psh}_{\min} * F_{ywe} = \text{Min}(\text{psh}_x * F_{ywe}, \text{psh}_y * F_{ywe}) = 1.41645$$

$$\text{psh}_x * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 2.53374$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$\text{psh}_y * F_{ywe} = \text{psh}_1 * F_{ywe1} + \text{ps}_2 * F_{ywe2} = 1.41645$$

$$\text{ps}_1 (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirups, } n_{s_1} = 2.00$$

$$h_1 = 400.00$$

$$\text{ps}_2 (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirups, } n_{s_2} = 2.00$$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$$s_2 = 300.00$$

$$f_{ywe1} = 781.25$$

$$f_{ywe2} = 781.25$$

$$f_{ce} = 30.00$$

$$\text{From ((5.A5), TBDY), TBDY: } \phi_c = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$y_1 = 0.0008757$$

$$sh_1 = 0.00280225$$

$$f_{t1} = 328.3881$$

$$f_{y1} = 273.6568$$

$$su_1 = 0.00280225$$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

$$l_o / l_{ou, \min} = l_b / l_d = 0.14834034$$

$$su_1 = 0.4 * esu_{1_nominal} ((5.5), \text{TBDY}) = 0.032$$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,
For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs1 = (fs_jacket \cdot Asl_ten_jacket + fs_core \cdot Asl_ten_core) / Asl_ten = 273.6568$
with $Es1 = (Es_jacket \cdot Asl_ten_jacket + Es_core \cdot Asl_ten_core) / Asl_ten = 200000.00$
 $y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esu2_nominal = 0.08$,
For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fs2 = (fs_jacket \cdot Asl_com_jacket + fs_core \cdot Asl_com_core) / Asl_com = 273.6568$
with $Es2 = (Es_jacket \cdot Asl_com_jacket + Es_core \cdot Asl_com_core) / Asl_com = 200000.00$
 $yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.032$
From table 5A.1, TBDY: $esuv_nominal = 0.08$,
considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1, sh1, ft1, fy1$, are also multiplied by $Min(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
with $fsv = (fs_jacket \cdot Asl_mid_jacket + fs_mid \cdot Asl_mid_core) / Asl_mid = 273.6568$
with $Esv = (Es_jacket \cdot Asl_mid_jacket + Es_mid \cdot Asl_mid_core) / Asl_mid = 200000.00$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.02582354$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.04604817$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01462572$
and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_ten / (b \cdot d) \cdot (fs1 / fc) = 0.0319073$
 $2 = Asl_com / (b \cdot d) \cdot (fs2 / fc) = 0.05689664$
 $v = Asl_mid / (b \cdot d) \cdot (fsv / fc) = 0.01807139$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.20240787$
 $Mu = MRc (4.14) = 1.1381E+008$
 $u = su (4.1) = 5.6034793E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $I_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_2 -

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$\mu = 5.7880076E-006$$

$$\mu = 2.2356E+008$$

with full section properties:

$$b = 400.00$$

$$d = 627.00$$

$$d' = 43.00$$

$$v = 0.00030396$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$\phi_0 \text{ (5A.5, TBDY)} = 0.002$$

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \phi_0) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } \mu = 0.00684112$$

$$\mu_e \text{ (5.4c)} = 0.00697692$$

$$\mu_{se} \text{ ((5.4d), TBDY)} = (\mu_{se1} * A_{ext} + \mu_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$\mu_{se1} = 0.14776895$$

$$b_{o,1} = 340.00$$

$$h_{o,1} = 610.00$$

$$b_{i,1} = 975400.00$$

$$\mu_{se2} = \text{Max}(\mu_{se1}, \mu_{se2}) = 0.14776895$$

$$b_{o,2} = 192.00$$

$$h_{o,2} = 492.00$$

$$b_{i,2} = 557856.00$$

$$\mu_{sh,min} * F_{ywe} = \text{Min}(\mu_{sh,x} * F_{ywe}, \mu_{sh,y} * F_{ywe}) = 1.41645$$

$$\mu_{sh,x} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 2.53374$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$$

No stirrups, $n_{s,1} = 2.00$

$$h_1 = 670.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$$

No stirrups, $n_{s,2} = 2.00$

$$h_2 = 500.00$$

$$\mu_{sh,y} * F_{ywe} = \mu_{sh1} * F_{ywe1} + \mu_{sh2} * F_{ywe2} = 1.41645$$

$$\mu_{sh1} \text{ (external)} = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir,1} * n_{s,1} = 157.0796$$

No stirrups, $n_{s,1} = 2.00$

$$h_1 = 400.00$$

$$\mu_{sh2} \text{ (internal)} = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00025008$$

$$A_{sh2} = A_{stir,2} * n_{s,2} = 100.531$$

No stirrups, $n_{s,2} = 2.00$

$$h_2 = 200.00$$

$$A_{sec} = 268000.00$$

$$s_1 = 150.00$$

$s_2 = 300.00$
 $fy_{we1} = 781.25$
 $fy_{we2} = 781.25$
 $f_{ce} = 30.00$
 From ((5A.5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $y_1 = 0.0008757$
 $sh_1 = 0.00280225$
 $ft_1 = 328.3881$
 $fy_1 = 273.6568$
 $su_1 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.14834034$
 $su_1 = 0.4 * esu_1 \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu_1 \text{ nominal} = 0.08$,
 For calculation of $esu_1 \text{ nominal}$ and y_1, sh_1, ft_1, fy_1 , it is considered
 characteristic value $fsy_1 = fs_1/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_1 = (fs_{jacket} * Asl, \text{ten, jacket} + fs_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 273.6568$
 with $Es_1 = (Es_{jacket} * Asl, \text{ten, jacket} + Es_{core} * Asl, \text{ten, core}) / Asl, \text{ten} = 200000.00$
 $y_2 = 0.0008757$
 $sh_2 = 0.00280225$
 $ft_2 = 328.3881$
 $fy_2 = 273.6568$
 $su_2 = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/lb, \min = 0.14834034$
 $su_2 = 0.4 * esu_2 \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esu_2 \text{ nominal} = 0.08$,
 For calculation of $esu_2 \text{ nominal}$ and y_2, sh_2, ft_2, fy_2 , it is considered
 characteristic value $fsy_2 = fs_2/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_2 = (fs_{jacket} * Asl, \text{com, jacket} + fs_{core} * Asl, \text{com, core}) / Asl, \text{com} = 273.6568$
 with $Es_2 = (Es_{jacket} * Asl, \text{com, jacket} + Es_{core} * Asl, \text{com, core}) / Asl, \text{com} = 200000.00$
 $y_v = 0.0008757$
 $sh_v = 0.00280225$
 $ft_v = 328.3881$
 $fy_v = 273.6568$
 $suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 * esuv \text{ nominal ((5.5), TBDY)} = 0.032$
 From table 5A.1, TBDY: $esuv \text{ nominal} = 0.08$,
 considering characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY
 For calculation of $esuv \text{ nominal}$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fsyv = fs_v/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs_v = (fs_{jacket} * Asl, \text{mid, jacket} + fs_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 273.6568$
 with $Es_v = (Es_{jacket} * Asl, \text{mid, jacket} + Es_{mid} * Asl, \text{mid, core}) / Asl, \text{mid} = 200000.00$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.04604817$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.02582354$
 $v = Asl, \text{mid} / (b * d) * (fs_v / f_c) = 0.01462572$
 and confined core properties:
 $b = 340.00$
 $d = 597.00$
 $d' = 13.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 31.27541$
 $cc \text{ (5A.5, TBDY)} = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl, \text{ten} / (b * d) * (fs_1 / f_c) = 0.05689664$
 $2 = Asl, \text{com} / (b * d) * (fs_2 / f_c) = 0.0319073$

$$v = A_{sl, mid} / (b * d) * (f_{sv} / f_c) = 0.01807139$$

Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u (4.9) = 0.22783602$$

$$\mu = M_{Rc} (4.14) = 2.2356E+008$$

$$u = s_u (4.1) = 5.7880076E-006$$

Calculation of ratio l_b / l_d

Lap Length: $l_b / l_d = 0.14834034$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of l_b, min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d, 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)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 592659.827$

Calculation of Shear Strength at edge 1, $V_{r1} = 592659.827$

$$V_{r1} = V_n ((22.5.1.1), \text{ACI 318-14})$$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f * V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$

= 1 (normal-weight concrete)

Mean concrete strength: $f'_c = (f'_c_{jacket} * \text{Area}_{jacket} + f'_c_{core} * \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$p_w = A_s / (b_w * d) = 0.00331157$$

$$A_s (\text{tension reinf.}) = 709.9999$$

$$b_w = 400.00$$

$$d = 536.00$$

$$V_u * d / \mu < 1 = 1.00$$

$$\mu = 1.1092E+006$$

$$V_u = 9840.634$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$

$V_{s1} = 350811.18$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 625.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

$V_{s2} = 41887.902$ is calculated for jacket, with:

$$d_2 = 400.00$$

$$A_v = 100530.965$$

$$f_y = 625.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 780103.388$$

Calculation of Shear Strength at edge 2, $V_{r2} = 592659.827$
 $V_{r2} = V_n ((22.5.1.1), \text{ACI } 318-14)$

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 199960.745$
= 1 (normal-weight concrete)
Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot \text{Area}_{jacket} + f'_{c_core} \cdot \text{Area}_{core}) / \text{Area}_{section} = 30.00$, but $f_c^{0.5} \leq 8.3$
MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / \mu_u < 1 = 1.00$
 $\mu_u = 1.1092E+006$
 $V_u = 9840.632$
From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 392699.082$
 $V_{s1} = 350811.18$ is calculated for jacket, with:
 $d = 536.00$
 $A_v = 157079.633$
 $f_y = 625.00$
 $s = 150.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 41887.902$ is calculated for jacket, with:
 $d = 400.00$
 $A_v = 100530.965$
 $f_y = 625.00$
 $s = 300.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 $V_f ((11-3)-(11.4), \text{ACI } 440) = 0.00$
From (11-11), ACI 440: $V_s + V_f \leq 780103.388$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At local axis: 3

Start Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcjars

Constant Properties

Knowledge Factor, = 1.00
Mean strength values are used for both shear and moment calculations.
Consequently:
Jacket
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$
Existing Column
New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$
New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$
Concrete Elasticity, $E_c = 25742.96$
Steel Elasticity, $E_s = 200000.00$

Note: Especially for the calculation of moment strengths,
the above steel re-bar strengths are multiplied by 1.25 according to R18.6.5, ACI 318-14
Jacket
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$
Existing Column
New material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 781.25$

#####

External Height, H = 670.00
External Width, W = 400.00
Internal Height, H = 500.00
Internal Width, W = 200.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.04251
Element Length, L = 3000.00
Primary 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 l_o = 300.00
No FRP Wrapping

Stepwise Properties

At local axis: 2
EDGE -A-
Shear Force, V_a = 8.9541895E-015
EDGE -B-
Shear Force, V_b = -8.9541895E-015
BOTH EDGES
Axial Force, F = -2287.027
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: A_{st} = 709.9999
-Compression: A_{sc} = 1668.186
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{st,ten}$ = 911.0619
-Compression: $A_{st,com}$ = 911.0619
-Middle: $A_{st,mid}$ = 556.0619

Calculation of Shear Capacity ratio , V_e/V_r = 0.15088696
Member Controlled by Flexure ($V_e/V_r < 1$)
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n \pm w_u * l_n / 2 = 59951.954$
with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 8.9928E+007$
 $\mu_{u1+} = 8.9928E+007$, 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
 $\mu_{u1-} = 8.9928E+007$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 8.9928E+007$
 $\mu_{u2+} = 8.9928E+007$, 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
 $\mu_{u2-} = 8.9928E+007$, 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
and
 $\pm w_u * l_n = (|V_1| + |V_2|)/2$
with
 $V_1 = 8.9541895E-015$, is the shear force acting at edge 1 for the the static loading combination
 $V_2 = -8.9541895E-015$, is the shear force acting at edge 2 for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 1.0089632E-005$
 $\mu_u = 8.9928E+007$

with full section properties:

$b = 670.00$
 $d = 357.00$
 $d' = 43.00$
 $v = 0.00031872$
 $N = 2287.027$
 $fc = 30.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00684112$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.00684112$
 $w_e(5.4c) = 0.00697692$
 $ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$
 $ase1 = 0.14776895$
 $bo_1 = 340.00$
 $ho_1 = 610.00$
 $bi2_1 = 975400.00$
 $ase2 = \text{Max}(ase1, ase2) = 0.14776895$
 $bo_2 = 192.00$
 $ho_2 = 492.00$
 $bi2_2 = 557856.00$
 $psh, \min * F_{ywe} = \text{Min}(psh, x * F_{ywe}, psh, y * F_{ywe}) = 1.41645$

$psh, x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$
 $ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00261799$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 670.00$
 $ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00062519$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 500.00$

$psh, y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$
 $ps1(\text{external}) = (Ash1 * h1 / s1) / A_{sec} = 0.00156298$
 $Ash1 = Astir_1 * ns_1 = 157.0796$
 No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2(\text{internal}) = (Ash2 * h2 / s2) / A_{sec} = 0.00025008$
 $Ash2 = Astir_2 * ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

$A_{sec} = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fywe1 = 781.25$
 $fywe2 = 781.25$
 $f_{ce} = 30.00$

From ((5.A.5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$

$su1 = 0.4 * esu1_{\text{nominal}}((5.5), TBDY) = 0.032$

From table 5A.1, TBDY: $esu1_{\text{nominal}} = 0.08$,

For calculation of $esu1_{\text{nominal}}$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1 / 1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs, \text{jacket} * A_{sl, \text{ten, jacket}} + fs, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 273.6568$

with $Es1 = (Es, \text{jacket} * A_{sl, \text{ten, jacket}} + Es, \text{core} * A_{sl, \text{ten, core}}) / A_{sl, \text{ten}} = 200000.00$

$y2 = 0.0008757$

```

sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14834034
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037
Mu = MRc (4.14) = 8.9928E+007
u = su (4.1) = 1.0089632E-005

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.14834034
lb = 300.00
lb = 2022.376
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
lb,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)
= 1
db = 15.23077
Mean strength value of all re-bars: fy = 781.25
t = 1.16154
s = 0.80

```


e = 1.00
cb = 25.00
Ktr = 2.64216
n = 13.00

Calculation of Mu1-

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:

$u = 1.0089632E-005$
 $Mu = 8.9928E+007$

with full section properties:

b = 670.00
d = 357.00
d' = 43.00
v = 0.00031872
N = 2287.027

fc = 30.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.00684112$
The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $\phi_u = 0.00684112$

we (5.4c) = 0.00697692

ase ((5.4d), TBDY) = $(ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$

ase1 = 0.14776895

bo_1 = 340.00

ho_1 = 610.00

bi2_1 = 975400.00

ase2 = $\text{Max}(ase1, ase2) = 0.14776895$

bo_2 = 192.00

ho_2 = 492.00

bi2_2 = 557856.00

$psh_{min} * F_{ywe} = \text{Min}(psh_x * F_{ywe}, psh_y * F_{ywe}) = 1.41645$

$psh_x * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 2.53374$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00261799$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 670.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00062519$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 500.00

$psh_y * F_{ywe} = psh1 * F_{ywe1} + ps2 * F_{ywe2} = 1.41645$

ps1 (external) = $(Ash1 * h1 / s1) / A_{sec} = 0.00156298$

Ash1 = $A_{stir_1} * ns_1 = 157.0796$

No stirups, ns_1 = 2.00

h1 = 400.00

ps2 (internal) = $(Ash2 * h2 / s2) / A_{sec} = 0.00025008$

Ash2 = $A_{stir_2} * ns_2 = 100.531$

No stirups, ns_2 = 2.00

h2 = 200.00

Asec = 268000.00

s1 = 150.00

s2 = 300.00

fywe1 = 781.25

fywe2 = 781.25

fce = 30.00

From ((5.A5), TBDY), TBDY: $\phi_c = 0.00242514$

c = confinement factor = 1.04251

y1 = 0.0008757

```

sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.14834034
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu1_nominal = 0.08,
    For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
    characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568
    with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00
y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/lb,min = 0.14834034
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esu2_nominal = 0.08,
    For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
    characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568
    with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00
yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568
suv = 0.00280225
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lo,min = lb/ld = 0.14834034
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.032
    From table 5A.1, TBDY: esuv_nominal = 0.08,
    considering characteristic value fsyv = fsv/1.2, from table 5.1, TBDY
    For calculation of esuv_nominal and yv, shv,ftv,fyv, it is considered
    characteristic value fsyv = fsv/1.2, from table 5.1, TBDY.
    y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/ld)^ 2/3), from 10.3.5, ASCE 41-17.
    with fsv = (fs,jacket*Asl,mid,jacket + fs,mid*Asl,mid,core)/Asl,mid = 273.6568
    with Esv = (Es,jacket*Asl,mid,jacket + Es,mid*Asl,mid,core)/Asl,mid = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.0347448
2 = Asl,com/(b*d)*(fs2/fc) = 0.0347448
v = Asl,mid/(b*d)*(fsv/fc) = 0.02120631
and confined core properties:
b = 610.00
d = 327.00
d' = 13.00
fcc (5A.2, TBDY) = 31.27541
cc (5A.5, TBDY) = 0.00242514
c = confinement factor = 1.04251
1 = Asl,ten/(b*d)*(fs1/fc) = 0.04166345
2 = Asl,com/(b*d)*(fs2/fc) = 0.04166345
v = Asl,mid/(b*d)*(fsv/fc) = 0.02542907
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.22203037

```

$$\begin{aligned} \mu &= M/R_c (4.14) = 8.9928E+007 \\ u &= s_u (4.1) = 1.0089632E-005 \end{aligned}$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14834034$$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

l_d ,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)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of μ_{2+}

Calculation of ultimate curvature μ according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$\mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$c_o (5A.5, TBDY) = 0.002$$

$$\text{Final value of } c_u: c_u = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } c_u = 0.00684112$$

$$w_e (5.4c) = 0.00697692$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{ext} + a_{se2} * A_{int}) / A_{sec} = 0.14776895$$

$$a_{se1} = 0.14776895$$

$$b_{o_1} = 340.00$$

$$h_{o_1} = 610.00$$

$$b_{i2_1} = 975400.00$$

$$a_{se2} = \text{Max}(a_{se1}, a_{se2}) = 0.14776895$$

$$b_{o_2} = 192.00$$

$$h_{o_2} = 492.00$$

$$b_{i2_2} = 557856.00$$

$$p_{sh,min} * F_{ywe} = \text{Min}(p_{sh,x} * F_{ywe}, p_{sh,y} * F_{ywe}) = 1.41645$$

$$p_{sh,x} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 2.53374$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00261799$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

$$\text{No stirrups, } n_{s_1} = 2.00$$

$$h_1 = 670.00$$

$$p_{s2} (\text{internal}) = (A_{sh2} * h_2 / s_2) / A_{sec} = 0.00062519$$

$$A_{sh2} = A_{stir_2} * n_{s_2} = 100.531$$

$$\text{No stirrups, } n_{s_2} = 2.00$$

$$h_2 = 500.00$$

$$p_{sh,y} * F_{ywe} = p_{sh1} * F_{ywe1} + p_{s2} * F_{ywe2} = 1.41645$$

$$p_{s1} (\text{external}) = (A_{sh1} * h_1 / s_1) / A_{sec} = 0.00156298$$

$$A_{sh1} = A_{stir_1} * n_{s_1} = 157.0796$$

No stirrups, $ns_1 = 2.00$
 $h1 = 400.00$
 $ps2 \text{ (internal)} = (Ash2 \cdot h2 / s2) / Asec = 0.00025008$
 $Ash2 = Astir_2 \cdot ns_2 = 100.531$
 No stirrups, $ns_2 = 2.00$
 $h2 = 200.00$

 $Asec = 268000.00$
 $s1 = 150.00$
 $s2 = 300.00$
 $fyw1 = 781.25$
 $fyw2 = 781.25$
 $fce = 30.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00242514$
 $c = \text{confinement factor} = 1.04251$

$y1 = 0.0008757$
 $sh1 = 0.00280225$
 $ft1 = 328.3881$
 $fy1 = 273.6568$
 $su1 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu1_nominal = 0.08$,

For calculation of $esu1_nominal$ and $y1, sh1, ft1, fy1$, it is considered
 characteristic value $fsy1 = fs1/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = (fs_jacket \cdot Asl, \text{ten}, \text{jacket} + fs_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 273.6568$

with $Es1 = (Es_jacket \cdot Asl, \text{ten}, \text{jacket} + Es_core \cdot Asl, \text{ten}, \text{core}) / Asl, \text{ten} = 200000.00$

$y2 = 0.0008757$
 $sh2 = 0.00280225$
 $ft2 = 328.3881$
 $fy2 = 273.6568$
 $su2 = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/lb, \min = 0.14834034$
 $su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esu2_nominal = 0.08$,

For calculation of $esu2_nominal$ and $y2, sh2, ft2, fy2$, it is considered
 characteristic value $fsy2 = fs2/1.2$, from table 5.1, TBDY.

$y2, sh2, ft2, fy2$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = (fs_jacket \cdot Asl, \text{com}, \text{jacket} + fs_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 273.6568$

with $Es2 = (Es_jacket \cdot Asl, \text{com}, \text{jacket} + Es_core \cdot Asl, \text{com}, \text{core}) / Asl, \text{com} = 200000.00$

$yv = 0.0008757$
 $shv = 0.00280225$
 $ftv = 328.3881$
 $fyv = 273.6568$
 $suv = 0.00280225$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$

$lo/lou, \min = lb/ld = 0.14834034$
 $suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.032$

From table 5A.1, TBDY: $esuv_nominal = 0.08$,

considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY

For calculation of $esuv_nominal$ and yv, shv, ftv, fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.

$y1, sh1, ft1, fy1$, are also multiplied by $\text{Min}(1, 1.25 \cdot (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fsv = (fs_jacket \cdot Asl, \text{mid}, \text{jacket} + fs_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 273.6568$

with $Esv = (Es_jacket \cdot Asl, \text{mid}, \text{jacket} + Es_mid \cdot Asl, \text{mid}, \text{core}) / Asl, \text{mid} = 200000.00$

$1 = Asl, \text{ten} / (b \cdot d) \cdot (fs1 / fc) = 0.0347448$

$2 = Asl, \text{com} / (b \cdot d) \cdot (fs2 / fc) = 0.0347448$

$v = Asl, \text{mid} / (b \cdot d) \cdot (fsv / fc) = 0.02120631$

and confined core properties:

$$b = 610.00$$

$$d = 327.00$$

$$d' = 13.00$$

$$fcc(5A.2, TBDY) = 31.27541$$

$$cc(5A.5, TBDY) = 0.00242514$$

$$c = \text{confinement factor} = 1.04251$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.04166345$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.04166345$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02542907$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

$v < v_{s,y2}$ - LHS eq.(4.5) is satisfied

--->

$$s_u(4.9) = 0.22203037$$

$$Mu = MR_c(4.14) = 8.9928E+007$$

$$u = s_u(4.1) = 1.0089632E-005$$

Calculation of ratio l_b/l_d

$$\text{Lap Length: } l_b/l_d = 0.14834034$$

$$l_b = 300.00$$

$$l_d = 2022.376$$

Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (9.1.2, TS500 - No provision in ACI 318)

$$= 1$$

$$d_b = 15.23077$$

Mean strength value of all re-bars: $f_y = 781.25$

$$t = 1.16154$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.64216$$

$$n = 13.00$$

Calculation of Mu_2 -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:

$$u = 1.0089632E-005$$

$$Mu = 8.9928E+007$$

with full section properties:

$$b = 670.00$$

$$d = 357.00$$

$$d' = 43.00$$

$$v = 0.00031872$$

$$N = 2287.027$$

$$f_c = 30.00$$

$$cc(5A.5, TBDY) = 0.002$$

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.00684112$$

The Shear_factor is considered equal to 1 (pure moment strength)

$$\text{From (5.4b), TBDY: } cu = 0.00684112$$

$$w_e(5.4c) = 0.00697692$$

$$ase((5.4d), TBDY) = (ase1 * A_{ext} + ase2 * A_{int}) / A_{sec} = 0.14776895$$

$$ase1 = 0.14776895$$

$$bo_1 = 340.00$$

$$ho_1 = 610.00$$

$$bi_2_1 = 975400.00$$

$$ase2 = \text{Max}(ase1, ase2) = 0.14776895$$

$$bo_2 = 192.00$$

$$ho_2 = 492.00$$

bi2_2 = 557856.00
psh,min*Fywe = Min(psh,x*Fywe , psh,y*Fywe) = 1.41645

psh_x*Fywe = psh1*Fywe1+ps2*Fywe2 = 2.53374
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00261799
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 670.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00062519
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 500.00

psh_y*Fywe = psh1*Fywe1+ps2*Fywe2 = 1.41645
ps1 (external) = (Ash1*h1/s1)/Asec = 0.00156298
Ash1 = Astir_1*ns_1 = 157.0796
No stirups, ns_1 = 2.00
h1 = 400.00
ps2 (internal) = (Ash2*h2/s2)/Asec = 0.00025008
Ash2 = Astir_2*ns_2 = 100.531
No stirups, ns_2 = 2.00
h2 = 200.00

Asec = 268000.00
s1 = 150.00
s2 = 300.00
fywe1 = 781.25
fywe2 = 781.25
fce = 30.00

From ((5.A5), TBDY), TBDY: cc = 0.00242514
c = confinement factor = 1.04251

y1 = 0.0008757
sh1 = 0.00280225
ft1 = 328.3881
fy1 = 273.6568
su1 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb = 0.14834034
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu1_nominal = 0.08,

For calculation of esu1_nominal and y1, sh1,ft1,fy1, it is considered
characteristic value fsy1 = fs1/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs1 = (fs,jacket*Asl,ten,jacket + fs,core*Asl,ten,core)/Asl,ten = 273.6568

with Es1 = (Es,jacket*Asl,ten,jacket + Es,core*Asl,ten,core)/Asl,ten = 200000.00

y2 = 0.0008757
sh2 = 0.00280225
ft2 = 328.3881
fy2 = 273.6568
su2 = 0.00280225

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00

lo/lou,min = lb/lb,min = 0.14834034
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.032

From table 5A.1, TBDY: esu2_nominal = 0.08,

For calculation of esu2_nominal and y2, sh2,ft2,fy2, it is considered
characteristic value fsy2 = fs2/1.2, from table 5.1, TBDY.

y1, sh1,ft1,fy1, are also multiplied by Min(1,1.25*(lb/lb)^2/3), from 10.3.5, ASCE 41-17.

with fs2 = (fs,jacket*Asl,com,jacket + fs,core*Asl,com,core)/Asl,com = 273.6568

with Es2 = (Es,jacket*Asl,com,jacket + Es,core*Asl,com,core)/Asl,com = 200000.00

yv = 0.0008757
shv = 0.00280225
ftv = 328.3881
fyv = 273.6568

$suv = 0.00280225$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/ld = 0.14834034$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.032$
 From table 5A.1, TBDY: $esuv_nominal = 0.08$,
 considering characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and yv , shv , ftv , fyv , it is considered
 characteristic value $fsyv = fsv/1.2$, from table 5.1, TBDY.
 $y1$, $sh1$, $ft1$, $fy1$, are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = (fs_{jacket} * Asl_{mid,jacket} + fs_{mid} * Asl_{mid,core}) / Asl_{mid} = 273.6568$
 with $Esv = (Es_{jacket} * Asl_{mid,jacket} + Es_{mid} * Asl_{mid,core}) / Asl_{mid} = 200000.00$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.0347448$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.0347448$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02120631$

and confined core properties:

$b = 610.00$
 $d = 327.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 31.27541$
 $cc (5A.5, TBDY) = 0.00242514$
 $c = \text{confinement factor} = 1.04251$
 $1 = Asl_{ten} / (b * d) * (fs1 / fc) = 0.04166345$
 $2 = Asl_{com} / (b * d) * (fs2 / fc) = 0.04166345$
 $v = Asl_{mid} / (b * d) * (fsv / fc) = 0.02542907$

Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.22203037$
 $Mu = MRc (4.14) = 8.9928E+007$
 $u = su (4.1) = 1.0089632E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.14834034$
 $lb = 300.00$
 $ld = 2022.376$
 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)
 $= 1$
 $db = 15.23077$
 Mean strength value of all re-bars: $fy = 781.25$
 $t = 1.16154$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.64216$
 $n = 13.00$

Calculation of Shear Strength $Vr = Min(Vr1, Vr2) = 397330.256$

Calculation of Shear Strength at edge 1, $Vr1 = 397330.256$
 $Vr1 = Vn ((22.5.1.1), ACI 318-14)$

NOTE: In expression (22.5.1.1) 'Vw' is replaced by 'Vw+ f*Vf'
 where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 187890.746$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $fc' = (fc'_{jacket} * Area_{jacket} + fc'_{core} * Area_{core}) / Area_{section} = 30.00$, but $fc'^{0.5} <= 8.3$

MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 4.3946131E-012$$

$$Vu = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$

$Vs1 = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d2 = 160.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

Calculation of Shear Strength at edge 2, $Vr2 = 397330.256$

$$Vr2 = Vn \text{ ((22.5.1.1), ACI 318-14)}$$

NOTE: In expression (22.5.1.1) ' Vw ' is replaced by ' $Vw + f*Vf$ '
where Vf is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $Vc = 187890.746$

= 1 (normal-weight concrete)

Mean concrete strength: $fc' = (fc'_{\text{jacket}} * Area_{\text{jacket}} + fc'_{\text{core}} * Area_{\text{core}}) / Area_{\text{section}} = 30.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$$pw = As/(bw*d) = 0.00331157$$

$$As \text{ (tension reinf.)} = 709.9999$$

$$bw = 670.00$$

$$d = 320.00$$

$$Vu*d/Mu < 1 = 0.00$$

$$Mu = 3.1257229E-011$$

$$Vu = 8.9541895E-015$$

From (11.5.4.8), ACI 318-14: $Vs1 + Vs2 = 209439.51$

$Vs1 = 209439.51$ is calculated for jacket, with:

$$d = 320.00$$

$$Av = 157079.633$$

$$fy = 625.00$$

$$s = 150.00$$

$Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$Vs2 = 0.00$ is calculated for jacket, with:

$$d = 160.00$$

$$Av = 100530.965$$

$$fy = 625.00$$

$$s = 300.00$$

$Vs2$ is considered 0 ($s > d$, according to ASCE 41-17,10.3.4)

$$Vf \text{ ((11-3)-(11.4), ACI 440)} = 0.00$$

$$\text{From (11-11), ACI 440: } Vs + Vf \leq 780103.388$$

End Of Calculation of Shear Capacity ratio for element: beam JB1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1

At local axis: 2

Integration Section: (b)

Section Type: rcjars

Constant Properties

Knowledge Factor, $\phi = 1.00$

Chord Rotation is generally considered as Deformation-Controlled Action according to Table C7-1, ASCE 41-17.

Mean strengths are used for Deformation-Controlled Actions according to 7.5.1.3, ASCE 41-17

Consequently:

Jacket

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

Existing Column

New material of Primary Member: Concrete Strength, $f_c = f_{cm} = 30.00$

New material of Primary Member: Steel Strength, $f_s = f_{sm} = 625.00$

Concrete Elasticity, $E_c = 25742.96$

Steel Elasticity, $E_s = 200000.00$

External Height, $H = 670.00$

External Width, $W = 400.00$

Internal Height, $H = 500.00$

Internal Width, $W = 200.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Primary 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 $l_b = 300.00$

No FRP Wrapping

Stepwise Properties

Bending Moment, $M = 1.4880E+007$

Shear Force, $V_2 = 1.6618325E-014$

Shear Force, $V_3 = 17662.265$

Axial Force, $F = -6910.482$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 709.9999$

-Compression: $As_c = 1668.186$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 709.9999$

-Compression: $As_{l,com} = 1266.062$

-Middle: $As_{l,mid} = 402.1239$

Longitudinal External Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten,jacket} = 402.1239$

-Compression: $As_{l,com,jacket} = 804.2477$

-Middle: $As_{l,mid,jacket} = 402.1239$

Longitudinal Internal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{l,ten,core} = 307.8761$

-Compression: $As_{l,com,core} = 461.8141$

-Middle: $As_{l,mid,core} = 0.00$

Mean Diameter of Tension Reinforcement, $Db_L = 15.00$

New component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = 1.0^*$ $u = 0.03045829$

$u = y + p = 0.03045829$

- Calculation of y -

$y = (M_y * L_s / 3) / E_{eff} = 0.00045829$ ((4.29), Biskinis Phd))

$M_y = 1.2635E+008$

$L_s = M/V$ (with $L_s > 0.1 * L$ and $L_s < 2 * L$) = 842.4716

From table 10.5, ASCE 41_17: $E_{eff} = 0.3 \cdot E_c \cdot I_g = 7.7425E+013$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \text{Min}(y_{ten}, y_{com})$

$y_{ten} = 2.5007389E-006$

with ((10.1), ASCE 41-17) $f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (l_b/d)^{2/3}) = 254.0405$

$d = 627.00$

$y = 0.18990306$

$A = 0.00959086$

$B = 0.00414227$

with $p_t = 0.00283094$

$p_c = 0.00504809$

$p_v = 0.00160336$

$N = 6910.482$

$b = 400.00$

" = 0.06858054

$y_{comp} = 1.7827067E-005$

with $f_c = 30.00$

$E_c = 25742.96$

$y = 0.18766697$

$A = 0.00941672$

$B = 0.0040338$

with $E_s = 200000.00$

Calculation of ratio l_b/d

Lap Length: $l_d/l_{d,min} = 0.18542542$

$l_b = 300.00$

$l_d = 1617.901$

Calculation of l according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.

$l_{d,min}$ from (25.4.3.2) is multiplied 2 times to account for smooth re-bars (10.3.5, ASCE 41-17)

= 1

$d_b = 15.23077$

Mean strength value of all re-bars: $f_y = 625.00$

$t = 1.16154$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.64216$

$n = 13.00$

- Calculation of p -

From table 10-7: $p = 0.03$

with:

- Condition iv occurred

Beam controlled by inadequate embedment into beam-column joint:

$(l_b/d < 1$ and With Lapping in the Vicinity of the End Regions

- Condition i occurred

Beam controlled by flexure: $V_p/V_o \leq 1$

shear control ratio $V_p/V_o = 0.26808017$

- Transverse Reinforcement: C

- Stirrup Spacing $\leq d/3$

- Low ductility demand, $\gamma < 2$ (table 10-6, ASCE 41-17)

= 1.0983613E-005

- Stirrup Spacing $\leq d/2$

$d = d_{external} = 627.00$

$s = s_{external} = 150.00$

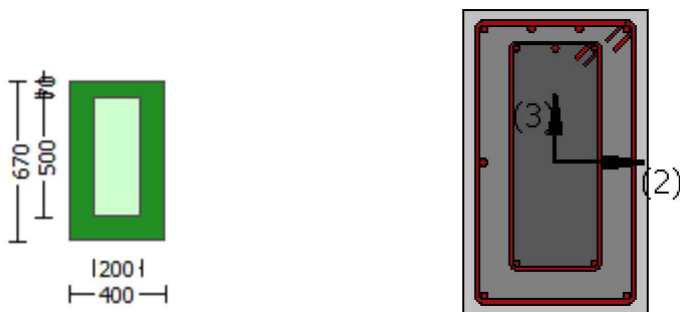
- Strength provided by hoops $V_s < 3/4 \cdot \text{design Shear}$

$V_s = 434586.984$, already given in calculation of shear control ratio
 design Shear = 17662.265
 $\rho = (V_s - V_c) / (b_w \cdot d) = -0.29412606$
 $\rho = A_{st} / (b_w \cdot d) = 0.00283094$
 Tension Reinf Area: $A_{st} = 709.9999$
 $\rho = A_{sc} / (b_w \cdot d) = 0.00665146$
 Compression Reinf Area: $A_{sc} = 1668.186$
 From (B-1), ACI 318-11: $\rho_{bal} = 0.01298939$
 $f_c = (f_{c_jacket} \cdot Area_jacket + f_{c_core} \cdot Area_core) / section_area = 30.00$
 $f_y = f_{y_jacket_bars} = 625.00$
 From 10.2.7.3, ACI 318-11: $\lambda = 0.65$
 From fig R10.3.3, ACI 318-11 (Ence 454, too): $87000 / (87000 + f_y) = c_b / d_t = 0.003 / (0.003 + \rho) = 0.48979592$
 $\rho = 0.003125$
 $V / (b_w \cdot d \cdot f_c^{0.5}) = 0.15483939$, NOTE: units in lb & in
 $b_w = 400.00$

 End Of Calculation of Chord Rotation Capacity for element: beam JB1 of floor 1
 At local axis: 2
 Integration Section: (b)

Calculation No. 15

beam B1, Floor 1
 Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Shear capacity V_{Rd}
 Edge: End
 Local Axis: (3)



Start Of Calculation of Shear Capacity for element: beam JB1 of floor 1
 At local axis: 3
 Integration Section: (b)
 Section Type: rcjars
 Constant Properties

Knowledge Factor, $\phi = 1.00$
 Member Shear Force is generally considered as Force-Controlled Action according to Table C7-1, ASCE 41-17.
 Lower-bound strengths are used for Force-Controlled Actions according to 7.5.1.3, ASCE 41-17
 Consequently:
 Jacket
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 Existing Column
 New material of Primary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 20.00$
 New material of Primary Member: Steel Strength, $f_s = f_{s_lower_bound} = 500.00$
 Concrete Elasticity, $E_c = 25742.96$
 Steel Elasticity, $E_s = 200000.00$
 External Height, $H = 670.00$
 External Width, $W = 400.00$
 Internal Height, $H = 500.00$
 Internal Width, $W = 200.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Primary 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 $l_o = l_b = 300.00$
 No FRP Wrapping

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 8.5853E+006$
 Shear Force, $V_a = 2019.001$
 EDGE -B-
 Bending Moment, $M_b = 1.4880E+007$
 Shear Force, $V_b = 17662.265$
 BOTH EDGES
 Axial Force, $F = -6910.482$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 709.9999$
 -Compression: $A_{sl,c} = 1668.186$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 709.9999$
 -Compression: $A_{sl,com} = 1266.062$
 -Middle: $A_{sl,mid} = 402.1239$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 15.00$

New component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = 1.0 \cdot V_n = 475250.631$
 V_n ((22.5.1.1), ACI 318-14) = 475250.631

NOTE: In expression (22.5.1.1) ' V_w ' is replaced by ' $V_w + f \cdot V_f$ '
 where V_f is the contribution of FRPs (11.3), ACI 440).

From Table (22.5.5.1), ACI 318-14: $V_c = 161091.365$
 $= 1$ (normal-weight concrete)
 Mean concrete strength: $f'_c = (f'_{c_jacket} \cdot Area_jacket + f'_{c_core} \cdot Area_core) / Area_section = 20.00$, but $f'_c^{0.5} \leq 8.3$
 MPa (22.5.3.1, ACI 318-14)
 $\rho_w = A_s / (b_w \cdot d) = 0.00331157$
 A_s (tension reinf.) = 709.9999
 $b_w = 400.00$
 $d = 536.00$
 $V_u \cdot d / M_u < 1 = 0.63622322$

$$M_u = 1.4880E+007$$

$$V_u = 17662.265$$

From (11.5.4.8), ACI 318-14: $V_{s1} + V_{s2} = 314159.265$

$V_{s1} = 280648.944$ is calculated for jacket, with:

$$d = 536.00$$

$$A_v = 157079.633$$

$$f_y = 500.00$$

$$s = 150.00$$

V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$V_{s2} = 33510.322$ is calculated for core, with:

$$d = 400.00$$

$$A_v = 100530.965$$

$$f_y = 500.00$$

$$s = 300.00$$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.50$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 0.00$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 636951.749$$

End Of Calculation of Shear Capacity for element: beam JB1 of floor 1

At local axis: 3

Integration Section: (b)
