

Detailed Member Calculations

Units: N&mm

Regulation: ASCE 41-17

Calculation No. 1

- wall W1, Floor 1
- Limit State: Immediate Occupancy (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: wall W1 of floor 1
- At local axis: 2
- Integration Section: (a)
- Section Type: rcrws

Constant Properties

- Knowledge Factor, $\gamma = 0.85$
- 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:
- Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
- Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$
- Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$
 Total Height, $H_{tot} = 3000.00$
 Edges Width, $W_{edg} = 250.00$
 Edges Height, $H_{edg} = 600.00$
 Web Width, $W_{web} = 250.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $e_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i: 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -9.6691022E-011$
 Shear Force, $V_a = -7.6985341E-015$
 EDGE -B-
 Bending Moment, $M_b = 7.0728943E-011$
 Shear Force, $V_b = 7.6985341E-015$
 BOTH EDGES
 Axial Force, $F = -29773.887$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2368.761$
 -Compression: $A_{sl,com} = 2368.761$
 -Middle: $A_{sl,mid} = 1608.495$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 265894.097$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c'^{0.5} \cdot h \cdot d = 312816.585$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 124920.997$
 $M_u/V_u - l_w/2 = 12434.667 > 0$
 = 1 (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 9.6691022E-011$
 $V_u = 7.6985341E-015$
 $N_u = 29773.887$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

$V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta, a)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

$f_{fe} ((11-5), \text{ACI 440}) = 259.312$

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 2

wall W1, Floor 1

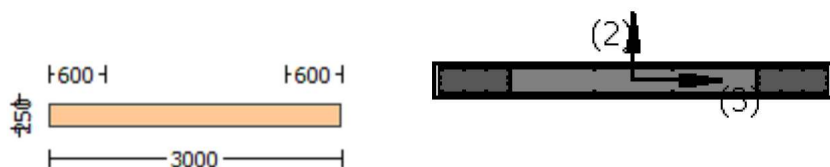
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (θ_u)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcrrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

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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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

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Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $bi: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 6.3108872E-029$

EDGE -B-

Shear Force, $V_b = -6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{ten} = 2865.133$

-Compression: $As_{com} = 2865.133$

-Middle: $As_{mid} = 0.00$

(According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 1.01783$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$

$\mu_{u1+} = 2.8453E+009$, 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

$\mu_{u1-} = 3.0413E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$

$\mu_{u2+} = 2.8453E+009$, 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

$\mu_{u2-} = 3.0413E+009$, 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

Calculation of μ_{u1+}

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

$\mu_u = 2.2735554E-006$

$\mu_u = 2.8453E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_u ((5.4c), TBDY) = $\alpha_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $\mu_{fx} = \alpha_f * \mu_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$\mu_{af} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$\mu_{af} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_f = 0.015$
 $ase((5.4d), TBDY) = (ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$
 $ase_1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase_2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase_3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$f_{ywe} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$

$ft1 = 348.235$
 $fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lo,min = lb/ld = 0.31638566$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/lb, min = 0.31638566$
 $su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 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 $fs2 = fs = 290.1959$
 with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lou, min = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b * d) * (fs1 / fc) = 0.07029503$
 $2 = Asl, com / (b * d) * (fs2 / fc) = 0.07029503$
 $v = Asl, mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl, ten / (b * d) * (fs1 / fc) = 0.09344146$
 $2 = Asl, com / (b * d) * (fs2 / fc) = 0.09344146$
 $v = Asl, mid / (b * d) * (fsv / fc) = 0.00$

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

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$v < vs, y2$ - LHS eq.(4.5) is satisfied

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$su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$

Id = 948.2098

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1

db = 16.85714

Mean strength value of all re-bars: $f_y = 500.00$

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of μ_1 -

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

$\mu = 2.2880917E-006$

$\mu_u = 3.0413E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

v = 0.00232618

N = 27514.027

$f_c = 16.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_{ue} ((5.4c), TBDY) = $a_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$a_f = 0.00$

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

bw = 250.00

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$a_f = 0.00$

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

bw = 3000.00

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = NL * t * \cos(\beta_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{u,f} = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$\mu_{sh,1} = 150.00$

$\mu_{bo,1} = 190.00$

$\mu_{ho,1} = 540.00$

$\mu_{bi2,1} = 655400.00$

$a_{se2} = 0.00$

$\mu_{sh,2} = 150.00$

$\mu_{bo,2} = 190.00$

$\mu_{ho,2} = 540.00$

$bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.31638566$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

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

$$\phi_u = 2.273554 \times 10^{-6}$$

$$M_u = 2.8453 \times 10^9$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503

2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503

v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

fcc (5A.2, TBDY) = 16.06499

$cc(5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09344146$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09344146$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.14318411$
 $Mu = MRc(4.14) = 3.0413E+009$
 $u = su(4.1) = 2.2880917E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f'_c^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $Mu = 2.8012401E-010$
 $V_u = 6.3108872E-029$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 2957.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943\text{E}+006$$

$$b_w = 250.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

$$\text{From (22.5.1.1) and 11.5.4.3, ACI 318-14: } V_{r2} = V_n < 0.83 * f_c'^{0.5} * h * d$$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$$\mu_u / \mu - l_w / 2 = 0.00 \leq 0$$

$= 1$ (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$\mu_u = 2.8012401\text{E}-010$$

$$\mu_u = 6.3108872\text{E}-029$$

$$N_u = 27514.027$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

```

dfv = d (figure 11.2, ACI 440) = 2957.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 1.5943E+006
bw = 250.00
-----

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 3

-----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrrws

Constant Properties
-----
Knowledge Factor, k = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = 0.00
EDGE -B-
Shear Force, Vb = 0.00
BOTH EDGES

```

Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 2368.761$
 -Compression: $As_{c,com} = 2368.761$
 -Middle: $As_{mid} = 0.00$
 (According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.7738E+008$
 $\mu_{u1+} = 1.4516E+008$, 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
 $\mu_{u1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.7738E+008$
 $\mu_{u2+} = 1.4516E+008$, 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
 $\mu_{u2-} = 1.7738E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (\text{5A.5, TBDY}) = 0.002$

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

we ((5.4c), TBDY) $= \alpha s_e * \text{sh}_{\min} * f_{ywe} / f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = \alpha f_p f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$
 $\alpha f = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.008128$
 $b_w = 250.00$
 effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$
 $\alpha f = 0.00$
 $b = 3000.00$
 $h = 250.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$
 $b_w = 3000.00$
 effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = N_L * t * \cos(b_1) = 1.016$

$f_u, f = 1055.00$

$E_f = 64828.00$

$u, f = 0.015$

$ase((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$

$ase1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$ase2 = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$ase3 = 0$ (grid does not provide confinement)

$psh, min = \min(psh, x, psh, y) = 0.00069813$

Expression ((5.4d), TBDY) for psh, min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$

$ps1, x$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$

$h1 = 600.00$

$As1 = Astir1 * ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2, x$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$

$h2 = 600.00$

$As2 = Astir2 * ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3, x$ (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$

$h3 = 1800.00$

$As3 = Astir3 * ns3 = 0.00$

No stirrups, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$

$ps1, y$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$

$h1 = 250.00$

$As1 = Astir1 * ns1 = 157.0796$

No stirrups, $ns1 = 2.00$

$ps2, y$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$

$h2 = 250.00$

$As2 = Astir2 * ns2 = 157.0796$

No stirrups, $ns2 = 2.00$

$ps3, y$ (web) = $(As3 * h3 / s_3) / A_c = 0.00$

$h3 = 250.00$

$As3 = Astir3 * ns3 = 157.0796$

No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$f_{ywe} = 500.00$

$f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$

c = confinement factor = 1.00406

$y1 = 0.00120915$

$sh1 = 0.00467215$

$ft1 = 348.235$

$fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lo_{min} = lb/ld = 0.31638566$

$su1 = 0.4 * esu1_{nominal}((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
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 $fs1 = fs = 290.1959$
with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.31638566$
 $su2 = 0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.06885062$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.06885062$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.08209659$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.08209659$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_1 -

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

$$\mu = 3.5153739E-005$$

$$\mu = 1.7738E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$\mu_e ((5.4c), TBDY) = \alpha \mu_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$$

where $\mu = \alpha * \mu_{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\mu_x = 0.00$$

$$\alpha \mu = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f / b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$f_y = 0.00$$

$$\alpha \mu = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f / b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(\beta_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$\mu_{u,f} = 0.015$$

$$\alpha \mu_e ((5.4d), TBDY) = (\alpha \mu_1 * A_{col1} + \alpha \mu_2 * A_{col2} + \alpha \mu_3 * A_{web}) / A_{sec} = 0.00$$

$$\alpha \mu_1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\alpha \mu_2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

ase3 = 0 (grid does not provide confinement)
 psh,min = Min(psh,x , psh,y) = 0.00069813
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
 ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
 h1 = 600.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
 h2 = 600.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
 h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirrups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirrups, ns3 = 0.00

Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00
 From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406
 y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: esu1_nominal = 0.08066667,
 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 = 290.1959
 with Es1 = Es = 200000.00
 y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 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 $fs2 = fs = 290.1959$
 with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Es_v = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20717489$
 $Mu = MRc (4.14) = 1.7738E+008$
 $u = su (4.1) = 3.5153739E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2+$

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

$$\phi_u = 3.4223799E-005$$

$$M_u = 1.4516E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

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

lo/lou,min = lb/l_d = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712

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

lo/lou,min = lb/l_d = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08066667$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 290.1959$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

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

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

---->
 $su \text{ (4.9)} = 0.18563201$
 $Mu = MR_c \text{ (4.14)} = 1.4516E+008$
 $u = su \text{ (4.1)} = 3.4223799E-005$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$
 $l_d = 948.2098$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

 Calculation of Mu_2 -

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

$u = 3.5153739E-005$
 $Mu = 1.7738E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$

$w_e ((5.4c), TBDY) = a_{se} \cdot sh_{min} \cdot f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$
where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$
 $a_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$
 $a_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,x} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,x} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$
No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,y} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,y} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$
No stirrups, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062

```

c = confinement factor = 1.00406

1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.08209659$

2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.08209659$

v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.05574729$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20717489

Mu = MRc (4.14) = 1.7738E+008

u = su (4.1) = 3.5153739E-005

Calculation of ratio lb/d

Lap Length: lb/d = 0.31638566

lb = 300.00

ld = 948.2098

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

= 1

db = 16.85714

Mean strength value of all re-bars: fy = 500.00

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*fc'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$Mu/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$fc' = 16.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

Mu = 1.9099438E-011

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\theta = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $\mu_u / V_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

Constant Properties

Knowledge Factor, $\phi = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\rho_n = 0.00069813$

with $\rho_n = \rho_{ps1} + \rho_{ps2} + \rho_{ps3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1 $\rho_{ps1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{ps2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{ps3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$
Tensile Strength, $f_{fu} = 1055.00$
Tensile Modulus, $E_f = 64828.00$
Elongation, $e_{fu} = 0.01$
Number of directions, $NoDir = 1$
Fiber orientations, $bi: 0.00^\circ$
Number of layers, $NL = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Axial Force, $F = -29773.887$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{ten} = 2865.133$
-Compression: $As_{com} = 2865.133$
-Middle: $As_{mid} = 615.7522$
Mean Diameter of Tension Reinforcement, $Db_L = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{R} = * u = 0.004$
from table 10-20: $u = 0.00470588$
with:

- Condition i (shear wall and wall segments)
- $(As - As') * f_y + P) / (t_w * l_w * f_c') = -0.20905275$
 $As = 0.00$
 $As' = 6346.017$
 $f_y = 400.00$
 $P = 29773.887$
 $t_w = 250.00$
 $l_w = 3000.00$
 $f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 3

wall W1, Floor 1

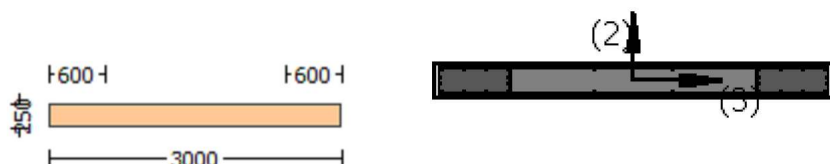
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 1.0286E+008$

Shear Force, $V_a = -34419.312$

EDGE -B-

Bending Moment, $M_b = 420173.225$

Shear Force, $V_b = 34419.312$

BOTH EDGES

Axial Force, $F = -29773.887$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 2865.133$

-Compression: $As_{c,com} = 2865.133$

-Middle: $As_{mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.6932E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.9920E+006$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 613369.253$

$\mu_u / \mu - l_w / 2 = 1488.32 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 1.0286E+008$

$V_u = 34419.312$

$N_u = 29773.887$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581E+006$

$f = 0.95$, for fully-wrapped sections

$w_f / s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i , as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\alpha_1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $tf1 = NL*t/NoDir = 1.016$
 $dfv = d$ (figure 11.2, ACI 440) = 2957.00
 ffe ((11-5), ACI 440) = 259.312
 $Ef = 64828.00$
 $fe = 0.004$, from (11.6a), ACI 440
 with $fu = 0.01$
 From (11-11), ACI 440: $Vs + Vf \leq 1.5943E+006$
 $bw = 250.00$

 End Of Calculation of Shear Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (a)

Calculation No. 4

wall W1, Floor 1
 Limit State: Immediate Occupancy (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: wall W1 of floor 1
 At Shear local axis: 3
 (Bending local axis: 2)
 Section Type: rcwrs

Constant Properties

 Knowledge Factor, $\phi = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$ 
#####
Total Height,  $H_{tot} = 3000.00$ 
Edges Width,  $W_{edg} = 250.00$ 
Edges Height,  $H_{edg} = 600.00$ 
Web Width,  $W_{web} = 250.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00406
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness,  $t = 1.016$ 
Tensile Strength,  $f_{fu} = 1055.00$ 
Tensile Modulus,  $E_f = 64828.00$ 
Elongation,  $e_{fu} = 0.01$ 
Number of directions,  $N_{oDir} = 1$ 
Fiber orientations,  $b_i = 0.00^\circ$ 
Number of layers,  $N_L = 1$ 
Radius of rounding corners,  $R = 40.00$ 
-----

Stepwise Properties
-----
At local axis: 3
EDGE -A-
Shear Force,  $V_a = 6.3108872E-029$ 
EDGE -B-
Shear Force,  $V_b = -6.3108872E-029$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{sl,t} = 0.00$ 
  -Compression:  $A_{sl,c} = 6346.017$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $A_{sl,ten} = 2865.133$ 
  -Compression:  $A_{sl,com} = 2865.133$ 
  -Middle:  $A_{sl,mid} = 0.00$ 
  (According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 1.01783$ 
Member Controlled by Shear ( $V_e/V_r > 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ 
with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 3.0413E+009$ 
 $M_{u1+} = 2.8453E+009$ , 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
 $M_{u1-} = 3.0413E+009$ , 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
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 3.0413E+009$ 
 $M_{u2+} = 2.8453E+009$ , 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
 $M_{u2-} = 3.0413E+009$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
-----

Calculation of  $M_{u1+}$ 

```

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

$$\phi_u = 2.273554E-006$$

$$\mu = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$

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

$lo/lou,min = lb/lb,min = 0.31638566$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $Es2 = Es = 200000.00$

$yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$

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

$l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $Min(1,1.25*(l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY: $c_u = 0.0035$

$w_e ((5.4c), TBDY) = a_{se} * sh_{min} * f_{ywe} / f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = a_f * p_f * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL * t * \text{Cos}(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{,f} = 0.015$

$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503

2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503

v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

```

fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2735554E-006
Mu = 2.8453E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx, fy) = 0.00
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
fx = 0.00
af = 0.00
b = 250.00
h = 3000.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.008128
bw = 250.00
effective stress from (A.35), ffe = 636.1644
fy = 0.00
af = 0.00
b = 3000.00

```

h = 250.00
From EC8 A4.4.3(6), $pf = 2tf/bw = 0.00067733$
bw = 3000.00
effective stress from (A.35), $ff,e = 944.3987$

R = 40.00
Effective FRP thickness, $tf = NL*t*\cos(b1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u,f = 0.015$
 $ase((5.4d), TBDY) = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1*h1/s_1)/Ac = 0.00083776$
h1 = 600.00
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps2,x$ (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$
h2 = 600.00
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps3,x$ (web) = $(As3*h3/s_3)/Ac = 0.00188496$
h3 = 1800.00
 $As3 = Astir3*ns3 = 0.00$
No stirrups, ns3 = 2.00

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1*h1/s_1)/Ac = 0.00034907$
h1 = 250.00
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps2,y$ (column 2) = $(As2*h2/s_2)/Ac = 0.00034907$
h2 = 250.00
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps3,y$ (web) = $(As3*h3/s_3)/Ac = 0.00$
h3 = 250.00
 $As3 = Astir3*ns3 = 157.0796$
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

```

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$

$l_d = 948.2098$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2 -

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

$\mu = 2.2880917E-006$

$\mu = 3.0413E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu = 0.0035$

μ_e ((5.4c), TBDY) = $\alpha s_e * \text{sh}_{\min} * f_{ywe}/f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$

where $f = \alpha f_p f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_x = 0.00$

$\alpha f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_y = 0.00$

$\alpha f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = N L^* t \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{,f} = 0.015$

αs_e ((5.4d), TBDY) = $(\alpha s_1 A_{col1} + \alpha s_2 A_{col2} + \alpha s_3 A_{web})/A_{sec} = 0.00$

$\alpha s_1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

```

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

```

```

ase3 = 0 (grid does not provide confinement)

```

```

psh,min = Min(psh,x , psh,y) = 0.00069813

```

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirrups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirrups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirrups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirrups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

```

```

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

```

```

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

```

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

```

lo/lou,min = lb/ld = 0.31638566

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

```

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 = 290.1959

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

```

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.31638566$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 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 $fs_2 = fs = 290.1959$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.07029503$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.07029503$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.01510726$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.09344146$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.09344146$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y_2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.14318411$
 $Mu = MRc (4.14) = 3.0413E+009$
 $u = su (4.1) = 2.2880917E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.9920\text{E}+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920\text{E}+006$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401\text{E}-010$

$V_u = 6.3108872\text{E}-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581\text{E}+006$

$f = 0.95$, for fully-wrapped sections

$w_f / s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $lw = 3000.00$
 $\mu_u = 2.8012401E-010$
 $V_u = 6.3108872E-029$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), ACI 440) = 1.5581E+006$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $a = 45^\circ$ and $a = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $a_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00
 $f_{fe} ((11-5), ACI 440) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcrws

Constant Properties

 Knowledge Factor, $\phi = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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

```

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$ 
#####
Total Height,  $H_{tot} = 3000.00$ 
Edges Width,  $W_{edg} = 250.00$ 
Edges Height,  $H_{edg} = 600.00$ 
Web Width,  $W_{web} = 250.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00406
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness,  $t = 1.016$ 
Tensile Strength,  $f_{fu} = 1055.00$ 
Tensile Modulus,  $E_f = 64828.00$ 
Elongation,  $\epsilon_{fu} = 0.01$ 
Number of directions,  $N_{oDir} = 1$ 
Fiber orientations,  $b_i: 0.00^\circ$ 
Number of layers,  $N_L = 1$ 
Radius of rounding corners,  $R = 40.00$ 
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 0.00$ 
EDGE -B-
Shear Force,  $V_b = 0.00$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{slt} = 0.00$ 
-Compression:  $A_{slc} = 6346.017$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{sl,ten} = 2368.761$ 
-Compression:  $A_{sl,com} = 2368.761$ 
-Middle:  $A_{sl,mid} = 0.00$ 
(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.14054053$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$ 
with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 1.7738E+008$ 
 $M_{u1+} = 1.4516E+008$ , 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
 $M_{u1-} = 1.7738E+008$ , 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
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 1.7738E+008$ 
 $M_{u2+} = 1.4516E+008$ , 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
 $M_{u2-} = 1.7738E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
-----

Calculation of  $M_{u1+}$ 
-----

```

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

$$\kappa_u = 3.4223799\text{E-}005$$

$$M_u = 1.4516\text{E+}008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \kappa_u: \kappa_u^* = \text{shear_factor} * \text{Max}(\kappa_u, \kappa_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \kappa_u = 0.0035$$

$$\omega_{se} \text{ ((5.4c), TBDY)} = \alpha_{se} * \frac{\min(f_{ywe}/f_{ce}, \min(f_x, f_y))}{f_{ce}} = 0.00$$

where $f = \alpha_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$f_x = 0.00$$

$$\alpha_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$f_y = 0.00$$

$$\alpha_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

$$\alpha_{se} \text{ ((5.4d), TBDY)} = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\alpha_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\alpha_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$\alpha_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.06885062$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.06885062$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.08209659$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.08209659$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 3.5153739E-005$
 $Mu = 1.7738E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062

2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062

v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.06499

$cc(5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.08209659$
 $2 = Asl_{com}/(b*d)*(fs2/fc) = 0.08209659$
 $v = Asl_{mid}/(b*d)*(fsv/fc) = 0.05574729$

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

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

$su(4.9) = 0.20717489$
 $Mu = MRc(4.14) = 1.7738E+008$
 $u = su(4.1) = 3.5153739E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of Mu_{2+}

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

$u = 3.4223799E-005$
 $Mu = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 $co(5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$
 $w_e((5.4c), TBDY) = ase * sh_{min} * fy_{we}/f_{ce} + \text{Min}(fx, fy) = 0.00$
 where $f = af * pf * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$fx = 0.00$
 $af = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $pf = 2tf/bw = 0.008128$
 $bw = 250.00$
 effective stress from (A.35), $ff_e = 636.1644$

$fy = 0.00$
 $af = 0.00$
 $b = 3000.00$
 $h = 250.00$

From EC8 A4.4.3(6), $pf = 2tf/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $ff_e = 944.3987$

$R = 40.00$
Effective FRP thickness, $tf = NL*t*\cos(b1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $ase((5.4d), TBDY) = (ase1*A_{col1} + ase2*A_{col2} + ase3*A_{web})/A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1*h1/s_1)/Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3*h3/s_3)/Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3*ns3 = 0.00$
No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1*h1/s_1)/Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2*h2/s_2)/Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3*h3/s_3)/Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3*ns3 = 157.0796$
No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu_{1,nominal} = 0.08066667$,
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 $fs_1 = fs = 290.1959$
with $Es_1 = Es = 200000.00$
 $y_2 = 0.00120915$
 $sh_2 = 0.00467215$
 $ft_2 = 348.235$
 $fy_2 = 290.1959$
 $su_2 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.31638566$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
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 $fs_2 = fs = 290.1959$
with $Es_2 = Es = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.06885062$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.06885062$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.08209659$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.08209659$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$

$l_d = 948.2098$

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

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2 -

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

$\mu = 3.5153739E-005$

$\mu_u = 1.7738E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

α (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_{we} ((5.4c), TBDY) = $\alpha s_e \cdot \text{sh}_{\min} \cdot f_{ywe} / f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $\mu_{fx} = \alpha f \cdot p_f \cdot f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$\alpha f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$\alpha f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(\beta_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{u,f} = 0.015$

αs_e ((5.4d), TBDY) = $(\alpha s_{e1} \cdot A_{col1} + \alpha s_{e2} \cdot A_{col2} + \alpha s_{e3} \cdot A_{web}) / A_{sec} = 0.00$

$\alpha s_{e1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi_{2,1} = 655400.00$

$\alpha s_{e2} = 0.00$

$sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_{b,min} = 0.31638566$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 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 $fs_2 = fs = 290.1959$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{o,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.04675268$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.05574729$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20717489$
 $Mu = MR_c (4.14) = 1.7738E+008$
 $u = su (4.1) = 3.5153739E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

$= 1$ (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f / s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot \alpha) \sin \alpha$ which is more a generalised expression, where α is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i , as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\alpha = \alpha_1 + 90^\circ = 90.00$

$V_f = \min(|V_f(45, \alpha_1)|, |V_f(-45, \alpha_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 V_f ((11-3)-(11.4), ACI 440) = 109599.773
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\theta = b1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 f_{fe} ((11-5), ACI 440) = 259.312
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 2

 Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (a)
 Section Type: rcrcws

Constant Properties

 Knowledge Factor, $K = 0.85$
 According to 10.7.2.3, ASCE 41-17, shear walls with
 transverse reinforcement percentage, $\rho_n < 0.0015$
 are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17
 $\rho_n = 0.00069813$

with $n = ps1 + ps2 + ps3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2
 (pseudo-col.1 $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.00034907$
 $h1 = 250.00$
 $s1 = 150.00$
 total area of hoops perpendicular to shear axis, $As1 = 157.0796$
 (pseudo-col.2 $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.00034907$
 $h2 = 250.00$
 $s2 = 150.00$
 total area of hoops perpendicular to shear axis, $As2 = 157.0796$
 (grid $ps3 = As3*b3/s3 = (As3*h3/s3) / Ac = 0.00$
 $h3 = 250.00$
 $s3 = 200.00$
 total area of hoops perpendicular to shear axis, $As3 = 0.00$
 total section area, $Ac = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$
 Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$
 Concrete Elasticity, $Ec = 21019.039$
 Steel Elasticity, $Es = 200000.00$
 Total Height, $H_{tot} = 3000.00$
 Edges Width, $Wedg = 250.00$
 Edges Height, $Hedg = 600.00$
 Web Width, $Wweb = 250.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $lb = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $ffu = 1055.00$
 Tensile Modulus, $Ef = 64828.00$
 Elongation, $efu = 0.01$
 Number of directions, $NoDir = 1$
 Fiber orientations, $bi: 0.00^\circ$
 Number of layers, $NL = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

Bending Moment, $M = -9.6691022E-011$
 Shear Force, $V2 = -7.6985341E-015$
 Shear Force, $V3 = -34419.312$
 Axial Force, $F = -29773.887$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $Aslt = 0.00$
 -Compression: $Aslc = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten} = 2368.761$
 -Compression: $Asl_{com} = 2368.761$
 -Middle: $Asl_{mid} = 1608.495$
 Mean Diameter of Tension Reinforcement, $DbL = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = * u = 0.00277127$
 $u = y + p = 0.00326031$

- Calculation of y -

$$y = (M_y \cdot I_p) / (E I)_{\text{Eff}} = 0.00126031 \text{ ((10-5), ASCE 41-17)}$$
$$M_y = 1.5091\text{E}+008$$
$$(E I)_{\text{Eff}} = 0.35 \cdot E_c \cdot I \text{ (table 10-5)}$$
$$E_c \cdot I = 8.2106\text{E}+013$$
$$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$$
$$y_{\text{ten}} = 8.7656668\text{E}-006$$
$$\text{with ((10.1), ASCE 41-17)} f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 269.394$$
$$d = 208.00$$
$$y = 0.26122943$$
$$A = 0.01034702$$
$$B = 0.00628884$$
$$\text{with } p_t = 0.00379609$$
$$p_c = 0.00379609$$
$$p_v = 0.00257772$$
$$N = 29773.887$$
$$b = 3000.00$$
$$" = 0.20192308$$
$$y_{\text{comp}} = 2.5442941\text{E}-005$$
$$\text{with } f_c^* (12.3, \text{ACI 440}) = 16.002$$
$$f_c = 16.00$$
$$f_l = 0.17503396$$
$$b = 3000.00$$
$$h = 250.00$$
$$A_g = 750000.00$$
$$\text{From (12.9), ACI 440: } k_a = 0.00364754$$
$$g = p_t + p_c + p_v = 0.0101699$$
$$r_c = 40.00$$
$$A_e / A_c = 0.52524587$$
$$\text{Effective FRP thickness, } t_f = N L \cdot t \cdot \cos(b_1) = 1.016$$
$$\text{effective strain from (12.5) and (12.12), } e_{fe} = 0.004$$
$$f_u = 0.01$$
$$E_f = 64828.00$$
$$E_c = 21019.039$$
$$y = 0.25894248$$
$$A = 0.0099958$$
$$B = 0.00611172$$
$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b / I_d

Lap Length: $I_d / I_{d,\text{min}} = 0.39548208$

$$I_b = 300.00$$

$$I_d = 758.5679$$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 400.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $p = 0.002$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20905275$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 29773.887$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 3.0903667E-020$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 \cdot d_b$ or $s_2 > 8 \cdot d_b$)

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ($V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$)

With

Boundary Element 1:

$V_{w1} = 83775.804$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 83775.804$

$s_2 = 150.00$

Grid Shear Force, $V_{w3} = 0.00$

Concrete Shear Force, $V_c = 124920.997$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 7.6985341E-015$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 5

wall W1, Floor 1

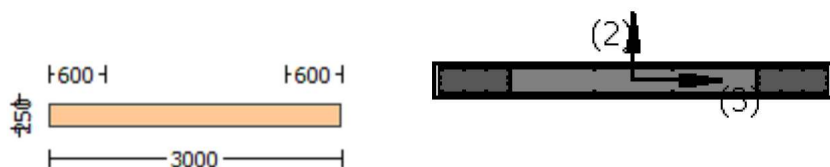
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity V_{Rd}

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (d)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $N_{oDir} = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $N_L = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -9.6691022E-011$

Shear Force, $V_a = -7.6985341E-015$

EDGE -B-

Bending Moment, $M_b = 7.0728943E-011$

Shear Force, $V_b = 7.6985341E-015$

BOTH EDGES

Axial Force, $F = -29773.887$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $Asl_{com} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten} = 2368.761$
 -Compression: $Asl_{com} = 2368.761$
 -Middle: $Asl_{mid} = 1608.495$
 Mean Diameter of Tension Reinforcement, $DbL_{ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 267450.65$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 314647.823$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 126752.235$
 $M_u/V_u - l_w/2 = 9062.326 > 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 7.0728943E-011$
 $V_u = 7.6985341E-015$
 $N_u = 29773.887$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2
Integration Section: (d)

Calculation No. 6

wall W1, Floor 1

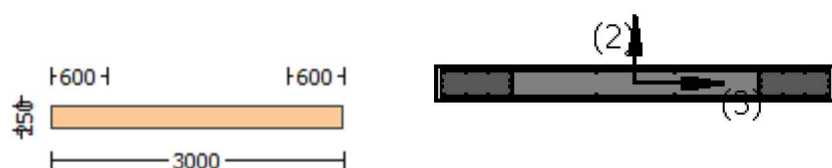
Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwls

Constant Properties

Knowledge Factor, $\phi = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i = 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 6.3108872E-029$
 EDGE -B-
 Shear Force, $V_b = -6.3108872E-029$
 BOTH EDGES
 Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2865.133$
 -Compression: $A_{sl,com} = 2865.133$
 -Middle: $A_{sl,mid} = 0.00$
 (According to 10.7.2.3 $A_{sl,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 1.01783$
 Member Controlled by Shear ($V_e/V_r > 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$
 $\mu_{u1+} = 2.8453E+009$, 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
 $\mu_{u1-} = 3.0413E+009$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$
 $\mu_{u2+} = 2.8453E+009$, 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
 $\mu_{u2-} = 3.0413E+009$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 2.2735554E-006$
 $M_u = 2.8453E+009$

with full section properties:
 $b = 250.00$
 $d = 2957.00$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } c_u = 0.0035$$

$$w_e((5.4c), TBDY) = a_{se} * s_{h,min} * f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$f_x = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$f_y = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se}((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$s_{h,1} = 150.00$$

$$b_{o,1} = 190.00$$

$$h_{o,1} = 540.00$$

$$b_{i2,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$s_{h,2} = 150.00$$

$$b_{o,2} = 190.00$$

$$h_{o,2} = 540.00$$

$$b_{i2,2} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{_2}) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{_3}) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

$$A_{s3} = A_{stir3} * n_{s3} = 0.00$$

$$\text{No stirrups, } n_{s3} = 2.00$$

$$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$$

$$p_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_{_1}) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$y1 = 0.00120915$$

$$sh1 = 0.00467215$$

$$ft1 = 348.235$$

$$fy1 = 290.1959$$

$$su1 = 0.00579712$$

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

$$lo/lou,min = lb/ld = 0.31638566$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08066667,$$

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.

$$\text{with } fs1 = fs = 290.1959$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00120915$$

$$sh2 = 0.00467215$$

$$ft2 = 348.235$$

$$fy2 = 290.1959$$

$$su2 = 0.00579712$$

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

$$lo/lou,min = lb/lb,min = 0.31638566$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08066667,$$

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.

$$\text{with } fs2 = fs = 290.1959$$

$$\text{with } Es2 = Es = 200000.00$$

$$yv = 0.00120915$$

$$shv = 0.00467215$$

$$ftv = 348.235$$

$$fyv = 290.1959$$

$$suv = 0.00579712$$

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

$$lo/lou,min = lb/ld = 0.31638566$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esuv_nominal = 0.08066667,$$

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.

$$\text{with } fsv = fs = 290.1959$$

$$\text{with } Esv = Es = 200000.00$$

$$1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.07029503$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07029503$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 16.06499$$

$$cc (5A.5, TBDY) = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09344146$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09344146$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su (4.9) = 0.13770595$$

$$Mu = M_{Rc} (4.14) = 2.8453E+009$$

$$u = su (4.1) = 2.2735554E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$$l_b = 300.00$$

$$l_d = 948.2098$$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Mu_1 -

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

$$u = 2.2880917E-006$$

$$Mu = 3.0413E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0035$$

$$w_e ((5.4c), TBDY) = a_s * sh_{\min} * f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$f_x = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.008128$$

bw = 250.00
effective stress from (A.35), $f_{f,e} = 636.1644$

fy = 0.00
af = 0.00
b = 3000.00
h = 250.00
From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
bw = 3000.00
effective stress from (A.35), $f_{f,e} = 944.3987$

R = 40.00
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
fu,f = 1055.00
Ef = 64828.00
u,f = 0.015
ase ((5.4d), TBDY) = $(ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$

ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min = Min(psh,x , psh,y) = 0.00069813

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = $ps_{1,x} + ps_{2,x} + ps_{3,x} = 0.00356047$
 $ps_{1,x}$ (column 1) = $(As_1 \cdot h_1 / s_1) / A_c = 0.00083776$
h1 = 600.00
 $As_1 = Astir_1 \cdot ns_1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps_{2,x}$ (column 2) = $(As_2 \cdot h_2 / s_2) / A_c = 0.00083776$
h2 = 600.00
 $As_2 = Astir_2 \cdot ns_2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps_{3,x}$ (web) = $(As_3 \cdot h_3 / s_3) / A_c = 0.00188496$
h3 = 1800.00
 $As_3 = Astir_3 \cdot ns_3 = 0.00$
No stirrups, ns3 = 2.00

psh,y = $ps_{1,y} + ps_{2,y} + ps_{3,y} = 0.00069813$
 $ps_{1,y}$ (column 1) = $(As_1 \cdot h_1 / s_1) / A_c = 0.00034907$
h1 = 250.00
 $As_1 = Astir_1 \cdot ns_1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps_{2,y}$ (column 2) = $(As_2 \cdot h_2 / s_2) / A_c = 0.00034907$
h2 = 250.00
 $As_2 = Astir_2 \cdot ns_2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps_{3,y}$ (web) = $(As_3 \cdot h_3 / s_3) / A_c = 0.00$
h3 = 250.00
 $As_3 = Astir_3 \cdot ns_3 = 157.0796$
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

```

c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

```

--->

$$s_u(4.9) = 0.14318411$$

$$M_u = M_{Rc}(4.14) = 3.0413E+009$$

$$u = s_u(4.1) = 2.2880917E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$$l_b = 300.00$$

$$l_d = 948.2098$$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of M_{u2+}

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

$$u = 2.273554E-006$$

$$M_u = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$\phi_{ue}((5.4c), TBDY) = a_s e * \phi_{u,min} * f_{ywe}/f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_{fx} = a_f * \phi_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

 $\phi_{fx} = 0.00$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

 $\phi_{fy} = 0.00$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

 $R = 40.00$

$$\text{Effective FRP thickness, } t_f = N L * t * \text{Cos}(\beta_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

```

ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.00069813
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959

```

```

with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.31638566
lb = 300.00
lb = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00

```

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

u = 2.2880917E-006
Mu = 3.0413E+009

with full section properties:

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027

fc = 16.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TBDY: $\phi_u = 0.0035$

ϕ_{we} ((5.4c), TBDY) = $\text{ase} * \phi_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$

where $\phi_f = \text{af} * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\phi_{fx} = 0.00$

$\text{af} = 0.00$

b = 250.00

h = 3000.00

From EC8 A.4.4.3(6), $\phi_f = 2t_f/bw = 0.008128$

bw = 250.00

effective stress from (A.35), $f_{fe} = 636.1644$

$\phi_{fy} = 0.00$

$\text{af} = 0.00$

b = 3000.00

h = 250.00

From EC8 A.4.4.3(6), $\phi_f = 2t_f/bw = 0.00067733$

bw = 3000.00

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{f,f} = 0.015$

ase ((5.4d), TBDY) = $(\text{ase}_1 * A_{col1} + \text{ase}_2 * A_{col2} + \text{ase}_3 * A_{web}) / A_{sec} = 0.00$

$\text{ase}_1 = 0.00$

$\phi_{sh,1} = 150.00$

$\phi_{bo,1} = 190.00$

$\phi_{ho,1} = 540.00$

$\phi_{bi2,1} = 655400.00$

$\text{ase}_2 = 0.00$

$\phi_{sh,2} = 150.00$

$\phi_{bo,2} = 190.00$

$\phi_{ho,2} = 540.00$

$\phi_{bi2,2} = 655400.00$

$\text{ase}_3 = 0$ (grid does not provide confinement)

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

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

$lo/lou,min = lb/l_d = 0.31638566$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$

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

$lo/lou,min = lb/l_b,min = 0.31638566$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.

with $fs2 = fs = 290.1959$

with $E_s = E_s = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{min} = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_{nominal}$ and y_v , sh_v , ft_v , fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 290.1959$
 with $E_s = E_s = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.07029503$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.07029503$
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.01510726$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d) * (fs_1/fc) = 0.09344146$
 $2 = A_{sl,com}/(b*d) * (fs_2/fc) = 0.09344146$
 $v = A_{sl,mid}/(b*d) * (fsv/fc) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.14318411$
 $Mu = MRc (4.14) = 3.0413E+009$
 $u = su (4.1) = 2.2880917E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 * f_c'^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/\nu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401E-010$

$\nu_u = 6.3108872E-029$

$\nu_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581E+006$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $a_i = 45^\circ$ and $a_i = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 * f'_c^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/\nu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401E-010$

$\nu_u = 6.3108872E-029$

$\nu_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln (11.3) \sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,
 where is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $= 45^\circ$ and $= -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcrrws

Constant Properties

 Knowledge Factor, $= 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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
 Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 500.00$
 #####
 Total Height, $H_{tot} = 3000.00$
 Edges Width, $W_{edg} = 250.00$
 Edges Height, $H_{edg} = 600.00$
 Web Width, $W_{web} = 250.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00406
 Element Length, $L = 3000.00$
 Secondary Member

Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i = 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = 0.00$
 EDGE -B-
 Shear Force, $V_b = 0.00$
 BOTH EDGES
 Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2368.761$
 -Compression: $A_{sl,com} = 2368.761$
 -Middle: $A_{sl,mid} = 0.00$
 (According to 10.7.2.3 $A_{sl,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.7738E+008$
 $M_{u1+} = 1.4516E+008$, 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
 $M_{u1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.7738E+008$
 $M_{u2+} = 1.4516E+008$, 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
 $M_{u2-} = 1.7738E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of M_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$

$v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of α : $\alpha = \text{shear_factor} * \text{Max}(\alpha_c, \alpha_s) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\alpha_c = 0.0035$
 $\alpha_s ((5.4c), TBDY) = \alpha_s * \text{sh}_{\min} * f_{ywe} / f_{ce} + \text{Min}(\alpha_x, \alpha_y) = 0.00$
 where $\alpha = \alpha_s * \rho_f * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\alpha_x = 0.00$
 $\alpha_s = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $\rho_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
 effective stress from (A.35), $f_{fe} = 636.1644$

$\alpha_y = 0.00$
 $\alpha_s = 0.00$
 $b = 3000.00$
 $h = 250.00$
 From EC8 A.4.4.3(6), $\rho_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
 effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = N L * t * \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{f,f} = 0.015$
 $\alpha_s ((5.4d), TBDY) = (\alpha_s1 * A_{col1} + \alpha_s2 * A_{col2} + \alpha_s3 * A_{web}) / A_{sec} = 0.00$
 $\alpha_s1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\alpha_s2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\alpha_s3 = 0$ (grid does not provide confinement)
 $p_{sh,\min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,\min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirrups, $n_{s2} = 2.00$
 $p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$
 No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $p_{s2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 * ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

 $Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$

$c =$ confinement factor $= 1.00406$

$y1 = 0.00120915$

$sh1 = 0.00467215$

$ft1 = 348.235$

$fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$

$sh2 = 0.00467215$

$ft2 = 348.235$

$fy2 = 290.1959$

$su2 = 0.00579712$

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

$lo/lou,min = lb/lb,min = 0.31638566$

$su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $Es2 = Es = 200000.00$

$yv = 0.00120915$

$shv = 0.00467215$

$ftv = 348.235$

$fyv = 290.1959$

$suv = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,

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 $fsv = fs = 290.1959$

with $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.06885062$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.06885062$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $\mu_u (4.9) = 0.18563201$
 $M_u = M_{Rc} (4.14) = 1.4516E+008$
 $u = \mu_u (4.1) = 3.4223799E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 3.5153739E-005$
 $M_u = 1.7738E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_u = 0.0035$
 $\mu_{we} ((5.4c), TBDY) = \alpha s e^* \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$
 where $f = \alpha f_p f_{ffe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

 $\mu_{fx} = 0.00$
 $\alpha f = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$

effective stress from (A.35), $f_{f,e} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{f,e} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

$a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, $n_{s3} = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$f_{ywe} = 500.00$

$f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$

c = confinement factor = 1.00406

```

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31638566
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu1_nominal = 0.08066667,
    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 = 290.1959
    with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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 = 290.1959
    with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31638566
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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 = 290.1959
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->

```

su (4.9) = 0.20717489
Mu = MRc (4.14) = 1.7738E+008
u = su (4.1) = 3.5153739E-005

Calculation of ratio lb/l_d

Lap Length: lb/l_d = 0.31638566

lb = 300.00

l_d = 948.2098

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

= 1

db = 16.85714

Mean strength value of all re-bars: fy = 500.00

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

K_{tr} = 2.24399

n = 28.00

Calculation of Mu₂₊

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

u = 3.4223799E-005

Mu = 1.4516E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

f_c = 16.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0035

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

From (5.4b), TBDY: cu = 0.0035

we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.00

where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

fx = 0.00

af = 0.00

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.008128

bw = 250.00

effective stress from (A.35), ff,e = 636.1644

fy = 0.00

af = 0.00

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.00067733

bw = 3000.00

effective stress from (A.35), ff,e = 944.3987

R = 40.00

Effective FRP thickness, tf = NL*t*cos(b1) = 1.016

fu,f = 1055.00

Ef = 64828.00

u,f = 0.015

ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00

```

ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00

```

```

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

```

```

ase3 = 0 (grid does not provide confinement)

```

```

psh,min = Min(psh,x , psh,y) = 0.00069813

```

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

```

-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

-----
psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

-----
Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

```

```

fywe = 500.00

```

```

fce = 16.00

```

```

From ((5.A5), TBDY), TBDY: cc = 0.00204062

```

```

c = confinement factor = 1.00406

```

```

y1 = 0.00120915

```

```

sh1 = 0.00467215

```

```

ft1 = 348.235

```

```

fy1 = 290.1959

```

```

su1 = 0.00579712

```

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

```

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 = 290.1959

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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 = 290.1959
    with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31638566
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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 = 290.1959
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18563201
Mu = MRc (4.14) = 1.4516E+008
u = su (4.1) = 3.4223799E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

$\phi_u = 3.5153739E-005$
 $M_u = 1.7738E+008$

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027

fc = 16.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$

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

From (5.4b), TBDY: $\phi_{cu} = 0.0035$

ϕ_{we} ((5.4c), TBDY) = $\text{ase} * \text{sh_min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$

where $\phi_{fx} = \text{af} * \text{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\phi_{fx} = 0.00$
 $\text{af} = 0.00$
b = 250.00
h = 3000.00
From EC8 A.4.4.3(6), $\text{pf} = 2t_f/b_w = 0.008128$
 $b_w = 250.00$
effective stress from (A.35), $f_{fe} = 636.1644$

$\phi_{fy} = 0.00$
 $\text{af} = 0.00$
b = 3000.00
h = 250.00
From EC8 A.4.4.3(6), $\text{pf} = 2t_f/b_w = 0.00067733$
 $b_w = 3000.00$
effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00
Effective FRP thickness, $t_f = N_L * t * \text{Cos}(\theta_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{f,f} = 0.015$
 ase ((5.4d), TBDY) = $(\text{ase}_1 * A_{col1} + \text{ase}_2 * A_{col2} + \text{ase}_3 * A_{web}) / A_{sec} = 0.00$
 $\text{ase}_1 = 0.00$
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
 $\text{ase}_2 = 0.00$
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

$\text{ase}_3 = 0$ (grid does not provide confinement)
 $\text{psh_min} = \text{Min}(\text{psh}_x, \text{psh}_y) = 0.00069813$

Expression ((5.4d), TBDY) for psh_min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\text{psh}_x = \text{ps}_{1,x} + \text{ps}_{2,x} + \text{ps}_{3,x} = 0.00356047$

$$ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$$

$$h1 = 600.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$$

$$h2 = 600.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$$

$$h3 = 1800.00$$

$$As3 = Astir3 \cdot ns3 = 0.00$$

$$\text{No stirups, } ns3 = 2.00$$

$$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$$

$$ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$$

$$h1 = 250.00$$

$$As1 = Astir1 \cdot ns1 = 157.0796$$

$$\text{No stirups, } ns1 = 2.00$$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

$$\text{From ((5.A5), TBDY), TBDY: } cc = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$y1 = 0.00120915$$

$$sh1 = 0.00467215$$

$$ft1 = 348.235$$

$$fy1 = 290.1959$$

$$su1 = 0.00579712$$

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

$$lo/lo_{u,min} = lb/ld = 0.31638566$$

$$su1 = 0.4 \cdot esu1_{nominal} ((5.5), \text{TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1_{nominal} = 0.08066667,$$

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

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

$$\text{with } fs1 = fs = 290.1959$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00120915$$

$$sh2 = 0.00467215$$

$$ft2 = 348.235$$

$$fy2 = 290.1959$$

$$su2 = 0.00579712$$

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

$$lo/lo_{u,min} = lb/lb_{min} = 0.31638566$$

$$su2 = 0.4 \cdot esu2_{nominal} ((5.5), \text{TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2_{nominal} = 0.08066667,$$

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

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

$$\text{with } fs2 = fs = 290.1959$$

$$\text{with } Es2 = Es = 200000.00$$

```

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20717489
Mu = MRc (4.14) = 1.7738E+008
u = su (4.1) = 3.5153739E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$M_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f'_c^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$M_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

Vs1 = 41887.902 is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

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

Vs2 = 41887.902 is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

$$V_f((11-3)-(11.4), \text{ACI 440}) = 109599.773$$

$$f = 0.95, \text{ for fully-wrapped sections}$$

$$w_f/s_f = 1 \text{ (FRP strips adjacent to one another).}$$

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

$$\text{orientation 1: } \theta = b_1 + 90^\circ = 90.00$$

$$V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a_1)|), \text{ with:}$$

$$\text{total thickness per orientation, } t_{f1} = N_L \cdot t / N_{oDir} = 1.016$$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 208.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\phi = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$$\rho_n = 0.00069813$$

with $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

$$(\text{pseudo-col.1 } \rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$s_1 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s1} = 157.0796$$

$$(\text{pseudo-col.2 } \rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$s_2 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s2} = 157.0796$$

(grid $ps3 = As3 \cdot b3 / s3 = (As3 \cdot h3 / s3) / Ac = 0.00$
 $h3 = 250.00$
 $s3 = 200.00$
total area of hoops perpendicular to shear axis, $As3 = 0.00$
total section area, $Ac = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$
Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$
Concrete Elasticity, $Ec = 21019.039$
Steel Elasticity, $Es = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $l_b = 300.00$
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, $t = 1.016$
Tensile Strength, $ff_u = 1055.00$
Tensile Modulus, $E_f = 64828.00$
Elongation, $ef_u = 0.01$
Number of directions, $NoDir = 1$
Fiber orientations, $bi: 0.00^\circ$
Number of layers, $NL = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Axial Force, $F = -29773.887$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 2865.133$
-Compression: $As_{c,com} = 2865.133$
-Middle: $As_{mid} = 615.7522$
Mean Diameter of Tension Reinforcement, $Db_L = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{i,R} = * u = 0.004$
from table 10-20: $u = 0.00470588$

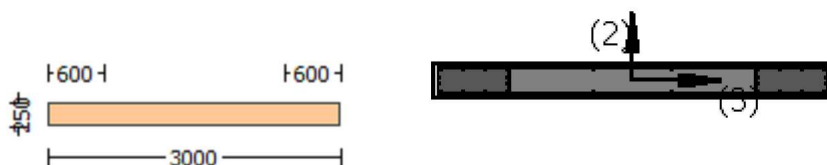
with:

- Condition i (shear wall and wall segments)
- $(As - As') \cdot fy + P / (tw \cdot lw \cdot fc') = -0.20905275$
 $As = 0.00$
 $As' = 6346.017$
 $fy = 400.00$
 $P = 29773.887$
 $tw = 250.00$
 $lw = 3000.00$
 $fc = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 7

wall W1, Floor 1
Limit State: Immediate Occupancy (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: wall W1 of floor 1
At local axis: 3
Integration Section: (d)
Section Type: rcrrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$
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:
Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$
Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$
Concrete Elasticity, $E_c = 21019.039$
Steel Elasticity, $E_s = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $W_{edg} = 250.00$
Edges Height, $H_{edg} = 600.00$
Web Width, $W_{web} = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$

Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i: 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = 1.0286E+008$
 Shear Force, $V_a = -34419.312$
 EDGE -B-
 Bending Moment, $M_b = 420173.225$
 Shear Force, $V_b = 34419.312$
 BOTH EDGES
 Axial Force, $F = -29773.887$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{st} = 0.00$
 -Compression: $A_{sc} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{st,ten} = 2865.133$
 -Compression: $A_{st,com} = 2865.133$
 -Middle: $A_{st,mid} = 615.7522$
 Mean Diameter of Tension Reinforcement, $D_{bL,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.6932E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.9920E+006$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653954.777$
 $\mu_u / \nu_u - l_w / 2 = -1487.793 \leq 0$
 = 1 (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $\mu_u = 420173.225$
 $\nu_u = 34419.312$
 $N_u = 29773.887$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$

$s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (d)

Calculation No. 8

wall W1, Floor 1
 Limit State: Immediate Occupancy (data interpolation between analysis steps 1 and 2)
 Analysis: Uniform +X
 Check: Chord rotation capacity (θ_u)
 Edge: End
 Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcrrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 6.3108872E-029$

EDGE -B-

Shear Force, $V_b = -6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{ten} = 2865.133$

-Compression: $As_{com} = 2865.133$

-Middle: $As_{mid} = 0.00$

(According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 1.01783$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$

$\mu_{u1+} = 2.8453E+009$, 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

$\mu_{u1-} = 3.0413E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$

$\mu_{u2+} = 2.8453E+009$, 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

$\mu_{u2-} = 3.0413E+009$, 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

Calculation of μ_{u1+}

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

$\mu_u = 2.2735554E-006$

$\mu_u = 2.8453E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_u ((5.4c), TBDY) = $\alpha_c * \mu_{u, \text{min}} * f_{ywe}/f_{ce} + \text{Min}(\mu_{ux}, \mu_{uy}) = 0.00$

where $\mu_{ux} = \alpha_c * \mu_{ux} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{ux} = 0.00$

$\mu_{uy} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $\mu_{ux} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{uy} = 0.00$

$\mu_{ux} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $\mu_{ux} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_f = 0.015$
 $ase((5.4d), TBDY) = (ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$
 $ase_1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase_2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase_3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$f_{ywe} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{u,min} = lb/ld = 0.31638566$

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

and confined core properties:

```

b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

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

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00

```

Id = 948.2098

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1

db = 16.85714

Mean strength value of all re-bars: $f_y = 500.00$

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of μ_1 -

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

$\mu = 2.2880917E-006$

$\mu = 3.0413E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

v = 0.00232618

N = 27514.027

$f_c = 16.00$

α (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$

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

From (5.4b), TBDY: $\mu = 0.0035$

μ_e ((5.4c), TBDY) = $\alpha \cdot \mu_{min} * f_{ywe} / f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = \alpha \cdot p_f \cdot f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$\alpha_f = 0.00$

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

bw = 250.00

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$\alpha_f = 0.00$

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

bw = 3000.00

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{f,f} = 0.015$

α_{se} ((5.4d), TBDY) = $(\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$

$\alpha_{se1} = 0.00$

sh_1 = 150.00

bo_1 = 190.00

ho_1 = 540.00

bi2_1 = 655400.00

$\alpha_{se2} = 0.00$

sh_2 = 150.00

bo_2 = 190.00

ho_2 = 540.00

$bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/lb,min = 0.31638566$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.31638566
lb = 300.00
lb = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

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

$$\phi_u = 2.2735554E-006$$

$$M_u = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f' * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f / b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f / b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 ---->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{,f} = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503

2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503

v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

fcc (5A.2, TBDY) = 16.06499

$cc(5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.14318411$
 $Mu = MRc(4.14) = 3.0413E+009$
 $u = su(4.1) = 2.2880917E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $Vr = \text{Min}(Vr1, Vr2) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $Vr1 = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $Vr1 = Vn < 0.83*fc'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $Vc = 653502.805$
 $Mu/Vu-lw/2 = 0.00 <= 0$
 $= 1$ (normal-weight concrete)
 $fc' = 16.00$, but $fc'^{0.5} <= 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $lw = 3000.00$
 $Mu = 2.8012401E-010$
 $Vu = 6.3108872E-029$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $Vs = Vs1 + Vs2 + Vs3 = 854513.202$
 $Vs1 = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $Av = 157079.633$
 $s = 150.00$
 $fy = 400.00$
 $Vs1$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $Vs2 = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $Av = 157079.633$
 $s = 150.00$
 $fy = 400.00$
 $Vs2$ has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $Vs3 = 452389.342$ is calculated for web, with:
 $d = 1440.00$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $= 45^\circ$ and $= -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = b_1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, a_1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 2957.00$$

$$f_{fe} ((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943\text{E}+006$$

$$b_w = 250.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

$$\text{From (22.5.1.1) and 11.5.4.3, ACI 318-14: } V_{r2} = V_n < 0.83 * f_c'^{0.5} * h * d$$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$$

$= 1$ (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$\mu_u = 2.8012401\text{E}-010$$

$$\mu_u = 6.3108872\text{E}-029$$

$$N_u = 27514.027$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $= 45^\circ$ and $= -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = b_1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, a_1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

```

dfv = d (figure 11.2, ACI 440) = 2957.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 1.5943E+006
bw = 250.00
-----

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 3

-----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrrws

Constant Properties
-----
Knowledge Factor, k = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = 0.00
EDGE -B-
Shear Force, Vb = 0.00
BOTH EDGES

```

Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 2368.761$
 -Compression: $As_{c,com} = 2368.761$
 -Middle: $As_{mid} = 0.00$
 (According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.7738E+008$
 $\mu_{u1+} = 1.4516E+008$, 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
 $\mu_{u1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.7738E+008$
 $\mu_{u2+} = 1.4516E+008$, 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
 $\mu_{u2-} = 1.7738E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$

$f_c = 16.00$
 $\alpha (\text{5A.5, TBDY}) = 0.002$

Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \mu_{cc}) = 0.0035$

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

From (5.4b), TBDY: $\mu_{cu} = 0.0035$

μ_{we} ((5.4c), TBDY) = $\alpha s_e * \text{sh}_{\min} f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = \alpha f_p f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$\alpha f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$\alpha f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$
 $f_u, f = 1055.00$
 $E_f = 64828.00$
 $u, f = 0.015$
 $ase \text{ ((5.4d), TBDY)} = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh, min = \min(psh, x, psh, y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh, min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$
 $ps1, x \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, x \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, x \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 * ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$
 $ps1, y \text{ (column 1)} = (As1 * h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, y \text{ (column 2)} = (As2 * h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, y \text{ (web)} = (As3 * h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 * ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c =$ confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $su1 = 0.4 * esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
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 $fs1 = fs = 290.1959$
with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.31638566$
 $su2 = 0.4 \cdot esu2_nominal \cdot ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.06885062$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.06885062$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.08209659$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.08209659$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su \text{ (4.9)} = 0.18563201$
 $Mu = MRc \text{ (4.14)} = 1.4516E+008$
 $u = su \text{ (4.1)} = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_1 -

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

$$\mu = 3.5153739E-005$$

$$\mu = 1.7738E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$\mu_e ((5.4c), TBDY) = \alpha \mu_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$$

where $\mu = \alpha * \mu_{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\mu_x = 0.00$$

$$\mu_y = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f/b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\mu_y = 0.00$$

$$\mu_x = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f/b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(\beta_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$\mu_{u,f} = 0.015$$

$$\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\alpha_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\alpha_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

ase3 = 0 (grid does not provide confinement)
 psh,min = Min(psh,x , psh,y) = 0.00069813
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
 ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
 h1 = 600.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
 h2 = 600.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
 h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirrups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
 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 $fs2 = fs = 290.1959$
 with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.31638566$
 $suv = 0.4 \cdot esuv_nominal \cdot ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Es_v = Es = 200000.00$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.06885062$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.06885062$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.04675268$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.08209659$
 $2 = Asl,com/(b \cdot d) \cdot (fs2/fc) = 0.08209659$
 $v = Asl,mid/(b \cdot d) \cdot (fsv/fc) = 0.05574729$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$su \text{ (4.9)} = 0.20717489$
 $Mu = MRc \text{ (4.14)} = 1.7738E+008$
 $u = su \text{ (4.1)} = 3.5153739E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$

$lb = 300.00$

$ld = 948.2098$

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

= 1

$db = 16.85714$

Mean strength value of all re-bars: $fy = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Mu_{2+}

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

$$u = 3.4223799E-005$$

$$Mu = 1.4516E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_u: \phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_u = 0.0035$$

$$w_e ((5.4c), TBDY) = a_{se} * \frac{\min(f_{ywe}/f_{ce}, \min(f_x, f_y))}{f_{ce}} = 0.00$$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$f_x = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$f_y = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$$

$$p_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$p_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$p_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08066667$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 290.1959$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

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

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

---->
 $su \text{ (4.9)} = 0.18563201$
 $Mu = MR_c \text{ (4.14)} = 1.4516E+008$
 $u = su \text{ (4.1)} = 3.4223799E-005$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$
 $l_d = 948.2098$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

 Calculation of Mu_2 -

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

$u = 3.5153739E-005$
 $Mu = 1.7738E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$

$w_e ((5.4c), TBDY) = a_{se} \cdot s_{h,min} \cdot f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$
where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$
 $a_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$
 $a_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_f = 0.015$
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $s_{h_1} = 150.00$
 $b_{o_1} = 190.00$
 $h_{o_1} = 540.00$
 $b_{i2_1} = 655400.00$
 $a_{se2} = 0.00$
 $s_{h_2} = 150.00$
 $b_{o_2} = 190.00$
 $h_{o_2} = 540.00$
 $b_{i2_2} = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,x} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,x} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$
No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,y} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,y} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$
No stirrups, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062

```


$c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05574729$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.20717489$
 $Mu = MRc(4.14) = 1.7738E+008$
 $u = su(4.1) = 3.5153739E-005$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f_c'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $Mu = 1.9099438E-011$
 $V_u = 0.00$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i ,
 as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\alpha_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $\mu_u / V_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Section Type: rcrrws

Constant Properties

Knowledge Factor, $\phi = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\rho_n = 0.00069813$

with $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$
Tensile Strength, $f_{fu} = 1055.00$
Tensile Modulus, $E_f = 64828.00$
Elongation, $e_{fu} = 0.01$
Number of directions, $NoDir = 1$
Fiber orientations, $bi: 0.00^\circ$
Number of layers, $NL = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Bending Moment, $M = 7.0728943E-011$
Shear Force, $V_2 = 7.6985341E-015$
Shear Force, $V_3 = 34419.312$
Axial Force, $F = -29773.887$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{t,ten} = 2368.761$
-Compression: $As_{c,com} = 2368.761$
-Middle: $As_{mid} = 1608.495$
Mean Diameter of Tension Reinforcement, $Db_L = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{R} = u = 0.00277127$
 $u = y + p = 0.00326031$

- Calculation of y -

$y = (M_y \cdot I_p) / (E I)_{Eff} = 0.00126031$ ((10-5), ASCE 41-17))
 $M_y = 1.5091E+008$
 $(E I)_{Eff} = 0.35 \cdot E_c \cdot I$ (table 10-5)
 $E_c \cdot I = 8.2106E+013$
 $I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \min(y_{ten}, y_{com})$
 $y_{ten} = 8.7656668E-006$
with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 269.394$
 $d = 208.00$
 $y = 0.26122943$
 $A = 0.01034702$
 $B = 0.00628884$
with $pt = 0.00379609$
 $pc = 0.00379609$
 $pv = 0.00257772$
 $N = 29773.887$
 $b = 3000.00$
 $" = 0.20192308$
 $y_{comp} = 2.5442941E-005$
with fc^* (12.3, (ACI 440)) = 16.002
 $fc = 16.00$
 $fl = 0.17503396$
 $b = 3000.00$
 $h = 250.00$
 $Ag = 750000.00$
From (12.9), ACI 440: $ka = 0.00364754$

$$g = p_t + p_c + p_v = 0.0101699$$

$$r_c = 40.00$$

$$A_e/A_c = 0.52524587$$

$$\text{Effective FRP thickness, } t_f = N_L * t * \cos(b_1) = 1.016$$

$$\text{effective strain from (12.5) and (12.12), } \epsilon_{fe} = 0.004$$

$$f_u = 0.01$$

$$E_f = 64828.00$$

$$E_c = 21019.039$$

$$y = 0.25894248$$

$$A = 0.0099958$$

$$B = 0.00611172$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b/I_d

$$\text{Lap Length: } I_d/I_{d,\min} = 0.39548208$$

$$I_b = 300.00$$

$$I_d = 758.5679$$

Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$$d_b = 16.85714$$

$$\text{Mean strength value of all re-bars: } f_y = 400.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
 from table 10-19: $p = 0.002$

with:

- Condition i (shear wall and wall segments)

$$-(A_s - A_s') * f_y + P / (t_w * I_w * f_c') = -0.20905275$$

$$A_s = 0.00$$

$$A_s' = 6346.017$$

$$f_y = 400.00$$

$$P = 29773.887$$

$$t_w = 3000.00$$

$$I_w = 250.00$$

$$f_c = 16.00$$

$$-V / (t_w * I_w * f_c^{0.5}) = 3.0903667E-020, \text{ NOTE: units in lb \& in}$$

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 * d_b$ or $s_2 > 8 * d_b$)

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ($V_{w1} + V_{w2} > 0.50 * (V - V_c - V_{w3})$)

With

Boundary Element 1:

$$V_{w1} = 83775.804$$

$$s_1 = 150.00$$

Boundary Element 2:

$$V_{w2} = 83775.804$$

$$s_2 = 150.00$$

$$\text{Grid Shear Force, } V_{w3} = 0.00$$

$$\text{Concrete Shear Force, } V_c = 126752.235$$

(The variables above have already been given in Shear control ratio calculation)

$$\text{Mean diameter of all bars, } d_b = 17.33333$$

$$\text{Design Shear Force, } V = 7.6985341E-015$$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Calculation No. 9

wall W1, 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: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcwrs

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = l_b = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i: 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-
 Bending Moment, $M_a = -8.3458925E-011$
 Shear Force, $V_a = -6.3856629E-015$
 EDGE -B-
 Bending Moment, $M_b = 6.1924294E-011$
 Shear Force, $V_b = 6.3856629E-015$
 BOTH EDGES
 Axial Force, $F = -29388.501$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2368.761$
 -Compression: $A_{sl,com} = 2368.761$
 -Middle: $A_{sl,mid} = 1608.495$
 Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 265728.266$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 312621.489$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 124725.901$
 $\mu_u / \mu_u - l_w / 2 = 12944.735 > 0$
 = 1 (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 8.3458925E-011$
 $V_u = 6.3856629E-015$
 $N_u = 29388.501$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17, 10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

$$V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$$

$$f = 0.95, \text{ for fully-wrapped sections}$$

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

$$\text{orientation 1: } \theta_1 = \theta_1 + 90^\circ = 90.00$$

$$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|), \text{ with:}$$

$$\text{total thickness per orientation, } t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 208.00$$

$$f_{fe} ((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 10

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (θ_u)

Edge: Start

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcrrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $bi: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 6.3108872E-029$

EDGE -B-

Shear Force, $V_b = -6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{ten} = 2865.133$

-Compression: $As_{com} = 2865.133$

-Middle: $As_{mid} = 0.00$

(According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 1.01783$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$

$\mu_{u1+} = 2.8453E+009$, 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

$\mu_{u1-} = 3.0413E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$

$\mu_{u2+} = 2.8453E+009$, 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

$\mu_{u2-} = 3.0413E+009$, 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

Calculation of μ_{u1+}

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

$\mu_u = 2.2735554E-006$

$\mu_u = 2.8453E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_u ((5.4c), TBDY) = $\alpha_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $\mu_{fx} = \alpha_f * \mu_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$\mu_{af} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$\mu_{af} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_f = 0.015$
 $ase((5.4d), TBDY) = (ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$
 $ase_1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase_2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase_3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$f_{ywe} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$

$ft1 = 348.235$
 $fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lo_{u,min} = lb/ld = 0.31638566$

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

and confined core properties:

```

b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

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

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00

```

Id = 948.2098

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1

db = 16.85714

Mean strength value of all re-bars: $f_y = 500.00$

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of μ_1 -

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

$\mu = 2.2880917E-006$

$\mu_u = 3.0413E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

$\nu = 0.00232618$

N = 27514.027

$f_c = 16.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_{ue} ((5.4c), TBDY) = $a_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$a_f = 0.00$

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

bw = 250.00

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$a_f = 0.00$

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

bw = 3000.00

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{u,f} = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$\mu_{sh,1} = 150.00$

$\mu_{bo,1} = 190.00$

$\mu_{ho,1} = 540.00$

$\mu_{bi2,1} = 655400.00$

$a_{se2} = 0.00$

$\mu_{sh,2} = 150.00$

$\mu_{bo,2} = 190.00$

$\mu_{ho,2} = 540.00$

$bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/l_d = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/l_b,min = 0.31638566$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.31638566
lb = 300.00
lb = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

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

$$\phi_u = 2.2735554E-006$$

$$M_u = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_{f'f} * f_{f'e} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{f'f} = 2t_f / b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{f'e} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{f'f} = 2t_f / b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{f'e} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_{,1} = 150.00$$

$$bo_{,1} = 190.00$$

$$ho_{,1} = 540.00$$

$$bi2_{,1} = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_{,2} = 150.00$$

$$bo_{,2} = 190.00$$

$$ho_{,2} = 540.00$$

$$bi2_{,2} = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_{,1}) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_{,2}) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_{,3}) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.07029503$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.07029503$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.09344146$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.09344146$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2$ -

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

$u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503

2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503

v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

fcc (5A.2, TBDY) = 16.06499

$cc(5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09344146$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09344146$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 'satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.14318411$
 $Mu = MRc(4.14) = 3.0413E+009$
 $u = su(4.1) = 2.2880917E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f'_c^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $Mu = 2.8012401E-010$
 $V_u = 6.3108872E-029$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 2957.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943\text{E}+006$$

$$b_w = 250.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

$$\text{From (22.5.1.1) and 11.5.4.3, ACI 318-14: } V_{r2} = V_n < 0.83 * f_c'^{0.5} * h * d$$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$$

$= 1$ (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$\mu_u = 2.8012401\text{E}-010$$

$$V_u = 6.3108872\text{E}-029$$

$$N_u = 27514.027$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

```

dfv = d (figure 11.2, ACI 440) = 2957.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 1.5943E+006
bw = 250.00
-----

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 3

-----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrrws

Constant Properties
-----
Knowledge Factor, k = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = 0.00
EDGE -B-
Shear Force, Vb = 0.00
BOTH EDGES

```

Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 2368.761$
 -Compression: $As_{c,com} = 2368.761$
 -Middle: $As_{mid} = 0.00$
 (According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.7738E+008$
 $\mu_{u1+} = 1.4516E+008$, 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
 $\mu_{u1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.7738E+008$
 $\mu_{u2+} = 1.4516E+008$, 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
 $\mu_{u2-} = 1.7738E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$

$f_c = 16.00$
 $\alpha (\text{5A.5, TBDY}) = 0.002$

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

we ((5.4c), TBDY) $= \alpha \epsilon_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\epsilon_{fx}, \epsilon_{fy}) = 0.00$

where $\epsilon_{fx} = \alpha f_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\epsilon_{fx} = 0.00$

$\alpha f_{pf} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$\alpha f_{pf} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL * t * \cos(b1) = 1.016$
 $f_u, f = 1055.00$
 $E_f = 64828.00$
 $u, f = 0.015$
 $ase ((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh, min = \min(psh, x, psh, y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh, min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$
 $ps1, x$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, x$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, x$ (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 * ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$
 $ps1, y$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, y$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, y$ (web) = $(As3 * h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 * ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $f_{ywe} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
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 $fs1 = fs = 290.1959$
with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.31638566$
 $su2 = 0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.06885062$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.06885062$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.08209659$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.08209659$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_1 -

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

$$\mu = 3.5153739E-005$$

$$\mu = 1.7738E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$\mu_e ((5.4c), TBDY) = \alpha \mu_{min} * f_{ywe} / f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$$

where $\mu = \alpha * \mu_{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\mu_x = 0.00$$

$$\alpha = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f / b_w = 0.008128$$

$$b_w = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\mu_y = 0.00$$

$$\alpha = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f / b_w = 0.00067733$$

$$b_w = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L * t * \cos(\beta_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$\mu_{u,f} = 0.015$$

$$\alpha \mu_e ((5.4d), TBDY) = (\alpha \mu_1 * A_{col1} + \alpha \mu_2 * A_{col2} + \alpha \mu_3 * A_{web}) / A_{sec} = 0.00$$

$$\alpha \mu_1 = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi_{2,1} = 655400.00$$

$$\alpha \mu_2 = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi_{2,2} = 655400.00$$

ase3 = 0 (grid does not provide confinement)
 psh,min = Min(psh,x , psh,y) = 0.00069813
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
 ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
 h1 = 600.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
 h2 = 600.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
 h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirrups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirrups, ns3 = 0.00

Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00
 From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406
 y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: esu1_nominal = 0.08066667,
 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 = 290.1959
 with Es1 = Es = 200000.00
 y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Es_v = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.20717489$
 $Mu = MRc (4.14) = 1.7738E+008$
 $u = su (4.1) = 3.5153739E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
Calculation of lb_{min} according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of $Mu2+$

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

$$\phi_u = 3.4223799E-005$$

$$M_u = 1.4516E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08066667$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v, sh_v, ft_v, f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 290.1959$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su \text{ (4.9)} = 0.18563201$
 $Mu = MR_c \text{ (4.14)} = 1.4516E+008$
 $u = su \text{ (4.1)} = 3.4223799E-005$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

 Calculation of Mu_2 -

 Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 3.5153739E-005$
 $Mu = 1.7738E+008$

 with full section properties:
 $b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$

we ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$
where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$
 $a_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$
 $a_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,x} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,x} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$
No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} \text{ (column 1)} = (A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,y} \text{ (column 2)} = (A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,y} \text{ (web)} = (A_{s3} \cdot h_3/s_3)/A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$
No stirrups, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062

```

c = confinement factor = 1.00406

1 = $Asl_{ten}/(b*d)*(fs1/fc) = 0.08209659$

2 = $Asl_{com}/(b*d)*(fs2/fc) = 0.08209659$

v = $Asl_{mid}/(b*d)*(fsv/fc) = 0.05574729$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

su (4.9) = 0.20717489

Mu = MRc (4.14) = 1.7738E+008

u = su (4.1) = 3.5153739E-005

Calculation of ratio lb/d

Lap Length: lb/d = 0.31638566

lb = 300.00

ld = 948.2098

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

= 1

db = 16.85714

Mean strength value of all re-bars: fy = 500.00

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*fc'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$Mu/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$fc' = 16.00$, but $fc'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

h = 3000.00

d = 200.00

lw = 250.00

Mu = 1.9099438E-011

Vu = 0.00

Nu = 27514.027

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

d = 200.00

Av = 157079.633

s = 150.00

fy = 400.00

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i ,
 as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\alpha_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $\mu_u / V_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrcws

Constant Properties

Knowledge Factor, $\phi = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\rho_n = 0.00069813$

with $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$
Tensile Strength, $f_{fu} = 1055.00$
Tensile Modulus, $E_f = 64828.00$
Elongation, $e_{fu} = 0.01$
Number of directions, $NoDir = 1$
Fiber orientations, $bi: 0.00^\circ$
Number of layers, $NL = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Axial Force, $F = -29388.501$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $As_t = 0.00$
-Compression: $As_c = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $As_{ten} = 2865.133$
-Compression: $As_{com} = 2865.133$
-Middle: $As_{mid} = 615.7522$
Mean Diameter of Tension Reinforcement, $Db_L = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{R} = \quad * u = 0.02$
from table 10-20: $u = 0.02352941$
with:

- Condition i (shear wall and wall segments)
- $(As - As') * f_y + P) / (t_w * l_w * f_c') = -0.20908486$
 $As = 0.00$
 $As' = 6346.017$
 $f_y = 400.00$
 $P = 29388.501$
 $t_w = 250.00$
 $l_w = 3000.00$
 $f_c = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
At local axis: 2
Integration Section: (a)

Calculation No. 11

wall W1, Floor 1

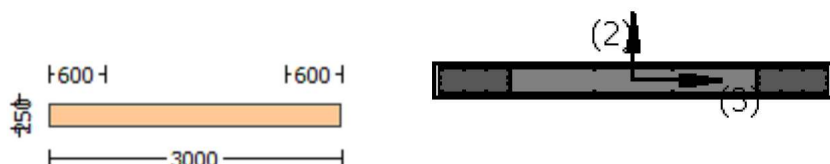
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: Start

Local Axis: (3)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.5315\text{E}+007$

Shear Force, $V_a = -28549.607$

EDGE -B-

Bending Moment, $M_b = 348518.893$

Shear Force, $V_b = 28549.607$

BOTH EDGES

Axial Force, $F = -29388.501$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{t,ten} = 2865.133$

-Compression: $As_{c,com} = 2865.133$

-Middle: $As_{mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.6932\text{E}+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.9920\text{E}+006$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 613244.962$

$M_u/V_u - l_w/2 = 1488.32 > 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 8.5315\text{E}+007$

$V_u = 28549.607$

$N_u = 29388.501$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581\text{E}+006$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i , as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\alpha_1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $tf1 = NL \cdot t / NoDir = 1.016$
 $dfv = d$ (figure 11.2, ACI 440) = 2957.00
 ffe ((11-5), ACI 440) = 259.312
 $Ef = 64828.00$
 $fe = 0.004$, from (11.6a), ACI 440
 with $fu = 0.01$
 From (11-11), ACI 440: $Vs + Vf \leq 1.5943E+006$
 $bw = 250.00$

 End Of Calculation of Shear Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (a)

Calculation No. 12

wall W1, Floor 1
 Limit State: Collapse Prevention (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: wall W1 of floor 1
 At Shear local axis: 3
 (Bending local axis: 2)
 Section Type: rcwrs

Constant Properties

 Knowledge Factor, $\gamma = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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
Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$ 
#####
Total Height,  $H_{tot} = 3000.00$ 
Edges Width,  $W_{edg} = 250.00$ 
Edges Height,  $H_{edg} = 600.00$ 
Web Width,  $W_{web} = 250.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00406
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness,  $t = 1.016$ 
Tensile Strength,  $f_{fu} = 1055.00$ 
Tensile Modulus,  $E_f = 64828.00$ 
Elongation,  $e_{fu} = 0.01$ 
Number of directions,  $N_{oDir} = 1$ 
Fiber orientations,  $b_i: 0.00^\circ$ 
Number of layers,  $N_L = 1$ 
Radius of rounding corners,  $R = 40.00$ 
-----

Stepwise Properties
-----
At local axis: 3
EDGE -A-
Shear Force,  $V_a = 6.3108872E-029$ 
EDGE -B-
Shear Force,  $V_b = -6.3108872E-029$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
  -Tension:  $A_{sl,t} = 0.00$ 
  -Compression:  $A_{sl,c} = 6346.017$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
  -Tension:  $A_{sl,ten} = 2865.133$ 
  -Compression:  $A_{sl,com} = 2865.133$ 
  -Middle:  $A_{sl,mid} = 0.00$ 
  (According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)
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Calculation of Shear Capacity ratio ,  $V_e/V_r = 1.01783$ 
Member Controlled by Shear ( $V_e/V_r > 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ 
with
 $M_{pr1} = \text{Max}(M_{u1+} , M_{u1-}) = 3.0413E+009$ 
 $M_{u1+} = 2.8453E+009$ , 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
 $M_{u1-} = 3.0413E+009$ , 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
 $M_{pr2} = \text{Max}(M_{u2+} , M_{u2-}) = 3.0413E+009$ 
 $M_{u2+} = 2.8453E+009$ , 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
 $M_{u2-} = 3.0413E+009$ , 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
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Calculation of  $M_{u1+}$ 

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

$$\phi_u = 2.273554E-006$$

$$\mu = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{co}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_{pf} = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$

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

$lo/lou,min = lb/lb,min = 0.31638566$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $Es2 = Es = 200000.00$

$yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$

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

$l_o/l_{o,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $Min(1, 1.25 * (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b * d) * (fs1/fc) = 0.07029503$
 $2 = Asl_{com}/(b * d) * (fs2/fc) = 0.07029503$
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl_{ten}/(b * d) * (fs1/fc) = 0.09344146$
 $2 = Asl_{com}/(b * d) * (fs2/fc) = 0.09344146$
 $v = Asl_{mid}/(b * d) * (fsv/fc) = 0.00$

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

--->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$

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

From (5.4b), TBDY: $c_u = 0.0035$

$w_e ((5.4c), TBDY) = a_{se} * sh_{min} * f_{ywe} / f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = a_f * p_f * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL * t * \text{Cos}(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{,f} = 0.015$

$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} * n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} * n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} * n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$$As3 = Astir3 * ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

$$\text{From } ((5A5), \text{ TBDY}), \text{ TBDY: } cc = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$y1 = 0.00120915$$

$$sh1 = 0.00467215$$

$$ft1 = 348.235$$

$$fy1 = 290.1959$$

$$su1 = 0.00579712$$

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

$$lo/lou,min = lb/ld = 0.31638566$$

$$su1 = 0.4 * esu1_nominal ((5.5), \text{ TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08066667,$$

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.

$$\text{with } fs1 = fs = 290.1959$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00120915$$

$$sh2 = 0.00467215$$

$$ft2 = 348.235$$

$$fy2 = 290.1959$$

$$su2 = 0.00579712$$

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

$$lo/lou,min = lb/lb,min = 0.31638566$$

$$su2 = 0.4 * esu2_nominal ((5.5), \text{ TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08066667,$$

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.

$$\text{with } fs2 = fs = 290.1959$$

$$\text{with } Es2 = Es = 200000.00$$

$$yv = 0.00120915$$

$$shv = 0.00467215$$

$$ftv = 348.235$$

$$fyv = 290.1959$$

$$suv = 0.00579712$$

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

$$lo/lou,min = lb/ld = 0.31638566$$

$$suv = 0.4 * esuv_nominal ((5.5), \text{ TBDY}) = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esuv_nominal = 0.08066667,$$

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.

$$\text{with } fsv = fs = 290.1959$$

$$\text{with } Esv = Es = 200000.00$$

$$1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503$$

$$2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503$$

$$v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

```

fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

```

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
u = 2.2735554E-006
Mu = 2.8453E+009

```

with full section properties:

```

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027
fc = 16.00
co (5A.5, TBDY) = 0.002
Final value of cu: cu* = shear_factor * Max( cu, cc) = 0.0035
The Shear_factor is considered equal to 1 (pure moment strength)
From (5.4b), TBDY: cu = 0.0035
we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min( fx, fy) = 0.00
where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
fx = 0.00
af = 0.00
b = 250.00
h = 3000.00
From EC8 A4.4.3(6), pf = 2tf/bw = 0.008128
bw = 250.00
effective stress from (A.35), ffe = 636.1644
fy = 0.00
af = 0.00
b = 3000.00

```


h = 250.00
From EC8 A4.4.3(6), $pf = 2tf/bw = 0.00067733$
bw = 3000.00
effective stress from (A.35), $ff_e = 944.3987$

R = 40.00
Effective FRP thickness, $tf = NL*t*\cos(b1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $ase((5.4d), TBDY) = (ase1*A_{col1} + ase2*A_{col2} + ase3*A_{web})/A_{sec} = 0.00$
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
 $psh_{,min} = \min(psh_x, psh_y) = 0.00069813$

Expression ((5.4d), TBDY) for $psh_{,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh_x = ps1_x + ps2_x + ps3_x = 0.00356047$
 $ps1_x$ (column 1) = $(As1*h1/s_1)/Ac = 0.00083776$
h1 = 600.00
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps2_x$ (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$
h2 = 600.00
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps3_x$ (web) = $(As3*h3/s_3)/Ac = 0.00188496$
h3 = 1800.00
 $As3 = Astir3*ns3 = 0.00$
No stirrups, ns3 = 2.00

$psh_y = ps1_y + ps2_y + ps3_y = 0.00069813$
 $ps1_y$ (column 1) = $(As1*h1/s_1)/Ac = 0.00034907$
h1 = 250.00
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps2_y$ (column 2) = $(As2*h2/s_2)/Ac = 0.00034907$
h2 = 250.00
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps3_y$ (web) = $(As3*h3/s_3)/Ac = 0.00$
h3 = 250.00
 $As3 = Astir3*ns3 = 157.0796$
No stirrups, ns3 = 0.00

$A_{sec} = 750000.00$
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
 $f_{ywe} = 500.00$
 $f_{ce} = 16.00$
From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
c = confinement factor = 1.00406
 $y1 = 0.00120915$
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

```

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs1 = fs = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fs2 = fs = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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/d)^ 2/3), from 10.3.5, ASCE 41-17.
with fsv = fs = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$

$l_d = 948.2098$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$d_b = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2 -

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

$\mu = 2.2880917E-006$

$\mu = 3.0413E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \phi) = 0.0035$

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

From (5.4b), TBDY: $\mu = 0.0035$

μ ((5.4c), TBDY) = $a_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$

where $\mu = a_{se} * \mu_{sh,min} * f_{ywe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_x = 0.00$

$a_{se} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $\mu_{sh,min} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{f,e} = 636.1644$

$\mu_y = 0.00$

$a_{se} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $\mu_{sh,min} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{f,e} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = N L^* t \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{u,f} = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

```

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

```

ase3 = 0 (grid does not provide confinement)

psh,min = Min(psh,x , psh,y) = 0.00069813

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirrups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirrups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirrups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirrups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirrups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

```

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

```

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

```

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

```

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

```

```

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 1.9920\text{E}+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920\text{E}+006$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401\text{E}-010$

$V_u = 6.3108872\text{E}-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17, 10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581\text{E}+006$

$f = 0.95$, for fully-wrapped sections

$w_f / s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $lw = 3000.00$
 $\mu_u = 2.8012401E-010$
 $V_u = 6.3108872E-029$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), ACI 440) = 1.5581E+006$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $a = 45^\circ$ and $a = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $a_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00
 $f_{fe} ((11-5), ACI 440) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcrws

Constant Properties

 Knowledge Factor, $\phi = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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

```

Existing material: Steel Strength,  $f_s = 1.25 \cdot f_{sm} = 500.00$ 
#####
Total Height,  $H_{tot} = 3000.00$ 
Edges Width,  $W_{edg} = 250.00$ 
Edges Height,  $H_{edg} = 600.00$ 
Web Width,  $W_{web} = 250.00$ 
Cover Thickness,  $c = 25.00$ 
Mean Confinement Factor overall section = 1.00406
Element Length,  $L = 3000.00$ 
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length  $l_o = 300.00$ 
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness,  $t = 1.016$ 
Tensile Strength,  $f_{fu} = 1055.00$ 
Tensile Modulus,  $E_f = 64828.00$ 
Elongation,  $\epsilon_{fu} = 0.01$ 
Number of directions,  $N_{oDir} = 1$ 
Fiber orientations,  $b_i: 0.00^\circ$ 
Number of layers,  $N_L = 1$ 
Radius of rounding corners,  $R = 40.00$ 
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force,  $V_a = 0.00$ 
EDGE -B-
Shear Force,  $V_b = 0.00$ 
BOTH EDGES
Axial Force,  $F = -27514.027$ 
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension:  $A_{slt} = 0.00$ 
-Compression:  $A_{slc} = 6346.017$ 
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension:  $A_{sl,ten} = 2368.761$ 
-Compression:  $A_{sl,com} = 2368.761$ 
-Middle:  $A_{sl,mid} = 0.00$ 
(According to 10.7.2.3  $A_{sl,mid}$  is setted equal to zero)
-----
-----

Calculation of Shear Capacity ratio ,  $V_e/V_r = 0.14054053$ 
Member Controlled by Flexure ( $V_e/V_r < 1$ )
Calculation of Shear Demand from fig. R18.6.5, ACI 318-14  $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$ 
with
 $M_{pr1} = \text{Max}(M_{u1+}, M_{u1-}) = 1.7738E+008$ 
 $M_{u1+} = 1.4516E+008$ , 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
 $M_{u1-} = 1.7738E+008$ , 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
 $M_{pr2} = \text{Max}(M_{u2+}, M_{u2-}) = 1.7738E+008$ 
 $M_{u2+} = 1.4516E+008$ , 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
 $M_{u2-} = 1.7738E+008$ , is the ultimate moment strength at the edge 2 of the member in the opposite moment
direction which is defined for the the static loading combination
-----

Calculation of  $M_{u1+}$ 
-----

```


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

$$\phi_u = 3.4223799\text{E-}005$$

$$M_u = 1.4516\text{E+}008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), \text{TB DY}) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = N L^* t \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

$$a_{se} ((5.4d), \text{TB DY}) = (a_{se1} A_{col1} + a_{se2} A_{col2} + a_{se3} A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TB DY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.06885062$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.06885062$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.08209659$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.08209659$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu1$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 3.5153739E-005$
 $Mu = 1.7738E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062

2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062

v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268

and confined core properties:

b = 2940.00

d = 178.00

d' = 12.00

fcc (5A.2, TBDY) = 16.06499

$$cc(5A.5, TBDY) = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$1 = Asl_{ten}/(b*d)*(fs1/fc) = 0.08209659$$

$$2 = Asl_{com}/(b*d)*(fs2/fc) = 0.08209659$$

$$v = Asl_{mid}/(b*d)*(fsv/fc) = 0.05574729$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$su(4.9) = 0.20717489$$

$$Mu = MRc(4.14) = 1.7738E+008$$

$$u = su(4.1) = 3.5153739E-005$$

Calculation of ratio lb/ld

$$\text{Lap Length: } lb/ld = 0.31638566$$

$$lb = 300.00$$

$$ld = 948.2098$$

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

$$= 1$$

$$db = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$cb = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of Mu_{2+}

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

$$u = 3.4223799E-005$$

$$Mu = 1.4516E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$fc = 16.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0035$$

$$w_e((5.4c), TBDY) = ase * sh_{min} * fy_{we}/f_{ce} + \text{Min}(fx, fy) = 0.00$$

where $f = af * pf * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$fx = 0.00$$

$$af = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } pf = 2tf/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } ff_e = 636.1644$$

$$fy = 0.00$$

$$af = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

From EC8 A4.4.3(6), $pf = 2tf/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $ff_e = 944.3987$

$R = 40.00$
Effective FRP thickness, $tf = NL*t*\cos(b1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $ase((5.4d), TBDY) = (ase1*Acol1 + ase2*Acol2 + ase3*Aweb)/Asec = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1*h1/s_1)/Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2*h2/s_2)/Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3*h3/s_3)/Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3*ns3 = 0.00$
No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1*h1/s_1)/Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1*ns1 = 157.0796$
No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2*h2/s_2)/Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2*ns2 = 157.0796$
No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3*h3/s_3)/Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3*ns3 = 157.0796$
No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c =$ confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $su_1 = 0.4 * esu_{1,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{1,nominal} = 0.08066667$,
 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 $fs_1 = fs = 290.1959$
 with $Es_1 = Es = 200000.00$
 $y_2 = 0.00120915$
 $sh_2 = 0.00467215$
 $ft_2 = 348.235$
 $fy_2 = 290.1959$
 $su_2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.31638566$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 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 $fs_2 = fs = 290.1959$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.06885062$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.06885062$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl_{ten}/(b*d) * (fs_1/fc) = 0.08209659$
 $2 = Asl_{com}/(b*d) * (fs_2/fc) = 0.08209659$
 $v = Asl_{mid}/(b*d) * (fsv/fc) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

 Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$

$l_d = 948.2098$

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

$= 1$

$db = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$cb = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of μ_2 -

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

$\mu = 3.5153739E-005$

$\mu = 1.7738E+008$

with full section properties:

$b = 3000.00$

$d = 208.00$

$d' = 42.00$

$v = 0.00275581$

$N = 27514.027$

$f_c = 16.00$

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

Final value of μ : $\mu^* = \text{shear_factor} * \text{Max}(\mu, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu = 0.0035$

μ_e ((5.4c), TBDY) = $\alpha s_e \cdot \text{sh}_{\min} \cdot f_{ywe}/f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$

where $f = \alpha f_p f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_x = 0.00$

$\alpha f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$\alpha f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{,f} = 0.015$

αs_e ((5.4d), TBDY) = $(\alpha s_{e1} \cdot A_{col1} + \alpha s_{e2} \cdot A_{col2} + \alpha s_{e3} \cdot A_{web})/A_{sec} = 0.00$

$\alpha s_{e1} = 0.00$

$sh_{_1} = 150.00$

$bo_{_1} = 190.00$

$ho_{_1} = 540.00$

$bi_{2_1} = 655400.00$

$\alpha s_{e2} = 0.00$

$sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/ld = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor

and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_{b,min} = 0.31638566$
 $su_2 = 0.4 * esu_{2,nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esu_{2,nominal} = 0.08066667$,
 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 $fs_2 = fs = 290.1959$
 with $Es_2 = Es = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 Shear_factor = 1.00
 $l_o/l_{ou,min} = l_b/l_d = 0.31638566$
 $suv = 0.4 * esuv_{nominal} ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_{nominal} = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Es_v = Es = 200000.00$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.04675268$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d) * (fs_1/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b*d) * (fs_2/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b*d) * (fsv/f_c) = 0.05574729$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.20717489$
 $Mu = MR_c (4.14) = 1.7738E+008$
 $u = su (4.1) = 3.5153739E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of $l_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u / V_u - l_w / 2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.9099438\text{E}-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f / s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i , as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\alpha = \alpha_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \alpha_1)|, |V_f(-45, \alpha_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 V_f ((11-3)-(11.4), ACI 440) = 109599.773
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\theta, a)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\theta = b1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 f_{fe} ((11-5), ACI 440) = 259.312
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 2

 Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1
 At local axis: 3
 Integration Section: (a)
 Section Type: rcrcws

Constant Properties

 Knowledge Factor, $\phi = 0.85$
 According to 10.7.2.3, ASCE 41-17, shear walls with
 transverse reinforcement percentage, $\rho_n < 0.0015$
 are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17
 $\rho_n = 0.00069813$

with $n = ps1 + ps2 + ps3$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2
 (pseudo-col.1 $ps1 = As1*b1/s1 = (As1*h1/s1) / Ac = 0.00034907$
 $h1 = 250.00$
 $s1 = 150.00$
 total area of hoops perpendicular to shear axis, $As1 = 157.0796$
 (pseudo-col.2 $ps2 = As2*b2/s2 = (As2*h2/s2) / Ac = 0.00034907$
 $h2 = 250.00$
 $s2 = 150.00$
 total area of hoops perpendicular to shear axis, $As2 = 157.0796$
 (grid $ps3 = As3*b3/s3 = (As3*h3/s3) / Ac = 0.00$
 $h3 = 250.00$
 $s3 = 200.00$
 total area of hoops perpendicular to shear axis, $As3 = 0.00$
 total section area, $Ac = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$
 Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$
 Concrete Elasticity, $Ec = 21019.039$
 Steel Elasticity, $Es = 200000.00$
 Total Height, $H_{tot} = 3000.00$
 Edges Width, $Wedg = 250.00$
 Edges Height, $Hedg = 600.00$
 Web Width, $Wweb = 250.00$
 Cover Thickness, $c = 25.00$
 Element Length, $L = 3000.00$
 Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $lb = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $ffu = 1055.00$
 Tensile Modulus, $Ef = 64828.00$
 Elongation, $efu = 0.01$
 Number of directions, $NoDir = 1$
 Fiber orientations, $bi: 0.00^\circ$
 Number of layers, $NL = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

Bending Moment, $M = -8.3458925E-011$
 Shear Force, $V2 = -6.3856629E-015$
 Shear Force, $V3 = -28549.607$
 Axial Force, $F = -29388.501$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $Aslt = 0.00$
 -Compression: $Aslc = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl_{ten} = 2368.761$
 -Compression: $Asl_{com} = 2368.761$
 -Middle: $Asl_{mid} = 1608.495$
 Mean Diameter of Tension Reinforcement, $DbL = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_R = * u = 0.01382101$
 $u = y + p = 0.01626001$

- Calculation of y -

$$y = (M_y \cdot I_p) / (E I)_{\text{Eff}} = 0.00126001 \text{ ((10-5), ASCE 41-17)}$$
$$M_y = 1.5087\text{E}+008$$
$$(E I)_{\text{Eff}} = 0.35 \cdot E_c \cdot I \text{ (table 10-5)}$$
$$E_c \cdot I = 8.2106\text{E}+013$$
$$I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$$y = \text{Min}(y_{\text{ten}}, y_{\text{com}})$$
$$y_{\text{ten}} = 8.7651352\text{E}-006$$
$$\text{with ((10.1), ASCE 41-17)} \quad f_y = \text{Min}(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 269.394$$
$$d = 208.00$$
$$y = 0.26118462$$
$$A = 0.01034472$$
$$B = 0.00628654$$
$$\text{with } p_t = 0.00379609$$
$$p_c = 0.00379609$$
$$p_v = 0.00257772$$
$$N = 29388.501$$
$$b = 3000.00$$
$$" = 0.20192308$$
$$y_{\text{comp}} = 2.5444482\text{E}-005$$
$$\text{with } f_c^* \text{ (12.3, (ACI 440))} = 16.002$$
$$f_c = 16.00$$
$$f_l = 0.17503396$$
$$b = 3000.00$$
$$h = 250.00$$
$$A_g = 750000.00$$
$$\text{From (12.9), ACI 440: } k_a = 0.00364754$$
$$g = p_t + p_c + p_v = 0.0101699$$
$$r_c = 40.00$$
$$A_e / A_c = 0.52524587$$
$$\text{Effective FRP thickness, } t_f = N L \cdot t \cdot \cos(b_1) = 1.016$$
$$\text{effective strain from (12.5) and (12.12), } e_{fe} = 0.004$$
$$f_u = 0.01$$
$$E_f = 64828.00$$
$$E_c = 21019.039$$
$$y = 0.2589268$$
$$A = 0.00999806$$
$$B = 0.00611172$$
$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b / I_d

Lap Length: $I_d / I_{d,\text{min}} = 0.39548208$

$$I_b = 300.00$$

$$I_d = 758.5679$$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 400.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
from table 10-19: $p = 0.015$

with:

- Condition i (shear wall and wall segments)

- $(A_s - A_s') \cdot f_y + P) / (t_w \cdot l_w \cdot f_c') = -0.20908486$

$A_s = 0.00$

$A_s' = 6346.017$

$f_y = 400.00$

$P = 29388.501$

$t_w = 3000.00$

$l_w = 250.00$

$f_c = 16.00$

- $V / (t_w \cdot l_w \cdot f_c'^{0.5}) = 2.5633503E-020$, NOTE: units in lb & in

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 \cdot d_b$ or $s_2 > 8 \cdot d_b$)

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ($V_{w1} + V_{w2} > 0.50 \cdot (V - V_c - V_{w3})$)

With

Boundary Element 1:

$V_{w1} = 83775.804$

$s_1 = 150.00$

Boundary Element 2:

$V_{w2} = 83775.804$

$s_2 = 150.00$

Grid Shear Force, $V_{w3} = 0.00$

Concrete Shear Force, $V_c = 124725.901$

(The variables above have already been given in Shear control ratio calculation)

Mean diameter of all bars, $d_b = 17.33333$

Design Shear Force, $V = 6.3856629E-015$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (a)

Calculation No. 13

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Shear capacity VR_d

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (d)

Section Type: rcrws

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $N_{oDir} = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $N_L = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = -8.3458925E-011$

Shear Force, $V_a = -6.3856629E-015$

EDGE -B-

Bending Moment, $M_b = 6.1924294E-011$

Shear Force, $V_b = 6.3856629E-015$

BOTH EDGES

Axial Force, $F = -29388.501$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $Asl,c = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $Asl,t = 2368.761$
 -Compression: $Asl,c = 2368.761$
 -Middle: $Asl,m = 1608.495$
 Mean Diameter of Tension Reinforcement, $DbL,t = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 267143.455$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 314286.417$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 126390.829$
 $M_u/V_u - l_w/2 = 9572.395 > 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $M_u = 6.1924294E+011$
 $V_u = 6.3856629E+015$
 $N_u = 29388.501$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$

V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i ,
 as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 2
Integration Section: (d)

Calculation No. 14

wall W1, Floor 1

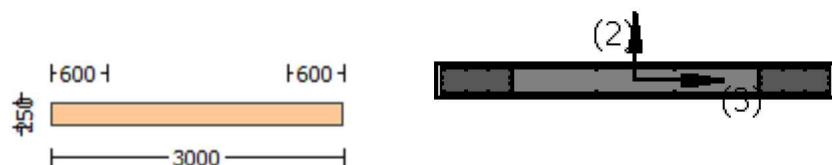
Limit State: Collapse Prevention (data interpolation between analysis steps 1 and 2)

Analysis: Uniform +X

Check: Chord rotation capacity (μ)

Edge: End

Local Axis: (2)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member
 Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i = 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3
 EDGE -A-
 Shear Force, $V_a = 6.3108872E-029$
 EDGE -B-
 Shear Force, $V_b = -6.3108872E-029$
 BOTH EDGES
 Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2865.133$
 -Compression: $A_{sl,com} = 2865.133$
 -Middle: $A_{sl,mid} = 0.00$
 (According to 10.7.2.3 $A_{sl,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio , $V_e/V_r = 1.01783$
 Member Controlled by Shear ($V_e/V_r > 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$
 $\mu_{u1+} = 2.8453E+009$, 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
 $\mu_{u1-} = 3.0413E+009$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$
 $\mu_{u2+} = 2.8453E+009$, 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
 $\mu_{u2-} = 3.0413E+009$, is the ultimate moment strength at the edge 2 of the member in the opposite moment
 direction which is defined for the the static loading combination

Calculation of μ_{u1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 2.2735554E-006$
 $M_u = 2.8453E+009$

with full section properties:
 $b = 250.00$
 $d = 2957.00$

$d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of α : $\alpha^* = \text{shear_factor} * \text{Max}(\alpha, \alpha_c) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\alpha = 0.0035$
 $\alpha_e ((5.4c), TBDY) = \alpha * \text{sh}_{\min} * f_{ywe} / f_{ce} + \text{Min}(\alpha_x, \alpha_y) = 0.00$
 where $\alpha = \alpha_f * p_f * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\alpha_x = 0.00$
 $\alpha_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
 effective stress from (A.35), $f_{fe} = 636.1644$

$\alpha_y = 0.00$
 $\alpha_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
 effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL * t * \text{Cos}(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{f,f} = 0.015$
 $\alpha_e ((5.4d), TBDY) = (\alpha_e1 * A_{col1} + \alpha_e2 * A_{col2} + \alpha_e3 * A_{web}) / A_{sec} = 0.00$
 $\alpha_e1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\alpha_e2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\alpha_e3 = 0$ (grid does not provide confinement)
 $p_{sh,\min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,\min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $p_{s2,x}$ (column 2) = $(A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirrups, $n_{s2} = 2.00$
 $p_{s3,x}$ (web) = $(A_{s3} * h_3 / s_3) / A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$
 No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y}$ (column 1) = $(A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$

$$ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$$

$$h2 = 250.00$$

$$As2 = Astir2 \cdot ns2 = 157.0796$$

$$\text{No stirups, } ns2 = 2.00$$

$$ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$$

$$h3 = 250.00$$

$$As3 = Astir3 \cdot ns3 = 157.0796$$

$$\text{No stirups, } ns3 = 0.00$$

$$Asec = 750000.00$$

$$s_1 = 150.00$$

$$s_2 = 150.00$$

$$s_3 = 200.00$$

$$fywe = 500.00$$

$$fce = 16.00$$

$$\text{From } ((5.A5), \text{ TBDY}), \text{ TBDY: } cc = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$y1 = 0.00120915$$

$$sh1 = 0.00467215$$

$$ft1 = 348.235$$

$$fy1 = 290.1959$$

$$su1 = 0.00579712$$

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

$$lo/lou,min = lb/d = 0.31638566$$

$$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu1_nominal = 0.08066667,$$

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs1 = fs = 290.1959$$

$$\text{with } Es1 = Es = 200000.00$$

$$y2 = 0.00120915$$

$$sh2 = 0.00467215$$

$$ft2 = 348.235$$

$$fy2 = 290.1959$$

$$su2 = 0.00579712$$

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

$$lo/lou,min = lb/lb,min = 0.31638566$$

$$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esu2_nominal = 0.08066667,$$

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fs2 = fs = 290.1959$$

$$\text{with } Es2 = Es = 200000.00$$

$$yv = 0.00120915$$

$$shv = 0.00467215$$

$$ftv = 348.235$$

$$fyv = 290.1959$$

$$suv = 0.00579712$$

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

$$lo/lou,min = lb/d = 0.31638566$$

$$suv = 0.4 \cdot esuv_nominal \text{ ((5.5), TBDY)} = 0.03226667$$

$$\text{From table 5A.1, TBDY: } esuv_nominal = 0.08066667,$$

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 $\text{Min}(1, 1.25 \cdot (lb/d)^{2/3})$, from 10.3.5, ASCE 41-17.

$$\text{with } fsv = fs = 290.1959$$

$$\text{with } Esv = Es = 200000.00$$

$$1 = Asl,ten/(b \cdot d) \cdot (fs1/fc) = 0.07029503$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.07029503$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

and confined core properties:

$$b = 190.00$$

$$d = 2927.00$$

$$d' = 13.00$$

$$f_{cc} (5A.2, TBDY) = 16.06499$$

$$cc (5A.5, TBDY) = 0.00204062$$

$$c = \text{confinement factor} = 1.00406$$

$$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09344146$$

$$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09344146$$

$$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$$s_u (4.9) = 0.13770595$$

$$M_u = M_{Rc} (4.14) = 2.8453E+009$$

$$u = s_u (4.1) = 2.2735554E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$$l_b = 300.00$$

$$l_d = 948.2098$$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of M_{u1} -

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

$$u = 2.2880917E-006$$

$$M_u = 3.0413E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } cu: cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } cu = 0.0035$$

$$w_e ((5.4c), TBDY) = a_s * s_{h,min} * f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$f_x = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } p_f = 2t_f/bw = 0.008128$$

bw = 250.00
effective stress from (A.35), $f_{f,e} = 636.1644$

fy = 0.00
af = 0.00
b = 3000.00
h = 250.00
From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
bw = 3000.00
effective stress from (A.35), $f_{f,e} = 944.3987$

R = 40.00
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
fu,f = 1055.00
Ef = 64828.00
u,f = 0.015
ase ((5.4d), TBDY) = $(ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$

ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

ase3 = 0 (grid does not provide confinement)

psh,min = Min(psh,x , psh,y) = 0.00069813

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = $ps_{1,x} + ps_{2,x} + ps_{3,x} = 0.00356047$
 $ps_{1,x}$ (column 1) = $(As_1 \cdot h_1 / s_1) / A_c = 0.00083776$
h1 = 600.00
 $As_1 = Astir_1 \cdot ns_1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps_{2,x}$ (column 2) = $(As_2 \cdot h_2 / s_2) / A_c = 0.00083776$
h2 = 600.00
 $As_2 = Astir_2 \cdot ns_2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps_{3,x}$ (web) = $(As_3 \cdot h_3 / s_3) / A_c = 0.00188496$
h3 = 1800.00
 $As_3 = Astir_3 \cdot ns_3 = 0.00$
No stirrups, ns3 = 2.00

psh,y = $ps_{1,y} + ps_{2,y} + ps_{3,y} = 0.00069813$
 $ps_{1,y}$ (column 1) = $(As_1 \cdot h_1 / s_1) / A_c = 0.00034907$
h1 = 250.00
 $As_1 = Astir_1 \cdot ns_1 = 157.0796$
No stirrups, ns1 = 2.00
 $ps_{2,y}$ (column 2) = $(As_2 \cdot h_2 / s_2) / A_c = 0.00034907$
h2 = 250.00
 $As_2 = Astir_2 \cdot ns_2 = 157.0796$
No stirrups, ns2 = 2.00
 $ps_{3,y}$ (web) = $(As_3 \cdot h_3 / s_3) / A_c = 0.00$
h3 = 250.00
 $As_3 = Astir_3 \cdot ns_3 = 157.0796$
No stirrups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062


```

c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied

```

--->

$$s_u(4.9) = 0.14318411$$

$$M_u = M_{Rc}(4.14) = 3.0413E+009$$

$$u = s_u(4.1) = 2.2880917E-006$$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$

$$l_b = 300.00$$

$$l_d = 948.2098$$

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

$$= 1$$

$$d_b = 16.85714$$

$$\text{Mean strength value of all re-bars: } f_y = 500.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of M_{u2+}

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

$$u = 2.273554E-006$$

$$M_u = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } c_u: c_u^* = \text{shear_factor} * \text{Max}(c_u, c_o) = 0.0035$$

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

$$\text{From (5.4b), TB DY: } c_u = 0.0035$$

$$w_e((5.4c), \text{TB DY}) = a_s e^* s_{h,min} * f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

 $f_x = 0.00$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } p_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

 $f_y = 0.00$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } p_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

 $R = 40.00$

$$\text{Effective FRP thickness, } t_f = N L^* t^* \text{Cos}(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{,f} = 0.015$$

```

ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00
ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00
ase3 = 0 (grid does not provide confinement)
psh,min = Min(psh,x , psh,y) = 0.00069813
Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without
earthquake detailing (90° closed stirrups)

```

```

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959

```

```

with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio lb/lb

```

Lap Length: lb/lb = 0.31638566
lb = 300.00
lb = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00

```

s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

u = 2.2880917E-006
Mu = 3.0413E+009

with full section properties:

b = 250.00
d = 2957.00
d' = 43.00
v = 0.00232618
N = 27514.027

fc = 16.00

co (5A.5, TBDY) = 0.002

Final value of ϕ_u : $\phi_u^* = \text{shear_factor} * \text{Max}(\phi_u, \phi_c) = 0.0035$

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

From (5.4b), TBDY: $\phi_u = 0.0035$

ϕ_{we} ((5.4c), TBDY) = $\text{ase} * \phi_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$

where $\phi_f = \text{af} * \text{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\phi_{fx} = 0.00$

$\text{af} = 0.00$

b = 250.00

h = 3000.00

From EC8 A.4.4.3(6), $\text{pf} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\phi_{fy} = 0.00$

$\text{af} = 0.00$

b = 3000.00

h = 250.00

From EC8 A.4.4.3(6), $\text{pf} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = N L * t * \text{Cos}(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_{f,f} = 0.015$

ase ((5.4d), TBDY) = $(\text{ase}_1 * A_{col1} + \text{ase}_2 * A_{col2} + \text{ase}_3 * A_{web}) / A_{sec} = 0.00$

$\text{ase}_1 = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$\text{ase}_2 = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$\text{ase}_3 = 0$ (grid does not provide confinement)

$\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,x \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y \text{ (column 1)} = (As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y \text{ (column 2)} = (As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y \text{ (web)} = (As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$su1 = 0.4 \cdot esu1_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$

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

$lo/lou,min = lb/lb,min = 0.31638566$

$su2 = 0.4 \cdot esu2_nominal \text{ ((5.5), TBDY)} = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $E_s = E_s = 200000.00$
 $y_v = 0.00120915$
 $sh_v = 0.00467215$
 $ft_v = 348.235$
 $fy_v = 290.1959$
 $suv = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou,min = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 considering characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY
 For calculation of $esuv_nominal$ and y_v, sh_v, ft_v, fy_v , it is considered
 characteristic value $fs_v = fsv/1.2$, from table 5.1, TBDY.
 y_1, sh_1, ft_1, fy_1 , are also multiplied by $Min(1, 1.25 * (lb/ld)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.07029503$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.07029503$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.01510726$
 and confined core properties:
 $b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.09344146$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.09344146$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = Min(V_{r1}, V_{r2}) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 * f_c' ^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401E-010$

$V_u = 6.3108872E-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$d = 1440.00$

$A_v = 157079.633$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

V_f ((11-3)-(11.4), ACI 440) = $1.5581E+006$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $a_i = 45^\circ$ and $a_i = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 250.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 * f'_c^{0.5} * h * d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/\mu_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$\mu_u = 2.8012401E-010$

$V_u = 6.3108872E-029$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$
 $A_v = 157079.633$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where a is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(,)$, is implemented for every different fiber orientation a_i ,
 as well as for 2 crack directions, $a = 45^\circ$ and $a = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $a_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, a_1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 2957.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943\text{E}+006$
 $b_w = 250.00$

 End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At local axis: 3

 Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
 At Shear local axis: 2
 (Bending local axis: 3)
 Section Type: rcrrws

Constant Properties

 Knowledge Factor, $\phi = 0.85$
 Mean strength values are used for both shear and moment calculations.
 Consequently:
 Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$
 Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$
 Concrete Elasticity, $E_c = 21019.039$
 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
 Existing material: Steel Strength, $f_s = 1.25 * f_{sm} = 500.00$
 #####
 Total Height, $H_{tot} = 3000.00$
 Edges Width, $W_{edg} = 250.00$
 Edges Height, $H_{edg} = 600.00$
 Web Width, $W_{web} = 250.00$
 Cover Thickness, $c = 25.00$
 Mean Confinement Factor overall section = 1.00406
 Element Length, $L = 3000.00$
 Secondary Member

Ribbed Bars
 Ductile Steel
 Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
 Longitudinal Bars With Ends Lapped Starting at the End Sections
 Lap Length $l_o = 300.00$
 FRP Wrapping Data
 Type: Carbon
 Cured laminate properties (design values)
 Thickness, $t = 1.016$
 Tensile Strength, $f_{fu} = 1055.00$
 Tensile Modulus, $E_f = 64828.00$
 Elongation, $\epsilon_{fu} = 0.01$
 Number of directions, $N_{oDir} = 1$
 Fiber orientations, $b_i: 0.00^\circ$
 Number of layers, $N_L = 1$
 Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 2
 EDGE -A-
 Shear Force, $V_a = 0.00$
 EDGE -B-
 Shear Force, $V_b = 0.00$
 BOTH EDGES
 Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $A_{sl,t} = 0.00$
 -Compression: $A_{sl,c} = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $A_{sl,ten} = 2368.761$
 -Compression: $A_{sl,com} = 2368.761$
 -Middle: $A_{sl,mid} = 0.00$
 (According to 10.7.2.3 $A_{sl,mid}$ is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(Mu_{1+}, Mu_{1-}) = 1.7738E+008$
 $Mu_{1+} = 1.4516E+008$, 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
 $Mu_{1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(Mu_{2+}, Mu_{2-}) = 1.7738E+008$
 $Mu_{2+} = 1.4516E+008$, 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
 $Mu_{2-} = 1.7738E+008$, is the ultimate moment strength at the edge 2 of the member in the opposite moment direction which is defined for the the static loading combination

Calculation of Mu_{1+}

Calculation of ultimate curvature ϕ_u according to 4.1, Biskinis/Fardis 2013:
 $\phi_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$

$v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\phi_c (5A.5, TBDY) = 0.002$
 Final value of ϕ_c : $\phi_c = \text{shear_factor} * \text{Max}(\phi_c, \phi_c) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\phi_c = 0.0035$
 $\phi_w ((5.4c), TBDY) = \phi_c * \phi_{w,min} * f_{ywe} / f_{ce} + \text{Min}(\phi_c, \phi_y) = 0.00$
 where $\phi_c = \phi_c * \phi_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\phi_x = 0.00$
 $\phi_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $\phi_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
 effective stress from (A.35), $\phi_{fe} = 636.1644$

$\phi_y = 0.00$
 $\phi_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
 From EC8 A.4.4.3(6), $\phi_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
 effective stress from (A.35), $\phi_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{f,f} = 0.015$
 $\phi_{se} ((5.4d), TBDY) = (\phi_{se1} * A_{col1} + \phi_{se2} * A_{col2} + \phi_{se3} * A_{web}) / A_{sec} = 0.00$
 $\phi_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $\phi_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $\phi_{se3} = 0$ (grid does not provide confinement)
 $\phi_{sh,min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $\phi_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$
 $\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} * n_{s2} = 157.0796$
 No stirrups, $n_{s2} = 2.00$
 $\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} * n_{s3} = 0.00$
 No stirrups, $n_{s3} = 2.00$

$\phi_{sh,y} = \phi_{s1,y} + \phi_{s2,y} + \phi_{s3,y} = 0.00069813$
 $\phi_{s1,y} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} * n_{s1} = 157.0796$
 No stirrups, $n_{s1} = 2.00$
 $\phi_{s2,y} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00034907$

$h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y (web) = (As3 * h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 * ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$fywe = 500.00$

$fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$

$c =$ confinement factor $= 1.00406$

$y1 = 0.00120915$

$sh1 = 0.00467215$

$ft1 = 348.235$

$fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$su1 = 0.4 * esu1_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$

$sh2 = 0.00467215$

$ft2 = 348.235$

$fy2 = 290.1959$

$su2 = 0.00579712$

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

$lo/lou,min = lb/lb,min = 0.31638566$

$su2 = 0.4 * esu2_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $Es2 = Es = 200000.00$

$yv = 0.00120915$

$shv = 0.00467215$

$ftv = 348.235$

$fyv = 290.1959$

$suv = 0.00579712$

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

$lo/lou,min = lb/ld = 0.31638566$

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,

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 $fsv = fs = 290.1959$

with $Esv = Es = 200000.00$

$1 = Asl,ten / (b * d) * (fs1 / fc) = 0.06885062$

$2 = Asl,com / (b * d) * (fs2 / fc) = 0.06885062$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.00$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $\mu_u (4.9) = 0.18563201$
 $\mu_u = M_{Rc} (4.14) = 1.4516E+008$
 $u = \mu_u (4.1) = 3.4223799E-005$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of μ_{u1} -

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $u = 3.5153739E-005$
 $\mu_u = 1.7738E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (5A.5, TBDY) = 0.002$
 Final value of μ_{cu} : $\mu_{cu}^* = \text{shear_factor} * \text{Max}(\mu_{cu}, \alpha) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $\mu_{cu} = 0.0035$
 $\mu_{we} ((5.4c), TBDY) = \alpha_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$
 where $f = \alpha_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)
 $\mu_{fx} = 0.00$
 $\alpha_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
 From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$

effective stress from (A.35), $f_{f,e} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{f,e} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

$a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1 / s_1) / A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2 / s_2) / A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3 / s_3) / A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, $n_{s3} = 0.00$

$A_{sec} = 750000.00$

$s_1 = 150.00$

$s_2 = 150.00$

$s_3 = 200.00$

$f_{ywe} = 500.00$

$f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$

c = confinement factor = 1.00406

```

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31638566
    su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu1_nominal = 0.08066667,
    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 = 290.1959
    with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
    su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esu2_nominal = 0.08066667,
    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 = 290.1959
    with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
    using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
    and also multiplied by the shear_factor according to 15.7.1.4, with
    Shear_factor = 1.00
    lo/lou,min = lb/ld = 0.31638566
    suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
    From table 5A.1, TBDY: esuv_nominal = 0.08066667,
    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 = 290.1959
    with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
---->
v < vs,y2 - LHS eq.(4.5) is satisfied
---->

```

su (4.9) = 0.20717489
Mu = MRc (4.14) = 1.7738E+008
u = su (4.1) = 3.5153739E-005

Calculation of ratio lb/l_d

Lap Length: lb/l_d = 0.31638566

lb = 300.00

l_d = 948.2098

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

= 1

db = 16.85714

Mean strength value of all re-bars: fy = 500.00

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

K_{tr} = 2.24399

n = 28.00

Calculation of Mu₂₊

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

u = 3.4223799E-005

Mu = 1.4516E+008

with full section properties:

b = 3000.00

d = 208.00

d' = 42.00

v = 0.00275581

N = 27514.027

f_c = 16.00

co (5A.5, TBDY) = 0.002

Final value of cu: cu* = shear_factor * Max(cu, cc) = 0.0035

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

From (5.4b), TBDY: cu = 0.0035

we ((5.4c), TBDY) = ase* sh,min*fywe/fce+Min(fx, fy) = 0.00

where f = af*pf*ffe/fce is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

fx = 0.00

af = 0.00

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.008128

bw = 250.00

effective stress from (A.35), ff,e = 636.1644

fy = 0.00

af = 0.00

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), pf = 2tf/bw = 0.00067733

bw = 3000.00

effective stress from (A.35), ff,e = 944.3987

R = 40.00

Effective FRP thickness, tf = NL*t*cos(b1) = 1.016

fu,f = 1055.00

Ef = 64828.00

u,f = 0.015

ase ((5.4d), TBDY) = (ase1*Acol1+ase2*Acol2+ase3*Aweb)/Asec = 0.00


```

ase1 = 0.00
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00

```

```

ase2 = 0.00
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

```

```

ase3 = 0 (grid does not provide confinement)

```

```

psh,min = Min(psh,x , psh,y) = 0.00069813

```

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

```

-----
psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
h1 = 600.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
h2 = 600.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
h3 = 1800.00
As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

```

```

-----
psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

```

```

-----
Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00

```

```

fywe = 500.00

```

```

fce = 16.00

```

```

From ((5.A5), TBDY), TBDY: cc = 0.00204062

```

```

c = confinement factor = 1.00406

```

```

y1 = 0.00120915

```

```

sh1 = 0.00467215

```

```

ft1 = 348.235

```

```

fy1 = 290.1959

```

```

su1 = 0.00579712

```

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

```

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

```

```

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

```

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 = 290.1959

```

```

with Es1 = Es = 200000.00

```

```

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.00
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.18563201
Mu = MRc (4.14) = 1.4516E+008
u = su (4.1) = 3.4223799E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80

```

e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

Calculation of Mu2-

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

$\phi_u = 3.5153739E-005$
 $M_u = 1.7738E+008$

with full section properties:

b = 3000.00
d = 208.00
d' = 42.00
v = 0.00275581
N = 27514.027

f_c = 16.00
co (5A.5, TBDY) = 0.002

Final value of ϕ_{cu} : $\phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$

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

From (5.4b), TBDY: $\phi_{cu} = 0.0035$

ϕ_{we} ((5.4c), TBDY) = $\text{ase} * \text{sh}_{\min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$

where $\phi_f = \text{af} * \text{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\phi_{fx} = 0.00$
 $\text{af} = 0.00$
b = 250.00
h = 3000.00
From EC8 A.4.4.3(6), $\text{pf} = 2\text{tf}/\text{bw} = 0.008128$
bw = 250.00
effective stress from (A.35), $f_{fe} = 636.1644$

$\phi_{fy} = 0.00$
 $\text{af} = 0.00$
b = 3000.00
h = 250.00
From EC8 A.4.4.3(6), $\text{pf} = 2\text{tf}/\text{bw} = 0.00067733$
bw = 3000.00
effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00
Effective FRP thickness, $\text{tf} = \text{NL} * t * \text{Cos}(\theta_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{f,f} = 0.015$
 ase ((5.4d), TBDY) = $(\text{ase}_1 * A_{col1} + \text{ase}_2 * A_{col2} + \text{ase}_3 * A_{web}) / A_{sec} = 0.00$
 $\text{ase}_1 = 0.00$
sh_1 = 150.00
bo_1 = 190.00
ho_1 = 540.00
bi2_1 = 655400.00
 $\text{ase}_2 = 0.00$
sh_2 = 150.00
bo_2 = 190.00
ho_2 = 540.00
bi2_2 = 655400.00

$\text{ase}_3 = 0$ (grid does not provide confinement)
 $\text{psh}_{\min} = \text{Min}(\text{psh}_x, \text{psh}_y) = 0.00069813$

Expression ((5.4d), TBDY) for psh_{\min} has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$\text{psh}_x = \text{ps}_{1,x} + \text{ps}_{2,x} + \text{ps}_{3,x} = 0.00356047$

$ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$fywe = 500.00$
 $fce = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$

$y1 = 0.00120915$
 $sh1 = 0.00467215$

$ft1 = 348.235$

$fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lo_{min} = lb/ld = 0.31638566$

$su1 = 0.4 \cdot esu1_{nominal} ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_{nominal} = 0.08066667$,

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 $fs1 = fs = 290.1959$

with $Es1 = Es = 200000.00$

$y2 = 0.00120915$

$sh2 = 0.00467215$

$ft2 = 348.235$

$fy2 = 290.1959$

$su2 = 0.00579712$

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

$lo/lo_{min} = lb/lb_{min} = 0.31638566$

$su2 = 0.4 \cdot esu2_{nominal} ((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu2_{nominal} = 0.08066667$,

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 $fs2 = fs = 290.1959$

with $Es2 = Es = 200000.00$

```

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659
2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659
v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.20717489
Mu = MRc (4.14) = 1.7738E+008
u = su (4.1) = 3.5153739E-005

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Shear Strength $V_r = \text{Min}(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$
From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$M_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$

$A_v = 0.00$

$s = 200.00$

$f_y = 400.00$

V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$2(1-s/d) = 0.00$

V_f ((11-3)-(11.4), ACI 440) = 109599.773

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\quad)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $a = 45^\circ$ and $a = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $1 = b_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{oDir} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f'_c^{0.5} \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$M_u/V_u - l_w/2 = 0.00 \leq 0$

= 1 (normal-weight concrete)

$f'_c = 16.00$, but $f'_c^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$M_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

Vs1 = 41887.902 is calculated for pseudo-Column 1, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

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

Vs2 = 41887.902 is calculated for pseudo-Column 2, with:

$$d = 200.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

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

Vs3 = 0.00 is calculated for web, with:

$$d = 200.00$$

$$A_v = 0.00$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)

$$2(1-s/d) = 0.00$$

$$V_f((11-3)-(11.4), \text{ACI 440}) = 109599.773$$

$$f = 0.95, \text{ for fully-wrapped sections}$$

$$w_f/s_f = 1 \text{ (FRP strips adjacent to one another).}$$

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a) \sin a$ which is more a generalised expression,

where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

$$\text{orientation 1: } \theta = b_1 + 90^\circ = 90.00$$

$$V_f = \text{Min}(|V_f(45, \theta)|, |V_f(-45, a_1)|), \text{ with:}$$

$$\text{total thickness per orientation, } t_{f1} = N_L \cdot t / N_{oDir} = 1.016$$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 208.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943E+006$$

$$b_w = 3000.00$$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Section Type: rcrws

Constant Properties

$$\text{Knowledge Factor, } \phi = 0.85$$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$$\rho_n = 0.00069813$$

with $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 3

$$(\text{pseudo-col.1 } \rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$$

$$h_1 = 250.00$$

$$s_1 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s1} = 157.0796$$

$$(\text{pseudo-col.2 } \rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$$

$$h_2 = 250.00$$

$$s_2 = 150.00$$

$$\text{total area of hoops perpendicular to shear axis, } A_{s2} = 157.0796$$

(grid $ps3 = As3 \cdot b3 / s3 = (As3 \cdot h3 / s3) / Ac = 0.00$
 $h3 = 250.00$
 $s3 = 200.00$
total area of hoops perpendicular to shear axis, $As3 = 0.00$
total section area, $Ac = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $fc = fc_lower_bound = 16.00$
Existing material of Secondary Member: Steel Strength, $fs = fs_lower_bound = 400.00$
Concrete Elasticity, $Ec = 21019.039$
Steel Elasticity, $Es = 200000.00$
Total Height, $H_{tot} = 3000.00$
Edges Width, $Wedg = 250.00$
Edges Height, $Hedg = 600.00$
Web Width, $Wweb = 250.00$
Cover Thickness, $c = 25.00$
Element Length, $L = 3000.00$
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length $lb = 300.00$
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, $t = 1.016$
Tensile Strength, $ffu = 1055.00$
Tensile Modulus, $Ef = 64828.00$
Elongation, $efu = 0.01$
Number of directions, $NoDir = 1$
Fiber orientations, $bi: 0.00^\circ$
Number of layers, $NL = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Axial Force, $F = -29388.501$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $Asl_t = 0.00$
-Compression: $Asl_c = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $Asl_{ten} = 2865.133$
-Compression: $Asl_{com} = 2865.133$
-Middle: $Asl_{mid} = 615.7522$
Mean Diameter of Tension Reinforcement, $DbL = 17.33333$

Considering wall controlled by Shear (shear control ratio > 1),
interstorey drift provided values are calculated
Existing component: From table 7-7, ASCE 41_17: Final interstorey drift Capacity $u_{R} = * u = 0.02$
from table 10-20: $u = 0.02352941$

with:

- Condition i (shear wall and wall segments)
- $(As - As') \cdot fy + P / (tw \cdot lw \cdot fc) = -0.20908486$
 $As = 0.00$
 $As' = 6346.017$
 $fy = 400.00$
 $P = 29388.501$
 $tw = 250.00$
 $lw = 3000.00$
 $fc = 16.00$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 2

Integration Section: (a)

Calculation No. 15

wall W1, 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: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Section Type: rcwvs

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $N_{oDir} = 1$

Fiber orientations, $b_i: 0.00^\circ$

Number of layers, $N_L = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

EDGE -A-

Bending Moment, $M_a = 8.5315E+007$

Shear Force, $V_a = -28549.607$

EDGE -B-

Bending Moment, $M_b = 348518.893$

Shear Force, $V_b = 28549.607$

BOTH EDGES

Axial Force, $F = -29388.501$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $A_{slt} = 0.00$

-Compression: $A_{slc} = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $A_{sl,ten} = 2865.133$

-Compression: $A_{sl,com} = 2865.133$

-Middle: $A_{sl,mid} = 615.7522$

Mean Diameter of Tension Reinforcement, $Db_{L,ten} = 17.33333$

Existing component: From table 7-7, ASCE 41_17: Final Shear Capacity $V_R = V_n = 1.6932E+006$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d = 1.9920E+006$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653877.70$

$\mu_u / \nu_u - l_w / 2 = -1487.793 \leq 0$

$= 1$ (normal-weight concrete)

$f_c' = 16.00$, but $f_c' \cdot 0.5 \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 250.00$

$d = 2400.00$

$l_w = 3000.00$

$M_u = 348518.893$

$V_u = 28549.607$

$N_u = 29388.501$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$d = 480.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$d = 480.00$

$A_v = 157079.633$

$$s = 150.00$$

$$f_y = 400.00$$

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

Vs3 = 452389.342 is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|), \text{ with:}$$

$$\text{total thickness per orientation, } t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 2957.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943\text{E}+006$$

$$b_w = 250.00$$

End Of Calculation of Shear Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Calculation No. 16

wall W1, Floor 1

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

Analysis: Uniform +X

Check: Chord rotation capacity (θ_u)

Edge: End

Local Axis: (3)



Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At Shear local axis: 3

(Bending local axis: 2)

Section Type: rcwrs

Constant Properties

Knowledge Factor, $\gamma = 0.85$

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

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{cm} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{sm} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

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

Existing material: Steel Strength, $f_s = 1.25 \cdot f_{sm} = 500.00$

#####

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Mean Confinement Factor overall section = 1.00406

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_o = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$

Tensile Strength, $f_{fu} = 1055.00$

Tensile Modulus, $E_f = 64828.00$

Elongation, $\epsilon_{fu} = 0.01$

Number of directions, $NoDir = 1$

Fiber orientations, $bi: 0.00^\circ$

Number of layers, $NL = 1$

Radius of rounding corners, $R = 40.00$

Stepwise Properties

At local axis: 3

EDGE -A-

Shear Force, $V_a = 6.3108872E-029$

EDGE -B-

Shear Force, $V_b = -6.3108872E-029$

BOTH EDGES

Axial Force, $F = -27514.027$

Longitudinal Reinforcement Area Distribution (in 2 divisions)

-Tension: $As_t = 0.00$

-Compression: $As_c = 6346.017$

Longitudinal Reinforcement Area Distribution (in 3 divisions)

-Tension: $As_{ten} = 2865.133$

-Compression: $As_{com} = 2865.133$

-Middle: $As_{mid} = 0.00$

(According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 1.01783$

Member Controlled by Shear ($V_e/V_r > 1$)

Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 2.0275E+006$ with

$M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 3.0413E+009$

$\mu_{u1+} = 2.8453E+009$, 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

$\mu_{u1-} = 3.0413E+009$, 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

$M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 3.0413E+009$

$\mu_{u2+} = 2.8453E+009$, 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

$\mu_{u2-} = 3.0413E+009$, 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

Calculation of μ_{u1+}

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

$\mu_u = 2.2735554E-006$

$\mu_u = 2.8453E+009$

with full section properties:

$b = 250.00$

$d = 2957.00$

$d' = 43.00$

$v = 0.00232618$

$N = 27514.027$

$f_c = 16.00$

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

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_u ((5.4c), TBDY) = $\alpha_{se} * \mu_{sh, \min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $\mu_{fx} = \alpha_f * \mu_{pf} * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$\mu_{af} = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$\mu_{af} = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $\mu_{pf} = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_f = 0.015$
 $ase((5.4d), TBDY) = (ase_1 \cdot A_{col1} + ase_2 \cdot A_{col2} + ase_3 \cdot A_{web}) / A_{sec} = 0.00$
 $ase_1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase_2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase_3 = 0$ (grid does not provide confinement)
 $psh,min = \min(psh,x, psh,y) = 0.00069813$

Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$

$f_{ywe} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$

$ft1 = 348.235$
 $fy1 = 290.1959$

$su1 = 0.00579712$

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

$lo/lo_{u,min} = lb/ld = 0.31638566$

```

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

and confined core properties:

```

b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.00

```

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

```

--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.13770595
Mu = MRc (4.14) = 2.8453E+009
u = su (4.1) = 2.2735554E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00

```

Id = 948.2098

Calculation of $I_{b,min}$ according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1

db = 16.85714

Mean strength value of all re-bars: $f_y = 500.00$

t = 1.00

s = 0.80

e = 1.00

cb = 25.00

Ktr = 2.24399

n = 28.00

Calculation of μ_1 -

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

$\mu = 2.2880917E-006$

$\mu_u = 3.0413E+009$

with full section properties:

b = 250.00

d = 2957.00

d' = 43.00

v = 0.00232618

N = 27514.027

$f_c = 16.00$

ϕ (5A.5, TBDY) = 0.002

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \mu_c) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

μ_{ue} ((5.4c), TBDY) = $a_{se} * \mu_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(\mu_{fx}, \mu_{fy}) = 0.00$

where $f = a_f * p_f * f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$\mu_{fx} = 0.00$

$a_f = 0.00$

b = 250.00

h = 3000.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

bw = 250.00

effective stress from (A.35), $f_{fe} = 636.1644$

$\mu_{fy} = 0.00$

$a_f = 0.00$

b = 3000.00

h = 250.00

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

bw = 3000.00

effective stress from (A.35), $f_{fe} = 944.3987$

R = 40.00

Effective FRP thickness, $t_f = NL * t * \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$\mu_{u,f} = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh,min = \text{Min}(psh,x, psh,y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh,x = ps1,x + ps2,x + ps3,x = 0.00356047$
 $ps1,x$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,x$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,x$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 \cdot ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh,y = ps1,y + ps2,y + ps3,y = 0.00069813$
 $ps1,y$ (column 1) = $(As1 \cdot h1 / s_1) / Ac = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 \cdot ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2,y$ (column 2) = $(As2 \cdot h2 / s_2) / Ac = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 \cdot ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3,y$ (web) = $(As3 \cdot h3 / s_3) / Ac = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 \cdot ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$Asec = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fywe = 500.00$
 $fce = 16.00$
 From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/l_d = 0.31638566$
 $su1 = 0.4 \cdot esu1_nominal$ ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
 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 $\text{Min}(1, 1.25 \cdot (lb/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $fs1 = fs = 290.1959$
 with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
 using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $\text{Shear_factor} = 1.00$
 $lo/lou,min = lb/l_b,min = 0.31638566$

```

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
lo/lou,min = lb/ld = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503
2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503
v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726
and confined core properties:
b = 190.00
d = 2927.00
d' = 13.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062
c = confinement factor = 1.00406
1 = Asl,ten/(b*d)*(fs1/fc) = 0.09344146
2 = Asl,com/(b*d)*(fs2/fc) = 0.09344146
v = Asl,mid/(b*d)*(fsv/fc) = 0.02008172
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
v < vs,y2 - LHS eq.(4.5) is satisfied
--->
su (4.9) = 0.14318411
Mu = MRc (4.14) = 3.0413E+009
u = su (4.1) = 2.2880917E-006

```

Calculation of ratio lb/ld

```

Lap Length: lb/ld = 0.31638566
lb = 300.00
ld = 948.2098
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
= 1
db = 16.85714
Mean strength value of all re-bars: fy = 500.00
t = 1.00
s = 0.80
e = 1.00
cb = 25.00
Ktr = 2.24399
n = 28.00

```

Calculation of Mu2+

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

$$\phi_u = 2.2735554E-006$$

$$M_u = 2.8453E+009$$

with full section properties:

$$b = 250.00$$

$$d = 2957.00$$

$$d' = 43.00$$

$$v = 0.00232618$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f' * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirups, ns3 = 2.00

 psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirups, ns3 = 0.00

 Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406

y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 * (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 * (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
 shv = 0.00467215
 ftv = 348.235
 fyv = 290.1959
 suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

$suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
 From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
 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 $fsv = fs = 290.1959$
 with $Esv = Es = 200000.00$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.07029503$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.07029503$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

and confined core properties:

$b = 190.00$
 $d = 2927.00$
 $d' = 13.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten / (b * d) * (fs1 / fc) = 0.09344146$
 $2 = Asl,com / (b * d) * (fs2 / fc) = 0.09344146$
 $v = Asl,mid / (b * d) * (fsv / fc) = 0.00$

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

--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
 --->
 $su (4.9) = 0.13770595$
 $Mu = MRc (4.14) = 2.8453E+009$
 $u = su (4.1) = 2.2735554E-006$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
 Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2$ -

Calculation of ultimate curvature u according to 4.1, Biskinis/Fardis 2013:
 $u = 2.2880917E-006$
 $Mu = 3.0413E+009$

with full section properties:

$b = 250.00$
 $d = 2957.00$
 $d' = 43.00$
 $v = 0.00232618$
 $N = 27514.027$
 $fc = 16.00$
 $co (5A.5, TBDY) = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} * \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)

From (5.4b), TBDY: $c_u = 0.0035$

w_e ((5.4c), TBDY) = $a_{se} \cdot \min(f_{ywe}/f_{ce} + \min(f_x, f_y)) = 0.00$

where $f = a_f \cdot p_f \cdot f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$a_f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.008128$

$bw = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$a_f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A4.4.3(6), $p_f = 2t_f/bw = 0.00067733$

$bw = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$

Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$

$f_{u,f} = 1055.00$

$E_f = 64828.00$

$u_f = 0.015$

a_{se} ((5.4d), TBDY) = $(a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web})/A_{sec} = 0.00$

$a_{se1} = 0.00$

$sh_1 = 150.00$

$bo_1 = 190.00$

$ho_1 = 540.00$

$bi2_1 = 655400.00$

$a_{se2} = 0.00$

$sh_2 = 150.00$

$bo_2 = 190.00$

$ho_2 = 540.00$

$bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)

$p_{sh,min} = \min(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$

$p_{s1,x}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00083776$

$h_1 = 600.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,x}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00083776$

$h_2 = 600.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,x}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00188496$

$h_3 = 1800.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$

No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$

$p_{s1,y}$ (column 1) = $(A_{s1} \cdot h_1/s_1)/A_c = 0.00034907$

$h_1 = 250.00$

$A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$

No stirrups, $n_{s1} = 2.00$

$p_{s2,y}$ (column 2) = $(A_{s2} \cdot h_2/s_2)/A_c = 0.00034907$

$h_2 = 250.00$

$A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$

No stirrups, $n_{s2} = 2.00$

$p_{s3,y}$ (web) = $(A_{s3} \cdot h_3/s_3)/A_c = 0.00$

$h_3 = 250.00$

$A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$

No stirrups, ns3 = 0.00

Asec = 750000.00

s_1 = 150.00

s_2 = 150.00

s_3 = 200.00

fywe = 500.00

fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062

c = confinement factor = 1.00406

y1 = 0.00120915

sh1 = 0.00467215

ft1 = 348.235

fy1 = 290.1959

su1 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs1 = fs = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915

sh2 = 0.00467215

ft2 = 348.235

fy2 = 290.1959

su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fs2 = fs = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915

shv = 0.00467215

ftv = 348.235

fyv = 290.1959

suv = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esuv_nominal = 0.08066667,

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 $\text{Min}(1, 1.25 \cdot (lb/lb)^{2/3})$, from 10.3.5, ASCE 41-17.

with fsv = fs = 290.1959

with Esv = Es = 200000.00

1 = Asl,ten/(b*d)*(fs1/fc) = 0.07029503

2 = Asl,com/(b*d)*(fs2/fc) = 0.07029503

v = Asl,mid/(b*d)*(fsv/fc) = 0.01510726

and confined core properties:

b = 190.00

d = 2927.00

d' = 13.00

fcc (5A.2, TBDY) = 16.06499

$cc(5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.09344146$
 $2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.09344146$
 $v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.02008172$
 Case/Assumption: Unconfined full section - Steel rupture
 ' satisfies Eq. (4.3)
 --->
 $v < v_{s,y2}$ - LHS eq.(4.5) is satisfied
 --->
 $su(4.9) = 0.14318411$
 $Mu = MRc(4.14) = 3.0413E+009$
 $u = su(4.1) = 2.2880917E-006$

Calculation of ratio l_b/l_d

Lap Length: $l_b/l_d = 0.31638566$
 $l_b = 300.00$
 $l_d = 948.2098$
 Calculation of l_b, \min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 1.9920E+006$

Calculation of Shear Strength at edge 1, $V_{r1} = 1.9920E+006$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f_c'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $Mu/V_u - l_w/2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 250.00$
 $d = 2400.00$
 $l_w = 3000.00$
 $Mu = 2.8012401E-010$
 $V_u = 6.3108872E-029$
 $Nu = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$
 $V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:
 $d = 480.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)
 $V_{s3} = 452389.342$ is calculated for web, with:
 $d = 1440.00$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

$$d_{fv} = d \text{ (figure 11.2, ACI 440)} = 2957.00$$

$$f_{fe}((11-5), \text{ACI 440}) = 259.312$$

$$E_f = 64828.00$$

$$f_e = 0.004, \text{ from (11.6a), ACI 440}$$

$$\text{with } f_u = 0.01$$

$$\text{From (11-11), ACI 440: } V_s + V_f \leq 1.5943\text{E}+006$$

$$b_w = 250.00$$

Calculation of Shear Strength at edge 2, $V_{r2} = 1.9920\text{E}+006$

$$\text{From (22.5.1.1) and 11.5.4.3, ACI 318-14: } V_{r2} = V_n < 0.83 * f_c'^{0.5} * h * d$$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$$\mu_u / \mu_u - l_w / 2 = 0.00 \leq 0$$

$= 1$ (normal-weight concrete)

$$f_c' = 16.00, \text{ but } f_c'^{0.5} \leq 8.3 \text{ MPa (22.5.3.1, ACI 318-14)}$$

$$h = 250.00$$

$$d = 2400.00$$

$$l_w = 3000.00$$

$$\mu_u = 2.8012401\text{E}-010$$

$$V_u = 6.3108872\text{E}-029$$

$$N_u = 27514.027$$

$$\text{From (11.5.4.8), ACI 318-14: } V_s = V_{s1} + V_{s2} + V_{s3} = 854513.202$$

$V_{s1} = 201061.93$ is calculated for pseudo-Column 1, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s2} = 201061.93$ is calculated for pseudo-Column 2, with:

$$d = 480.00$$

$$A_v = 157079.633$$

$$s = 150.00$$

$$f_y = 400.00$$

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

$V_{s3} = 452389.342$ is calculated for web, with:

$$d = 1440.00$$

$$A_v = 157079.633$$

$$s = 200.00$$

$$f_y = 400.00$$

Vs3 has been multiplied by 1 ($s < d/2$, according to ASCE 41-17,10.3.4)

$$V_f((11-3)-(11.4), \text{ACI 440}) = 1.5581\text{E}+006$$

$f = 0.95$, for fully-wrapped sections

$w_f/s_f = 1$ (FRP strips adjacent to one another).

In (11.3) $\sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression, where a is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation a_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta = b1 + 90^\circ = 90.00$

$$V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a1)|), \text{ with:}$$

total thickness per orientation, $t_{f1} = N_L * t / N_{oDir} = 1.016$

```

dfv = d (figure 11.2, ACI 440) = 2957.00
ffe ((11-5), ACI 440) = 259.312
Ef = 64828.00
fe = 0.004, from (11.6a), ACI 440
with fu = 0.01
From (11-11), ACI 440: Vs + Vf <= 1.5943E+006
bw = 250.00
-----

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At local axis: 3

-----

Start Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1
At Shear local axis: 2
(Bending local axis: 3)
Section Type: rcrrws

Constant Properties
-----
Knowledge Factor, k = 0.85
Mean strength values are used for both shear and moment calculations.
Consequently:
Existing material of Secondary Member: Concrete Strength, fc = fcm = 16.00
Existing material of Secondary Member: Steel Strength, fs = fsm = 400.00
Concrete Elasticity, Ec = 21019.039
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
Existing material: Steel Strength, fs = 1.25*fsm = 500.00
#####
Total Height, Htot = 3000.00
Edges Width, Wedg = 250.00
Edges Height, Hedg = 600.00
Web Width, Wweb = 250.00
Cover Thickness, c = 25.00
Mean Confinement Factor overall section = 1.00406
Element Length, L = 3000.00
Secondary Member
Ribbed Bars
Ductile Steel
Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)
Longitudinal Bars With Ends Lapped Starting at the End Sections
Lap Length lo = 300.00
FRP Wrapping Data
Type: Carbon
Cured laminate properties (design values)
Thickness, t = 1.016
Tensile Strength, ffu = 1055.00
Tensile Modulus, Ef = 64828.00
Elongation, efu = 0.01
Number of directions, NoDir = 1
Fiber orientations, bi: 0.00°
Number of layers, NL = 1
Radius of rounding corners, R = 40.00
-----

Stepwise Properties
-----
At local axis: 2
EDGE -A-
Shear Force, Va = 0.00
EDGE -B-
Shear Force, Vb = 0.00
BOTH EDGES

```

Axial Force, $F = -27514.027$
 Longitudinal Reinforcement Area Distribution (in 2 divisions)
 -Tension: $As_t = 0.00$
 -Compression: $As_c = 6346.017$
 Longitudinal Reinforcement Area Distribution (in 3 divisions)
 -Tension: $As_{t,ten} = 2368.761$
 -Compression: $As_{c,com} = 2368.761$
 -Middle: $As_{mid} = 0.00$
 (According to 10.7.2.3 As_{mid} is setted equal to zero)

Calculation of Shear Capacity ratio, $V_e/V_r = 0.14054053$
 Member Controlled by Flexure ($V_e/V_r < 1$)
 Calculation of Shear Demand from fig. R18.6.5, ACI 318-14 $V_e = (M_{pr1} + M_{pr2})/l_n = 118250.575$
 with
 $M_{pr1} = \text{Max}(\mu_{u1+}, \mu_{u1-}) = 1.7738E+008$
 $\mu_{u1+} = 1.4516E+008$, 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
 $\mu_{u1-} = 1.7738E+008$, 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
 $M_{pr2} = \text{Max}(\mu_{u2+}, \mu_{u2-}) = 1.7738E+008$
 $\mu_{u2+} = 1.4516E+008$, 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
 $\mu_{u2-} = 1.7738E+008$, 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

Calculation of μ_{u1+}

Calculation of ultimate curvature μ_u according to 4.1, Biskinis/Fardis 2013:
 $\mu_u = 3.4223799E-005$
 $M_u = 1.4516E+008$

with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $\alpha (\text{5A.5, TBDY}) = 0.002$

Final value of μ_u : $\mu_u^* = \text{shear_factor} * \text{Max}(\mu_u, \alpha) = 0.0035$

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

From (5.4b), TBDY: $\mu_u = 0.0035$

we ((5.4c), TBDY) $= \alpha \epsilon_{sh,min} * f_{ywe}/f_{ce} + \text{Min}(f_x, f_y) = 0.00$

where $f = \alpha f_p f_{fe}/f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$

$\alpha f = 0.00$

$b = 250.00$

$h = 3000.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.008128$

$b_w = 250.00$

effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$

$\alpha f = 0.00$

$b = 3000.00$

$h = 250.00$

From EC8 A.4.4.3(6), $p_f = 2t_f/b_w = 0.00067733$

$b_w = 3000.00$

effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
 Effective FRP thickness, $t_f = N_L * t * \cos(b_1) = 1.016$
 $f_u, f = 1055.00$
 $E_f = 64828.00$
 $u, f = 0.015$
 $ase((5.4d), TBDY) = (ase1 * A_{col1} + ase2 * A_{col2} + ase3 * A_{web}) / A_{sec} = 0.00$
 $ase1 = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $ase2 = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$
 $ase3 = 0$ (grid does not provide confinement)
 $psh, min = \min(psh, x, psh, y) = 0.00069813$
 Expression ((5.4d), TBDY) for psh, min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$psh, x = ps1, x + ps2, x + ps3, x = 0.00356047$
 $ps1, x$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00083776$
 $h1 = 600.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, x$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00083776$
 $h2 = 600.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, x$ (web) = $(As3 * h3 / s_3) / A_c = 0.00188496$
 $h3 = 1800.00$
 $As3 = Astir3 * ns3 = 0.00$
 No stirrups, $ns3 = 2.00$

$psh, y = ps1, y + ps2, y + ps3, y = 0.00069813$
 $ps1, y$ (column 1) = $(As1 * h1 / s_1) / A_c = 0.00034907$
 $h1 = 250.00$
 $As1 = Astir1 * ns1 = 157.0796$
 No stirrups, $ns1 = 2.00$
 $ps2, y$ (column 2) = $(As2 * h2 / s_2) / A_c = 0.00034907$
 $h2 = 250.00$
 $As2 = Astir2 * ns2 = 157.0796$
 No stirrups, $ns2 = 2.00$
 $ps3, y$ (web) = $(As3 * h3 / s_3) / A_c = 0.00$
 $h3 = 250.00$
 $As3 = Astir3 * ns3 = 157.0796$
 No stirrups, $ns3 = 0.00$

$A_{sec} = 750000.00$
 $s_1 = 150.00$
 $s_2 = 150.00$
 $s_3 = 200.00$
 $fy_{we} = 500.00$
 $f_{ce} = 16.00$

From ((5.A5), TBDY), TBDY: $cc = 0.00204062$
 c = confinement factor = 1.00406

$y1 = 0.00120915$
 $sh1 = 0.00467215$
 $ft1 = 348.235$
 $fy1 = 290.1959$
 $su1 = 0.00579712$

using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
 and also multiplied by the shear_factor according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lo_{min} = lb/ld = 0.31638566$
 $su1 = 0.4 * esu1_{nominal}((5.5), TBDY) = 0.03226667$

From table 5A.1, TBDY: $esu1_nominal = 0.08066667$,
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 $fs1 = fs = 290.1959$
with $Es1 = Es = 200000.00$
 $y2 = 0.00120915$
 $sh2 = 0.00467215$
 $ft2 = 348.235$
 $fy2 = 290.1959$
 $su2 = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/lb, min = 0.31638566$
 $su2 = 0.4 \cdot esu2_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with $shear_factor$
and also multiplied by the $shear_factor$ according to 15.7.1.4, with
 $Shear_factor = 1.00$
 $lo/lou, min = lb/ld = 0.31638566$
 $suv = 0.4 \cdot esuv_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Esv = Es = 200000.00$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.06885062$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.06885062$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl, ten / (b \cdot d) \cdot (fs1 / fc) = 0.08209659$
 $2 = Asl, com / (b \cdot d) \cdot (fs2 / fc) = 0.08209659$
 $v = Asl, mid / (b \cdot d) \cdot (fsv / fc) = 0.00$
Case/Assumption: Unconfined full section - Steel rupture
'satisfies Eq. (4.3)
--->
 $v < vs, y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.18563201$
 $Mu = MRc (4.14) = 1.4516E+008$
 $u = su (4.1) = 3.4223799E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$

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

$$= 1$$

$$d_b = 16.85714$$

Mean strength value of all re-bars: $f_y = 500.00$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

Calculation of μ_1 -

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

$$\mu = 3.5153739E-005$$

$$\mu = 1.7738E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \mu: \mu^* = \text{shear_factor} * \text{Max}(\mu, \alpha) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \mu = 0.0035$$

$$\mu_e ((5.4c), TBDY) = \alpha \mu_{sh,min} * f_{ywe} / f_{ce} + \text{Min}(\mu_x, \mu_y) = 0.00$$

where $\mu = \alpha * \mu_{pf} * f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\mu_x = 0.00$$

$$\alpha_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$f_y = 0.00$$

$$\alpha_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A4.4.3(6), } \mu_{pf} = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(\beta_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$\mu_{u,f} = 0.015$$

$$\alpha_{se} ((5.4d), TBDY) = (\alpha_{se1} * A_{col1} + \alpha_{se2} * A_{col2} + \alpha_{se3} * A_{web}) / A_{sec} = 0.00$$

$$\alpha_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$\alpha_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

ase3 = 0 (grid does not provide confinement)
 psh,min = Min(psh,x , psh,y) = 0.00069813
 Expression ((5.4d), TBDY) for psh,min has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

psh,x = ps1,x+ps2,x+ps3,x = 0.00356047
 ps1,x (column 1) = (As1*h1/s_1)/Ac = 0.00083776
 h1 = 600.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,x (column 2) = (As2*h2/s_2)/Ac = 0.00083776
 h2 = 600.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,x (web) = (As3*h3/s_3)/Ac = 0.00188496
 h3 = 1800.00
 As3 = Astir3*ns3 = 0.00
 No stirrups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
 ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
 h1 = 250.00
 As1 = Astir1*ns1 = 157.0796
 No stirrups, ns1 = 2.00
 ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
 h2 = 250.00
 As2 = Astir2*ns2 = 157.0796
 No stirrups, ns2 = 2.00
 ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
 h3 = 250.00
 As3 = Astir3*ns3 = 157.0796
 No stirrups, ns3 = 0.00

Asec = 750000.00
 s_1 = 150.00
 s_2 = 150.00
 s_3 = 200.00
 fywe = 500.00
 fce = 16.00
 From ((5.A5), TBDY), TBDY: cc = 0.00204062
 c = confinement factor = 1.00406
 y1 = 0.00120915
 sh1 = 0.00467215
 ft1 = 348.235
 fy1 = 290.1959
 su1 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
 From table 5A.1, TBDY: esu1_nominal = 0.08066667,
 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 = 290.1959
 with Es1 = Es = 200000.00
 y2 = 0.00120915
 sh2 = 0.00467215
 ft2 = 348.235
 fy2 = 290.1959
 su2 = 0.00579712
 using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
 su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $esu2_nominal = 0.08066667$,
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 $fs2 = fs = 290.1959$
with $Es2 = Es = 200000.00$
 $yv = 0.00120915$
 $shv = 0.00467215$
 $ftv = 348.235$
 $fyv = 290.1959$
 $suv = 0.00579712$
using (30) in Biskinis/Fardis (2013) multiplied with shear_factor
and also multiplied by the shear_factor according to 15.7.1.4, with
Shear_factor = 1.00
 $lo/lo_{u,min} = lb/ld = 0.31638566$
 $suv = 0.4 * esuv_nominal ((5.5), TBDY) = 0.03226667$
From table 5A.1, TBDY: $esuv_nominal = 0.08066667$,
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 $fsv = fs = 290.1959$
with $Es v = Es = 200000.00$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268$
and confined core properties:
 $b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $fcc (5A.2, TBDY) = 16.06499$
 $cc (5A.5, TBDY) = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = Asl,ten/(b*d)*(fs1/fc) = 0.08209659$
 $2 = Asl,com/(b*d)*(fs2/fc) = 0.08209659$
 $v = Asl,mid/(b*d)*(fsv/fc) = 0.05574729$
Case/Assumption: Unconfined full section - Steel rupture
' satisfies Eq. (4.3)
--->
 $v < vs,y2$ - LHS eq.(4.5) is satisfied
--->
 $su (4.9) = 0.20717489$
 $Mu = MRc (4.14) = 1.7738E+008$
 $u = su (4.1) = 3.5153739E-005$

Calculation of ratio lb/ld

Lap Length: $lb/ld = 0.31638566$
 $lb = 300.00$
 $ld = 948.2098$
Calculation of lb,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$
 $db = 16.85714$
Mean strength value of all re-bars: $fy = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $Ktr = 2.24399$
 $n = 28.00$

Calculation of $Mu2+$

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

$$\phi_u = 3.4223799E-005$$

$$M_u = 1.4516E+008$$

with full section properties:

$$b = 3000.00$$

$$d = 208.00$$

$$d' = 42.00$$

$$v = 0.00275581$$

$$N = 27514.027$$

$$f_c = 16.00$$

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

$$\text{Final value of } \phi_{cu}: \phi_{cu}^* = \text{shear_factor} * \text{Max}(\phi_{cu}, \phi_{cc}) = 0.0035$$

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

$$\text{From (5.4b), TBDY: } \phi_{cu} = 0.0035$$

$$\phi_{we} ((5.4c), TBDY) = a_{se} * \phi_{sh, \min} * f_{ywe} / f_{ce} + \text{Min}(\phi_{fx}, \phi_{fy}) = 0.00$$

where $\phi_f = a_f * \phi_f^* f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$$\phi_{fx} = 0.00$$

$$a_f = 0.00$$

$$b = 250.00$$

$$h = 3000.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.008128$$

$$bw = 250.00$$

$$\text{effective stress from (A.35), } f_{fe} = 636.1644$$

$$\phi_{fy} = 0.00$$

$$a_f = 0.00$$

$$b = 3000.00$$

$$h = 250.00$$

$$\text{From EC8 A.4.4.3(6), } \phi_f = 2t_f/bw = 0.00067733$$

$$bw = 3000.00$$

$$\text{effective stress from (A.35), } f_{fe} = 944.3987$$

$$R = 40.00$$

$$\text{Effective FRP thickness, } t_f = NL * t * \cos(b_1) = 1.016$$

$$f_{u,f} = 1055.00$$

$$E_f = 64828.00$$

$$u_{f,f} = 0.015$$

$$a_{se} ((5.4d), TBDY) = (a_{se1} * A_{col1} + a_{se2} * A_{col2} + a_{se3} * A_{web}) / A_{sec} = 0.00$$

$$a_{se1} = 0.00$$

$$sh_1 = 150.00$$

$$bo_1 = 190.00$$

$$ho_1 = 540.00$$

$$bi2_1 = 655400.00$$

$$a_{se2} = 0.00$$

$$sh_2 = 150.00$$

$$bo_2 = 190.00$$

$$ho_2 = 540.00$$

$$bi2_2 = 655400.00$$

$$a_{se3} = 0 \text{ (grid does not provide confinement)}$$

$$\phi_{sh, \min} = \text{Min}(\phi_{sh,x}, \phi_{sh,y}) = 0.00069813$$

Expression ((5.4d), TBDY) for $\phi_{sh, \min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$$\phi_{sh,x} = \phi_{s1,x} + \phi_{s2,x} + \phi_{s3,x} = 0.00356047$$

$$\phi_{s1,x} \text{ (column 1)} = (A_{s1} * h_1 / s_1) / A_c = 0.00083776$$

$$h_1 = 600.00$$

$$A_{s1} = A_{stir1} * n_{s1} = 157.0796$$

$$\text{No stirrups, } n_{s1} = 2.00$$

$$\phi_{s2,x} \text{ (column 2)} = (A_{s2} * h_2 / s_2) / A_c = 0.00083776$$

$$h_2 = 600.00$$

$$A_{s2} = A_{stir2} * n_{s2} = 157.0796$$

$$\text{No stirrups, } n_{s2} = 2.00$$

$$\phi_{s3,x} \text{ (web)} = (A_{s3} * h_3 / s_3) / A_c = 0.00188496$$

$$h_3 = 1800.00$$

As3 = Astir3*ns3 = 0.00
No stirups, ns3 = 2.00

psh,y = ps1,y+ps2,y+ps3,y = 0.00069813
ps1,y (column 1) = (As1*h1/s_1)/Ac = 0.00034907
h1 = 250.00
As1 = Astir1*ns1 = 157.0796
No stirups, ns1 = 2.00
ps2,y (column 2) = (As2*h2/s_2)/Ac = 0.00034907
h2 = 250.00
As2 = Astir2*ns2 = 157.0796
No stirups, ns2 = 2.00
ps3,y (web) = (As3*h3/s_3)/Ac = 0.00
h3 = 250.00
As3 = Astir3*ns3 = 157.0796
No stirups, ns3 = 0.00

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00

From ((5.A5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406

y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu1_nominal = 0.08066667,

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 = 290.1959

with Es1 = Es = 200000.00

y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712

using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566

su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: esu2_nominal = 0.08066667,

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 = 290.1959

with Es2 = Es = 200000.00

yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712

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

lo/lou,min = lb/ld = 0.31638566

suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667

From table 5A.1, TBDY: $e_{suv_nominal} = 0.08066667$,
 considering characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY
 For calculation of $e_{suv_nominal}$ and y_v , sh_v , ft_v , f_{yv} , it is considered
 characteristic value $f_{syv} = f_{sv}/1.2$, from table 5.1, TBDY.
 y_1 , sh_1 , ft_1 , f_{y1} , are also multiplied by $\text{Min}(1, 1.25 \cdot (l_b/l_d)^{2/3})$, from 10.3.5, ASCE 41-17.
 with $f_{sv} = f_s = 290.1959$
 with $E_{sv} = E_s = 200000.00$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.06885062$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.06885062$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

and confined core properties:

$b = 2940.00$
 $d = 178.00$
 $d' = 12.00$
 $f_{cc} \text{ (5A.2, TBDY)} = 16.06499$
 $cc \text{ (5A.5, TBDY)} = 0.00204062$
 $c = \text{confinement factor} = 1.00406$
 $1 = A_{sl,ten}/(b \cdot d) \cdot (f_{s1}/f_c) = 0.08209659$
 $2 = A_{sl,com}/(b \cdot d) \cdot (f_{s2}/f_c) = 0.08209659$
 $v = A_{sl,mid}/(b \cdot d) \cdot (f_{sv}/f_c) = 0.00$

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

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

---->
 $su \text{ (4.9)} = 0.18563201$
 $Mu = MR_c \text{ (4.14)} = 1.4516E+008$
 $u = su \text{ (4.1)} = 3.4223799E-005$

 Calculation of ratio l_b/l_d

 Lap Length: $l_b/l_d = 0.31638566$

$l_b = 300.00$
 $l_d = 948.2098$

Calculation of l_b ,min according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$db = 16.85714$
 Mean strength value of all re-bars: $f_y = 500.00$
 $t = 1.00$
 $s = 0.80$
 $e = 1.00$
 $cb = 25.00$
 $K_{tr} = 2.24399$
 $n = 28.00$

 Calculation of Mu_2 -

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

$u = 3.5153739E-005$
 $Mu = 1.7738E+008$

 with full section properties:

$b = 3000.00$
 $d = 208.00$
 $d' = 42.00$
 $v = 0.00275581$
 $N = 27514.027$
 $f_c = 16.00$
 $co \text{ (5A.5, TBDY)} = 0.002$
 Final value of cu : $cu^* = \text{shear_factor} \cdot \text{Max}(cu, cc) = 0.0035$
 The Shear_factor is considered equal to 1 (pure moment strength)
 From (5.4b), TBDY: $cu = 0.0035$

$w_e ((5.4c), TBDY) = a_{se} \cdot \frac{sh_{min} \cdot f_{ywe}}{f_{ce}} + \text{Min}(f_x, f_y) = 0.00$
where $f = a_f \cdot p_f \cdot f_{fe} / f_{ce}$ is accounting for FRP contribution like EC8-part3 A.4.4.3(6)

$f_x = 0.00$
 $a_f = 0.00$
 $b = 250.00$
 $h = 3000.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.008128$
 $bw = 250.00$
effective stress from (A.35), $f_{fe} = 636.1644$

$f_y = 0.00$
 $a_f = 0.00$
 $b = 3000.00$
 $h = 250.00$
From EC8 A.4.4.3(6), $p_f = 2t_f/bw = 0.00067733$
 $bw = 3000.00$
effective stress from (A.35), $f_{fe} = 944.3987$

$R = 40.00$
Effective FRP thickness, $t_f = NL \cdot t \cdot \cos(b_1) = 1.016$
 $f_{u,f} = 1055.00$
 $E_f = 64828.00$
 $u_{,f} = 0.015$
 $a_{se} ((5.4d), TBDY) = (a_{se1} \cdot A_{col1} + a_{se2} \cdot A_{col2} + a_{se3} \cdot A_{web}) / A_{sec} = 0.00$
 $a_{se1} = 0.00$
 $sh_1 = 150.00$
 $bo_1 = 190.00$
 $ho_1 = 540.00$
 $bi2_1 = 655400.00$
 $a_{se2} = 0.00$
 $sh_2 = 150.00$
 $bo_2 = 190.00$
 $ho_2 = 540.00$
 $bi2_2 = 655400.00$

$a_{se3} = 0$ (grid does not provide confinement)
 $p_{sh,min} = \text{Min}(p_{sh,x}, p_{sh,y}) = 0.00069813$

Expression ((5.4d), TBDY) for $p_{sh,min}$ has been multiplied by 0.3 according to 15.7.1.3 for members without earthquake detailing (90° closed stirrups)

$p_{sh,x} = p_{s1,x} + p_{s2,x} + p_{s3,x} = 0.00356047$
 $p_{s1,x} \text{ (column 1)} = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00083776$
 $h_1 = 600.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,x} \text{ (column 2)} = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00083776$
 $h_2 = 600.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,x} \text{ (web)} = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00188496$
 $h_3 = 1800.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 0.00$
No stirrups, $n_{s3} = 2.00$

$p_{sh,y} = p_{s1,y} + p_{s2,y} + p_{s3,y} = 0.00069813$
 $p_{s1,y} \text{ (column 1)} = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$
 $h_1 = 250.00$
 $A_{s1} = A_{stir1} \cdot n_{s1} = 157.0796$
No stirrups, $n_{s1} = 2.00$
 $p_{s2,y} \text{ (column 2)} = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$
 $h_2 = 250.00$
 $A_{s2} = A_{stir2} \cdot n_{s2} = 157.0796$
No stirrups, $n_{s2} = 2.00$
 $p_{s3,y} \text{ (web)} = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$
 $h_3 = 250.00$
 $A_{s3} = A_{stir3} \cdot n_{s3} = 157.0796$
No stirrups, $n_{s3} = 0.00$

```

Asec = 750000.00
s_1 = 150.00
s_2 = 150.00
s_3 = 200.00
fywe = 500.00
fce = 16.00
From ((5.A.5), TBDY), TBDY: cc = 0.00204062
c = confinement factor = 1.00406
y1 = 0.00120915
sh1 = 0.00467215
ft1 = 348.235
fy1 = 290.1959
su1 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su1 = 0.4*esu1_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu1_nominal = 0.08066667,
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 = 290.1959
with Es1 = Es = 200000.00
y2 = 0.00120915
sh2 = 0.00467215
ft2 = 348.235
fy2 = 290.1959
su2 = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
su2 = 0.4*esu2_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esu2_nominal = 0.08066667,
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 = 290.1959
with Es2 = Es = 200000.00
yv = 0.00120915
shv = 0.00467215
ftv = 348.235
fyv = 290.1959
suv = 0.00579712
using (30) in Biskinis/Fardis (2013) multiplied with 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 = 0.31638566
suv = 0.4*esuv_nominal ((5.5), TBDY) = 0.03226667
From table 5A.1, TBDY: esuv_nominal = 0.08066667,
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 = 290.1959
with Esv = Es = 200000.00
1 = Asl,ten/(b*d)*(fs1/fc) = 0.06885062
2 = Asl,com/(b*d)*(fs2/fc) = 0.06885062
v = Asl,mid/(b*d)*(fsv/fc) = 0.04675268
and confined core properties:
b = 2940.00
d = 178.00
d' = 12.00
fcc (5A.2, TBDY) = 16.06499
cc (5A.5, TBDY) = 0.00204062

```

$c = \text{confinement factor} = 1.00406$

$1 = A_{sl,ten}/(b*d)*(f_{s1}/f_c) = 0.08209659$

$2 = A_{sl,com}/(b*d)*(f_{s2}/f_c) = 0.08209659$

$v = A_{sl,mid}/(b*d)*(f_{sv}/f_c) = 0.05574729$

Case/Assumption: Unconfined full section - Steel rupture

' satisfies Eq. (4.3)

--->

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

--->

$\mu_u(4.9) = 0.20717489$

$\mu_u = M_{Rc}(4.14) = 1.7738E+008$

$u = \mu_u(4.1) = 3.5153739E-005$

Calculation of ratio l_b/d

Lap Length: $l_b/d = 0.31638566$

$l_b = 300.00$

$l_d = 948.2098$

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

$= 1$

$d_b = 16.85714$

Mean strength value of all re-bars: $f_y = 500.00$

$t = 1.00$

$s = 0.80$

$e = 1.00$

$c_b = 25.00$

$K_{tr} = 2.24399$

$n = 28.00$

Calculation of Shear Strength $V_r = \min(V_{r1}, V_{r2}) = 841398.394$

Calculation of Shear Strength at edge 1, $V_{r1} = 841398.394$

From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r1} = V_n < 0.83*f_c'^{0.5}*h*d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$

$\mu_u/V_u - l_w/2 = 0.00 \leq 0$

$= 1$ (normal-weight concrete)

$f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)

$h = 3000.00$

$d = 200.00$

$l_w = 250.00$

$\mu_u = 1.9099438E-011$

$V_u = 0.00$

$N_u = 27514.027$

From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$

$V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:

$d = 200.00$

$A_v = 157079.633$

$s = 150.00$

$f_y = 400.00$

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

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

$V_{s3} = 0.00$ is calculated for web, with:

$d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).
 This later relation, considered as a function $V_f(\alpha)$, is implemented for every different fiber orientation α_i ,
 as well as for 2 crack directions, $\alpha = 45^\circ$ and $\alpha = -45^\circ$ to take into consideration the cyclic seismic loading.
 orientation 1: $\alpha_1 = b_1 + 90^\circ = 90.00$
 $V_f = \text{Min}(|V_f(45, 1)|, |V_f(-45, a_1)|)$, with:
 total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$
 $d_{fv} = d$ (figure 11.2, ACI 440) = 208.00
 $f_{fe} ((11-5), \text{ACI 440}) = 259.312$
 $E_f = 64828.00$
 $f_e = 0.004$, from (11.6a), ACI 440
 with $f_u = 0.01$
 From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$
 $b_w = 3000.00$

Calculation of Shear Strength at edge 2, $V_{r2} = 841398.394$
 From (22.5.1.1) and 11.5.4.3, ACI 318-14: $V_{r2} = V_n < 0.83 \cdot f_c' \cdot 0.5 \cdot h \cdot d$

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 (11.5.4.6(d-e)), ACI 318-14: $V_c = 653502.805$
 $\mu_u / V_u - l_w / 2 = 0.00 \leq 0$
 $= 1$ (normal-weight concrete)
 $f_c' = 16.00$, but $f_c'^{0.5} \leq 8.3$ MPa (22.5.3.1, ACI 318-14)
 $h = 3000.00$
 $d = 200.00$
 $l_w = 250.00$
 $\mu_u = 1.9099438E-011$
 $V_u = 0.00$
 $N_u = 27514.027$
 From (11.5.4.8), ACI 318-14: $V_s = V_{s1} + V_{s2} + V_{s3} = 83775.804$
 $V_{s1} = 41887.902$ is calculated for pseudo-Column 1, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s1} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s2} = 41887.902$ is calculated for pseudo-Column 2, with:
 $d = 200.00$
 $A_v = 157079.633$
 $s = 150.00$
 $f_y = 400.00$
 V_{s2} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.50$
 $V_{s3} = 0.00$ is calculated for web, with:
 $d = 200.00$
 $A_v = 0.00$
 $s = 200.00$
 $f_y = 400.00$
 V_{s3} has been multiplied by $2(1-s/d)$ ($s > d/2$, according to ASCE 41-17,10.3.4)
 $2(1-s/d) = 0.00$
 $V_f ((11-3)-(11.4), \text{ACI 440}) = 109599.773$
 $f = 0.95$, for fully-wrapped sections
 $w_f/s_f = 1$ (FRP strips adjacent to one another).
 $\ln(11.3) \sin + \cos$ is replaced with $(\cot + \cot a)\sin a$ which is more a generalised expression,
 where α is the angle of the crack direction (see KANEPE).

This later relation, considered as a function $V_f(\theta)$, is implemented for every different fiber orientation θ_i , as well as for 2 crack directions, $\theta = 45^\circ$ and $\theta = -45^\circ$ to take into consideration the cyclic seismic loading.

orientation 1: $\theta_1 = \theta_1 + 90^\circ = 90.00$

$V_f = \text{Min}(|V_f(45, \theta_1)|, |V_f(-45, \theta_1)|)$, with:

total thickness per orientation, $t_{f1} = N_L \cdot t / N_{\text{Dir}} = 1.016$

$d_{fv} = d$ (figure 11.2, ACI 440) = 208.00

f_{fe} ((11-5), ACI 440) = 259.312

$E_f = 64828.00$

$f_e = 0.004$, from (11.6a), ACI 440

with $f_u = 0.01$

From (11-11), ACI 440: $V_s + V_f \leq 1.5943E+006$

$b_w = 3000.00$

End Of Calculation of Shear Capacity ratio for element: wall W1 of floor 1

At local axis: 2

Start Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

Section Type: rcrrws

Constant Properties

Knowledge Factor, $\phi = 0.85$

According to 10.7.2.3, ASCE 41-17, shear walls with

transverse reinforcement percentage, $\rho_n < 0.0015$

are considered Force-Controlled and lower-bound strengths are used according to 7.5.1.3, ASCE 41-17

$\rho_n = 0.00069813$

with $\rho_n = \rho_{s1} + \rho_{s2} + \rho_{s3}$, being the shear reinf. ratio in a plane perpendicular to the shear axis 2

(pseudo-col.1 $\rho_{s1} = A_{s1} \cdot b_1 / s_1 = (A_{s1} \cdot h_1 / s_1) / A_c = 0.00034907$

$h_1 = 250.00$

$s_1 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s1} = 157.0796$

(pseudo-col.2 $\rho_{s2} = A_{s2} \cdot b_2 / s_2 = (A_{s2} \cdot h_2 / s_2) / A_c = 0.00034907$

$h_2 = 250.00$

$s_2 = 150.00$

total area of hoops perpendicular to shear axis, $A_{s2} = 157.0796$

(grid $\rho_{s3} = A_{s3} \cdot b_3 / s_3 = (A_{s3} \cdot h_3 / s_3) / A_c = 0.00$

$h_3 = 250.00$

$s_3 = 200.00$

total area of hoops perpendicular to shear axis, $A_{s3} = 0.00$

total section area, $A_c = 750000.00$

Consequently:

Existing material of Secondary Member: Concrete Strength, $f_c = f_{c_lower_bound} = 16.00$

Existing material of Secondary Member: Steel Strength, $f_s = f_{s_lower_bound} = 400.00$

Concrete Elasticity, $E_c = 21019.039$

Steel Elasticity, $E_s = 200000.00$

Total Height, $H_{tot} = 3000.00$

Edges Width, $W_{edg} = 250.00$

Edges Height, $H_{edg} = 600.00$

Web Width, $W_{web} = 250.00$

Cover Thickness, $c = 25.00$

Element Length, $L = 3000.00$

Secondary Member

Ribbed Bars

Ductile Steel

Without Detailing for Earthquake Resistance (including stirrups not closed at 135°)

Longitudinal Bars With Ends Lapped Starting at the End Sections

Lap Length $l_b = 300.00$

FRP Wrapping Data

Type: Carbon

Cured laminate properties (design values)

Thickness, $t = 1.016$
Tensile Strength, $f_{fu} = 1055.00$
Tensile Modulus, $E_f = 64828.00$
Elongation, $\epsilon_{fu} = 0.01$
Number of directions, $N_{oDir} = 1$
Fiber orientations, $b_i = 0.00^\circ$
Number of layers, $N_L = 1$
Radius of rounding corners, $R = 40.00$

Stepwise Properties

Bending Moment, $M = 6.1924294E-011$
Shear Force, $V_2 = 6.3856629E-015$
Shear Force, $V_3 = 28549.607$
Axial Force, $F = -29388.501$
Longitudinal Reinforcement Area Distribution (in 2 divisions)
-Tension: $A_{sl,t} = 0.00$
-Compression: $A_{sl,c} = 6346.017$
Longitudinal Reinforcement Area Distribution (in 3 divisions)
-Tension: $A_{sl,ten} = 2368.761$
-Compression: $A_{sl,com} = 2368.761$
-Middle: $A_{sl,mid} = 1608.495$
Mean Diameter of Tension Reinforcement, $D_{bL} = 17.20$

Existing component: From table 7-7, ASCE 41_17: Final chord rotation Capacity $u_{,R} = u = 0.01382101$
 $u = y + p = 0.01626001$

- Calculation of y -

$y = (M_y \cdot I_p) / (E I)_{Eff} = 0.00126001$ ((10-5), ASCE 41-17))
 $M_y = 1.5087E+008$
 $(E I)_{Eff} = 0.35 \cdot E_c \cdot I$ (table 10-5)
 $E_c \cdot I = 8.2106E+013$
 $I_p = 0.5 \cdot d = 0.5 \cdot (0.8 \cdot h) = 240.00$

Calculation of Yielding Moment M_y

Calculation of y and M_y according to Annex 7 -

$y = \min(y_{,ten}, y_{,com})$
 $y_{,ten} = 8.7651352E-006$
with ((10.1), ASCE 41-17) $f_y = \min(f_y, 1.25 \cdot f_y \cdot (I_b / I_d)^{2/3}) = 269.394$
 $d = 208.00$
 $y = 0.26118462$
 $A = 0.01034472$
 $B = 0.00628654$
with $p_t = 0.00379609$
 $p_c = 0.00379609$
 $p_v = 0.00257772$
 $N = 29388.501$
 $b = 3000.00$
 $" = 0.20192308$
 $y_{,comp} = 2.5444482E-005$
with $f_c^* (12.3, (ACI 440)) = 16.002$
 $f_c = 16.00$
 $f_l = 0.17503396$
 $b = 3000.00$
 $h = 250.00$
 $A_g = 750000.00$
From (12.9), ACI 440: $k_a = 0.00364754$

$$g = p_t + p_c + p_v = 0.0101699$$

$$r_c = 40.00$$

$$A_e/A_c = 0.52524587$$

$$\text{Effective FRP thickness, } t_f = N_L * t * \cos(b_1) = 1.016$$

$$\text{effective strain from (12.5) and (12.12), } \epsilon_{fe} = 0.004$$

$$f_u = 0.01$$

$$E_f = 64828.00$$

$$E_c = 21019.039$$

$$y = 0.2589268$$

$$A = 0.00999806$$

$$B = 0.00611172$$

$$\text{with } E_s = 200000.00$$

Calculation of ratio I_b/I_d

$$\text{Lap Length: } I_d/I_{d,\min} = 0.39548208$$

$$I_b = 300.00$$

$$I_d = 758.5679$$

Calculation of I according to (25.4.3.2), ACI 318-14, using mean values for all the section re-bars.
 $= 1$

$$d_b = 16.85714$$

$$\text{Mean strength value of all re-bars: } f_y = 400.00$$

$$t = 1.00$$

$$s = 0.80$$

$$e = 1.00$$

$$c_b = 25.00$$

$$K_{tr} = 2.24399$$

$$n = 28.00$$

- Calculation of p -

Considering wall controlled by flexure (shear control ratio ≤ 1),
 from table 10-19: $p = 0.015$

with:

- Condition i (shear wall and wall segments)

$$-(A_s - A_s') * f_y + P / (t_w * I_w * f_c') = -0.20908486$$

$$A_s = 0.00$$

$$A_s' = 6346.017$$

$$f_y = 400.00$$

$$P = 29388.501$$

$$t_w = 3000.00$$

$$I_w = 250.00$$

$$f_c = 16.00$$

$$-V / (t_w * I_w * f_c^{0.5}) = 2.5633503E-020, \text{ NOTE: units in lb \& in}$$

- Confined Boundary: No

Boundary hoops spacing exceed $8d_b$ ($s_1 > 8 * d_b$ or $s_2 > 8 * d_b$)

Boundary Trans. Reinf. does not exceed 50% of ACI 318 provision ($V_{w1} + V_{w2} > 0.50 * (V - V_c - V_{w3})$)

With

Boundary Element 1:

$$V_{w1} = 83775.804$$

$$s_1 = 150.00$$

Boundary Element 2:

$$V_{w2} = 83775.804$$

$$s_2 = 150.00$$

$$\text{Grid Shear Force, } V_{w3} = 0.00$$

$$\text{Concrete Shear Force, } V_c = 126390.829$$

(The variables above have already been given in Shear control ratio calculation)

$$\text{Mean diameter of all bars, } d_b = 17.33333$$

$$\text{Design Shear Force, } V = 6.3856629E-015$$

End Of Calculation of Chord Rotation Capacity for element: wall W1 of floor 1

At local axis: 3

Integration Section: (d)

