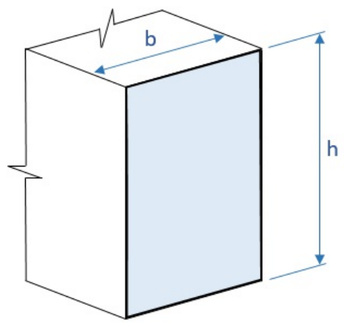
REFERENCES	CALCULATIONS	RESULTS
Code: ENV 1992-1-1 :1991	# MEMBER #1 (SECTION POSITION 8000.0 mm) COLUMN DESIGN REPORT ## Project details **Project Name:** **Project ID:** Company: Designer: Client: Project Notes: Project Units: Metric ## General member design information Dimentions:  Height $h = 550\ \text{mm}$ Width $b = 550\ \text{mm}$ Member length = $8000\ \text{mm}$ Material properties: Concrete strength $f_{ck} = 25\ \text{MPa}$ Steel strength of longitudinal rebar $f_{yk} = 500\ \text{MPa}$ Steel strength of shear rebar $f_{ywk} = 500\ \text{MPa}$ Limiting crack width $\omega_{max} = 0.3\ \text{mm}$ Design Factors and Settings: Partial safety factor for concrete $\gamma_c = 1.50$ Partial safety factor for rebar $\gamma_s = 1.15$ Long term and unfavorable effects for concrete $\alpha_{cc} = 0.85$ ## Load Combinations Ultimate Limit State: LC 1: 1.35DL (N = 2025.00 kN, Mz = -129.60 kN-m, My = -193.05 kN-m) LC 2: 1.35DL+1.5LL (N = 2025.00 kN, Mz = -129.60 kN-m, My = -193.05 kN-m) LC 3: 1.0DL+1.5WL (N = 1500.00 kN, Mz = -96.00 kN-m, My = -143.00 kN-m) LC 4: 1.35DL+1.5WL (N = 2025.00 kN, Mz = -129.60 kN-m, My = -193.05 kN-m) LC 5: 1.35DL+1.5LL+0.9WL (N = 2025.00 kN, Mz = -129.60 kN-m, My = -193.05 kN-m) LC 6: 1.35DL+1.05LL+1.5WL (N = 2025.00 kN, Mz = -129.60 kN-m, My = -193.05 kN-m) LC 7: 1.0DL+1.0EL (N = 1500.00 kN, Mz = -96.00 kN-m, My = -143.00 kN-m) LC 8: 1.0DL+0.3LL+1.0EL (N = 1500.00 kN, Mz = -96.00 kN-m, My = -143.00 kN-m) Serviceabiity Limit State: LC 1: 1.0DL (N = 1500.00 kN, Mz = -96.00 kN-m, My = -143.00 kN-m) LC 2: 1.0DL+1.0LL (N = 1500.00 kN, Mz = -96.00 kN-m, My = -143.00 kN-m) DL - Dead Load LL - Live Load WL - Wind Load LrL - Roof Live Load RL - Rain Load SL - Snow Load EL - Earthquake Load	
	Strength status of column section based on all load combinations	

LC #	Description	N (kN)	Mz (kN-m)	My (kN-m)	Ratio	Status
1	1.35DL	2025.00	-129.60	-193.05	0.921	OK
2	1.35DL+1.5LL	2025.00	-129.60	-193.05	0.921	OK
3	1.0DL+1.5WL	1500.00	-96.00	-143.00	0.690	OK
4	1.35DL+1.5WL	2025.00	-129.60	-193.05	0.921	OK
5	1.35DL+1.5LL+0.9WL	2025.00	-129.60	-193.05	0.921	OK
6	1.35DL+1.05LL+1.5WL	2025.00	-129.60	-193.05	0.921	OK
7	1.0DL+1.0EL	1500.00	-96.00	-143.00	0.690	OK
8	1.0DL+0.3LL+1.0EL	1500.00	-96.00	-143.00	0.690	OK

The below detailed report is based on the worst load combination: 1.35DL

Detailing of Members

9.5.2(2), 9.5.2(3)
9.2.1.1(1)

DETAILING RULES FOR COLUMN (LONGITUDINAL REINFORCEMENT)

Section input data:
Design strength of rebar $f_{yd} = f_{yk}/\gamma_s = 500/1.15 = 434.78\ \text{MPa}$
Mean width of tension zone $b_t = 550\ \text{mm}$
Section concrete area $A_c = 302500.00\ \text{mm}^2$
Longitudinal rebar area $A_{st} = 4908.70\ \text{mm}^2$
Given axial force $N_{ed} = 2025.00\ \text{kN}$

1. Calculation of maximum allowed longitudinal reinforcement (9.5.2(2), 9.5.2(3))

$$f_{ck} = 25\ \text{MPa} \leq 50\ \text{MPa}$$

$$f_{ctm} = 0.3 \cdot f_{ck}^{2/3} = 0.3 \cdot 25^{2/3} = 2.56\ \text{MPa}$$

$$A_{s,max} = 0.04 \cdot A_c = 0.04 \cdot 302500 = 12100\ \text{mm}^2$$

2. Calculation of minimum allowed longitudinal reinforcement (9.2.1.1(1))

$$A_{s,min1} = 0.1 \cdot \frac{N_{ed}}{f_{yd}} = 0.1 \cdot \frac{2025000.00}{434.78} = 465.75\ \text{mm}^2$$

$$A_{s,min2} = 0.002 \cdot A_c = 0.002 \cdot 302500.00 = 605.00\ \text{mm}^2$$

$$A_{s,min} = max\left[A_{s,min1}, A_{s,min2}\right] = 605.00\ \text{mm}^2$$

3. Check of allowed longitudinal reinforcement

$$A_{st} = 4908.70\ \text{mm}^2 \leq A_{s,max} = 12100.00\ \text{mm}^2$$

STATUS OK!

$$A_{st} = 4908.70\ \text{mm}^2 \geq A_{s,min} = 605.00\ \text{mm}^2$$

STATUS OK!

Slenderness of column braced against sidesway

Section input data:
Effective Length factor $K_z = 0.80$
Effective Length factor $K_y = 0.80$
Unsupported length of the column $l = 8000.00\ \text{mm}$
Section axial load based on current load combination $N_{ed} = 2025.00\ \text{kN}$
Section flexure about major axis based on current load combination $M_{edz} = -129.60\ \text{kN-m}$
Section flexure about minor axis based on current load combination $M_{edy} = -193.05\ \text{kN-m}$
Top column section moment about major axis $M_{edz,top} = 206.55\ \text{kN-m}$
Top column section moment about minor axis $M_{edy,top} = 96.53\ \text{kN-m}$
Bottom column section moment about major axis $M_{edz,bot} = -129.60\ \text{kN-m}$
Bottom column section moment about minor axis $M_{edy,bot} = -193.05\ \text{kN-m}$
Design compressive strength of concrete $f_{cd} = \alpha_{cc} \cdot f_{ck}/\gamma_c = 0.85 \cdot 25/1.5 = 14.17\ \text{MPa}$

Design strength of rebar $f_{yd} = f_{yk}/\gamma_s = 500/1.15 = 434.78$ MPa
Section concrete area $A_c = 302500.00$ mm^2
Longitudinal rebar area $A_{st} = 4908.70$ mm^2

Second-order moment about major axis Z

1. Check if the column is long

$$e_i = \frac{l}{400} = \frac{8000}{400} = 20.00 \text{ mm}$$

$$N_{ed} \cdot e_i = 2025.00 \cdot 20.00 \cdot 0.001 = 40.50 \text{ kN-m}$$

$$M_{01} = min\left\{|M_{top}|, |M_{bot}|\right\} + N_{ed} \cdot e_i = -129.60 + 40.50 = -89.10 \text{ kN-m}$$

$$M_{02} = max\left\{|M_{top}|, |M_{bot}|\right\} + N_{ed} \cdot e_i = 206.55 + 40.50 = 247.05 \text{ kN-m}$$

Radius of gyration $r_z = 0.3 \cdot h = 0.3 \cdot 550 = 165.00$ mm

$$\omega = (\frac{A_{st} \cdot f_{yd}}{A_c \cdot f_{cd}}) = (\frac{4908.70 \cdot 434.78}{302500.00 \cdot 14.17}) = 0.50$$

$$A = 0.7$$

$$B = \sqrt{1 + 2 \cdot \omega} = \sqrt{1 + 2 \cdot 0.50} = 1.41$$

$$C = 1.7 - \frac{M_{01}}{M_{02}} = 1.7 - \frac{-89.10}{247.05} = 2.06$$

$$n = \frac{N_{Ed}}{A_c \cdot f_{cd}} = \frac{2025.00 \cdot 1000}{302500.00 \cdot 14.17} = 0.47$$

$$\lambda_{lim} = \frac{20 \cdot A \cdot B \cdot C}{\sqrt{n}} = \frac{20 \cdot 0.70 \cdot 1.41 \cdot 2.06}{\sqrt{0.47}} = 59.29$$

$$\frac{K_y \cdot l}{r_z} = \frac{0.8 \cdot 8000}{165.00} = 38.79 \leq \lambda_{lim} = 59.29$$

Column is short. Second-order moment can be ignored.

$$0.6 \cdot M_{02} + 0.4 \cdot M_{01} = 0.6 \cdot 247.05 + 0.4 \cdot -89.10 = 112.59 \text{ kN-m} \geq 0.4 \cdot M_{02} = 0.4 \cdot 247.05 = 98.82 \text{ kN-m}$$

$$M_{0ed} = 112.59 \text{ kN-m}$$

$$M_{ed} = max\left\{M_{02}, M_{0ed} + M_2, M_{01} - 0.5 \cdot M_2\right\} =$$

$$= max\left\{247.05, 112.59, |-89.10|\right\} = 247.05 \text{ kN-m}$$

Second-order moment about minor axis Y

1. Check if the column is long

$$e_i = \frac{l}{400} = \frac{8000}{400} = 20.00 \text{ mm}$$

$$N_{ed} \cdot e_i = 2025.0000000000002 \cdot 20.00 \cdot 0.001 = 40.50 \text{ kN-m}$$

$$M_{01} = min\left\{|M_{top}|, |M_{bot}|\right\} + N_{ed} \cdot e_i = -96.53 + 40.50 = -56.02 \text{ kN-m}$$

$$M_{02} = max\left\{|M_{top}|, |M_{bot}|\right\} + N_{ed} \cdot e_i = 193.05 + 40.50 = 233.55 \text{ kN-m}$$

Radius of gyration $r_y = 0.3 \cdot h = 0.3 \cdot 550 = 165.00$ mm

$$\omega = (\frac{A_{st} \cdot f_{yd}}{A_c \cdot f_{cd}}) = (\frac{4908.70 \cdot 434.78}{302500.00 \cdot 14.17}) = 0.50$$

$$A = 0.7$$

$$B = \sqrt{1 + 2 \cdot \omega} = \sqrt{1 + 2 \cdot 0.50} = 1.41$$

$$C = 1.7 - \frac{M_{01}}{M_{02}} = 1.7 - \frac{-56.02}{233.55} = 1.94$$

$$n = \frac{N_{Ed}}{A_c \cdot f_{cd}} = \frac{2025.00 \cdot 1000}{302500.00 \cdot 14.17} = 0.47$$

$$\lambda_{lim} = \frac{20 \cdot A \cdot B \cdot C}{\sqrt{n}} = \frac{20 \cdot 0.70 \cdot 1.41 \cdot 1.94}{\sqrt{0.47}} = 55.82$$

$$\frac{K_z \cdot l}{r_y} = \frac{0.8 \cdot 8000}{165.00} = 38.79 \leq \lambda_{lim} = 55.82$$

Column is short. Second-order moment can be ignored.

$$0.6 \cdot M_{02} + 0.4 \cdot M_{01} = 0.6 \cdot 233.55 + 0.4 \cdot -56.02 = 117.72 \text{ kN-m} \geq 0.4 \cdot M_{02} = 0.4 \cdot 233.55 = 93.42 \text{ kN-m}$$

$$M_{0ed} = 117.72 \text{ kN-m}$$

$$M_{ed} = max\left\{M_{02}, M_{0ed} + M_2, M_{01} - 0.5 \cdot M_2\right\} =$$

$$= max\left\{233.55, 117.72, |-56.02|\right\} = 233.55 \text{ kN-m}$$

Column check

MAXIMUM AXIAL COMPRESSION

Section input data:
Design compressive strength of concrete $f_{cd} = \alpha_{cc} \cdot f_{ck} / \gamma_c = 0.85 \cdot 25 / 1.5 = 14.17$ MPa
Design strength of rebar $f_{yd} = f_{yk} / \gamma_s = 500 / 1.15 = 434.78$ MPa
Effective strength of concrete factor (3.1.7(3)) $\eta = 1.00$
Section concrete area $A_g = 302500.00$ mm^2
Longitudinal rebar area $A_{st} = 4908.70$ mm^2

Calculate the axial load capacity for concentric loading

$$N_{Rd} = \eta \cdot f_{cd} \cdot (A_g - A_{st}) + f_{yd} \cdot A_{st} = 1 \cdot 14.17 \cdot (302500.00 - 4908.70) + 434.78 \cdot 4908.70 = 6350.09 \text{ kN}$$

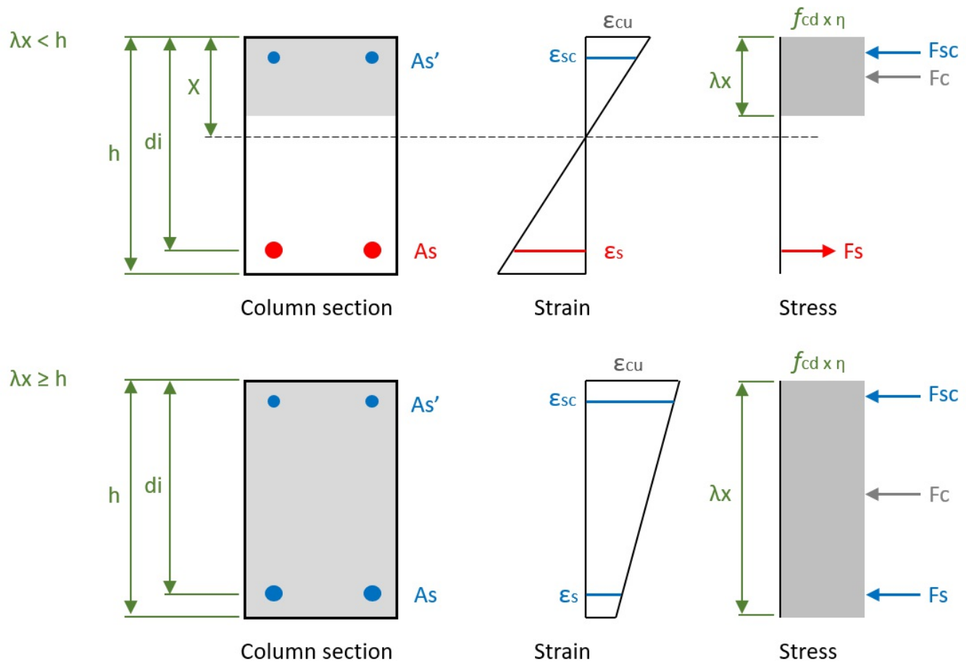
MAXIMUM AXIAL TENSION

Section input data:
Design strength of rebar $f_{yd} = f_{yk} / \gamma_s = 500 / 1.15 = 434.78$ MPa
Longitudinal rebar area $A_{st} = 4908.70$ mm^2

Calculate the axial load capacity for concentric loading

$$N_{Rdt} = -f_{yd} \cdot A_{st} = -434.78 \cdot 4908.70 = -2134.22 \text{ kN}$$

M-N INTERACTION



Section input data:

Design compressive strength of concrete $f_{cd} = \alpha_{cc} \cdot f_{ck}/\gamma_c = 0.85 \cdot 25/1.5 = 14.17\ \text{MPa}$

Design strength of rebar $f_{yd} = f_{yk}/\gamma_s = 500/1.15 = 434.78\ \text{MPa}$

Design yield strain of rebar $e_y = f_{yd}/E_s = 434.78/200000 = 0.00217$

Ultimate strain in concrete (Table 3) $e_{cu} = 0.00350$

Effective height of the compression zone factor (3.1.7(3)) $\lambda = 0.80$

Effective strength of concrete factor (3.1.7(3)) $\eta = 1.00$

Calculation is based on iterative process:

- Calculate plastic centroid location $\overline{x}$
- Assume x in tension control zone and compression control zone
- Calculate strain e_s and e_{sc} when x < h:

$e_{sc} = e_{cu} \cdot ((x - \acute{d})/x)$

$e_s = e_{cu} \cdot ((d - x)/x)$

and x > h:

$e_{sc} = 0.002 \cdot (7 \cdot (x - \acute{d})/(7 \cdot x - 3 \cdot h))$

$e_s = 0.002 \cdot (7 \cdot (x - d)/(7 \cdot x - 3 \cdot h))$

- Calculate reinforcement stresses $f_s = \{e_s E_s\ (e_s \leq e_y),\ e_y\ (e_s > e_y)\}$
- Calculate equilibrium forces:

$N = F_{cc} + F_{sc} + F_s$

$\lambda x < h\text{: } N = f_{cd} \cdot b \cdot \lambda \cdot x + \sum f_{sci} \cdot \acute{A}_{si} + \sum f_{si} \cdot A_{si}$

$\lambda x \geq h\text{: } N = f_{cd} \cdot b \cdot h + \sum f_{sci} \cdot \acute{A}_{si} + \sum f_{si} \cdot A_{si}$

$\lambda x < h\text{: } M = F_{cc} \cdot (\overline{x_p} - \lambda x/2) + \sum f_{sci} \cdot (\overline{x_p} - \acute{d}_i) - \sum f_{si} \cdot (d_i - \overline{x_p})$

$\lambda x < h\text{: } M = F_{cc} \cdot (\overline{x_p} - h/2) + \sum f_{sci} \cdot (\overline{x_p} - \acute{d}_i) - \sum f_s \cdot (d_i - \overline{x_p})$

1. Axial + positive flexure about major axis

Section input data:

Section height h based on major axis: 550 mm

Section width b based on major axis: 550 mm

Section Rebar

Depth di (mm)	bar diameter (mm)	bar area Asi (mm2)
500.00	25.00	490.87
500.00	25.00	490.87
500.00	25.00	490.87
500.00	25.00	490.87
275.00	25.00	490.87
275.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87

Calculation of plastic centroid location

$$\overline{x_p} = \frac{f_{cd} \cdot A_g \cdot (h - \text{neutral axis}) + \sum F_{sci} \cdot a_{sci} + \sum F_{si} \cdot a_{si}}{f_{cd} \cdot A_g + f_{yd} \cdot A_s + f_{yd} \cdot \acute{A}_s} =$$

$$= \frac{14.17 \cdot 302500.00 \cdot (550 - 275) + 426843478.26 + 160066304.35}{14.17 \cdot 302500.00 + 434.78 \cdot 2945.22 + 434.78 \cdot 1963.48} = 275.00\ \text{mm}$$

M-N interaction values

Iter.	x (mm)	N (kN)	M (kN-m)	e (m)
Tension Control				
1	-	-2134.2	0	0
2	12.3	-2057.3	20.8	-0.010
3	24.7	-1980.4	40.8	-0.021
4	37.0	-1532.2	143.6	-0.094
5	49.3	-991.1	266.5	-0.269
6	61.7	-635.6	346.9	-0.546
7	74.0	-373.1	405.7	-1.087
8	86.4	-163.5	451.7	-2.762
9	98.7	12.8	489.6	38.156
10	111.0	167.1	521.7	3.122
11	123.4	305.9	549.5	1.796
12	135.7	419.1	570.9	1.362
13	148.0	496.0	583.3	1.176
14	160.4	572.9	594.9	1.039
15	172.7	669.7	605.8	0.905
16	185.1	819.5	616.0	0.752
17	197.4	960.2	625.4	0.651
18	209.7	1093.5	634.0	0.580
19	222.1	1220.4	641.9	0.526
20	234.4	1342.1	649.0	0.484
21	246.7	1459.3	655.3	0.449
22	259.1	1572.7	660.9	0.420
23	271.4	1682.8	665.7	0.396
24	283.8	1789.9	669.8	0.374
25	296.1	1894.6	673.1	0.355
26	308.4	1997.0	675.7	0.338
Compression Control				
27	318.1	2143.6	661.9	0.309
28	327.8	2285.0	648.6	0.284
29	337.4	2421.8	635.6	0.262
30	347.1	2554.3	622.9	0.244
31	356.7	2682.9	610.5	0.228
32	366.4	2807.9	598.2	0.213
33	376.1	2929.6	586.0	0.200
34	385.7	3048.2	573.9	0.188
35	395.4	3163.9	561.9	0.178
36	405.1	3277.0	549.8	0.168
37	414.7	3387.7	537.7	0.159
38	424.4	3496.0	525.6	0.150
39	434.0	3602.2	513.4	0.143
40	443.7	3706.4	501.0	0.135

41	453.4	3808.7	488.5	0.128
42	463.0	3909.3	475.9	0.122
43	472.7	4008.2	463.1	0.116
44	482.4	4105.6	450.1	0.110
45	492.0	4201.5	436.9	0.104
46	501.7	4296.0	423.5	0.099
47	511.3	4389.2	409.8	0.093
48	521.0	4481.2	395.9	0.088
49	530.7	4572.1	381.7	0.083
50	540.3	4661.9	367.3	0.079
51	550.0	4750.6	352.5	0.074
52	-	6350.1	0	0

2. Axial + negative flexure about major axis

Section input data:
Section height h based on major axis: 550 mm
Section width b based on major axis: 550 mm

Section Rebar

Depth di (mm)	bar diameter (mm)	bar area Asi (mm2)
500.00	25.00	490.87
500.00	25.00	490.87
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500.00	25.00	490.87
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50.00	25.00	490.87

Calculation of plastic centroid location

$$\overline{x_p} = \frac{f_{cd} \cdot A_g \cdot (h - \text{neutral axis}) + \sum F_{sci} \cdot a_{sci} + \sum F_{si} \cdot a_{si}}{f_{cd} \cdot A_g + f_{yd} \cdot A_s + f_{yd} \cdot \acute{A}_s} =$$

$$= \frac{14.17 \cdot 302500.00 \cdot (550 - 275) + 426843478.26 + 160066304.35}{14.17 \cdot 302500.00 + 434.78 \cdot 2945.22 + 434.78 \cdot 1963.48} = 275.00 \text{ mm}$$

M-N interaction values

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5	49.3	-991.1	266.5	-0.269
6	61.7	-635.6	346.9	-0.546

7	74.0	-373.1	405.7	-1.087	
8	86.4	-163.5	451.7	-2.762	
9	98.7	12.8	489.6	38.156	
10	111.0	167.1	521.7	3.122	
11	123.4	305.9	549.5	1.796	
12	135.7	419.1	570.9	1.362	
13	148.0	496.0	583.3	1.176	
14	160.4	572.9	594.9	1.039	
15	172.7	669.7	605.8	0.905	
16	185.1	819.5	616.0	0.752	
17	197.4	960.2	625.4	0.651	
18	209.7	1093.5	634.0	0.580	
19	222.1	1220.4	641.9	0.526	
20	234.4	1342.1	649.0	0.484	
21	246.7	1459.3	655.3	0.449	
22	259.1	1572.7	660.9	0.420	
23	271.4	1682.8	665.7	0.396	
24	283.8	1789.9	669.8	0.374	
25	296.1	1894.6	673.1	0.355	
26	308.4	1997.0	675.7	0.338	
Compression Control					
27	318.1	2143.6	661.9	0.309	
28	327.8	2285.0	648.6	0.284	
29	337.4	2421.8	635.6	0.262	
30	347.1	2554.3	622.9	0.244	
31	356.7	2682.9	610.5	0.228	
32	366.4	2807.9	598.2	0.213	
33	376.1	2929.6	586.0	0.200	
34	385.7	3048.2	573.9	0.188	
35	395.4	3163.9	561.9	0.178	
36	405.1	3277.0	549.8	0.168	
37	414.7	3387.7	537.7	0.159	
38	424.4	3496.0	525.6	0.150	
39	434.0	3602.2	513.4	0.143	
40	443.7	3706.4	501.0	0.135	
41	453.4	3808.7	488.5	0.128	
42	463.0	3909.3	475.9	0.122	
43	472.7	4008.2	463.1	0.116	
44	482.4	4105.6	450.1	0.110	
45	492.0	4201.5	436.9	0.104	
46	501.7	4296.0	423.5	0.099	
47	511.3	4389.2	409.8	0.093	
48	521.0	4481.2	395.9	0.088	
49	530.7	4572.1	381.7	0.083	

50	540.3	4661.9	367.3	0.079
51	550.0	4750.6	352.5	0.074
52	-	6350.1	0	0

3. Axial + positive flexure about minor axis

Section input data:
Section height h based on minor axis: 550 mm
Section width b based on minor axis: 550 mm

Section Rebar

Depth di (mm)	bar diameter (mm)	bar area Asi (mm2)
500.00	25.00	490.87
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500.00	25.00	490.87
350.00	25.00	490.87
350.00	25.00	490.87
200.00	25.00	490.87
200.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87

Calculation of plastic centroid location

$$\overline{x_p} = \frac{f_{cd} \cdot A_g \cdot (h - \text{neutral axis}) + \sum F_{sci} \cdot a_{sci} + \sum F_{si} \cdot a_{si}}{f_{cd} \cdot A_g + f_{yd} \cdot A_s + f_{yd} \cdot \acute{A}_s} =$$

$$= \frac{14.17 \cdot 302500.00 \cdot (550 - 275) + 469527826.09 + 117381956.52}{14.17 \cdot 302500.00 + 434.78 \cdot 2454.35 + 434.78 \cdot 2454.35} = 275.00 \text{ mm}$$

M-N interaction values

Iter.	x (mm)	N (kN)	M (kN-m)	e (m)
Tension Control				
1	-	-2134.2	0	0
2	10.9	-2066.5	18.3	-0.009
3	21.7	-1998.9	36.0	-0.018
4	32.6	-1842.6	73.1	-0.040
5	43.4	-1379.3	178.7	-0.130
6	54.3	-1074.2	248.1	-0.231
7	65.1	-848.3	299.0	-0.353
8	76.0	-667.6	339.3	-0.508
9	86.9	-515.2	372.5	-0.723
10	97.7	-381.6	401.0	-1.051
11	108.6	-261.1	425.9	-1.631
12	119.4	-150.3	448.0	-2.981
13	130.3	12.4	472.4	38.046
14	141.1	166.3	490.9	2.952
15	152.0	303.5	506.8	1.670
16	162.9	431.5	521.4	1.208

17	173.7	551.9	534.9	0.969
18	184.6	666.1	547.3	0.822
19	195.4	775.2	558.7	0.721
20	206.3	879.9	569.2	0.647
21	217.1	987.2	578.4	0.586
22	228.0	1137.7	583.2	0.513
23	238.8	1280.8	587.7	0.459
24	249.7	1417.3	591.7	0.417
25	260.6	1548.0	595.2	0.384
26	271.4	1673.7	598.2	0.357
Compression Control				
27	282.6	1798.1	600.8	0.334
28	293.7	1918.3	602.8	0.314
29	304.8	2034.8	604.3	0.297
30	316.0	2188.0	596.3	0.273
31	327.1	2353.7	584.2	0.248
32	338.3	2513.1	572.3	0.228
33	349.4	2666.8	560.7	0.210
34	360.6	2815.3	549.1	0.195
35	371.7	2959.0	537.6	0.182
36	382.9	3098.5	526.0	0.170
37	394.0	3233.9	514.4	0.159
38	405.1	3365.7	502.7	0.149
39	416.3	3494.2	490.8	0.140
40	427.4	3619.6	478.7	0.132
41	438.6	3742.2	466.4	0.125
42	449.7	3862.1	453.8	0.118
43	460.9	3979.6	441.0	0.111
44	472.0	4094.9	427.8	0.104
45	483.1	4208.0	414.3	0.098
46	494.3	4319.1	400.5	0.093
47	505.4	4428.4	386.3	0.087
48	516.6	4536.0	371.7	0.082
49	527.7	4642.0	356.8	0.077
50	538.9	4741.2	341.0	0.072
51	550.0	4839.1	324.8	0.067
52	-	6350.1	0	0

4. Axial + negative flexure about minor axis

Section input data:
Section height h based on minor axis: 550 mm
Section width b based on minor axis: 550 mm

Section Rebar

Depth di (mm)	bar diameter (mm)	bar area Asi (mm2)
500.00	25.00	490.87
500.00	25.00	490.87
500.00	25.00	490.87
350.00	25.00	490.87
350.00	25.00	490.87
200.00	25.00	490.87
200.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87
50.00	25.00	490.87

Calculation of plastic centroid location

$$\overline{x_p} = \frac{f_{cd} \cdot A_g \cdot (h - \text{neutral axis}) + \sum F_{sci} \cdot a_{sci} + \sum F_{si} \cdot a_{si}}{f_{cd} \cdot A_g + f_{yd} \cdot A_s + f_{yd} \cdot \acute{A}_s} =$$

$$= \frac{14.17 \cdot 302500.00 \cdot (550 - 275) + 469527826.09 + 117381956.52}{14.17 \cdot 302500.00 + 434.78 \cdot 2454.35 + 434.78 \cdot 2454.35} = 275.00 \text{ mm}$$

M-N interaction values

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9	86.9	-515.2	372.5	-0.723
10	97.7	-381.6	401.0	-1.051
11	108.6	-261.1	425.9	-1.631
12	119.4	-150.3	448.0	-2.981
13	130.3	12.4	472.4	38.046
14	141.1	166.3	490.9	2.952
15	152.0	303.5	506.8	1.670
16	162.9	431.5	521.4	1.208
17	173.7	551.9	534.9	0.969
18	184.6	666.1	547.3	0.822
19	195.4	775.2	558.7	0.721
20	206.3	879.9	569.2	0.647
21	217.1	987.2	578.4	0.586
22	228.0	1137.7	583.2	0.513
23	238.8	1280.8	587.7	0.459

24	249.7	1417.3	591.7	0.417
25	260.6	1548.0	595.2	0.384
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Compression Control				
27	282.6	1798.1	600.8	0.334
28	293.7	1918.3	602.8	0.314
29	304.8	2034.8	604.3	0.297
30	316.0	2188.0	596.3	0.273
31	327.1	2353.7	584.2	0.248
32	338.3	2513.1	572.3	0.228
33	349.4	2666.8	560.7	0.210
34	360.6	2815.3	549.1	0.195
35	371.7	2959.0	537.6	0.182
36	382.9	3098.5	526.0	0.170
37	394.0	3233.9	514.4	0.159
38	405.1	3365.7	502.7	0.149
39	416.3	3494.2	490.8	0.140
40	427.4	3619.6	478.7	0.132
41	438.6	3742.2	466.4	0.125
42	449.7	3862.1	453.8	0.118
43	460.9	3979.6	441.0	0.111
44	472.0	4094.9	427.8	0.104
45	483.1	4208.0	414.3	0.098
46	494.3	4319.1	400.5	0.093
47	505.4	4428.4	386.3	0.087
48	516.6	4536.0	371.7	0.082
49	527.7	4642.0	356.8	0.077
50	538.9	4741.2	341.0	0.072
51	550.0	4839.1	324.8	0.067
52	-	6350.1	0	0

5. Strength check

Section input data:
Actual axial force $N_{ed} = 2025.00\ \text{kN}$
Actual bending moment about major axis $M_{zed} = 247.05\ \text{kN-m}$
Actual bending moment about minor axis $M_{yed} = 233.55\ \text{kN-m}$
Eccentricity of actual forces along major axis $e_y = 0.1220\ \text{m}$
Eccentricity of actual forces along minor axis $e_z = 0.1153\ \text{m}$
Limited axial force (Mx-N axis plane) $N_{zRd} = 3905.27\ \text{kN}$
Limited axial force (My-N axis plane) $N_{yRd} = 3900.22\ \text{kN}$
Limited bending moment about major axis $M_{zRd} = 476.42\ \text{kN-m}$
Limited bending moment about minor axis $M_{yRd} = 449.65\ \text{kN-m}$

$$\text{Axial + biaxial bending check case for rectangular section}$$

$$\frac{N_{ed}}{N_{Rd}} = \frac{2025.00}{6350.09} = 0.319 \rightarrow \alpha = 1.18$$

$$\left[\frac{M_{zed}}{M_{zRd}}\right]^{\alpha_1} + \left[\frac{M_{yed}}{M_{yRd}}\right]^{\alpha_2} = \left[\frac{247.05}{476.42}\right]^{1.18} + \left[\frac{233.55}{449.65}\right]^{1.18} = 0.92 \leq 1.0$$

	Axial compression check case $N_{ed} = 2025.00 \text{ kN} \leq N_{Rd} = 6350.09 \text{ kN}$	**STATUS OK!** **STATUS OK!**