COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	431.624 kN	From analysis results
M_2	-8.720 kN·m	From analysis results
M_3	5.635 kN·m	From analysis results
M_{2s}	-14.663 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.475 kN·m	Including second-order magnification and accidental eccentricity

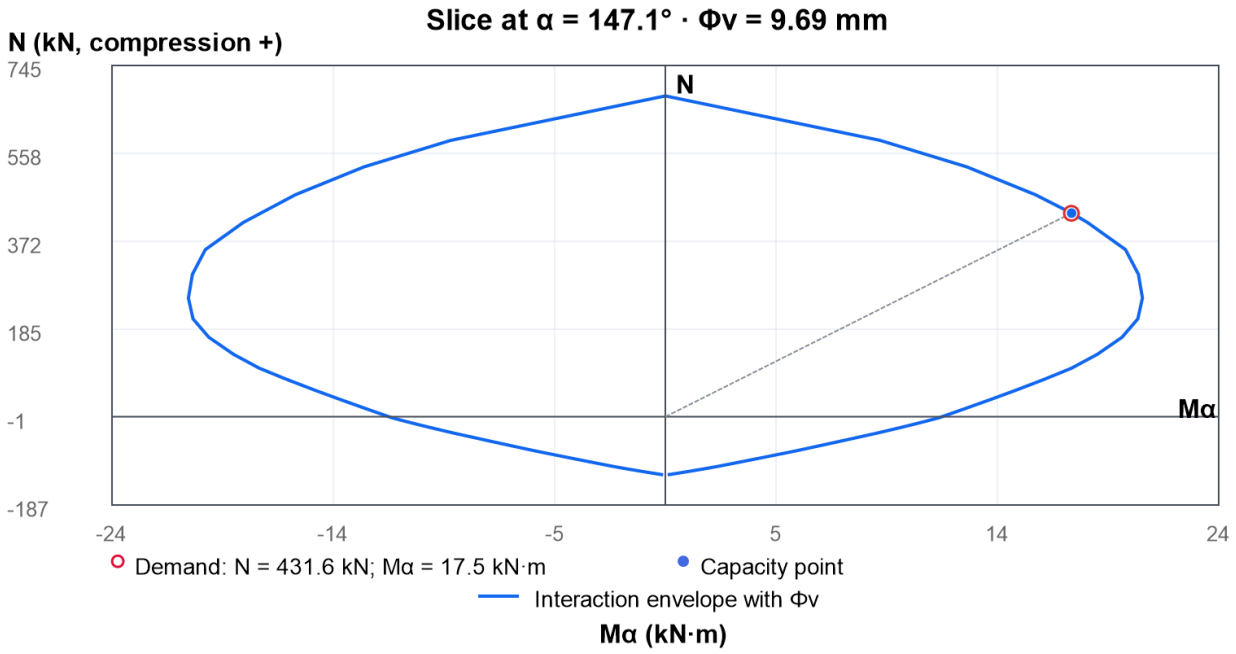
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	20.20	13.06	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,624,195	2,624,195	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,262,115,142,357	1,262,115,142,357	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,064.99	1,064.99	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6815	1.6815	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

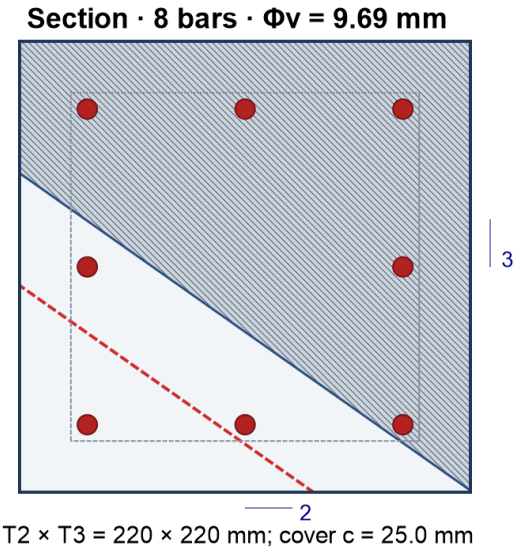
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 179.19 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	590.14 mm^2	Calculation results
Φ_v	9.6914 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	54.8661°	Geometry at the check point
Normal vector n	(0.575489; 0.817809)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	179.1916 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.575489 \cdot x_2 + 0.817809 \cdot x_3 = -25.9287$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.575489 \cdot x_2 + 0.817809 \cdot x_3 = -70.7266$ mm	Geometry at the check point
Compressed concrete area A_b	31,175.121 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(20.029; 32.100) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	358.514 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-11.508 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.181 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.6914 mm / 73.767 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	73.767	260.547	-0.57124	-114.247	-8.428	-0.649	0.649
2	0.000	-77.000	73.767	216.234	0.12118	24.236	1.788	0.138	0.000
3	77.000	-77.000	73.767	171.921	0.81360	162.720	12.003	0.924	0.924
4	-77.000	77.000	73.767	134.604	1.39671	210.000	15.491	-1.193	-1.193
5	0.000	77.000	73.767	90.292	2.08913	210.000	15.491	-1.193	0.000
6	77.000	77.000	73.767	45.979	2.78155	210.000	15.491	-1.193	1.193
7	-77.000	0.000	73.767	197.576	0.41274	82.547	6.089	0.000	-0.469
8	77.000	0.000	73.767	108.950	1.79757	210.000	15.491	0.000	1.193
Σ N_{si}, M_{xsi}, M_{ysi}							73.417	-3.165	2.297

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	358.514	-11.508	7.181	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	73.417	-3.165	2.297	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**431.931**	**-14.674**	**9.478**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	433.575 kN	From analysis results
M_2	-3.098 kN·m	From analysis results
M_3	1.990 kN·m	From analysis results
M_{2s}	-8.602 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.602 kN·m	Including second-order magnification and accidental eccentricity

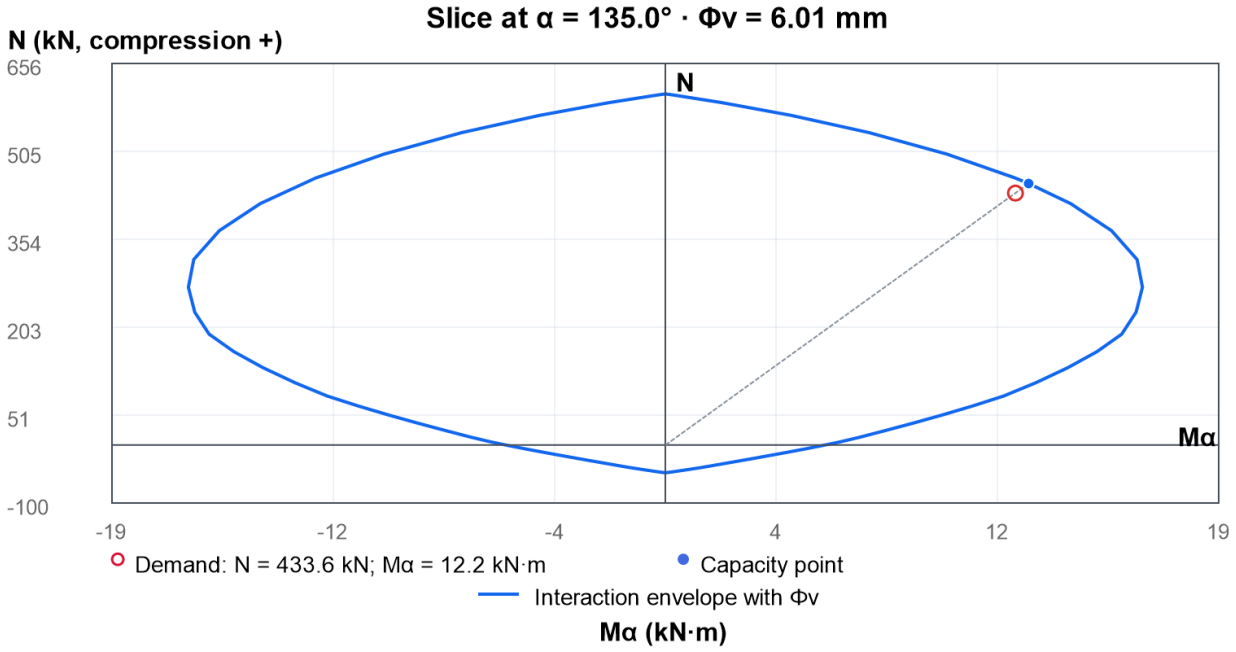
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9840	1.9840	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

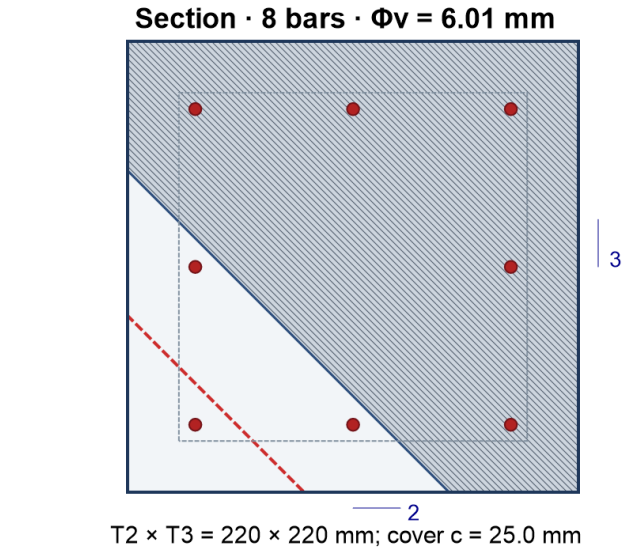
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.17 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9634	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0000°	Geometry at the check point
Normal vector n	(0.707107; 0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	200.1683 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -44.6049$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -94.6469$ mm	Geometry at the check point
Compressed concrete area A_b	36,088.181 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.683; 19.683) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	415.014 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.169 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.169 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	-0.19930	-39.859	-1.131	-0.087	0.087
2	0.000	-77.000	28.366	210.011	0.56232	112.465	3.190	0.246	0.000
3	77.000	-77.000	28.366	155.563	1.32394	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.32394	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.116	2.08556	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.84718	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.56232	112.465	3.190	0.000	-0.246
8	77.000	0.000	28.366	101.116	2.08556	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							35.035	-0.759	0.759

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	415.014	-8.169	8.169	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.035	-0.759	0.759	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**450.049**	**-8.927**	**8.927**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	436.176 kN	From analysis results
M_2	4.397 kN·m	From analysis results
M_3	-2.871 kN·m	From analysis results
M_{2s}	8.776 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.705 kN·m	Including second-order magnification and accidental eccentricity

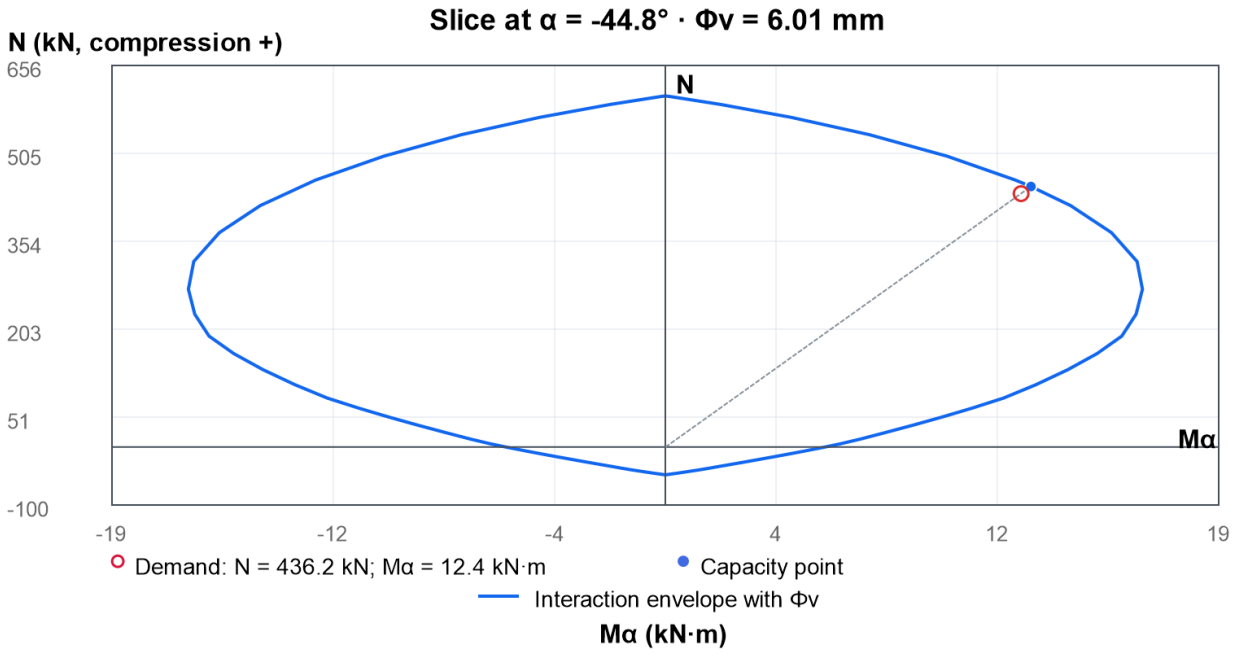
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.08	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9958	1.9958	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

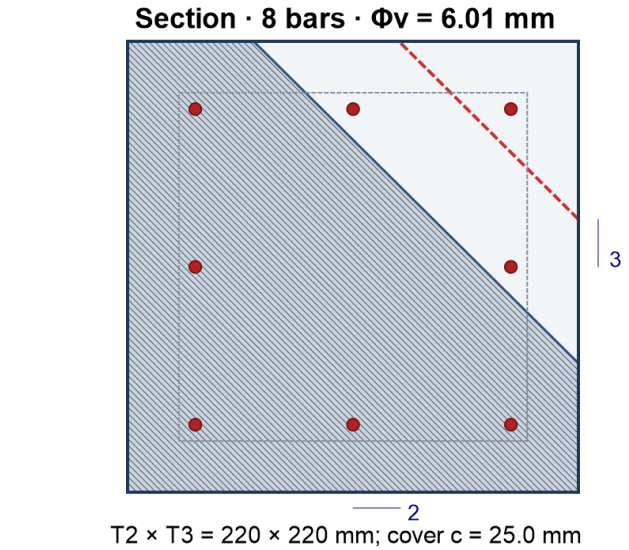
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.57 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9728	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.2560°	Geometry at the check point
Normal vector n	(-0.703940; -0.710260)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	199.5739 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.703940 \cdot x_2 - 0.710260 \cdot x_3 = -44.0119$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.703940 \cdot x_2 - 0.710260 \cdot x_3 = -93.9054$ mm	Geometry at the check point
Compressed concrete area A_b	35,956.098 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.789; -19.951) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	413.495 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.250 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.182 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.84524	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	100.872	2.08478	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.075	1.32431	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	156.049	1.31066	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.252	0.55019	110.038	3.121	-0.240	0.000
6	77.000	77.000	28.366	264.455	-0.21028	-42.056	-1.193	0.092	-0.092
7	-77.000	0.000	28.366	101.359	2.07795	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	209.765	0.55702	111.403	3.160	0.000	0.243
Σ N_{si}, M_{xsi}, M_{ysi}							34.873	0.769	-0.766

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	413.495	8.250	-8.182	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	34.873	0.769	-0.766	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**448.368**	**9.019**	**-8.948**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	653.017 kN	From analysis results
M_2	4.330 kN·m	From analysis results
M_3	6.154 kN·m	From analysis results
M_{2s}	11.694 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.694 kN·m	Including second-order magnification and accidental eccentricity

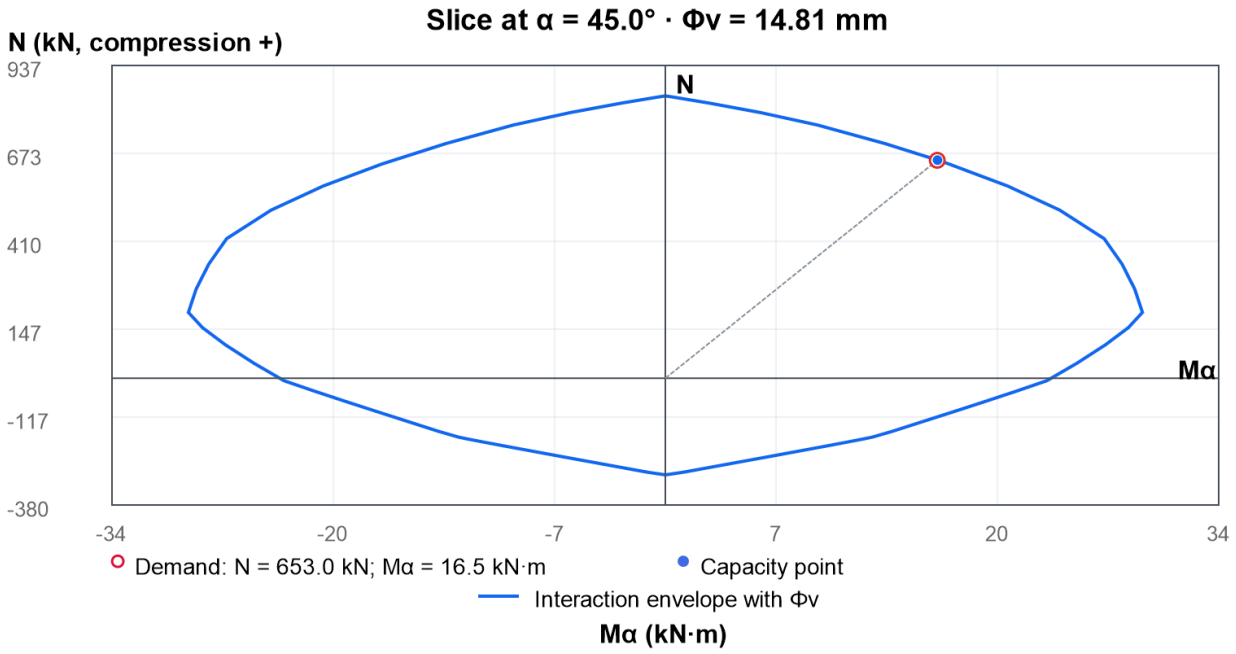
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	6,127,033	6,127,033	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,752,512,399,535	1,752,512,399,535	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,478.80	1,478.80	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.7908	1.7908	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

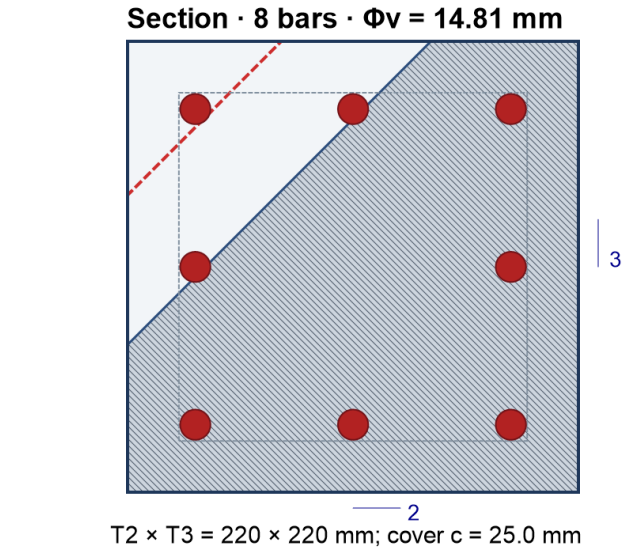
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.51 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,377.87 mm^2	Calculation results
Φ_v	14.8086 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	206.5116 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -50.9481$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -102.5760$ mm	Geometry at the check point
Compressed concrete area A_b	37,455.622 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(17.732; -17.732) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.740 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.638 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.638 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.8086 mm / 172.233 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	172.233	155.563	1.39078	210.000	36.169	2.785	-2.785
2	0.000	-77.000	172.233	101.116	2.12901	210.000	36.169	2.785	0.000
3	77.000	-77.000	172.233	46.669	2.86723	210.000	36.169	2.785	2.785
4	-77.000	77.000	172.233	264.458	-0.08567	-17.134	-2.951	0.227	0.227
5	0.000	77.000	172.233	210.011	0.65256	130.511	22.478	-1.731	0.000
6	77.000	77.000	172.233	155.563	1.39078	210.000	36.169	-2.785	2.785
7	-77.000	0.000	172.233	210.011	0.65256	130.511	22.478	0.000	-1.731
8	77.000	0.000	172.233	101.116	2.12901	210.000	36.169	0.000	2.785
Σ N_{si}, M_{xsi}, M_{ysi}							222.851	4.066	4.066

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.740	7.638	7.638	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	222.851	4.066	4.066	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**653.591**	**11.704**	**11.704**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	654.968 kN	From analysis results
M_2	1.587 kN·m	From analysis results
M_3	2.181 kN·m	From analysis results
M_{2s}	11.720 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.720 kN·m	Including second-order magnification and accidental eccentricity

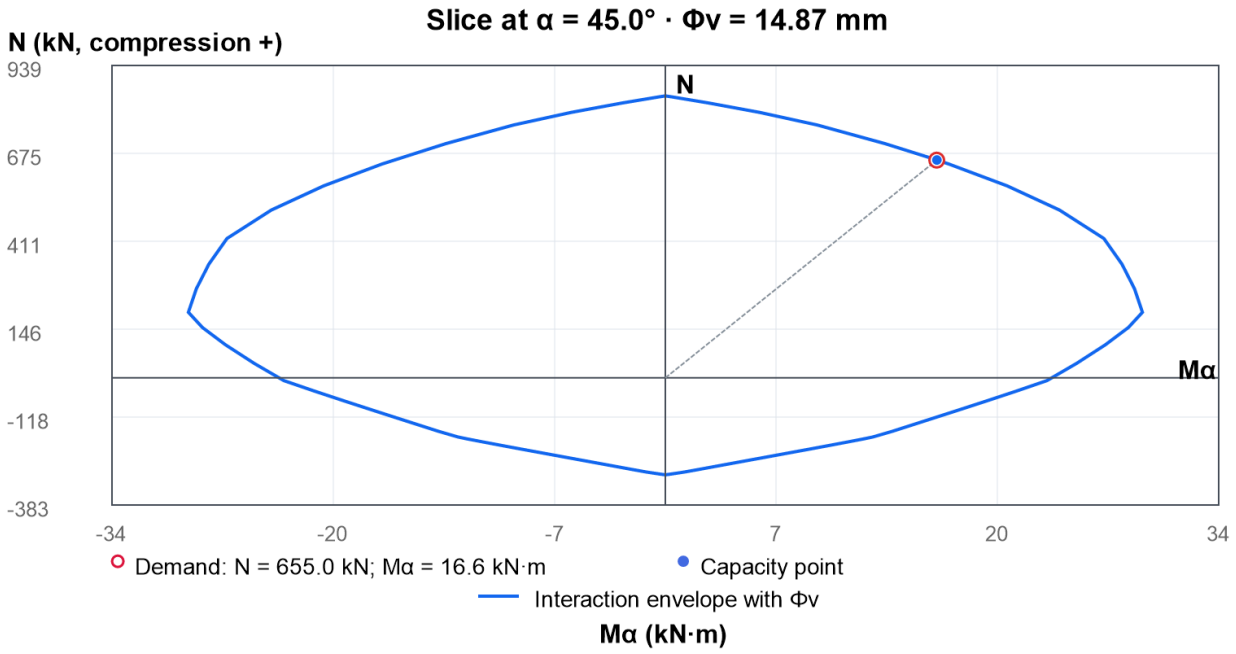
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	6,176,442	6,176,442	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,759,429,727,351	1,759,429,727,351	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,484.63	1,484.63	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7894	1.7894	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

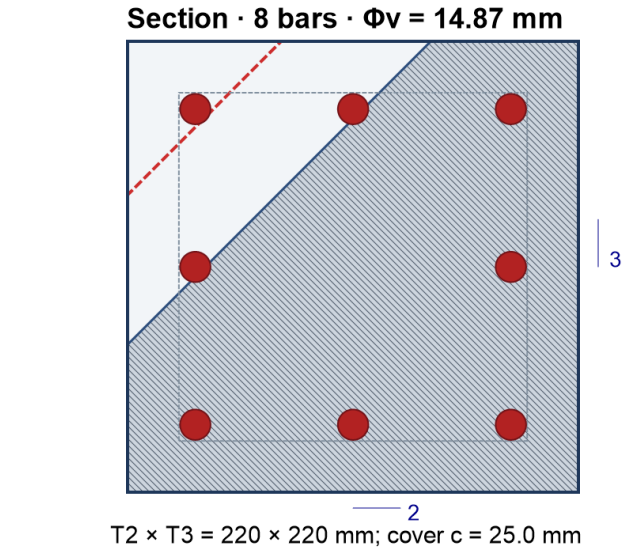
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.55 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,388.98 mm^2	Calculation results
Φ_v	14.8682 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	206.5509 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -50.9874$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -102.6251$ mm	Geometry at the check point
Compressed concrete area A_b	37,463.842 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(17.720; -17.720) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.834 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.634 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.634 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.8682 mm / 173.622 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	173.622	155.563	1.39118	210.000	36.461	2.807	-2.807
2	0.000	-77.000	173.622	101.116	2.12927	210.000	36.461	2.807	0.000
3	77.000	-77.000	173.622	46.669	2.86736	210.000	36.461	2.807	2.807
4	-77.000	77.000	173.622	264.458	-0.08499	-16.997	-2.951	0.227	0.227
5	0.000	77.000	173.622	210.011	0.65310	130.620	22.679	-1.746	0.000
6	77.000	77.000	173.622	155.563	1.39118	210.000	36.461	-2.807	2.807
7	-77.000	0.000	173.622	210.011	0.65310	130.620	22.679	0.000	-1.746
8	77.000	0.000	173.622	101.116	2.12927	210.000	36.461	0.000	2.807
Σ N_{si}, M_{xsi}, M_{ysi}							224.709	4.096	4.096

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.834	7.634	7.634	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	224.709	4.096	4.096	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**655.544**	**11.730**	**11.730**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	657.569 kN	From analysis results
M_2	-2.069 kN·m	From analysis results
M_3	-3.116 kN·m	From analysis results
M_{2s}	-11.756 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.756 kN·m	Including second-order magnification and accidental eccentricity

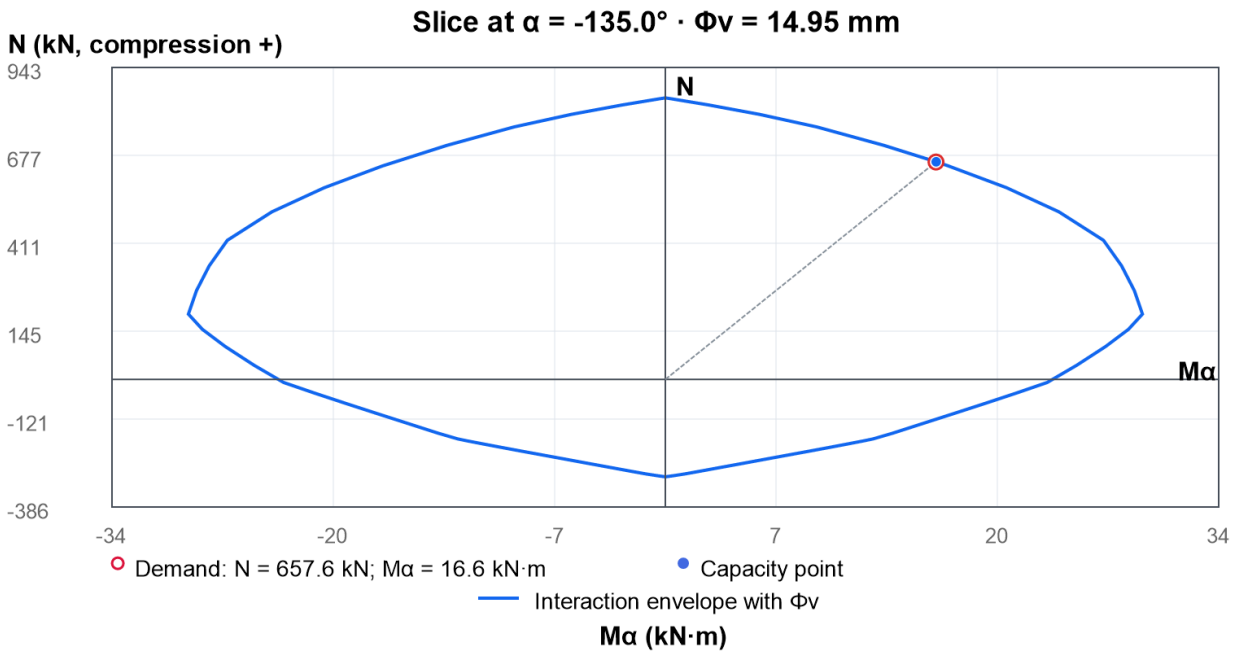
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	6,240,690	6,240,690	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,768,424,323,216	1,768,424,323,216	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,492.22	1,492.22	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7878	1.7878	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

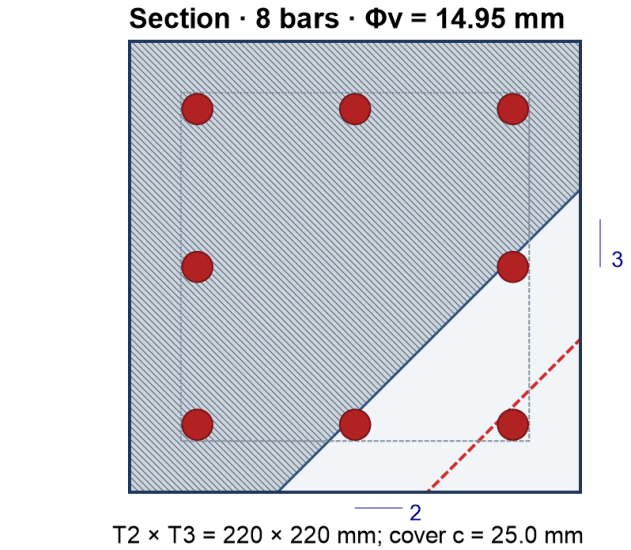
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.60 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,403.43 mm^2	Calculation results
Φ_v	14.9453 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	135.0000°	Geometry at the check point
Normal vector n	(-0.707107; 0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	206.5976 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -51.0341$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -102.6835$ mm	Geometry at the check point
Compressed concrete area A_b	37,473.613 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-17.706; 17.706) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.947 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.630 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.630 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.9453 mm / 175.428 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	175.428	155.563	1.39166	210.000	36.840	2.837	-2.837
2	0.000	-77.000	175.428	210.011	0.65374	130.749	22.937	1.766	0.000
3	77.000	-77.000	175.428	264.458	-0.08418	-16.835	-2.953	-0.227	-0.227
4	-77.000	77.000	175.428	46.669	2.86750	210.000	36.840	-2.837	-2.837
5	0.000	77.000	175.428	101.116	2.12958	210.000	36.840	-2.837	0.000
6	77.000	77.000	175.428	155.563	1.39166	210.000	36.840	-2.837	2.837
7	-77.000	0.000	175.428	101.116	2.12958	210.000	36.840	0.000	-2.837
8	77.000	0.000	175.428	210.011	0.65374	130.749	22.937	0.000	1.766
Σ N_{si}, M_{xsi}, M_{ysi}							227.120	-4.135	-4.135

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.947	-7.630	-7.630	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	227.120	-4.135	-4.135	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**658.067**	**-11.765**	**-11.765**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	478.590 kN	From analysis results
M_2	0.729 kN·m	From analysis results
M_3	4.991 kN·m	From analysis results
M_{2s}	9.398 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.801 kN·m	Including second-order magnification and accidental eccentricity

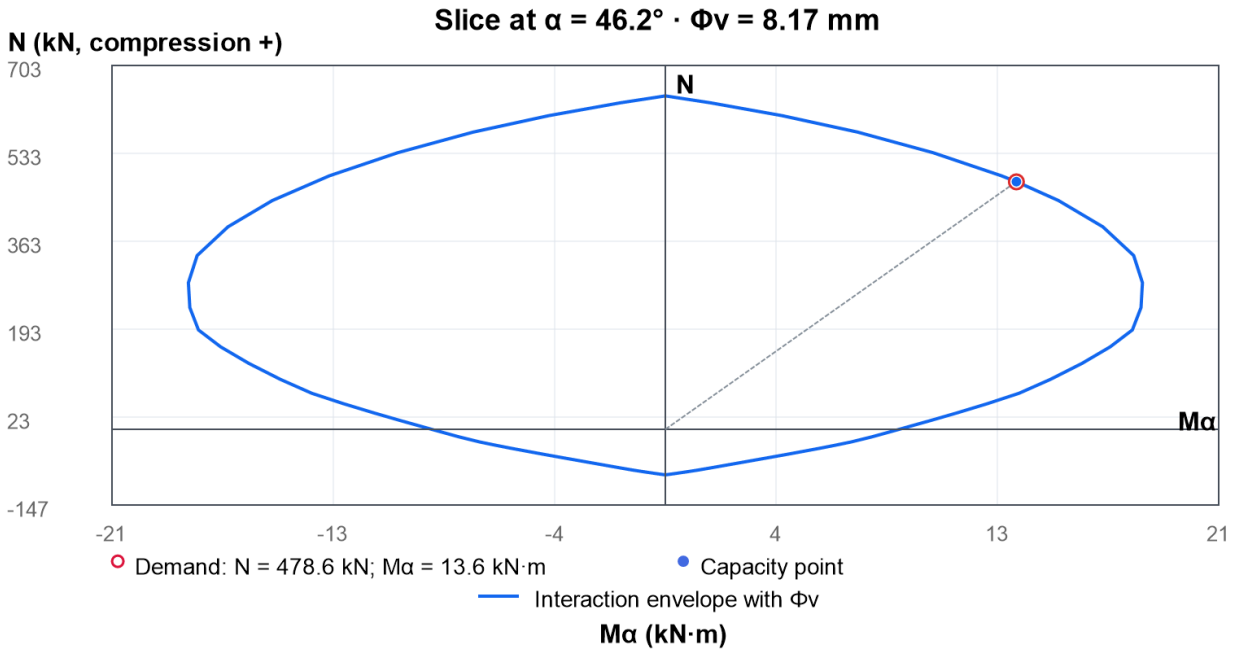
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.43	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,864,021	1,864,021	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,155,690,667,491	1,155,690,667,491	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	975.19	975.19	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.9637	1.9637	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

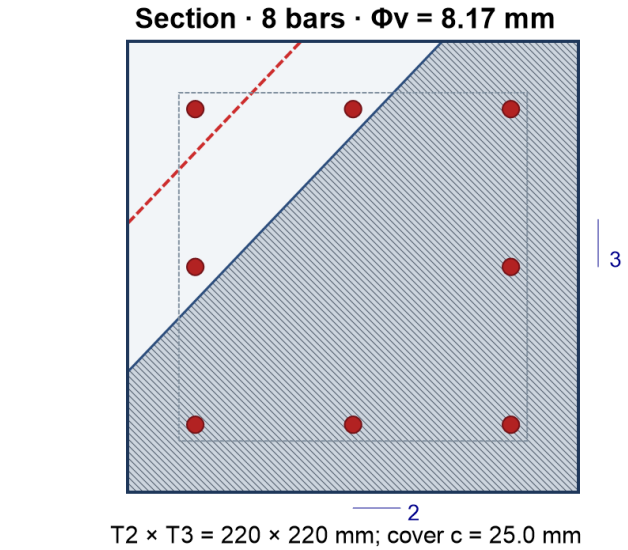
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.85 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	419.19 mm^2	Calculation results
Φ_v	8.1680 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	316.4063°	Geometry at the check point
Normal vector n	(0.724247; -0.689541)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	199.8468 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.724247 \cdot x_2 - 0.689541 \cdot x_3 = -44.3301$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.724247 \cdot x_2 - 0.689541 \cdot x_3 = -94.2918$ mm	Geometry at the check point
Compressed concrete area A_b	36,022.652 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(20.213; -19.328) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	414.260 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.007 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.373 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.1680 mm / 52.398 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	52.398	158.189	1.28366	210.000	11.004	0.847	-0.847
2	0.000	-77.000	52.398	102.422	2.06499	210.000	11.004	0.847	0.000
3	77.000	-77.000	52.398	46.655	2.84633	210.000	11.004	0.847	0.847
4	-77.000	77.000	52.398	264.378	-0.20413	-40.827	-2.139	0.165	0.165
5	0.000	77.000	52.398	208.611	0.57720	115.441	6.049	-0.466	0.000
6	77.000	77.000	52.398	152.844	1.35854	210.000	11.004	-0.847	0.847
7	-77.000	0.000	52.398	211.284	0.53976	107.952	5.657	0.000	-0.436
8	77.000	0.000	52.398	99.750	2.10243	210.000	11.004	0.000	0.847
Σ N_{si}, M_{xsi}, M_{ysi}							64.584	1.394	1.424

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	414.260	8.007	8.373	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	64.584	1.394	1.424	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**478.845**	**9.400**	**9.797**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	480.541 kN	From analysis results
M_2	0.295 kN·m	From analysis results
M_3	1.767 kN·m	From analysis results
M_{2s}	9.494 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.494 kN·m	Including second-order magnification and accidental eccentricity

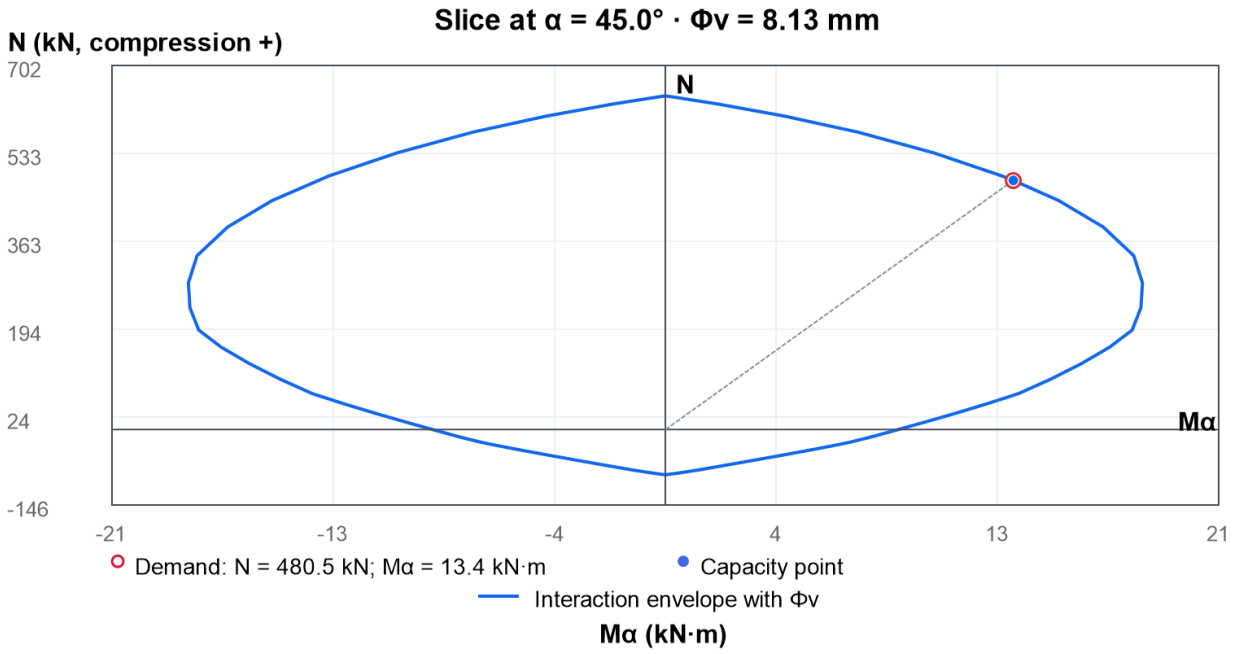
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,846,234	1,846,234	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,153,200,577,820	1,153,200,577,820	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	973.09	973.09	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9756	1.9756	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

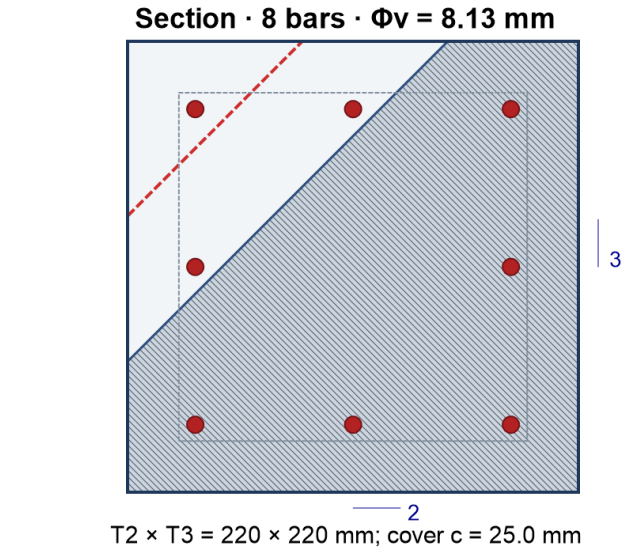
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.72 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	415.19 mm^2	Calculation results
Φ_v	8.1289 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	314.9897°	Geometry at the check point
Normal vector n	(0.706979; -0.707234)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	200.7234 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.706979 \cdot x_2 - 0.707234 \cdot x_3 = -45.1599$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.706979 \cdot x_2 - 0.707234 \cdot x_3 = -95.3408$ mm	Geometry at the check point
Compressed concrete area A_b	36,211.054 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.505; -19.511) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	416.427 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.125 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.122 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.1289 mm / 51.898 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	51.898	155.544	1.33023	210.000	10.899	0.839	-0.839
2	0.000	-77.000	51.898	101.106	2.08961	210.000	10.899	0.839	0.000
3	77.000	-77.000	51.898	46.669	2.84899	210.000	10.899	0.839	0.839
4	-77.000	77.000	51.898	264.458	-0.18907	-37.813	-1.962	0.151	0.151
5	0.000	77.000	51.898	210.021	0.57031	114.062	5.920	-0.456	0.000
6	77.000	77.000	51.898	155.583	1.32969	210.000	10.899	-0.839	0.839
7	-77.000	0.000	51.898	210.001	0.57058	114.117	5.922	0.000	-0.456
8	77.000	0.000	51.898	101.126	2.08934	210.000	10.899	0.000	0.839
Σ N_{si}, M_{xsi}, M_{ysi}							64.373	1.374	1.373

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	416.427	8.125	8.122	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	64.373	1.374	1.373	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**480.800**	**9.499**	**9.496**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	483.142 kN	From analysis results
M_2	-0.285 kN·m	From analysis results
M_3	-2.532 kN·m	From analysis results
M_{2s}	-9.525 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.525 kN·m	Including second-order magnification and accidental eccentricity

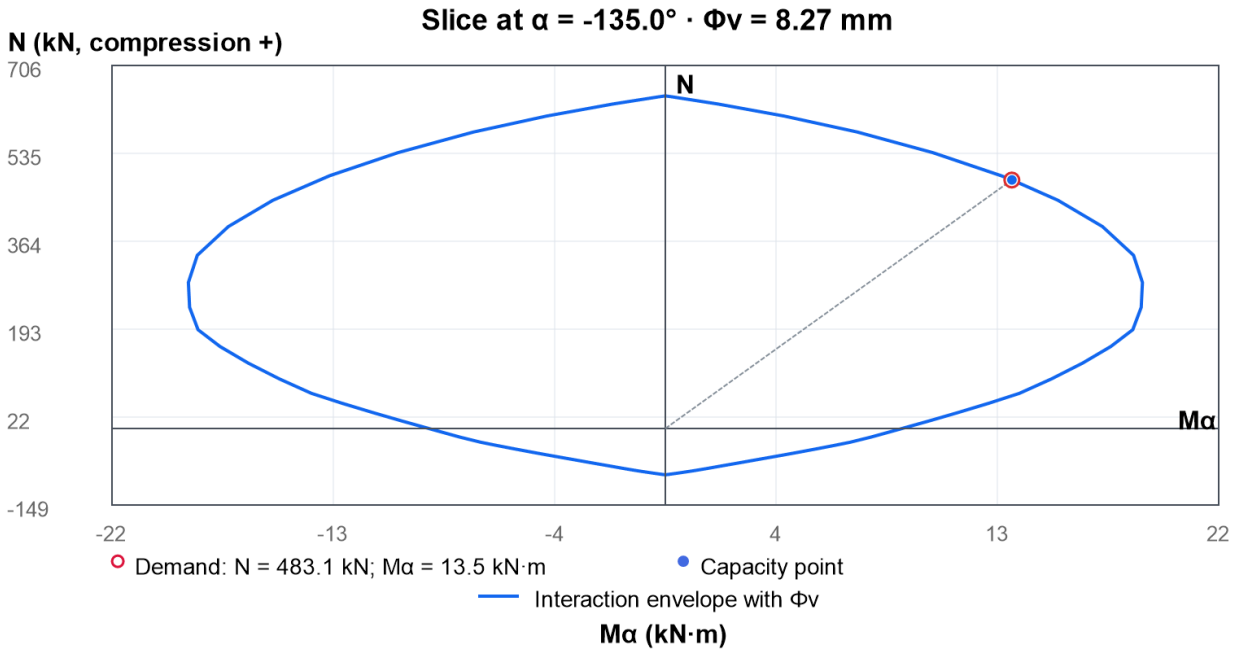
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,908,860	1,908,860	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,161,968,116,705	1,161,968,116,705	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	980.49	980.49	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9714	1.9714	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

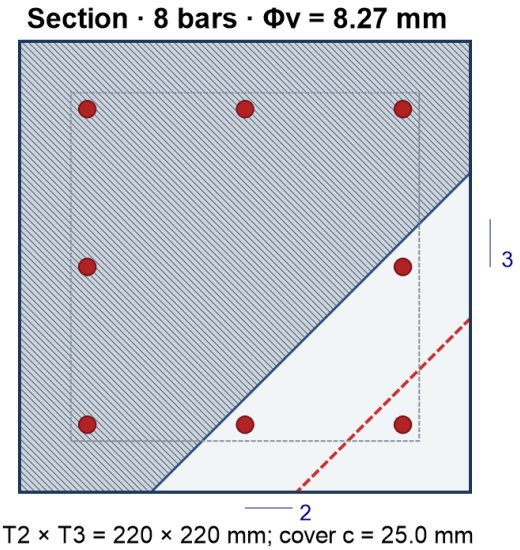
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.86 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	429.27 mm^2	Calculation results
Φ_v	8.2656 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	135.0105°	Geometry at the check point
Normal vector n	(-0.707236; 0.706978)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	200.8638 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707236 \cdot x_2 + 0.706978 \cdot x_3 = -45.3003$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707236 \cdot x_2 + 0.706978 \cdot x_3 = -95.5163$ mm	Geometry at the check point
Compressed concrete area A_b	36,242.033 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.467; 19.461) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	416.783 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.111 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.114 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.2656 mm / 53.659 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	53.659	155.544	1.33175	210.000	11.268	0.868	-0.868
2	0.000	-77.000	53.659	210.001	0.57263	114.527	6.145	0.473	0.000
3	77.000	-77.000	53.659	264.458	-0.18649	-37.298	-2.001	-0.154	-0.154
4	-77.000	77.000	53.659	46.669	2.84944	210.000	11.268	-0.868	-0.868
5	0.000	77.000	53.659	101.126	2.09032	210.000	11.268	-0.868	0.000
6	77.000	77.000	53.659	155.583	1.33120	210.000	11.268	-0.868	0.868
7	-77.000	0.000	53.659	101.106	2.09060	210.000	11.268	0.000	-0.868
8	77.000	0.000	53.659	210.021	0.57236	114.471	6.142	0.000	0.473
Σ N_{si}, M_{xsi}, M_{ysi}							66.628	-1.416	-1.416

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	416.783	-8.111	-8.114	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	66.628	-1.416	-1.416	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**483.412**	**-9.527**	**-9.530**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	572.036 kN	From analysis results
M_2	-5.978 kN·m	From analysis results
M_3	5.599 kN·m	From analysis results
M_{2s}	-11.043 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.567 kN·m	Including second-order magnification and accidental eccentricity

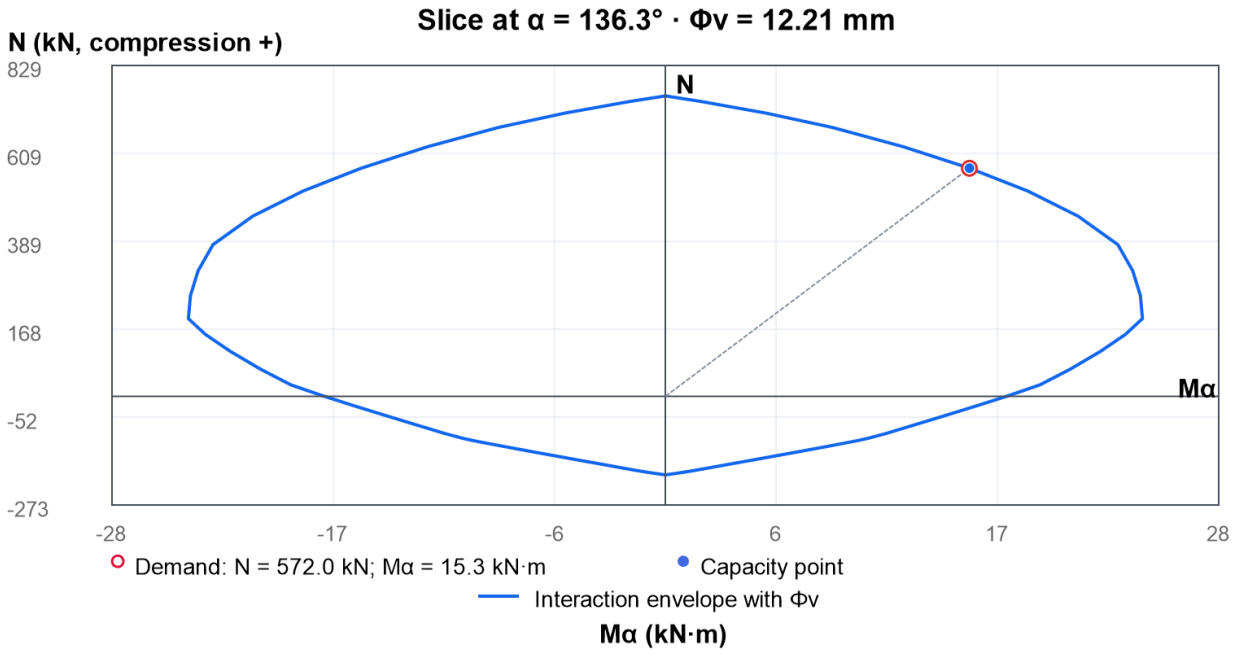
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.45	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	4,166,013	4,166,013	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,477,969,568,249	1,477,969,568,249	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,247.13	1,247.13	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.8473	1.8473	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

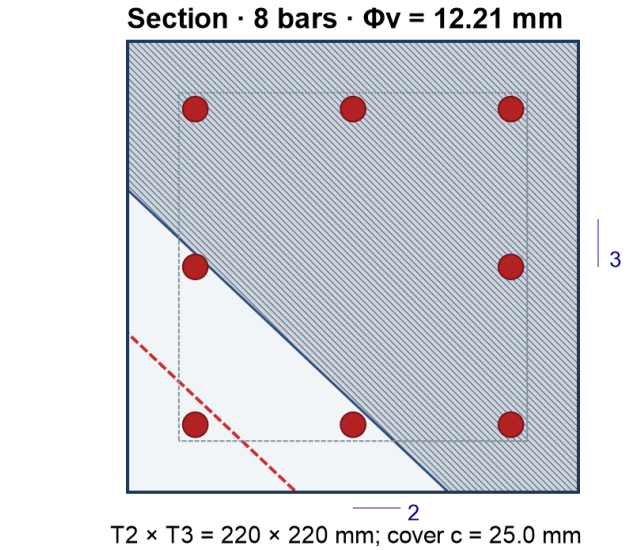
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 203.59 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	936.87 mm^2	Calculation results
Φ_v	12.2109 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9997	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	46.7052°	Geometry at the check point
Normal vector n	(0.685753; 0.727835)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	203.5933 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.685753 \cdot x_2 + 0.727835 \cdot x_3 = -48.0987$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.685753 \cdot x_2 + 0.727835 \cdot x_3 = -98.9970$ mm	Geometry at the check point
Compressed concrete area A_b	36,845.657 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.124; 19.071) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	423.725 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.081 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.680 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.2109 mm / 117.108 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	117.108	264.341	-0.13546	-27.091	-3.173	-0.244	0.244
2	0.000	-77.000	117.108	211.538	0.59074	118.148	13.836	1.065	0.000
3	77.000	-77.000	117.108	158.735	1.31693	210.000	24.593	1.894	1.894
4	-77.000	77.000	117.108	152.254	1.40606	210.000	24.593	-1.894	-1.894
5	0.000	77.000	117.108	99.451	2.13225	210.000	24.593	-1.894	0.000
6	77.000	77.000	117.108	46.648	2.85845	210.000	24.593	-1.894	1.894
7	-77.000	0.000	117.108	208.298	0.63530	127.061	14.880	0.000	-1.146
8	77.000	0.000	117.108	102.692	2.08769	210.000	24.593	0.000	1.894
Σ N_{si}, M_{xsi}, M_{ysi}							148.507	-2.966	2.886

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	423.725	-8.081	7.680	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	148.507	-2.966	2.886	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**572.232**	**-11.047**	**10.566**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	573.987 kN	From analysis results
M_2	-2.114 kN·m	From analysis results
M_3	1.988 kN·m	From analysis results
M_{2s}	-10.663 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.663 kN·m	Including second-order magnification and accidental eccentricity

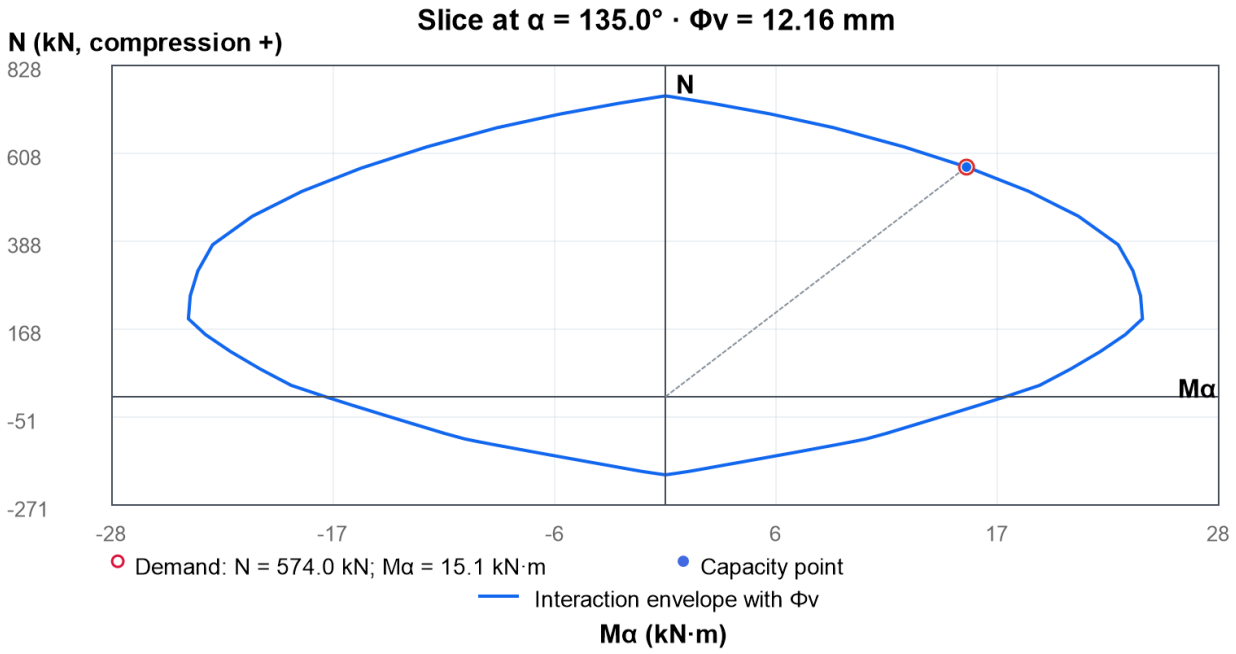
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,132,762	4,132,762	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,473,314,452,446	1,473,314,452,446	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,243.21	1,243.21	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.8577	1.8577	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

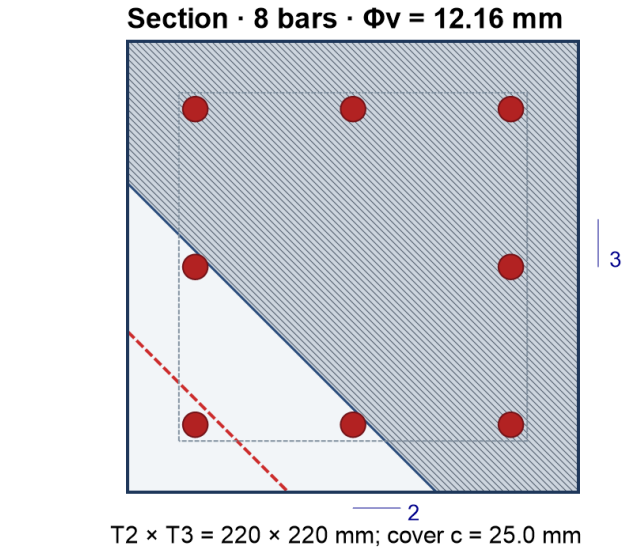
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.52 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	929.39 mm^2	Calculation results
Φ_v	12.1621 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9998	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0105°	Geometry at the check point
Normal vector n	(0.706977; 0.707236)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	204.5170 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.706977 \cdot x_2 + 0.707236 \cdot x_3 = -48.9535$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.706977 \cdot x_2 + 0.707236 \cdot x_3 = -100.0827$ mm	Geometry at the check point
Compressed concrete area A_b	37,034.307 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.332; 18.338) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	425.895 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.810 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.808 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.1621 mm / 116.174 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	116.174	264.458	-0.12064	-24.128	-2.803	-0.216	0.216
2	0.000	-77.000	116.174	210.021	0.62465	124.930	14.514	1.118	0.000
3	77.000	-77.000	116.174	155.583	1.36994	210.000	24.396	1.879	1.879
4	-77.000	77.000	116.174	155.544	1.37049	210.000	24.396	-1.879	-1.879
5	0.000	77.000	116.174	101.106	2.11577	210.000	24.396	-1.879	0.000
6	77.000	77.000	116.174	46.669	2.86106	210.000	24.396	-1.879	1.879
7	-77.000	0.000	116.174	210.001	0.62492	124.985	14.520	0.000	-1.118
8	77.000	0.000	116.174	101.126	2.11550	210.000	24.396	0.000	1.879
Σ N_{si}, M_{xsi}, M_{ysi}							148.213	-2.855	2.855

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	425.895	-7.810	7.808	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	148.213	-2.855	2.855	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**574.107**	**-10.665**	**10.662**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	576.588 kN	From analysis results
M_2	3.038 kN·m	From analysis results
M_3	-2.826 kN·m	From analysis results
M_{2s}	10.689 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.689 kN·m	Including second-order magnification and accidental eccentricity

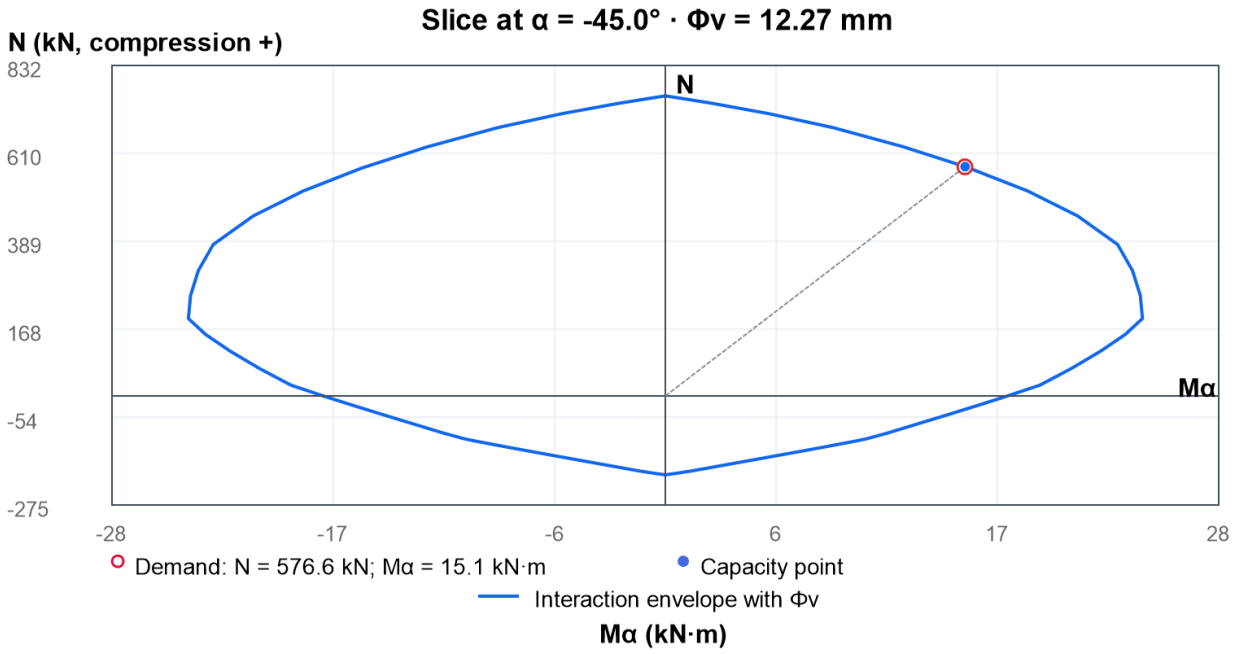
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,206,090	4,206,090	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,483,580,327,587	1,483,580,327,587	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,251.87	1,251.87	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.8539	1.8539	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

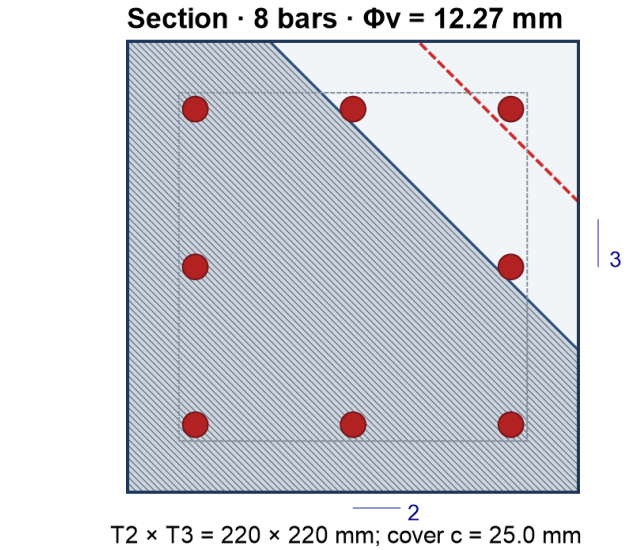
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.63 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	945.88 mm^2	Calculation results
Φ_v	12.2695 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	224.9896°	Geometry at the check point
Normal vector n	(-0.707235; -0.706978)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	204.6321 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707235 \cdot x_2 - 0.706978 \cdot x_3 = -49.0686$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707235 \cdot x_2 - 0.706978 \cdot x_3 = -100.2267$ mm	Geometry at the check point
Compressed concrete area A_b	37,058.843 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.303; -18.297) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	426.177 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.798 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.800 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.2695 mm / 118.235 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	118.235	46.669	2.86142	210.000	24.829	1.912	-1.912
2	0.000	-77.000	118.235	101.126	2.11628	210.000	24.829	1.912	0.000
3	77.000	-77.000	118.235	155.583	1.37114	210.000	24.829	1.912	1.912
4	-77.000	77.000	118.235	155.544	1.37168	210.000	24.829	-1.912	-1.912
5	0.000	77.000	118.235	210.001	0.62654	125.308	14.816	-1.141	0.000
6	77.000	77.000	118.235	264.458	-0.11860	-23.720	-2.805	0.216	-0.216
7	-77.000	0.000	118.235	101.106	2.11655	210.000	24.829	0.000	-1.912
8	77.000	0.000	118.235	210.021	0.62627	125.254	14.809	0.000	1.140
Σ N_{si}, M_{xsi}, M_{ysi}							150.967	2.899	-2.899

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	426.177	7.798	-7.800	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	150.967	2.899	-2.899	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**577.144**	**10.697**	**-10.700**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	429.211 kN	From analysis results
M_2	10.092 kN·m	From analysis results
M_3	5.599 kN·m	From analysis results
M_{2s}	16.365 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.080 kN·m	Including second-order magnification and accidental eccentricity

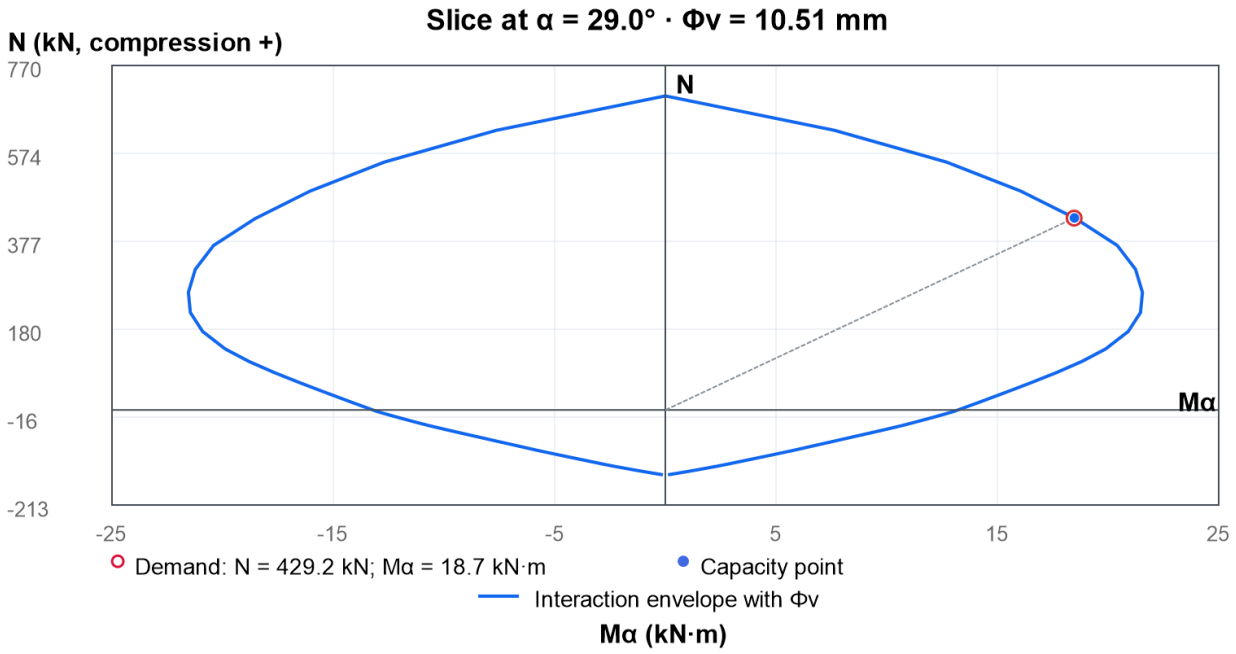
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	23.51	13.05	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,087,238	3,087,238	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,326,941,033,871	1,326,941,033,871	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,119.69	1,119.69	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6216	1.6216	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

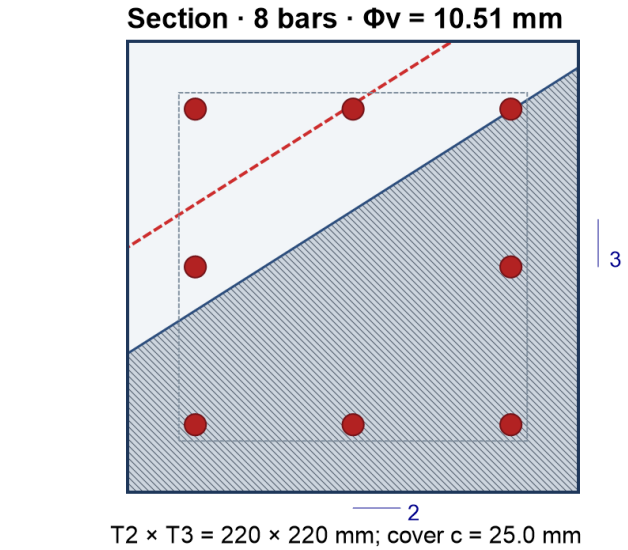
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 175.06 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	694.27 mm^2	Calculation results
Φ_v	10.5117 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	302.3876°	Geometry at the check point
Normal vector n	(0.535645; -0.844443)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	175.0556 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.535645 \cdot x_2 - 0.844443 \cdot x_3 = -23.2459$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.535645 \cdot x_2 - 0.844443 \cdot x_3 = -67.0097$ mm	Geometry at the check point
Compressed concrete area A_b	30,256.165 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.603; -35.336) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.946 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.295 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.473 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.5117 mm / 86.784 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	86.784	128.032	1.45213	210.000	18.225	1.403	-1.403
2	0.000	-77.000	86.784	86.788	2.11184	210.000	18.225	1.403	0.000
3	77.000	-77.000	86.784	45.543	2.77154	210.000	18.225	1.403	1.403
4	-77.000	77.000	86.784	258.076	-0.62791	-125.583	-10.899	0.839	0.839
5	0.000	77.000	86.784	216.832	0.03179	6.358	0.552	-0.042	0.000
6	77.000	77.000	86.784	175.587	0.69150	138.299	12.002	-0.924	0.924
7	-77.000	0.000	86.784	193.054	0.41211	82.422	7.153	0.000	-0.551
8	77.000	0.000	86.784	110.565	1.73152	210.000	18.225	0.000	1.403
Σ N_{si}, M_{xsi}, M_{ysi}							81.706	4.082	2.616

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.946	12.295	6.473	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	81.706	4.082	2.616	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**429.652**	**16.377**	**9.089**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	431.161 kN	From analysis results
M_2	3.656 kN·m	From analysis results
M_3	1.994 kN·m	From analysis results
M_{2s}	8.508 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.508 kN·m	Including second-order magnification and accidental eccentricity

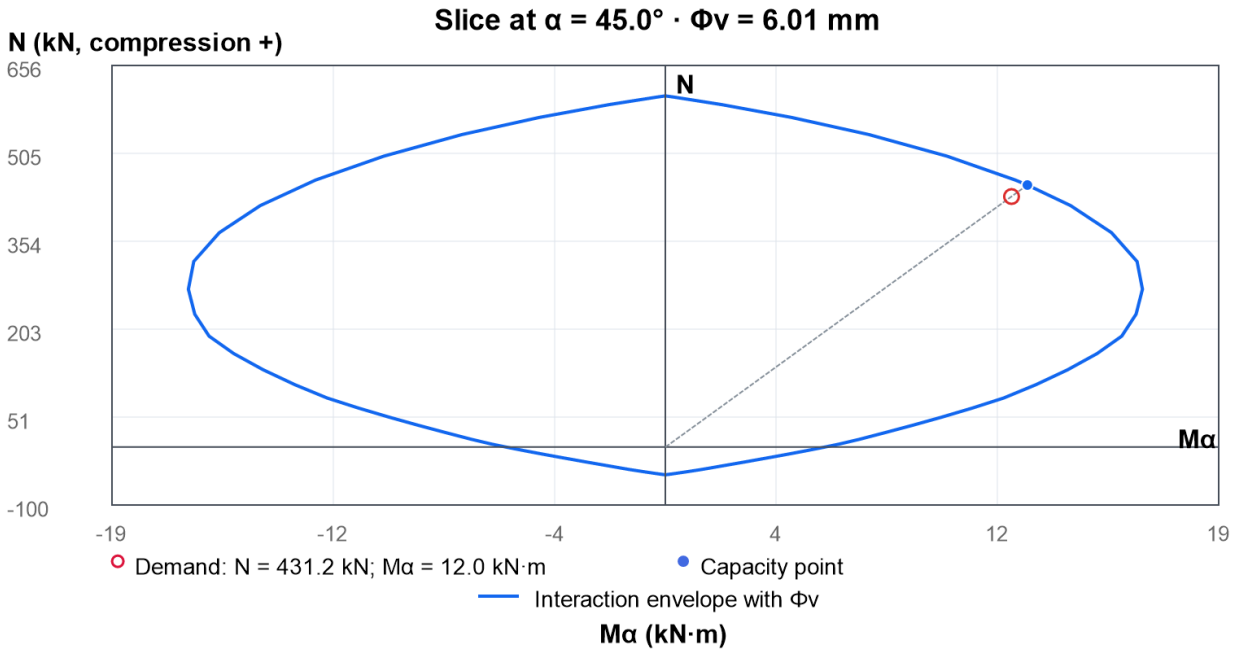
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9732	1.9732	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

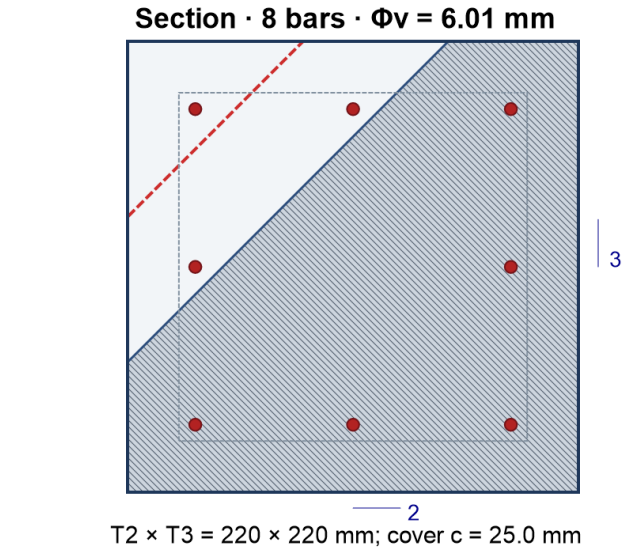
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.49 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9561	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	200.4917 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -44.9282$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -95.0512$ mm	Geometry at the check point
Compressed concrete area A_b	36,159.841 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.581; -19.581) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	415.838 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.143 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.143 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.563	1.32745	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.08784	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.84824	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	-0.19333	-38.666	-1.097	0.084	0.084
5	0.000	77.000	28.366	210.011	0.56706	113.412	3.217	-0.248	0.000
6	77.000	77.000	28.366	155.563	1.32745	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.56706	113.412	3.217	0.000	-0.248
8	77.000	0.000	28.366	101.116	2.08784	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							35.122	0.754	0.754

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	415.838	8.143	8.143	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.122	0.754	0.754	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**450.960**	**8.897**	**8.897**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	433.763 kN	From analysis results
M_2	-4.925 kN·m	From analysis results
M_3	-2.813 kN·m	From analysis results
M_{2s}	-9.775 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.610 kN·m	Including second-order magnification and accidental eccentricity

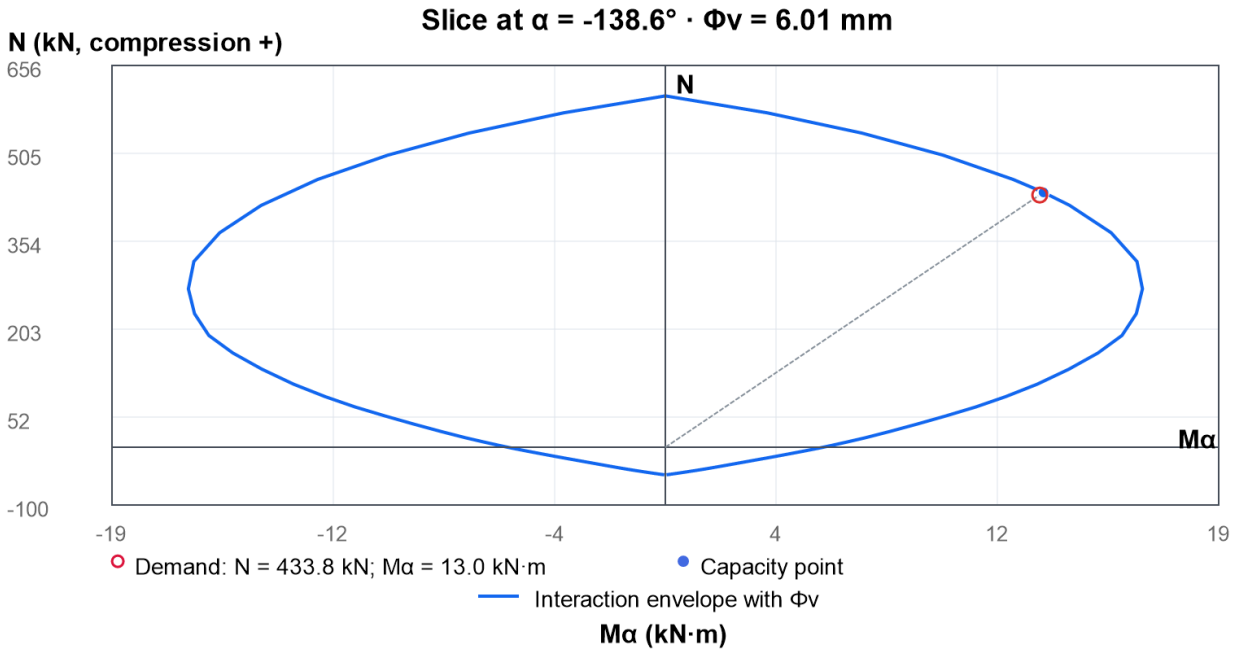
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	11.35	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.9849	1.9849	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

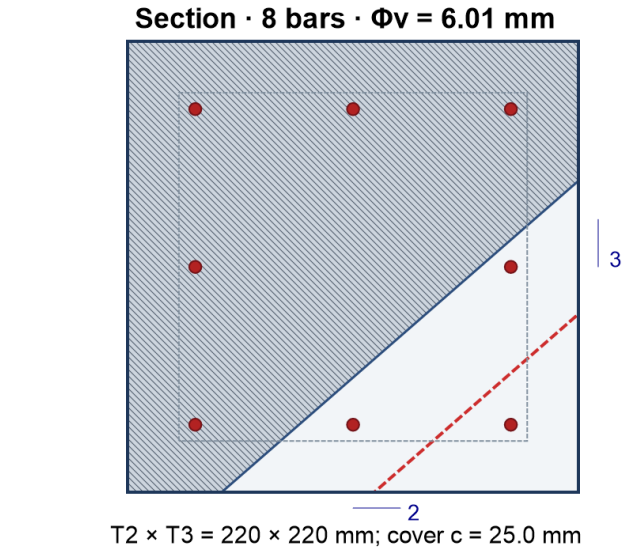
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 195.89 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9896	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	131.1091°	Geometry at the check point
Normal vector n	(-0.657495; 0.753459)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	195.8861 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.657495 \cdot x_2 + 0.753459 \cdot x_3 = -40.6811$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.657495 \cdot x_2 + 0.753459 \cdot x_3 = -89.6527$ mm	Geometry at the check point
Compressed concrete area A_b	35,162.396 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.554; 22.338) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	404.368 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-9.033 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.907 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	162.594	1.17588	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	213.221	0.45221	90.442	2.566	0.198	0.000
3	77.000	-77.000	28.366	263.848	-0.27145	-54.291	-1.540	-0.119	-0.119
4	-77.000	77.000	28.366	46.561	2.83445	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	97.189	2.11078	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	147.816	1.38712	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	104.578	2.00516	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	205.832	0.55783	111.566	3.165	0.000	0.244
Σ N_{si}, M_{xsi}, M_{ysi}							33.975	-0.838	-0.792

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	404.368	-9.033	-7.907	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	33.975	-0.838	-0.792	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**438.343**	**-9.871**	**-8.699**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	427.766 kN	From analysis results
M_2	-8.620 kN·m	From analysis results
M_3	-5.493 kN·m	From analysis results
M_{2s}	-14.557 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.276 kN·m	Including second-order magnification and accidental eccentricity

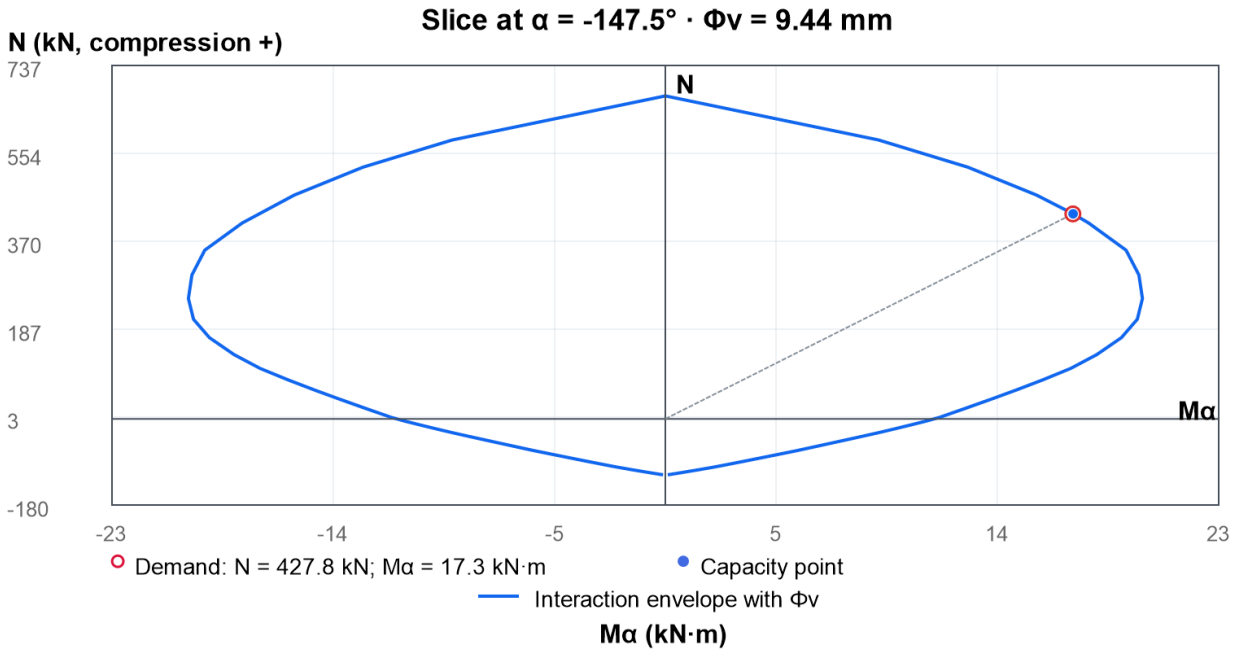
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	20.15	12.84	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,488,494	2,488,494	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,243,116,868,319	1,243,116,868,319	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,048.96	1,048.96	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6886	1.6886	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

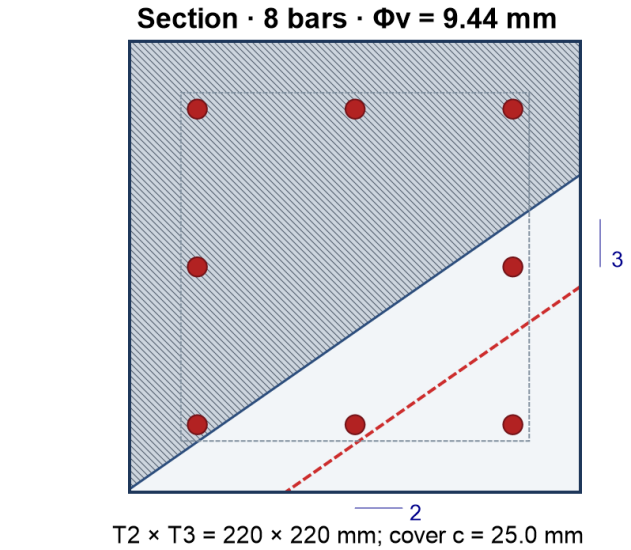
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 179.14 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	559.62 mm^2	Calculation results
Φ_v	9.4375 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	124.8897°	Geometry at the check point
Normal vector n	(-0.571999; 0.820254)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	179.1362 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.571999 \cdot x_2 + 0.820254 \cdot x_3 = -25.9883$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.571999 \cdot x_2 + 0.820254 \cdot x_3 = -70.7724$ mm	Geometry at the check point
Compressed concrete area A_b	31,170.312 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.851; 32.237) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	358.459 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-11.556 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.116 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.4375 mm / 69.953 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	69.953	172.264	0.80742	161.485	11.296	0.870	-0.870
2	0.000	-77.000	69.953	216.307	0.11899	23.798	1.665	0.128	0.000
3	77.000	-77.000	69.953	260.351	-0.56944	-113.888	-7.967	-0.613	-0.613
4	-77.000	77.000	69.953	45.944	2.78186	210.000	14.690	-1.131	-1.131
5	0.000	77.000	69.953	89.988	2.09343	210.000	14.690	-1.131	0.000
6	77.000	77.000	69.953	134.032	1.40500	210.000	14.690	-1.131	1.131
7	-77.000	0.000	69.953	109.104	1.79464	210.000	14.690	0.000	-1.131
8	77.000	0.000	69.953	197.192	0.41778	83.556	5.845	0.000	0.450
Σ N_{si}, M_{xsi}, M_{ysi}							69.599	-3.009	-2.164

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	358.459	-11.556	-7.116	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	69.599	-3.009	-2.164	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**428.058**	**-14.564**	**-9.280**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	429.716 kN	From analysis results
M_2	-3.059 kN·m	From analysis results
M_3	-2.006 kN·m	From analysis results
M_{2s}	-8.452 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.452 kN·m	Including second-order magnification and accidental eccentricity

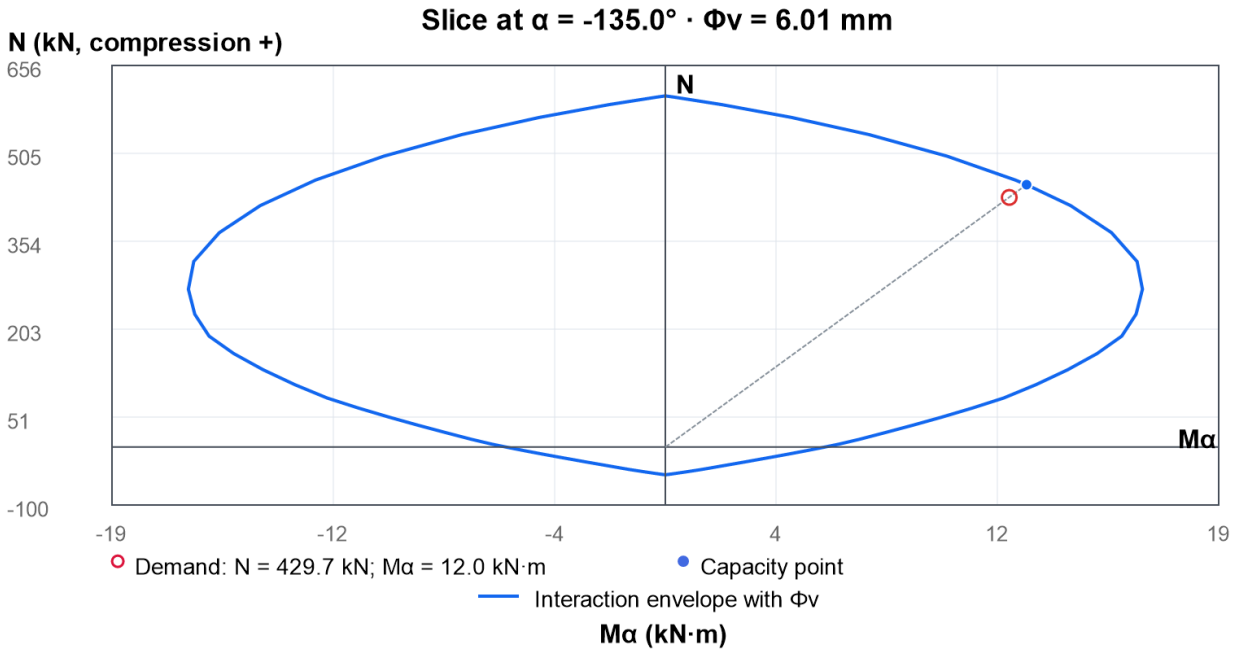
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9668	1.9668	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

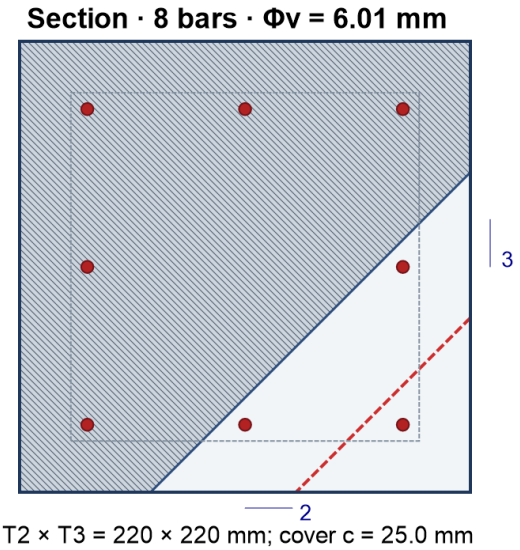
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.71 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9516	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	135.0000°	Geometry at the check point
Normal vector n	(-0.707107; 0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	200.7061 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -45.1427$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -95.3192$ mm	Geometry at the check point
Compressed concrete area A_b	36,207.239 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.514; 19.514) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	416.383 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.125 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.125 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.563	1.32977	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.011	0.57019	114.039	3.235	0.249	0.000
3	77.000	-77.000	28.366	264.458	-0.18938	-37.877	-1.074	-0.083	-0.083
4	-77.000	77.000	28.366	46.669	2.84893	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.116	2.08935	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.563	1.32977	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.116	2.08935	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.57019	114.039	3.235	0.000	0.249
Σ N_{si}, M_{xsi}, M_{ysi}							35.180	-0.751	-0.751

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	416.383	-8.125	-8.125	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.180	-0.751	-0.751	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**451.563**	**-8.876**	**-8.876**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	432.318 kN	From analysis results
M_2	4.357 kN·m	From analysis results
M_3	2.643 kN·m	From analysis results
M_{2s}	8.619 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.553 kN·m	Including second-order magnification and accidental eccentricity

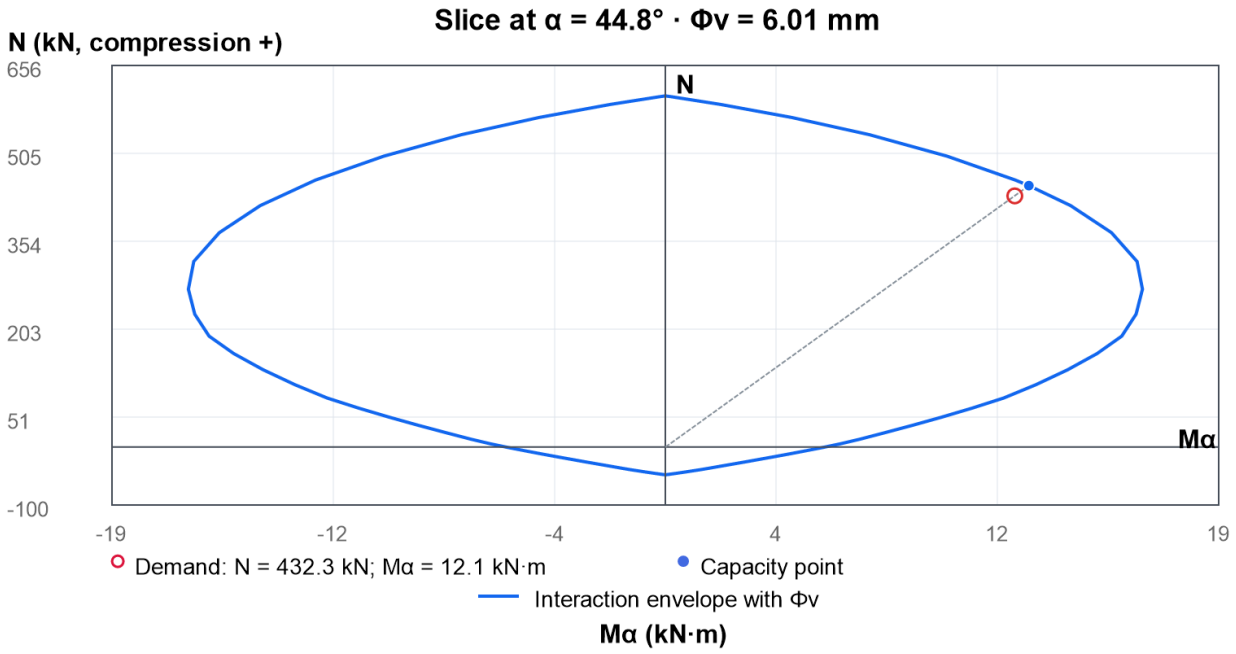
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.08	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.9784	1.9784	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

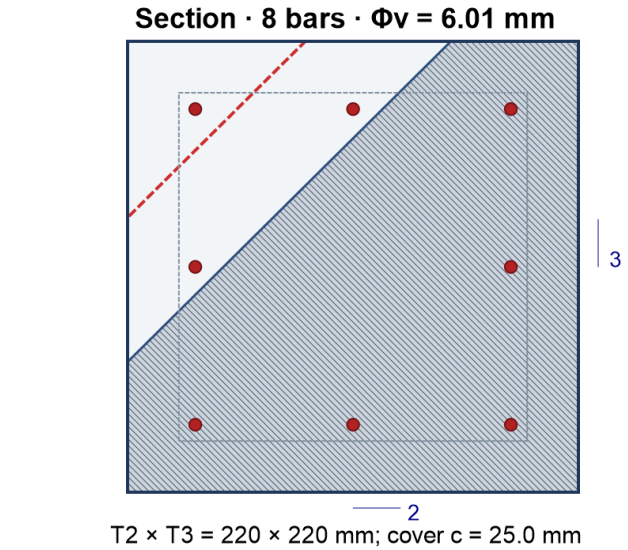
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.11 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9610	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	314.7558°	Geometry at the check point
Normal vector n	(0.704086; -0.710115)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	200.1062 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.704086 \cdot x_2 - 0.710115 \cdot x_3 = -44.5441$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.704086 \cdot x_2 - 0.710115 \cdot x_3 = -94.5707$ mm	Geometry at the check point
Compressed concrete area A_b	36,074.570 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.626; -19.778) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	414.858 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.205 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.142 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.098	1.32978	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	100.883	2.08838	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.84699	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.456	-0.20041	-40.082	-1.137	0.088	0.088
5	0.000	77.000	28.366	210.241	0.55819	111.638	3.167	-0.244	0.000
6	77.000	77.000	28.366	156.026	1.31679	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	209.777	0.56469	112.937	3.204	0.000	-0.247
8	77.000	0.000	28.366	101.347	2.08189	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							35.018	0.761	0.758

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	414.858	8.205	8.142	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.018	0.761	0.758	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**449.876**	**8.966**	**8.900**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	638.489 kN	From analysis results
M_2	4.128 kN·m	From analysis results
M_3	-6.596 kN·m	From analysis results
M_{2s}	11.451 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.830 kN·m	Including second-order magnification and accidental eccentricity

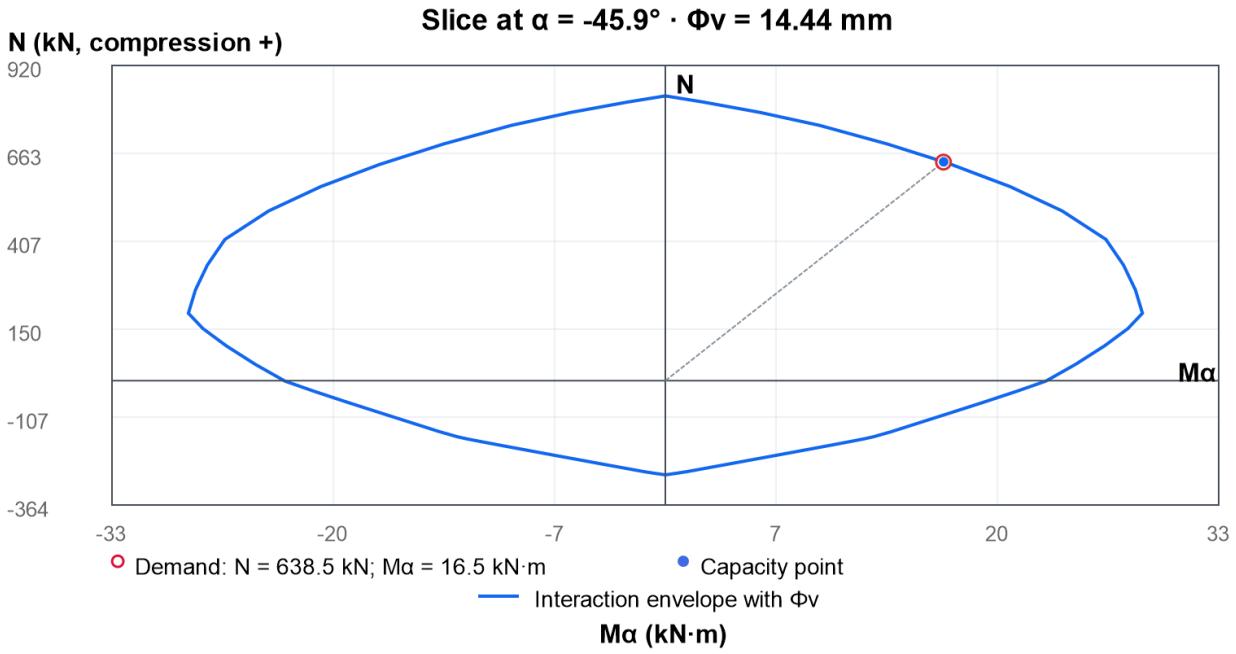
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.33	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	5,825,368	5,825,368	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,710,279,337,855	1,710,279,337,855	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,443.16	1,443.16	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7935	1.7935	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

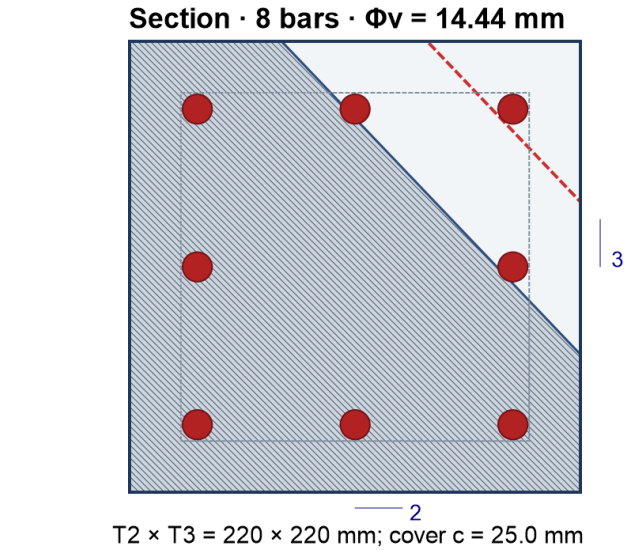
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 205.58 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,310.03 mm^2	Calculation results
Φ_v	14.4394 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	223.6696°	Geometry at the check point
Normal vector n	(-0.723334; -0.690498)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	205.5758 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.723334 \cdot x_2 - 0.690498 \cdot x_3 = -50.0543$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.723334 \cdot x_2 - 0.690498 \cdot x_3 = -101.4482$ mm	Geometry at the check point
Compressed concrete area A_b	37,264.642 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.347; -17.656) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	428.543 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.566 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.862 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.4394 mm / 163.754 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	163.754	46.656	2.86453	210.000	34.388	2.648	-2.648
2	0.000	-77.000	163.754	102.353	2.10592	210.000	34.388	2.648	0.000
3	77.000	-77.000	163.754	158.050	1.34732	210.000	34.388	2.648	2.648
4	-77.000	77.000	163.754	152.993	1.41619	210.000	34.388	-2.648	-2.648
5	0.000	77.000	163.754	208.690	0.65759	131.517	21.536	-1.658	0.000
6	77.000	77.000	163.754	264.387	-0.10102	-20.204	-3.308	0.255	-0.255
7	-77.000	0.000	163.754	99.825	2.14036	210.000	34.388	0.000	-2.648
8	77.000	0.000	163.754	211.218	0.62315	124.630	20.409	0.000	1.571
Σ N_{si}, M_{xsi}, M_{ysi}							210.578	3.892	-3.979

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	428.543	7.566	-7.862	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	210.578	3.892	-3.979	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**639.121**	**11.459**	**-11.841**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	640.440 kN	From analysis results
M_2	1.519 kN·m	From analysis results
M_3	-2.397 kN·m	From analysis results
M_{2s}	11.527 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.527 kN·m	Including second-order magnification and accidental eccentricity

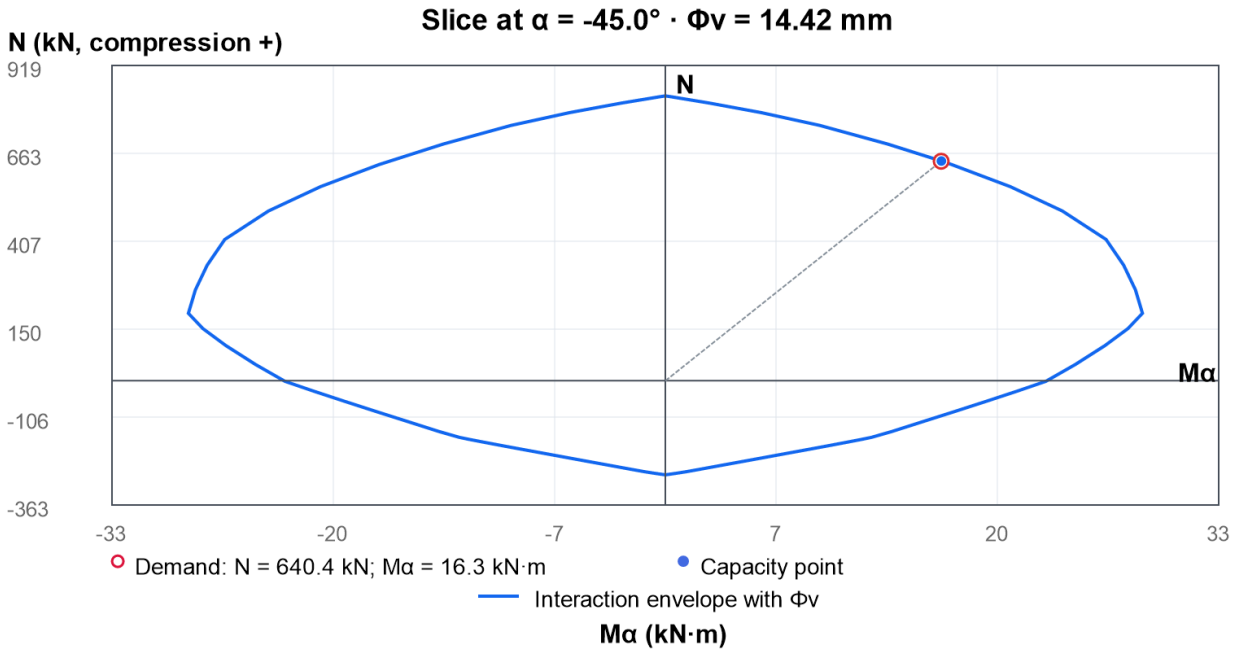
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	5,808,055	5,808,055	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,707,855,518,131	1,707,855,518,131	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,441.12	1,441.12	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7999	1.7999	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

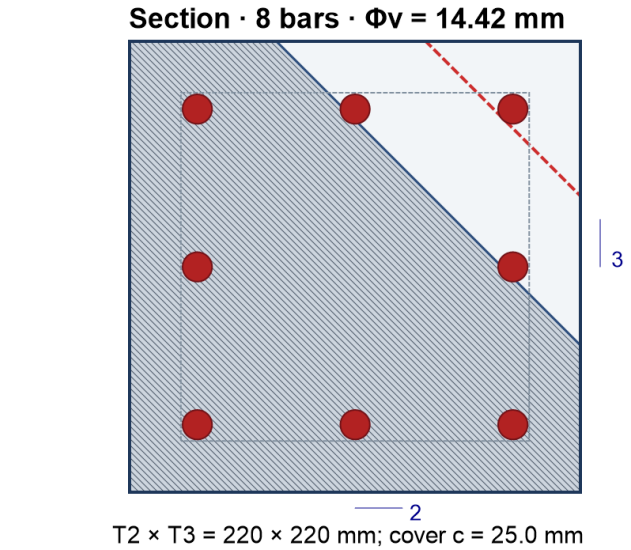
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.25 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,306.13 mm^2	Calculation results
Φ_v	14.4180 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0070°	Geometry at the check point
Normal vector n	(-0.707021; -0.707193)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	206.2487 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707021 \cdot x_2 - 0.707193 \cdot x_3 = -50.6852$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707021 \cdot x_2 - 0.707193 \cdot x_3 = -102.2474$ mm	Geometry at the check point
Compressed concrete area A_b	37,400.553 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-17.809; -17.812) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.106 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.661 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.660 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.4180 mm / 163.267 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	163.267	46.669	2.86643	210.000	34.286	2.640	-2.640
2	0.000	-77.000	163.267	101.110	2.12735	210.000	34.286	2.640	0.000
3	77.000	-77.000	163.267	155.550	1.38827	210.000	34.286	2.640	2.640
4	-77.000	77.000	163.267	155.577	1.38791	210.000	34.286	-2.640	-2.640
5	0.000	77.000	163.267	210.017	0.64884	129.768	21.187	-1.631	0.000
6	77.000	77.000	163.267	264.458	-0.09024	-18.048	-2.947	0.227	-0.227
7	-77.000	0.000	163.267	101.123	2.12717	210.000	34.286	0.000	-2.640
8	77.000	0.000	163.267	210.004	0.64902	129.804	21.193	0.000	1.632
Σ N_{si}, M_{xsi}, M_{ysi}							210.863	3.876	-3.875

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.106	7.661	-7.660	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	210.863	3.876	-3.875	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**640.969**	**11.537**	**-11.535**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	643.041 kN	From analysis results
M_2	-1.961 kN·m	From analysis results
M_3	3.202 kN·m	From analysis results
M_{2s}	-11.570 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.570 kN·m	Including second-order magnification and accidental eccentricity

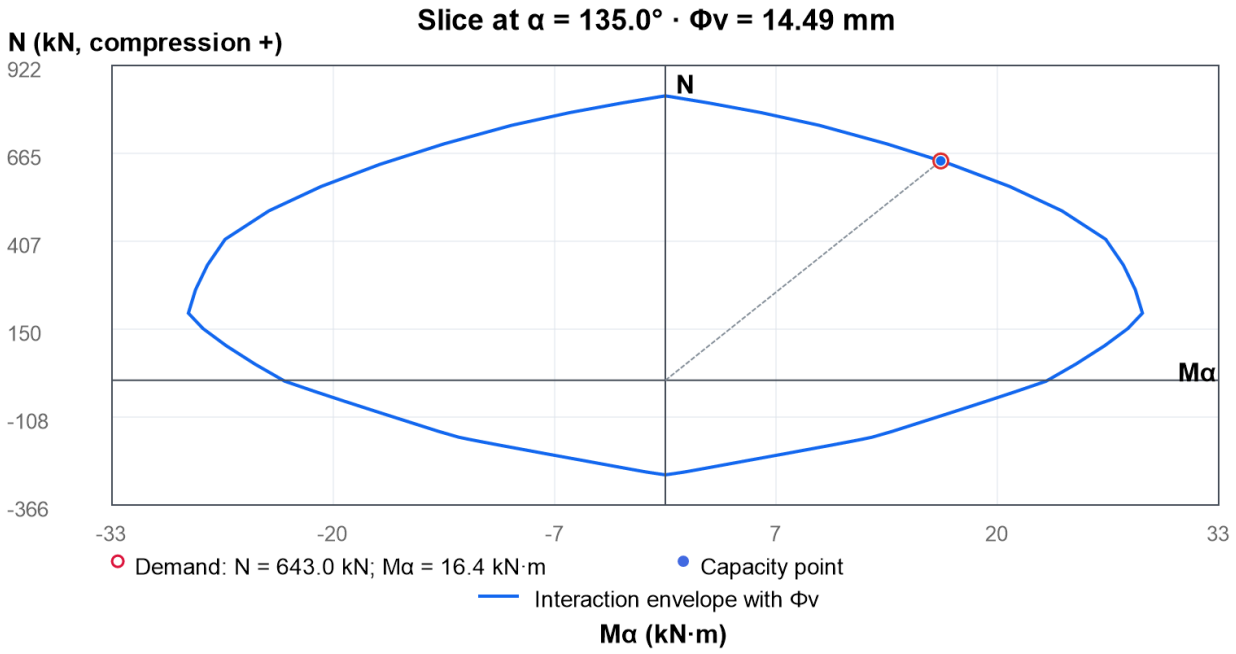
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	5,863,261	5,863,261	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,715,584,301,069	1,715,584,301,069	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,447.64	1,447.64	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7992	1.7992	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

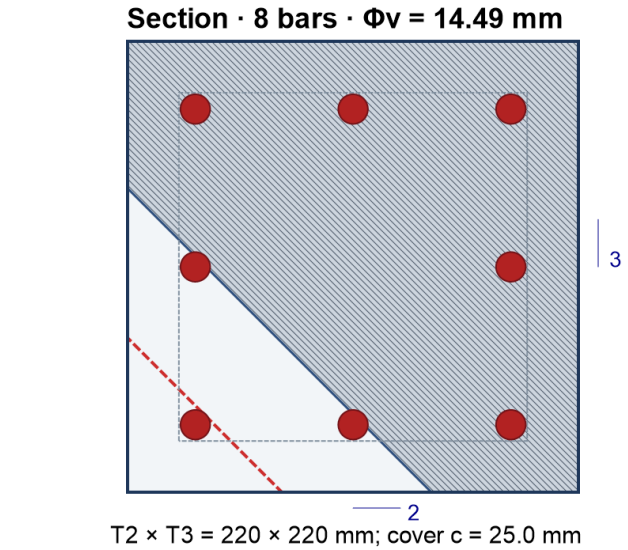
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.29 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,318.55 mm^2	Calculation results
Φ_v	14.4863 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9998	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0000°	Geometry at the check point
Normal vector n	(0.707107; 0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	206.2921 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -50.7286$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -102.3016$ mm	Geometry at the check point
Compressed concrete area A_b	37,409.644 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(17.798; 17.798) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.211 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.657 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.657 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	14.4863 mm / 164.819 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	164.819	264.458	-0.08948	-17.897	-2.950	-0.227	0.227
2	0.000	-77.000	164.819	210.011	0.64953	129.905	21.411	1.649	0.000
3	77.000	-77.000	164.819	155.563	1.38854	210.000	34.612	2.665	2.665
4	-77.000	77.000	164.819	155.563	1.38854	210.000	34.612	-2.665	-2.665
5	0.000	77.000	164.819	101.116	2.12755	210.000	34.612	-2.665	0.000
6	77.000	77.000	164.819	46.669	2.86656	210.000	34.612	-2.665	2.665
7	-77.000	0.000	164.819	210.011	0.64953	129.905	21.411	0.000	-1.649
8	77.000	0.000	164.819	101.116	2.12755	210.000	34.612	0.000	2.665
Σ N_{si}, M_{xsi}, M_{ysi}							212.932	-3.909	3.909

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.211	-7.657	7.657	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	212.932	-3.909	3.909	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**643.143**	**-11.565**	**11.565**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	459.014 kN	From analysis results
M_2	0.541 kN·m	From analysis results
M_3	-5.300 kN·m	From analysis results
M_{2s}	8.970 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.357 kN·m	Including second-order magnification and accidental eccentricity

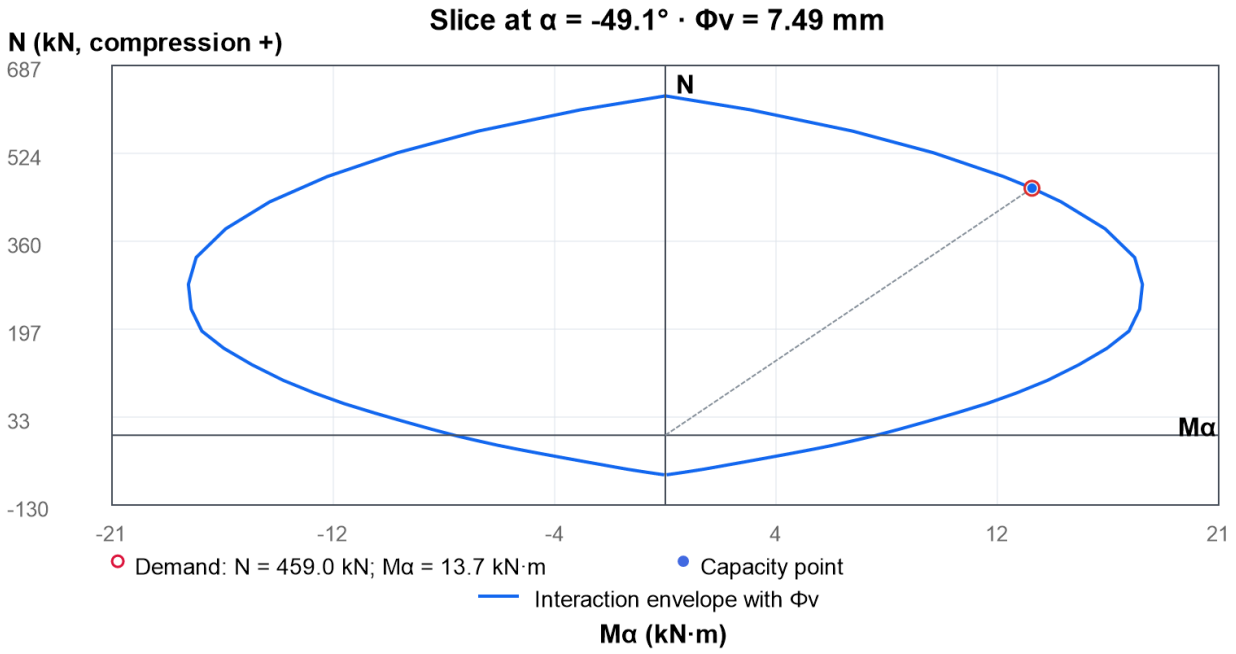
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	11.55	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,567,136	1,567,136	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,114,126,760,288	1,114,126,760,288	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	940.12	940.12	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9541	1.9541	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

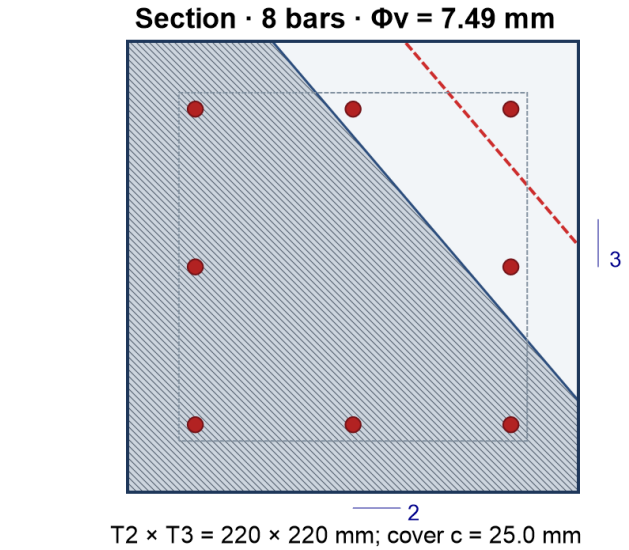
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 196.44 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	352.42 mm^2	Calculation results
Φ_v	7.4893 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9998	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	220.4273°	Geometry at the check point
Normal vector n	(-0.761229; -0.648483)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	196.4351 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.761229 \cdot x_2 - 0.648483 \cdot x_3 = -41.3668$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.761229 \cdot x_2 - 0.648483 \cdot x_3 = -90.4756$ mm	Geometry at the check point
Compressed concrete area A_b	35,305.501 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-22.332; -19.121) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	406.013 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.764 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-9.067 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.4893 mm / 44.053 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	44.053	46.520	2.83689	210.000	9.251	0.712	-0.712
2	0.000	-77.000	44.053	105.135	2.00140	210.000	9.251	0.712	0.000
3	77.000	-77.000	44.053	163.750	1.16590	210.000	9.251	0.712	0.712
4	-77.000	77.000	44.053	146.387	1.41339	210.000	9.251	-0.712	-0.712
5	0.000	77.000	44.053	205.001	0.57789	115.579	5.092	-0.392	0.000
6	77.000	77.000	44.053	263.616	-0.25760	-51.521	-2.270	0.175	-0.175
7	-77.000	0.000	44.053	96.454	2.12514	210.000	9.251	0.000	-0.712
8	77.000	0.000	44.053	213.683	0.45415	90.829	4.001	0.000	0.308
Σ N_{si}, M_{xsi}, M_{ysi}							53.079	1.207	-1.291

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	406.013	7.764	-9.067	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	53.079	1.207	-1.291	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**459.092**	**8.971**	**-10.358**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	460.965 kN	From analysis results
M_2	0.231 kN·m	From analysis results
M_3	-1.928 kN·m	From analysis results
M_{2s}	9.255 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.255 kN·m	Including second-order magnification and accidental eccentricity

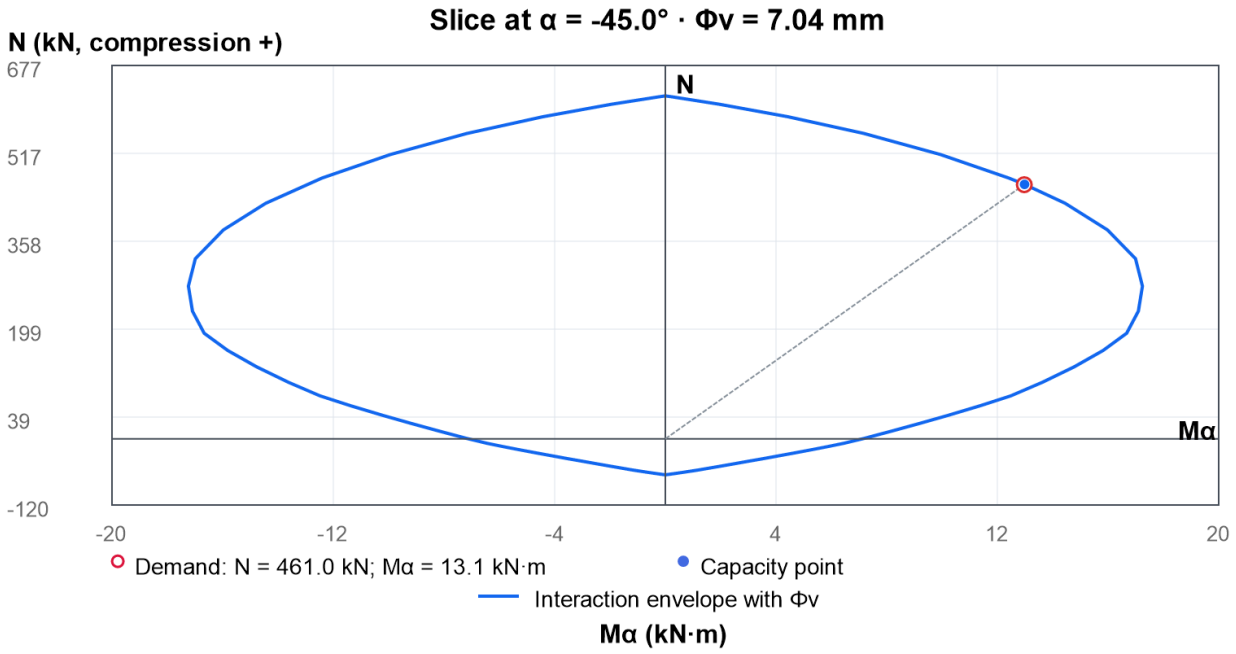
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,382,834	1,382,834	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,088,324,550,272	1,088,324,550,272	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	918.35	918.35	(45); $N_{cr} = \pi^2 D/L_0^2$
η	2.0078	2.0078	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

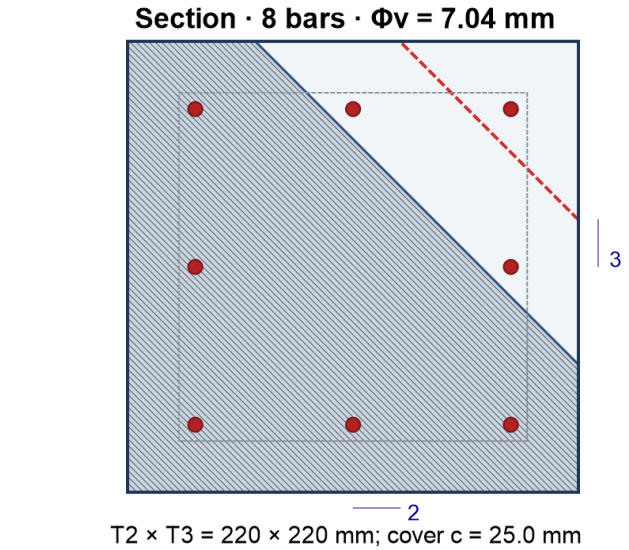
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.63 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	310.98 mm^2	Calculation results
Φ_v	7.0352 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0000°	Geometry at the check point
Normal vector n	(-0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	199.6319 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -44.0684$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -93.9764$ mm	Geometry at the check point
Compressed concrete area A_b	35,968.853 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.852; -19.852) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	413.642 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.212 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.212 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.0352 mm / 38.872 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	38.872	46.669	2.84543	210.000	8.163	0.629	-0.629
2	0.000	-77.000	38.872	101.116	2.08176	210.000	8.163	0.629	0.000
3	77.000	-77.000	38.872	155.563	1.31810	210.000	8.163	0.629	0.629
4	-77.000	77.000	38.872	155.563	1.31810	210.000	8.163	-0.629	-0.629
5	0.000	77.000	38.872	210.011	0.55443	110.886	4.310	-0.332	0.000
6	77.000	77.000	38.872	264.458	-0.20924	-41.847	-1.627	0.125	-0.125
7	-77.000	0.000	38.872	101.116	2.08176	210.000	8.163	0.000	-0.629
8	77.000	0.000	38.872	210.011	0.55443	110.886	4.310	0.000	0.332
Σ N_{si}, M_{xsi}, M_{ysi}							47.810	1.050	-1.050

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	413.642	8.212	-8.212	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	47.810	1.050	-1.050	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**461.451**	**9.262**	**-9.262**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	463.566 kN	From analysis results
M_2	-0.183 kN·m	From analysis results
M_3	2.567 kN·m	From analysis results
M_{2s}	-9.294 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.294 kN·m	Including second-order magnification and accidental eccentricity

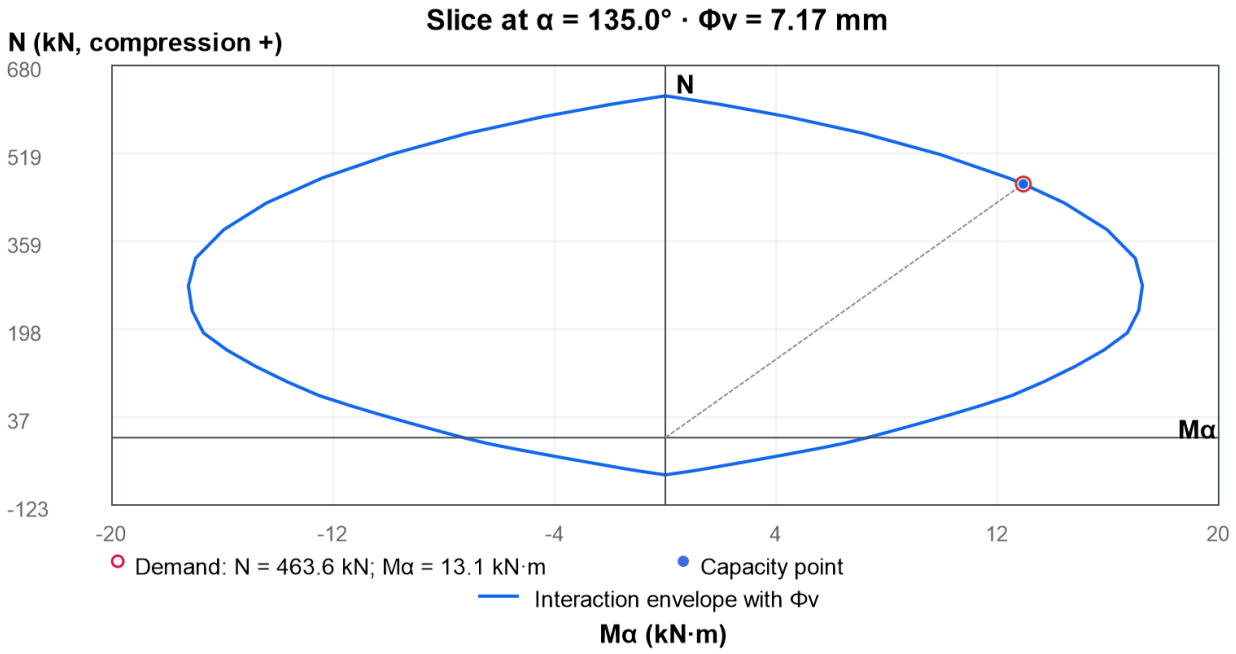
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,437,714	1,437,714	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,096,007,725,381	1,096,007,725,381	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	924.83	924.83	(45); $N_{cr}=\pi^2D/L_0^2$
η	2.0050	2.0050	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

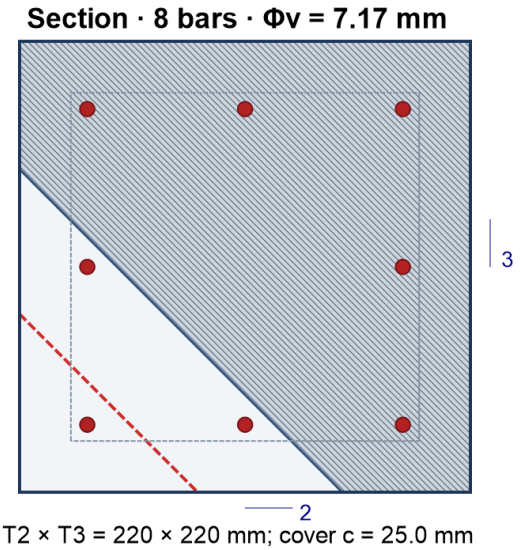
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.73 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	323.32 mm^2	Calculation results
Φ_v	7.1734 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9999	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	44.9906°	Geometry at the check point
Normal vector n	(0.707222; 0.706991)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	199.7260 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707222 \cdot x_2 + 0.706991 \cdot x_3 = -44.1625$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707222 \cdot x_2 + 0.706991 \cdot x_3 = -94.0940$ mm	Geometry at the check point
Compressed concrete area A_b	35,989.824 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.825; 19.819) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	413.883 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.203 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.205 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.1734 mm / 40.415 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	40.415	264.458	-0.20749	-41.498	-1.677	-0.129	0.129
2	0.000	-77.000	40.415	210.002	0.55594	111.188	4.494	0.346	0.000
3	77.000	-77.000	40.415	155.546	1.31937	210.000	8.487	0.654	0.654
4	-77.000	77.000	40.415	155.581	1.31887	210.000	8.487	-0.654	-0.654
5	0.000	77.000	40.415	101.125	2.08231	210.000	8.487	-0.654	0.000
6	77.000	77.000	40.415	46.669	2.84574	210.000	8.487	-0.654	0.654
7	-77.000	0.000	40.415	210.020	0.55569	111.138	4.492	0.000	-0.346
8	77.000	0.000	40.415	101.107	2.08255	210.000	8.487	0.000	0.654
Σ N_{si}, M_{xsi}, M_{ysi}							49.744	-1.090	1.090

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	413.883	-8.203	8.205	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	49.744	-1.090	1.090	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**463.627**	**-9.293**	**9.296**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	573.530 kN	From analysis results
M_2	-6.028 kN·m	From analysis results
M_3	-5.458 kN·m	From analysis results
M_{2s}	-11.113 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.573 kN·m	Including second-order magnification and accidental eccentricity

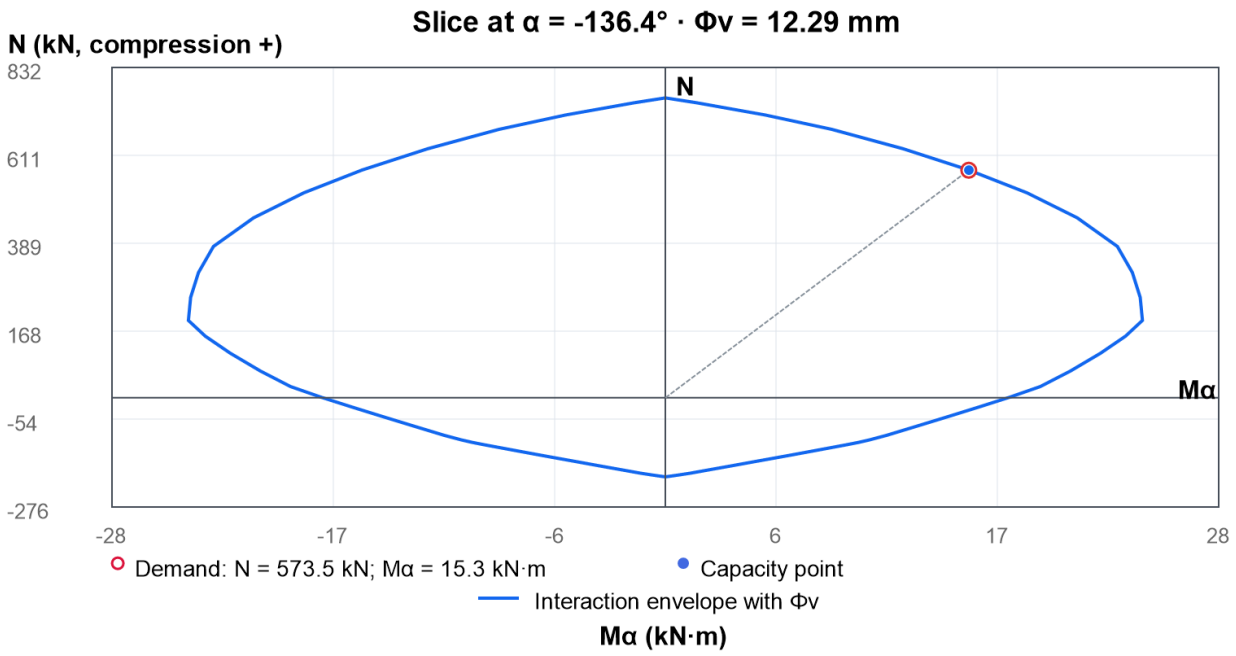
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.51	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	4,219,491	4,219,491	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,485,456,549,275	1,485,456,549,275	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,253.45	1,253.45	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.8435	1.8435	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

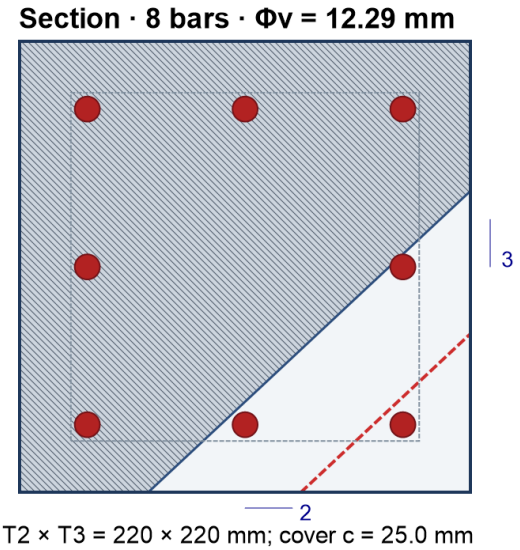
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 203.54 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	948.89 mm^2	Calculation results
Φ_v	12.2891 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	133.0725°	Geometry at the check point
Normal vector n	(-0.682923; 0.730490)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	203.5383 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.682923 \cdot x_2 + 0.730490 \cdot x_3 = -48.0628$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.682923 \cdot x_2 + 0.730490 \cdot x_3 = -98.9474$ mm	Geometry at the check point
Compressed concrete area A_b	36,836.357 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.073; 19.145) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	423.618 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.110 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.656 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.2891 mm / 118.612 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	118.612	159.138	1.31080	210.000	24.908	1.918	-1.918
2	0.000	-77.000	118.612	211.723	0.58740	117.481	13.935	1.073	0.000
3	77.000	-77.000	118.612	264.308	-0.13599	-27.198	-3.226	-0.248	-0.248
4	-77.000	77.000	118.612	46.643	2.85835	210.000	24.908	-1.918	-1.918
5	0.000	77.000	118.612	99.228	2.13496	210.000	24.908	-1.918	0.000
6	77.000	77.000	118.612	151.813	1.41157	210.000	24.908	-1.918	1.918
7	-77.000	0.000	118.612	102.890	2.08458	210.000	24.908	0.000	-1.918
8	77.000	0.000	118.612	208.061	0.63779	127.558	15.130	0.000	1.165
Σ N_{si}, M_{xsi}, M_{ysi}							150.381	-3.011	-2.919

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	423.618	-8.110	-7.656	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	150.381	-3.011	-2.919	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**573.999**	**-11.121**	**-10.575**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	575.481 kN	From analysis results
M_2	-2.128 kN·m	From analysis results
M_3	-1.982 kN·m	From analysis results
M_{2s}	-10.674 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.674 kN·m	Including second-order magnification and accidental eccentricity

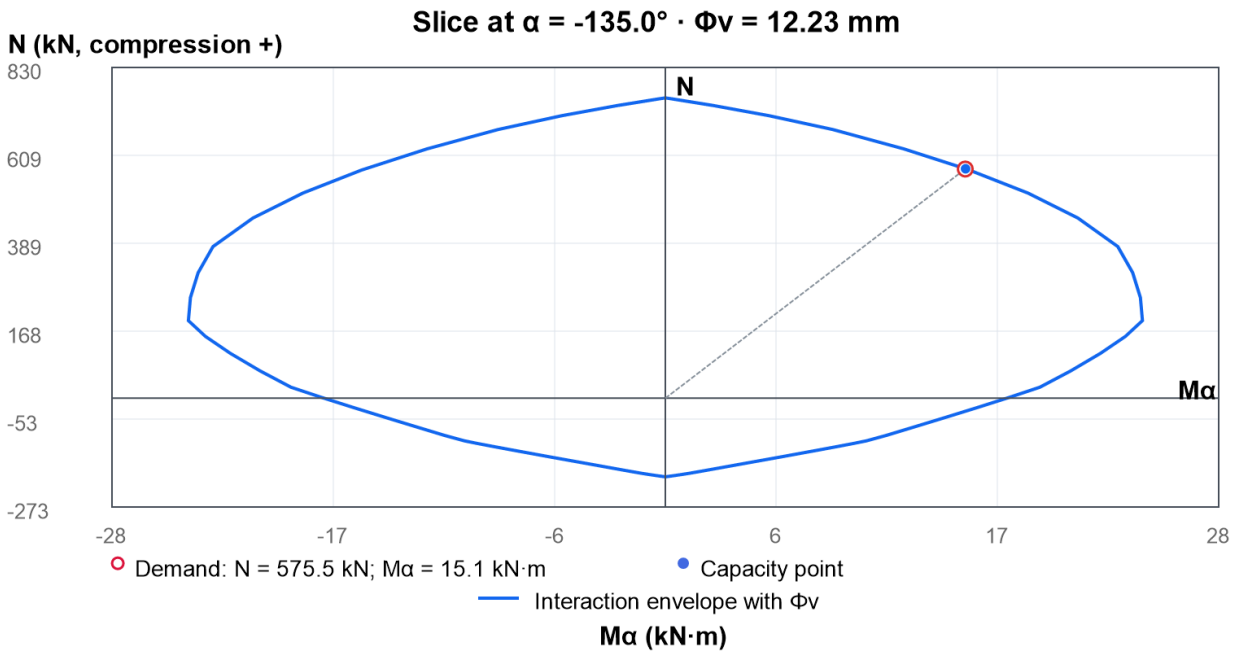
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	4,179,350	4,179,350	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,479,836,837,074	1,479,836,837,074	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,248.71	1,248.71	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.8548	1.8548	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

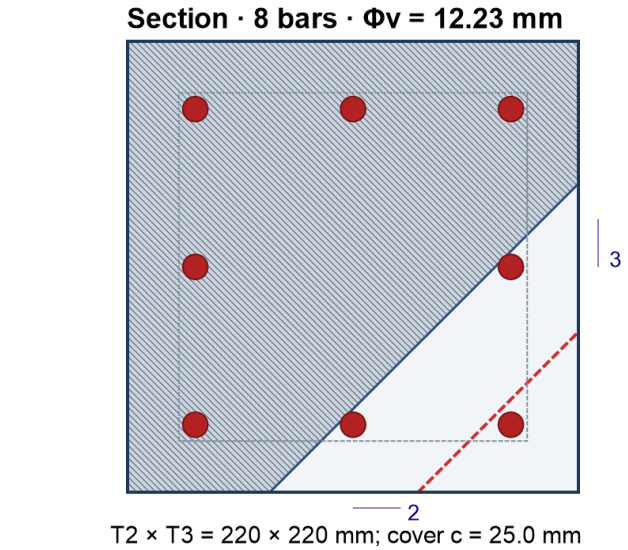
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.60 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	939.87 mm^2	Calculation results
Φ_v	12.2305 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	134.9896°	Geometry at the check point
Normal vector n	(-0.706978; 0.707236)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	204.6025 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.706978 \cdot x_2 + 0.707236 \cdot x_3 = -49.0390$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.706978 \cdot x_2 + 0.707236 \cdot x_3 = -100.1897$ mm	Geometry at the check point
Compressed concrete area A_b	37,052.538 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.306; 18.312) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	426.104 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.803 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.800 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.2305 mm / 117.483 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	117.483	155.583	1.37083	210.000	24.671	1.900	-1.900
2	0.000	-77.000	117.483	210.021	0.62585	125.171	14.705	1.132	0.000
3	77.000	-77.000	117.483	264.458	-0.11913	-23.825	-2.799	-0.216	-0.216
4	-77.000	77.000	117.483	46.669	2.86133	210.000	24.671	-1.900	-1.900
5	0.000	77.000	117.483	101.106	2.11635	210.000	24.671	-1.900	0.000
6	77.000	77.000	117.483	155.544	1.37137	210.000	24.671	-1.900	1.900
7	-77.000	0.000	117.483	101.126	2.11608	210.000	24.671	0.000	-1.900
8	77.000	0.000	117.483	210.001	0.62612	125.225	14.712	0.000	1.133
Σ N_{si}, M_{xsi}, M_{ysi}							149.976	-2.883	-2.882

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	426.104	-7.803	-7.800	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	149.976	-2.883	-2.882	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**576.080**	**-10.685**	**-10.682**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	578.082 kN	From analysis results
M_2	3.072 kN·m	From analysis results
M_3	2.653 kN·m	From analysis results
M_{2s}	10.706 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.706 kN·m	Including second-order magnification and accidental eccentricity

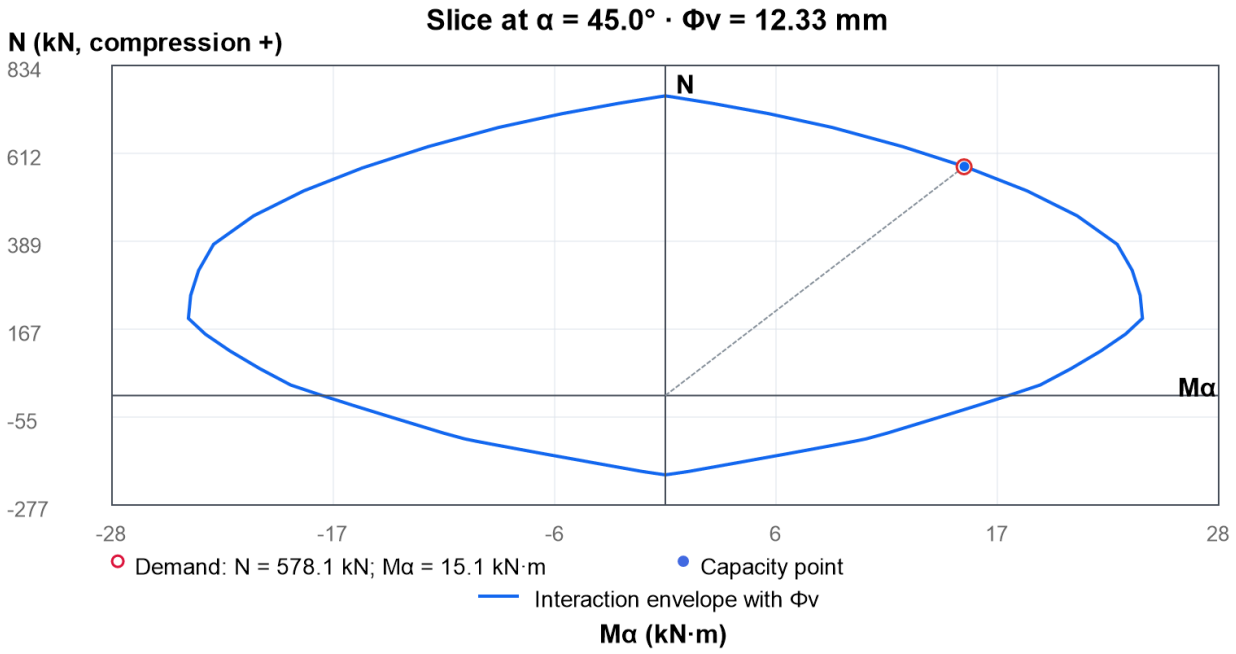
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,246,358	4,246,358	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,489,217,945,514	1,489,217,945,514	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,256.63	1,256.63	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.8519	1.8519	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

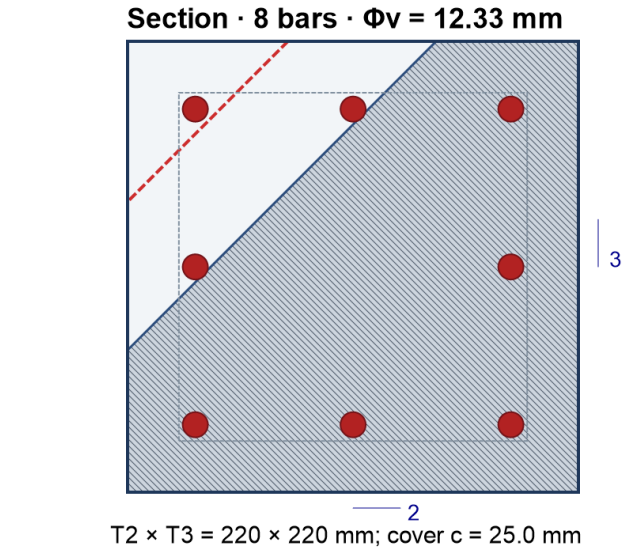
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.69 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	954.94 mm^2	Calculation results
Φ_v	12.3281 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9988	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0103°	Geometry at the check point
Normal vector n	(0.707234; -0.706979)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	204.6894 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707234 \cdot x_2 - 0.706979 \cdot x_3 = -49.1259$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707234 \cdot x_2 - 0.706979 \cdot x_3 = -100.2983$ mm	Geometry at the check point
Compressed concrete area A_b	37,071.045 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.285; -18.280) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	426.317 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.793 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.795 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.3281 mm / 119.367 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	119.367	155.583	1.37174	210.000	25.067	1.930	-1.930
2	0.000	-77.000	119.367	101.126	2.11667	210.000	25.067	1.930	0.000
3	77.000	-77.000	119.367	46.669	2.86160	210.000	25.067	1.930	1.930
4	-77.000	77.000	119.367	264.458	-0.11759	-23.518	-2.807	0.216	0.216
5	0.000	77.000	119.367	210.001	0.62734	125.469	14.977	-1.153	0.000
6	77.000	77.000	119.367	155.544	1.37228	210.000	25.067	-1.930	1.930
7	-77.000	0.000	119.367	210.021	0.62707	125.415	14.970	0.000	-1.153
8	77.000	0.000	119.367	101.106	2.11694	210.000	25.067	0.000	1.930
Σ N_{si}, M_{xsi}, M_{ysi}							152.475	2.923	2.924

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	426.317	7.793	7.795	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	152.475	2.923	2.924	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**578.792**	**10.716**	**10.719**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	427.151 kN	From analysis results
M_2	10.065 kN·m	From analysis results
M_3	-5.524 kN·m	From analysis results
M_{2s}	16.343 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.969 kN·m	Including second-order magnification and accidental eccentricity

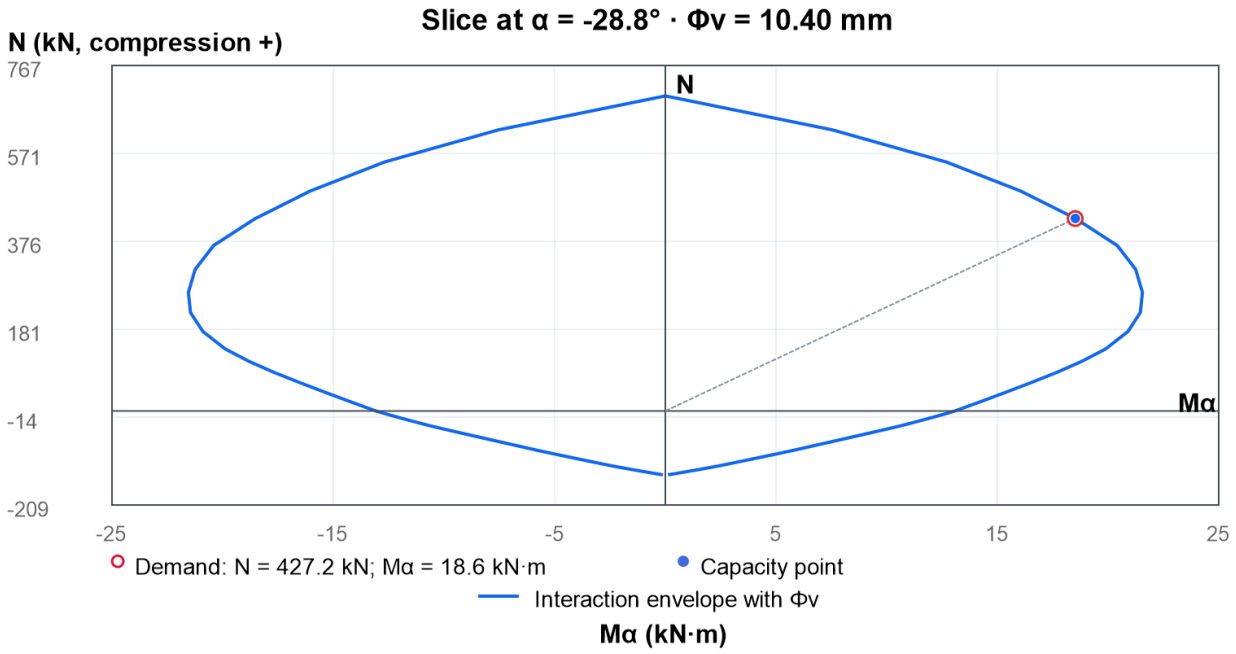
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	23.56	12.93	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,022,105	3,022,105	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,317,822,539,198	1,317,822,539,198	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,112.00	1,112.00	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6237	1.6237	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

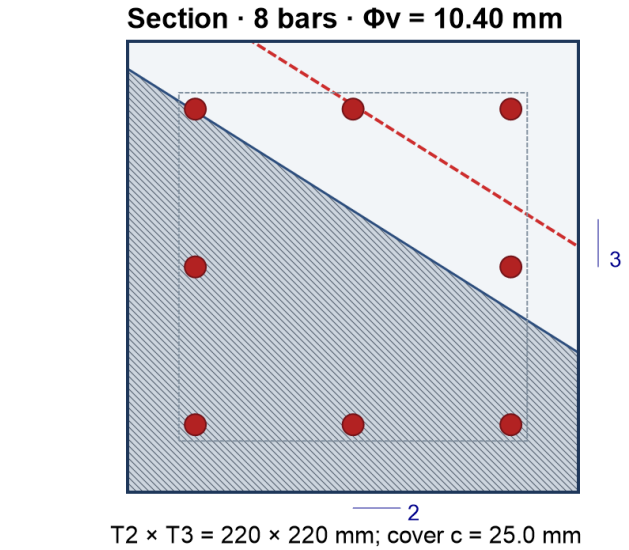
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 174.87 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	679.62 mm^2	Calculation results
Φ_v	10.4002 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	237.8110°	Geometry at the check point
Normal vector n	(-0.532714; -0.846295)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	174.8667 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.532714 \cdot x_2 - 0.846295 \cdot x_3 = -23.1757$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.532714 \cdot x_2 - 0.846295 \cdot x_3 = -66.8923$ mm	Geometry at the check point
Compressed concrete area A_b	30,224.666 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.480; -35.491) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.584 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.336 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.423 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.4002 mm / 84.953 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	84.953	45.507	2.77133	210.000	17.840	1.374	-1.374
2	0.000	-77.000	84.953	86.526	2.11452	210.000	17.840	1.374	0.000
3	77.000	-77.000	84.953	127.545	1.45772	210.000	17.840	1.374	1.374
4	-77.000	77.000	84.953	175.837	0.68447	136.893	11.629	-0.895	-0.895
5	0.000	77.000	84.953	216.856	0.02766	5.533	0.470	-0.036	0.000
6	77.000	77.000	84.953	257.875	-0.62914	-125.828	-10.689	0.823	-0.823
7	-77.000	0.000	84.953	110.672	1.72790	210.000	17.840	0.000	-1.374
8	77.000	0.000	84.953	192.710	0.41429	82.858	7.039	0.000	0.542
Σ N_{si}, M_{xsi}, M_{ysi}							79.809	4.012	-2.550

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.584	12.336	-6.423	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	79.809	4.012	-2.550	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**427.393**	**16.349**	**-8.974**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	429.102 kN	From analysis results
M_2	3.650 kN·m	From analysis results
M_3	-2.000 kN·m	From analysis results
M_{2s}	8.428 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.428 kN·m	Including second-order magnification and accidental eccentricity

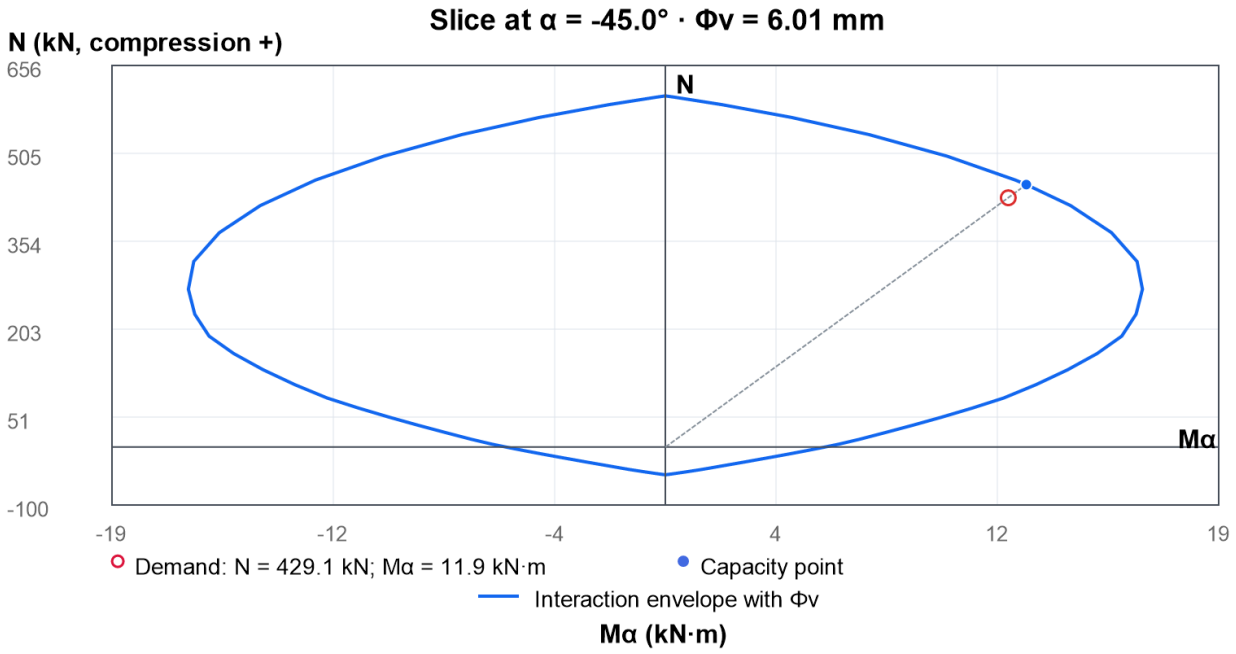
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9641	1.9641	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

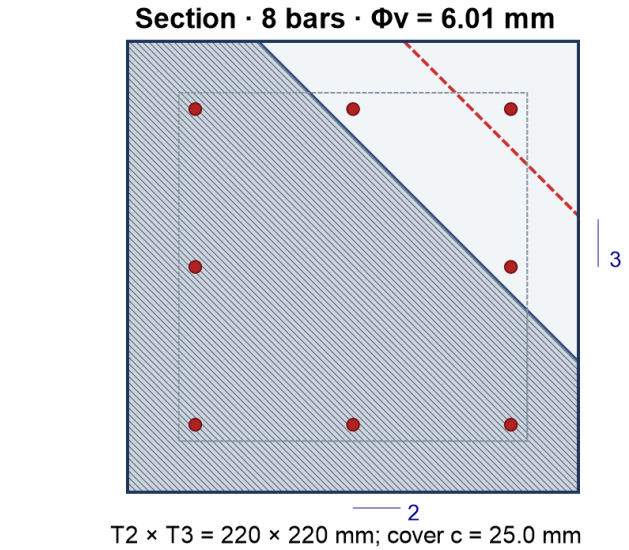
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 200.77 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9499	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0000°	Geometry at the check point
Normal vector n	(-0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	200.7658 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -45.2023$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -95.3937$ mm	Geometry at the check point
Compressed concrete area A_b	36,220.399 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.495; -19.495) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	416.535 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.120 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.120 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.84913	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.08977	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.563	1.33042	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.33042	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.011	0.57106	114.213	3.240	-0.249	0.000
6	77.000	77.000	28.366	264.458	-0.18829	-37.658	-1.068	0.082	-0.082
7	-77.000	0.000	28.366	101.116	2.08977	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.57106	114.213	3.240	0.000	0.249
Σ N_{si}, M_{xsi}, M_{ysi}							35.196	0.750	-0.750

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	416.535	8.120	-8.120	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.196	0.750	-0.750	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**451.731**	**8.870**	**-8.870**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	431.703 kN	From analysis results
M_2	-4.903 kN·m	From analysis results
M_3	2.699 kN·m	From analysis results
M_{2s}	-9.686 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.529 kN·m	Including second-order magnification and accidental eccentricity

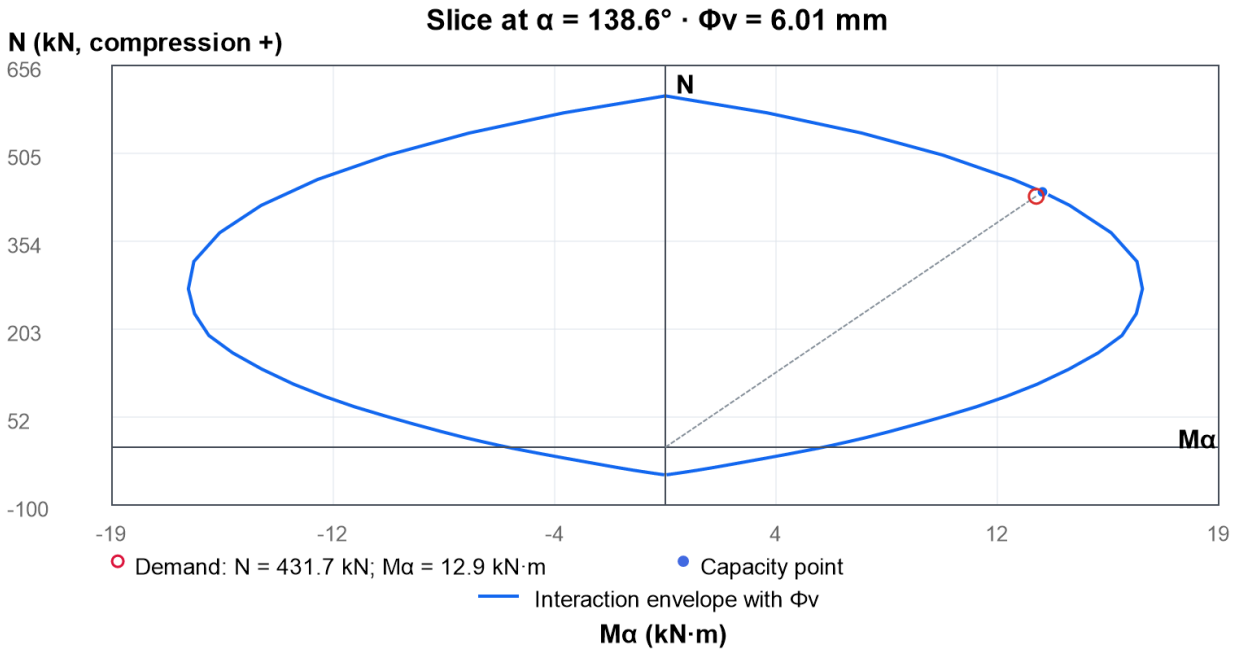
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	11.36	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9756	1.9756	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

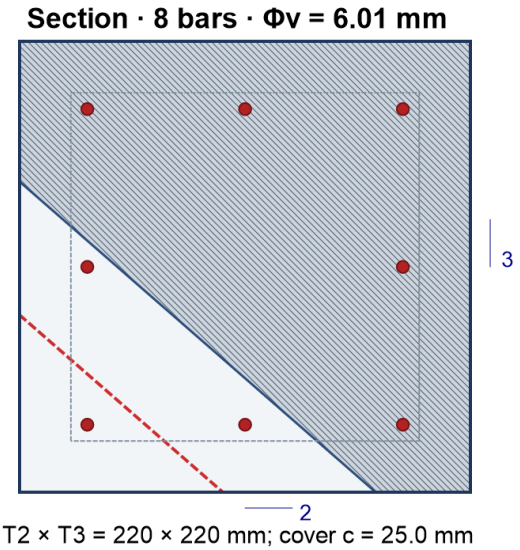
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 196.16 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9831	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	48.9137°	Geometry at the check point
Normal vector n	(0.657194; 0.753721)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	196.1583 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.657194 \cdot x_2 + 0.753721 \cdot x_3 = -40.9576$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.657194 \cdot x_2 + 0.753721 \cdot x_3 = -89.9971$ mm	Geometry at the check point
Compressed concrete area A_b	35,225.754 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.468; 22.244) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	405.096 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-9.011 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.887 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	263.841	-0.26612	-53.224	-1.510	-0.116	0.116
2	0.000	-77.000	28.366	213.237	0.45621	91.242	2.588	0.199	0.000
3	77.000	-77.000	28.366	162.633	1.17854	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	147.768	1.39073	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	97.164	2.11306	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.560	2.83539	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	205.805	0.56231	112.461	3.190	0.000	-0.246
8	77.000	0.000	28.366	104.597	2.00697	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							34.053	-0.834	0.788

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	405.096	-9.011	7.887	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	34.053	-0.834	0.788	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**439.150**	**-9.845**	**8.675**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	340.303 kN	From analysis results
M_2	-12.678 kN·m	From analysis results
M_3	7.968 kN·m	From analysis results
M_{2s}	-18.283 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.355 kN·m	Including second-order magnification and accidental eccentricity

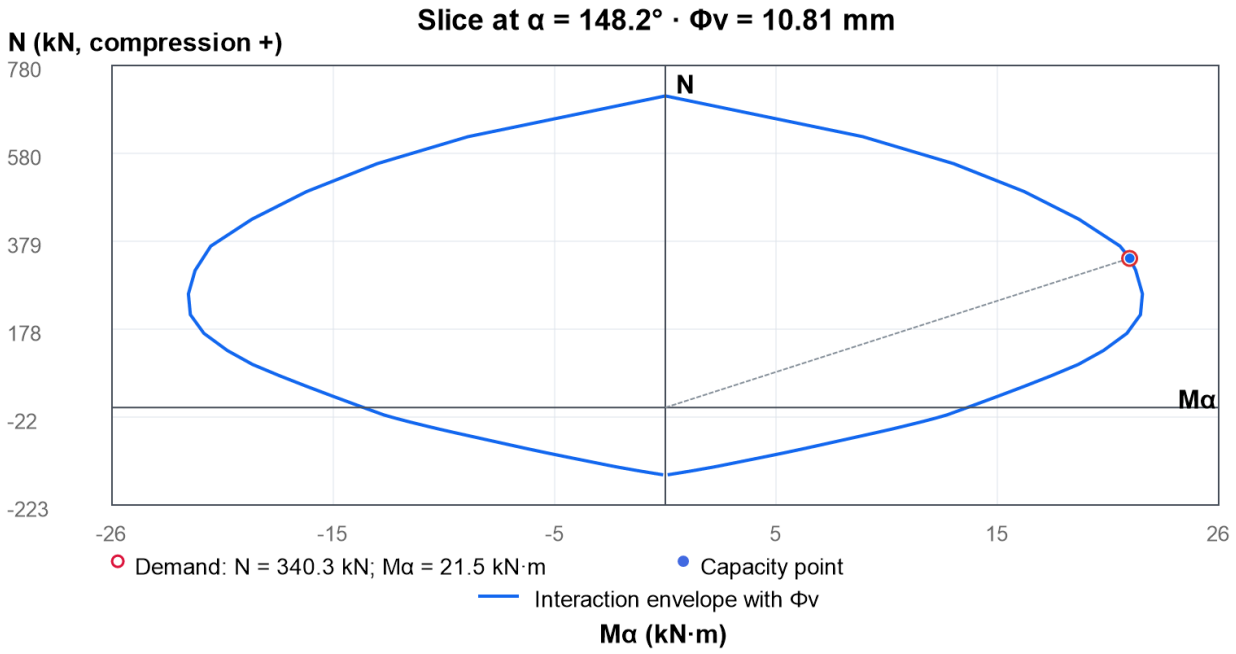
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	37.25	23.41	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.17	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.15980	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,267,621	3,267,621	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,315,333,097,432	1,352,194,748,001	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,109.90	1,141.00	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4422	1.4250	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

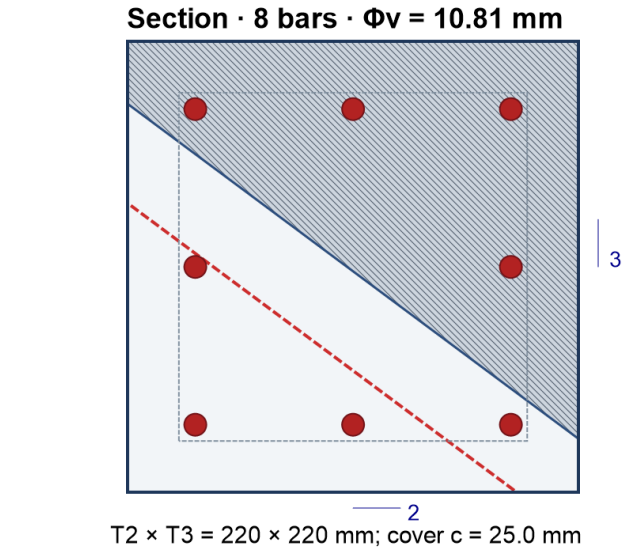
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 155.63 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	734.83 mm^2	Calculation results
Φ_v	10.8145 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	53.3950°	Geometry at the check point
Normal vector n	(0.596295; 0.802766)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	155.6336 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.596295 \cdot x_2 + 0.802766 \cdot x_3 = -1.7370$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.596295 \cdot x_2 + 0.802766 \cdot x_3 = -40.6454$ mm	Geometry at the check point
Compressed concrete area A_b	24,676.018 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(26.711; 43.998) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	283.774 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.485 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.580 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.8145 mm / 91.854 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	91.854	261.624	-1.20688	-210.000	-19.289	-1.485	1.485
2	0.000	-77.000	91.854	215.710	-0.38083	-76.165	-6.996	-0.539	0.000
3	77.000	-77.000	91.854	169.795	0.44522	89.045	8.179	0.630	0.630
4	-77.000	77.000	91.854	137.998	1.01727	203.455	18.688	-1.439	-1.439
5	0.000	77.000	91.854	92.084	1.84332	210.000	19.289	-1.485	0.000
6	77.000	77.000	91.854	46.169	2.66937	210.000	19.289	-1.485	1.485
7	-77.000	0.000	91.854	199.811	-0.09480	-18.960	-1.742	0.000	0.134
8	77.000	0.000	91.854	107.982	1.55730	210.000	19.289	0.000	1.485
Σ N_{si}, M_{xsi}, M_{ysi}							56.708	-5.804	3.781

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	283.774	-12.485	7.580	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	56.708	-5.804	3.781	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**340.483**	**-18.289**	**11.361**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	342.254 kN	From analysis results
M_2	-1.828 kN·m	From analysis results
M_3	1.009 kN·m	From analysis results
M_{2s}	-5.625 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	5.625 kN·m	Including second-order magnification and accidental eccentricity

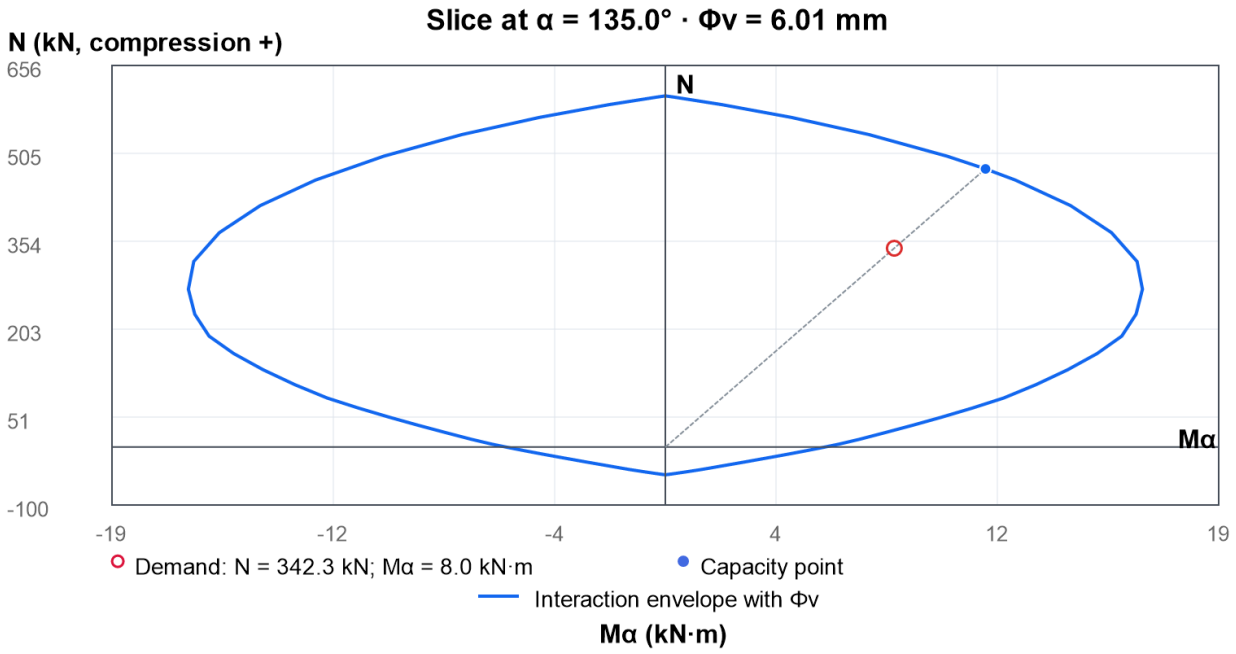
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6434	1.6434	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

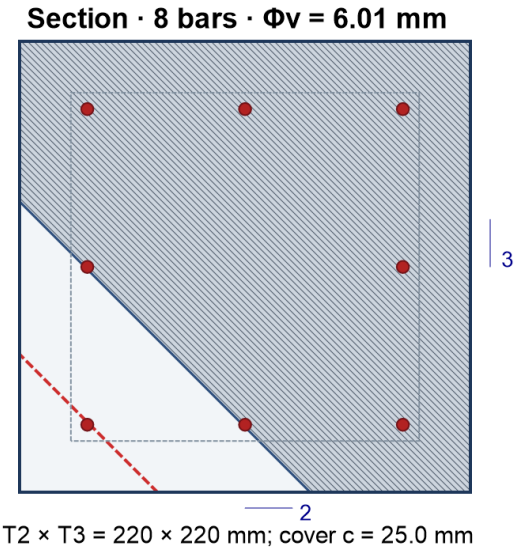
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 210.84 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7149	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0001°	Geometry at the check point
Normal vector n	(0.707105; 0.707108)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	210.8362 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707105 \cdot x_2 + 0.707108 \cdot x_3 = -55.2727$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707105 \cdot x_2 + 0.707108 \cdot x_3 = -107.9818$ mm	Geometry at the check point
Compressed concrete area A_b	38,341.764 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(16.454; 16.454) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	440.930 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.255 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.255 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	-0.01212	-2.424	-0.069	-0.005	0.005
2	0.000	-77.000	28.366	210.011	0.71096	142.192	4.033	0.311	0.000
3	77.000	-77.000	28.366	155.564	1.43404	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.43405	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.116	2.15713	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.88021	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.71096	142.193	4.034	0.000	-0.311
8	77.000	0.000	28.366	101.116	2.15713	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							37.783	-0.612	0.612

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	440.930	-7.255	7.255	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.783	-0.612	0.612	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**478.713**	**-7.867**	**7.867**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	344.855 kN	From analysis results
M_2	12.638 kN·m	From analysis results
M_3	-8.269 kN·m	From analysis results
M_{2s}	18.201 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.788 kN·m	Including second-order magnification and accidental eccentricity

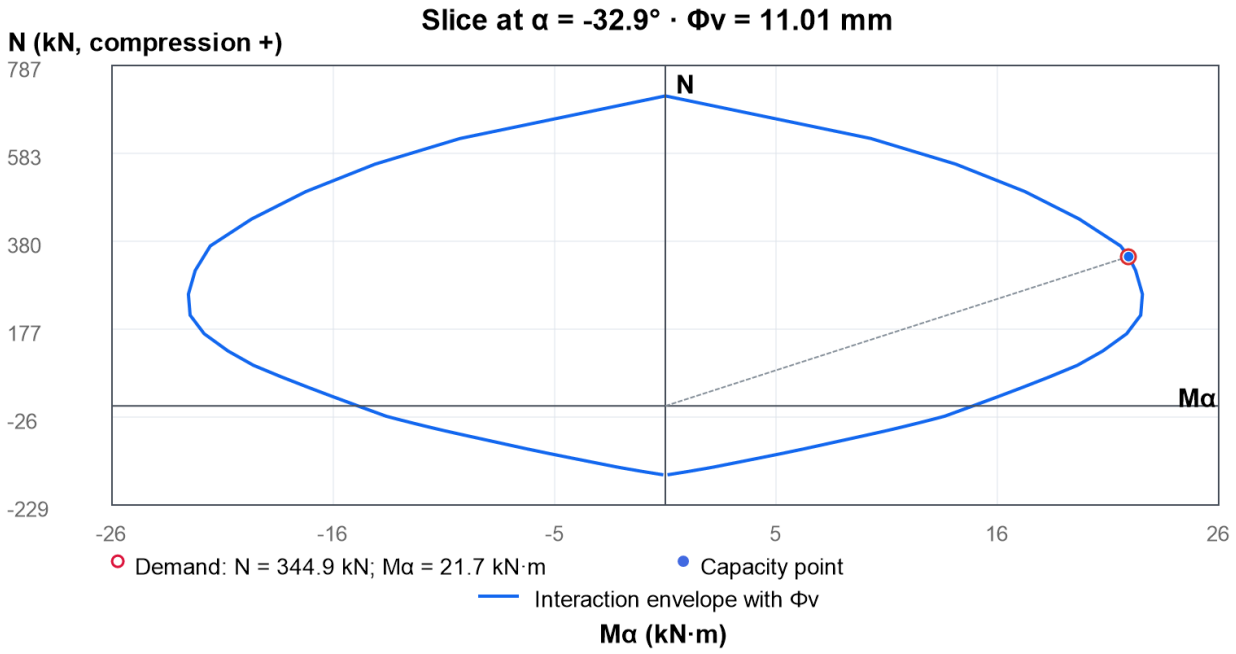
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	36.65	23.98	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.17	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16075	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,386,557	3,386,557	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,337,059,614,674	1,368,845,790,928	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,128.23	1,155.05	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4402	1.4256	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

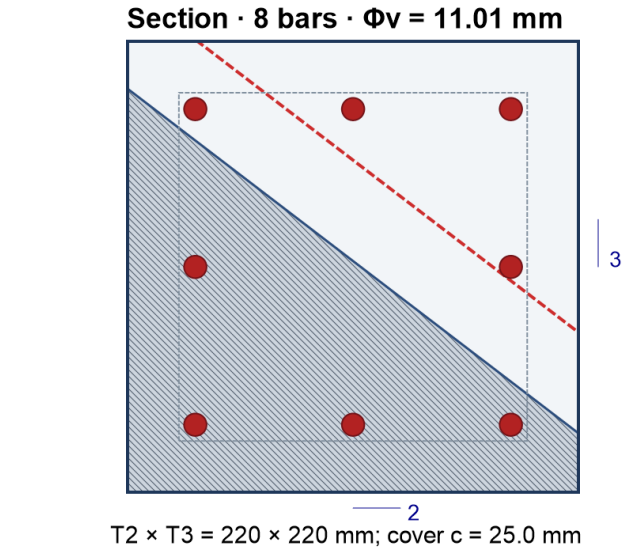
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 156.45 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	761.58 mm^2	Calculation results
Φ_v	11.0095 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	232.6214°	Geometry at the check point
Normal vector n	(-0.607080; -0.794641)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	156.4535 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.607080 \cdot x_2 - 0.794641 \cdot x_3 = -2.2642$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.607080 \cdot x_2 - 0.794641 \cdot x_3 = -41.3776$ mm	Geometry at the check point
Compressed concrete area A_b	24,826.855 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-27.305; -43.145) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	285.509 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.318 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.796 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	11.0095 mm / 95.198 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	95.198	46.257	2.67216	210.000	19.991	1.539	-1.539
2	0.000	-77.000	95.198	93.002	1.83557	210.000	19.991	1.539	0.000
3	77.000	-77.000	95.198	139.747	0.99899	199.798	19.020	1.465	1.465
4	-77.000	77.000	95.198	168.632	0.48205	96.411	9.178	-0.707	-0.707
5	0.000	77.000	95.198	215.377	-0.35453	-70.906	-6.750	0.520	0.000
6	77.000	77.000	95.198	262.122	-1.19111	-210.000	-19.991	1.539	-1.539
7	-77.000	0.000	95.198	107.444	1.57710	210.000	19.991	0.000	-1.539
8	77.000	0.000	95.198	200.934	-0.09606	-19.212	-1.829	0.000	-0.141
Σ N_{si}, M_{xsi}, M_{ysi}							59.602	5.896	-4.001

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	285.509	12.318	-7.796	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	59.602	5.896	-4.001	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**345.111**	**18.214**	**-11.797**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	513.227 kN	From analysis results
M_2	6.586 kN·m	From analysis results
M_3	9.800 kN·m	From analysis results
M_{2s}	10.849 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	16.142 kN·m	Including second-order magnification and accidental eccentricity

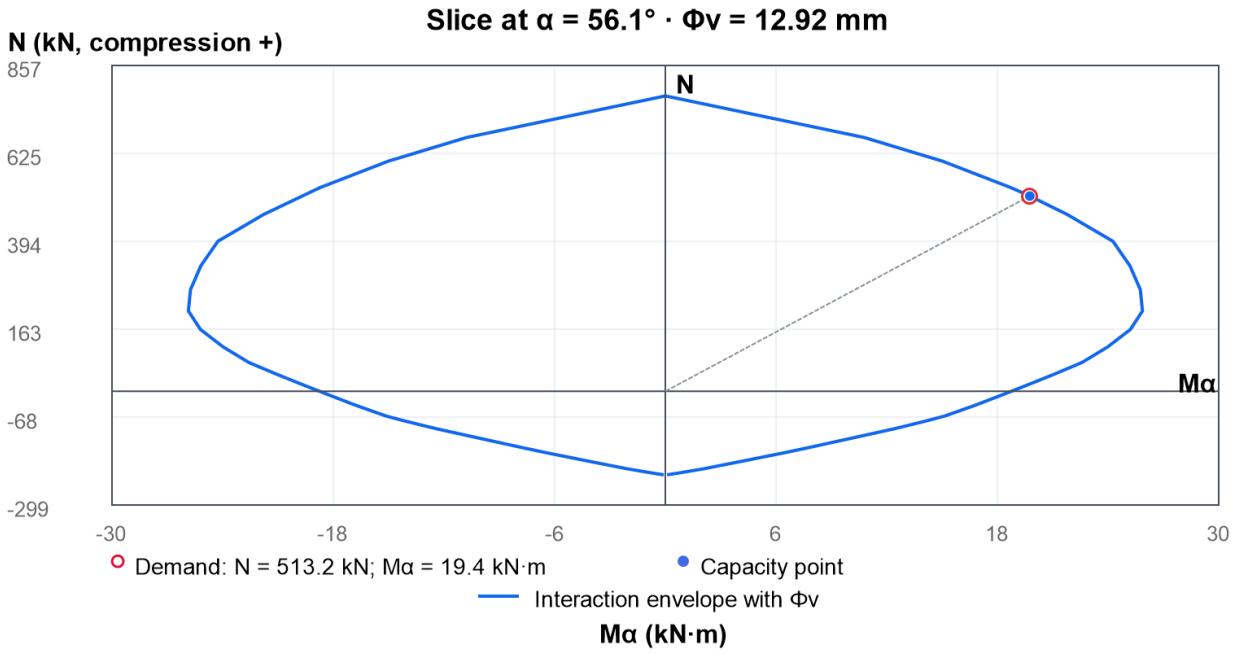
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	12.83	19.09	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	4,666,647	4,666,647	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,548,058,325,760	1,548,058,325,760	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,306.28	1,306.28	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6472	1.6472	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

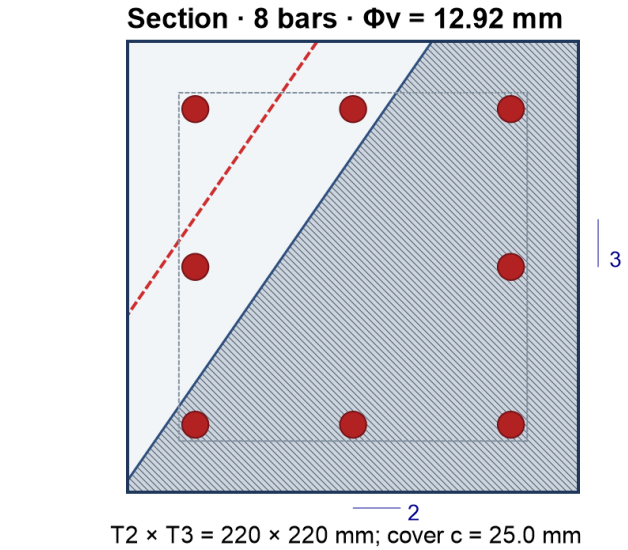
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 184.12 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,049.45 mm^2	Calculation results
Φ_v	12.9238 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	325.2668°	Geometry at the check point
Normal vector n	(0.821814; -0.569755)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	184.1166 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.821814 \cdot x_2 - 0.569755 \cdot x_3 = -31.0439$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.821814 \cdot x_2 - 0.569755 \cdot x_3 = -77.0731$ mm	Geometry at the check point
Compressed concrete area A_b	32,498.720 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(29.604; -18.890) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	373.735 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.060 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.064 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.9238 mm / 131.181 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	131.181	172.481	0.87695	175.390	23.008	1.772	-1.772
2	0.000	-77.000	131.181	109.202	1.83929	210.000	27.548	2.121	0.000
3	77.000	-77.000	131.181	45.922	2.80163	210.000	27.548	2.121	2.121
4	-77.000	77.000	131.181	260.224	-0.45742	-91.483	-12.001	0.924	0.924
5	0.000	77.000	131.181	196.944	0.50493	100.985	13.247	-1.020	0.000
6	77.000	77.000	131.181	133.664	1.46727	210.000	27.548	-2.121	2.121
7	-77.000	0.000	131.181	216.352	0.20977	41.953	5.503	0.000	-0.424
8	77.000	0.000	131.181	89.793	2.13445	210.000	27.548	0.000	2.121
Σ N_{si}, M_{xsi}, M_{ysi}							139.950	3.797	5.092

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	373.735	7.060	11.064	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	139.950	3.797	5.092	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**513.685**	**10.857**	**16.156**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	515.178 kN	From analysis results
M_2	0.869 kN·m	From analysis results
M_3	1.502 kN·m	From analysis results
M_{2s}	9.914 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.914 kN·m	Including second-order magnification and accidental eccentricity

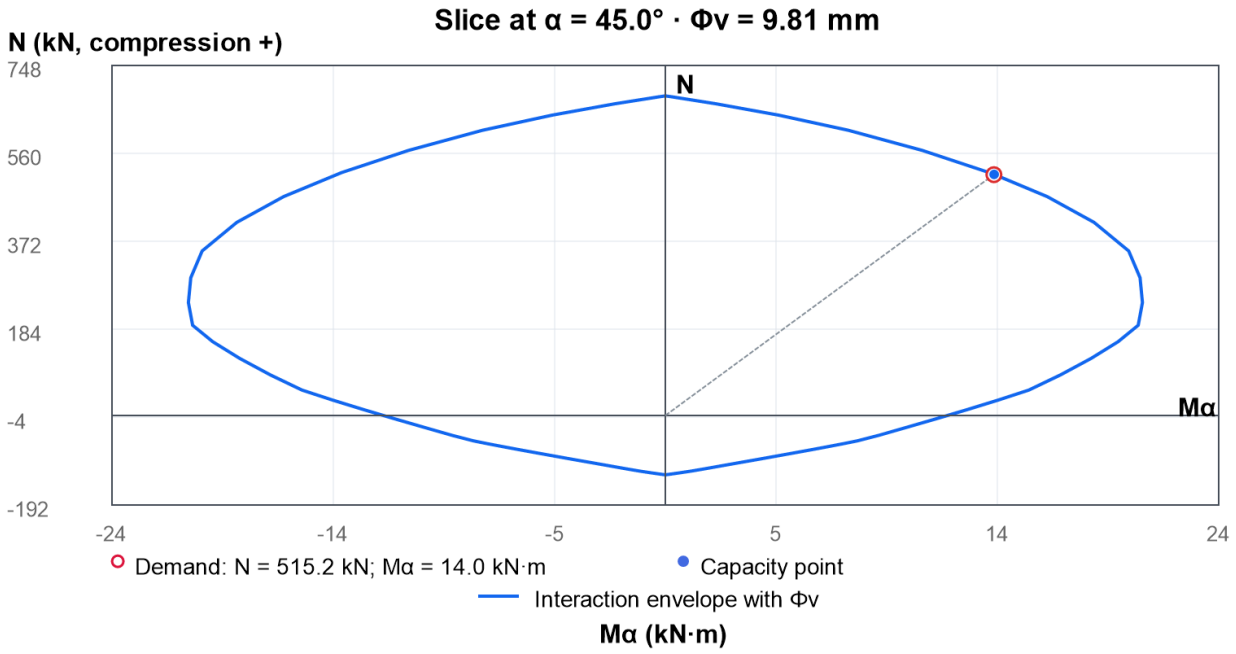
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,688,042	2,688,042	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,271,053,680,929	1,271,053,680,929	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,072.53	1,072.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9243	1.9243	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

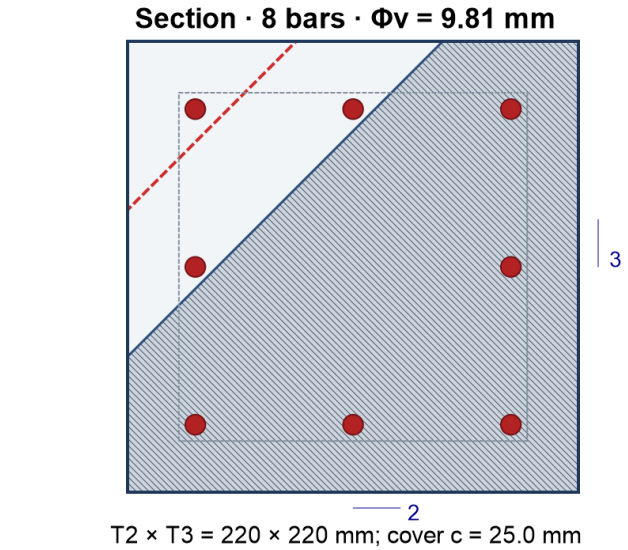
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 202.42 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	604.50 mm^2	Calculation results
Φ_v	9.8086 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	202.4249 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -46.8614$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -97.4676$ mm	Geometry at the check point
Compressed concrete area A_b	36,583.856 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.978; -18.978) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	420.714 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.984 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.984 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.8086 mm / 75.562 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	75.562	155.563	1.34820	210.000	15.868	1.222	-1.222
2	0.000	-77.000	75.562	101.116	2.10133	210.000	15.868	1.222	0.000
3	77.000	-77.000	75.562	46.669	2.85446	210.000	15.868	1.222	1.222
4	-77.000	77.000	75.562	264.458	-0.15806	-31.612	-2.389	0.184	0.184
5	0.000	77.000	75.562	210.011	0.59507	119.014	8.993	-0.692	0.000
6	77.000	77.000	75.562	155.563	1.34820	210.000	15.868	-1.222	1.222
7	-77.000	0.000	75.562	210.011	0.59507	119.014	8.993	0.000	-0.692
8	77.000	0.000	75.562	101.116	2.10133	210.000	15.868	0.000	1.222
Σ N_{si}, M_{xsi}, M_{ysi}							94.937	1.935	1.935

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	420.714	7.984	7.984	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	94.937	1.935	1.935	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**515.652**	**9.919**	**9.919**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	517.779 kN	From analysis results
M_2	-6.754 kN·m	From analysis results
M_3	-9.562 kN·m	From analysis results
M_{2s}	-11.165 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.808 kN·m	Including second-order magnification and accidental eccentricity

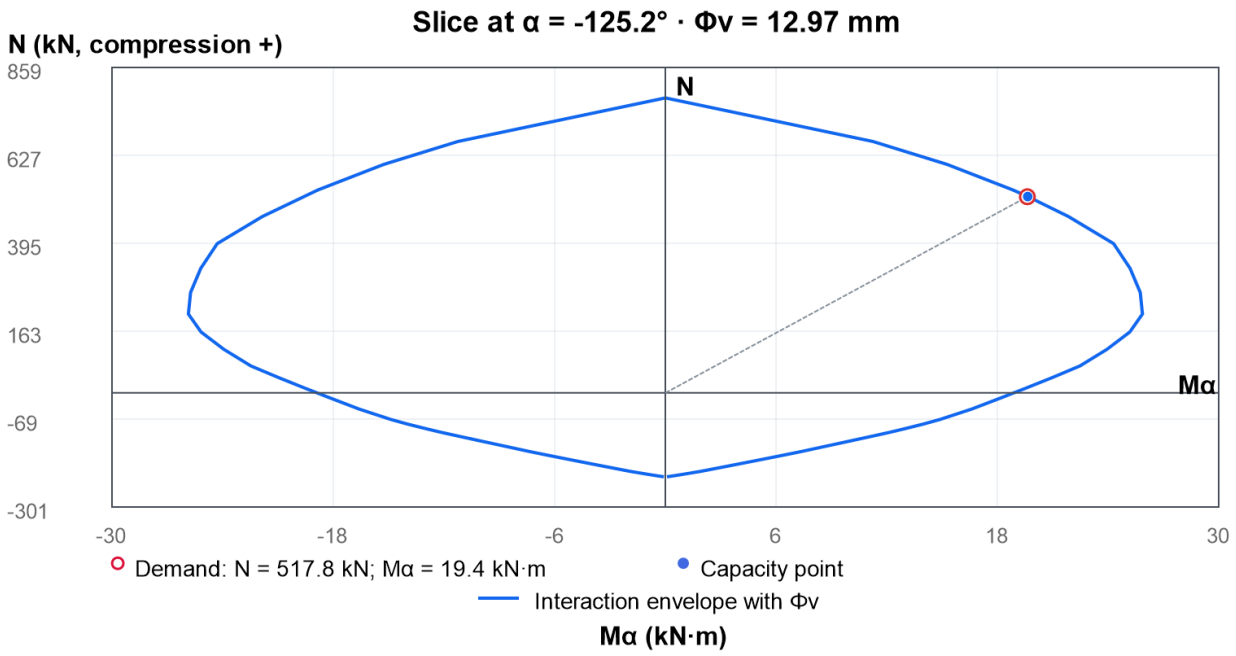
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	13.04	18.47	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,702,003	4,702,003	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,553,008,224,165	1,553,008,224,165	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,310.45	1,310.45	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6532	1.6532	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

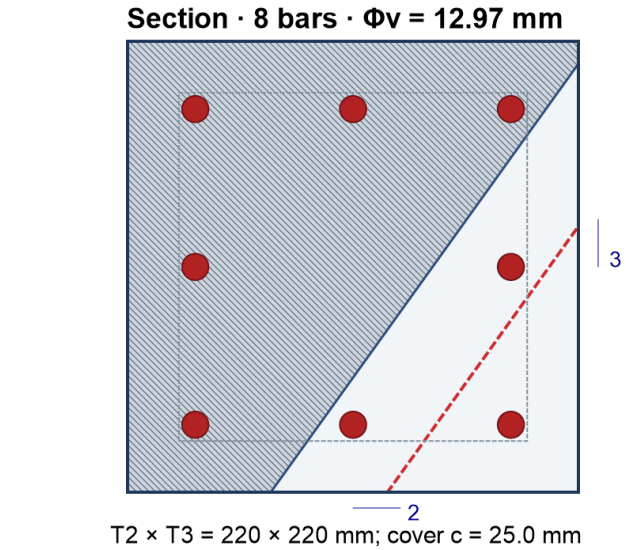
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 185.02 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,057.40 mm^2	Calculation results
Φ_v	12.9727 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9988	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	144.3164°	Geometry at the check point
Normal vector n	(-0.812251; 0.583309)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	185.0226 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.812251 \cdot x_2 + 0.583309 \cdot x_3 = -31.5110$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.812251 \cdot x_2 + 0.583309 \cdot x_3 = -77.7667$ mm	Geometry at the check point
Compressed concrete area A_b	32,692.588 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-28.795; 19.354) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	375.965 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.276 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-10.826 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.9727 mm / 132.175 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	132.175	135.883	1.44364	210.000	27.757	2.137	-2.137
2	0.000	-77.000	132.175	198.426	0.49716	99.431	13.142	1.012	0.000
3	77.000	-77.000	132.175	260.970	-0.44933	-89.866	-11.878	-0.915	-0.915
4	-77.000	77.000	132.175	46.053	2.80306	210.000	27.757	-2.137	-2.137
5	0.000	77.000	132.175	108.597	1.85657	210.000	27.757	-2.137	0.000
6	77.000	77.000	132.175	171.140	0.91009	182.018	24.058	-1.852	1.852
7	-77.000	0.000	132.175	90.968	2.12335	210.000	27.757	0.000	-2.137
8	77.000	0.000	132.175	216.055	0.23038	46.076	6.090	0.000	0.469
Σ N_{si}, M_{xsi}, M_{ysi}							142.440	-3.892	-5.005

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	375.965	-7.276	-10.826	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	142.440	-3.892	-5.005	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**518.405**	**-11.169**	**-15.831**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	394.317 kN	From analysis results
M_2	1.195 kN·m	From analysis results
M_3	9.111 kN·m	From analysis results
M_{2s}	6.664 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	15.397 kN·m	Including second-order magnification and accidental eccentricity

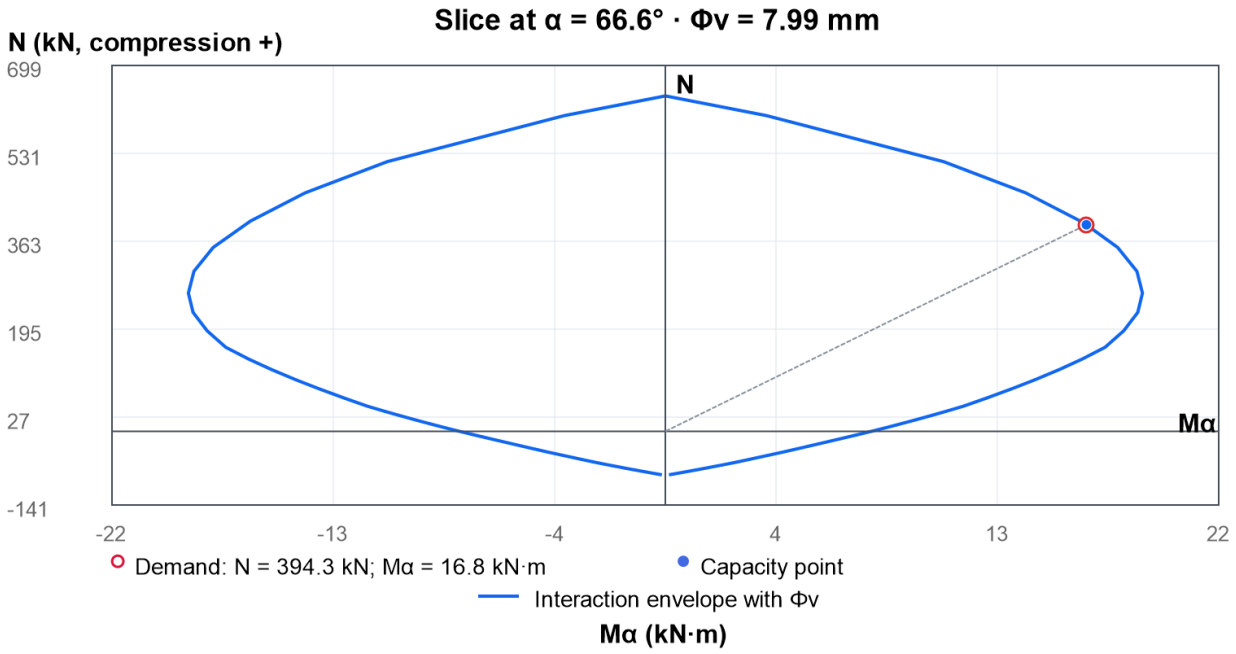
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	23.11	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,784,654	1,784,654	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,144,579,269,033	1,144,579,269,033	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	965.81	965.81	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6900	1.6900	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

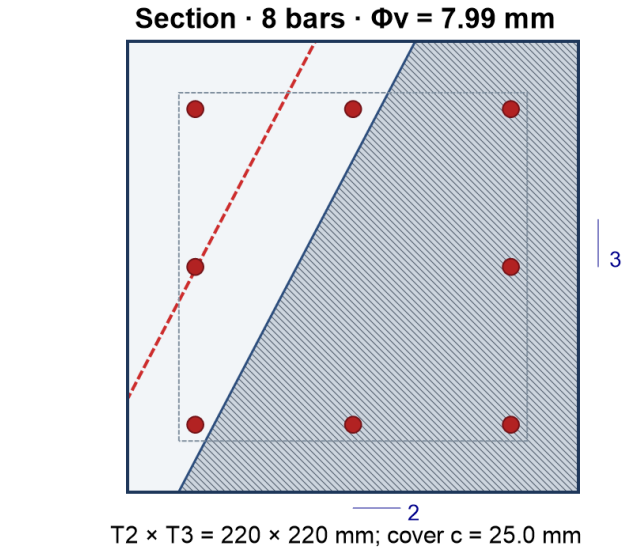
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 172.82 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	401.34 mm^2	Calculation results
Φ_v	7.9922 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	332.2945°	Geometry at the check point
Normal vector n	(0.885349; -0.464927)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	172.8173 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.885349 \cdot x_2 - 0.464927 \cdot x_3 = -24.2869$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.885349 \cdot x_2 - 0.464927 \cdot x_3 = -67.4912$ mm	Geometry at the check point
Compressed concrete area A_b	30,235.047 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(37.237; -15.412) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.703 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.359 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.948 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.9922 mm / 50.167 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	50.167	180.903	0.56900	113.799	5.709	0.440	-0.440
2	0.000	-77.000	50.167	112.731	1.67352	210.000	10.535	0.811	0.000
3	77.000	-77.000	50.167	44.559	2.77805	210.000	10.535	0.811	0.811
4	-77.000	77.000	50.167	252.502	-0.59105	-118.210	-5.930	0.457	0.457
5	0.000	77.000	50.167	184.330	0.51347	102.695	5.152	-0.397	0.000
6	77.000	77.000	50.167	116.158	1.61800	210.000	10.535	-0.811	0.811
7	-77.000	0.000	50.167	216.702	-0.01103	-2.206	-0.111	0.000	0.009
8	77.000	0.000	50.167	80.358	2.19803	210.000	10.535	0.000	0.811
Σ N_{si}, M_{xsi}, M_{ysi}							46.961	1.311	2.459

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.703	5.359	12.948	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	46.961	1.311	2.459	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**394.664**	**6.669**	**15.407**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	396.268 kN	From analysis results
M_2	0.097 kN·m	From analysis results
M_3	1.632 kN·m	From analysis results
M_{2s}	7.248 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	7.248 kN·m	Including second-order magnification and accidental eccentricity

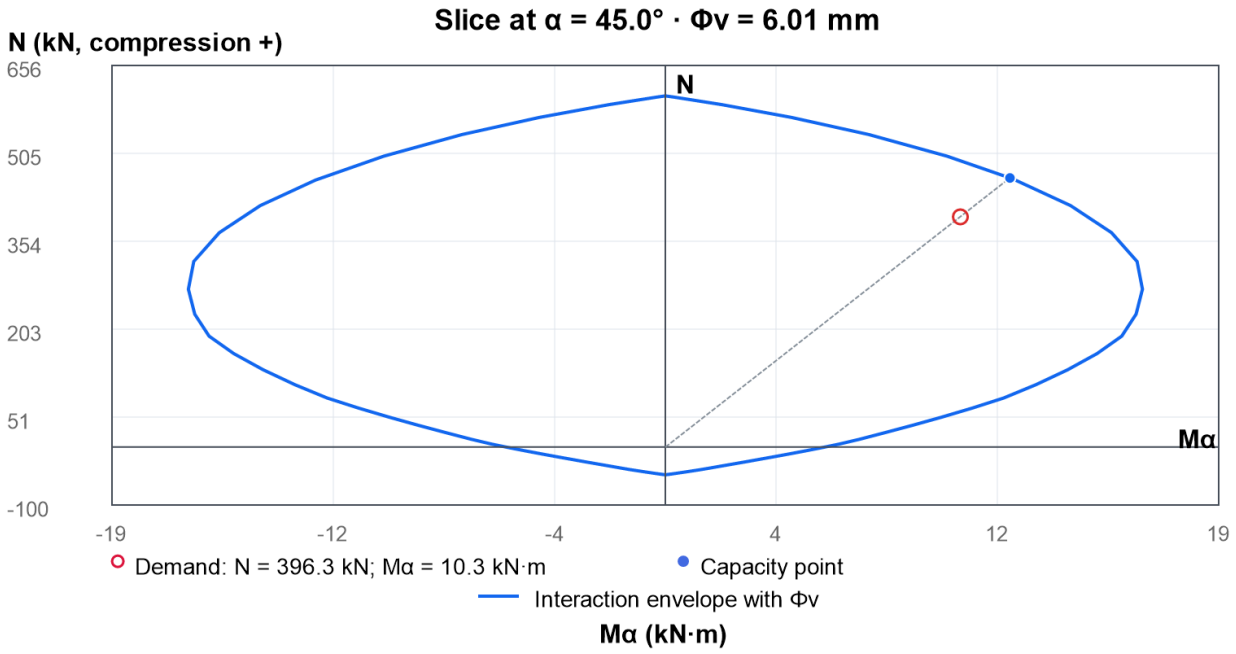
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.8291	1.8291	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

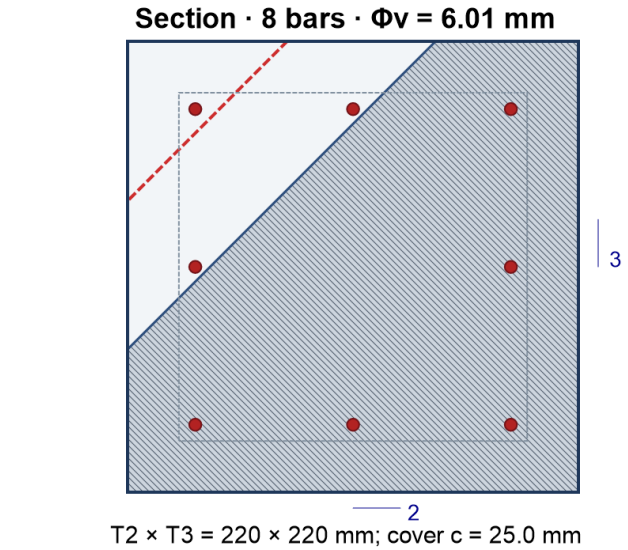
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.91 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.8556	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	204.9060 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -49.3425$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -100.5690$ mm	Geometry at the check point
Compressed concrete area A_b	37,117.096 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(18.217; -18.217) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	426.847 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.776 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.776 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.563	1.37426	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.11827	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.86228	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	-0.11377	-22.753	-0.645	0.050	0.050
5	0.000	77.000	28.366	210.011	0.63024	126.049	3.576	-0.275	0.000
6	77.000	77.000	28.366	155.563	1.37426	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.63024	126.049	3.576	0.000	-0.275
8	77.000	0.000	28.366	101.116	2.11827	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							36.290	0.692	0.692

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	426.847	7.776	7.776	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	36.290	0.692	0.692	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**463.137**	**8.467**	**8.467**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	398.869 kN	From analysis results
M_2	-1.366 kN·m	From analysis results
M_3	-8.340 kN·m	From analysis results
M_{2s}	-6.928 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-14.486 kN·m	Including second-order magnification and accidental eccentricity

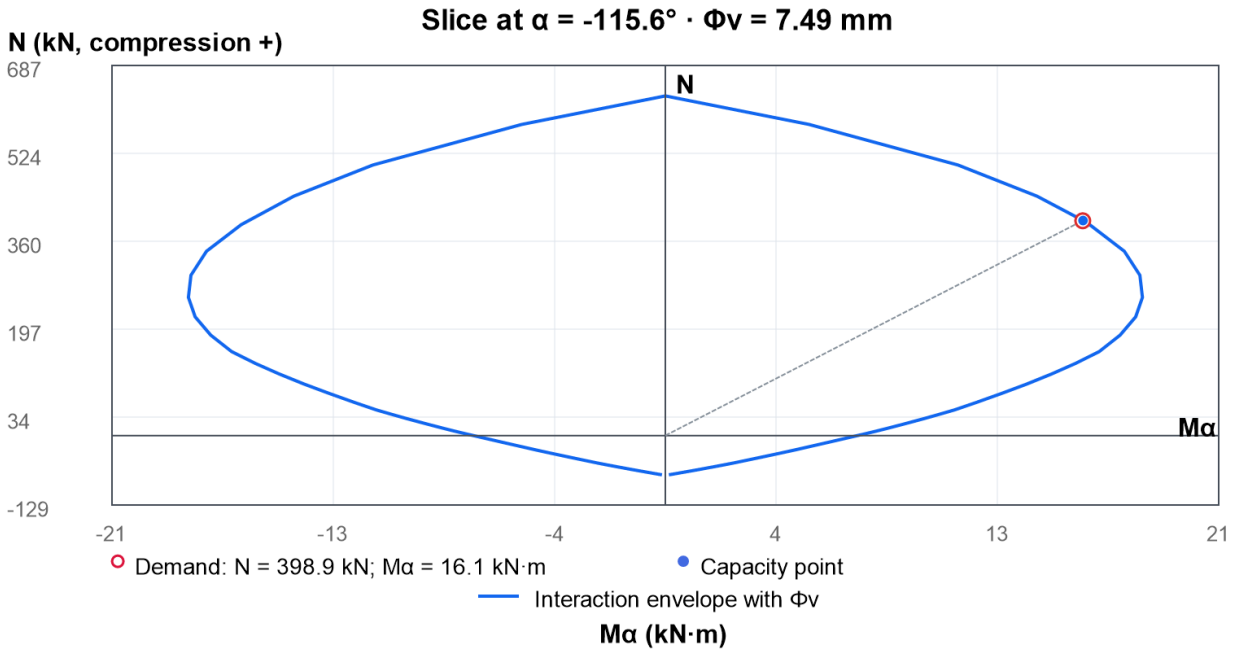
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	20.91	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,567,136	1,567,136	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,114,126,760,288	1,114,126,760,288	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	940.12	940.12	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7369	1.7369	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

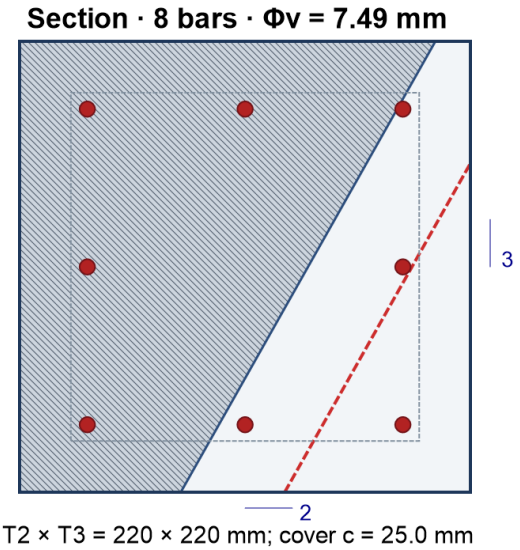
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 176.62 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	352.42 mm^2	Calculation results
Φ_v	7.4893 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	150.5418°	Geometry at the check point
Normal vector n	(-0.870715; 0.491789)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	176.6235 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.870715 \cdot x_2 + 0.491789 \cdot x_3 = -26.7481$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.870715 \cdot x_2 + 0.491789 \cdot x_3 = -70.9040$ mm	Geometry at the check point
Compressed concrete area A_b	30,958.336 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-35.068; 16.189) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	356.021 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.764 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-12.485 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.4893 mm / 44.053 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	44.053	120.698	1.58658	210.000	9.251	0.712	-0.712
2	0.000	-77.000	44.053	187.743	0.52372	104.744	4.614	0.355	0.000
3	77.000	-77.000	44.053	254.788	-0.53914	-107.828	-4.750	-0.366	-0.366
4	-77.000	77.000	44.053	44.963	2.78721	210.000	9.251	-0.712	-0.712
5	0.000	77.000	44.053	112.008	1.72435	210.000	9.251	-0.712	0.000
6	77.000	77.000	44.053	179.053	0.66149	132.298	5.828	-0.449	0.449
7	-77.000	0.000	44.053	82.830	2.18690	210.000	9.251	0.000	-0.712
8	77.000	0.000	44.053	216.920	0.06118	12.235	0.539	0.000	0.042
Σ N_{si}, M_{xsi}, M_{ysi}							43.236	-1.172	-2.012

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	356.021	-5.764	-12.485	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	43.236	-1.172	-2.012	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**399.256**	**-6.935**	**-14.498**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	433.101 kN	From analysis results
M_2	-6.892 kN·m	From analysis results
M_3	9.521 kN·m	From analysis results
M_{2s}	-11.121 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	15.364 kN·m	Including second-order magnification and accidental eccentricity

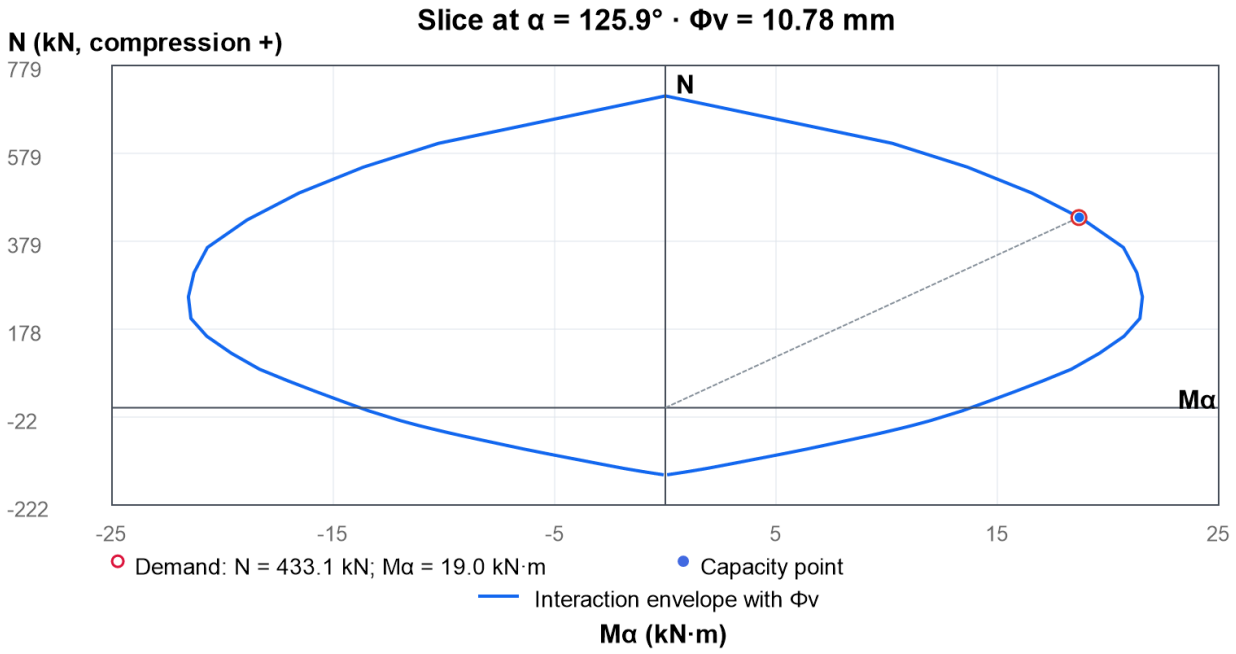
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	15.91	21.98	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,249,157	3,249,157	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,349,609,692,767	1,349,609,692,767	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,138.82	1,138.82	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6137	1.6137	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

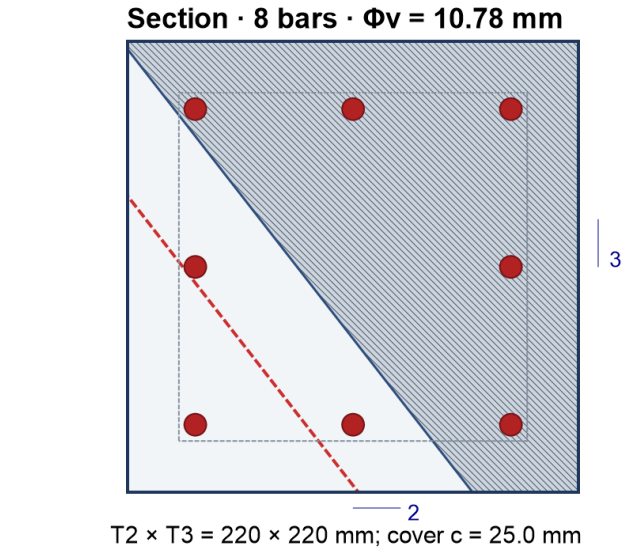
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 175.94 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	730.68 mm^2	Calculation results
Φ_v	10.7839 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9989	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	37.9167°	Geometry at the check point
Normal vector n	(0.788905; 0.614516)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	175.9375 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.788905 \cdot x_2 + 0.614516 \cdot x_3 = -21.5613$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.788905 \cdot x_2 + 0.614516 \cdot x_3 = -65.5456$ mm	Geometry at the check point
Compressed concrete area A_b	30,206.906 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(32.452; 22.861) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.379 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.941 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.273 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.7839 mm / 91.335 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	91.335	262.440	-0.67666	-135.332	-12.361	-0.952	0.952
2	0.000	-77.000	91.335	201.694	0.29009	58.019	5.299	0.408	0.000
3	77.000	-77.000	91.335	140.948	1.25684	210.000	19.180	1.477	1.477
4	-77.000	77.000	91.335	167.804	0.82944	165.888	15.151	-1.167	-1.167
5	0.000	77.000	91.335	107.059	1.79619	210.000	19.180	-1.477	0.000
6	77.000	77.000	91.335	46.313	2.76294	210.000	19.180	-1.477	1.477
7	-77.000	0.000	91.335	215.122	0.07639	15.278	1.395	0.000	-0.107
8	77.000	0.000	91.335	93.631	2.00989	210.000	19.180	0.000	1.477
Σ N_{si}, M_{xsi}, M_{ysi}							86.207	-3.187	4.108

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.379	-7.941	11.273	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	86.207	-3.187	4.108	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**433.586**	**-11.129**	**15.382**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	435.052 kN	From analysis results
M_2	-0.638 kN·m	From analysis results
M_3	1.584 kN·m	From analysis results
M_{2s}	-8.661 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.661 kN·m	Including second-order magnification and accidental eccentricity

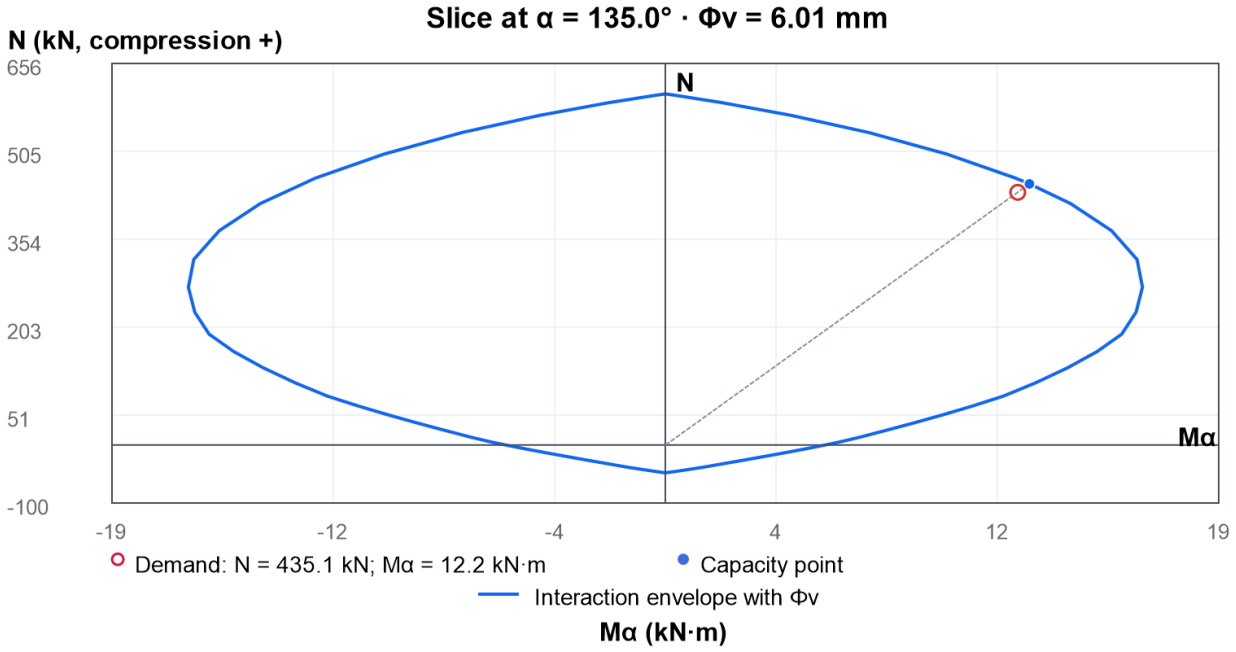
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9907	1.9907	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

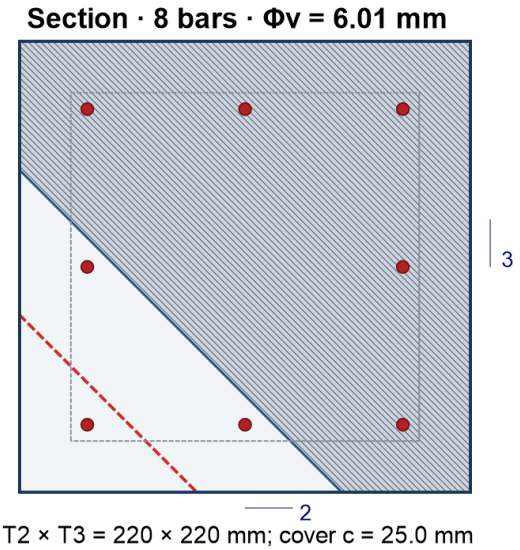
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.97 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9679	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0000°	Geometry at the check point
Normal vector n	(0.707107; 0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	199.9691 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -44.4056$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 + 0.707107 \cdot x_3 = -94.3979$ mm	Geometry at the check point
Compressed concrete area A_b	36,043.931 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.746; 19.746) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	414.505 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.185 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.185 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	-0.20298	-40.597	-1.152	-0.089	0.089
2	0.000	-77.000	28.366	210.011	0.55940	111.879	3.174	0.244	0.000
3	77.000	-77.000	28.366	155.563	1.32177	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.32177	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.116	2.08415	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.84653	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.55940	111.879	3.174	0.000	-0.244
8	77.000	0.000	28.366	101.116	2.08415	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							34.980	-0.762	0.762

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	414.505	-8.185	8.185	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	34.980	-0.762	0.762	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**449.486**	**-8.946**	**8.946**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	437.653 kN	From analysis results
M_2	7.702 kN·m	From analysis results
M_3	-8.999 kN·m	From analysis results
M_{2s}	12.428 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-14.521 kN·m	Including second-order magnification and accidental eccentricity

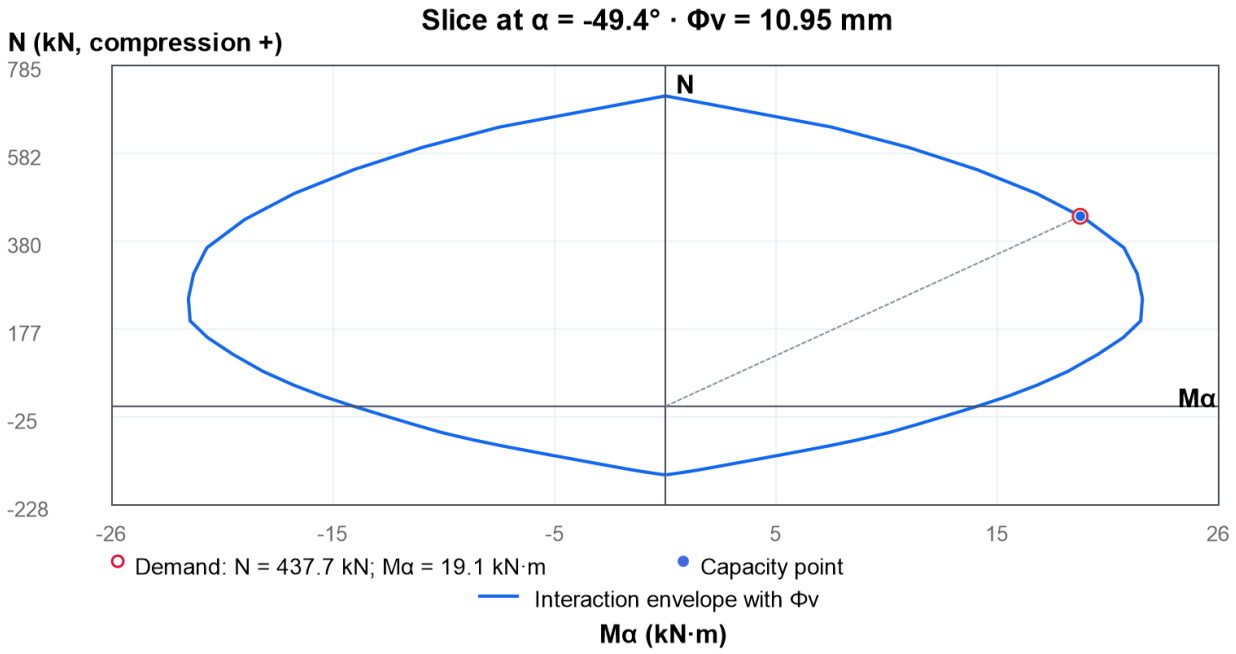
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	17.60	20.56	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,350,763	3,350,763	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,363,834,663,815	1,363,834,663,815	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,150.82	1,150.82	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6137	1.6137	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

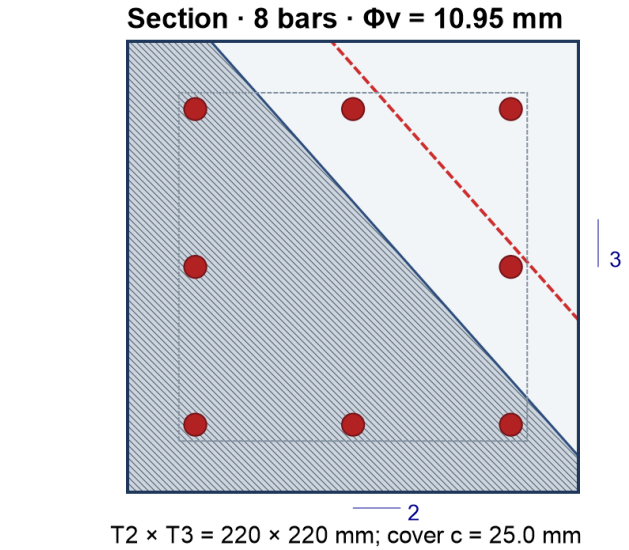
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 176.33 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	753.53 mm^2	Calculation results
Φ_v	10.9512 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	221.5562°	Geometry at the check point
Normal vector n	(-0.748305; -0.663354)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	176.3268 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.748305 \cdot x_2 - 0.663354 \cdot x_3 = -21.0443$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.748305 \cdot x_2 - 0.663354 \cdot x_3 = -65.1260$ mm	Geometry at the check point
Compressed concrete area A_b	30,249.088 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-30.124; -25.529) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.865 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.881 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-10.479 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.9512 mm / 94.191 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	94.191	46.585	2.76025	210.000	19.780	1.523	-1.523
2	0.000	-77.000	94.191	104.204	1.84528	210.000	19.780	1.523	0.000
3	77.000	-77.000	94.191	161.824	0.93030	186.060	17.525	1.349	1.349
4	-77.000	77.000	94.191	148.741	1.13805	210.000	19.780	-1.523	-1.523
5	0.000	77.000	94.191	206.361	0.22307	44.614	4.202	-0.324	0.000
6	77.000	77.000	94.191	263.980	-0.69190	-138.381	-13.034	1.004	-1.004
7	-77.000	0.000	94.191	97.663	1.94915	210.000	19.780	0.000	-1.523
8	77.000	0.000	94.191	212.902	0.11920	23.840	2.246	0.000	0.173
Σ N_{si}, M_{xsi}, M_{ysi}							90.060	3.553	-4.051

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.865	8.881	-10.479	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	90.060	3.553	-4.051	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**437.924**	**12.433**	**-14.530**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	333.918 kN	From analysis results
M_2	10.900 kN·m	From analysis results
M_3	7.857 kN·m	From analysis results
M_{2s}	15.974 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.513 kN·m	Including second-order magnification and accidental eccentricity

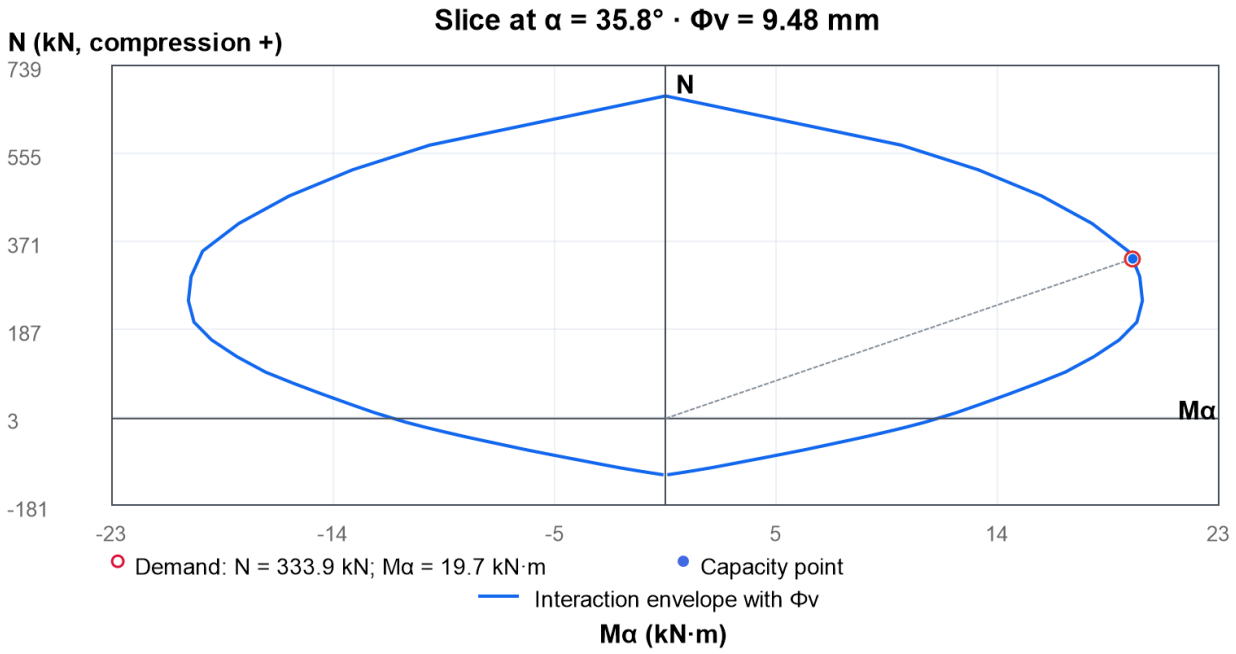
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	32.64	23.53	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,509,136	2,509,136	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,246,006,852,544	1,246,006,852,544	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,051.40	1,051.40	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4654	1.4654	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

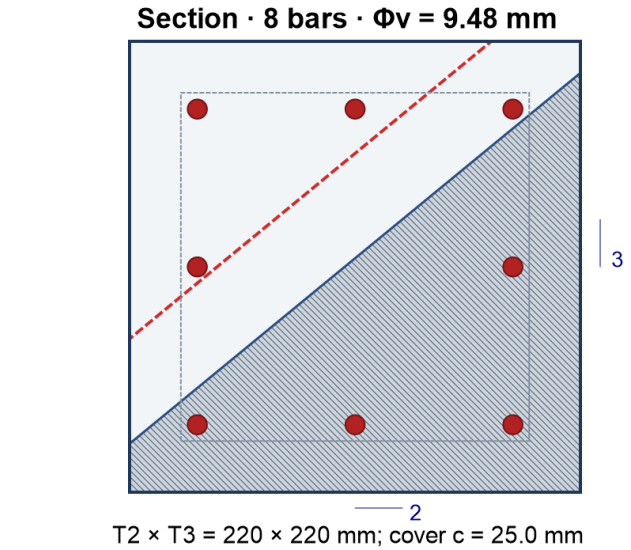
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 158.08 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	564.26 mm^2	Calculation results
Φ_v	9.4766 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	309.4297°	Geometry at the check point
Normal vector n	(0.635130; -0.772405)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	158.0761 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.635130 \cdot x_2 - 0.772405 \cdot x_3 = -3.2472$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.635130 \cdot x_2 - 0.772405 \cdot x_3 = -42.7663$ mm	Geometry at the check point
Compressed concrete area A_b	25,124.890 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(29.040; -40.958) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	288.936 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	11.834 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.391 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.4766 mm / 70.533 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	70.533	144.259	0.94475	188.949	13.327	1.026	-1.026
2	0.000	-77.000	70.533	95.354	1.81100	210.000	14.812	1.141	0.000
3	77.000	-77.000	70.533	46.449	2.67726	210.000	14.812	1.141	1.141
4	-77.000	77.000	70.533	263.209	-1.16222	-210.000	-14.812	1.141	1.141
5	0.000	77.000	70.533	214.304	-0.29596	-59.193	-4.175	0.321	0.000
6	77.000	77.000	70.533	165.399	0.57029	114.058	8.045	-0.619	0.619
7	-77.000	0.000	70.533	203.734	-0.10874	-21.747	-1.534	0.000	0.118
8	77.000	0.000	70.533	105.924	1.62377	210.000	14.812	0.000	1.141
Σ N_{si}, M_{xsi}, M_{ysi}							45.287	4.150	3.133

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	288.936	11.834	8.391	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	45.287	4.150	3.133	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**334.223**	**15.984**	**11.524**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	335.869 kN	From analysis results
M_2	0.555 kN·m	From analysis results
M_3	0.989 kN·m	From analysis results
M_{2s}	5.454 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	5.454 kN·m	Including second-order magnification and accidental eccentricity

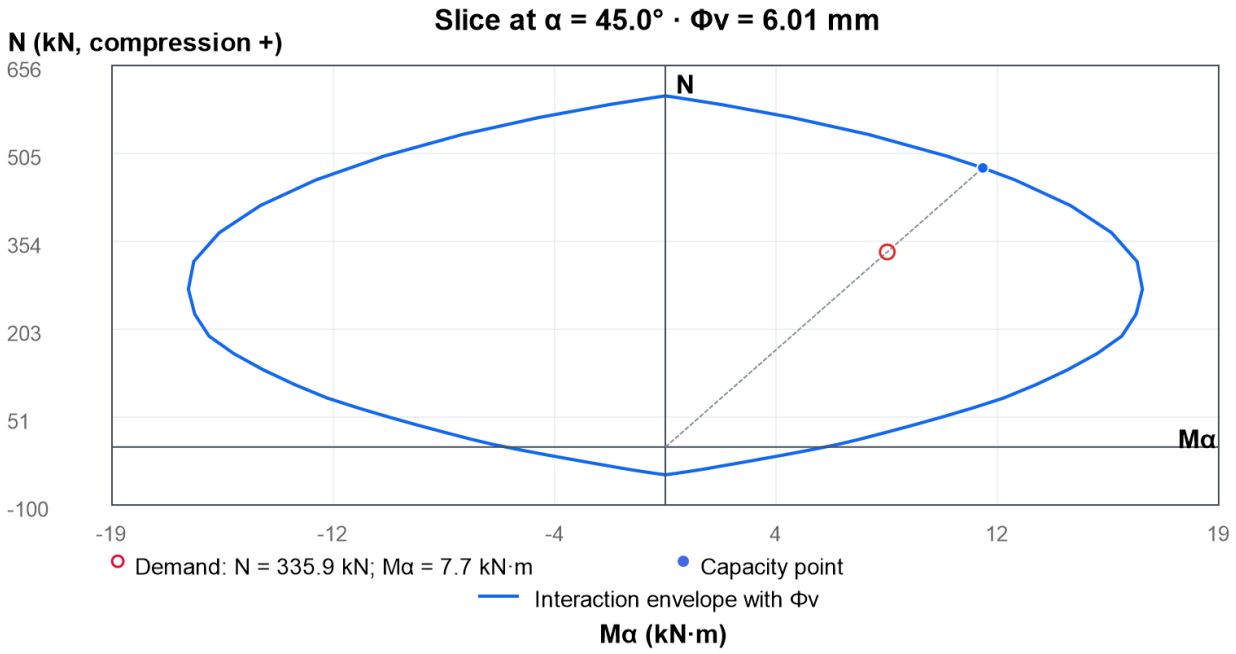
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6239	1.6239	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

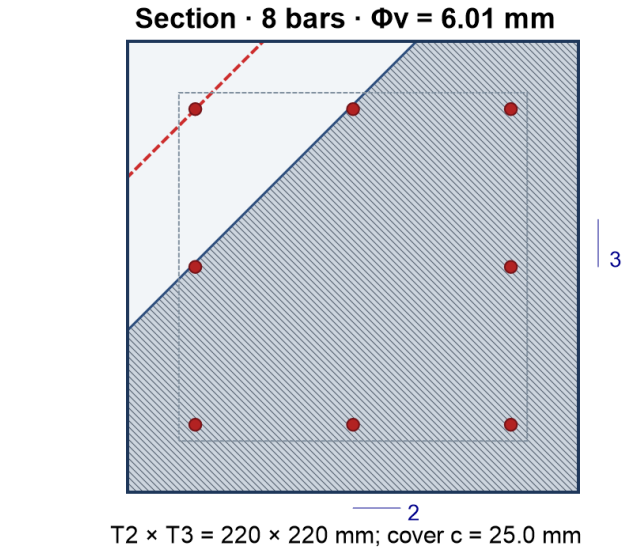
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 211.48 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.6992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0001°	Geometry at the check point
Normal vector n	(0.707108; -0.707105)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	211.4811 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707108 \cdot x_2 - 0.707105 \cdot x_3 = -55.9176$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707108 \cdot x_2 - 0.707105 \cdot x_3 = -108.7878$ mm	Geometry at the check point
Compressed concrete area A_b	38,470.692 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(16.267; -16.267) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	442.413 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.197 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.197 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.564	1.44034	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.16122	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.88210	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	-0.00141	-0.282	-0.008	0.001	0.001
5	0.000	77.000	28.366	210.011	0.71947	143.894	4.082	-0.314	0.000
6	77.000	77.000	28.366	155.563	1.44035	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.71947	143.893	4.082	0.000	-0.314
8	77.000	0.000	28.366	101.116	2.16123	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							37.940	0.604	0.604

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	442.413	7.197	7.197	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.940	0.604	0.604	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**480.353**	**7.800**	**7.801**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	338.470 kN	From analysis results
M_2	-13.239 kN·m	From analysis results
M_3	-8.168 kN·m	From analysis results
M_{2s}	-18.927 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.493 kN·m	Including second-order magnification and accidental eccentricity

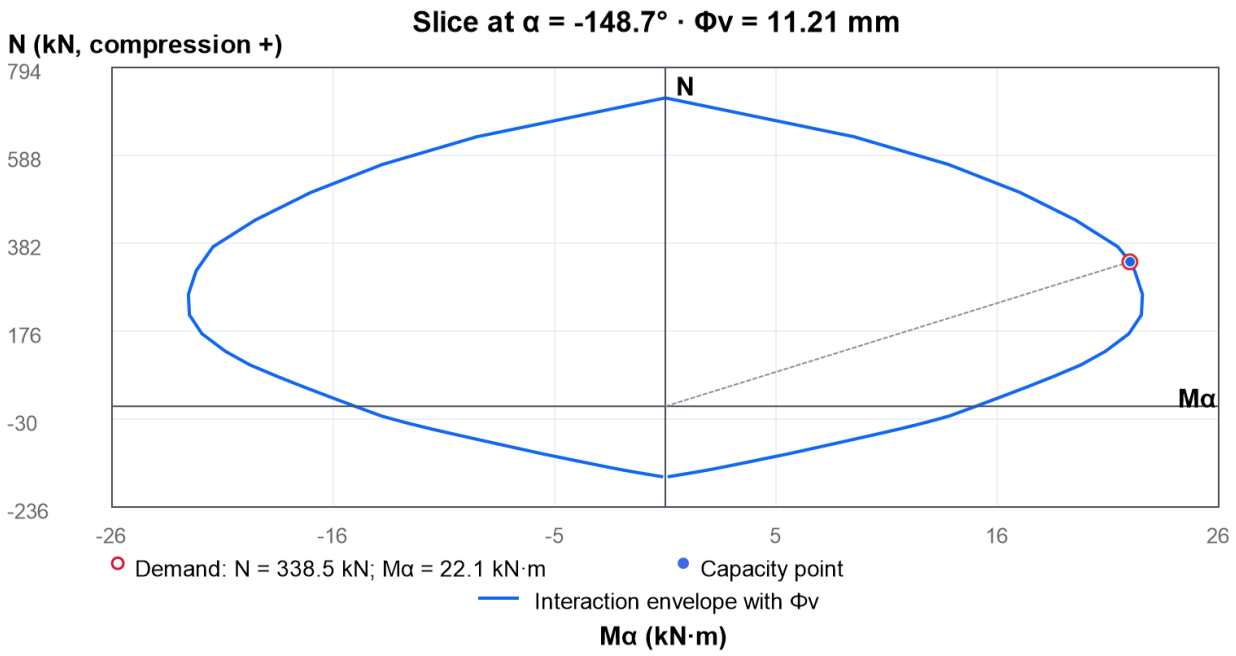
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	39.11	24.13	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.18	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.15697	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,514,059	3,514,059	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,334,652,627,380	1,386,696,023,696	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,126.20	1,170.12	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4297	1.4070	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

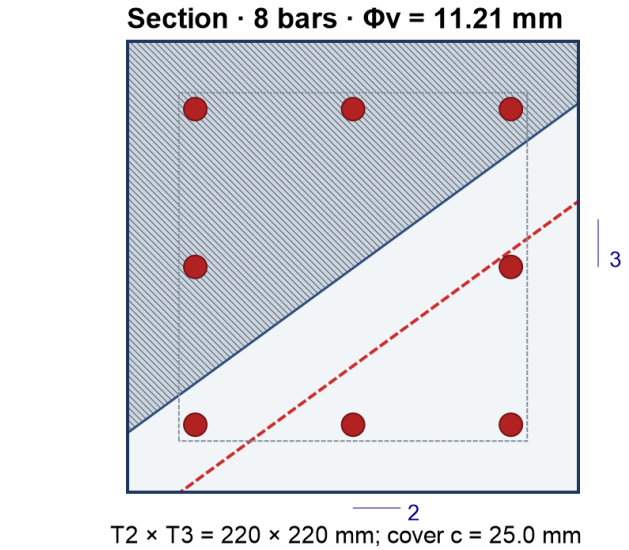
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 154.19 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	790.25 mm^2	Calculation results
Φ_v	11.2148 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	126.1545°	Geometry at the check point
Normal vector n	(-0.589965; 0.807429)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	154.1891 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.589965 \cdot x_2 + 0.807429 \cdot x_3 = -0.4758$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.589965 \cdot x_2 + 0.807429 \cdot x_3 = -39.0231$ mm	Geometry at the check point
Compressed concrete area A_b	24,329.642 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-26.649; 44.970) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	279.791 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.582 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.456 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	11.2148 mm / 98.782 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	98.782	170.458	0.40457	80.913	7.993	0.615	-0.615
2	0.000	-77.000	98.782	215.885	-0.42037	-84.075	-8.305	-0.639	0.000
3	77.000	-77.000	98.782	261.313	-1.24531	-210.000	-20.744	-1.597	-1.597
4	-77.000	77.000	98.782	46.114	2.66259	210.000	20.744	-1.597	-1.597
5	0.000	77.000	98.782	91.541	1.83765	210.000	20.744	-1.597	0.000
6	77.000	77.000	98.782	136.969	1.01272	202.543	20.008	-1.541	1.541
7	-77.000	0.000	98.782	108.286	1.53358	210.000	20.744	0.000	-1.597
8	77.000	0.000	98.782	199.141	-0.11630	-23.260	-2.298	0.000	-0.177
Σ N_{si}, M_{xsi}, M_{ysi}							58.886	-6.357	-4.044

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	279.791	-12.582	-7.456	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	58.886	-6.357	-4.044	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**338.677**	**-18.939**	**-11.500**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	337.256 kN	From analysis results
M_2	-12.553 kN·m	From analysis results
M_3	-7.568 kN·m	From analysis results
M_{2s}	-18.191 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.833 kN·m	Including second-order magnification and accidental eccentricity

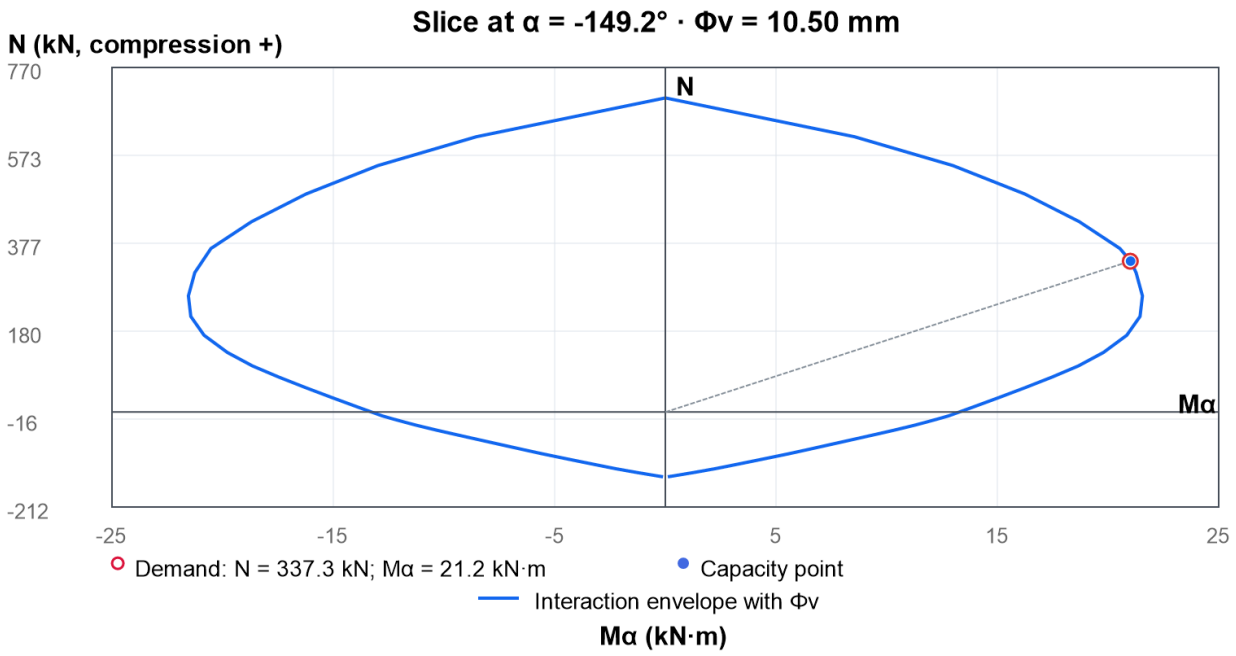
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	37.22	22.44	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.17	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.15985	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,081,407	3,081,407	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,289,540,168,972	1,326,124,749,787	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,088.13	1,119.00	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4491	1.4314	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

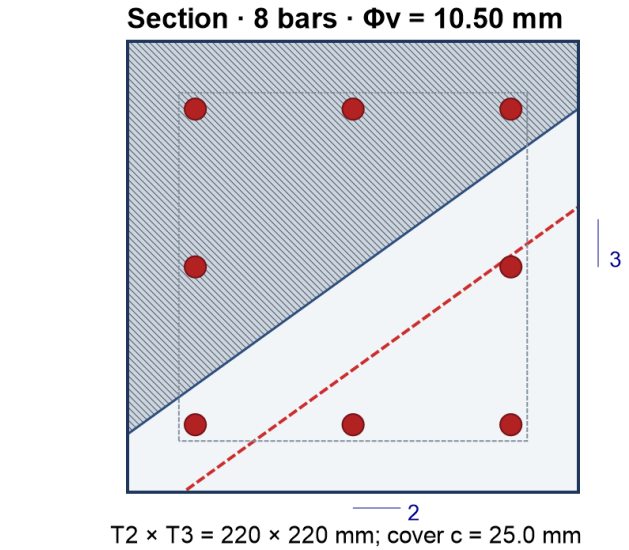
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 155.37 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	692.96 mm^2	Calculation results
Φ_v	10.5018 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	125.8243°	Geometry at the check point
Normal vector n	(-0.585302; 0.810815)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	155.3688 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.585302 \cdot x_2 + 0.810815 \cdot x_3 = -1.7959$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.585302 \cdot x_2 + 0.810815 \cdot x_3 = -40.6381$ mm	Geometry at the check point
Compressed concrete area A_b	24,687.287 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-25.946; 44.528) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	283.904 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.642 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.366 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.5018 mm / 86.620 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	86.620	170.937	0.41943	83.886	7.266	0.559	-0.559
2	0.000	-77.000	86.620	216.006	-0.39278	-78.555	-6.804	-0.524	0.000
3	77.000	-77.000	86.620	261.074	-1.20498	-210.000	-18.190	-1.401	-1.401
4	-77.000	77.000	86.620	46.072	2.66971	210.000	18.190	-1.401	-1.401
5	0.000	77.000	86.620	91.140	1.85751	210.000	18.190	-1.401	0.000
6	77.000	77.000	86.620	136.208	1.04530	209.061	18.109	-1.394	1.394
7	-77.000	0.000	86.620	108.505	1.54457	210.000	18.190	0.000	-1.401
8	77.000	0.000	86.620	198.641	-0.07984	-15.968	-1.383	0.000	-0.106
Σ N_{si}, M_{xsi}, M_{ysi}							53.568	-5.561	-3.474

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	283.904	-12.642	-7.366	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	53.568	-5.561	-3.474	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**337.471**	**-18.202**	**-10.840**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	339.207 kN	From analysis results
M_2	-1.814 kN·m	From analysis results
M_3	-0.971 kN·m	From analysis results
M_{2s}	-5.543 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-5.543 kN·m	Including second-order magnification and accidental eccentricity

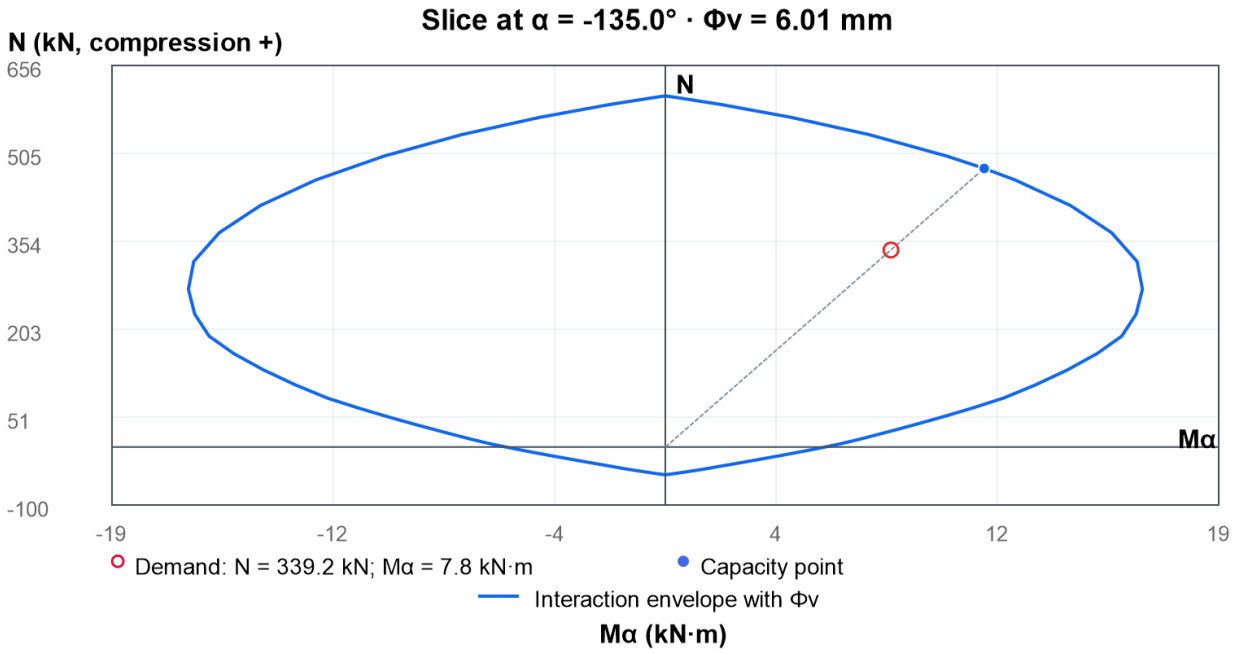
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6340	1.6340	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

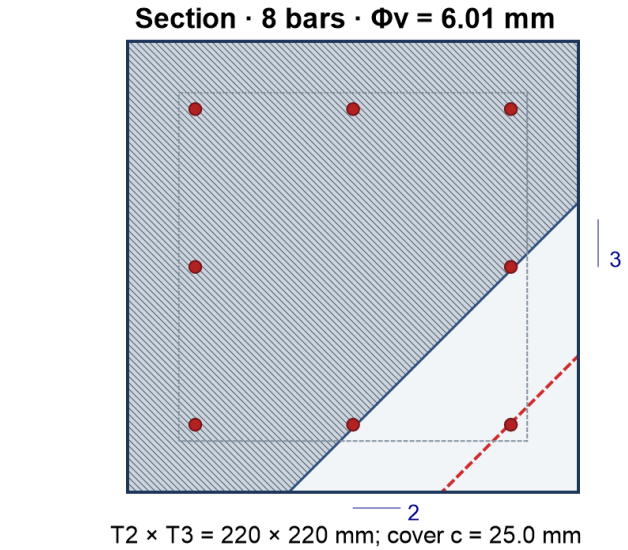
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 211.15 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7074	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	134.9999°	Geometry at the check point
Normal vector n	(-0.707105; 0.707108)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	211.1454 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707105 \cdot x_2 + 0.707108 \cdot x_3 = -55.5819$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707105 \cdot x_2 + 0.707108 \cdot x_3 = -108.3682$ mm	Geometry at the check point
Compressed concrete area A_b	38,403.675 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-16.364; 16.364) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	441.642 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.227 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.227 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.564	1.43707	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.011	0.71505	143.009	4.057	0.312	0.000
3	77.000	-77.000	28.366	264.458	-0.00698	-1.396	-0.040	-0.003	-0.003
4	-77.000	77.000	28.366	46.669	2.88112	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.116	2.15910	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.563	1.43707	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.116	2.15910	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.71505	143.010	4.057	0.000	0.312
Σ N_{si}, M_{xsi}, M_{ysi}							37.859	-0.608	-0.608

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	441.642	-7.227	-7.227	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.859	-0.608	-0.608	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**479.501**	**-7.835**	**-7.835**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	341.808 kN	From analysis results
M_2	12.505 kN·m	From analysis results
M_3	7.825 kN·m	From analysis results
M_{2s}	18.109 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.215 kN·m	Including second-order magnification and accidental eccentricity

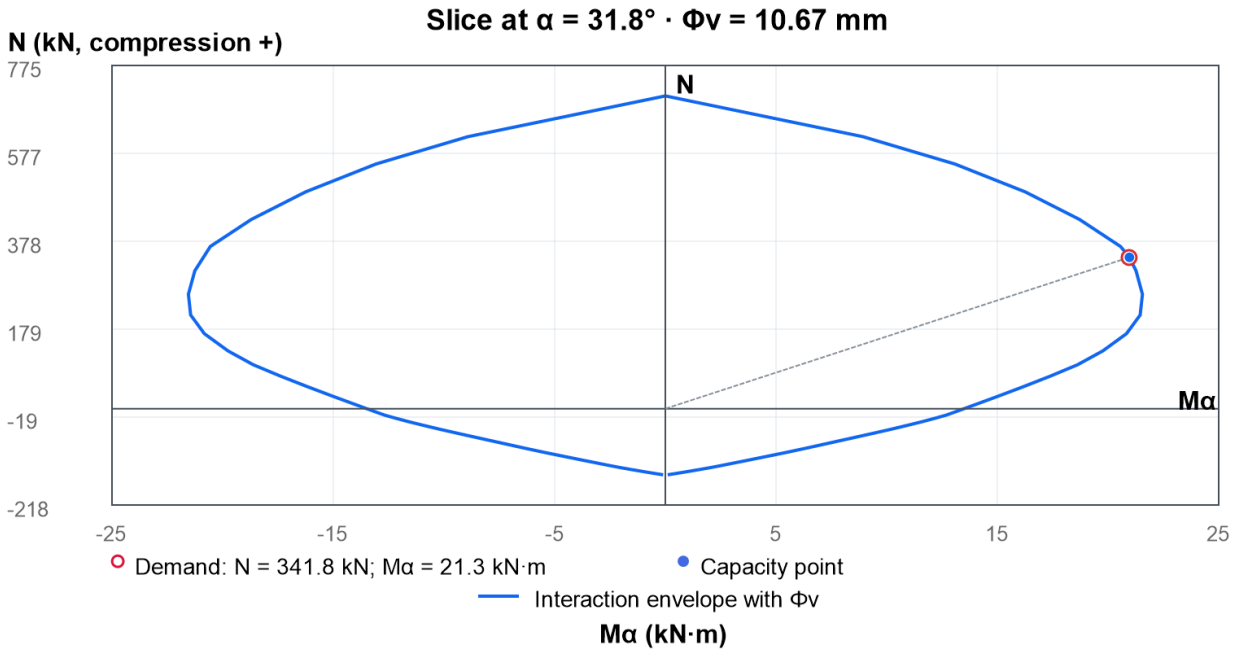
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	36.58	22.89	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.17	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16084	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,181,523	3,181,523	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,308,886,567,926	1,340,141,024,946	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,104.46	1,130.83	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4482	1.4332	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

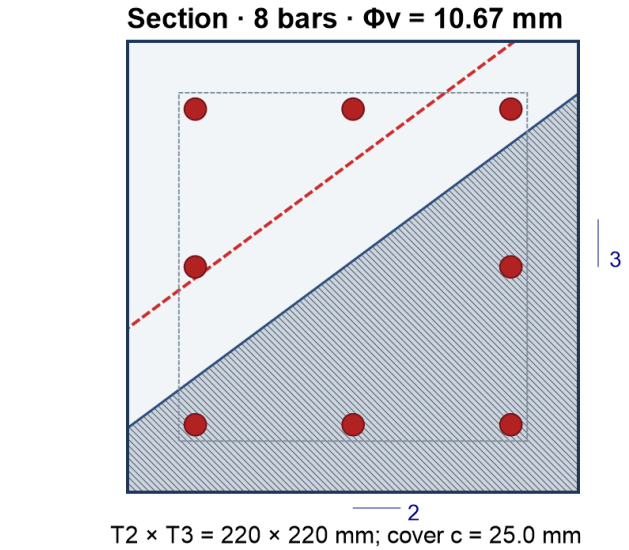
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 156.28 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	715.47 mm^2	Calculation results
Φ_v	10.6710 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	306.5572°	Geometry at the check point
Normal vector n	(0.595624; -0.803263)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	156.2813 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.595624 \cdot x_2 - 0.803263 \cdot x_3 = -2.4037$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.595624 \cdot x_2 - 0.803263 \cdot x_3 = -41.4740$ mm	Geometry at the check point
Compressed concrete area A_b	24,858.322 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(26.469; -43.691) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	285.871 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.490 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.567 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.6710 mm / 89.434 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	89.434	137.889	1.02952	205.903	18.415	1.418	-1.418
2	0.000	-77.000	89.434	92.026	1.85122	210.000	18.781	1.446	0.000
3	77.000	-77.000	89.434	46.163	2.67292	210.000	18.781	1.446	1.446
4	-77.000	77.000	89.434	261.592	-1.18679	-210.000	-18.781	1.446	1.446
5	0.000	77.000	89.434	215.729	-0.36509	-73.018	-6.530	0.503	0.000
6	77.000	77.000	89.434	169.866	0.45661	91.323	8.167	-0.629	0.629
7	-77.000	0.000	89.434	199.741	-0.07864	-15.727	-1.407	0.000	0.108
8	77.000	0.000	89.434	108.015	1.56477	210.000	18.781	0.000	1.446
Σ N_{si}, M_{xsi}, M_{ysi}							56.208	5.630	3.658

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	285.871	12.490	7.567	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	56.208	5.630	3.658	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**342.078**	**18.120**	**11.224**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	501.431 kN	From analysis results
M_2	6.426 kN·m	From analysis results
M_3	-10.285 kN·m	From analysis results
M_{2s}	10.475 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-16.767 kN·m	Including second-order magnification and accidental eccentricity

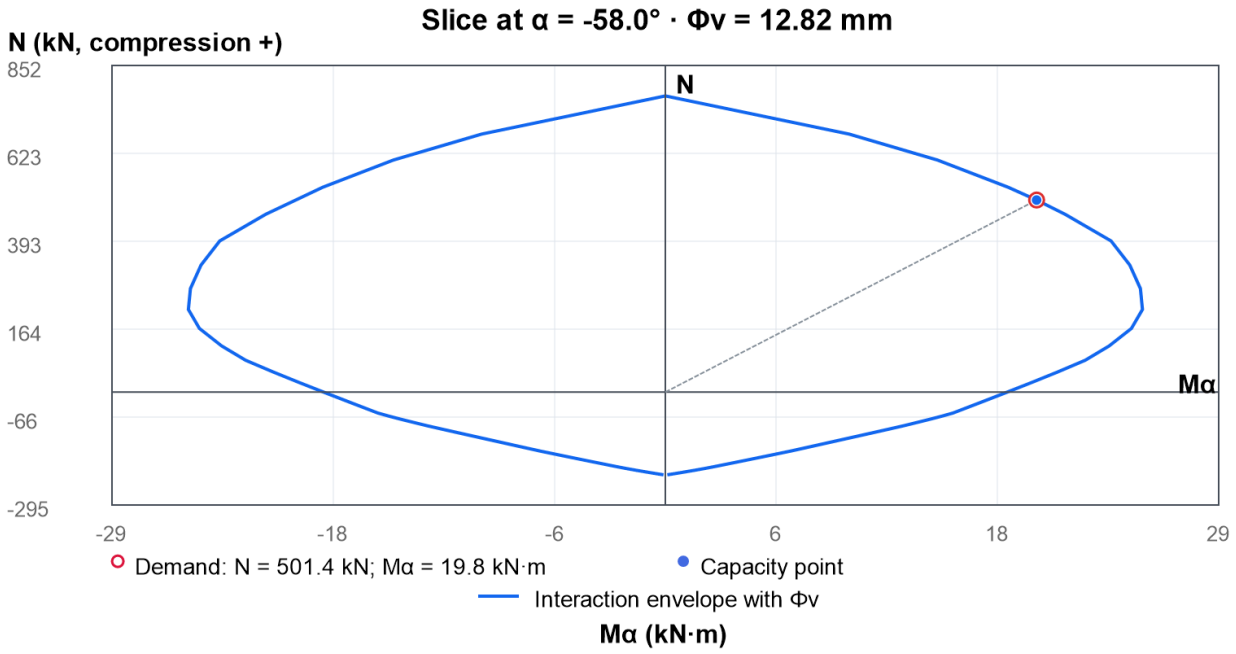
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	12.81	20.51	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,589,392	4,589,392	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,537,242,595,607	1,537,242,595,607	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,297.15	1,297.15	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6302	1.6302	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

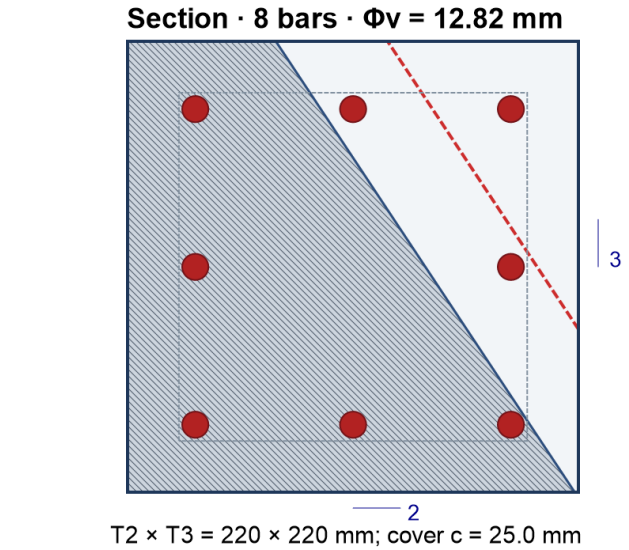
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 181.86 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,032.08 mm^2	Calculation results
Φ_v	12.8164 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9999	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	213.5434°	Geometry at the check point
Normal vector n	(-0.833468; -0.552568)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	181.8614 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.833468 \cdot x_2 - 0.552568 \cdot x_3 = -29.3974$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.833468 \cdot x_2 - 0.552568 \cdot x_3 = -74.8628$ mm	Geometry at the check point
Compressed concrete area A_b	31,959.669 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-31.263; -18.407) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	367.536 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.765 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.490 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.8164 mm / 129.010 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	129.010	45.739	2.79578	210.000	27.092	2.086	-2.086
2	0.000	-77.000	129.010	109.916	1.80769	210.000	27.092	2.086	0.000
3	77.000	-77.000	129.010	174.093	0.81960	163.920	21.147	1.628	1.628
4	-77.000	77.000	129.010	130.835	1.48563	210.000	27.092	-2.086	-2.086
5	0.000	77.000	129.010	195.012	0.49753	99.507	12.837	-0.988	0.000
6	77.000	77.000	129.010	259.189	-0.49056	-98.112	-12.657	0.975	-0.975
7	-77.000	0.000	129.010	88.287	2.14070	210.000	27.092	0.000	-2.086
8	77.000	0.000	129.010	216.641	0.16452	32.904	4.245	0.000	0.327
Σ N_{si}, M_{xsi}, M_{ysi}							133.940	3.701	-5.278

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	367.536	6.765	-11.490	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	133.940	3.701	-5.278	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**501.477**	**10.466**	**-16.768**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	503.382 kN	From analysis results
M_2	0.878 kN·m	From analysis results
M_3	-1.587 kN·m	From analysis results
M_{2s}	9.767 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.767 kN·m	Including second-order magnification and accidental eccentricity

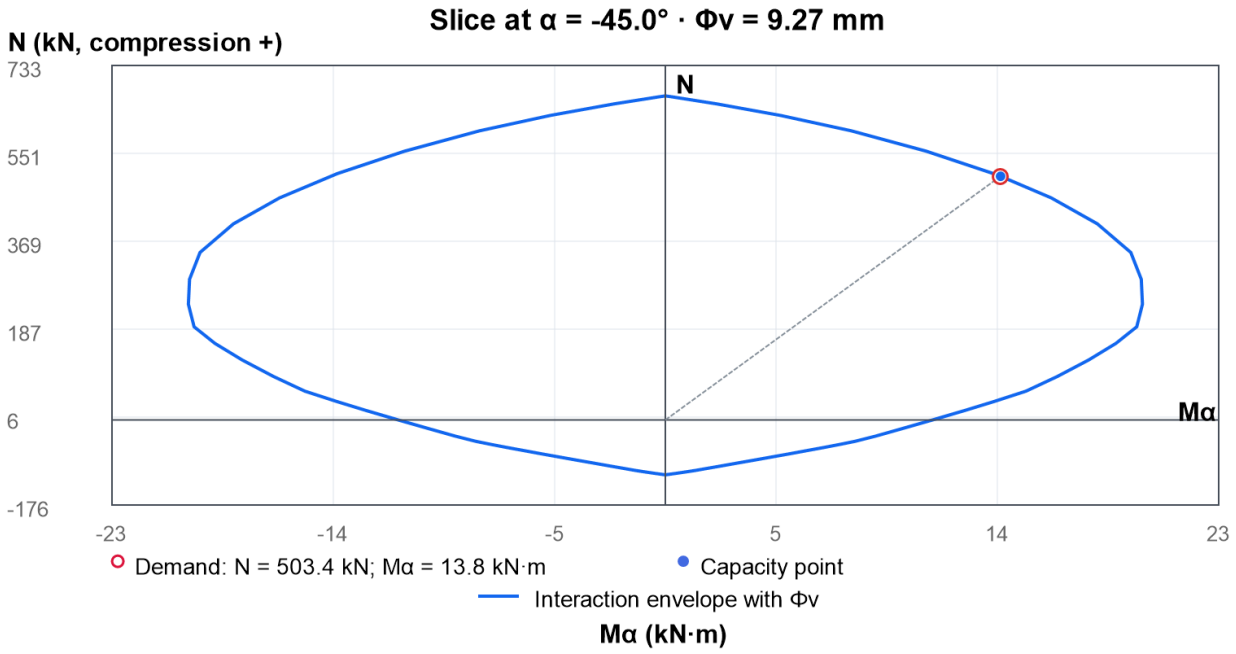
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,401,713	2,401,713	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,230,967,609,199	1,230,967,609,199	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,038.71	1,038.71	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.9403	1.9403	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

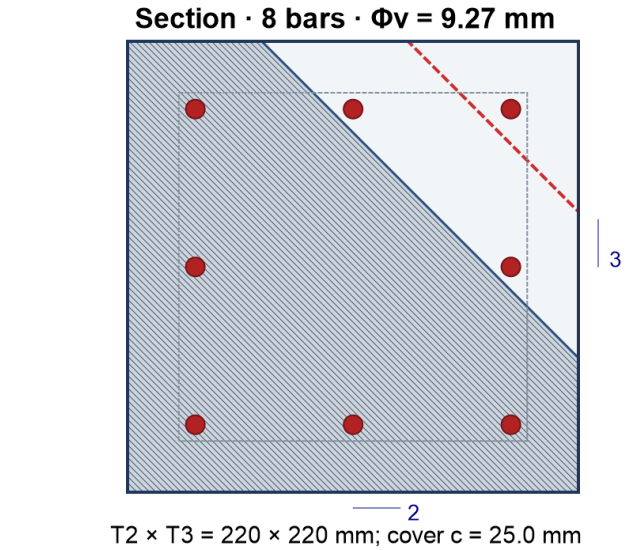
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 201.89 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	540.11 mm^2	Calculation results
Φ_v	9.2715 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0112°	Geometry at the check point
Normal vector n	(-0.706969; -0.707245)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	201.8930 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.706969 \cdot x_2 - 0.707245 \cdot x_3 = -46.3295$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.706969 \cdot x_2 - 0.707245 \cdot x_3 = -96.8028$ mm	Geometry at the check point
Compressed concrete area A_b	36,467.939 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.140; -19.146) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	419.381 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.030 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.027 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.2715 mm / 67.513 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	67.513	46.669	2.85276	210.000	14.178	1.092	-1.092
2	0.000	-77.000	67.513	101.106	2.09779	210.000	14.178	1.092	0.000
3	77.000	-77.000	67.513	155.542	1.34283	210.000	14.178	1.092	1.092
4	-77.000	77.000	67.513	155.585	1.34224	210.000	14.178	-1.092	-1.092
5	0.000	77.000	67.513	210.021	0.58727	117.454	7.930	-0.611	0.000
6	77.000	77.000	67.513	264.458	-0.16770	-33.539	-2.264	0.174	-0.174
7	-77.000	0.000	67.513	101.127	2.09750	210.000	14.178	0.000	-1.092
8	77.000	0.000	67.513	210.000	0.58757	117.513	7.934	0.000	0.611
Σ N_{si}, M_{xsi}, M_{ysi}							84.488	1.747	-1.747

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	419.381	8.030	-8.027	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	84.488	1.747	-1.747	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**503.869**	**9.777**	**-9.774**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	505.983 kN	From analysis results
M_2	-6.518 kN·m	From analysis results
M_3	10.010 kN·m	From analysis results
M_{2s}	-10.682 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	16.405 kN·m	Including second-order magnification and accidental eccentricity

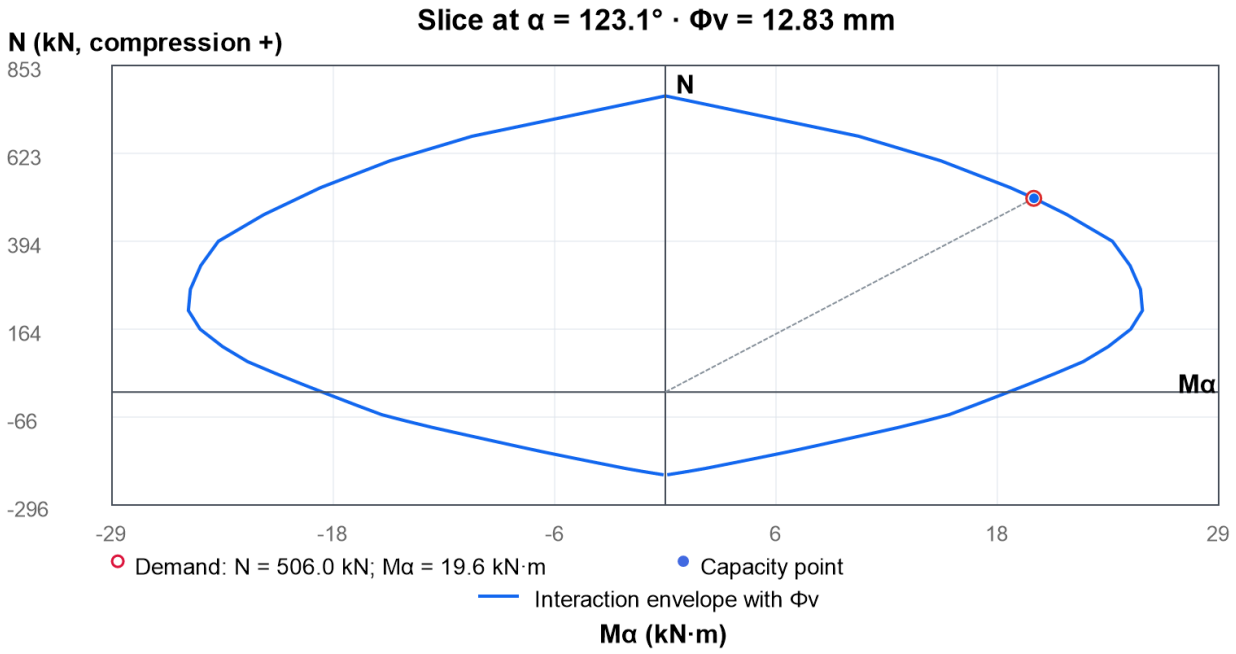
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	12.88	19.78	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	4,596,388	4,596,388	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,538,222,113,443	1,538,222,113,443	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,297.98	1,297.98	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6389	1.6389	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

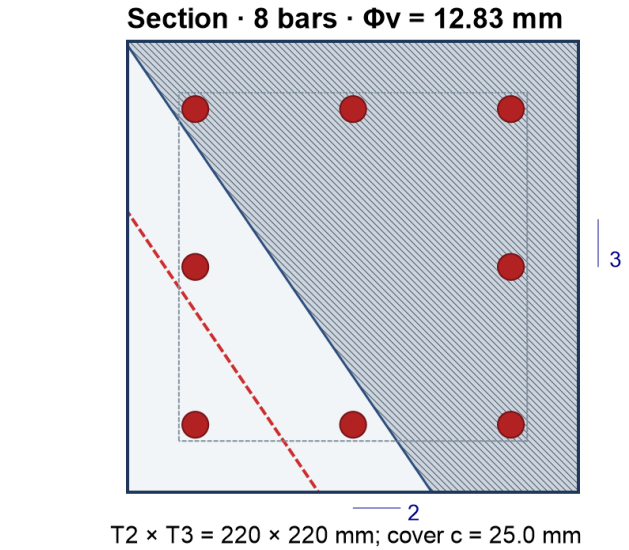
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 182.95 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	1,033.65 mm^2	Calculation results
Φ_v	12.8262 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	34.2578°	Geometry at the check point
Normal vector n	(0.826513; 0.562917)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	182.9453 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.826513 \cdot x_2 + 0.562917 \cdot x_3 = -30.1079$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.826513 \cdot x_2 + 0.562917 \cdot x_3 = -75.8442$ mm	Geometry at the check point
Compressed concrete area A_b	32,212.746 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(30.403; 18.756) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	370.447 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.948 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.263 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	12.8262 mm / 129.206 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	129.206	259.824	-0.47663	-95.326	-12.317	-0.948	0.948
2	0.000	-77.000	129.206	196.182	0.49741	99.482	12.854	0.990	0.000
3	77.000	-77.000	129.206	132.540	1.47145	210.000	27.133	2.089	2.089
4	-77.000	77.000	129.206	173.134	0.85016	170.032	21.969	-1.692	-1.692
5	0.000	77.000	129.206	109.493	1.82420	210.000	27.133	-2.089	0.000
6	77.000	77.000	129.206	45.851	2.79824	210.000	27.133	-2.089	2.089
7	-77.000	0.000	129.206	216.479	0.18676	37.353	4.826	0.000	-0.372
8	77.000	0.000	129.206	89.196	2.13485	210.000	27.133	0.000	2.089
Σ N_{si}, M_{xsi}, M_{ysi}							135.866	-3.740	5.153

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	370.447	-6.948	11.263	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	135.866	-3.740	5.153	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**506.312**	**-10.688**	**16.416**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	380.121 kN	From analysis results
M_2	0.822 kN·m	From analysis results
M_3	-9.526 kN·m	From analysis results
M_{2s}	6.316 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.828 kN·m	Including second-order magnification and accidental eccentricity

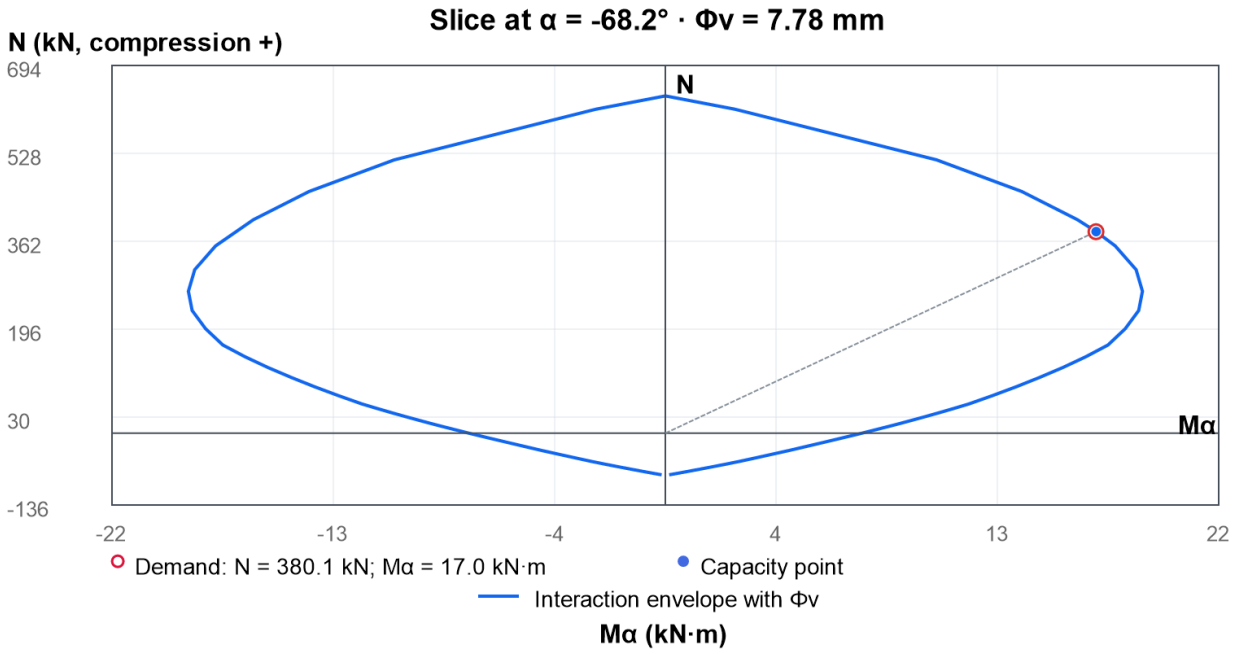
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	25.06	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,689,994	1,689,994	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,131,326,942,566	1,131,326,942,566	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	954.63	954.63	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6616	1.6616	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

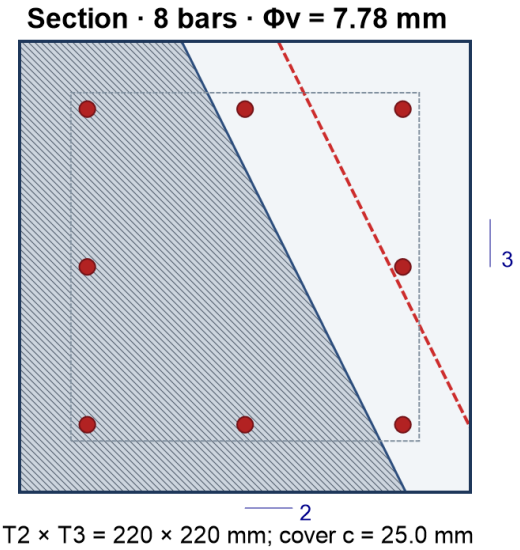
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 168.77 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	380.05 mm^2	Calculation results
Φ_v	7.7773 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	206.4395°	Geometry at the check point
Normal vector n	(-0.895405; -0.445252)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	168.7691 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.895405 \cdot x_2 - 0.445252 \cdot x_3 = -21.2967$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.895405 \cdot x_2 - 0.445252 \cdot x_3 = -63.4890$ mm	Geometry at the check point
Compressed concrete area A_b	29,432.586 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-39.380; -14.991) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	338.475 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.074 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-13.329 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.7773 mm / 47.506 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	47.506	44.242	2.76600	210.000	9.976	0.768	-0.768
2	0.000	-77.000	47.506	113.188	1.62213	210.000	9.976	0.768	0.000
3	77.000	-77.000	47.506	182.134	0.47826	95.653	4.544	0.350	0.350
4	-77.000	77.000	47.506	112.811	1.62839	210.000	9.976	-0.768	-0.768
5	0.000	77.000	47.506	181.757	0.48453	96.905	4.604	-0.354	0.000
6	77.000	77.000	47.506	250.703	-0.65934	-131.868	-6.265	0.482	-0.482
7	-77.000	0.000	47.506	78.526	2.19720	210.000	9.976	0.000	-0.768
8	77.000	0.000	47.506	216.419	-0.09054	-18.108	-0.860	0.000	-0.066
Σ N_{si}, M_{xsi}, M_{ysi}							41.928	1.246	-2.503

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	338.475	5.074	-13.329	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	41.928	1.246	-2.503	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**380.403**	**6.320**	**-15.833**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	382.072 kN	From analysis results
M_2	0.026 kN·m	From analysis results
M_3	-1.732 kN·m	From analysis results
M_{2s}	6.787 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-6.787 kN·m	Including second-order magnification and accidental eccentricity

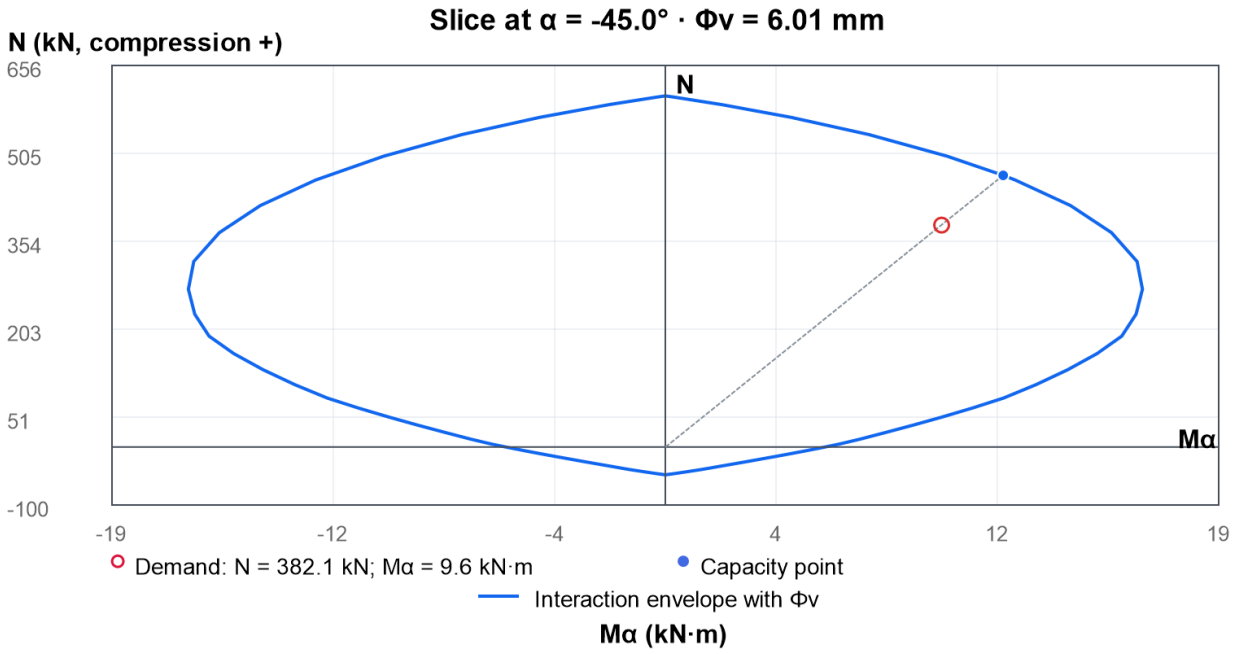
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7764	1.7764	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

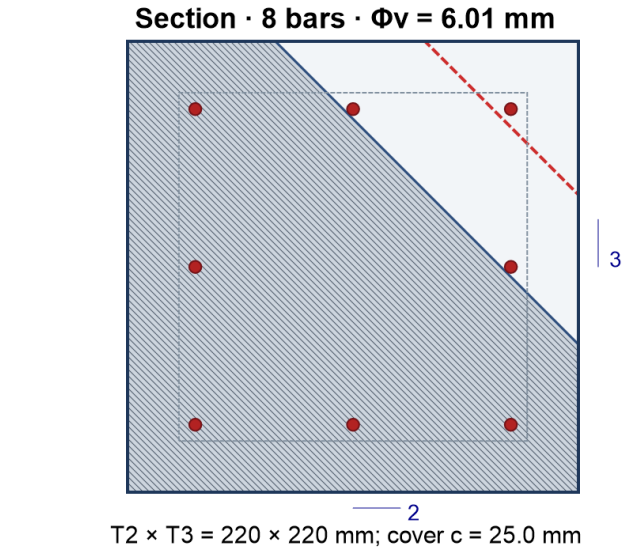
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.57 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.8171	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0000°	Geometry at the check point
Normal vector n	(-0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	206.5725 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -51.0090$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -102.6521$ mm	Geometry at the check point
Compressed concrete area A_b	37,468.354 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-17.713; -17.713) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	430.886 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.632 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.632 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.86742	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.12941	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.563	1.39140	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.39140	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.011	0.65340	130.679	3.707	-0.285	0.000
6	77.000	77.000	28.366	264.458	-0.08461	-16.922	-0.480	0.037	-0.037
7	-77.000	0.000	28.366	101.116	2.12941	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.65340	130.679	3.707	0.000	0.285
Σ N_{si}, M_{xsi}, M_{ysi}							36.719	0.669	-0.669

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	430.886	7.632	-7.632	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	36.719	0.669	-0.669	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**467.605**	**8.301**	**-8.301**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	384.673 kN	From analysis results
M_2	-1.035 kN·m	From analysis results
M_3	8.659 kN·m	From analysis results
M_{2s}	-6.591 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.837 kN·m	Including second-order magnification and accidental eccentricity

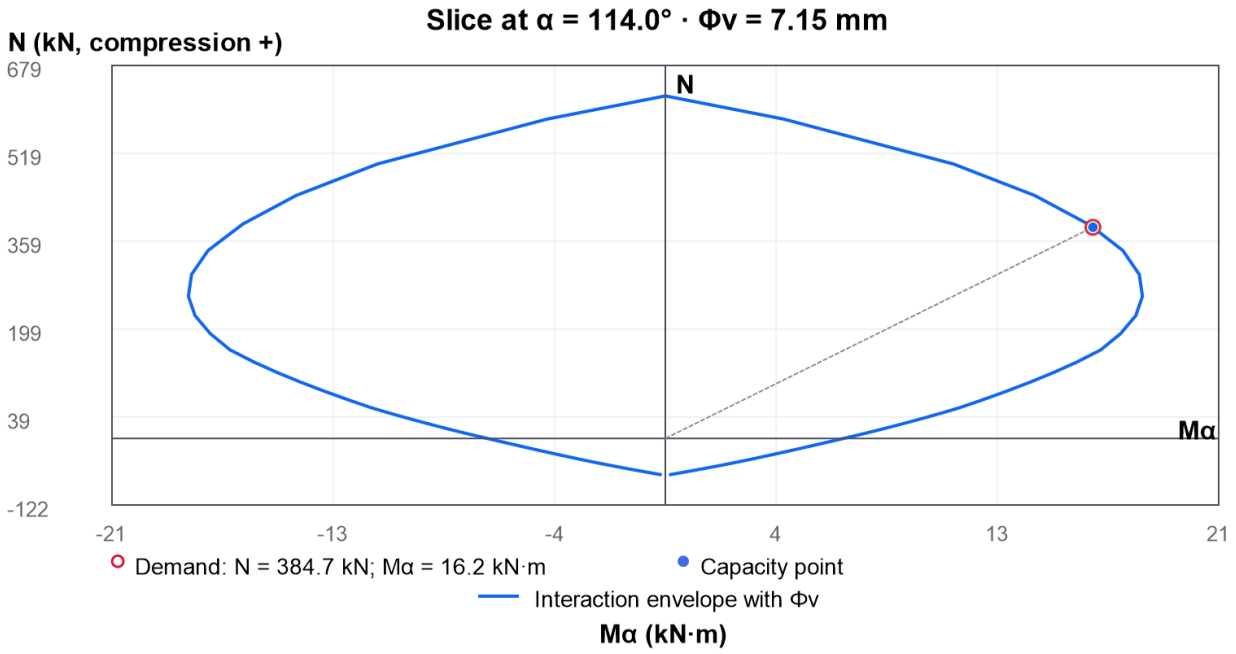
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	22.51	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,429,287	1,429,287	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,094,827,910,066	1,094,827,910,066	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	923.83	923.83	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7135	1.7135	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

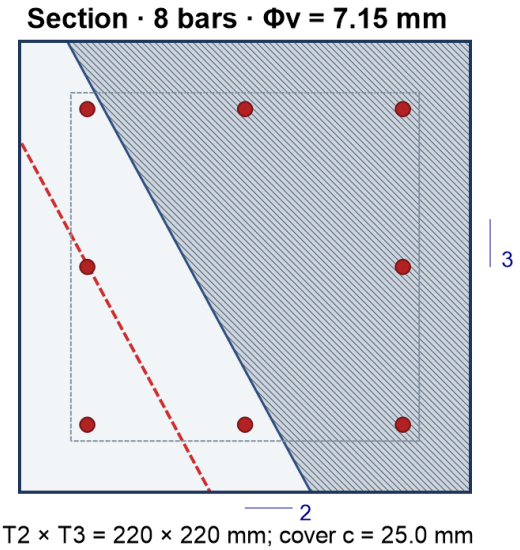
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 173.06 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	321.42 mm^2	Calculation results
Φ_v	7.1523 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9996	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	28.3987°	Geometry at the check point
Normal vector n	(0.879659; 0.475604)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	173.0624 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.879659 \cdot x_2 + 0.475604 \cdot x_3 = -23.9834$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.879659 \cdot x_2 + 0.475604 \cdot x_3 = -67.2490$ mm	Geometry at the check point
Compressed concrete area A_b	30,198.170 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(37.073; 15.887) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	347.279 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.517 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.875 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.1523 mm / 40.178 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	40.178	253.434	-0.60035	-120.070	-4.824	-0.371	0.371
2	0.000	-77.000	40.178	185.701	0.49553	99.105	3.982	0.307	0.000
3	77.000	-77.000	40.178	117.967	1.59140	210.000	8.437	0.650	0.650
4	-77.000	77.000	40.178	180.191	0.58466	116.932	4.698	-0.362	-0.362
5	0.000	77.000	40.178	112.457	1.68054	210.000	8.437	-0.650	0.000
6	77.000	77.000	40.178	44.724	2.77641	210.000	8.437	-0.650	0.650
7	-77.000	0.000	40.178	216.813	-0.00784	-1.569	-0.063	0.000	0.005
8	77.000	0.000	40.178	81.345	2.18390	210.000	8.437	0.000	0.650
Σ N_{si}, M_{xsi}, M_{ysi}							37.542	-1.076	1.964

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	347.279	-5.517	12.875	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.542	-1.076	1.964	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**384.821**	**-6.593**	**14.838**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	435.360 kN	From analysis results
M_2	-6.902 kN·m	From analysis results
M_3	-9.380 kN·m	From analysis results
M_{2s}	-11.181 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.196 kN·m	Including second-order magnification and accidental eccentricity

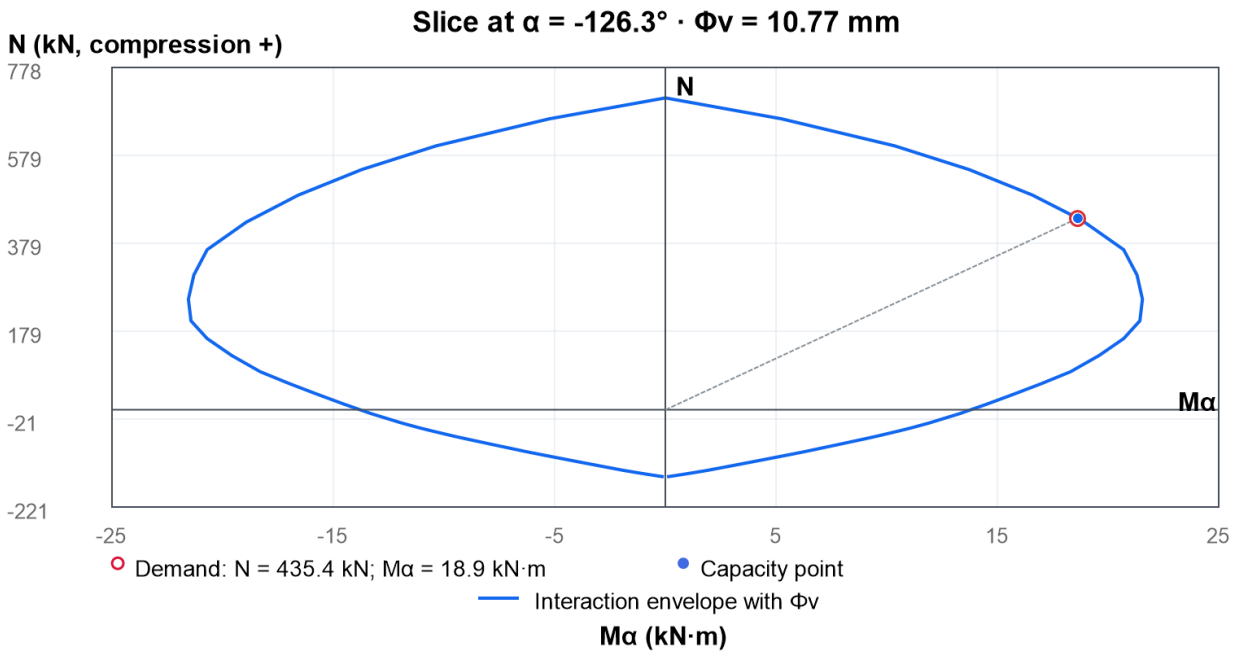
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	15.85	21.55	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,238,181	3,238,181	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,348,073,073,628	1,348,073,073,628	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,137.53	1,137.53	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.6200	1.6200	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

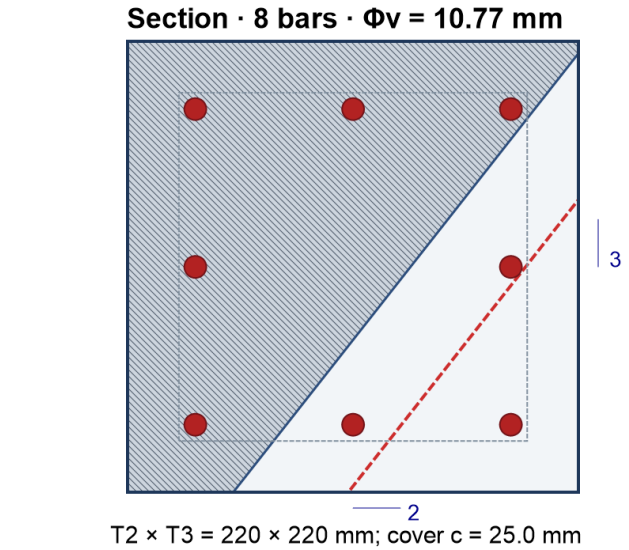
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 176.50 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	728.21 mm^2	Calculation results
Φ_v	10.7656 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	141.8082°	Geometry at the check point
Normal vector n	(-0.785945; 0.618297)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	176.4988 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.785945 \cdot x_2 + 0.618297 \cdot x_3 = -22.0323$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.785945 \cdot x_2 + 0.618297 \cdot x_3 = -66.1570$ mm	Geometry at the check point
Compressed concrete area A_b	30,353.956 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-32.004; 22.950) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	349.070 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.011 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.172 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.7656 mm / 91.027 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	91.027	141.558	1.25431	210.000	19.116	1.472	-1.472
2	0.000	-77.000	91.027	202.075	0.29425	58.850	5.357	0.412	0.000
3	77.000	-77.000	91.027	262.593	-0.66581	-133.162	-12.121	-0.933	-0.933
4	-77.000	77.000	91.027	46.340	2.76486	210.000	19.116	-1.472	-1.472
5	0.000	77.000	91.027	106.858	1.80480	210.000	19.116	-1.472	0.000
6	77.000	77.000	91.027	167.375	0.84473	168.947	15.379	-1.184	1.184
7	-77.000	0.000	91.027	93.949	2.00958	210.000	19.116	0.000	-1.472
8	77.000	0.000	91.027	214.984	0.08946	17.892	1.629	0.000	0.125
Σ N_{si}, M_{xsi}, M_{ysi}							86.705	-3.177	-4.039

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	349.070	-8.011	-11.172	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	86.705	-3.177	-4.039	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**435.776**	**-11.188**	**-15.211**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	437.311 kN	From analysis results
M_2	-0.623 kN·m	From analysis results
M_3	-1.628 kN·m	From analysis results
M_{2s}	-8.750 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.750 kN·m	Including second-order magnification and accidental eccentricity

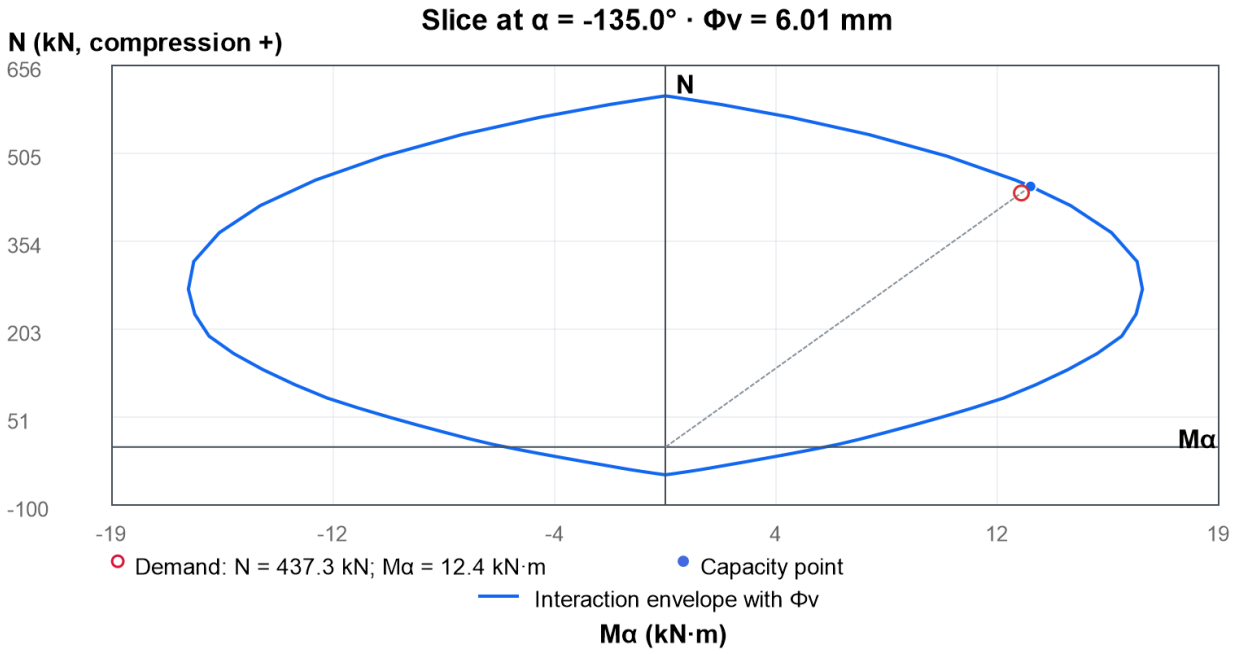
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	2.0010	2.0010	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

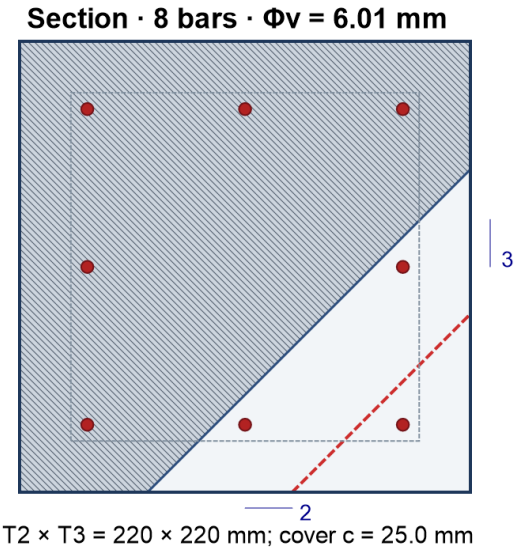
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 199.66 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9748	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	134.9899°	Geometry at the check point
Normal vector n	(-0.706983; 0.707231)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	199.6628 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.706983 \cdot x_2 + 0.707231 \cdot x_3 = -44.0993$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.706983 \cdot x_2 + 0.707231 \cdot x_3 = -94.0150$ mm	Geometry at the check point
Compressed concrete area A_b	35,975.739 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.839; 19.845) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	413.721 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-8.210 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.208 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.583	1.31817	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.020	0.55475	110.950	3.147	0.242	0.000
3	77.000	-77.000	28.366	264.458	-0.20866	-41.733	-1.184	-0.091	-0.091
4	-77.000	77.000	28.366	46.669	2.84553	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.107	2.08212	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.544	1.31870	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.126	2.08185	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.001	0.55502	111.004	3.149	0.000	0.242
Σ N_{si}, M_{xsi}, M_{ysi}							34.897	-0.766	-0.766

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	413.721	-8.210	-8.208	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	34.897	-0.766	-0.766	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**448.618**	**-8.977**	**-8.974**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	439.912 kN	From analysis results
M_2	7.748 kN·m	From analysis results
M_3	8.709 kN·m	From analysis results
M_{2s}	12.576 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.136 kN·m	Including second-order magnification and accidental eccentricity

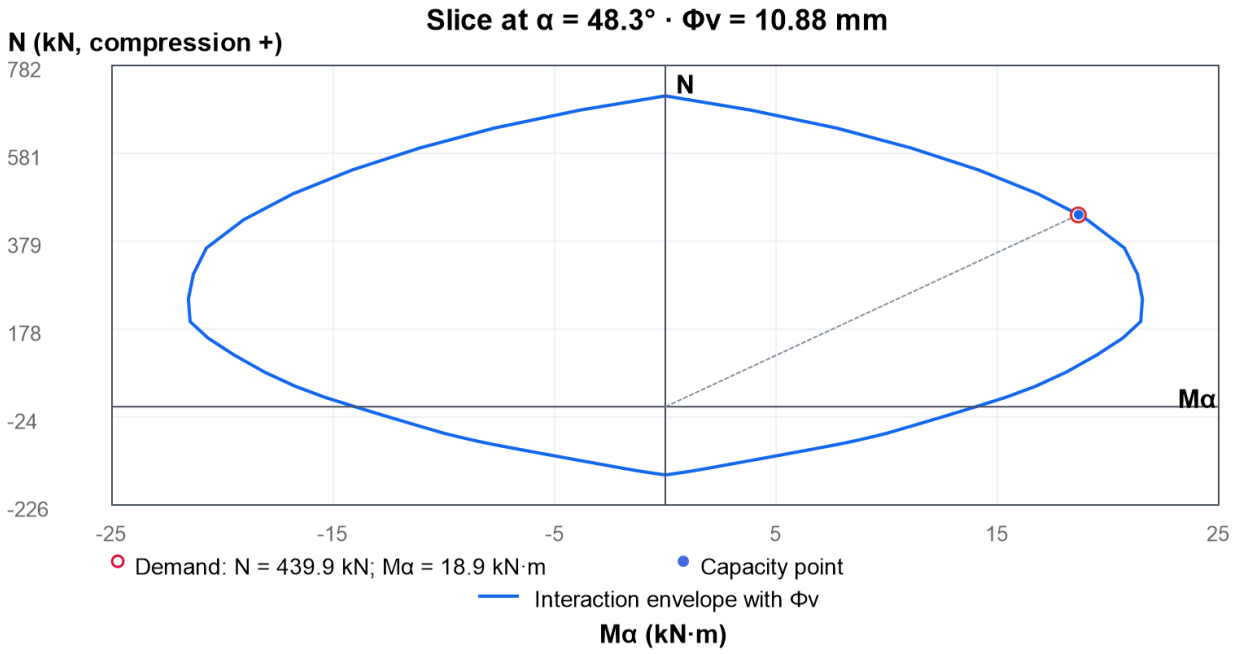
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	17.61	19.80	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,309,062	3,309,062	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,357,996,427,146	1,357,996,427,146	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,145.90	1,145.90	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6231	1.6231	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

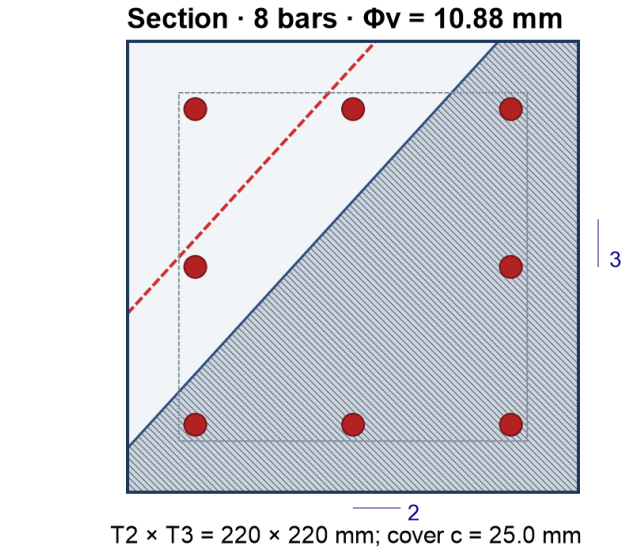
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 177.11 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	744.15 mm^2	Calculation results
Φ_v	10.8828 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9986	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	317.6349°	Geometry at the check point
Normal vector n	(0.738866; -0.673852)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	177.1140 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.738866 \cdot x_2 - 0.673852 \cdot x_3 = -21.7150$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.738866 \cdot x_2 - 0.673852 \cdot x_3 = -65.9935$ mm	Geometry at the check point
Compressed concrete area A_b	30,452.723 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(29.284; -25.855) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	350.206 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	9.055 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	10.256 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.8828 mm / 93.019 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	93.019	160.405	0.96415	192.830	17.937	1.381	-1.381
2	0.000	-77.000	93.019	103.512	1.86357	210.000	19.534	1.504	0.000
3	77.000	-77.000	93.019	46.620	2.76299	210.000	19.534	1.504	1.504
4	-77.000	77.000	93.019	264.178	-0.67640	-135.280	-12.584	0.969	0.969
5	0.000	77.000	93.019	207.286	0.22302	44.603	4.149	-0.319	0.000
6	77.000	77.000	93.019	150.393	1.12243	210.000	19.534	-1.504	1.504
7	-77.000	0.000	93.019	212.292	0.14387	28.775	2.677	0.000	-0.206
8	77.000	0.000	93.019	98.506	1.94271	210.000	19.534	0.000	1.504
Σ N_{si}, M_{xsi}, M_{ysi}							90.315	3.535	3.894

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	350.206	9.055	10.256	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	90.315	3.535	3.894	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**440.521**	**12.589**	**14.150**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	331.942 kN	From analysis results
M_2	11.342 kN·m	From analysis results
M_3	-7.699 kN·m	From analysis results
M_{2s}	16.556 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.197 kN·m	Including second-order magnification and accidental eccentricity

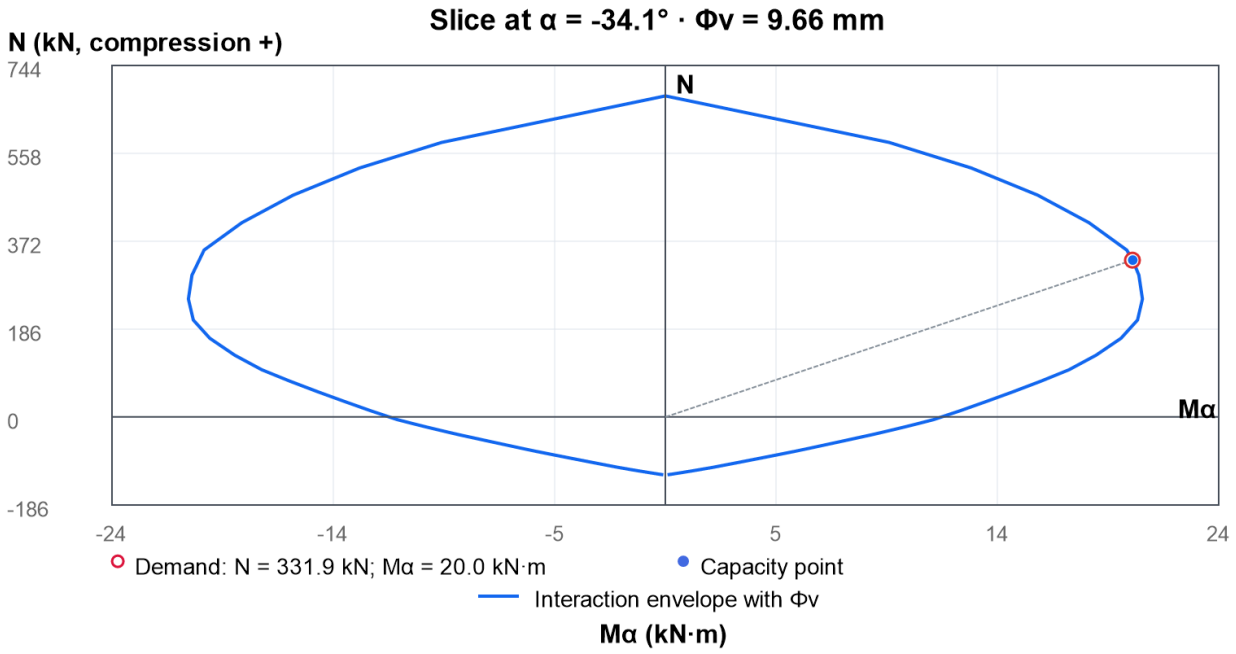
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	34.17	23.19	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.16	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16472	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,604,833	2,604,833	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,248,974,035,560	1,259,404,452,315	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,053.90	1,062.71	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4598	1.4542	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

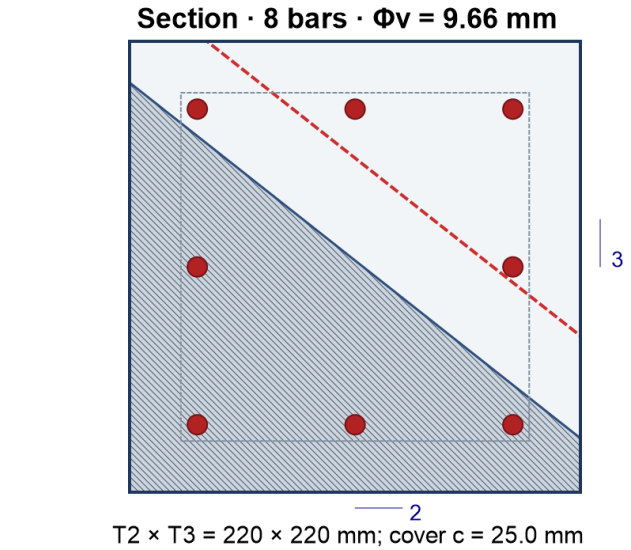
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 156.94 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	585.78 mm^2	Calculation results
Φ_v	9.6556 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	231.7384°	Geometry at the check point
Normal vector n	(-0.619253; -0.785191)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	156.9357 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.619253 \cdot x_2 - 0.785191 \cdot x_3 = -2.4467$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.619253 \cdot x_2 - 0.785191 \cdot x_3 = -41.6807$ mm	Geometry at the check point
Compressed concrete area A_b	24,885.546 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-28.121; -42.353) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	286.184 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.121 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.048 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.6556 mm / 73.223 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	73.223	46.347	2.67310	210.000	15.377	1.184	-1.184
2	0.000	-77.000	73.223	94.029	1.82236	210.000	15.377	1.184	0.000
3	77.000	-77.000	73.223	141.712	0.97162	194.324	14.229	1.096	1.096
4	-77.000	77.000	73.223	167.266	0.51569	103.137	7.552	-0.582	-0.582
5	0.000	77.000	73.223	214.949	-0.33505	-67.010	-4.907	0.378	0.000
6	77.000	77.000	73.223	262.631	-1.18579	-210.000	-15.377	1.184	-1.184
7	-77.000	0.000	73.223	106.806	1.59439	210.000	15.377	0.000	-1.184
8	77.000	0.000	73.223	202.171	-0.10708	-21.417	-1.568	0.000	-0.121
Σ N_{si}, M_{xsi}, M_{ysi}							46.060	4.444	-3.159

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	286.184	12.121	-8.048	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	46.060	4.444	-3.159	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**332.244**	**16.565**	**-11.206**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	333.893 kN	From analysis results
M_2	0.724 kN·m	From analysis results
M_3	-1.000 kN·m	From analysis results
M_{2s}	5.402 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-5.402 kN·m	Including second-order magnification and accidental eccentricity

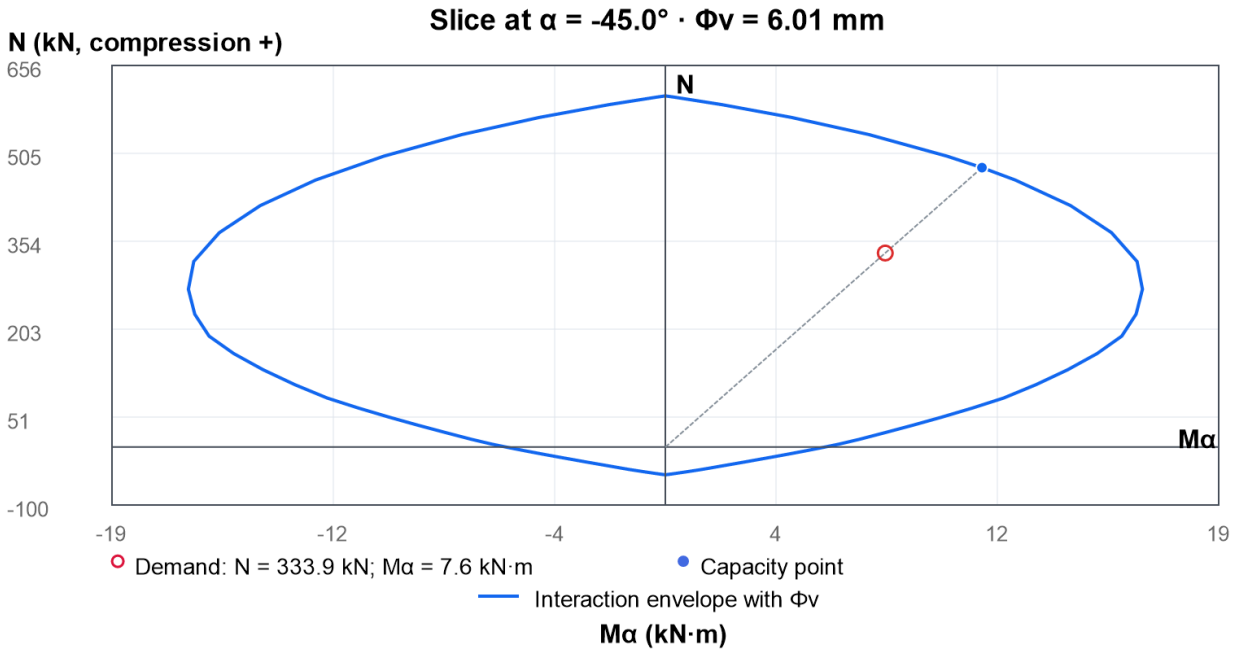
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.6180	1.6180	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

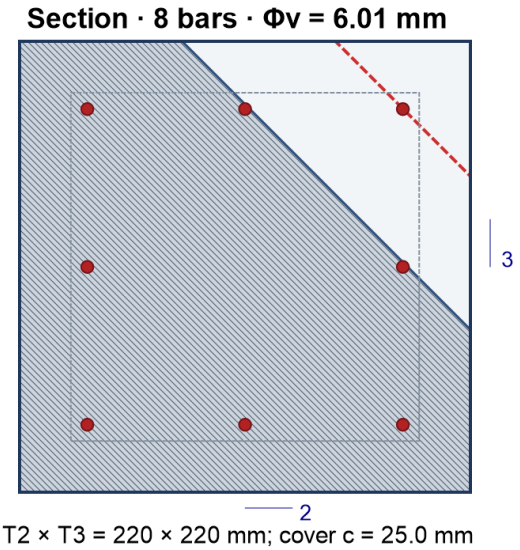
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 211.68 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.6944	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0001°	Geometry at the check point
Normal vector n	(-0.707105; -0.707109)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	211.6784 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707105 \cdot x_2 - 0.707109 \cdot x_3 = -56.1149$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707105 \cdot x_2 - 0.707109 \cdot x_3 = -109.0345$ mm	Geometry at the check point
Compressed concrete area A_b	38,509.974 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-16.210; -16.210) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	442.865 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.179 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.179 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.88268	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.16247	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.563	1.44227	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.564	1.44226	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.011	0.72206	144.411	4.096	-0.315	0.000
6	77.000	77.000	28.366	264.458	0.00185	0.370	0.011	-0.001	0.001
7	-77.000	0.000	28.366	101.116	2.16247	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.72206	144.412	4.096	0.000	0.315
Σ N_{si}, M_{xsi}, M_{ysi}							37.988	0.601	-0.601

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	442.865	7.179	-7.179	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.988	0.601	-0.601	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**480.853**	**7.780**	**-7.780**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	336.494 kN	From analysis results
M_2	-13.434 kN·m	From analysis results
M_3	7.932 kN·m	From analysis results
M_{2s}	-19.208 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.139 kN·m	Including second-order magnification and accidental eccentricity

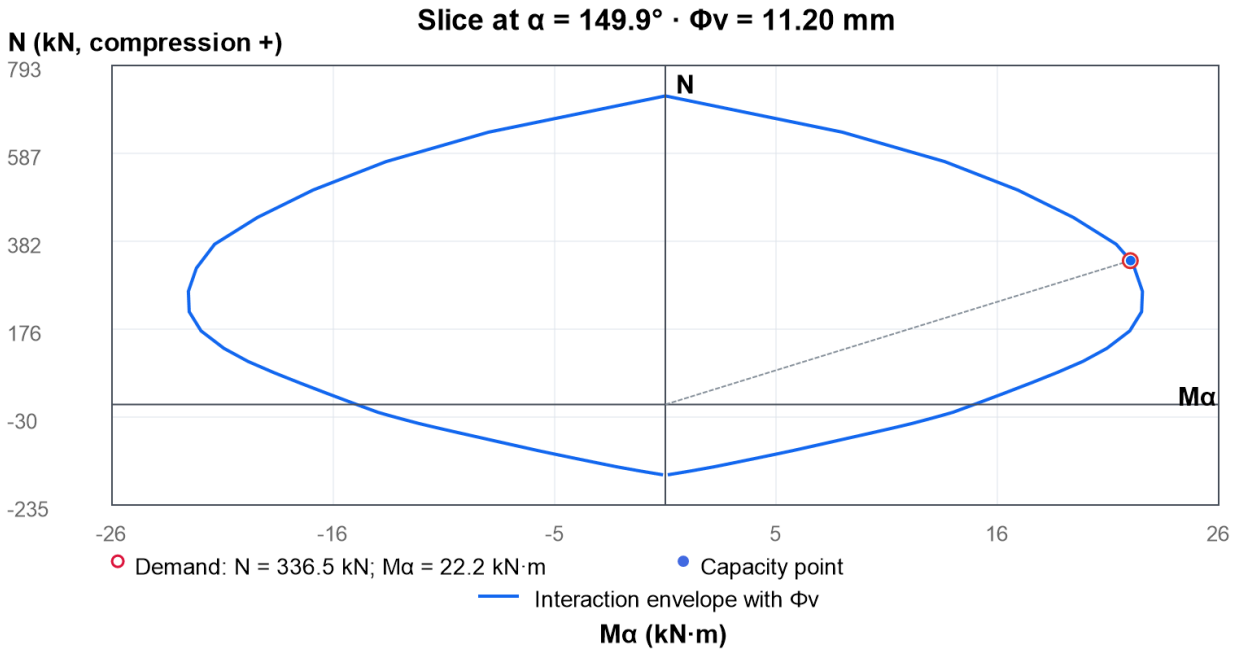
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	39.92	23.57	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.18	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.15578	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	3,501,830	3,501,830	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,326,513,776,222	1,384,983,937,833	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,119.33	1,168.67	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4298	1.4044	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

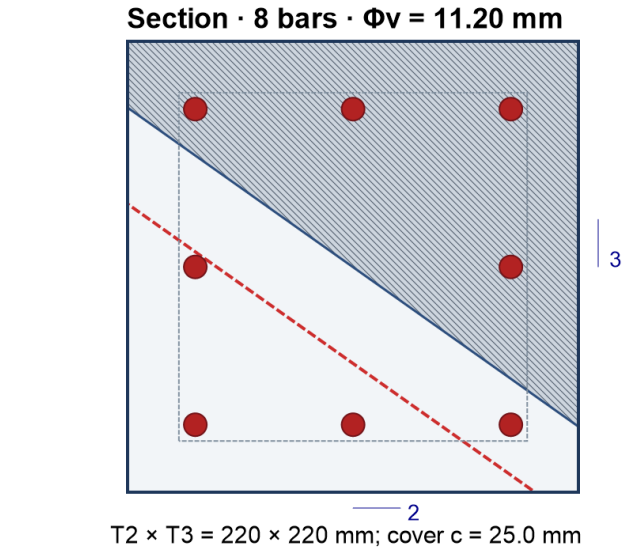
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 153.44 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	787.50 mm^2	Calculation results
Φ_v	11.1953 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	54.7266°	Geometry at the check point
Normal vector n	(0.577479; 0.816405)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	153.4405 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.577479 \cdot x_2 + 0.816405 \cdot x_3 = -0.1132$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.577479 \cdot x_2 + 0.816405 \cdot x_3 = -38.4733$ mm	Geometry at the check point
Compressed concrete area A_b	24,230.509 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(25.903; 45.769) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	278.651 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.754 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.218 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	11.1953 mm / 98.438 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	98.438	260.656	-1.25649	-210.000	-20.672	-1.592	1.592
2	0.000	-77.000	98.438	216.191	-0.44507	-89.014	-8.762	-0.675	0.000
3	77.000	-77.000	98.438	171.725	0.36635	73.270	7.213	0.555	0.555
4	-77.000	77.000	98.438	134.930	1.03778	207.556	20.431	-1.573	-1.573
5	0.000	77.000	98.438	90.464	1.84920	210.000	20.672	-1.592	0.000
6	77.000	77.000	98.438	45.998	2.66062	210.000	20.672	-1.592	1.592
7	-77.000	0.000	98.438	197.793	-0.10935	-21.871	-2.153	0.000	0.166
8	77.000	0.000	98.438	108.861	1.51348	210.000	20.672	0.000	1.592
Σ N_{si}, M_{xsi}, M_{ysi}							58.073	-6.468	3.923

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	278.651	-12.754	7.218	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	58.073	-6.468	3.923	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**336.724**	**-19.221**	**11.141**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	247.335 kN	From analysis results
M_2	-12.753 kN·m	From analysis results
M_3	7.854 kN·m	From analysis results
M_{2s}	-17.400 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.289 kN·m	Including second-order magnification and accidental eccentricity

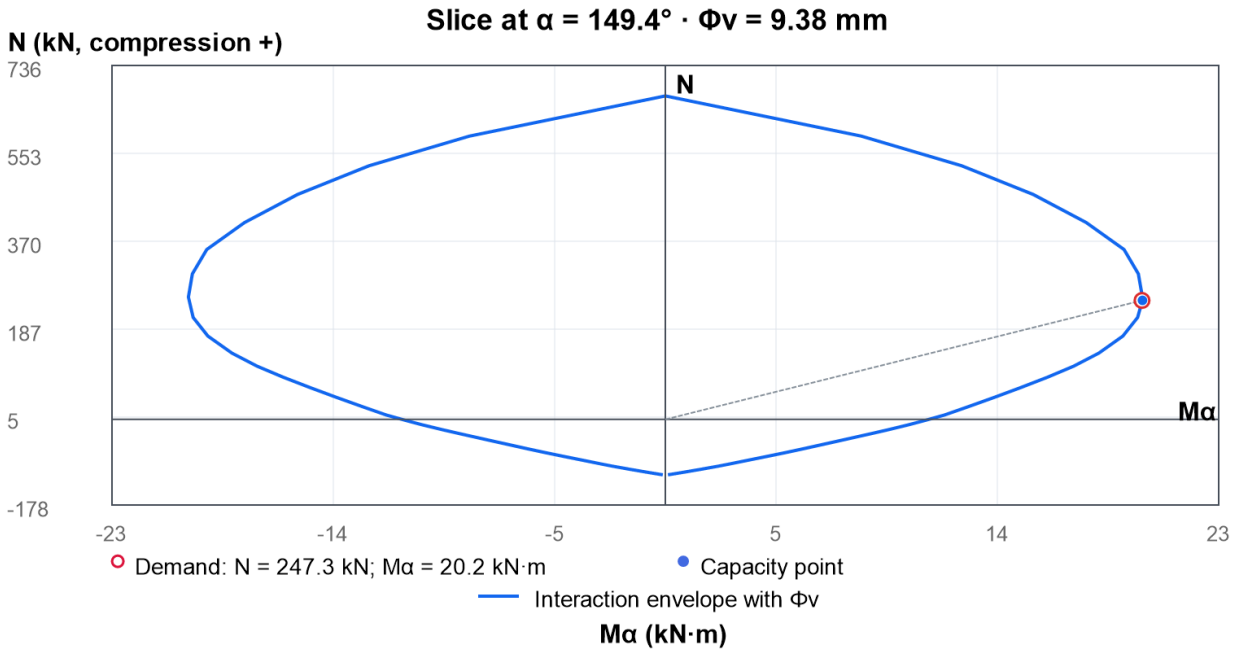
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	51.56	31.76	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.23	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.14035	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,457,689	2,457,689	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,097,536,268,914	1,238,804,274,138	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	926.12	1,045.32	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3644	1.3099	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

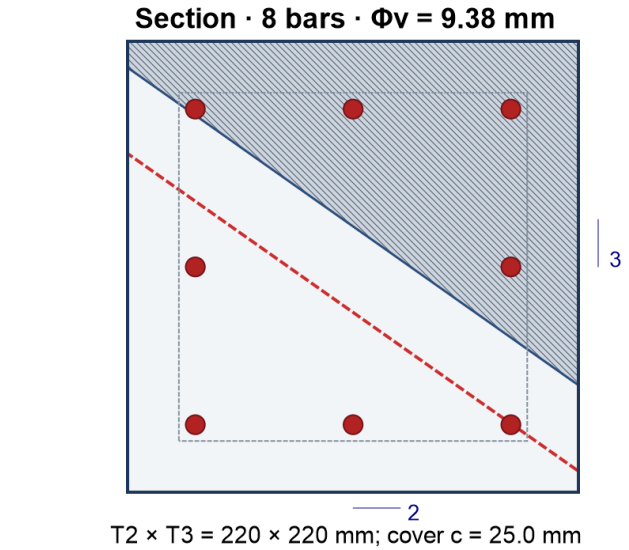
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 137.14 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	552.69 mm^2	Calculation results
Φ_v	9.3789 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9989	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	54.8438°	Geometry at the check point
Normal vector n	(0.575808; 0.817585)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	137.1397 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.575808 \cdot x_2 + 0.817585 \cdot x_3 = 16.1335$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.575808 \cdot x_2 + 0.817585 \cdot x_3 = -18.1514$ mm	Geometry at the check point
Compressed concrete area A_b	19,858.716 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(31.469; 53.785) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	228.375 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.283 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.187 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.3789 mm / 69.087 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	69.087	260.564	-1.81998	-210.000	-14.508	-1.117	1.117
2	0.000	-77.000	69.087	216.227	-0.91474	-182.948	-12.639	-0.973	0.000
3	77.000	-77.000	69.087	171.890	-0.00950	-1.900	-0.131	-0.010	-0.010
4	-77.000	77.000	69.087	134.656	0.75070	150.140	10.373	-0.799	-0.799
5	0.000	77.000	69.087	90.319	1.65594	210.000	14.508	-1.117	0.000
6	77.000	77.000	69.087	45.982	2.56118	210.000	14.508	-1.117	1.117
7	-77.000	0.000	69.087	197.610	-0.53464	-106.928	-7.387	0.000	0.569
8	77.000	0.000	69.087	108.936	1.27584	210.000	14.508	0.000	1.117
Σ N_{si}, M_{xsi}, M_{ysi}							19.231	-5.133	3.111

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	228.375	-12.283	7.187	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	19.231	-5.133	3.111	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**247.606**	**-17.417**	**10.298**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	249.286 kN	From analysis results
M_2	-1.935 kN·m	From analysis results
M_3	1.144 kN·m	From analysis results
M_{2s}	-3.487 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	3.487 kN·m	Including second-order magnification and accidental eccentricity

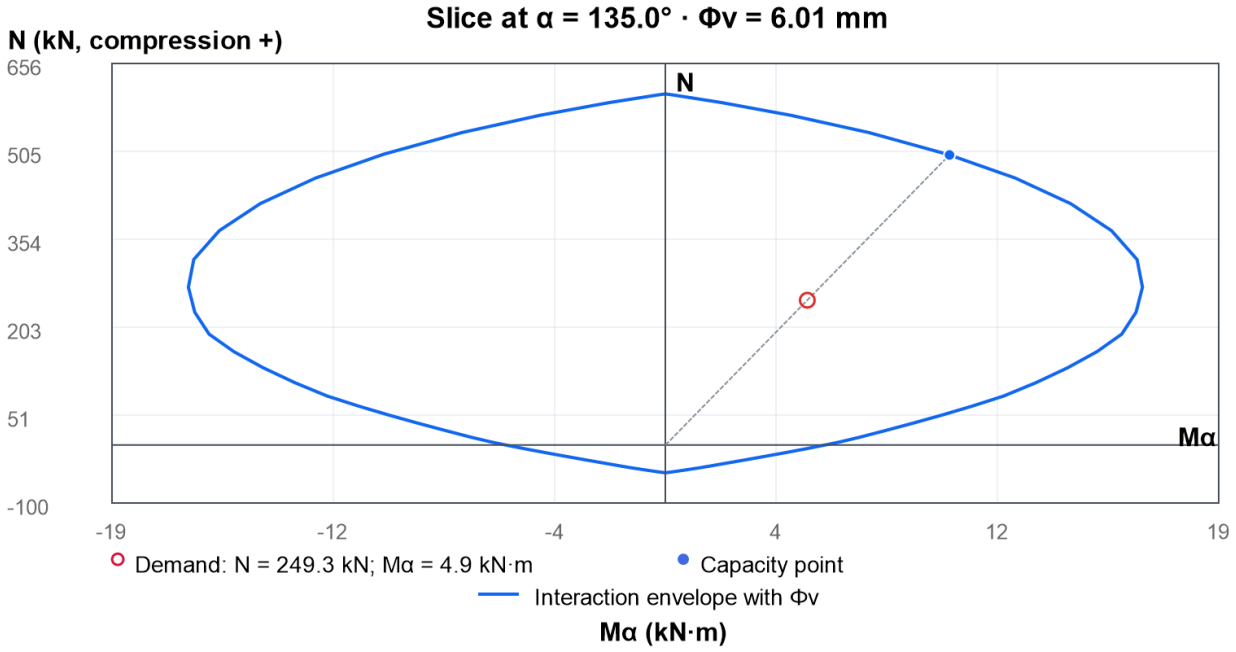
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3989	1.3989	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

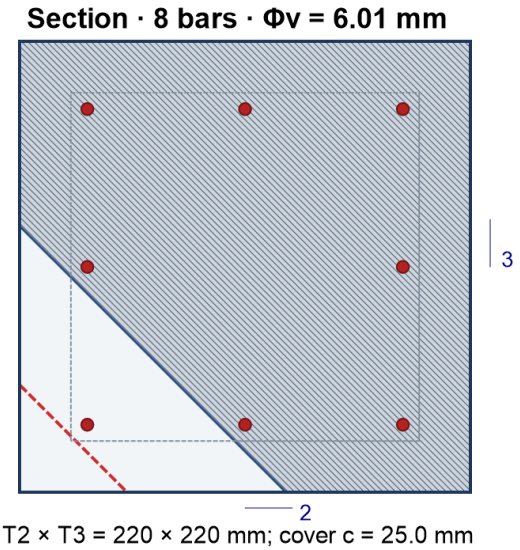
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 219.23 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0141°	Geometry at the check point
Normal vector n	(0.706932; 0.707281)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	219.2312 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.706932 \cdot x_2 + 0.707281 \cdot x_3 = -63.6677$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.706932 \cdot x_2 + 0.707281 \cdot x_3 = -118.4756$ mm	Geometry at the check point
Compressed concrete area A_b	39,955.172 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(14.091; 14.096) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	459.484 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.477 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.475 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	0.12237	24.474	0.694	0.053	-0.053
2	0.000	-77.000	28.366	210.024	0.81759	163.518	4.638	0.357	0.000
3	77.000	-77.000	28.366	155.590	1.51282	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.537	1.51350	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.103	2.20872	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.90395	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	209.997	0.81794	163.587	4.640	0.000	-0.357
8	77.000	0.000	28.366	101.130	2.20838	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							39.758	-0.507	0.507

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	459.484	-6.477	6.475	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	39.758	-0.507	0.507	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**499.242**	**-6.983**	**6.981**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	251.887 kN	From analysis results
M_2	12.490 kN·m	From analysis results
M_3	-7.802 kN·m	From analysis results
M_{2s}	17.145 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.309 kN·m	Including second-order magnification and accidental eccentricity

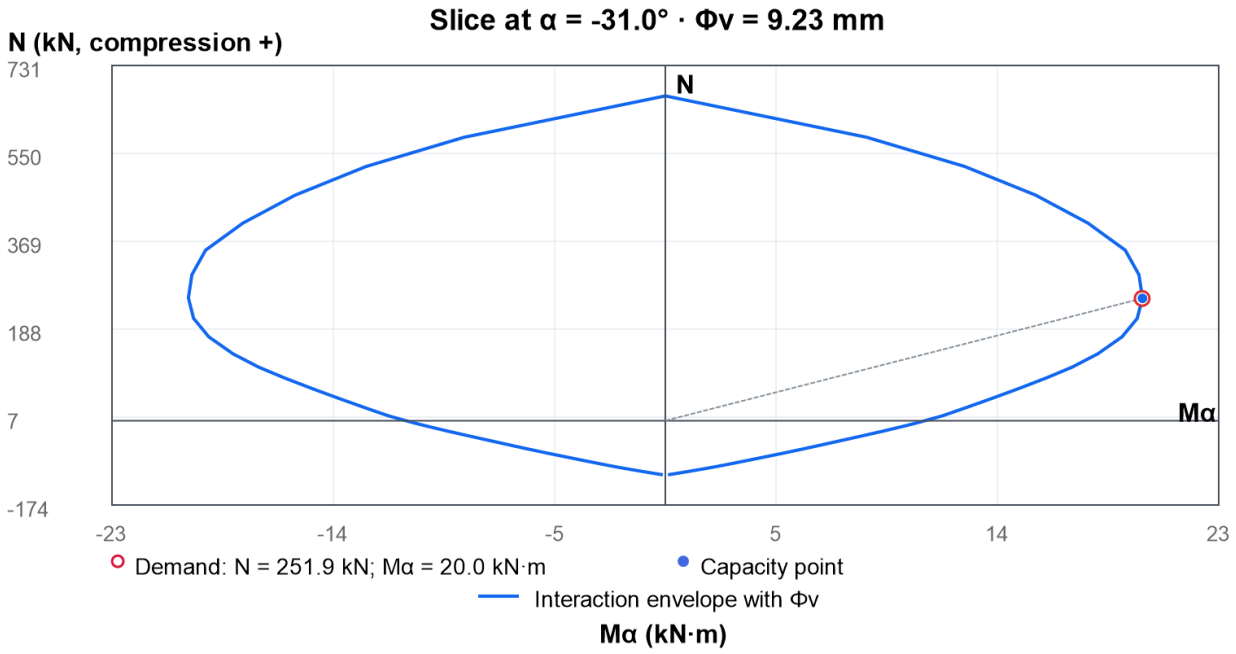
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	49.59	30.98	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.23	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.14275	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,378,642	2,378,642	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,099,354,888,296	1,227,737,645,347	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	927.65	1,035.98	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3727	1.3212	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

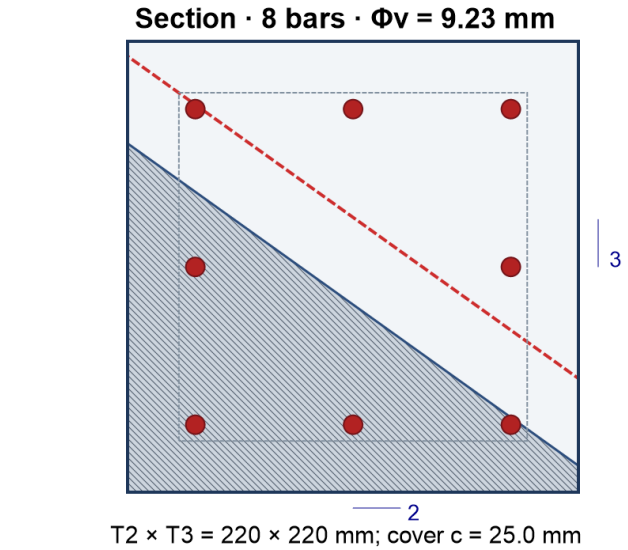
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 138.48 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	534.92 mm^2	Calculation results
Φ_v	9.2268 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	234.4484°	Geometry at the check point
Normal vector n	(-0.581437; -0.813592)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	138.4824 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.581437 \cdot x_2 - 0.813592 \cdot x_3 = 14.9707$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.581437 \cdot x_2 - 0.813592 \cdot x_3 = -19.6499$ mm	Geometry at the check point
Compressed concrete area A_b	20,151.828 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-31.468; -52.956) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	231.746 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.272 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.293 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.2268 mm / 66.865 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	66.865	46.036	2.56919	210.000	14.042	1.081	-1.081
2	0.000	-77.000	66.865	90.807	1.66397	210.000	14.042	1.081	0.000
3	77.000	-77.000	66.865	135.577	0.75874	151.748	10.147	0.781	0.781
4	-77.000	77.000	66.865	171.329	0.03587	7.173	0.480	-0.037	-0.037
5	0.000	77.000	66.865	216.100	-0.86936	-173.872	-11.626	0.895	0.000
6	77.000	77.000	66.865	260.870	-1.77458	-210.000	-14.042	1.081	-1.081
7	-77.000	0.000	66.865	108.682	1.30253	210.000	14.042	0.000	-1.081
8	77.000	0.000	66.865	198.224	-0.50792	-101.584	-6.792	0.000	-0.523
Σ N_{si}, M_{xsi}, M_{ysi}							20.291	4.883	-3.022

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	231.746	12.272	-7.293	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	20.291	4.883	-3.022	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**252.037**	**17.156**	**-10.315**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	368.077 kN	From analysis results
M_2	6.905 kN·m	From analysis results
M_3	10.018 kN·m	From analysis results
M_{2s}	10.695 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	15.517 kN·m	Including second-order magnification and accidental eccentricity

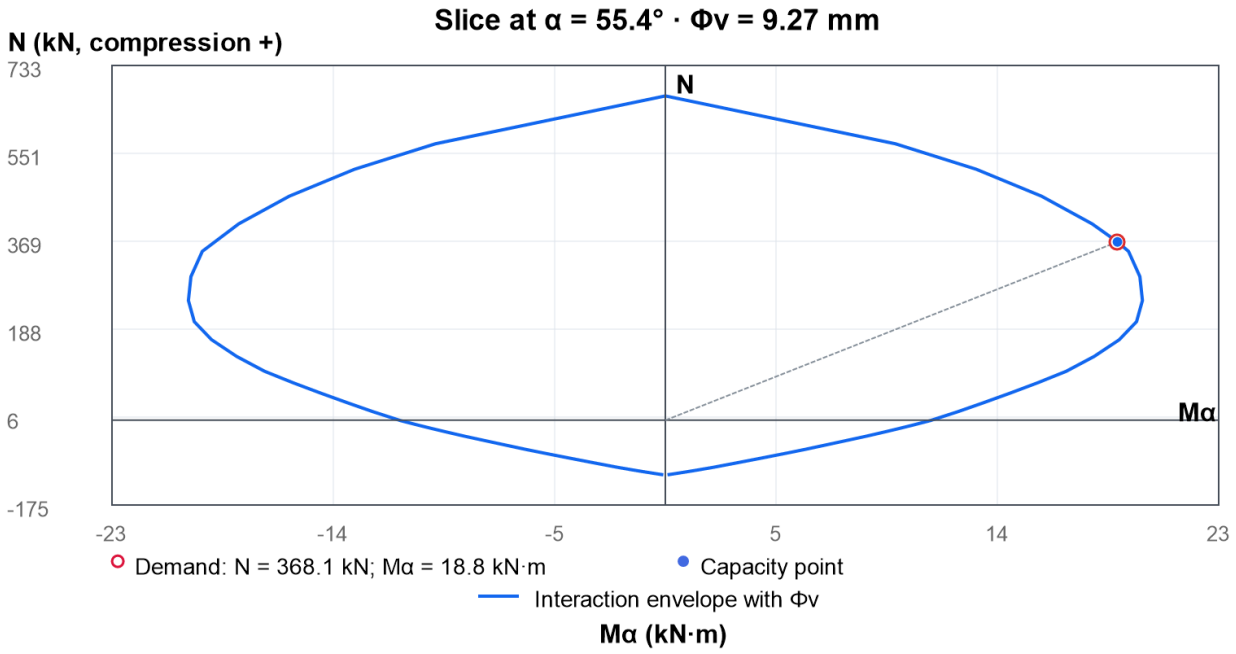
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	18.76	27.22	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,401,713	2,401,713	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,230,967,609,199	1,230,967,609,199	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,038.71	1,038.71	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.5489	1.5489	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

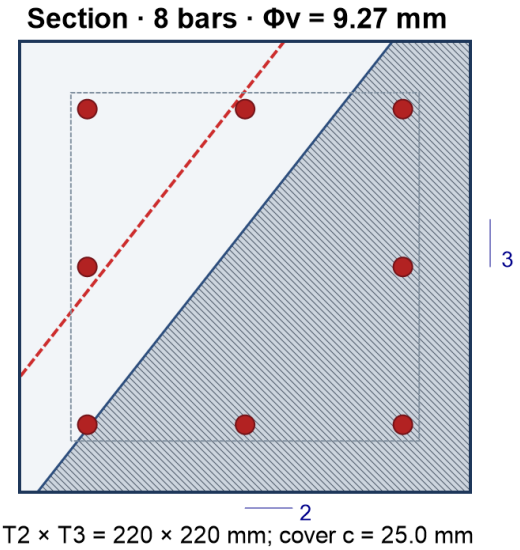
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 166.05 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	540.11 mm^2	Calculation results
Φ_v	9.2715 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9989	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	321.7692°	Geometry at the check point
Normal vector n	(0.785525; -0.618830)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	166.0537 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.785525 \cdot x_2 - 0.618830 \cdot x_3 = -11.5747$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.785525 \cdot x_2 - 0.618830 \cdot x_3 = -53.0881$ mm	Geometry at the check point
Compressed concrete area A_b	27,441.685 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(37.599; -25.473) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	315.579 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	8.039 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.865 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.2715 mm / 67.513 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	67.513	167.315	0.67874	135.748	9.165	0.706	-0.706
2	0.000	-77.000	67.513	106.829	1.69865	210.000	14.178	1.092	0.000
3	77.000	-77.000	67.513	46.344	2.71855	210.000	14.178	1.092	1.092
4	-77.000	77.000	67.513	262.614	-0.92821	-185.642	-12.533	0.965	0.965
5	0.000	77.000	67.513	202.129	0.09170	18.340	1.238	-0.095	0.000
6	77.000	77.000	67.513	141.644	1.11160	210.000	14.178	-1.092	1.092
7	-77.000	0.000	67.513	214.964	-0.12473	-24.947	-1.684	0.000	0.130
8	77.000	0.000	67.513	93.994	1.91508	210.000	14.178	0.000	1.092
Σ N_{si}, M_{xsi}, M_{ysi}							52.897	2.667	3.664

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	315.579	8.039	11.865	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	52.897	2.667	3.664	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**368.476**	**10.706**	**15.529**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	370.028 kN	From analysis results
M_2	0.986 kN·m	From analysis results
M_3	1.412 kN·m	From analysis results
M_{2s}	6.416 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	6.416 kN·m	Including second-order magnification and accidental eccentricity

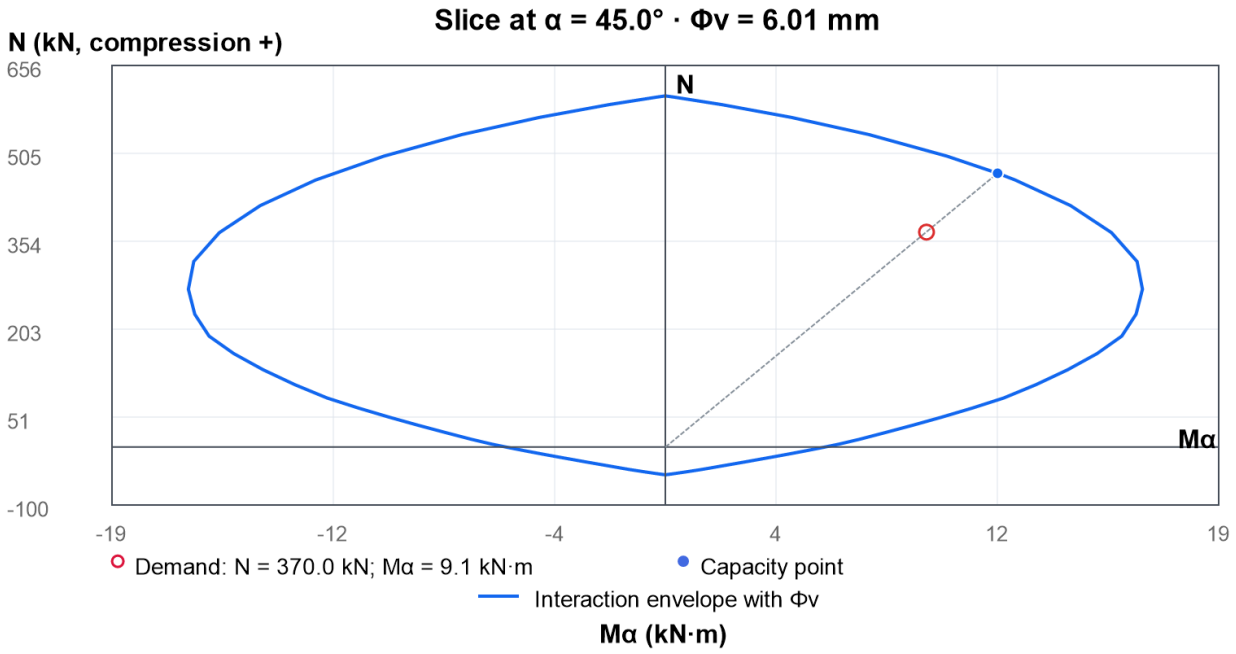
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.7339	1.7339	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

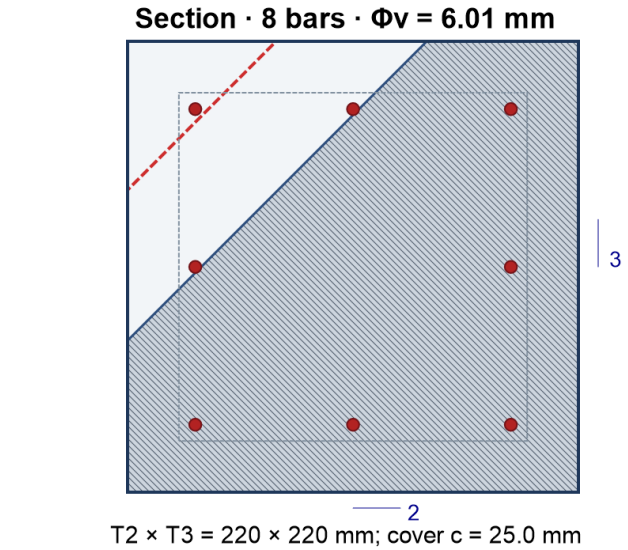
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 207.93 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7853	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	207.9329 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -52.3694$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -104.3526$ mm	Geometry at the check point
Compressed concrete area A_b	37,750.975 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(17.307; -17.307) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	434.136 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.514 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.514 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.563	1.40520	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.13838	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.87156	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	-0.06116	-12.232	-0.347	0.027	0.027
5	0.000	77.000	28.366	210.011	0.67202	134.404	3.813	-0.294	0.000
6	77.000	77.000	28.366	155.563	1.40520	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.67202	134.404	3.813	0.000	-0.294
8	77.000	0.000	28.366	101.116	2.13838	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							37.063	0.651	0.651

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	434.136	7.514	7.514	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.063	0.651	0.651	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**471.199**	**8.164**	**8.164**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	372.629 kN	From analysis results
M_2	-6.906 kN·m	From analysis results
M_3	-10.064 kN·m	From analysis results
M_{2s}	-10.714 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.612 kN·m	Including second-order magnification and accidental eccentricity

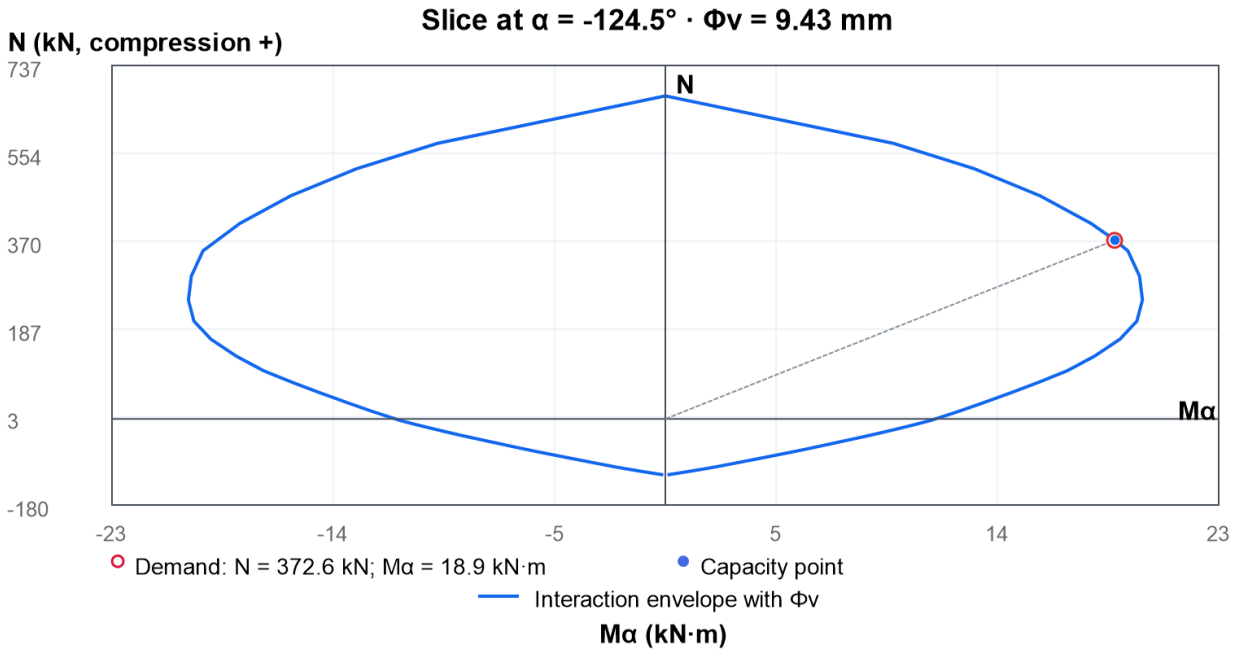
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	18.53	27.01	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,484,505	2,484,505	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,242,558,454,295	1,242,558,454,295	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,048.49	1,048.49	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.5513	1.5513	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

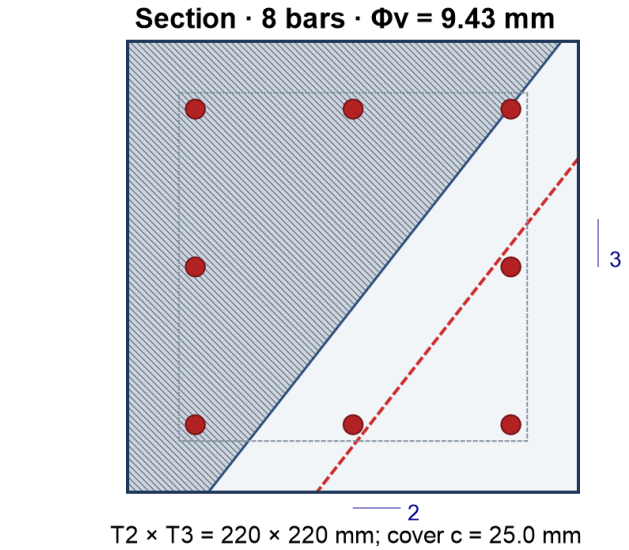
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 166.65 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	558.72 mm^2	Calculation results
Φ_v	9.4299 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	141.9253°	Geometry at the check point
Normal vector n	(-0.787208; 0.616688)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	166.6470 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.787208 \cdot x_2 + 0.616688 \cdot x_3 = -12.2184$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.787208 \cdot x_2 + 0.616688 \cdot x_3 = -53.8802$ mm	Geometry at the check point
Compressed concrete area A_b	27,614.674 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-37.380; 25.172) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	317.569 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.994 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.871 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.4299 mm / 69.840 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	69.840	141.298	1.12590	210.000	14.666	1.129	-1.129
2	0.000	-77.000	69.840	201.913	0.10745	21.491	1.501	0.116	0.000
3	77.000	-77.000	69.840	262.528	-0.91100	-182.200	-12.725	-0.980	-0.980
4	-77.000	77.000	69.840	46.329	2.72159	210.000	14.666	-1.129	-1.129
5	0.000	77.000	69.840	106.944	1.70314	210.000	14.666	-1.129	0.000
6	77.000	77.000	69.840	167.559	0.68468	136.937	9.564	-0.736	0.736
7	-77.000	0.000	69.840	93.814	1.92375	210.000	14.666	0.000	-1.129
8	77.000	0.000	69.840	215.044	-0.11316	-22.632	-1.581	0.000	-0.122
Σ N_{si}, M_{xsi}, M_{ysi}							55.425	-2.730	-3.753

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	317.569	-7.994	-11.871	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	55.425	-2.730	-3.753	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**372.994**	**-10.724**	**-15.624**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	287.211 kN	From analysis results
M_2	1.759 kN·m	From analysis results
M_3	9.872 kN·m	From analysis results
M_{2s}	4.277 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.788 kN·m	Including second-order magnification and accidental eccentricity

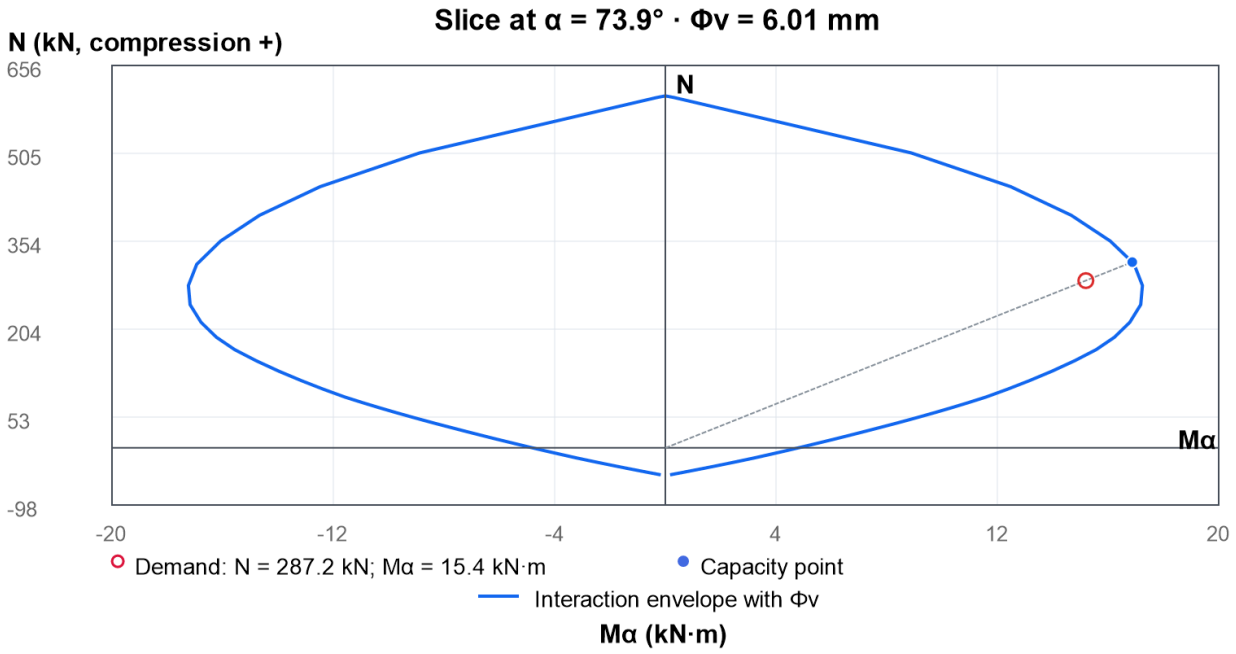
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	34.37	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.16	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16439	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,023,779,158,029	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	863.88	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4893	1.4981	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

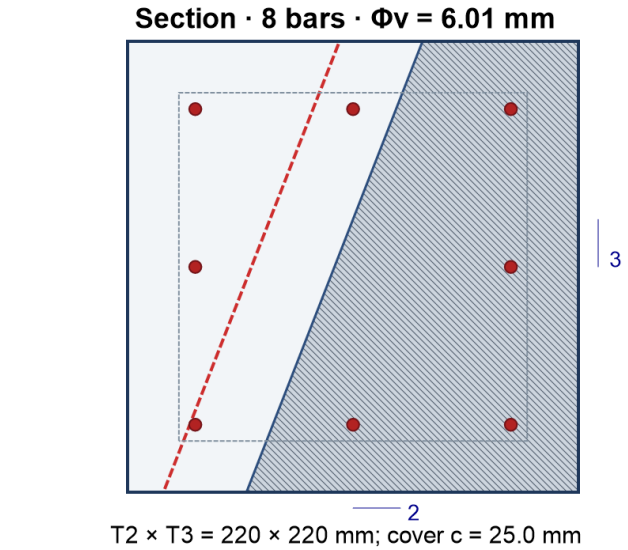
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 150.95 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9004	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	338.6675°	Geometry at the check point
Normal vector n	(0.931485; -0.363780)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	150.9495 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.931485 \cdot x_2 - 0.363780 \cdot x_3 = -8.4704$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.931485 \cdot x_2 - 0.363780 \cdot x_3 = -46.2078$ mm	Geometry at the check point
Compressed concrete area A_b	26,200.554 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(47.871; -13.226) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	301.306 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	3.985 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	14.424 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	186.192	0.04627	9.254	0.263	0.020	-0.020
2	0.000	-77.000	28.366	114.468	1.37670	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	42.744	2.70714	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	242.215	-0.99290	-198.579	-5.633	0.434	0.434
5	0.000	77.000	28.366	170.490	0.33754	67.507	1.915	-0.147	0.000
6	77.000	77.000	28.366	98.766	1.66797	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	214.203	-0.47331	-94.663	-2.685	0.000	0.207
8	77.000	0.000	28.366	70.755	2.18755	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							17.687	0.765	1.996

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	301.306	3.985	14.424	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	17.687	0.765	1.996	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**318.993**	**4.750**	**16.420**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	289.162 kN	From analysis results
M_2	0.305 kN·m	From analysis results
M_3	1.395 kN·m	From analysis results
M_{2s}	4.321 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	4.321 kN·m	Including second-order magnification and accidental eccentricity

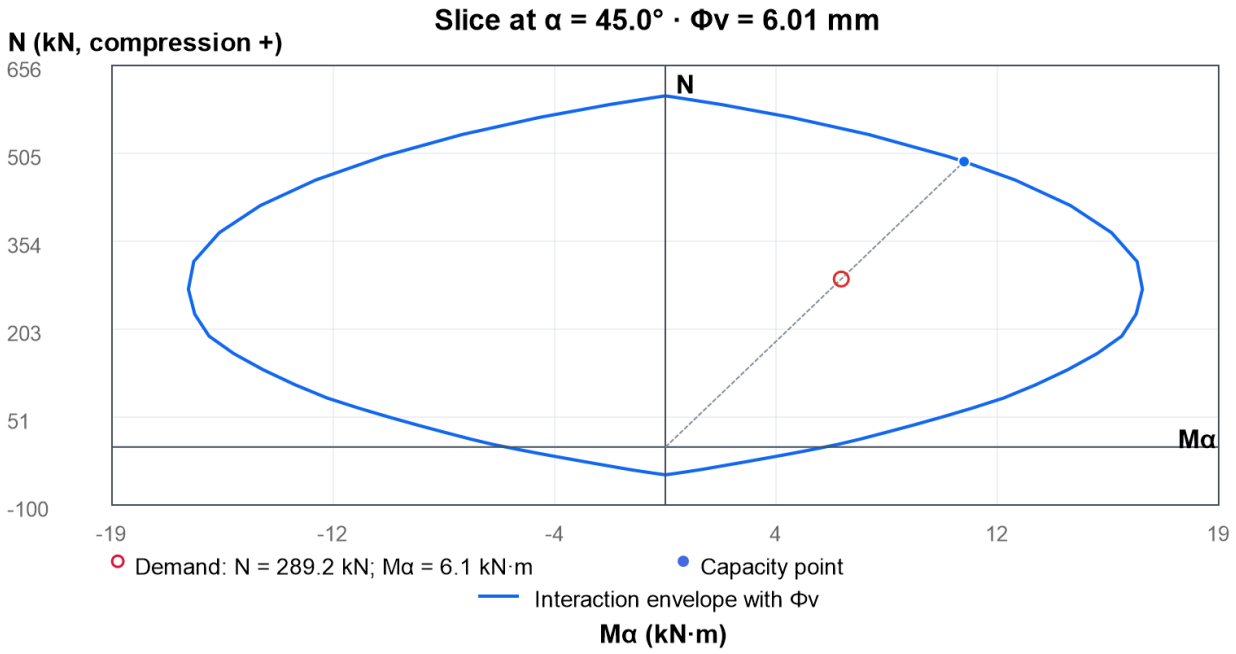
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4943	1.4943	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

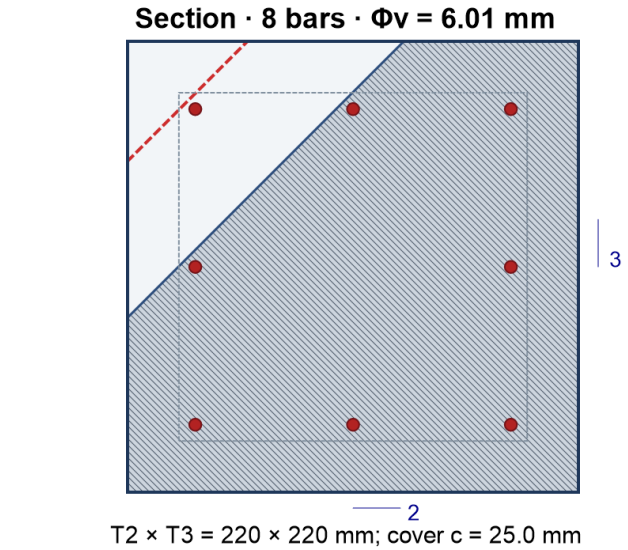
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 215.88 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.5886	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	314.9954°	Geometry at the check point
Normal vector n	(0.707050; -0.707164)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	215.8757 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707050 \cdot x_2 - 0.707164 \cdot x_3 = -60.3122$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707050 \cdot x_2 - 0.707164 \cdot x_3 = -114.2811$ mm	Geometry at the check point
Compressed concrete area A_b	39,327.185 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(15.017; -15.019) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	452.263 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.793 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.792 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.555	1.48239	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.112	2.18854	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.89468	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	0.06987	13.973	0.396	-0.031	-0.031
5	0.000	77.000	28.366	210.015	0.77601	155.203	4.403	-0.339	0.000
6	77.000	77.000	28.366	155.572	1.48216	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.006	0.77613	155.226	4.403	0.000	-0.339
8	77.000	0.000	28.366	101.121	2.18842	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							38.987	0.548	0.548

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	452.263	6.793	6.792	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	38.987	0.548	0.548	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**491.250**	**7.340**	**7.340**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	291.763 kN	From analysis results
M_2	-1.634 kN·m	From analysis results
M_3	-9.907 kN·m	From analysis results
M_{2s}	-4.379 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-14.932 kN·m	Including second-order magnification and accidental eccentricity

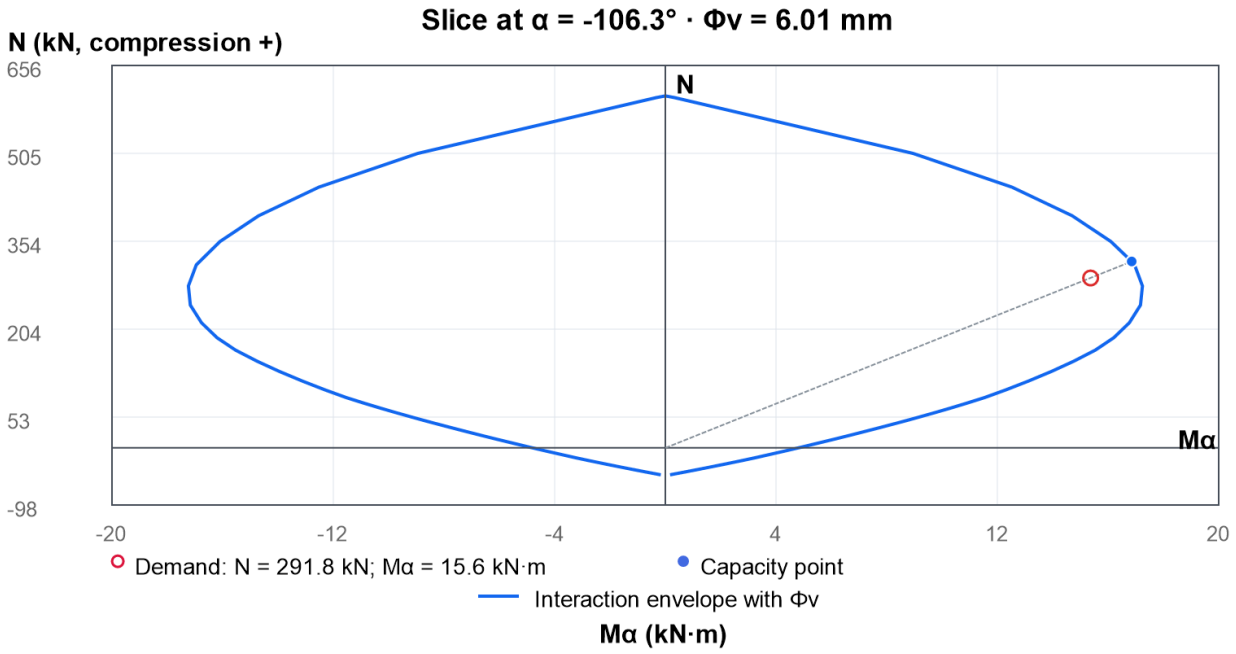
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	33.96	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16507	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,027,449,446,745	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	866.98	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.5009	1.5072	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

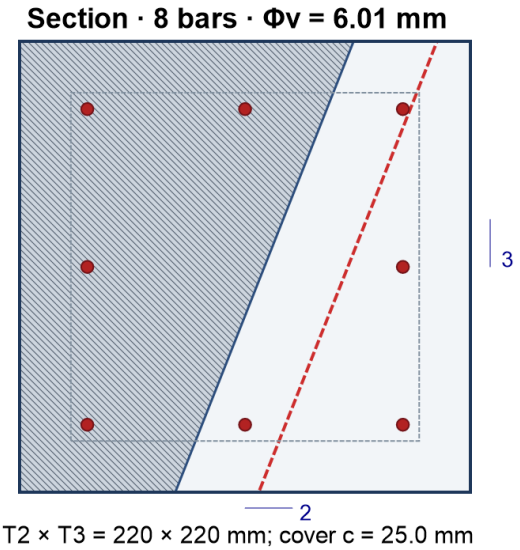
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 151.52 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9115	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	158.4205°	Geometry at the check point
Normal vector n	(-0.929908; 0.367791)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	151.5244 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.929908 \cdot x_2 + 0.367791 \cdot x_3 = -8.7774$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.929908 \cdot x_2 + 0.367791 \cdot x_3 = -46.6585$ mm	Geometry at the check point
Compressed concrete area A_b	26,276.577 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-47.639; 13.356) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	302.181 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-4.036 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-14.396 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	99.464	1.66202	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	171.067	0.33888	67.775	1.923	0.148	0.000
3	77.000	-77.000	28.366	242.670	-0.98427	-196.853	-5.584	-0.430	-0.430
4	-77.000	77.000	28.366	42.824	2.70866	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	114.427	1.38552	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	186.030	0.06238	12.475	0.354	-0.027	0.027
7	-77.000	0.000	28.366	71.144	2.18534	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	214.350	-0.46095	-92.189	-2.615	0.000	-0.201
Σ N_{si}, M_{xsi}, M_{ysi}							17.905	-0.768	-1.980

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	302.181	-4.036	-14.396	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	17.905	-0.768	-1.980	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**320.086**	**-4.804**	**-16.376**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	289.808 kN	From analysis results
M_2	-5.810 kN·m	From analysis results
M_3	10.058 kN·m	From analysis results
M_{2s}	-8.586 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.967 kN·m	Including second-order magnification and accidental eccentricity

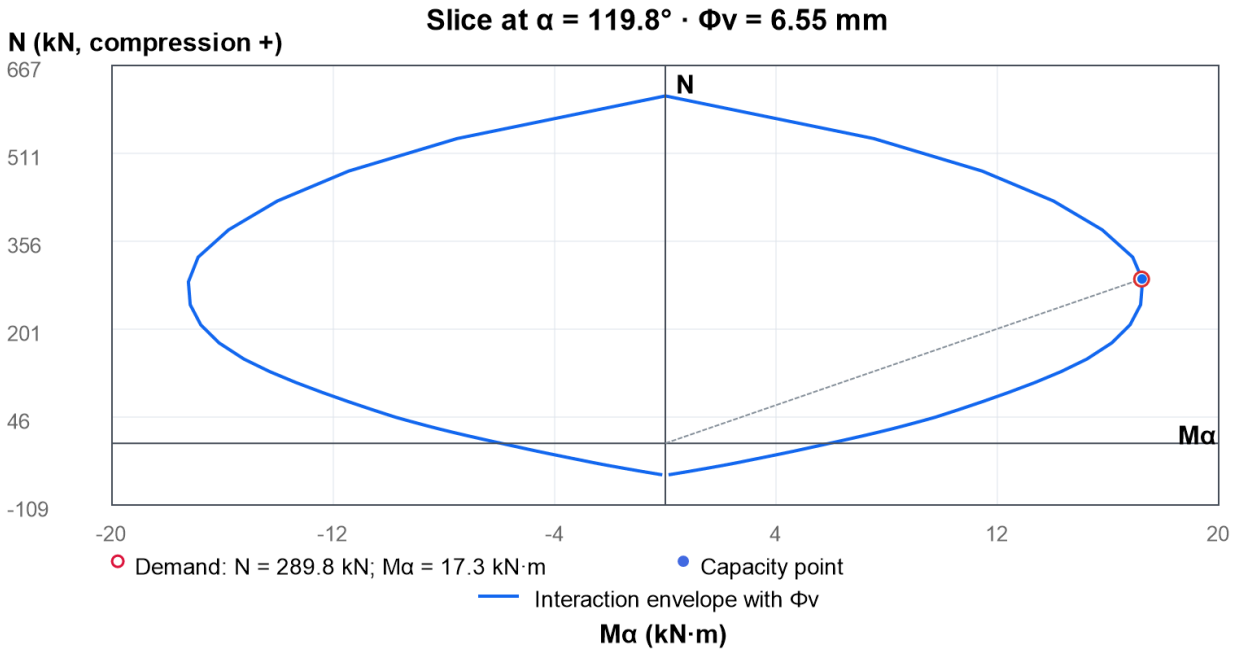
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	20.05	34.71	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16384	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,197,542	1,197,542	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,062,383,629,288	1,047,219,212,119	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	896.46	883.66	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4777	1.4880	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

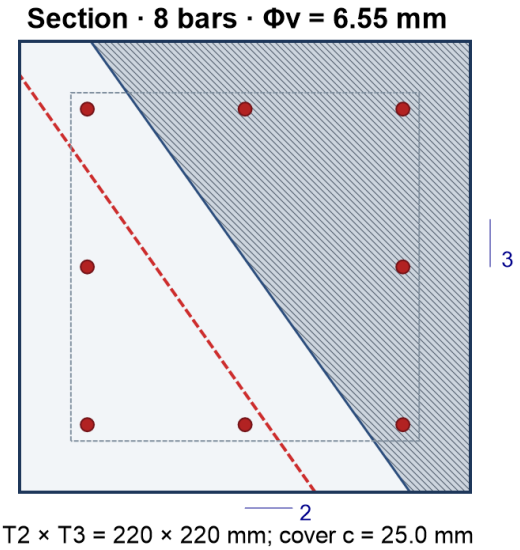
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 151.19 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	269.31 mm^2	Calculation results
Φ_v	6.5469 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9988	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	35.3157°	Geometry at the check point
Normal vector n	(0.815979; 0.578081)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	151.1911 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.815979 \cdot x_2 + 0.578081 \cdot x_3 = 2.1555$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.815979 \cdot x_2 + 0.578081 \cdot x_3 = -35.6422$ mm	Geometry at the check point
Compressed concrete area A_b	23,618.834 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(46.893; 26.616) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	271.617 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.229 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.737 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.5469 mm / 33.663 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	33.663	260.689	-1.32786	-210.000	-7.069	-0.544	0.544
2	0.000	-77.000	33.663	197.859	-0.16427	-32.854	-1.106	-0.085	0.000
3	77.000	-77.000	33.663	135.028	0.99933	199.865	6.728	0.518	0.518
4	-77.000	77.000	33.663	171.665	0.32083	64.167	2.160	-0.166	-0.166
5	0.000	77.000	33.663	108.834	1.48443	210.000	7.069	-0.544	0.000
6	77.000	77.000	33.663	46.004	2.64802	210.000	7.069	-0.544	0.544
7	-77.000	0.000	33.663	216.177	-0.50351	-100.703	-3.390	0.000	0.261
8	77.000	0.000	33.663	90.516	1.82367	210.000	7.069	0.000	0.544
Σ N_{si}, M_{xsi}, M_{ysi}							18.531	-1.366	2.246

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	271.617	-7.229	12.737	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	18.531	-1.366	2.246	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**290.147**	**-8.596**	**14.983**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	291.759 kN	From analysis results
M_2	-0.873 kN·m	From analysis results
M_3	1.427 kN·m	From analysis results
M_{2s}	-4.379 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	4.379 kN·m	Including second-order magnification and accidental eccentricity

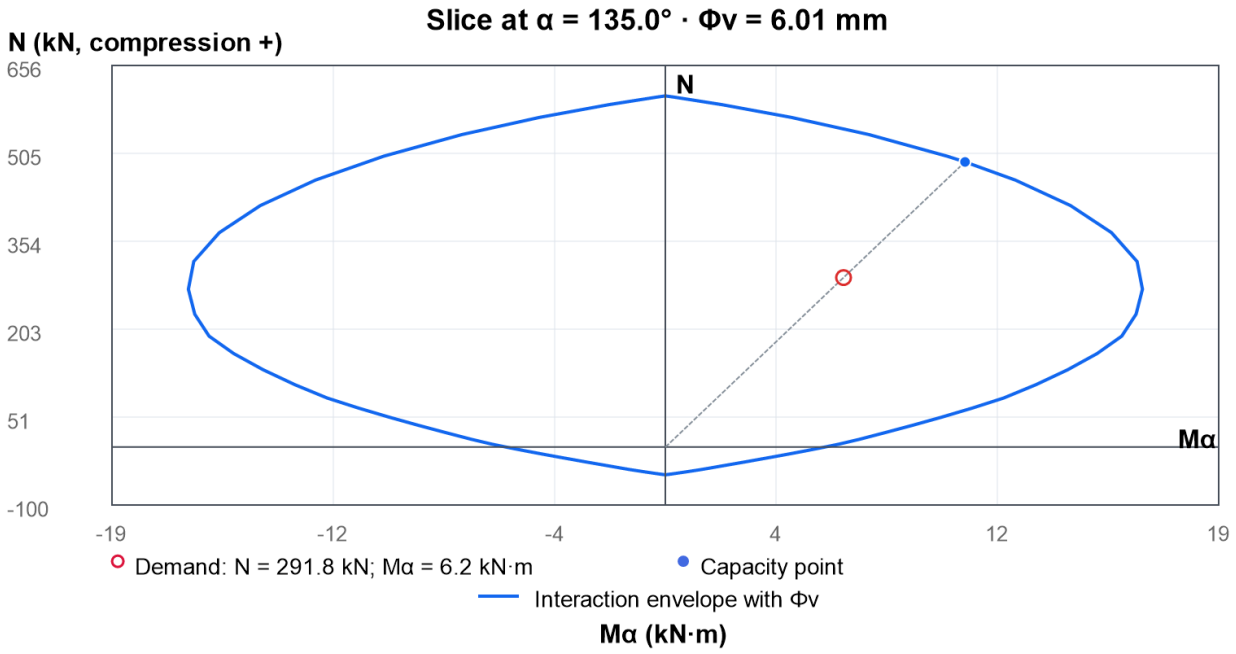
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.5009	1.5009	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

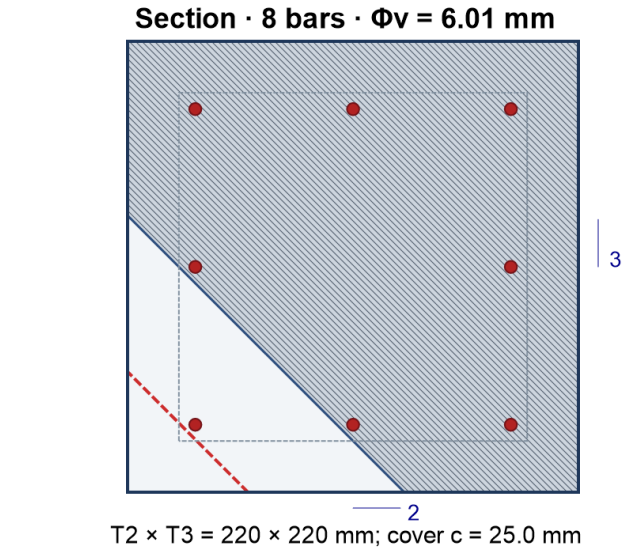
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 215.65 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.5946	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0042°	Geometry at the check point
Normal vector n	(0.707055; 0.707159)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	215.6453 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707055 \cdot x_2 + 0.707159 \cdot x_3 = -60.0818$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707055 \cdot x_2 + 0.707159 \cdot x_3 = -113.9931$ mm	Geometry at the check point
Compressed concrete area A_b	39,283.243 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(15.082; 15.083) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	451.757 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.814 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.813 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	0.06620	13.240	0.376	0.029	-0.029
2	0.000	-77.000	28.366	210.015	0.77311	154.622	4.386	0.338	0.000
3	77.000	-77.000	28.366	155.571	1.48002	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.555	1.48022	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.112	2.18713	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.89404	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.007	0.77321	154.643	4.387	0.000	-0.338
8	77.000	0.000	28.366	101.120	2.18703	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							38.933	-0.551	0.551

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	451.757	-6.814	6.813	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	38.933	-0.551	0.551	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**490.690**	**-7.365**	**7.364**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	294.360 kN	From analysis results
M_2	5.710 kN·m	From analysis results
M_3	-10.082 kN·m	From analysis results
M_{2s}	8.493 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.075 kN·m	Including second-order magnification and accidental eccentricity

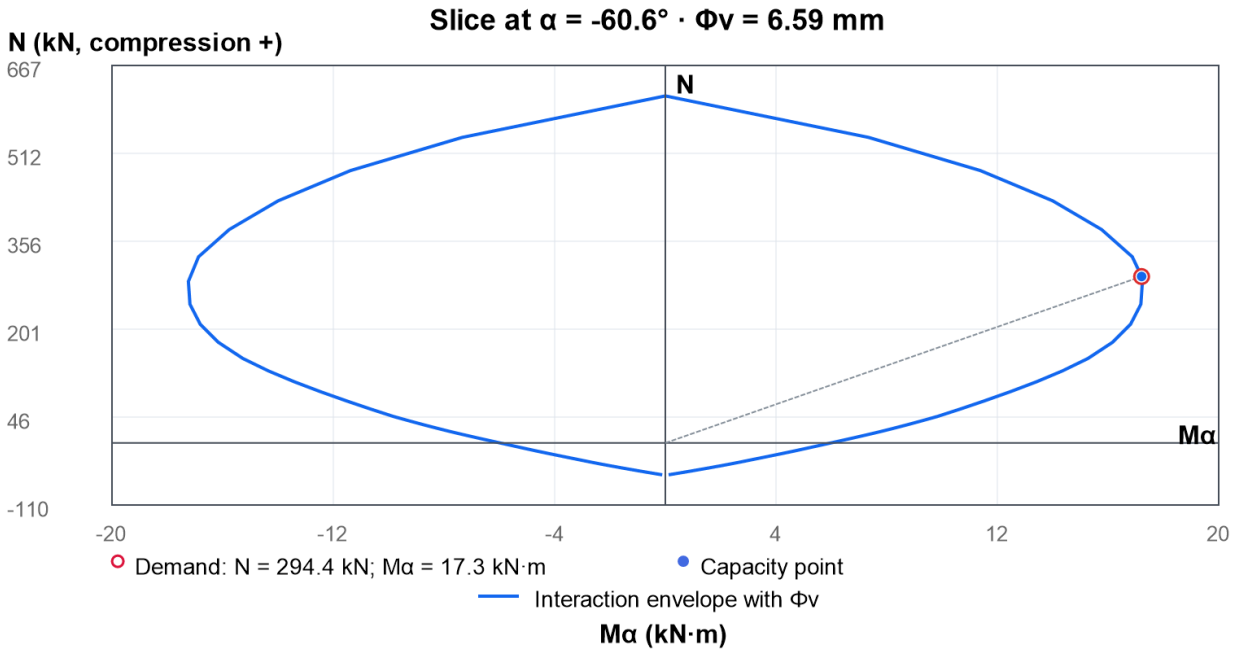
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, L_y = μ·L (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	19.40	34.25	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16459	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,212,155	1,212,155	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,064,429,509,247	1,053,258,745,580	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	898.18	888.76	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4875	1.4952	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

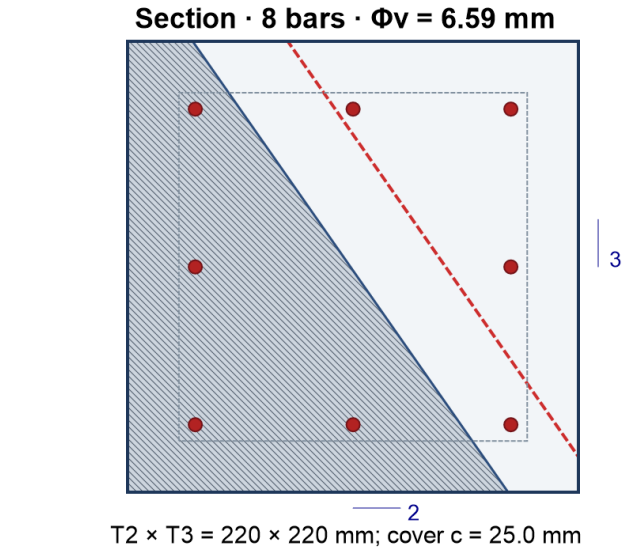
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 152.15 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	272.59 mm^2	Calculation results
Φ_v	6.5867 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	214.9805°	Geometry at the check point
Normal vector n	(-0.819348; -0.573297)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	152.1515 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.819348 \cdot x_2 - 0.573297 \cdot x_3 = 1.0395$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.819348 \cdot x_2 - 0.573297 \cdot x_3 = -36.9984$ mm	Geometry at the check point
Compressed concrete area A_b	23,920.900 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-46.554; -25.955) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	275.090 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.140 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-12.807 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.5867 mm / 34.074 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	34.074	45.957	2.65426	210.000	7.156	0.551	-0.551
2	0.000	-77.000	34.074	109.047	1.49324	210.000	7.156	0.551	0.000
3	77.000	-77.000	34.074	172.137	0.33222	66.443	2.264	0.174	0.174
4	-77.000	77.000	34.074	134.245	1.02953	205.905	7.016	-0.540	-0.540
5	0.000	77.000	34.074	197.335	-0.13150	-26.299	-0.896	0.069	0.000
6	77.000	77.000	34.074	260.425	-1.29252	-210.000	-7.156	0.551	-0.551
7	-77.000	0.000	34.074	90.101	1.84189	210.000	7.156	0.000	-0.551
8	77.000	0.000	34.074	216.281	-0.48015	-96.030	-3.272	0.000	-0.252
Σ N_{si}, M_{xsi}, M_{ysi}							19.423	1.356	-2.271

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	275.090	7.140	-12.807	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	19.423	1.356	-2.271	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**294.513**	**8.496**	**-15.077**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	208.184 kN	From analysis results
M_2	9.778 kN·m	From analysis results
M_3	7.530 kN·m	From analysis results
M_{2s}	13.238 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.911 kN·m	Including second-order magnification and accidental eccentricity

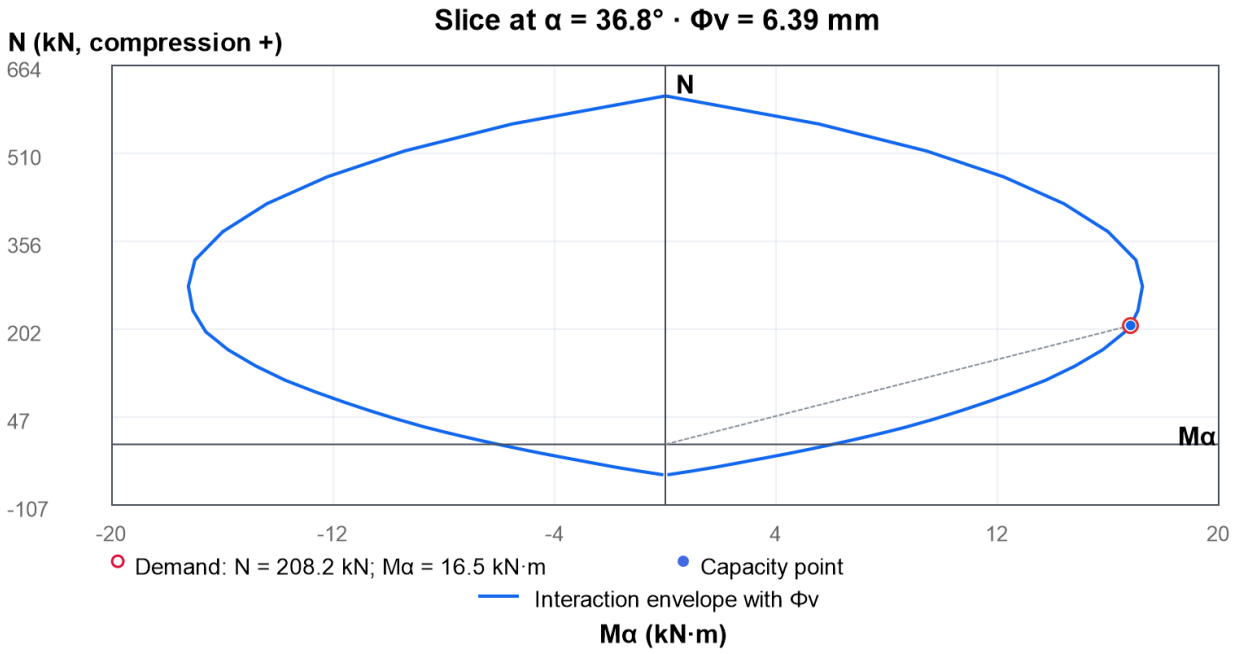
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	46.97	36.17	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.21	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.14606	0.16150	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,142,587	1,142,587	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	944,045,731,035	1,026,931,158,686	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	796.60	866.54	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3538	1.3162	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

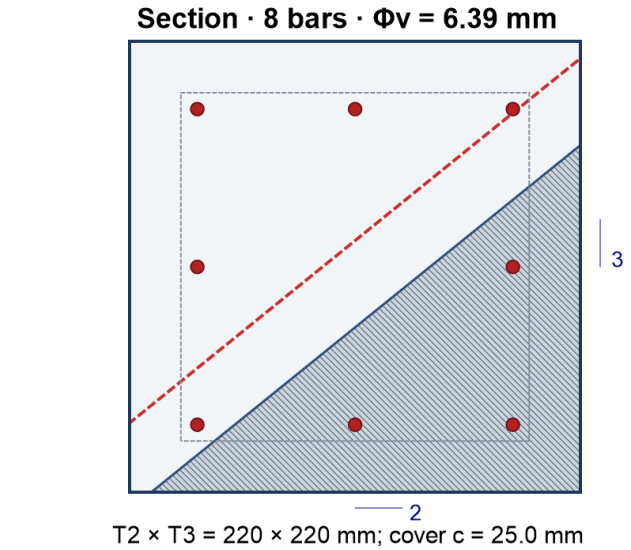
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 131.74 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	256.95 mm^2	Calculation results
Φ_v	6.3949 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	308.9559°	Geometry at the check point
Normal vector n	(0.628722; -0.777630)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	131.7397 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.628722 \cdot x_2 - 0.777630 \cdot x_3 = 22.9590$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.628722 \cdot x_2 - 0.777630 \cdot x_3 = -9.9759$ mm	Geometry at the check point
Compressed concrete area A_b	17,748.905 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(40.155; -53.529) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	204.112 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	10.926 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.196 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.3949 mm / 32.119 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	32.119	143.233	0.45573	91.145	2.927	0.225	-0.225
2	0.000	-77.000	32.119	94.821	1.48467	210.000	6.745	0.519	0.000
3	77.000	-77.000	32.119	46.410	2.51361	210.000	6.745	0.519	0.519
4	-77.000	77.000	32.119	262.988	-2.08955	-210.000	-6.745	0.519	0.519
5	0.000	77.000	32.119	214.576	-1.06061	-210.000	-6.745	0.519	0.000
6	77.000	77.000	32.119	166.165	-0.03167	-6.334	-0.203	0.016	-0.016
7	-77.000	0.000	32.119	203.110	-0.81691	-163.383	-5.248	0.000	0.404
8	77.000	0.000	32.119	106.287	1.24097	210.000	6.745	0.000	0.519
Σ N_{si}, M_{xsi}, M_{ysi}							4.221	2.319	1.721

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	204.112	10.926	8.196	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	4.221	2.319	1.721	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**208.334**	**13.245**	**9.917**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	210.134 kN	From analysis results
M_2	1.546 kN·m	From analysis results
M_3	1.056 kN·m	From analysis results
M_{2s}	2.766 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	2.766 kN·m	Including second-order magnification and accidental eccentricity

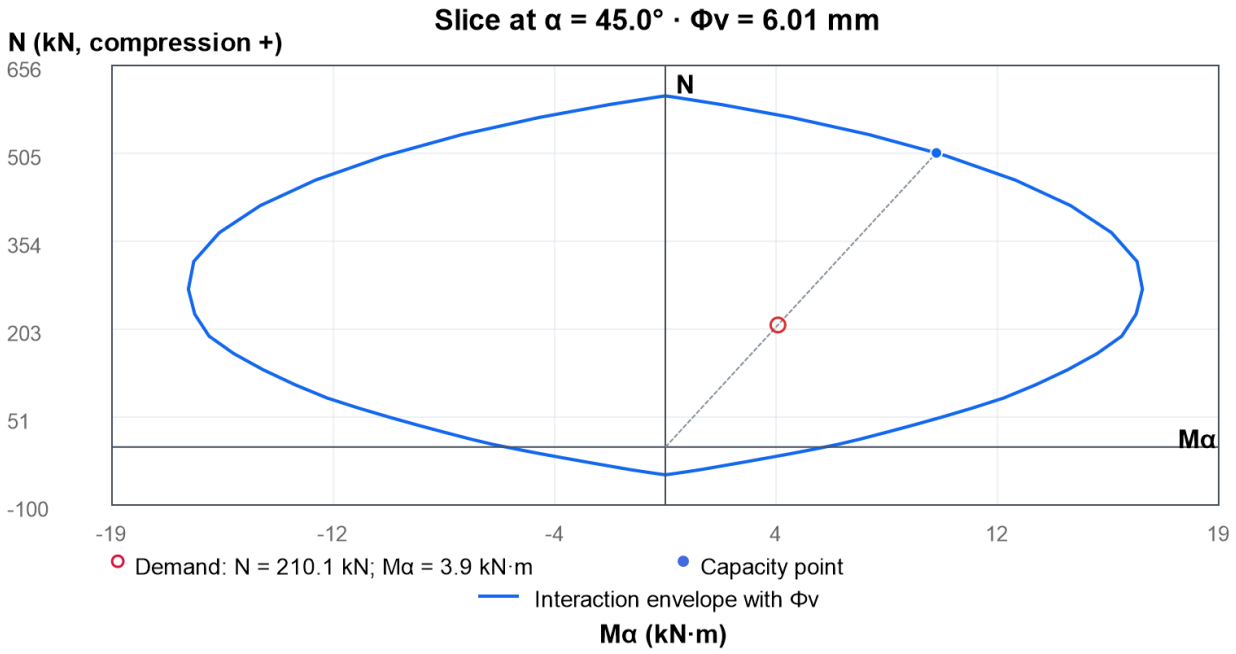
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3164	1.3164	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

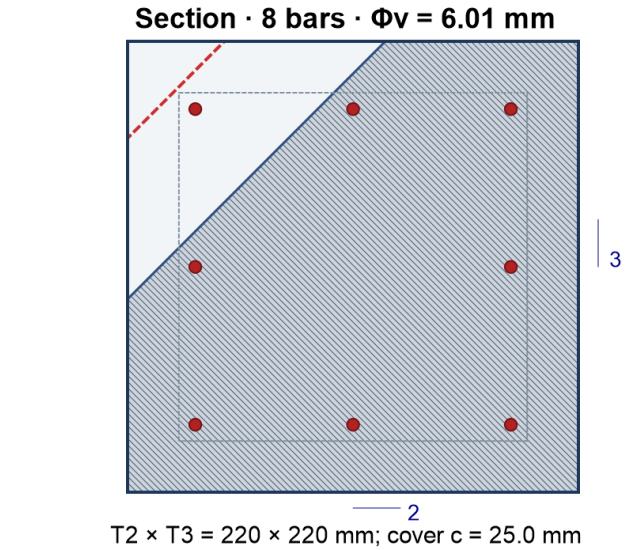
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 222.23 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4152	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0000°	Geometry at the check point
Normal vector n	(0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	222.2254 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -66.6619$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -122.2183$ mm	Geometry at the check point
Compressed concrete area A_b	40,496.511 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(13.289; -13.289) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	465.710 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.189 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.189 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.563	1.53993	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.22595	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.91198	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	0.16788	33.576	0.952	-0.073	-0.073
5	0.000	77.000	28.366	210.011	0.85390	170.781	4.844	-0.373	0.000
6	77.000	77.000	28.366	155.563	1.53993	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.011	0.85390	170.781	4.844	0.000	-0.373
8	77.000	0.000	28.366	101.116	2.22595	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							40.426	0.471	0.471

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	465.710	6.189	6.189	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.426	0.471	0.471	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**506.136**	**6.660**	**6.660**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	212.736 kN	From analysis results
M_2	-9.430 kN·m	From analysis results
M_3	-7.575 kN·m	From analysis results
M_{2s}	-12.845 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.071 kN·m	Including second-order magnification and accidental eccentricity

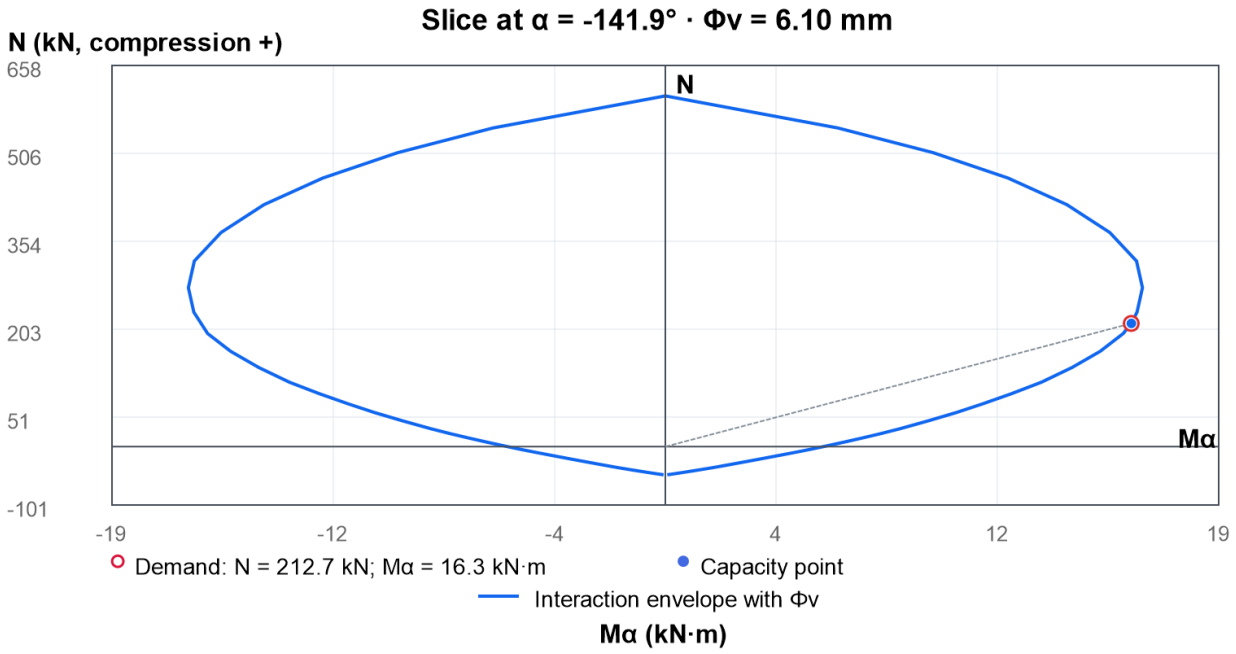
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	44.33	35.61	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.20	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.14955	0.16239	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,040,165	1,040,165	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	948,472,155,948	1,017,377,678,547	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	800.34	858.48	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3620	1.3294	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

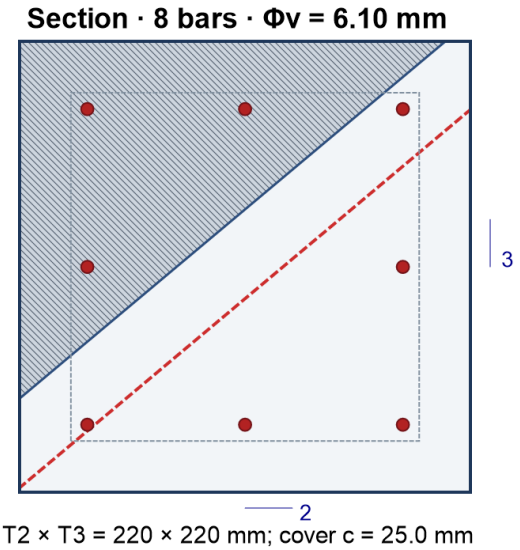
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 133.47 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	233.92 mm^2	Calculation results
Φ_v	6.1015 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	129.9873°	Geometry at the check point
Normal vector n	(-0.642618; 0.766187)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	133.4742 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.642618 \cdot x_2 + 0.766187 \cdot x_3 = 21.4944$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.642618 \cdot x_2 + 0.766187 \cdot x_3 = -11.8742$ mm	Geometry at the check point
Compressed concrete area A_b	18,091.595 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-40.765; 51.931) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	208.053 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-10.805 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.481 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.1015 mm / 29.239 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	29.239	164.483	0.04950	9.899	0.289	0.022	-0.022
2	0.000	-77.000	29.239	213.965	-0.98852	-197.704	-5.781	-0.445	0.000
3	77.000	-77.000	29.239	263.446	-2.02654	-210.000	-6.140	-0.473	-0.473
4	-77.000	77.000	29.239	46.491	2.52473	210.000	6.140	-0.473	-0.473
5	0.000	77.000	29.239	95.972	1.48671	210.000	6.140	-0.473	0.000
6	77.000	77.000	29.239	145.454	0.44869	89.739	2.624	-0.202	0.202
7	-77.000	0.000	29.239	105.487	1.28711	210.000	6.140	0.000	-0.473
8	77.000	0.000	29.239	204.450	-0.78892	-157.785	-4.614	0.000	-0.355
Σ N_{si}, M_{xsi}, M_{ysi}							4.800	-2.043	-1.594

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	208.053	-10.805	-8.481	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	4.800	-2.043	-1.594	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**212.853**	**-12.848**	**-10.075**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	245.181 kN	From analysis results
M_2	-12.632 kN·m	From analysis results
M_3	-7.377 kN·m	From analysis results
M_{2s}	-17.326 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.700 kN·m	Including second-order magnification and accidental eccentricity

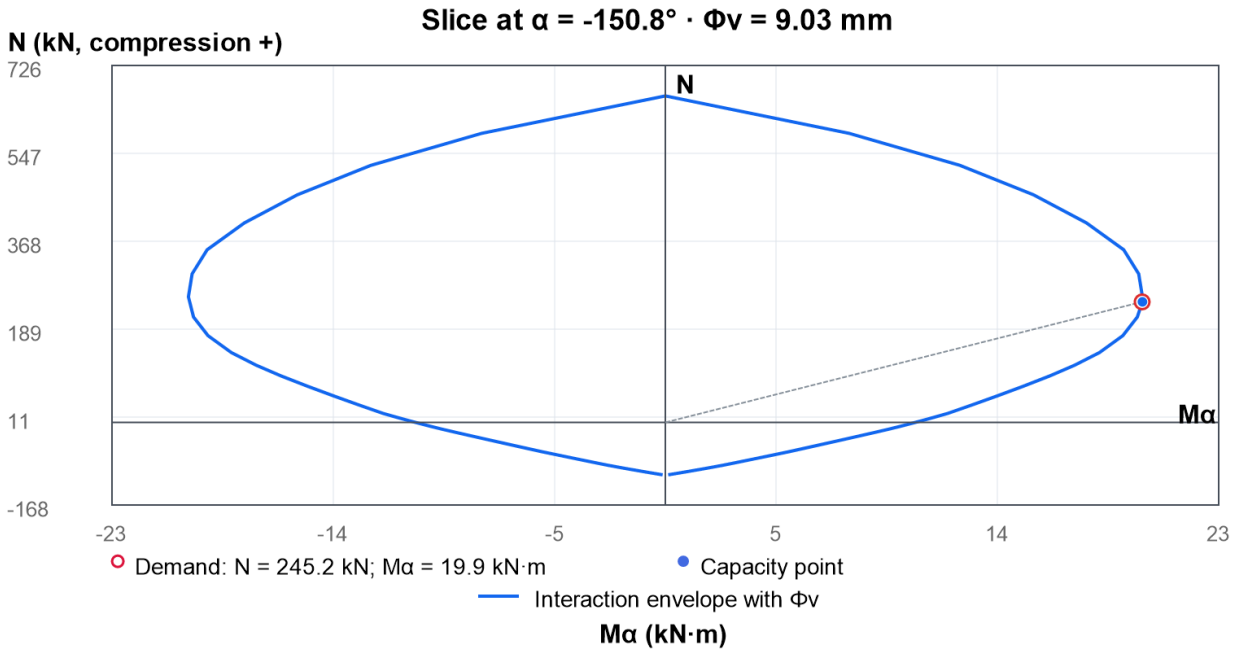
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	51.52	30.09	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.23	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.14040	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,276,893	2,276,893	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,072,481,230,017	1,213,492,739,434	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	904.98	1,023.96	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.3716	1.3148	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

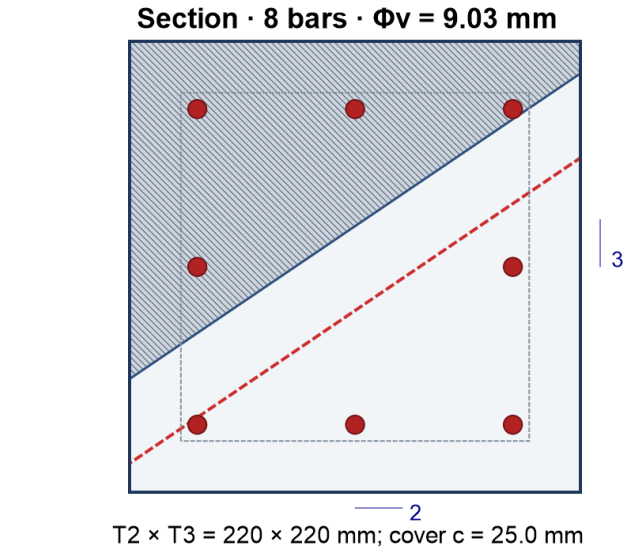
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 136.32 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	512.04 mm^2	Calculation results
Φ_v	9.0273 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	124.1228°	Geometry at the check point
Normal vector n	(-0.560969; 0.827837)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	136.3184 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.560969 \cdot x_2 + 0.827837 \cdot x_3 = 16.4502$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.560969 \cdot x_2 + 0.827837 \cdot x_3 = -17.6294$ mm	Geometry at the check point
Compressed concrete area A_b	19,828.308 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-30.325; 54.661) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	228.026 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-12.464 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.915 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.0273 mm / 64.004 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	64.004	173.318	-0.05997	-11.993	-0.768	-0.059	0.059
2	0.000	-77.000	64.004	216.512	-0.94719	-189.438	-12.125	-0.934	0.000
3	77.000	-77.000	64.004	259.707	-1.83441	-210.000	-13.441	-1.035	-1.035
4	-77.000	77.000	64.004	45.831	2.55863	210.000	13.441	-1.035	-1.035
5	0.000	77.000	64.004	89.025	1.67141	210.000	13.441	-1.035	0.000
6	77.000	77.000	64.004	132.220	0.78419	156.837	10.038	-0.773	0.773
7	-77.000	0.000	64.004	109.574	1.24933	210.000	13.441	0.000	-1.035
8	77.000	0.000	64.004	195.963	-0.52511	-105.023	-6.722	0.000	-0.518
Σ N_{si}, M_{xsi}, M_{ysi}							17.306	-4.871	-2.790

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	228.026	-12.464	-6.915	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	17.306	-4.871	-2.790	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**245.331**	**-17.335**	**-9.705**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	247.132 kN	From analysis results
M_2	-1.916 kN·m	From analysis results
M_3	-1.084 kN·m	From analysis results
M_{2s}	-3.445 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-3.445 kN·m	Including second-order magnification and accidental eccentricity

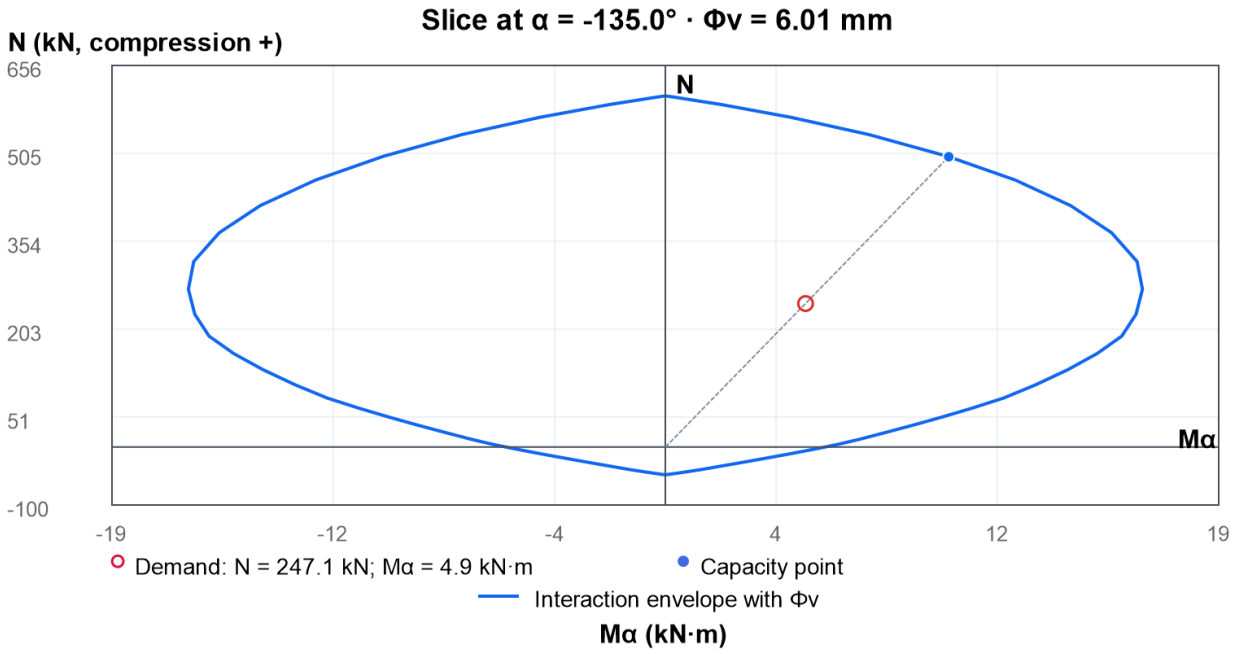
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.3941	1.3941	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

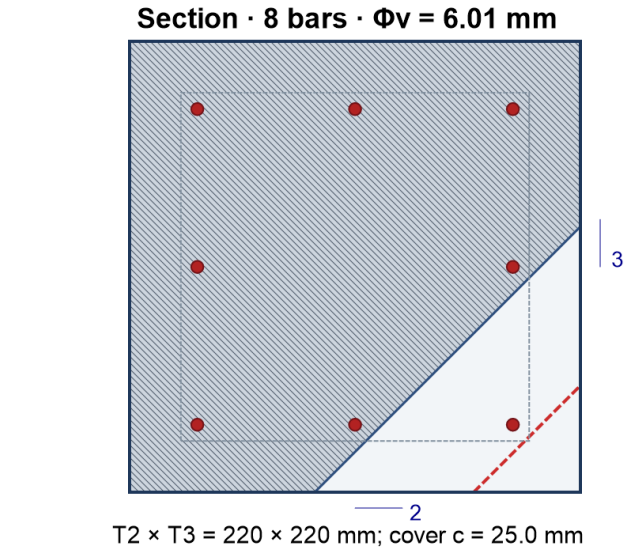
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 219.40 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4946	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	134.9859°	Geometry at the check point
Normal vector n	(-0.706933; 0.707281)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	219.4030 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.706933 \cdot x_2 + 0.707281 \cdot x_3 = -63.8395$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.706933 \cdot x_2 + 0.707281 \cdot x_3 = -118.6902$ mm	Geometry at the check point
Compressed concrete area A_b	39,986.706 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-14.044; 14.049) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	459.847 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.460 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.458 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.590	1.51437	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.024	0.81969	163.938	4.650	0.358	0.000
3	77.000	-77.000	28.366	264.458	0.12501	25.003	0.709	0.055	0.055
4	-77.000	77.000	28.366	46.669	2.90441	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.103	2.20973	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.537	1.51506	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.130	2.20939	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	209.997	0.82003	164.007	4.652	0.000	0.358
Σ N_{si}, M_{xsi}, M_{ysi}							39.797	-0.505	-0.505

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	459.847	-6.460	-6.458	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	39.797	-0.505	-0.505	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**499.644**	**-6.965**	**-6.963**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	249.733 kN	From analysis results
M_2	12.372 kN·m	From analysis results
M_3	7.306 kN·m	From analysis results
M_{2s}	17.076 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.692 kN·m	Including second-order magnification and accidental eccentricity

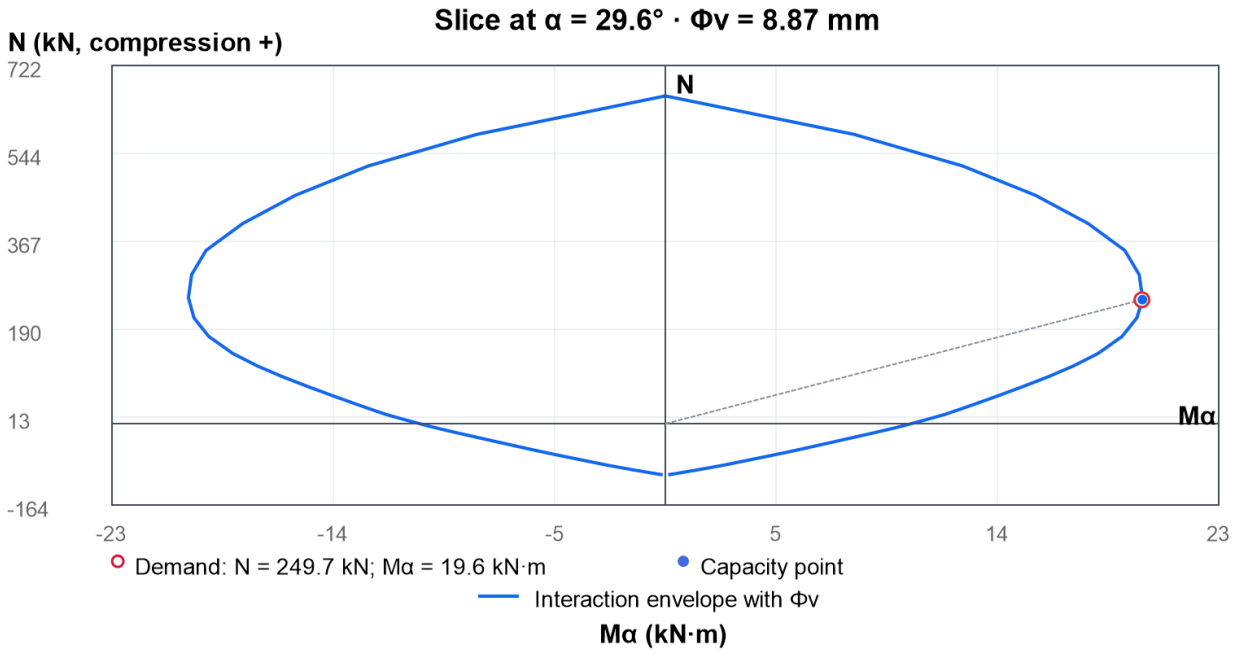
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	49.54	29.26	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.23	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.14281	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,198,755	2,198,755	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,074,457,830,471	1,202,553,534,377	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	906.64	1,014.73	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.3802	1.3264	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

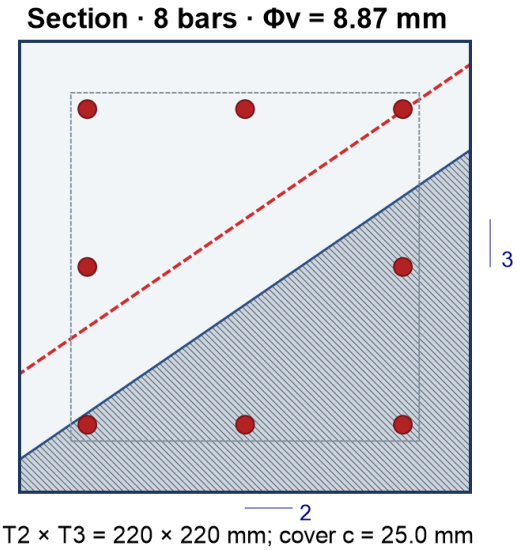
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 137.74 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	494.46 mm^2	Calculation results
Φ_v	8.8711 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9987	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	304.4676°	Geometry at the check point
Normal vector n	(0.565941; -0.824446)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	137.7423 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.565941 \cdot x_2 - 0.824446 \cdot x_3 = 15.2003$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.565941 \cdot x_2 - 0.824446 \cdot x_3 = -19.2353$ mm	Geometry at the check point
Compressed concrete area A_b	20,143.873 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(30.238; -53.840) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	231.655 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	12.472 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.005 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.8711 mm / 61.808 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	61.808	133.038	0.79564	159.127	9.835	0.757	-0.757
2	0.000	-77.000	61.808	89.460	1.68147	210.000	12.980	0.999	0.000
3	77.000	-77.000	61.808	45.883	2.56730	210.000	12.980	0.999	0.999
4	-77.000	77.000	61.808	260.002	-1.78528	-210.000	-12.980	0.999	0.999
5	0.000	77.000	61.808	216.425	-0.89945	-179.889	-11.119	0.856	0.000
6	77.000	77.000	61.808	172.847	-0.01361	-2.722	-0.168	0.013	-0.013
7	-77.000	0.000	61.808	196.520	-0.49482	-98.964	-6.117	0.000	0.471
8	77.000	0.000	61.808	109.365	1.27685	210.000	12.980	0.000	0.999
Σ N_{si}, M_{xsi}, M_{ysi}							18.391	4.625	2.699

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	231.655	12.472	7.005	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	18.391	4.625	2.699	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**250.046**	**17.097**	**9.704**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	360.471 kN	From analysis results
M_2	6.869 kN·m	From analysis results
M_3	-10.431 kN·m	From analysis results
M_{2s}	10.511 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.961 kN·m	Including second-order magnification and accidental eccentricity

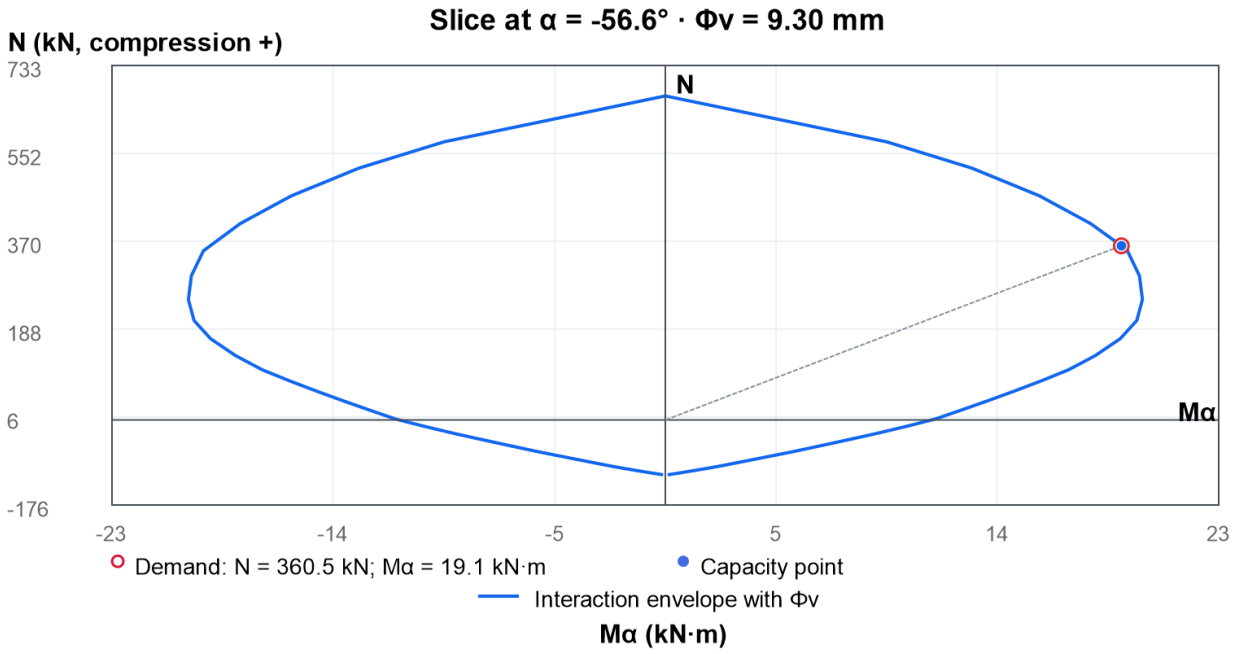
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	19.06	28.94	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,416,915	2,416,915	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,233,095,928,592	1,233,095,928,592	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,040.51	1,040.51	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.5301	1.5301	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

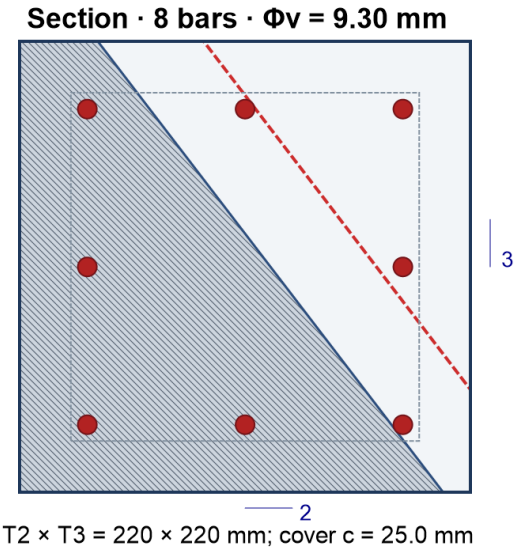
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 164.08 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	543.52 mm^2	Calculation results
Φ_v	9.3008 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	217.4524°	Geometry at the check point
Normal vector n	(-0.793859; -0.608102)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	164.0846 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.793859 \cdot x_2 - 0.608102 \cdot x_3 = -9.8689$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.793859 \cdot x_2 - 0.608102 \cdot x_3 = -50.8901$ mm	Geometry at the check point
Compressed concrete area A_b	26,934.943 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-39.119; -25.235) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	309.752 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.817 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-12.117 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.3008 mm / 67.941 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	67.941	46.265	2.71052	210.000	14.268	1.099	-1.099
2	0.000	-77.000	67.941	107.392	1.66743	210.000	14.268	1.099	0.000
3	77.000	-77.000	67.941	168.519	0.62433	124.866	8.483	0.653	0.653
4	-77.000	77.000	67.941	139.912	1.11248	210.000	14.268	-1.099	-1.099
5	0.000	77.000	67.941	201.040	0.06939	13.877	0.943	-0.073	0.000
6	77.000	77.000	67.941	262.167	-0.97371	-194.742	-13.231	1.019	-1.019
7	-77.000	0.000	67.941	93.089	1.91150	210.000	14.268	0.000	-1.099
8	77.000	0.000	67.941	215.343	-0.17469	-34.938	-2.374	0.000	-0.183
Σ N_{si}, M_{xsi}, M_{ysi}							50.892	2.698	-3.844

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	309.752	7.817	-12.117	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	50.892	2.698	-3.844	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**360.644**	**10.515**	**-15.961**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	362.421 kN	From analysis results
M_2	0.992 kN·m	From analysis results
M_3	-1.479 kN·m	From analysis results
M_{2s}	6.191 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-6.191 kN·m	Including second-order magnification and accidental eccentricity

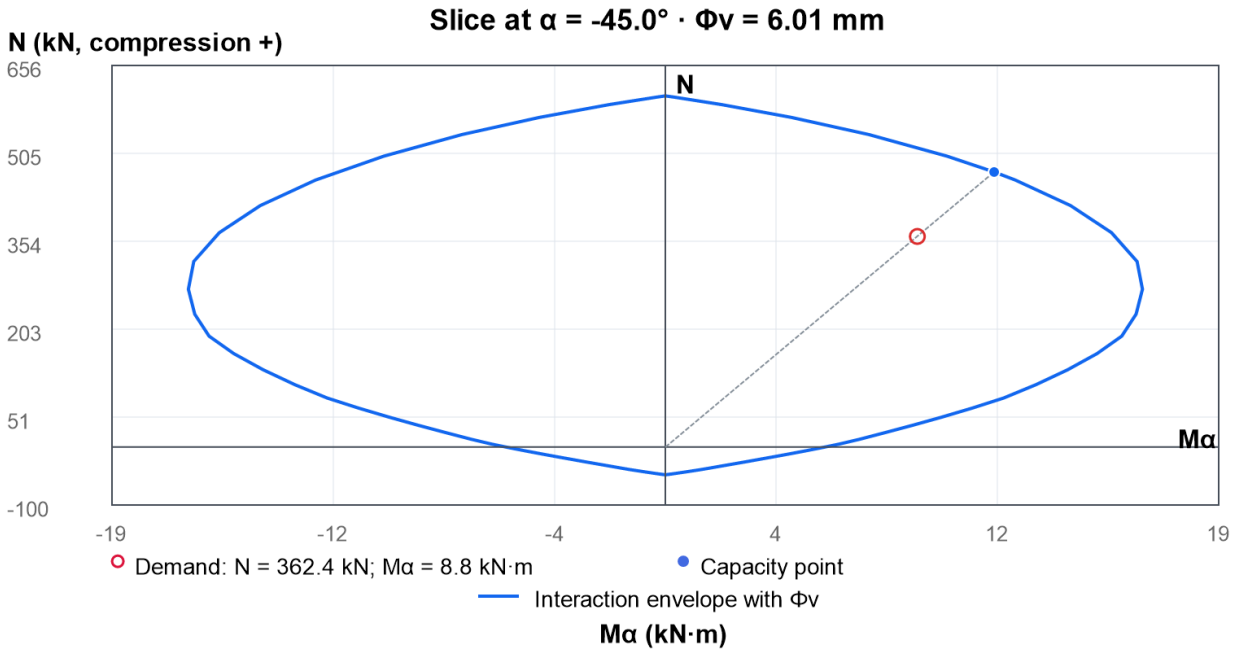
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.7082	1.7082	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

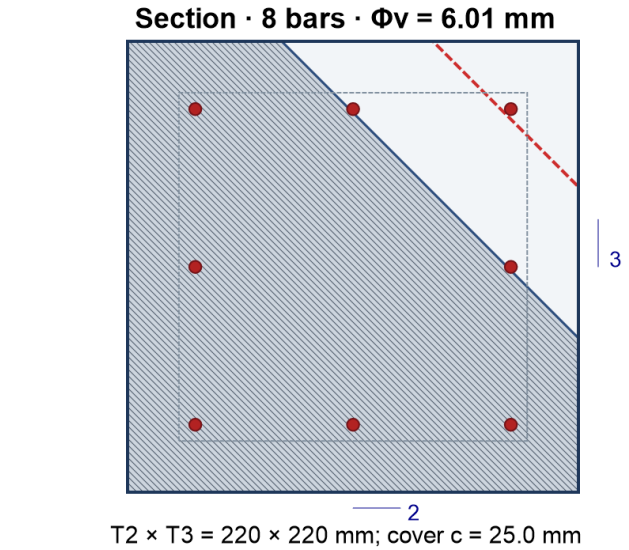
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 208.77 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7656	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0000°	Geometry at the check point
Normal vector n	(-0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	208.7680 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -53.2045$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -105.3965$ mm	Geometry at the check point
Compressed concrete area A_b	37,922.638 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-17.060; -17.060) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	436.110 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.440 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.440 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.87407	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.14383	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.563	1.41358	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.41358	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.011	0.68333	136.667	3.877	-0.299	0.000
6	77.000	77.000	28.366	264.458	-0.04691	-9.383	-0.266	0.020	-0.020
7	-77.000	0.000	28.366	101.116	2.14383	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.68333	136.667	3.877	0.000	0.299
Σ N_{si}, M_{xsi}, M_{ysi}							37.272	0.639	-0.639

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	436.110	7.440	-7.440	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.272	0.639	-0.639	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**473.382**	**8.079**	**-8.079**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	365.023 kN	From analysis results
M_2	-6.844 kN·m	From analysis results
M_3	10.456 kN·m	From analysis results
M_{2s}	-10.496 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	16.037 kN·m	Including second-order magnification and accidental eccentricity

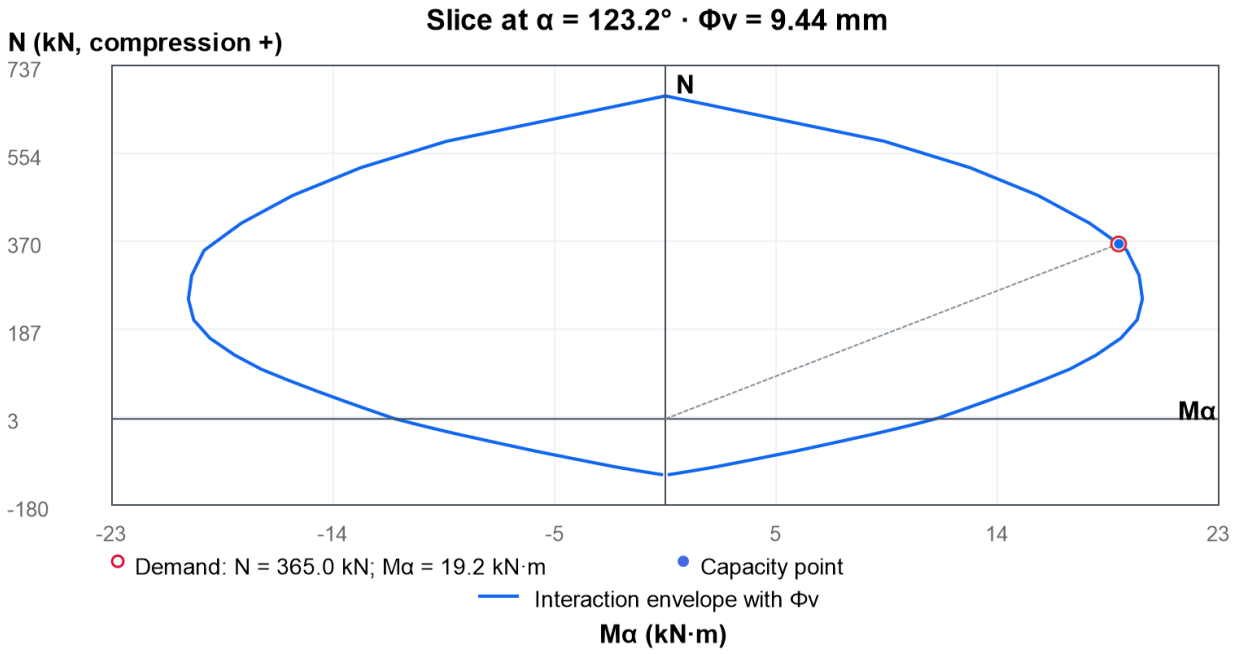
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	18.75	28.65	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,488,494	2,488,494	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,243,116,868,319	1,243,116,868,319	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	1,048.96	1,048.96	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.5337	1.5337	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

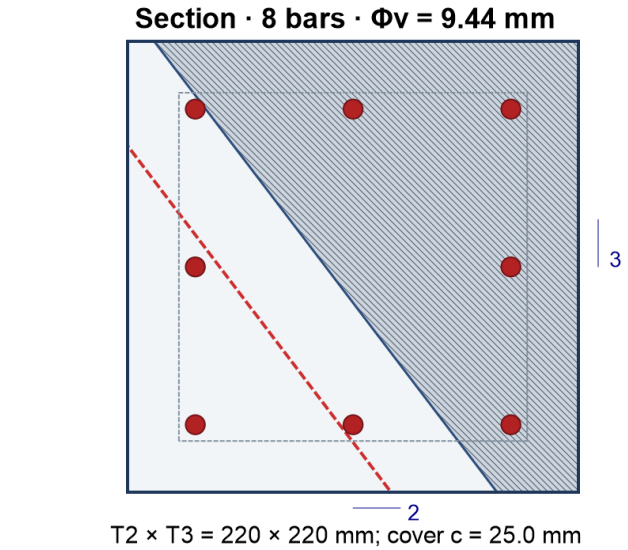
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 164.77 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	559.62 mm^2	Calculation results
Φ_v	9.4375 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	37.2557°	Geometry at the check point
Normal vector n	(0.795942; 0.605373)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	164.7704 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.795942 \cdot x_2 + 0.605373 \cdot x_3 = -10.6258$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.795942 \cdot x_2 + 0.605373 \cdot x_3 = -51.8184$ mm	Geometry at the check point
Compressed concrete area A_b	27,136.987 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(38.867; 24.869) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	312.075 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.761 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.130 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.4375 mm / 69.953 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	69.953	262.046	-0.95304	-190.607	-13.333	-1.027	1.027
2	0.000	-77.000	69.953	200.758	0.08844	17.689	1.237	0.095	0.000
3	77.000	-77.000	69.953	139.471	1.12992	210.000	14.690	1.131	1.131
4	-77.000	77.000	69.953	168.818	0.63121	126.242	8.831	-0.680	-0.680
5	0.000	77.000	69.953	107.531	1.67269	210.000	14.690	-1.131	0.000
6	77.000	77.000	69.953	46.243	2.71417	210.000	14.690	-1.131	1.131
7	-77.000	0.000	69.953	215.432	-0.16091	-32.182	-2.251	0.000	0.173
8	77.000	0.000	69.953	92.857	1.92205	210.000	14.690	0.000	1.131
Σ N_{si}, M_{xsi}, M_{ysi}							53.244	-2.743	3.913

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	312.075	-7.761	12.130	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	53.244	-2.743	3.913	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**365.319**	**-10.504**	**16.043**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	279.940 kN	From analysis results
M_2	1.339 kN·m	From analysis results
M_3	-10.316 kN·m	From analysis results
M_{2s}	4.118 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-15.418 kN·m	Including second-order magnification and accidental eccentricity

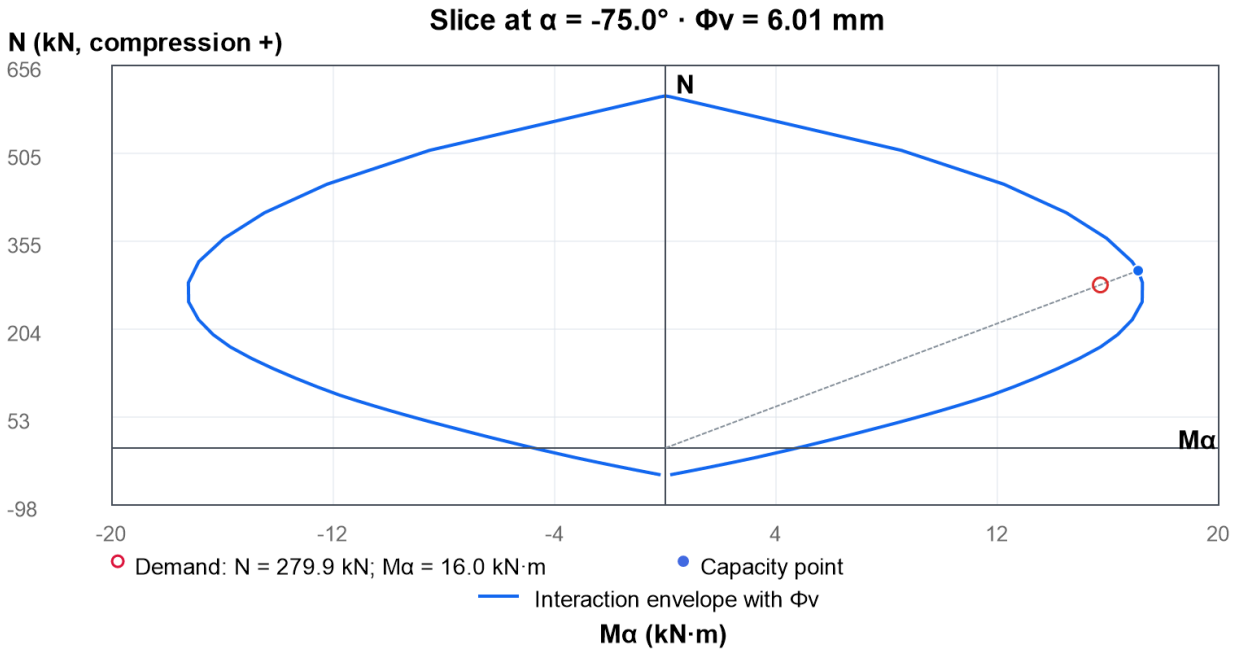
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	36.85	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.17	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16043	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,002,517,135,108	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	845.94	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4711	1.4946	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

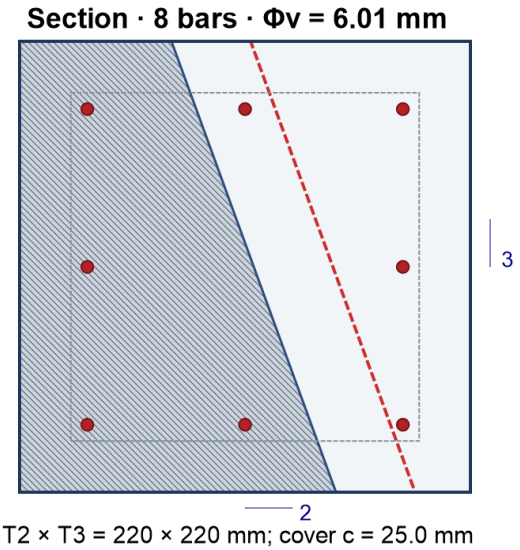
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 145.04 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9199	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	200.0484°	Geometry at the check point
Normal vector n	(-0.939403; -0.342814)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	145.0375 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.939403 \cdot x_2 - 0.342814 \cdot x_3 = -3.9936$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.939403 \cdot x_2 - 0.342814 \cdot x_3 = -40.2529$ mm	Geometry at the check point
Compressed concrete area A_b	25,135.258 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-50.524; -12.883) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	289.055 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	3.724 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-14.604 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	42.313	2.68313	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	114.647	1.28669	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	186.981	-0.10974	-21.948	-0.623	-0.048	-0.048
4	-77.000	77.000	28.366	95.106	1.66394	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	167.441	0.26750	53.500	1.518	-0.117	0.000
6	77.000	77.000	28.366	239.775	-1.12893	-210.000	-5.957	0.459	-0.459
7	-77.000	0.000	28.366	68.710	2.17353	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	213.378	-0.61934	-123.868	-3.514	0.000	-0.271
Σ N_{si}, M_{xsi}, M_{ysi}							15.252	0.753	-2.153

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	289.055	3.724	-14.604	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	15.252	0.753	-2.153	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**304.308**	**4.476**	**-16.757**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	281.891 kN	From analysis results
M_2	0.244 kN·m	From analysis results
M_3	-1.476 kN·m	From analysis results
M_{2s}	4.160 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-4.160 kN·m	Including second-order magnification and accidental eccentricity

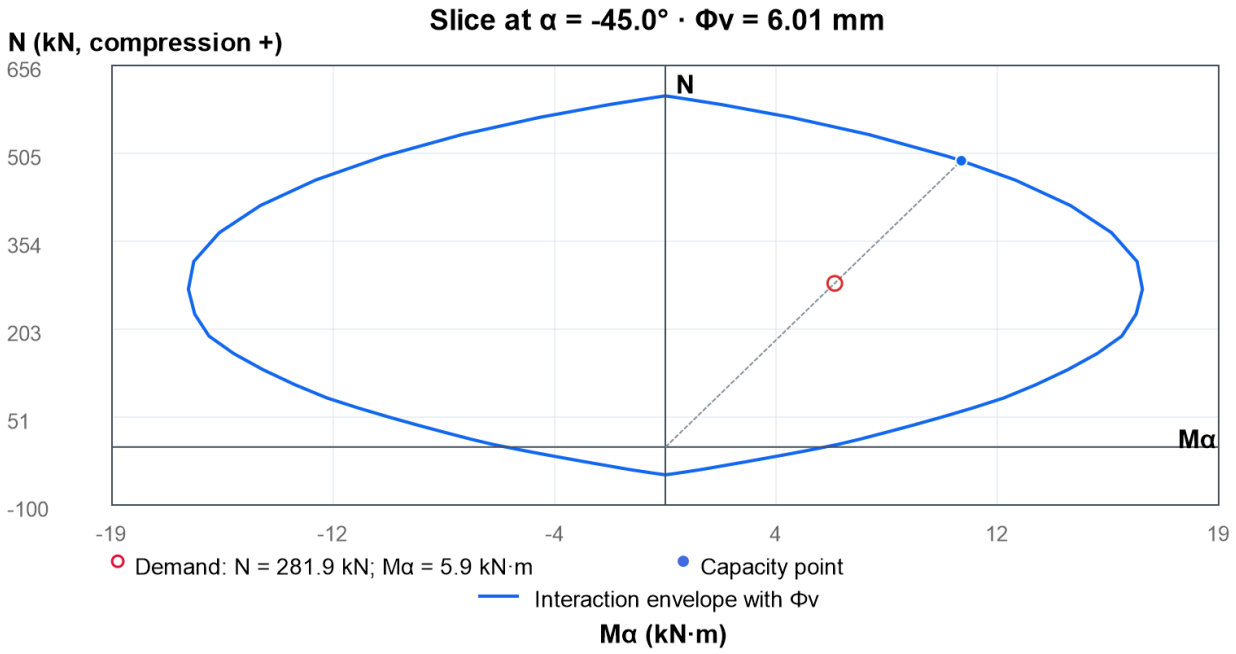
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4759	1.4759	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

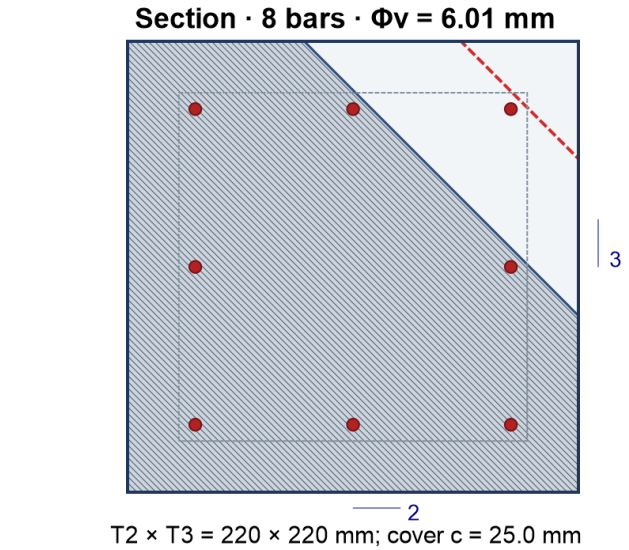
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 216.52 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.5720	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	224.9888°	Geometry at the check point
Normal vector n	(-0.707245; -0.706969)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	216.5153 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707245 \cdot x_2 - 0.706969 \cdot x_3 = -60.9518$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707245 \cdot x_2 - 0.706969 \cdot x_3 = -115.0807$ mm	Geometry at the check point
Compressed concrete area A_b	39,448.635 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-14.842; -14.838) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	453.659 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.731 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.733 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.89647	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.127	2.19222	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.585	1.48796	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.542	1.48851	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.000	0.78426	156.851	4.449	-0.343	0.000
6	77.000	77.000	28.366	264.458	0.08000	16.000	0.454	-0.035	0.035
7	-77.000	0.000	28.366	101.106	2.19249	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.021	0.78398	156.796	4.448	0.000	0.342
Σ N_{si}, M_{xsi}, M_{ysi}							39.136	0.540	-0.540

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	453.659	6.731	-6.733	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	39.136	0.540	-0.540	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**492.795**	**7.271**	**-7.273**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	284.492 kN	From analysis results
M_2	-1.217 kN·m	From analysis results
M_3	10.309 kN·m	From analysis results
M_{2s}	-4.217 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	15.493 kN·m	Including second-order magnification and accidental eccentricity

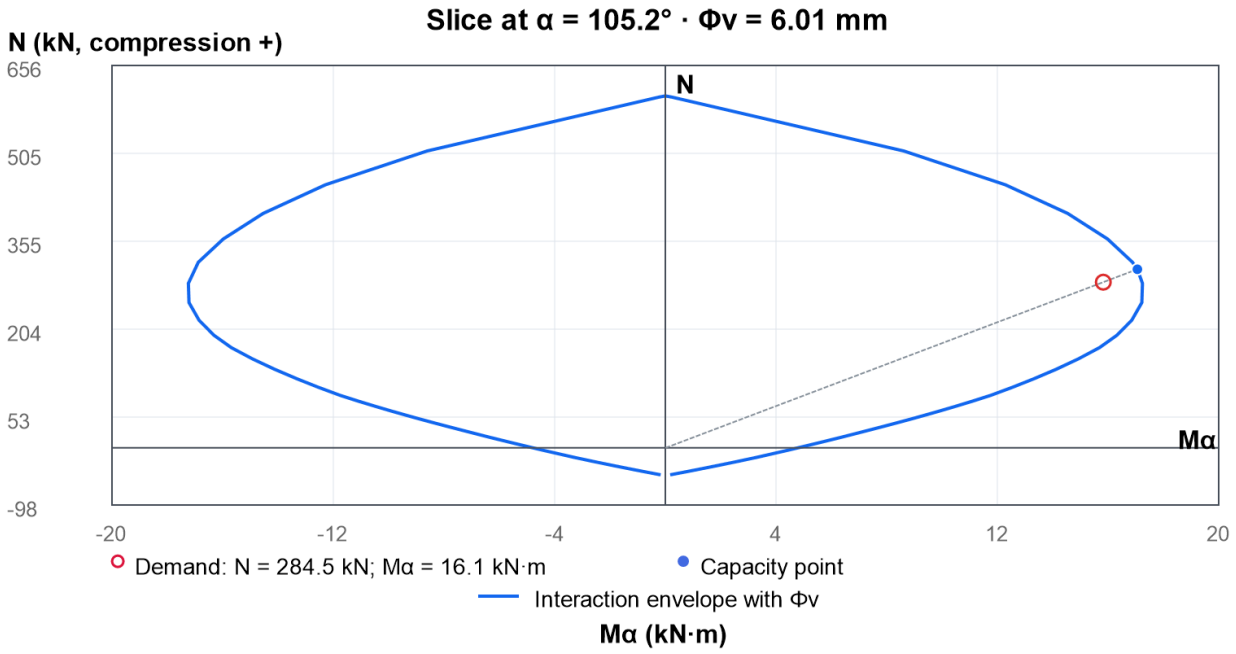
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	36.24	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.16	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16139	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,007,664,340,270	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	850.28	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.4824	1.5028	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

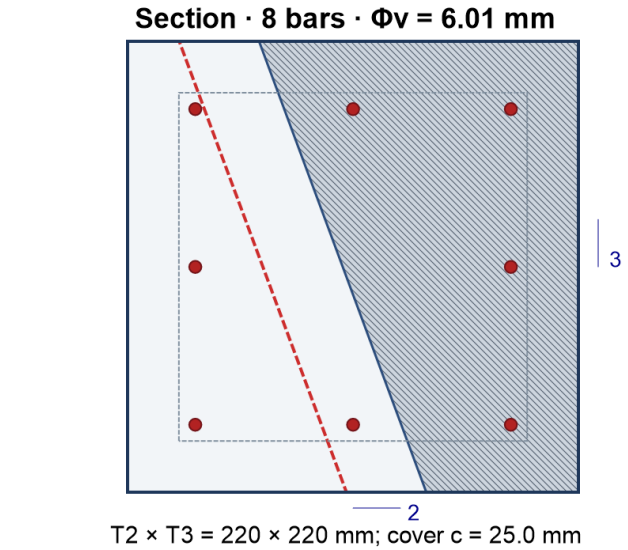
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 146.12 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9276	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	20.3517°	Geometry at the check point
Normal vector n	(0.937576; 0.347782)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	146.1248 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.937576 \cdot x_2 + 0.347782 \cdot x_3 = -4.7355$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.937576 \cdot x_2 + 0.347782 \cdot x_3 = -41.2667$ mm	Geometry at the check point
Compressed concrete area A_b	25,311.168 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(50.063; 13.004) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	291.078 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-3.785 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	14.572 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	240.362	-1.10574	-210.000	-5.957	-0.459	0.459
2	0.000	-77.000	28.366	168.168	0.27760	55.521	1.575	0.121	0.000
3	77.000	-77.000	28.366	95.975	1.66095	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	186.803	-0.07947	-15.895	-0.451	0.035	0.035
5	0.000	77.000	28.366	114.610	1.30387	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	42.417	2.68722	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	213.583	-0.59261	-118.522	-3.362	0.000	0.259
8	77.000	0.000	28.366	69.196	2.17409	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							15.633	-0.761	2.128

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	291.078	-3.785	14.572	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	15.633	-0.761	2.128	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**306.711**	**-4.547**	**16.701**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	289.371 kN	From analysis results
M_2	-5.801 kN·m	From analysis results
M_3	-9.929 kN·m	From analysis results
M_{2s}	-8.599 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-14.798 kN·m	Including second-order magnification and accidental eccentricity

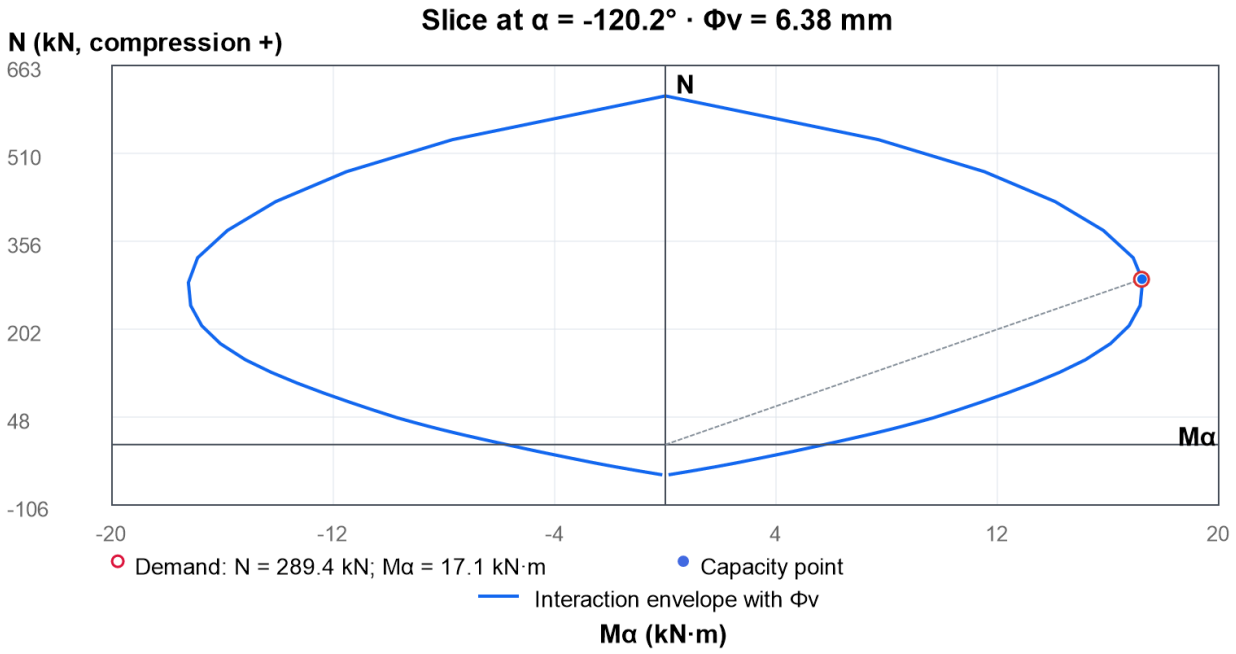
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	20.05	34.31	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16448	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,138,559	1,138,559	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,054,125,989,565	1,042,407,725,274	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	889.49	879.60	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4822	1.4903	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

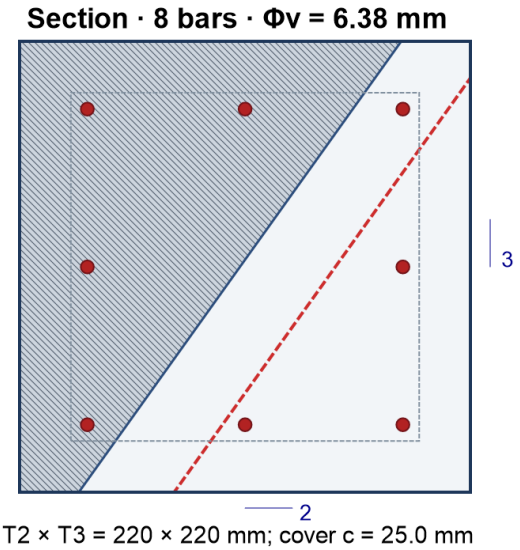
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 151.43 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	256.04 mm^2	Calculation results
Φ_v	6.3836 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9990	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	144.4280°	Geometry at the check point
Normal vector n	(-0.813386; 0.581725)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	151.4308 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.813386 \cdot x_2 + 0.581725 \cdot x_3 = 2.0313$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.813386 \cdot x_2 + 0.581725 \cdot x_3 = -35.8264$ mm	Geometry at the check point
Compressed concrete area A_b	23,650.578 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-46.653; 26.833) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	271.982 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.298 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-12.689 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.3836 mm / 32.005 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	32.005	135.624	0.99227	198.454	6.352	0.489	-0.489
2	0.000	-77.000	32.005	198.255	-0.16579	-33.158	-1.061	-0.082	0.000
3	77.000	-77.000	32.005	260.886	-1.32385	-210.000	-6.721	-0.518	-0.518
4	-77.000	77.000	32.005	46.039	2.64873	210.000	6.721	-0.518	-0.518
5	0.000	77.000	32.005	108.669	1.49067	210.000	6.721	-0.518	0.000
6	77.000	77.000	32.005	171.300	0.33261	66.523	2.129	-0.164	0.164
7	-77.000	0.000	32.005	90.831	1.82050	210.000	6.721	0.000	-0.518
8	77.000	0.000	32.005	216.093	-0.49562	-99.124	-3.172	0.000	-0.244
Σ N_{si}, M_{xsi}, M_{ysi}							17.689	-1.309	-2.122

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	271.982	-7.298	-12.689	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	17.689	-1.309	-2.122	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**289.671**	**-8.607**	**-14.811**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	291.322 kN	From analysis results
M_2	-0.875 kN·m	From analysis results
M_3	-1.410 kN·m	From analysis results
M_{2s}	-4.369 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-4.369 kN·m	Including second-order magnification and accidental eccentricity

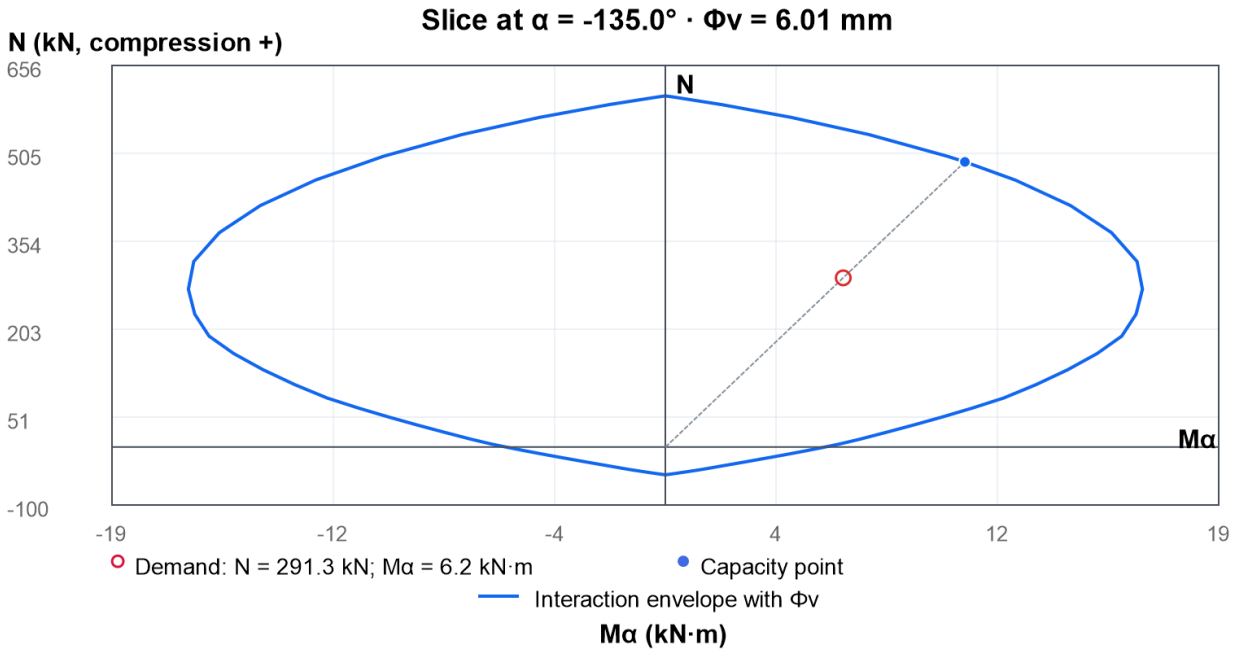
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4998	1.4998	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

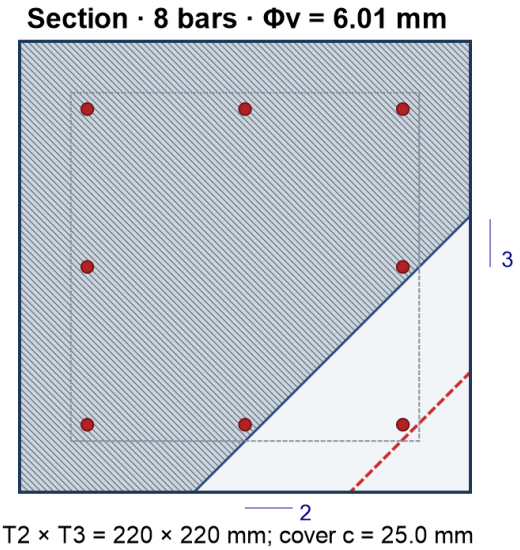
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 215.68 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.5936	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	135.0043°	Geometry at the check point
Normal vector n	(-0.707160; 0.707054)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	215.6841 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707160 \cdot x_2 + 0.707054 \cdot x_3 = -60.1206$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707160 \cdot x_2 + 0.707054 \cdot x_3 = -114.0416$ mm	Geometry at the check point
Compressed concrete area A_b	39,290.658 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-15.073; 15.071) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	451.843 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.810 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.810 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.555	1.48059	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.007	0.77370	154.741	4.389	0.338	0.000
3	77.000	-77.000	28.366	264.458	0.06682	13.364	0.379	0.029	0.029
4	-77.000	77.000	28.366	46.669	2.89414	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.120	2.18726	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.572	1.48038	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.112	2.18737	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.015	0.77360	154.720	4.389	0.000	0.338
Σ N_{si}, M_{xsi}, M_{ysi}							38.942	-0.550	-0.550

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	451.843	-6.810	-6.810	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	38.942	-0.550	-0.550	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**490.785**	**-7.360**	**-7.361**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	293.923 kN	From analysis results
M_2	5.693 kN·m	From analysis results
M_3	9.949 kN·m	From analysis results
M_{2s}	8.496 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.899 kN·m	Including second-order magnification and accidental eccentricity

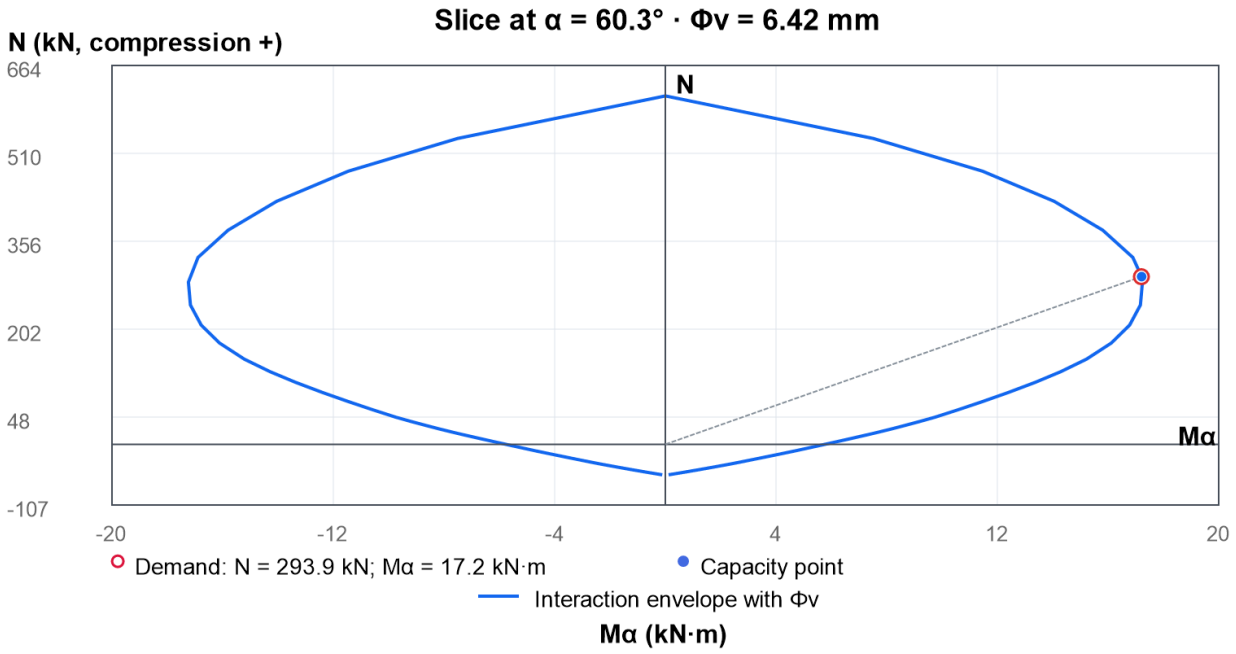
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	19.37	33.85	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16525	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,151,548	1,151,548	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,055,944,506,287	1,048,352,128,052	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	891.02	884.62	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.4923	1.4976	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

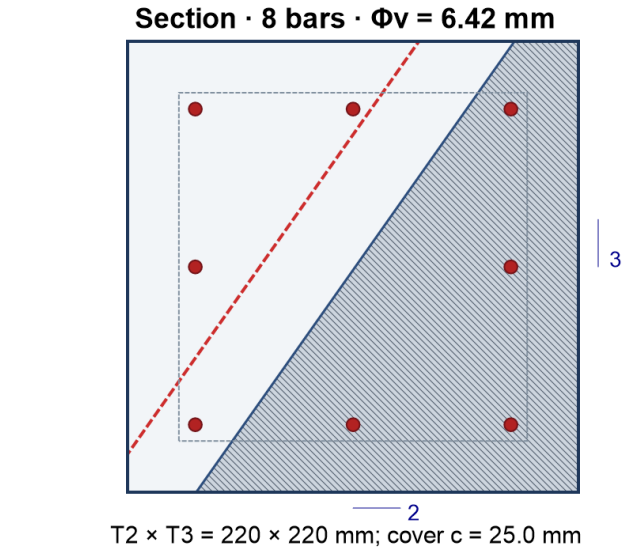
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 152.42 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	258.96 mm^2	Calculation results
Φ_v	6.4199 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	324.7809°	Geometry at the check point
Normal vector n	(0.816952; -0.576705)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	152.4199 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.816952 \cdot x_2 - 0.576705 \cdot x_3 = 0.8824$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.816952 \cdot x_2 - 0.576705 \cdot x_3 = -37.2226$ mm	Geometry at the check point
Compressed concrete area A_b	23,962.375 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(46.313; -26.141) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	275.567 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.203 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.762 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.4199 mm / 32.370 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	32.370	171.801	0.34396	68.791	2.227	0.171	-0.171
2	0.000	-77.000	32.370	108.896	1.49955	210.000	6.798	0.523	0.000
3	77.000	-77.000	32.370	45.991	2.65514	210.000	6.798	0.523	0.523
4	-77.000	77.000	32.370	260.614	-1.28756	-210.000	-6.798	0.523	0.523
5	0.000	77.000	32.370	197.709	-0.13197	-26.393	-0.854	0.066	0.000
6	77.000	77.000	32.370	134.803	1.02362	204.725	6.627	-0.510	0.510
7	-77.000	0.000	32.370	216.208	-0.47180	-94.360	-3.054	0.000	0.235
8	77.000	0.000	32.370	90.397	1.83938	210.000	6.798	0.000	0.523
Σ N_{si}, M_{xsi}, M_{ysi}							18.541	1.297	2.144

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	275.567	7.203	12.762	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	18.541	1.297	2.144	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**294.108**	**8.501**	**14.907**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	207.209 kN	From analysis results
M_2	10.465 kN·m	From analysis results
M_3	-7.325 kN·m	From analysis results
M_{2s}	14.128 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.532 kN·m	Including second-order magnification and accidental eccentricity

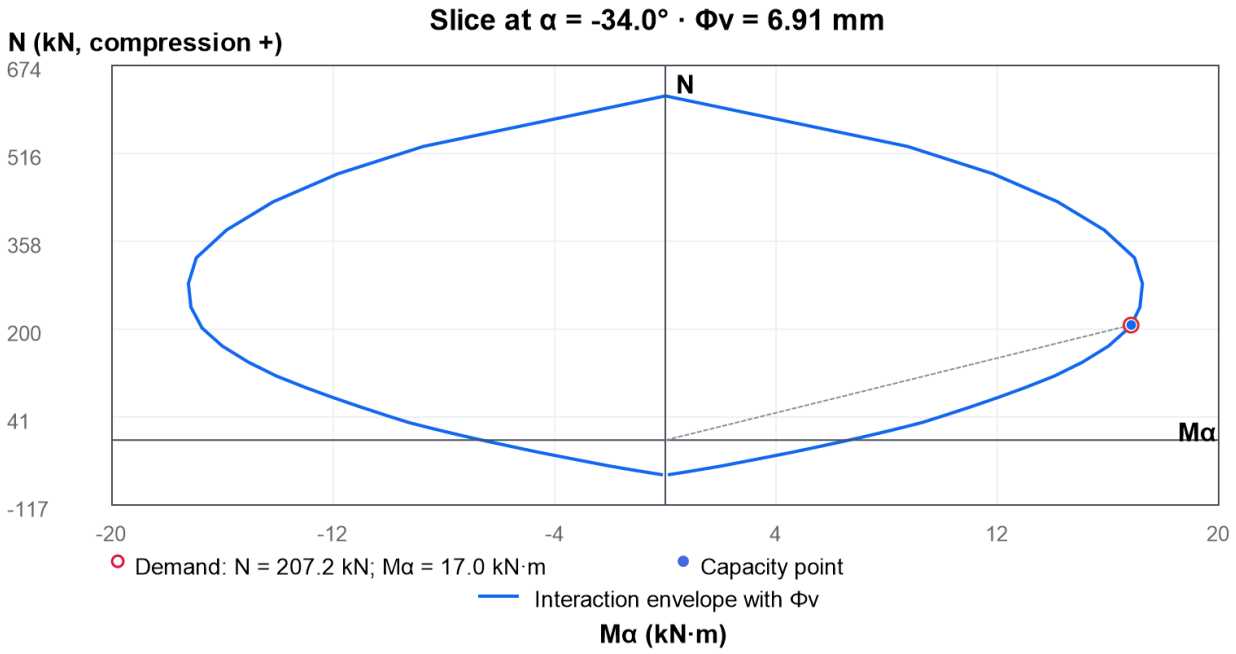
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	50.51	35.35	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.23	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.14162	0.16280	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,335,575	1,335,575	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	947,264,239,395	1,060,935,731,115	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	799.32	895.23	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3500	1.3012	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

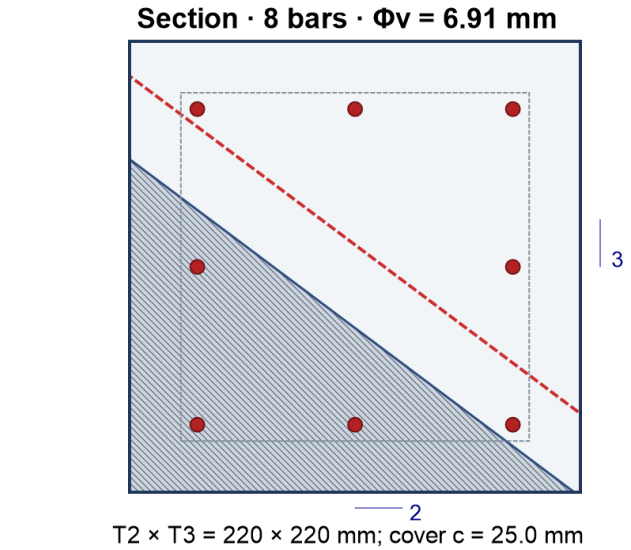
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 130.07 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	300.35 mm^2	Calculation results
Φ_v	6.9139 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	233.1805°	Geometry at the check point
Normal vector n	(-0.599296; -0.800528)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	130.0669 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.599296 \cdot x_2 - 0.800528 \cdot x_3 = 23.9137$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.599296 \cdot x_2 - 0.800528 \cdot x_3 = -8.6031$ mm	Geometry at the check point
Compressed concrete area A_b	17,631.373 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-37.656; -55.841) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	202.761 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	11.322 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.635 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.9139 mm / 37.544 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	37.544	46.194	2.50556	210.000	7.884	0.607	-0.607
2	0.000	-77.000	37.544	92.340	1.51216	210.000	7.884	0.607	0.000
3	77.000	-77.000	37.544	138.486	0.51876	103.753	3.895	0.300	0.300
4	-77.000	77.000	37.544	169.475	-0.14836	-29.672	-1.114	0.086	0.086
5	0.000	77.000	37.544	215.621	-1.14176	-210.000	-7.884	0.607	0.000
6	77.000	77.000	37.544	261.767	-2.13516	-210.000	-7.884	0.607	-0.607
7	-77.000	0.000	37.544	107.835	1.17860	210.000	7.884	0.000	-0.607
8	77.000	0.000	37.544	200.126	-0.80820	-161.639	-6.069	0.000	-0.467
Σ N_{si}, M_{xsi}, M_{ysi}							4.597	2.814	-1.903

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	202.761	11.322	-7.635	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	4.597	2.814	-1.903	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**207.358**	**14.136**	**-9.538**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	209.159 kN	From analysis results
M_2	1.645 kN·m	From analysis results
M_3	-1.030 kN·m	From analysis results
M_{2s}	2.749 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-2.749 kN·m	Including second-order magnification and accidental eccentricity

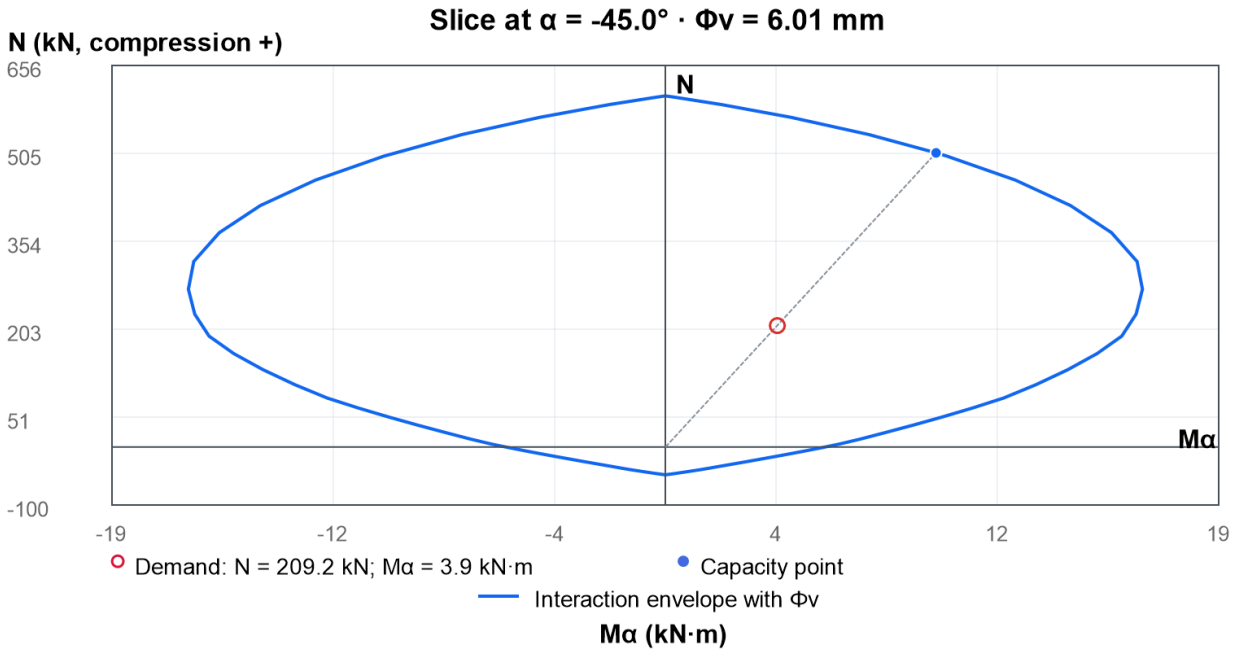
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3145	1.3145	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

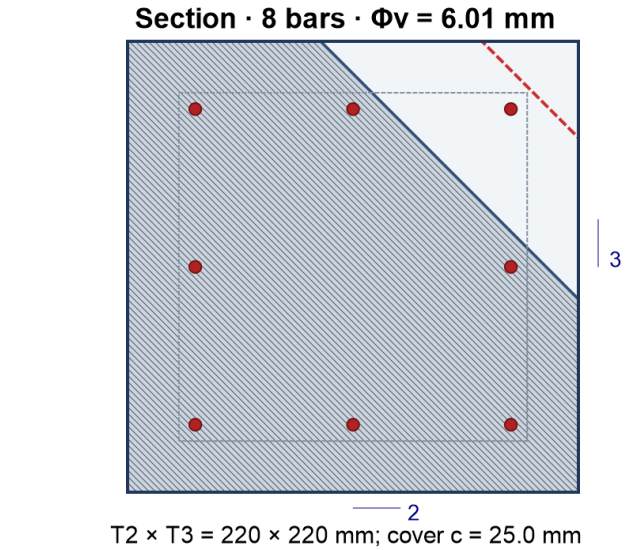
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 222.30 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4131	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	225.0000°	Geometry at the check point
Normal vector n	(-0.707107; -0.707107)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	222.2959 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -66.7324$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707107 \cdot x_2 - 0.707107 \cdot x_3 = -122.3064$ mm	Geometry at the check point
Compressed concrete area A_b	40,509.043 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-13.270; -13.270) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	465.854 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.182 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.182 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.91216	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.116	2.22636	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.563	1.54055	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.563	1.54055	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	210.011	0.85474	170.948	4.849	-0.373	0.000
6	77.000	77.000	28.366	264.458	0.16893	33.787	0.958	-0.074	0.074
7	-77.000	0.000	28.366	101.116	2.22636	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.011	0.85474	170.948	4.849	0.000	0.373
Σ N_{si}, M_{xsi}, M_{ysi}							40.442	0.470	-0.470

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	465.854	6.182	-6.182	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.442	0.470	-0.470	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**506.296**	**6.652**	**-6.652**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	211.761 kN	From analysis results
M_2	-10.115 kN·m	From analysis results
M_3	7.364 kN·m	From analysis results
M_{2s}	-13.749 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.677 kN·m	Including second-order magnification and accidental eccentricity

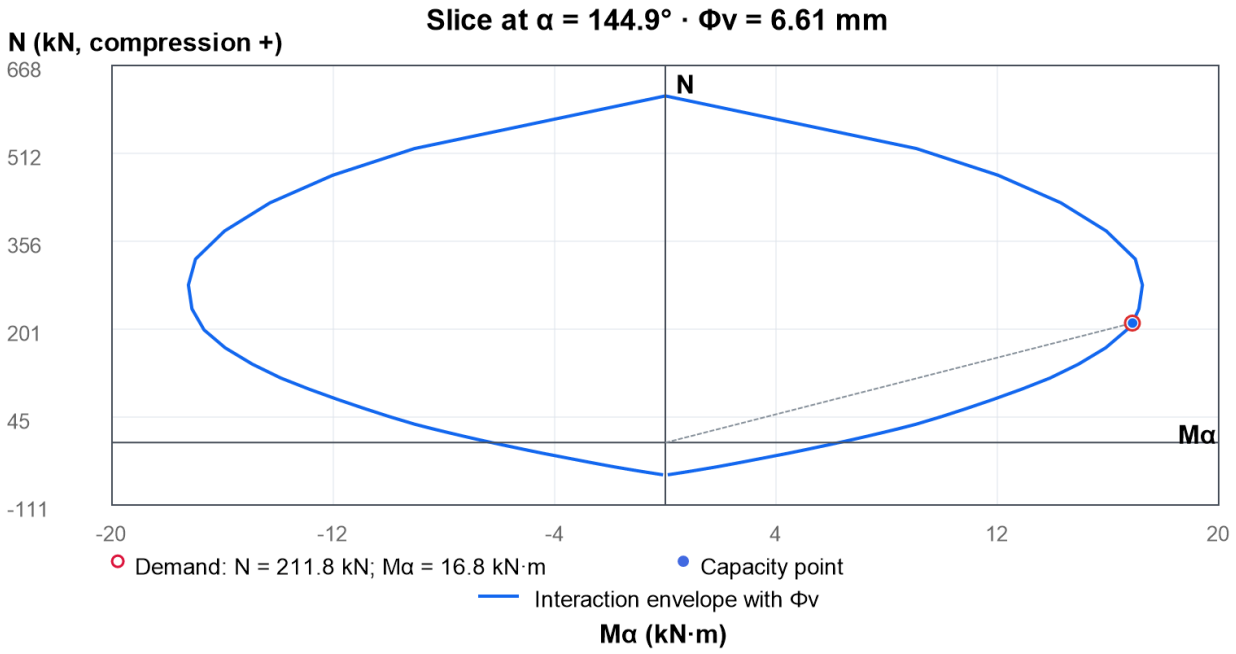
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	47.77	34.77	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.22	0.16	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.14504	0.16373	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,220,475	1,220,475	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	949,470,547,576	1,049,842,866,612	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	801.18	885.87	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3593	1.3141	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

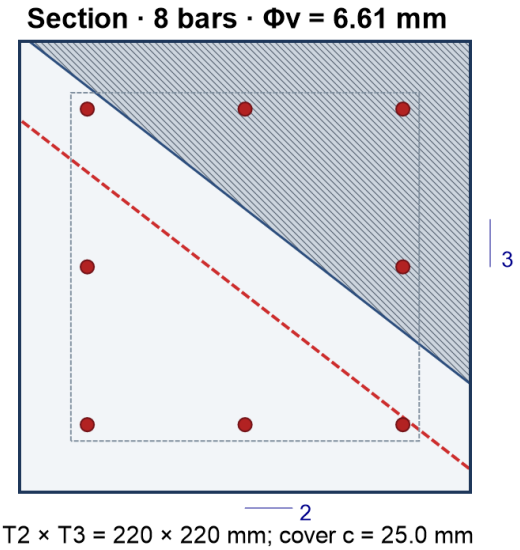
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 132.01 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	274.46 mm^2	Calculation results
Φ_v	6.6093 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9996	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	52.1749°	Geometry at the check point
Normal vector n	(0.613253; 0.789887)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	132.0114 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.613253 \cdot x_2 + 0.789887 \cdot x_3 = 22.3339$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.613253 \cdot x_2 + 0.789887 \cdot x_3 = -10.6689$ mm	Geometry at the check point
Compressed concrete area A_b	17,988.239 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(38.245; 54.291) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	206.865 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-11.231 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.912 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.6093 mm / 34.308 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	34.308	262.387	-2.06531	-210.000	-7.205	-0.555	0.555
2	0.000	-77.000	34.308	215.167	-1.06375	-210.000	-7.205	-0.555	0.000
3	77.000	-77.000	34.308	167.946	-0.06219	-12.437	-0.427	-0.033	-0.033
4	-77.000	77.000	34.308	140.745	0.51477	102.954	3.532	-0.272	-0.272
5	0.000	77.000	34.308	93.524	1.51633	210.000	7.205	-0.555	0.000
6	77.000	77.000	34.308	46.304	2.51789	210.000	7.205	-0.555	0.555
7	-77.000	0.000	34.308	201.566	-0.77527	-155.054	-5.320	0.000	0.410
8	77.000	0.000	34.308	107.125	1.22785	210.000	7.205	0.000	0.555
Σ N_{si}, M_{xsi}, M_{ysi}							4.991	-2.524	1.769

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	206.865	-11.231	7.912	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	4.991	-2.524	1.769	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**211.855**	**-13.755**	**9.681**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	153.736 kN	From analysis results
M_2	-12.990 kN·m	From analysis results
M_3	7.435 kN·m	From analysis results
M_{2s}	-16.236 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.915 kN·m	Including second-order magnification and accidental eccentricity

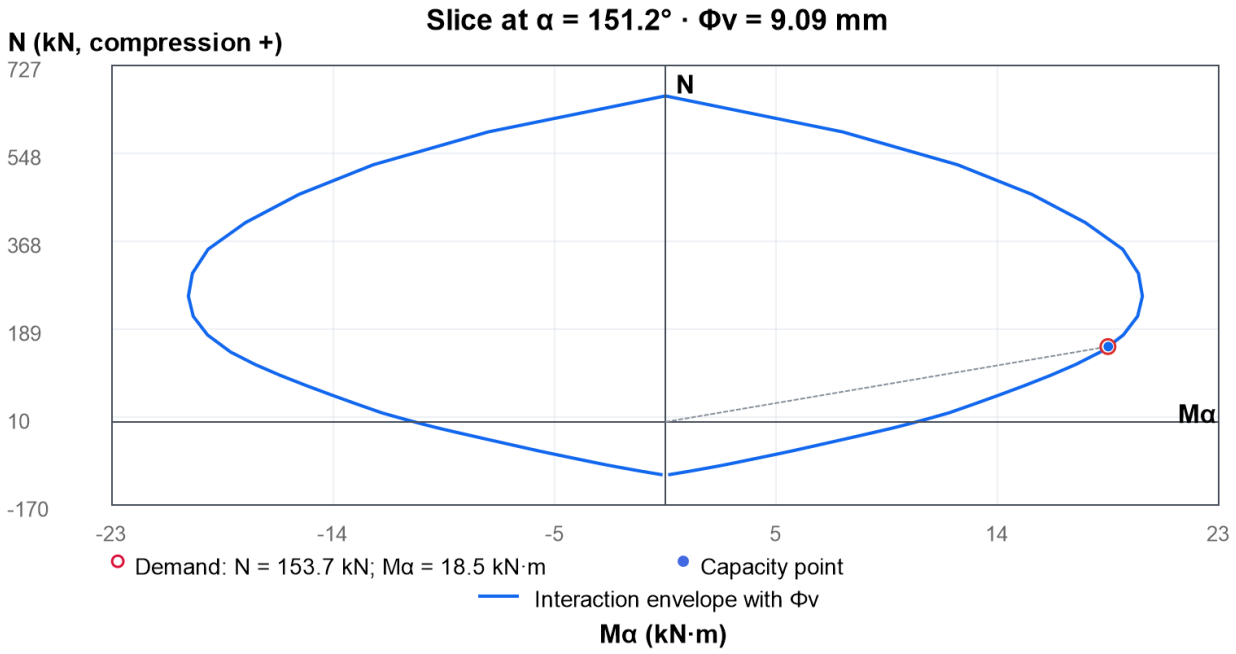
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	84.50	48.36	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.38	0.22	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.10964	0.14428	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,306,546	2,306,546	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	911,483,331,138	1,097,444,328,832	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	769.12	926.04	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.2498	1.1991	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

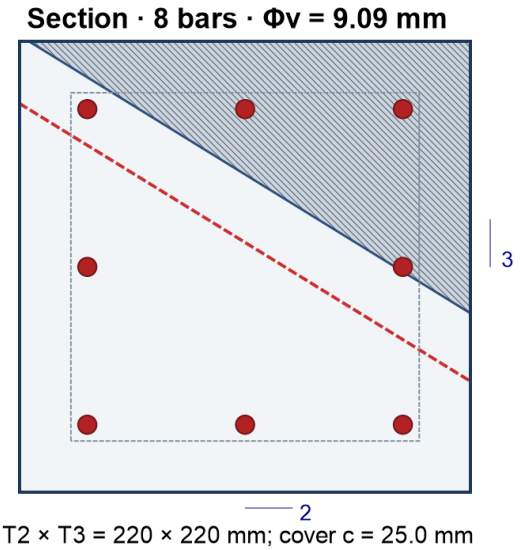
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 112.95 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	518.70 mm^2	Calculation results
Φ_v	9.0859 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	58.3740°	Geometry at the check point
Normal vector n	(0.524372; 0.851489)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	112.9486 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.524372 \cdot x_2 + 0.851489 \cdot x_3 = 38.3962$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.524372 \cdot x_2 + 0.851489 \cdot x_3 = 10.1590$ mm	Geometry at the check point
Compressed concrete area A_b	14,286.071 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(38.201; 65.784) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	164.290 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-10.808 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.276 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.0859 mm / 64.838 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	64.838	257.286	-2.87813	-210.000	-13.616	-1.048	1.048
2	0.000	-77.000	64.838	216.909	-1.87719	-210.000	-13.616	-1.048	0.000
3	77.000	-77.000	64.838	176.533	-0.87625	-175.251	-11.363	-0.875	-0.875
4	-77.000	77.000	64.838	126.157	0.37257	74.514	4.831	-0.372	-0.372
5	0.000	77.000	64.838	85.780	1.37351	210.000	13.616	-1.048	0.000
6	77.000	77.000	64.838	45.403	2.37445	210.000	13.616	-1.048	1.048
7	-77.000	0.000	64.838	191.721	-1.25278	-210.000	-13.616	0.000	1.048
8	77.000	0.000	64.838	110.968	0.74910	149.819	9.714	0.000	0.748
Σ N_{si}, M_{xsi}, M_{ysi}							-10.434	-5.441	2.646

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	164.290	-10.808	6.276	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-10.434	-5.441	2.646	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**153.856**	**-16.248**	**8.922**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	155.687 kN	From analysis results
M_2	-1.839 kN·m	From analysis results
M_3	0.957 kN·m	From analysis results
M_{2s}	-2.238 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.894 kN·m	Including second-order magnification and accidental eccentricity

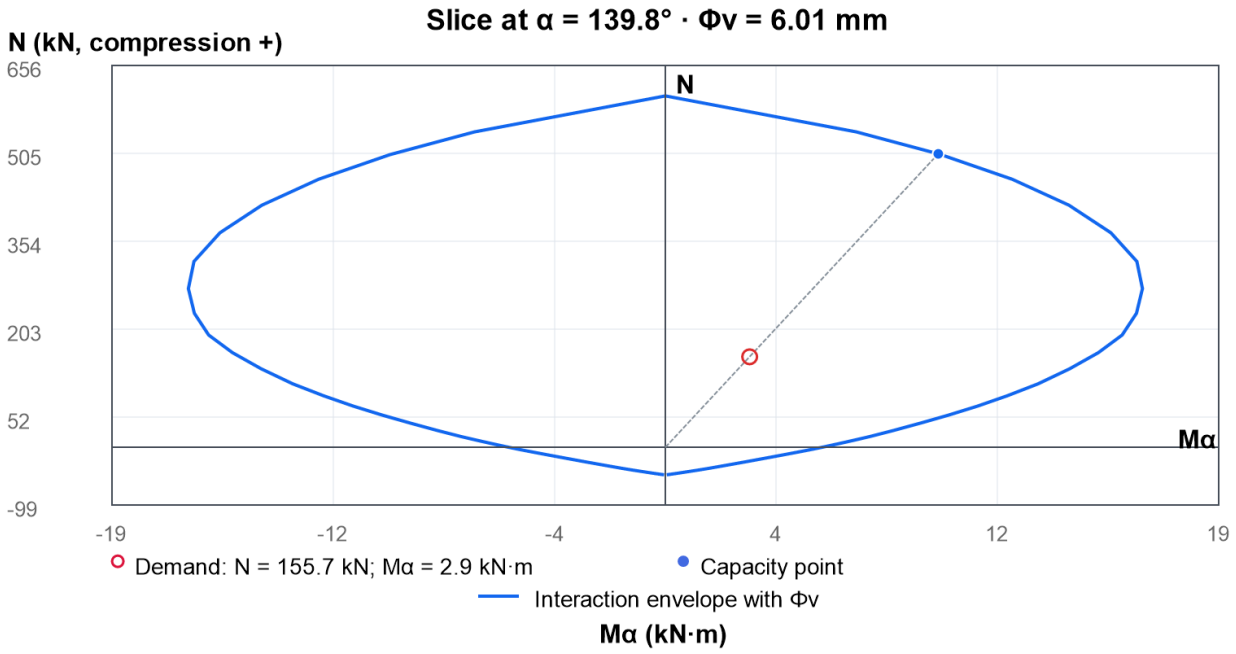
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	11.82	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2167	1.2167	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

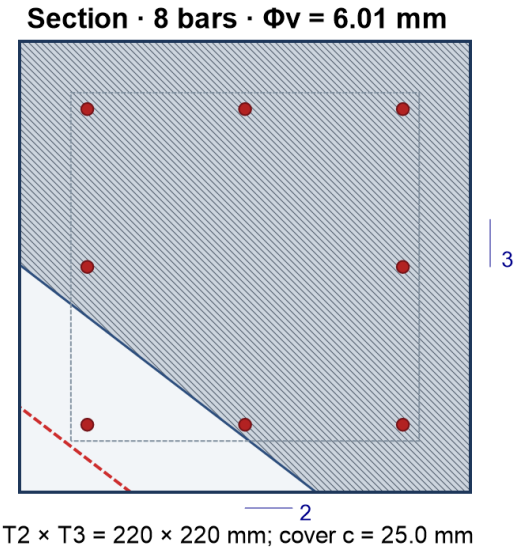
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 220.37 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.3085	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	52.5140°	Geometry at the check point
Normal vector n	(0.608568; 0.793502)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	220.3688 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.608568 \cdot x_2 + 0.793502 \cdot x_3 = -66.1412$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.608568 \cdot x_2 + 0.793502 \cdot x_3 = -121.2334$ mm	Geometry at the check point
Compressed concrete area A_b	40,365.998 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(12.290; 14.528) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	464.209 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.744 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	5.705 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	262.187	0.16866	33.732	0.957	0.074	-0.074
2	0.000	-77.000	28.366	215.327	0.76406	152.811	4.335	0.334	0.000
3	77.000	-77.000	28.366	168.468	1.35946	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	139.988	1.72132	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	93.128	2.31672	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.268	2.91212	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	201.087	0.94499	188.998	5.361	0.000	-0.413
8	77.000	0.000	28.366	107.368	2.13579	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							40.438	-0.510	0.431

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	464.209	-6.744	5.705	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.438	-0.510	0.431	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**504.647**	**-7.254**	**6.136**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	158.289 kN	From analysis results
M_2	13.028 kN·m	From analysis results
M_3	-7.680 kN·m	From analysis results
M_{2s}	16.330 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.252 kN·m	Including second-order magnification and accidental eccentricity

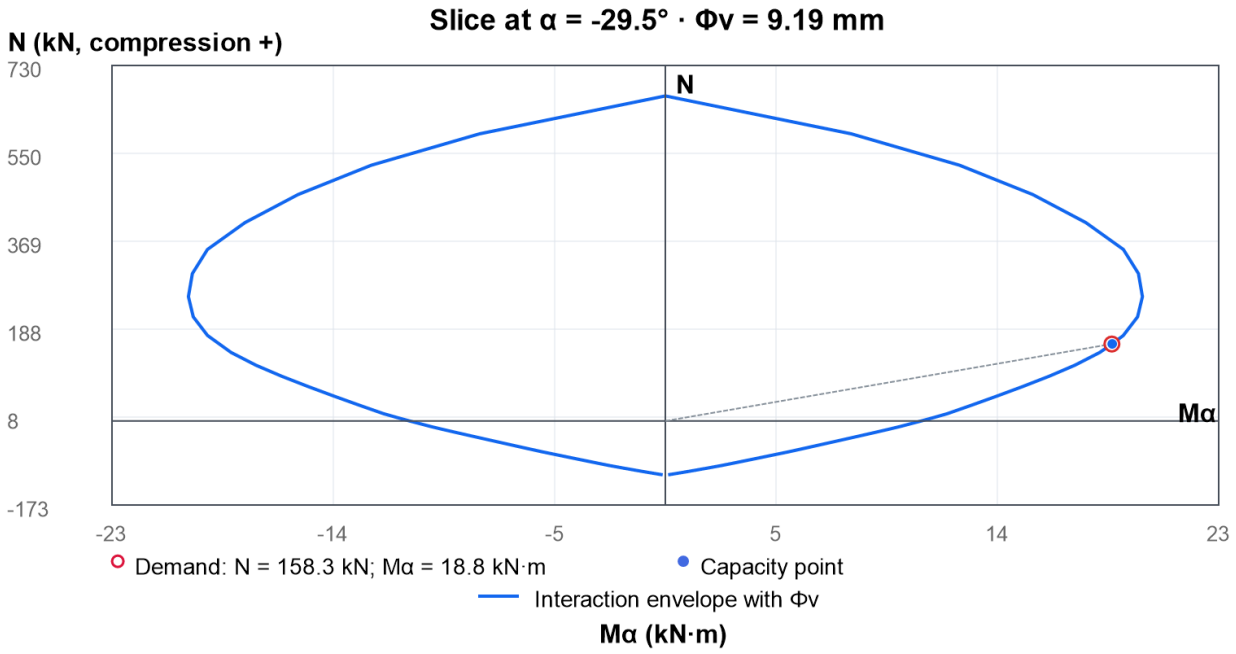
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	82.31	48.52	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.37	0.22	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.11125	0.14408	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,361,222	2,361,222	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	927,828,531,191	1,104,049,335,962	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	782.92	931.61	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2534	1.2047	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

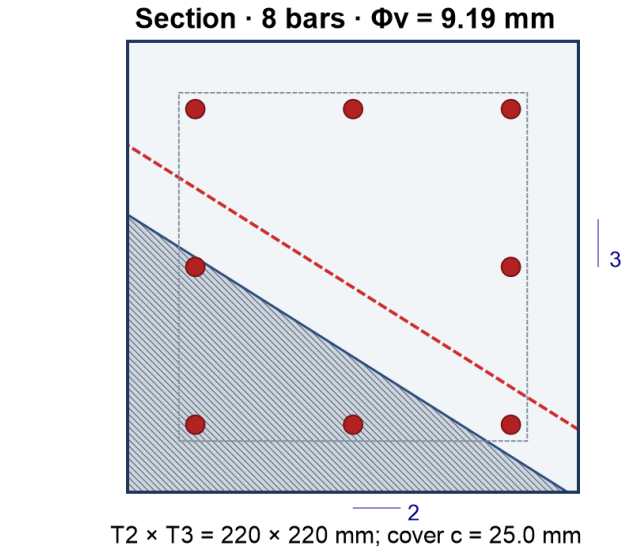
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 114.58 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	531.00 mm^2	Calculation results
Φ_v	9.1930 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	237.7599°	Geometry at the check point
Normal vector n	(-0.533468; -0.845820)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	114.5838 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.533468 \cdot x_2 - 0.845820 \cdot x_3 = 37.1379$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.533468 \cdot x_2 - 0.845820 \cdot x_3 = 8.4919$ mm	Geometry at the check point
Compressed concrete area A_b	14,548.905 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-38.403; -64.843) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	167.312 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	10.849 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.425 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.1930 mm / 66.375 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	66.375	45.517	2.38775	210.000	13.939	1.073	-1.073
2	0.000	-77.000	66.375	86.594	1.38398	210.000	13.939	1.073	0.000
3	77.000	-77.000	66.375	127.671	0.38021	76.042	5.047	0.389	0.389
4	-77.000	77.000	66.375	175.773	-0.79523	-159.046	-10.557	0.813	0.813
5	0.000	77.000	66.375	216.850	-1.79900	-210.000	-13.939	1.073	0.000
6	77.000	77.000	66.375	257.927	-2.80277	-210.000	-13.939	1.073	-1.073
7	-77.000	0.000	66.375	110.645	0.79626	159.252	10.570	0.000	-0.814
8	77.000	0.000	66.375	192.799	-1.21128	-210.000	-13.939	0.000	-1.073
Σ N_{si}, M_{xsi}, M_{ysi}							-8.878	5.495	-2.832

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	167.312	10.849	-6.425	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-8.878	5.495	-2.832	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**158.435**	**16.344**	**-9.258**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	224.913 kN	From analysis results
M_2	6.468 kN·m	From analysis results
M_3	9.554 kN·m	From analysis results
M_{2s}	8.709 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	13.237 kN·m	Including second-order magnification and accidental eccentricity

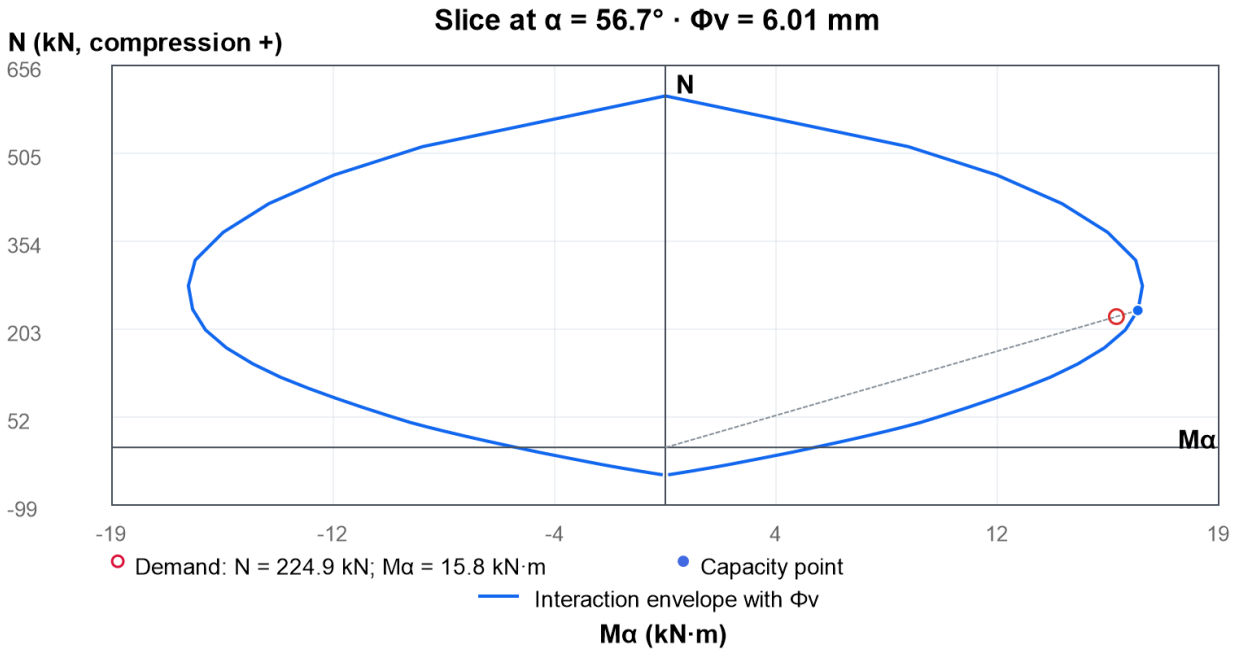
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	28.76	42.48	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.19	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.15211	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	957,834,593,647	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	808.24	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3464	1.3856	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

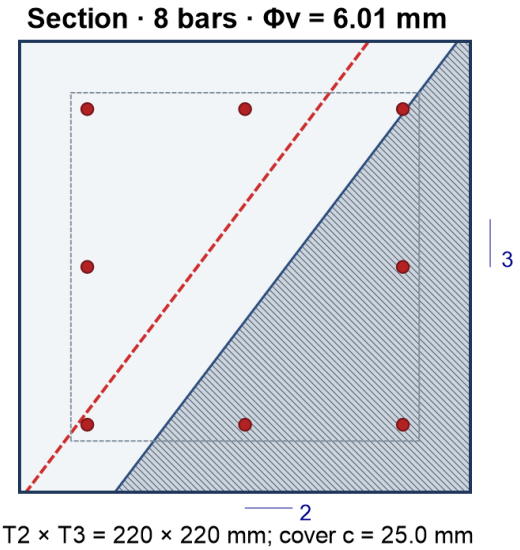
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 138.17 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9547	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	322.7534°	Geometry at the check point
Normal vector n	(0.796038; -0.605247)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	138.1701 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.796038 \cdot x_2 - 0.605247 \cdot x_3 = 15.9712$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.796038 \cdot x_2 - 0.605247 \cdot x_3 = -18.5713$ mm	Geometry at the check point
Compressed concrete area A_b	19,786.051 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(52.069; -34.098) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	227.540 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.759 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.848 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	168.832	0.07864	15.727	0.446	0.034	-0.034
2	0.000	-77.000	28.366	107.537	1.32077	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.242	2.56290	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	262.040	-1.81021	-210.000	-5.957	0.459	0.459
5	0.000	77.000	28.366	200.745	-0.56808	-113.616	-3.223	0.248	0.000
6	77.000	77.000	28.366	139.450	0.67405	134.811	3.824	-0.294	0.294
7	-77.000	0.000	28.366	215.436	-0.86579	-173.158	-4.912	0.000	0.378
8	77.000	0.000	28.366	92.846	1.61848	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							8.049	1.364	2.014

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	227.540	7.759	11.848	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	8.049	1.364	2.014	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**235.589**	**9.123**	**13.862**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	226.864 kN	From analysis results
M_2	0.841 kN·m	From analysis results
M_3	1.274 kN·m	From analysis results
M_{2s}	3.064 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	3.064 kN·m	Including second-order magnification and accidental eccentricity

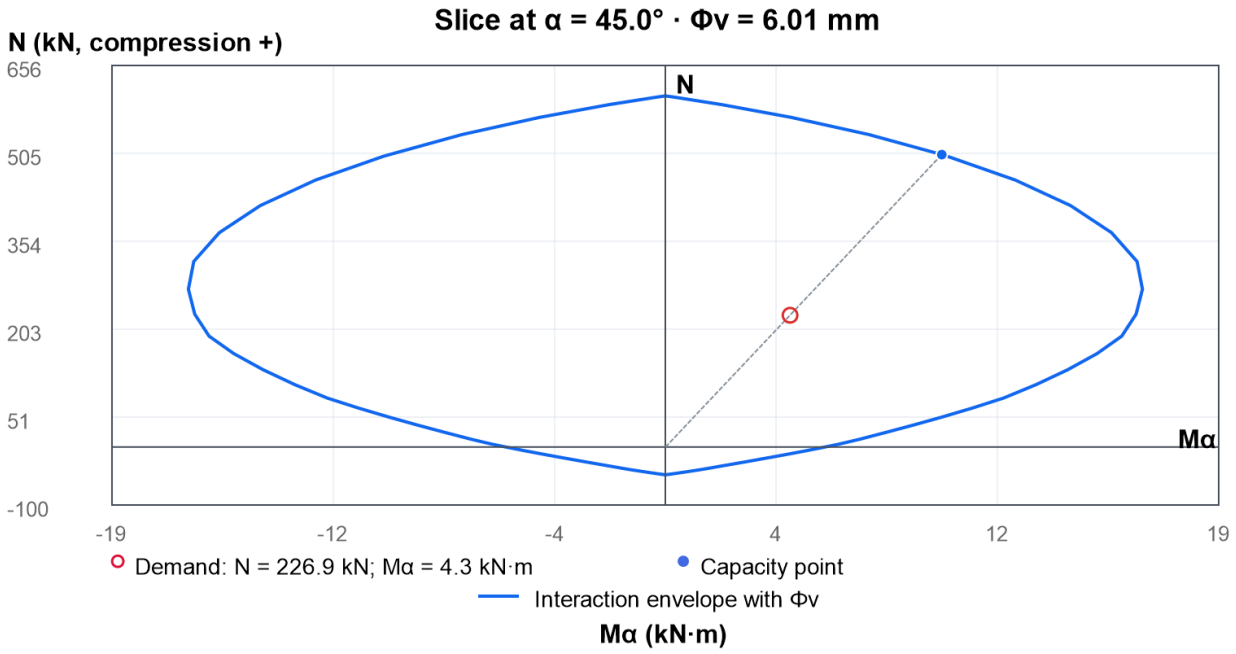
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3505	1.3505	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

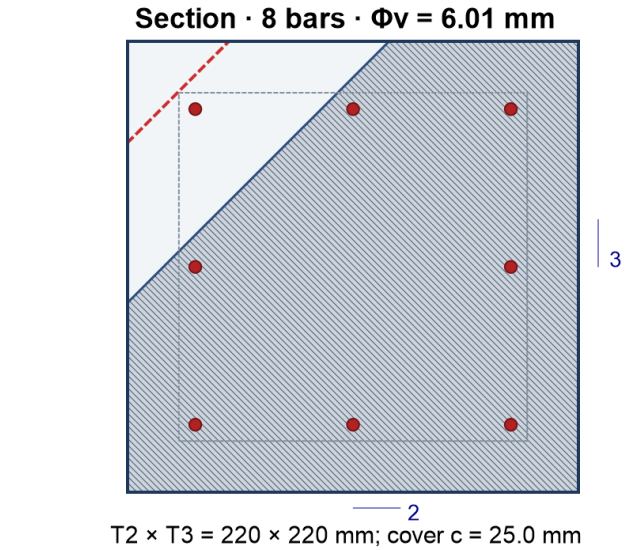
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 220.99 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4507	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	314.9702°	Geometry at the check point
Normal vector n	(0.706739; -0.707474)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	220.9918 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.706739 \cdot x_2 - 0.707474 \cdot x_3 = -65.4283$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.706739 \cdot x_2 - 0.707474 \cdot x_3 = -120.6762$ mm	Geometry at the check point
Compressed concrete area A_b	40,275.645 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(13.614; -13.622) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	463.170 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.310 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.305 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.507	1.52970	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.088	2.21920	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.90870	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	0.14928	29.855	0.847	-0.065	-0.065
5	0.000	77.000	28.366	210.039	0.83877	167.755	4.759	-0.366	0.000
6	77.000	77.000	28.366	155.620	1.52827	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	209.982	0.83949	167.898	4.763	0.000	-0.367
8	77.000	0.000	28.366	101.145	2.21848	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							40.153	0.486	0.485

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	463.170	6.310	6.305	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.153	0.486	0.485	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**503.323**	**6.795**	**6.791**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	229.466 kN	From analysis results
M_2	-6.661 kN·m	From analysis results
M_3	-9.764 kN·m	From analysis results
M_{2s}	-9.031 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-13.639 kN·m	Including second-order magnification and accidental eccentricity

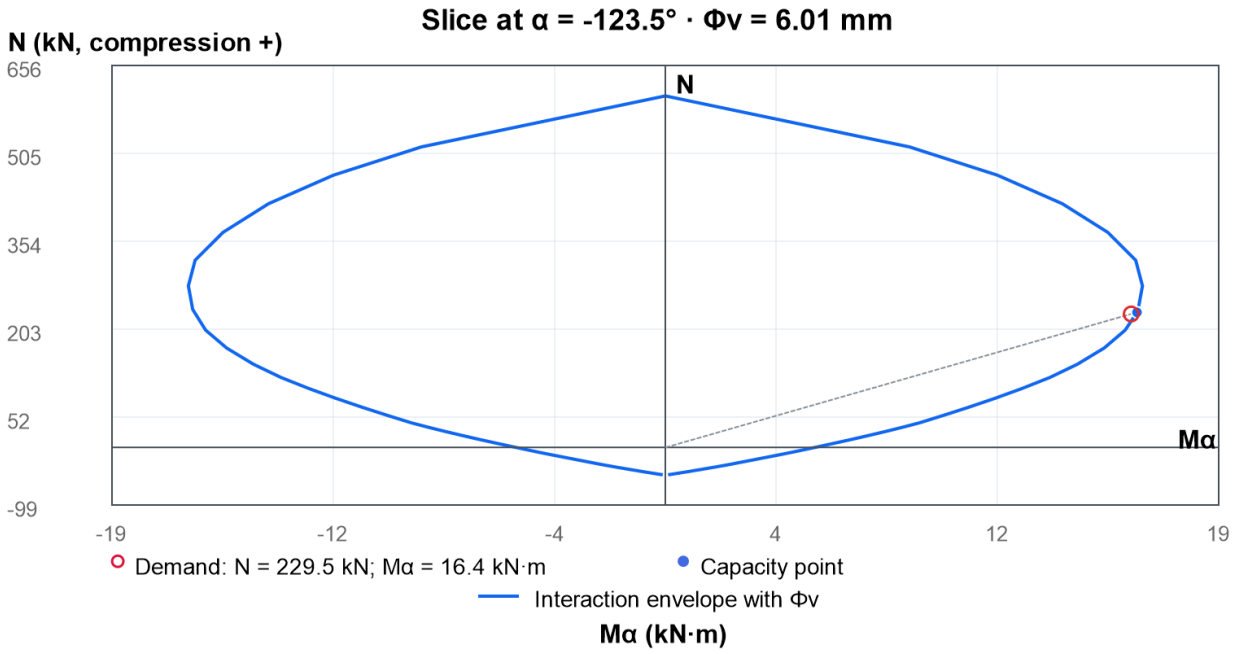
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	29.03	42.55	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.19	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.15200	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	957,264,086,104	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	807.75	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3559	1.3968	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

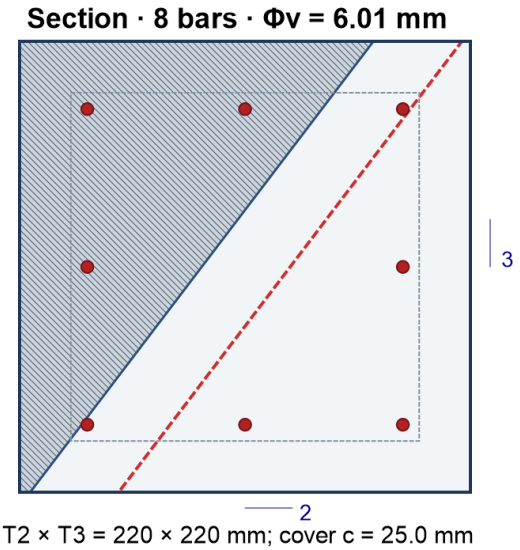
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 137.34 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9876	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	142.7146°	Geometry at the check point
Normal vector n	(-0.795628; 0.605786)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	137.3372 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.795628 \cdot x_2 + 0.605786 \cdot x_3 = 16.8183$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.795628 \cdot x_2 + 0.605786 \cdot x_3 = -17.5160$ mm	Geometry at the check point
Compressed concrete area A_b	19,549.553 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-52.413; 34.559) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	224.820 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.770 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.783 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	139.538	0.65514	131.027	3.717	0.286	-0.286
2	0.000	-77.000	28.366	200.801	-0.59389	-118.777	-3.369	-0.259	0.000
3	77.000	-77.000	28.366	262.064	-1.84291	-210.000	-5.957	-0.459	-0.459
4	-77.000	77.000	28.366	46.247	2.55713	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	107.510	1.30811	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	168.773	0.05909	11.818	0.335	-0.026	0.026
7	-77.000	0.000	28.366	92.892	1.60614	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	215.419	-0.89191	-178.382	-5.060	0.000	-0.390
ΣN_{si}, M_{xsi}, M_{ysi}							7.537	-1.375	-2.026

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	224.820	-7.770	-11.783	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	7.537	-1.375	-2.026	ΣN_{si}; ΣM_{si}
Total concrete and reinforcement	**232.356**	**-9.145**	**-13.809**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	178.544 kN	From analysis results
M_2	1.821 kN·m	From analysis results
M_3	8.990 kN·m	From analysis results
M_{2s}	2.288 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.743 kN·m	Including second-order magnification and accidental eccentricity

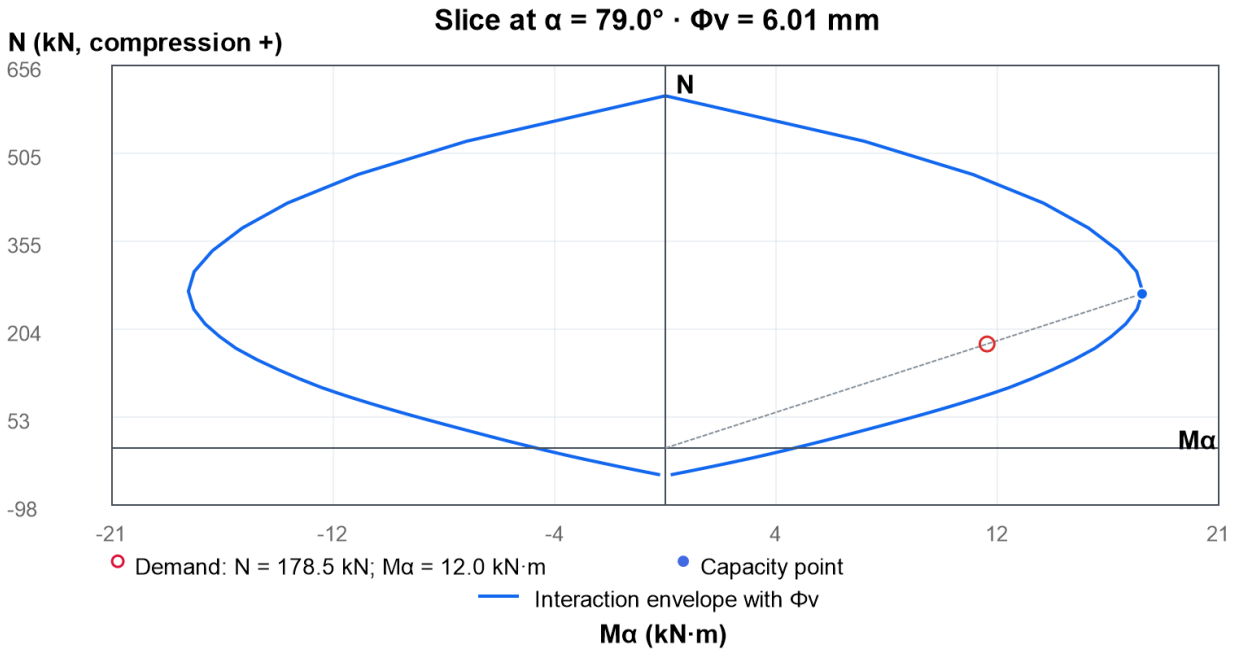
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.20	50.35	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.23	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.14181	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	902,576,771,160	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	761.61	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.2567	1.3062	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

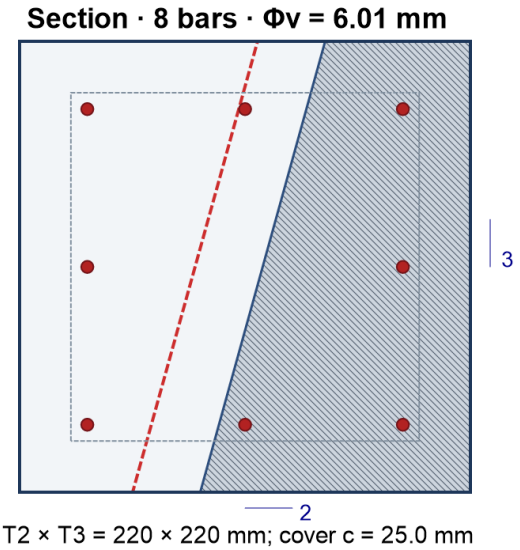
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 127.11 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.6746	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	344.5132°	Geometry at the check point
Normal vector n	(0.963692; -0.267017)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	127.1124 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.963692 \cdot x_2 - 0.267017 \cdot x_3 = 8.2656$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.963692 \cdot x_2 - 0.267017 \cdot x_3 = -23.5125$ mm	Geometry at the check point
Compressed concrete area A_b	22,313.051 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(57.762; -11.019) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	256.600 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	2.827 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	14.822 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	189.022	-0.66373	-132.746	-3.766	-0.290	0.290
2	0.000	-77.000	28.366	114.818	0.97082	194.165	5.508	0.424	0.000
3	77.000	-77.000	28.366	40.613	2.60538	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	230.143	-1.56952	-210.000	-5.957	0.459	0.459
5	0.000	77.000	28.366	155.938	0.06503	13.006	0.369	-0.028	0.000
6	77.000	77.000	28.366	81.734	1.69958	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	209.582	-1.11663	-210.000	-5.957	0.000	0.459
8	77.000	0.000	28.366	61.174	2.15248	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							8.068	0.564	2.583

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	256.600	2.827	14.822	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	8.068	0.564	2.583	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**264.668**	**3.392**	**17.405**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	180.495 kN	From analysis results
M_2	0.259 kN·m	From analysis results
M_3	1.104 kN·m	From analysis results
M_{2s}	2.275 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	2.275 kN·m	Including second-order magnification and accidental eccentricity

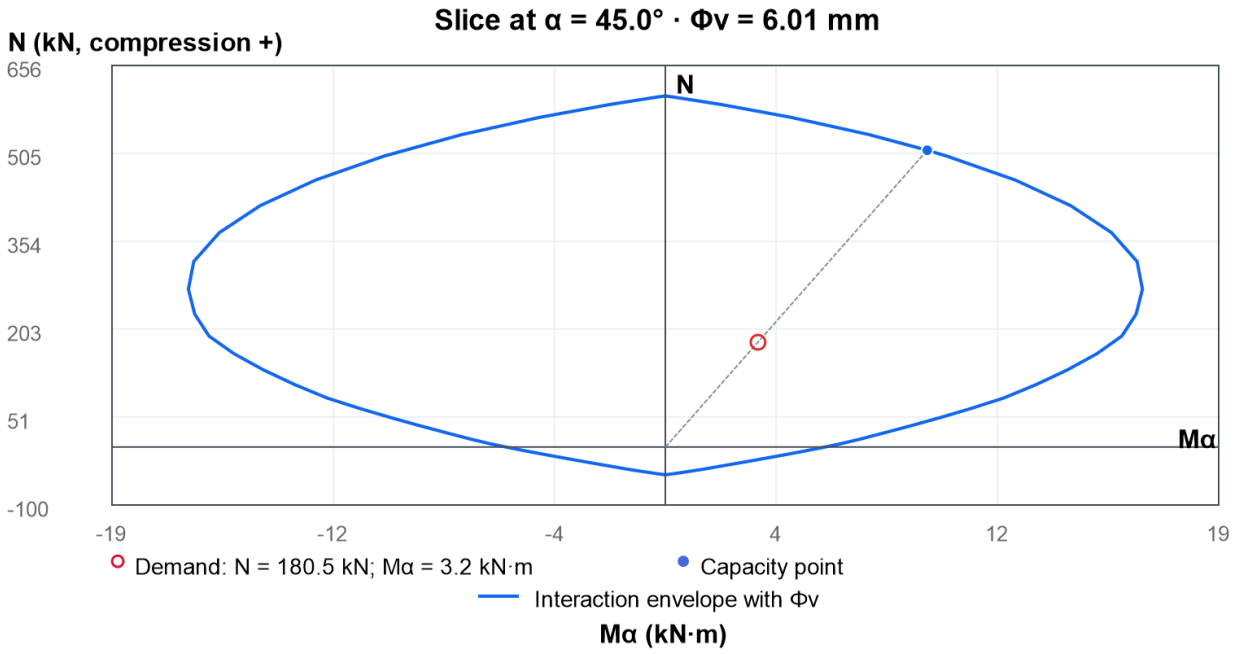
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2602	1.2602	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

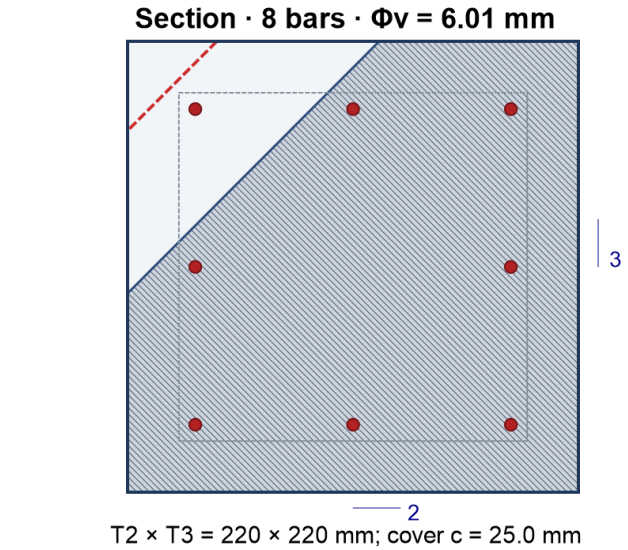
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 224.30 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.3534	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	315.0374°	Geometry at the check point
Normal vector n	(0.707568; -0.706645)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	224.3027 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.707568 \cdot x_2 - 0.706645 \cdot x_3 = -68.7392$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.707568 \cdot x_2 - 0.706645 \cdot x_3 = -124.8149$ mm	Geometry at the check point
Compressed concrete area A_b	40,861.549 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(12.748; -12.738) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	469.908 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.986 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	5.990 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.635	1.55719	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.152	2.23731	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.669	2.91742	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.458	0.19874	39.748	1.127	-0.087	-0.087
5	0.000	77.000	28.366	209.975	0.87885	175.771	4.986	-0.384	0.000
6	77.000	77.000	28.366	155.492	1.55897	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	210.046	0.87797	175.593	4.981	0.000	-0.384
8	77.000	0.000	28.366	101.081	2.23820	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							40.879	0.447	0.447

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	469.908	5.986	5.990	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.879	0.447	0.447	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**510.787**	**6.432**	**6.437**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	183.096 kN	From analysis results
M_2	-1.824 kN·m	From analysis results
M_3	-9.411 kN·m	From analysis results
M_{2s}	-2.316 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-12.420 kN·m	Including second-order magnification and accidental eccentricity

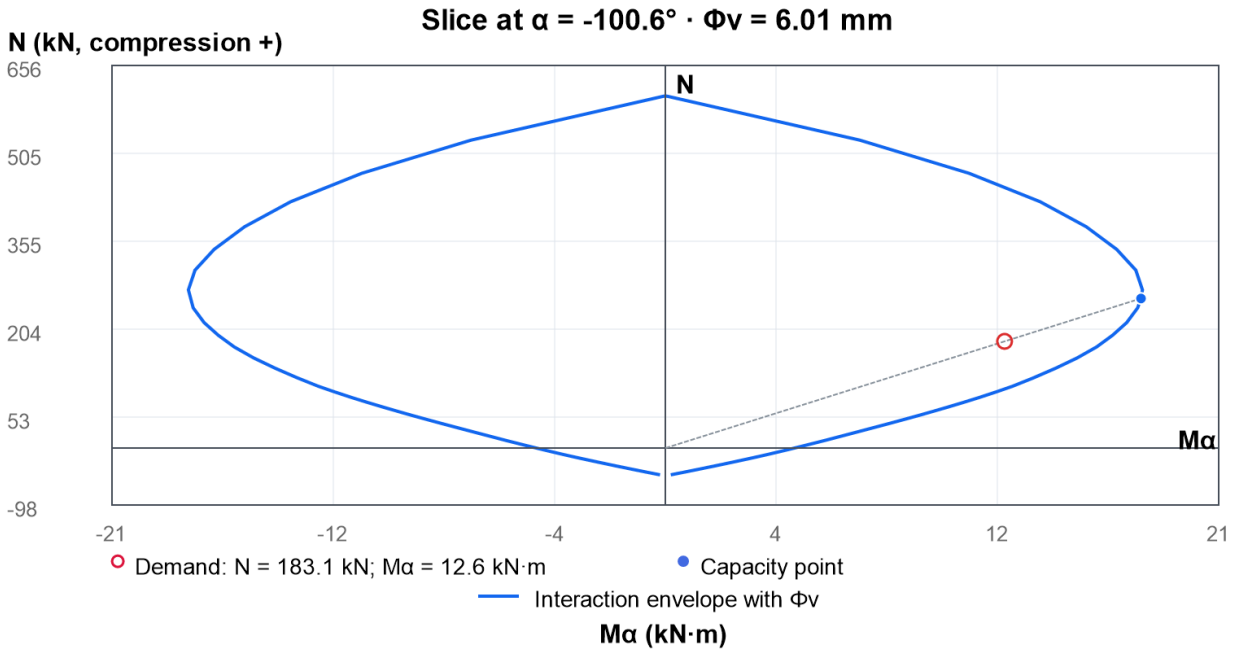
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	51.40	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.23	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.14054	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	895,769,151,733	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	755.86	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2649	1.3197	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

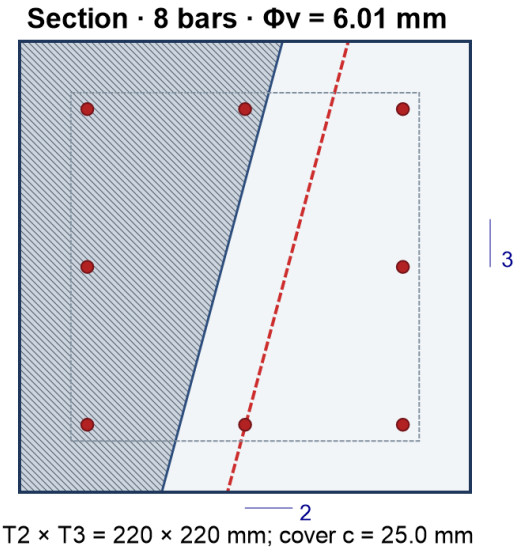
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 123.92 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7132	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	165.0021°	Geometry at the check point
Normal vector n	(-0.965935; 0.258784)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	123.9152 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.965935 \cdot x_2 + 0.258784 \cdot x_3 = 10.8039$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.965935 \cdot x_2 + 0.258784 \cdot x_3 = -20.1750$ mm	Geometry at the check point
Compressed concrete area A_b	21,739.328 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-59.128; 10.935) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	250.002 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-2.734 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-14.782 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	80.268	1.68625	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	154.645	0.00562	1.123	0.032	0.002	0.000
3	77.000	-77.000	28.366	229.022	-1.67501	-210.000	-5.957	-0.459	-0.459
4	-77.000	77.000	28.366	40.416	2.58676	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	114.793	0.90613	181.227	5.141	-0.396	0.000
6	77.000	77.000	28.366	189.170	-0.77450	-154.899	-4.394	0.338	-0.338
7	-77.000	0.000	28.366	60.342	2.13650	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	209.096	-1.22475	-210.000	-5.957	0.000	-0.459
Σ N_{si}, M_{xsi}, M_{ysi}							6.736	-0.514	-2.632

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	250.002	-2.734	-14.782	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	6.736	-0.514	-2.632	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**256.738**	**-3.248**	**-17.414**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	146.807 kN	From analysis results
M_2	-4.421 kN·m	From analysis results
M_3	9.110 kN·m	From analysis results
M_{2s}	-5.313 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.515 kN·m	Including second-order magnification and accidental eccentricity

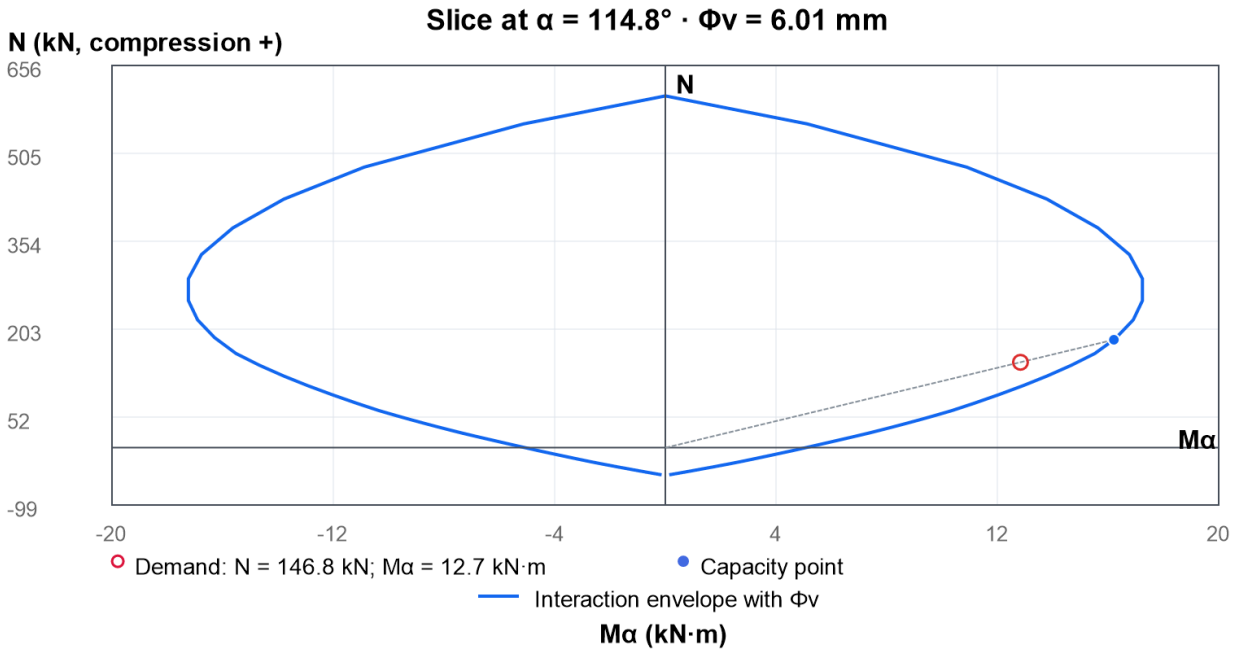
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	30.11	62.05	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.28	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.12885	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	832,999,682,296	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	702.90	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.2018	1.2640	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

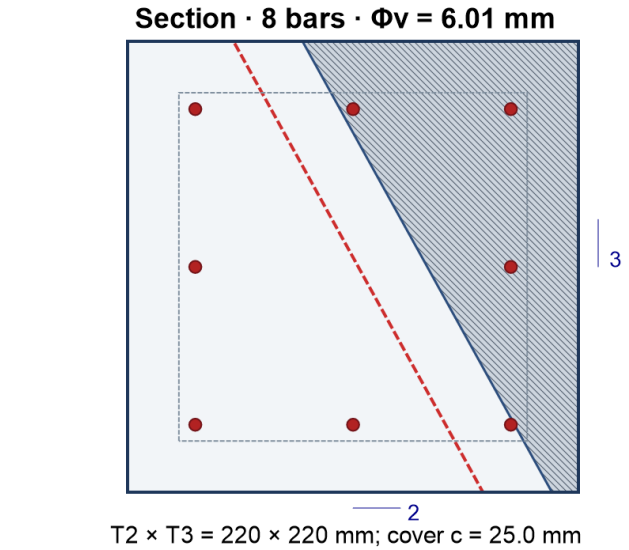
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 117.81 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7915	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	28.9520°	Geometry at the check point
Normal vector n	(0.875026; 0.484077)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	117.8145 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.875026 \cdot x_2 + 0.484077 \cdot x_3 = 31.6867$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.875026 \cdot x_2 + 0.484077 \cdot x_3 = 2.2331$ mm	Geometry at the check point
Compressed concrete area A_b	16,233.291 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(64.742; 30.239) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	186.683 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.645 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	12.086 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	254.152	-2.54022	-210.000	-5.957	-0.459	0.459
2	0.000	-77.000	28.366	186.775	-0.93893	-187.786	-5.327	-0.410	0.000
3	77.000	-77.000	28.366	119.398	0.66236	132.473	3.758	0.289	0.289
4	-77.000	77.000	28.366	179.604	-0.76851	-153.701	-4.360	0.336	0.336
5	0.000	77.000	28.366	112.227	0.83279	166.557	4.725	-0.364	0.000
6	77.000	77.000	28.366	44.850	2.43408	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	216.878	-1.65436	-210.000	-5.957	0.000	0.459
8	77.000	0.000	28.366	82.124	1.54822	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							-1.204	-1.066	2.460

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	186.683	-5.645	12.086	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-1.204	-1.066	2.460	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**185.478**	**-6.711**	**14.546**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	148.758 kN	From analysis results
M_2	-0.298 kN·m	From analysis results
M_3	1.106 kN·m	From analysis results
M_{2s}	-1.793 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.793 kN·m	Including second-order magnification and accidental eccentricity

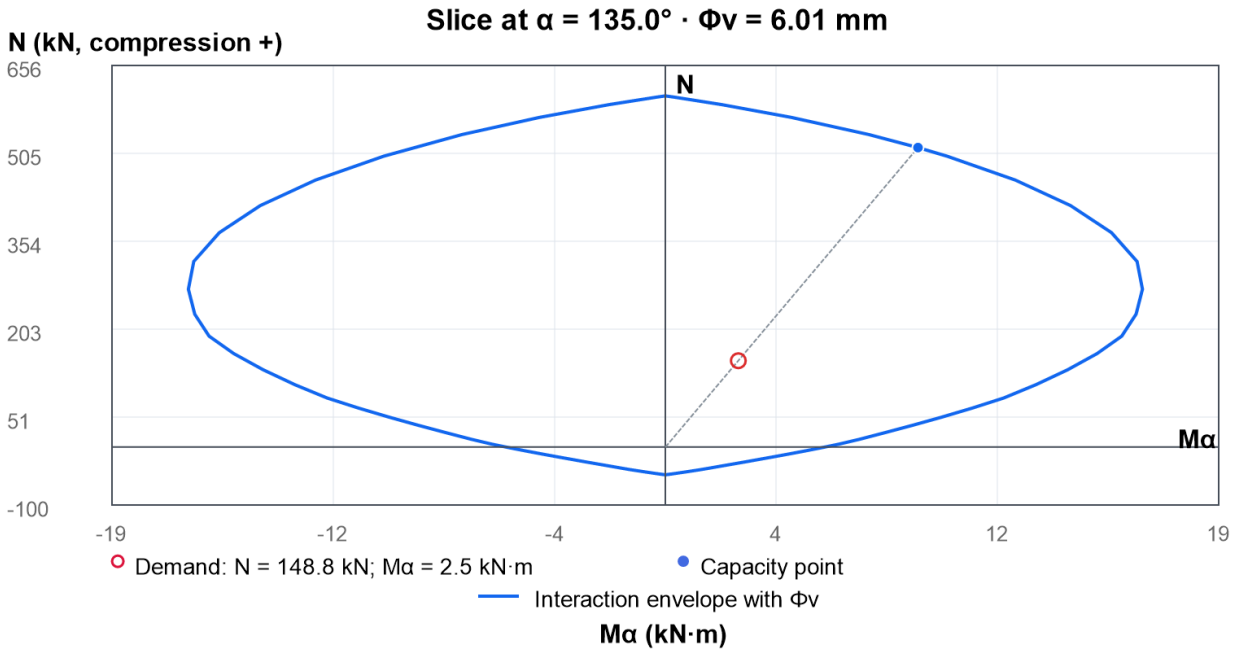
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2051	1.2051	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

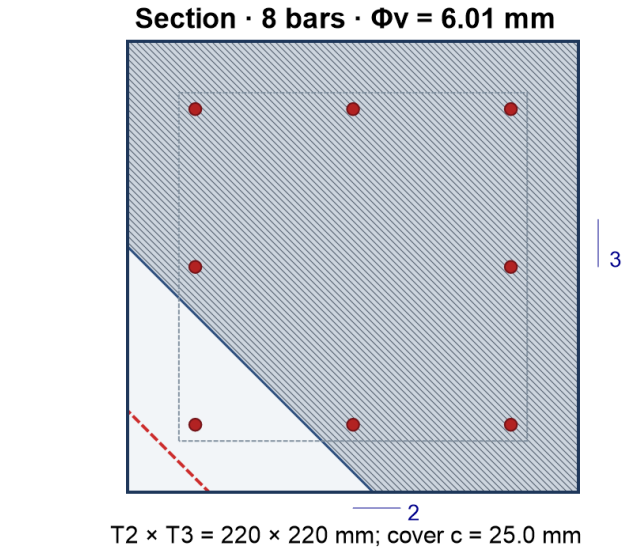
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 226.39 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.2887	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	45.0139°	Geometry at the check point
Normal vector n	(0.706935; 0.707279)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	226.3878 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.706935 \cdot x_2 + 0.707279 \cdot x_3 = -70.8243$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.706935 \cdot x_2 + 0.707279 \cdot x_3 = -127.4213$ mm	Geometry at the check point
Compressed concrete area A_b	41,219.271 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(12.202; 12.206) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	474.022 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.786 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	5.784 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	264.458	0.22914	45.829	1.300	0.100	-0.100
2	0.000	-77.000	28.366	210.024	0.90239	180.478	5.120	0.394	0.000
3	77.000	-77.000	28.366	155.590	1.57564	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.537	1.57629	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.103	2.24954	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.669	2.92279	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	209.997	0.90272	180.544	5.121	0.000	-0.394
8	77.000	0.000	28.366	101.130	2.24921	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							41.326	-0.423	0.423

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	474.022	-5.786	5.784	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	41.326	-0.423	0.423	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**515.347**	**-6.209**	**6.207**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	151.359 kN	From analysis results
M_2	5.199 kN·m	From analysis results
M_3	-9.565 kN·m	From analysis results
M_{2s}	6.303 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-12.215 kN·m	Including second-order magnification and accidental eccentricity

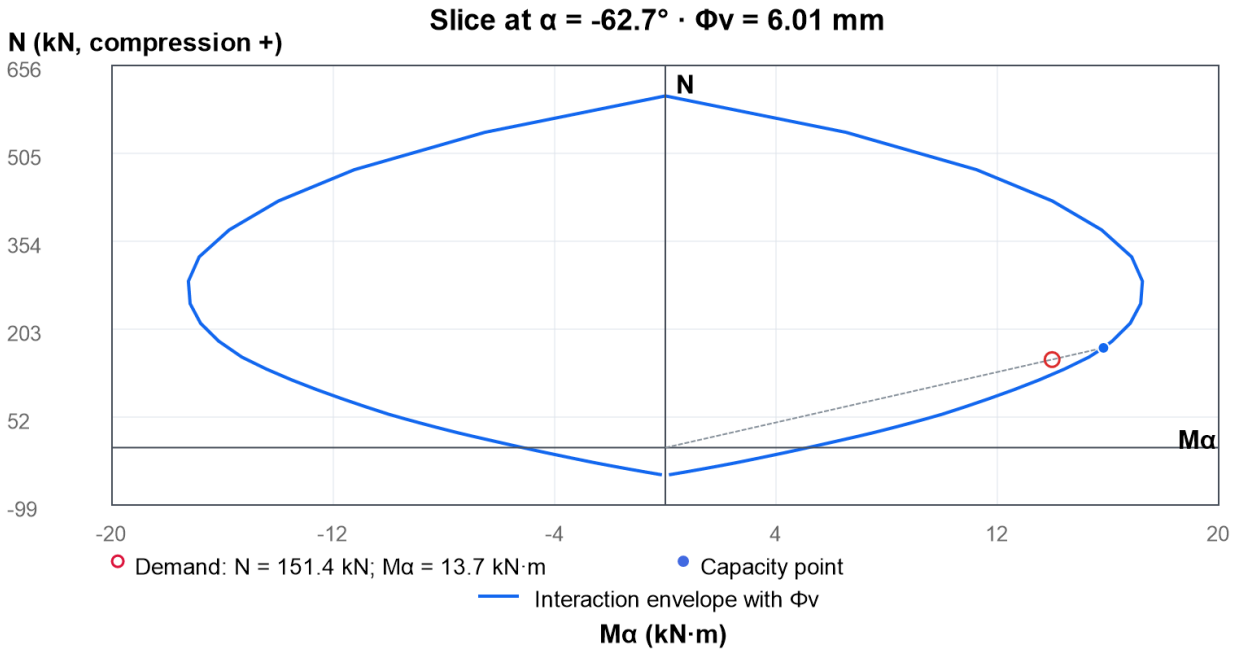
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	34.35	63.20	8.1.2.2.4; $e_0 = \max(\lvert M\rvert/N; e_a)$
δ_e	0.16	0.29	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16443	0.12771	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,023,991,286,222	826,882,593,780	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	864.06	697.74	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2124	1.2770	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

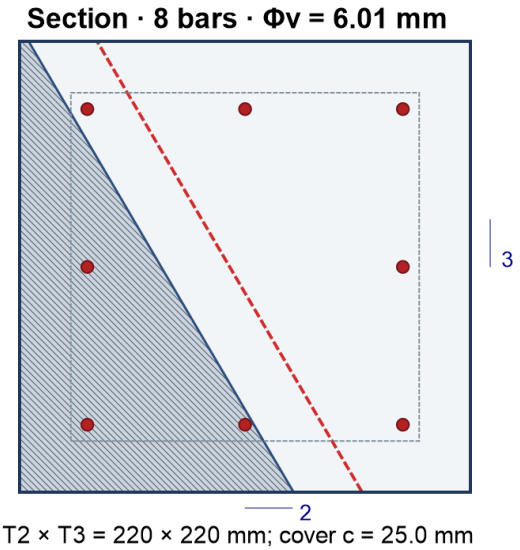
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 115.28 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.8827	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	210.4517°	Geometry at the check point
Normal vector n	(-0.862057; -0.506811)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	115.2835 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.862057 \cdot x_2 - 0.506811 \cdot x_3 = 35.2921$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.862057 \cdot x_2 - 0.506811 \cdot x_3 = 6.4712$ mm	Geometry at the check point
Compressed concrete area A_b	15,193.343 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-65.377; -34.336) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	174.723 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.999 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.423 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	45.173	2.40285	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	111.551	0.79065	158.131	4.486	0.345	0.000
3	77.000	-77.000	28.366	177.929	-0.82154	-164.309	-4.661	-0.359	-0.359
4	-77.000	77.000	28.366	123.222	0.50720	101.440	2.877	-0.222	-0.222
5	0.000	77.000	28.366	189.600	-1.10500	-210.000	-5.957	0.459	0.000
6	77.000	77.000	28.366	255.978	-2.71719	-210.000	-5.957	0.459	-0.459
7	-77.000	0.000	28.366	84.197	1.45502	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	216.954	-1.76937	-210.000	-5.957	0.000	-0.459
Σ N_{si}, M_{xsi}, M_{ysi}							-3.255	1.141	-2.415

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	174.723	5.999	-11.423	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-3.255	1.141	-2.415	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**171.469**	**7.140**	**-13.838**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	82.355 kN	From analysis results
M_2	9.183 kN·m	From analysis results
M_3	8.833 kN·m	From analysis results
M_{2s}	10.510 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.087 kN·m	Including second-order magnification and accidental eccentricity

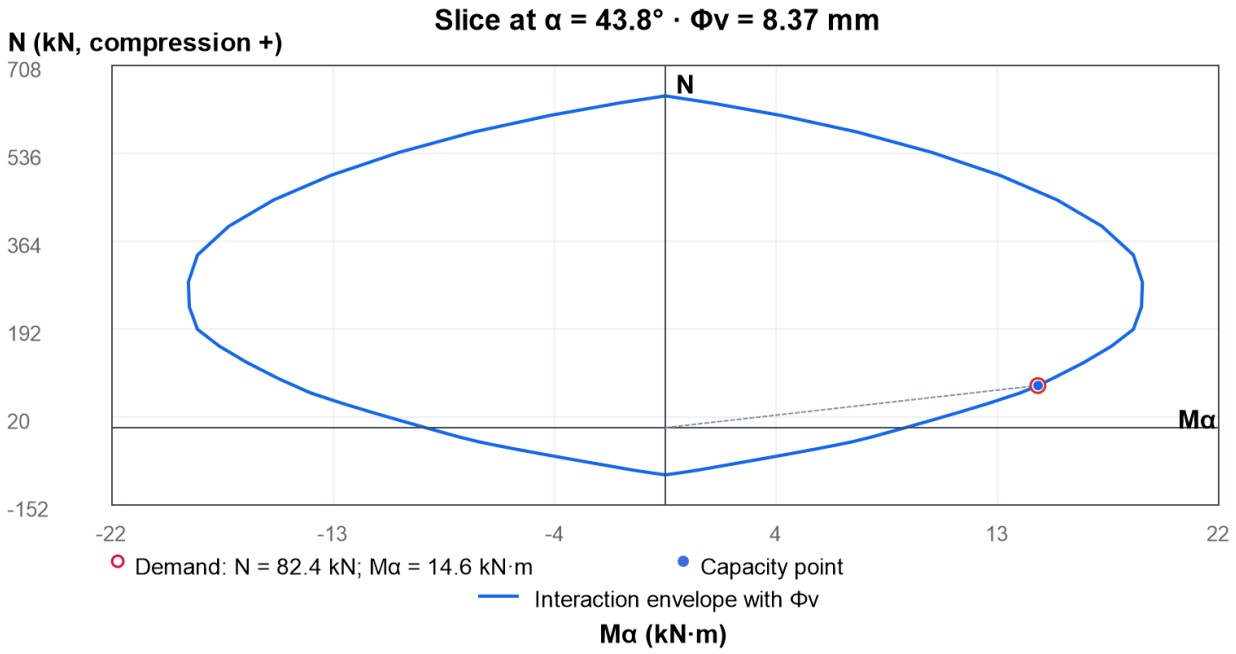
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	111.50	107.26	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.51	0.49	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.09296	0.09523	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,957,074	1,957,074	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	773,009,021,554	785,233,166,190	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	652.28	662.59	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.1445	1.1419	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

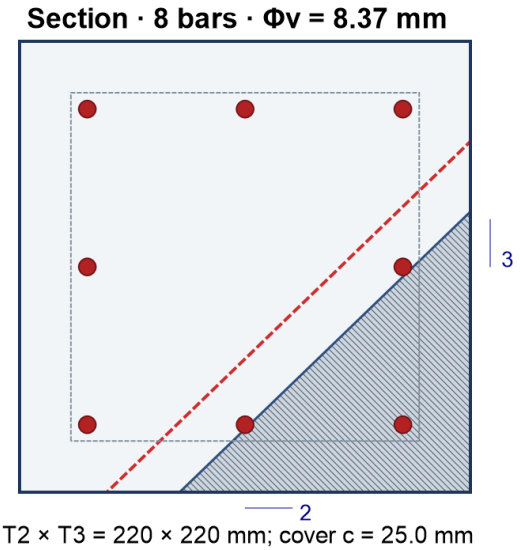
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 98.59 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	440.11 mm^2	Calculation results
Φ_v	8.3694 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	313.9690°	Geometry at the check point
Normal vector n	(0.694269; -0.719715)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	98.5925 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.694269 \cdot x_2 - 0.719715 \cdot x_3 = 56.9458$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.694269 \cdot x_2 - 0.719715 \cdot x_3 = 32.2977$ mm	Geometry at the check point
Compressed concrete area A_b	9,726.783 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(62.664; -64.337) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	111.858 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.197 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.009 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.3694 mm / 55.014 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	55.014	153.579	-0.86160	-172.320	-9.480	-0.730	0.730
2	0.000	-77.000	55.014	100.120	0.65661	131.323	7.225	0.556	0.000
3	77.000	-77.000	55.014	46.661	2.17483	210.000	11.553	0.890	0.890
4	-77.000	77.000	55.014	264.415	-4.00932	-210.000	-11.553	0.890	0.890
5	0.000	77.000	55.014	210.956	-2.49110	-210.000	-11.553	0.890	0.000
6	77.000	77.000	55.014	157.498	-0.97289	-194.578	-10.705	0.824	-0.824
7	-77.000	0.000	55.014	208.997	-2.43546	-210.000	-11.553	0.000	0.890
8	77.000	0.000	55.014	102.080	0.60097	120.194	6.612	0.000	0.509
Σ N_{si}, M_{xsi}, M_{ysi}							-29.454	3.319	3.084

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	111.858	7.197	7.009	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-29.454	3.319	3.084	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**82.404**	**10.516**	**10.093**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	84.306 kN	From analysis results
M_2	1.121 kN·m	From analysis results
M_3	1.562 kN·m	From analysis results
M_{2s}	1.241 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.729 kN·m	Including second-order magnification and accidental eccentricity

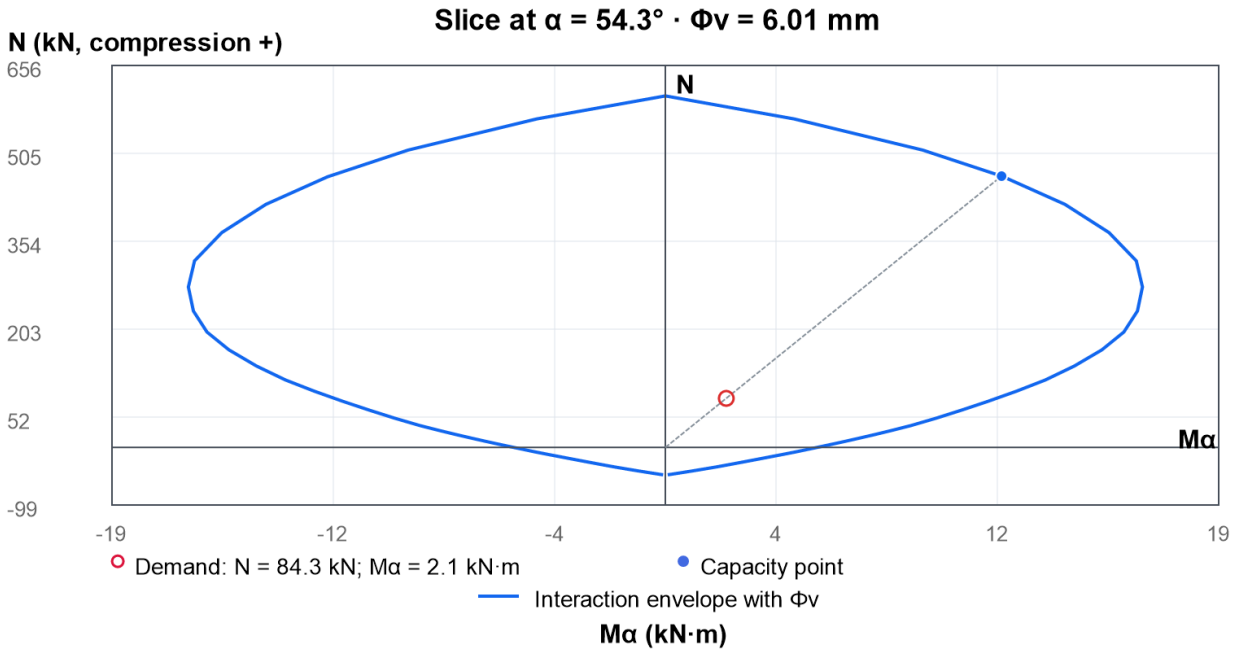
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	13.30	18.53	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1067	1.1067	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

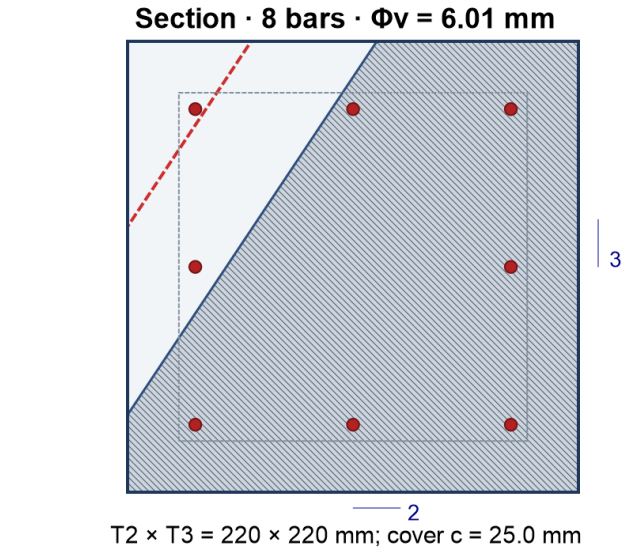
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.01 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1808	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	326.2760°	Geometry at the check point
Normal vector n	(0.831722; -0.555192)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	204.0107 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.831722 \cdot x_2 - 0.555192 \cdot x_3 = -51.4501$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.831722 \cdot x_2 - 0.555192 \cdot x_3 = -102.4528$ mm	Geometry at the check point
Compressed concrete area A_b	37,330.180 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(20.603; -14.618) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	429.297 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.275 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.845 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	173.853	1.11390	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	109.811	1.99287	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	45.768	2.87184	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	259.353	-0.05956	-11.912	-0.338	0.026	0.026
5	0.000	77.000	28.366	195.310	0.81941	163.882	4.649	-0.358	0.000
6	77.000	77.000	28.366	131.268	1.69838	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	216.603	0.52717	105.434	2.991	0.000	-0.230
8	77.000	0.000	28.366	88.518	2.28511	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							37.086	0.585	0.713

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	429.297	6.275	8.845	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.086	0.585	0.713	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**466.383**	**6.861**	**9.558**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C5 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	86.907 kN	From analysis results
M_2	-9.628 kN·m	From analysis results
M_3	-8.133 kN·m	From analysis results
M_{2s}	-11.129 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.305 kN·m	Including second-order magnification and accidental eccentricity

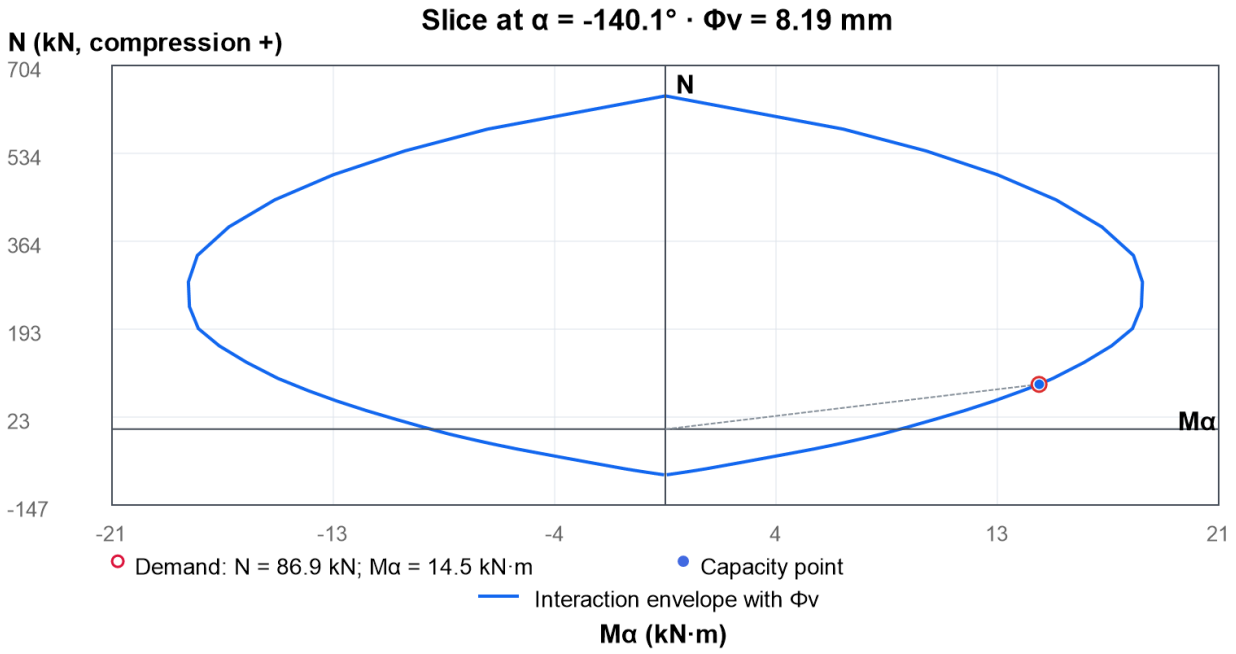
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	110.79	93.59	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.50	0.43	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.09333	0.10339	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,876,141	1,876,141	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	763,695,802,174	817,709,102,633	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	644.42	690.00	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1559	1.1441	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

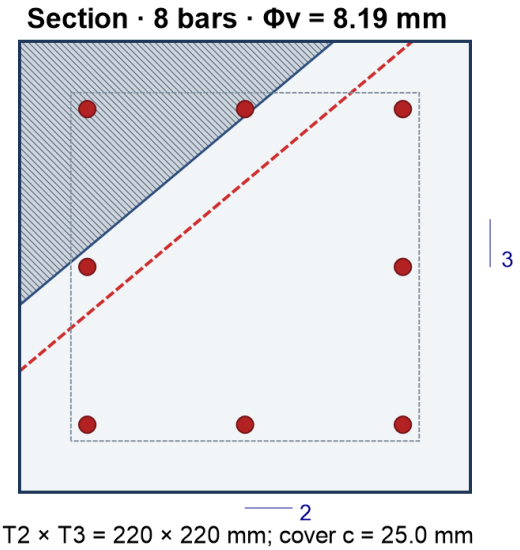
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 98.55 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	421.91 mm^2	Calculation results
Φ_v	8.1945 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	130.0088°	Geometry at the check point
Normal vector n	(-0.642905; 0.765946)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	98.5496 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.642905 \cdot x_2 + 0.765946 \cdot x_3 = 56.4240$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.642905 \cdot x_2 + 0.765946 \cdot x_3 = 31.7866$ mm	Geometry at the check point
Compressed concrete area A_b	9,861.313 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-58.904; 67.112) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	113.405 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.611 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.680 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.1945 mm / 52.739 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	52.739	164.448	-1.17230	-210.000	-11.075	-0.853	0.853
2	0.000	-77.000	52.739	213.951	-2.57881	-210.000	-11.075	-0.853	0.000
3	77.000	-77.000	52.739	263.455	-3.98531	-210.000	-11.075	-0.853	-0.853
4	-77.000	77.000	52.739	46.492	2.17906	210.000	11.075	-0.853	-0.853
5	0.000	77.000	52.739	95.996	0.77256	154.512	8.149	-0.627	0.000
6	77.000	77.000	52.739	145.500	-0.63394	-126.789	-6.687	0.515	-0.515
7	-77.000	0.000	52.739	105.470	0.50338	100.676	5.310	0.000	-0.409
8	77.000	0.000	52.739	204.477	-2.30963	-210.000	-11.075	0.000	-0.853
Σ N_{si}, M_{xsi}, M_{ysi}							-26.454	-3.524	-2.629

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	113.405	-7.611	-6.680	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-26.454	-3.524	-2.629	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**86.951**	**-11.135**	**-9.309**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	152.499 kN	From analysis results
M_2	-12.886 kN·m	From analysis results
M_3	-6.926 kN·m	From analysis results
M_{2s}	-16.165 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.291 kN·m	Including second-order magnification and accidental eccentricity

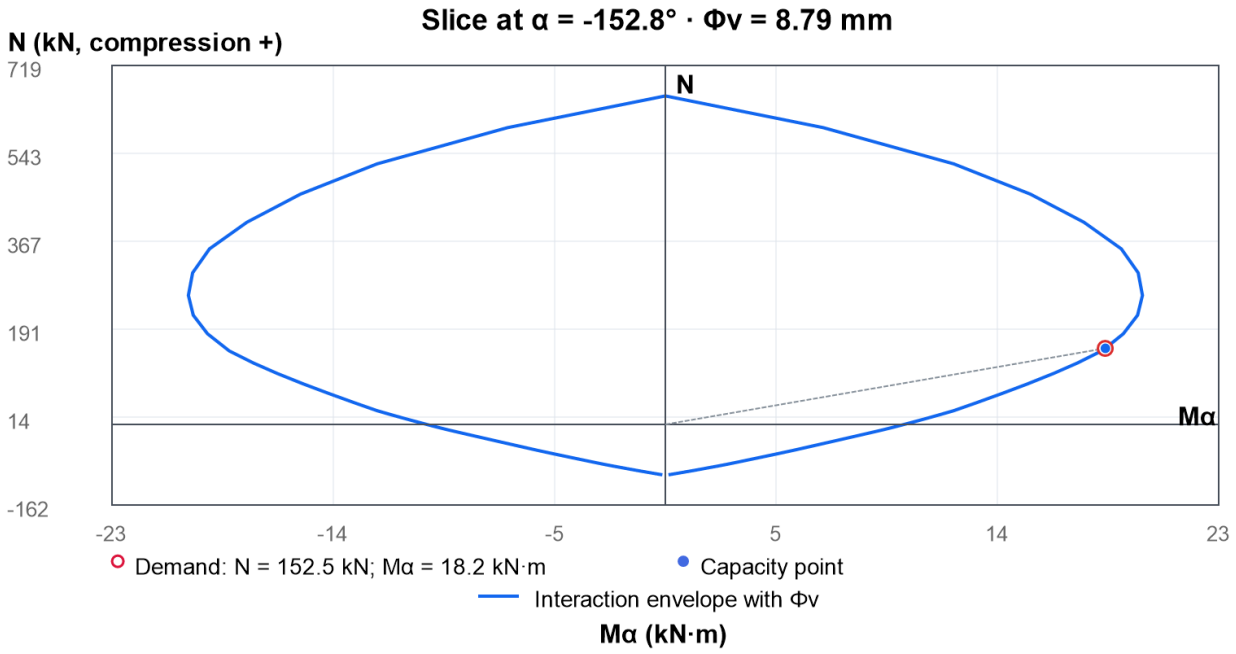
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	84.50	45.42	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.38	0.21	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.10963	0.14809	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,160,198	2,160,198	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	890,983,498,615	1,097,447,199,076	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	751.83	926.04	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.2544	1.1971	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

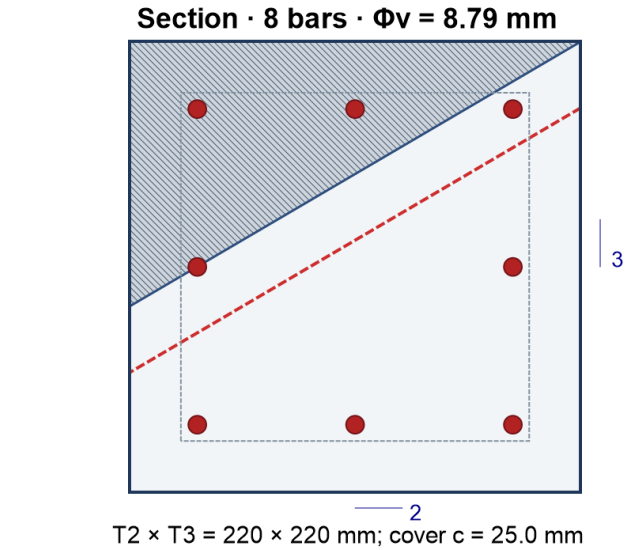
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 111.47 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	485.79 mm^2	Calculation results
Φ_v	8.7930 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	120.4003°	Geometry at the check point
Normal vector n	(-0.506039; 0.862511)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	111.4732 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.506039 \cdot x_2 + 0.862511 \cdot x_3 = 39.0672$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.506039 \cdot x_2 + 0.862511 \cdot x_3 = 11.1989$ mm	Geometry at the check point
Compressed concrete area A_b	14,235.150 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-36.572; 66.919) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	163.704 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-10.955 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.987 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.7930 mm / 60.724 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	60.724	177.989	-0.97075	-194.149	-11.790	-0.908	0.908
2	0.000	-77.000	60.724	216.954	-1.94948	-210.000	-12.752	-0.982	0.000
3	77.000	-77.000	60.724	255.919	-2.92820	-210.000	-12.752	-0.982	-0.982
4	-77.000	77.000	60.724	45.162	2.36561	210.000	12.752	-0.982	-0.982
5	0.000	77.000	60.724	84.127	1.38688	210.000	12.752	-0.982	0.000
6	77.000	77.000	60.724	123.092	0.40816	81.631	4.957	-0.382	0.382
7	-77.000	0.000	60.724	111.575	0.69743	139.486	8.470	0.000	-0.652
8	77.000	0.000	60.724	189.505	-1.26002	-210.000	-12.752	0.000	-0.982
Σ N_{si}, M_{xsi}, M_{ysi}							-11.114	-5.217	-2.308

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	163.704	-10.955	-5.987	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-11.114	-5.217	-2.308	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**152.590**	**-16.172**	**-8.295**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	154.449 kN	From analysis results
M_2	-1.826 kN·m	From analysis results
M_3	-0.880 kN·m	From analysis results
M_{2s}	-2.218 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.876 kN·m	Including second-order magnification and accidental eccentricity

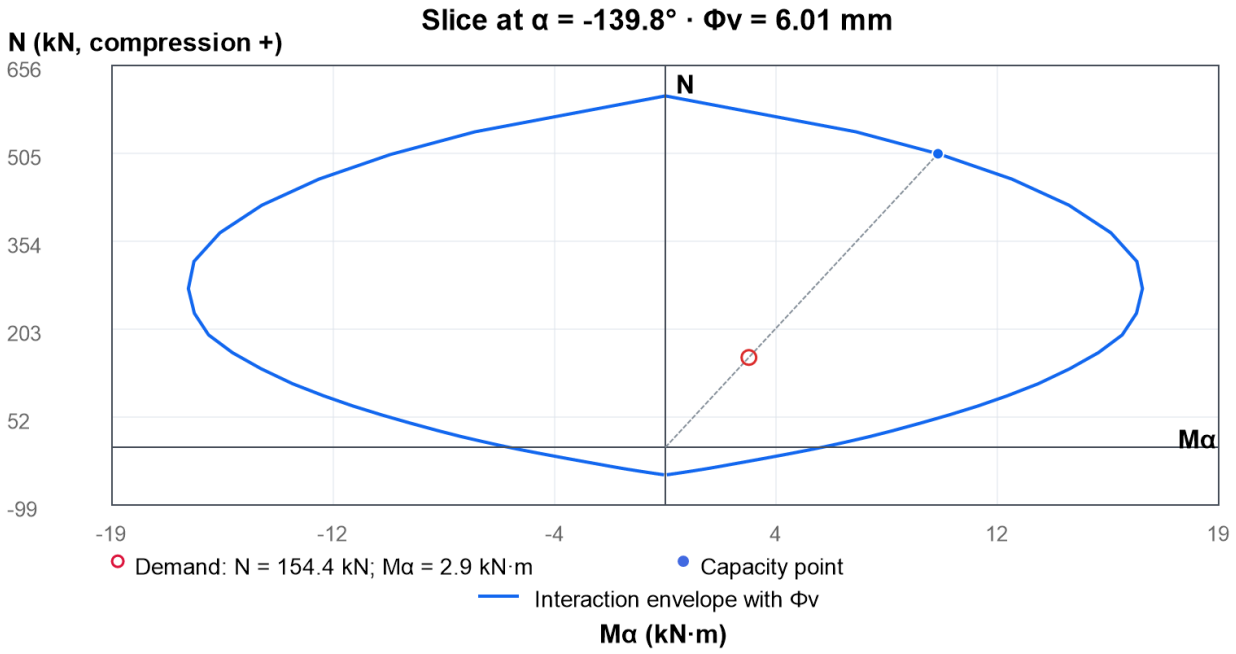
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	11.82	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2146	1.2146	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

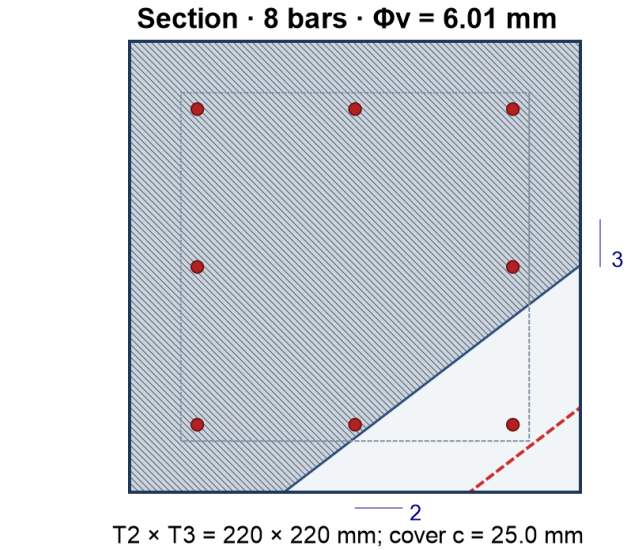
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 220.42 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.3060	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	127.4457°	Geometry at the check point
Normal vector n	(-0.608009; 0.793930)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	220.4152 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.608009 \cdot x_2 + 0.793930 \cdot x_3 = -66.2019$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.608009 \cdot x_2 + 0.793930 \cdot x_3 = -121.3058$ mm	Geometry at the check point
Compressed concrete area A_b	40,376.660 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-12.270; 14.516) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	464.332 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.740 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.697 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	168.529	1.35912	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	215.346	0.76440	152.879	4.337	0.334	0.000
3	77.000	-77.000	28.366	262.163	0.16967	33.934	0.963	0.074	0.074
4	-77.000	77.000	28.366	46.264	2.91229	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	93.081	2.31757	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	139.897	1.72284	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	107.397	2.13571	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	201.030	0.94626	189.251	5.368	0.000	0.413
Σ N_{si}, M_{xsi}, M_{ysi}							40.452	-0.509	-0.430

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	464.332	-6.740	-5.697	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.452	-0.509	-0.430	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**504.784**	**-7.249**	**-6.127**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	157.051 kN	From analysis results
M_2	12.920 kN·m	From analysis results
M_3	7.181 kN·m	From analysis results
M_{2s}	16.255 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.640 kN·m	Including second-order magnification and accidental eccentricity

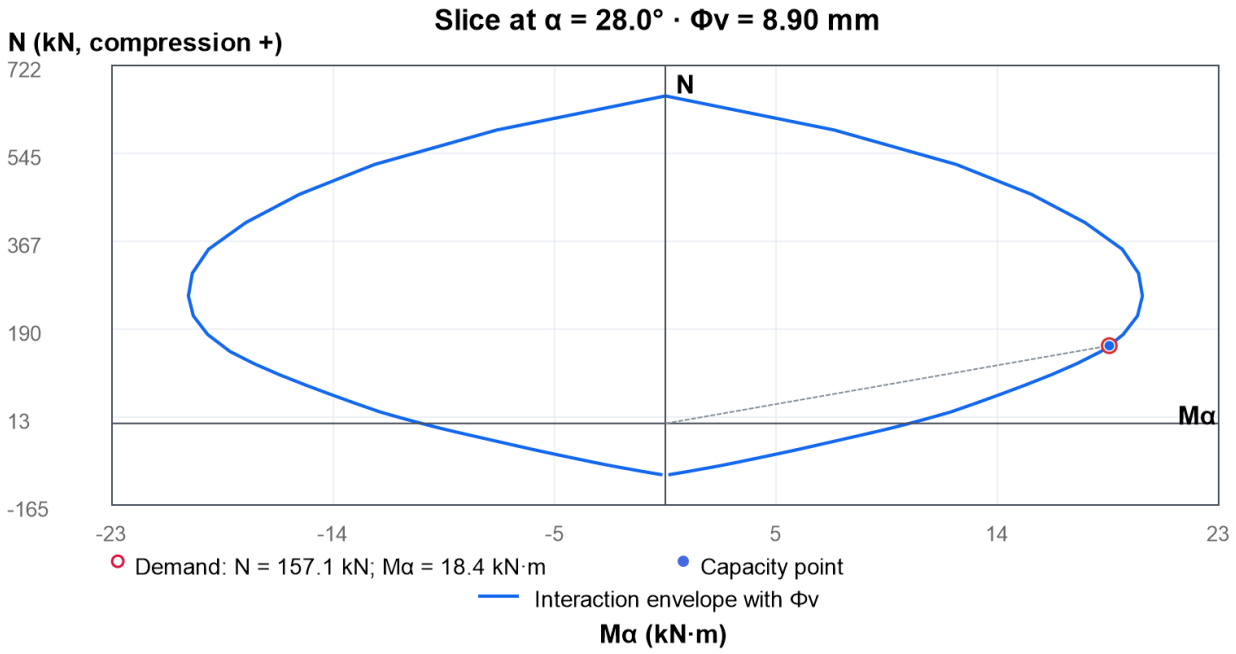
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	82.27	45.73	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.37	0.21	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.11128	0.14768	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,212,933	2,212,933	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	907,227,345,800	1,102,622,716,186	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	765.53	930.41	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2581	1.2031	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

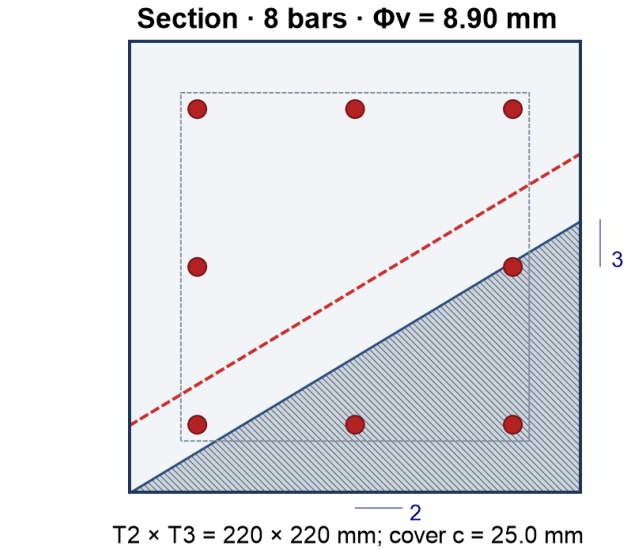
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 113.20 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	497.65 mm^2	Calculation results
Φ_v	8.8996 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9997	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	301.0722°	Geometry at the check point
Normal vector n	(0.516118; -0.856517)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	113.2033 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.516118 \cdot x_2 - 0.856517 \cdot x_3 = 37.7866$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.516118 \cdot x_2 - 0.856517 \cdot x_3 = 9.4858$ mm	Geometry at the check point
Compressed concrete area A_b	14,494.488 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(36.888; -65.944) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	166.687 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	10.992 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.149 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.8996 mm / 62.206 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	62.206	124.779	0.41368	82.736	5.147	0.396	-0.396
2	0.000	-77.000	62.206	85.038	1.39665	210.000	13.063	1.006	0.000
3	77.000	-77.000	62.206	45.297	2.37961	210.000	13.063	1.006	1.006
4	-77.000	77.000	62.206	256.683	-2.84886	-210.000	-13.063	1.006	1.006
5	0.000	77.000	62.206	216.942	-1.86589	-210.000	-13.063	1.006	0.000
6	77.000	77.000	62.206	177.201	-0.88293	-176.585	-10.985	0.846	-0.846
7	-77.000	0.000	62.206	190.731	-1.21759	-210.000	-13.063	0.000	1.006
8	77.000	0.000	62.206	111.249	0.74834	149.669	9.310	0.000	0.717
Σ N_{si}, M_{xsi}, M_{ysi}							-9.591	5.266	2.492

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	166.687	10.992	6.149	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-9.591	5.266	2.492	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**157.096**	**16.258**	**8.641**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	221.842 kN	From analysis results
M_2	6.465 kN·m	From analysis results
M_3	-9.986 kN·m	From analysis results
M_{2s}	8.664 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-13.869 kN·m	Including second-order magnification and accidental eccentricity

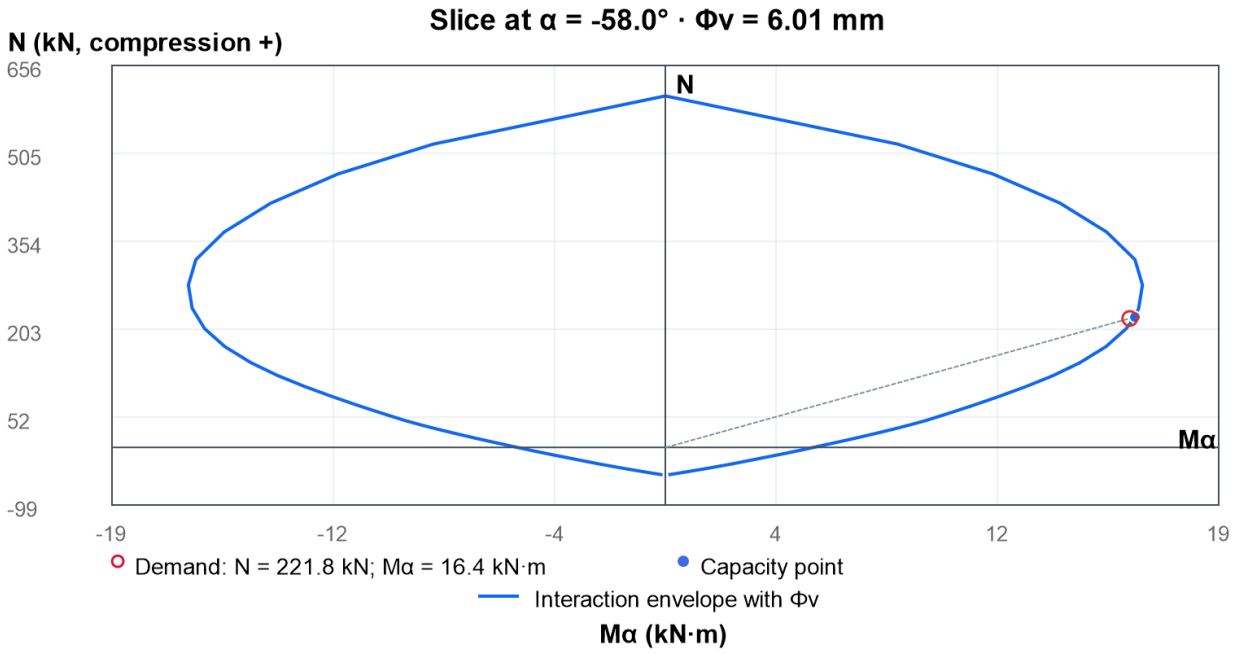
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	29.14	45.02	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.20	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.14863	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	939,161,187,965	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	792.48	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.3401	1.3888	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

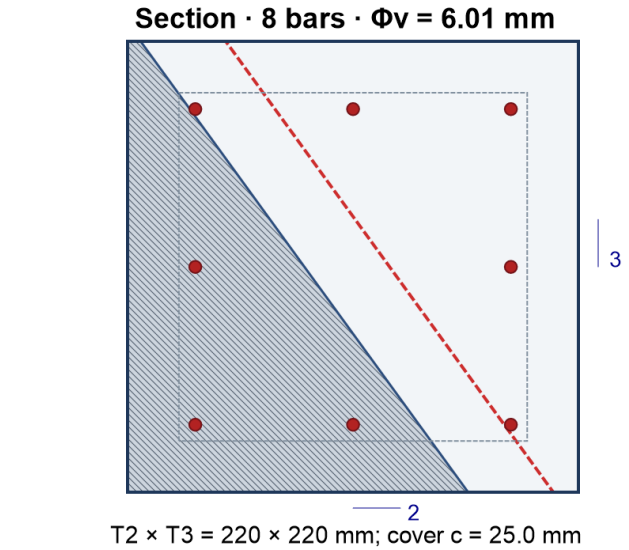
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 134.46 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9890	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	216.0001°	Geometry at the check point
Normal vector n	(-0.809016; -0.587787)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	134.4579 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.809016 \cdot x_2 - 0.587787 \cdot x_3 = 19.1904$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.809016 \cdot x_2 - 0.587787 \cdot x_3 = -14.4241$ mm	Geometry at the check point
Compressed concrete area A_b	18,981.460 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-54.522; -33.964) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	218.287 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.414 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.901 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.094	2.54011	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	108.389	1.24287	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	170.683	-0.05436	-10.872	-0.308	-0.024	-0.024
4	-77.000	77.000	28.366	136.614	0.65511	131.022	3.717	-0.286	-0.286
5	0.000	77.000	28.366	198.908	-0.64213	-128.426	-3.643	0.281	0.000
6	77.000	77.000	28.366	261.202	-1.93937	-210.000	-5.957	0.459	-0.459
7	-77.000	0.000	28.366	91.354	1.59761	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	215.943	-0.99686	-199.373	-5.655	0.000	-0.435
Σ N_{si}, M_{xsi}, M_{ysi}							6.024	1.347	-2.121

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	218.287	7.414	-11.901	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	6.024	1.347	-2.121	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**224.310**	**8.761**	**-14.023**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	223.792 kN	From analysis results
M_2	0.845 kN·m	From analysis results
M_3	-1.335 kN·m	From analysis results
M_{2s}	3.008 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-3.008 kN·m	Including second-order magnification and accidental eccentricity

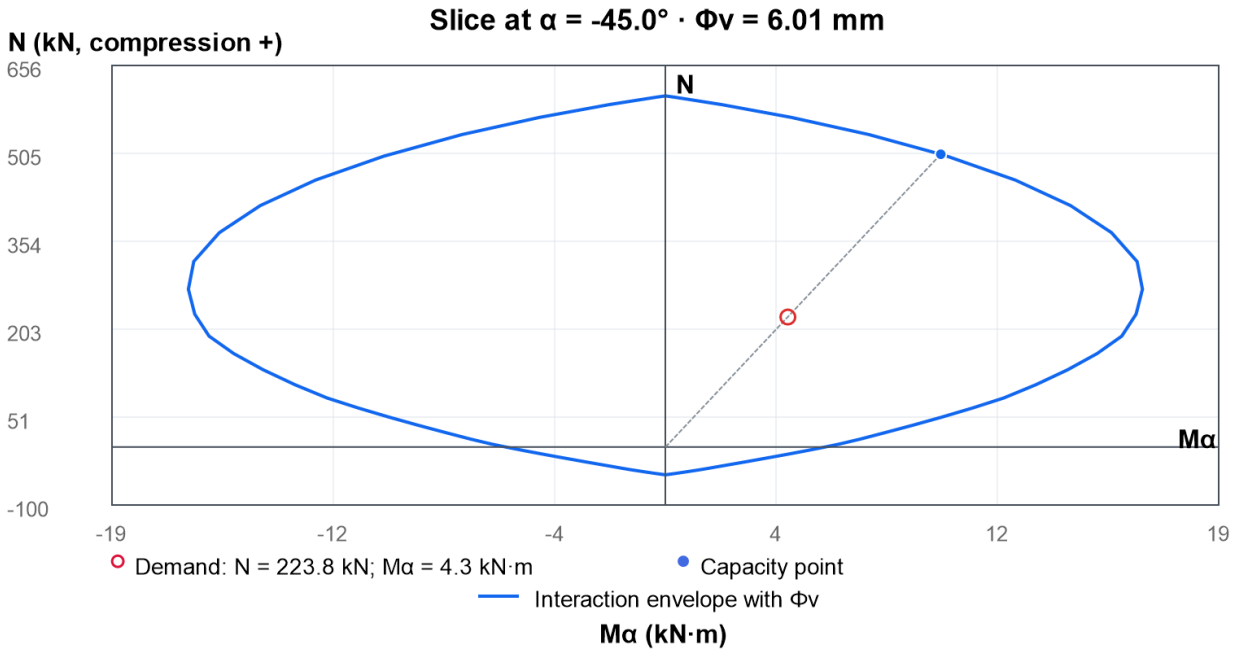
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3441	1.3441	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

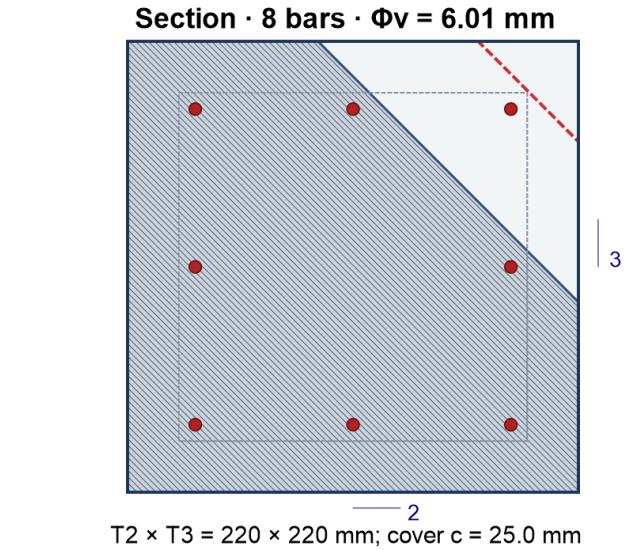
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 221.23 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.4442	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	224.9655°	Geometry at the check point
Normal vector n	(-0.707532; -0.706681)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	221.2278 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707532 \cdot x_2 - 0.706681 \cdot x_3 = -65.6644$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707532 \cdot x_2 - 0.706681 \cdot x_3 = -120.9713$ mm	Geometry at the check point
Compressed concrete area A_b	40,318.148 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-13.560; -13.550) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	463.659 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.282 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.287 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.90933	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.149	2.21979	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.629	1.53026	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.498	1.53192	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	209.978	0.84239	168.477	4.779	-0.368	0.000
6	77.000	77.000	28.366	264.458	0.15285	30.571	0.867	-0.067	0.067
7	-77.000	0.000	28.366	101.083	2.22062	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.043	0.84156	168.311	4.774	0.000	0.368
Σ N_{si}, M_{xsi}, M_{ysi}							40.205	0.483	-0.483

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	463.659	6.282	-6.287	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.205	0.483	-0.483	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**503.864**	**6.765**	**-6.770**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	226.394 kN	From analysis results
M_2	-6.648 kN·m	From analysis results
M_3	10.199 kN·m	From analysis results
M_{2s}	-8.931 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	14.199 kN·m	Including second-order magnification and accidental eccentricity

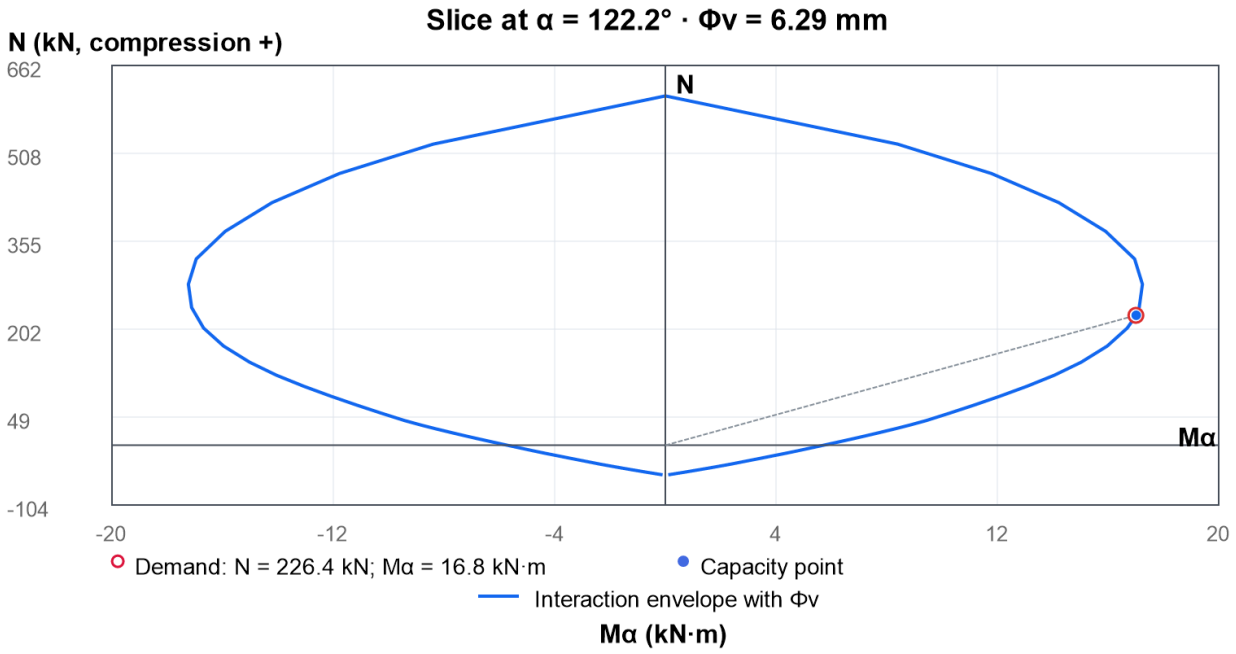
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	29.37	45.05	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.20	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.14858	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,106,589	1,106,589	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,049,650,218,490	952,550,733,351	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	885.71	803.78	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.3434	1.3921	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

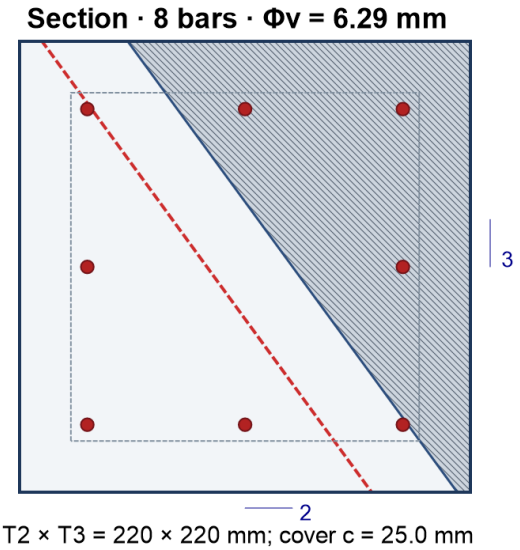
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 135.00 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	248.85 mm^2	Calculation results
Φ_v	6.2933 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	36.1668°	Geometry at the check point
Normal vector n	(0.807302; 0.590138)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	134.9978 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.807302 \cdot x_2 + 0.590138 \cdot x_3 = 18.7207$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.807302 \cdot x_2 + 0.590138 \cdot x_3 = -15.0287$ mm	Geometry at the check point
Compressed concrete area A_b	19,098.378 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(54.181; 33.963) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	219.631 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.459 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.900 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.2933 mm / 31.107 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	31.107	261.321	-1.92009	-210.000	-6.532	-0.503	0.503
2	0.000	-77.000	31.107	199.159	-0.63078	-126.155	-3.924	-0.302	0.000
3	77.000	-77.000	31.107	136.997	0.65854	131.708	4.097	0.315	0.315
4	-77.000	77.000	31.107	170.440	-0.03511	-7.023	-0.218	0.017	0.017
5	0.000	77.000	31.107	108.278	1.25420	210.000	6.532	-0.503	0.000
6	77.000	77.000	31.107	46.116	2.54351	210.000	6.532	-0.503	0.503
7	-77.000	0.000	31.107	215.881	-0.97760	-195.520	-6.082	0.000	0.468
8	77.000	0.000	31.107	91.556	1.60103	210.000	6.532	0.000	0.503
Σ N_{si}, M_{xsi}, M_{ysi}							6.937	-1.479	2.310

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	219.631	-7.459	11.900	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	6.937	-1.479	2.310	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**226.568**	**-8.938**	**14.209**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	177.568 kN	From analysis results
M_2	1.616 kN·m	From analysis results
M_3	-9.569 kN·m	From analysis results
M_{2s}	2.228 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-12.576 kN·m	Including second-order magnification and accidental eccentricity

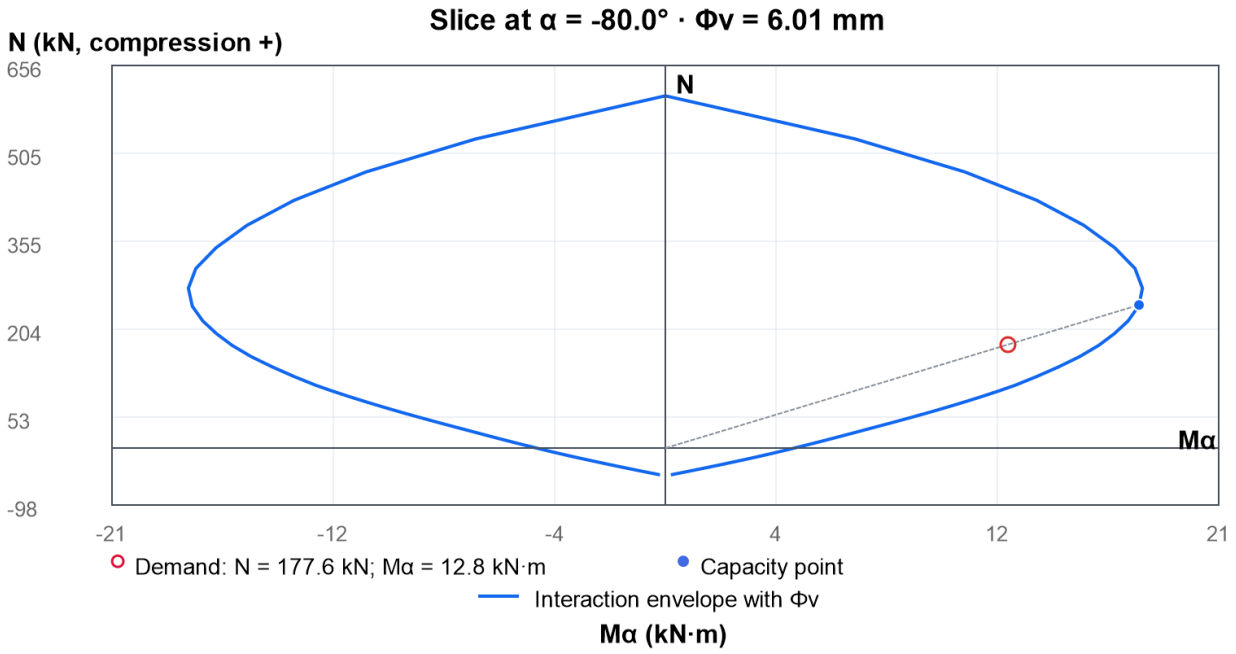
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	53.89	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.24	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.13763	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	880,111,873,888	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	742.65	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2549	1.3142	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

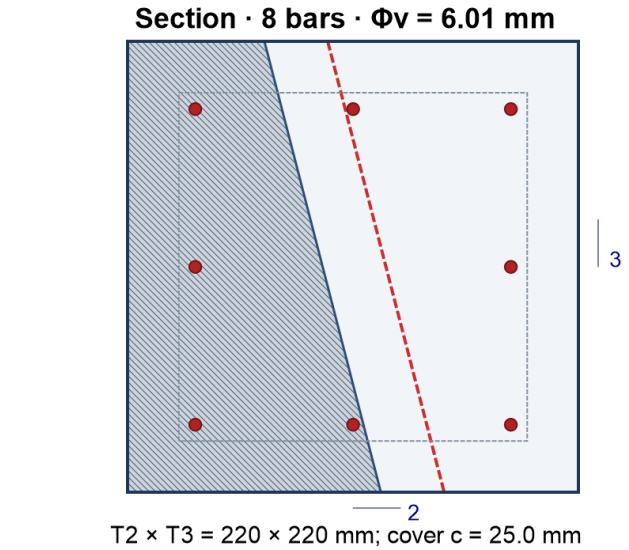
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 119.65 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7231	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	194.4821°	Geometry at the check point
Normal vector n	(-0.968226; -0.250078)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	119.6499 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.968226 \cdot x_2 - 0.250078 \cdot x_3 = 14.3635$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.968226 \cdot x_2 - 0.250078 \cdot x_3 = -15.5490$ mm	Geometry at the check point
Compressed concrete area A_b	20,936.332 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-61.004; -10.947) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	240.768 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	2.636 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-14.688 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	40.204	2.55916	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	114.757	0.81449	162.899	4.621	0.356	0.000
3	77.000	-77.000	28.366	189.311	-0.93018	-186.035	-5.277	-0.406	-0.406
4	-77.000	77.000	28.366	78.716	1.65792	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	153.269	-0.08675	-17.350	-0.492	0.038	0.000
6	77.000	77.000	28.366	227.823	-1.83142	-210.000	-5.957	0.459	-0.459
7	-77.000	0.000	28.366	59.460	2.10854	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	208.567	-1.38080	-210.000	-5.957	0.000	-0.459
Σ N_{si}, M_{xsi}, M_{ysi}							4.808	0.446	-2.700

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	240.768	2.636	-14.688	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	4.808	0.446	-2.700	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**245.576**	**3.082**	**-17.388**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	179.519 kN	From analysis results
M_2	0.279 kN·m	From analysis results
M_3	-1.202 kN·m	From analysis results
M_{2s}	2.259 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-2.259 kN·m	Including second-order magnification and accidental eccentricity

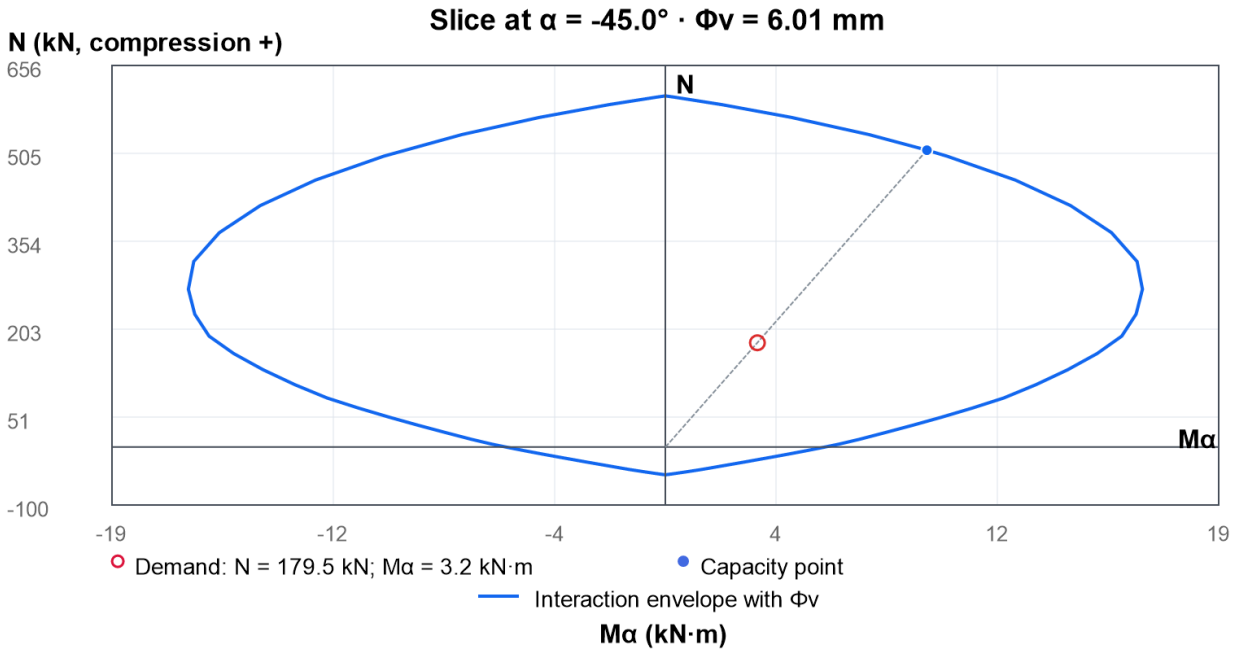
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2584	1.2584	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

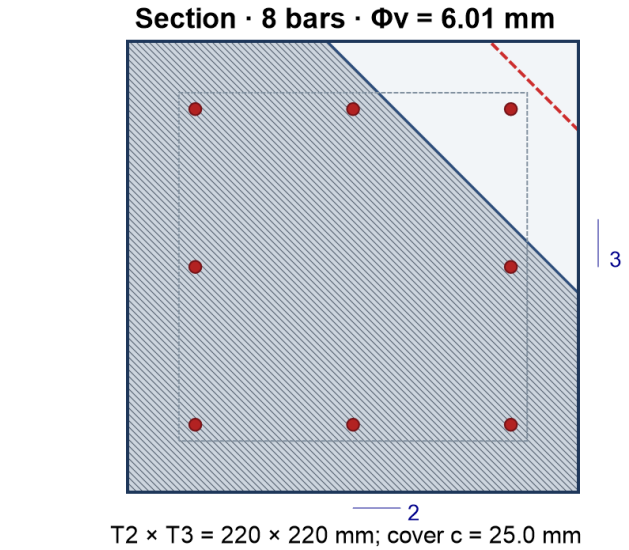
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 224.37 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.3514	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	224.9624°	Geometry at the check point
Normal vector n	(-0.707570; -0.706643)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	224.3690 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.707570 \cdot x_2 - 0.706643 \cdot x_3 = -68.8056$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.707570 \cdot x_2 - 0.706643 \cdot x_3 = -124.8978$ mm	Geometry at the check point
Compressed concrete area A_b	40,873.060 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-12.730; -12.720) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	470.040 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.979 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.984 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.669	2.91760	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	101.152	2.23768	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	155.635	1.55776	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	155.492	1.55955	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	209.975	0.87963	175.926	4.990	-0.384	0.000
6	77.000	77.000	28.366	264.458	0.19971	39.943	1.133	-0.087	0.087
7	-77.000	0.000	28.366	101.081	2.23857	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	210.046	0.87874	175.748	4.985	0.000	0.384
Σ N_{si}, M_{xsi}, M_{ysi}							40.894	0.446	-0.446

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	470.040	5.979	-5.984	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	40.894	0.446	-0.446	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**510.934**	**6.425**	**-6.430**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	182.120 kN	From analysis results
M_2	-1.503 kN·m	From analysis results
M_3	9.955 kN·m	From analysis results
M_{2s}	-2.300 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	13.212 kN·m	Including second-order magnification and accidental eccentricity

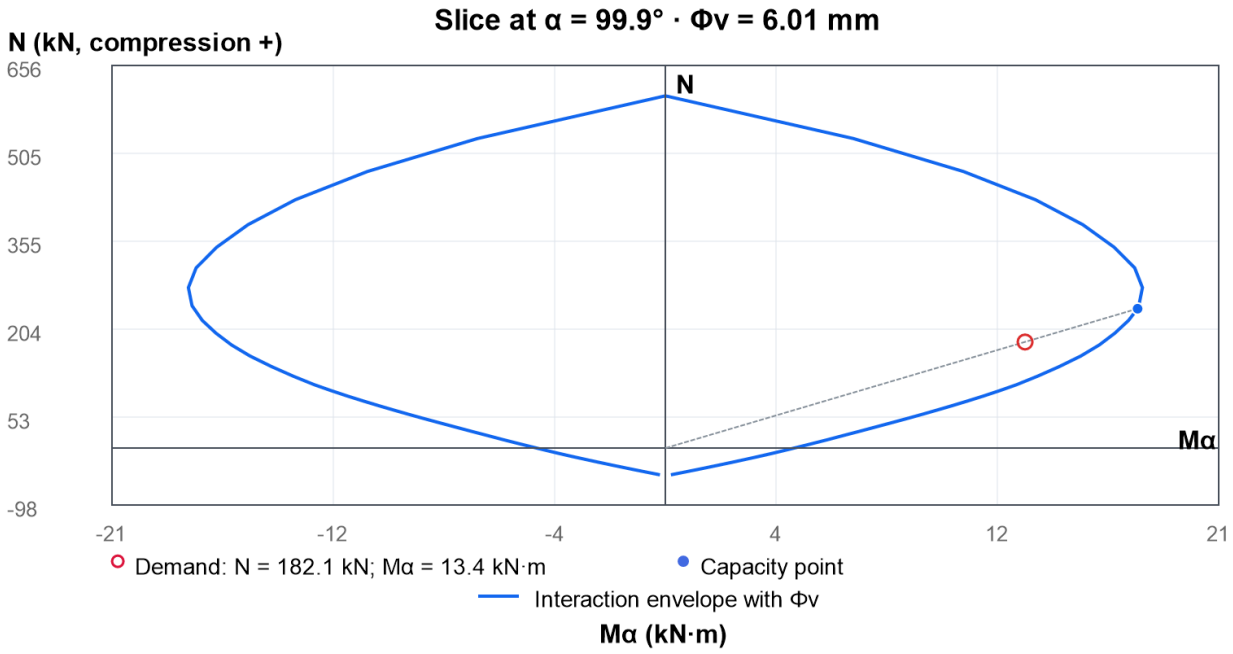
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	54.66	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.25	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.13675	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	875,388,706,172	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	874.20	738.67	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.2632	1.3272	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

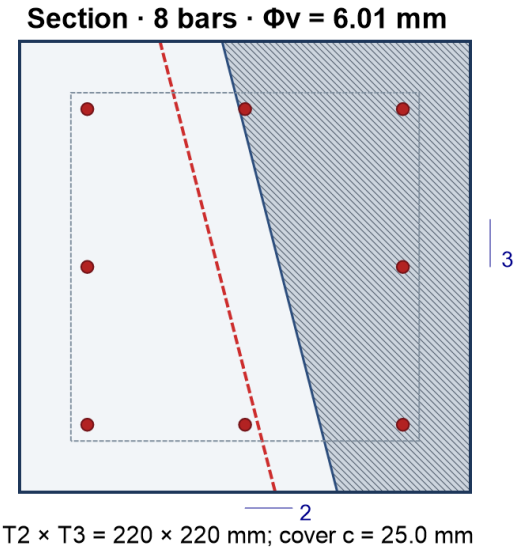
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 117.42 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7614	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	14.3420°	Geometry at the check point
Normal vector n	(0.968835; 0.247709)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	117.4229 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.968835 \cdot x_2 + 0.247709 \cdot x_3 = 16.3969$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.968835 \cdot x_2 + 0.247709 \cdot x_3 = -12.9588$ mm	Geometry at the check point
Compressed concrete area A_b	20,476.643 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(62.046; 11.079) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	235.481 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-2.609 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	14.611 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	227.494	-1.92469	-210.000	-5.957	-0.459	0.459
2	0.000	-77.000	28.366	152.893	-0.14581	-29.162	-0.827	-0.064	0.000
3	77.000	-77.000	28.366	78.293	1.63307	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	189.346	-1.01505	-203.010	-5.759	0.443	0.443
5	0.000	77.000	28.366	114.746	0.76383	152.765	4.333	-0.334	0.000
6	77.000	77.000	28.366	40.146	2.54270	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	208.420	-1.46987	-210.000	-5.957	0.000	0.459
8	77.000	0.000	28.366	59.219	2.08788	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							3.704	-0.413	2.737

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	235.481	-2.609	14.611	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	3.704	-0.413	2.737	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**239.186**	**-3.022**	**17.347**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	143.951 kN	From analysis results
M_2	-4.565 kN·m	From analysis results
M_3	-8.798 kN·m	From analysis results
M_{2s}	-5.465 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.047 kN·m	Including second-order magnification and accidental eccentricity

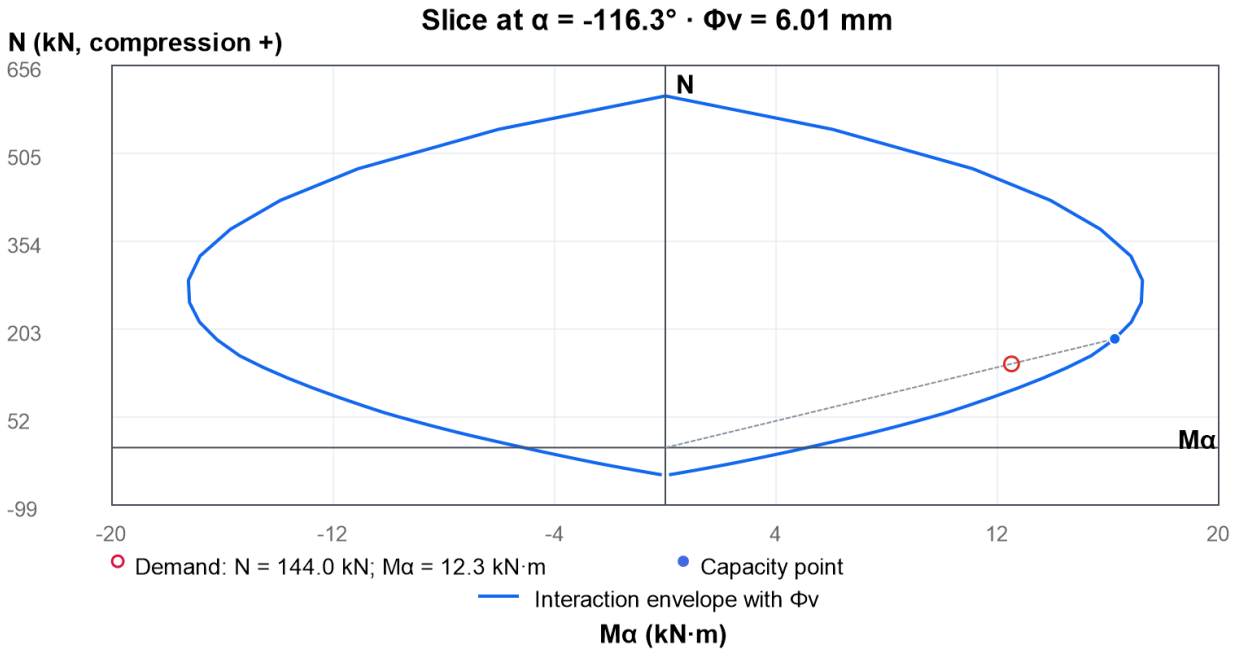
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	31.71	61.12	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.28	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.12980	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	838,080,471,204	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	707.19	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1971	1.2556	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

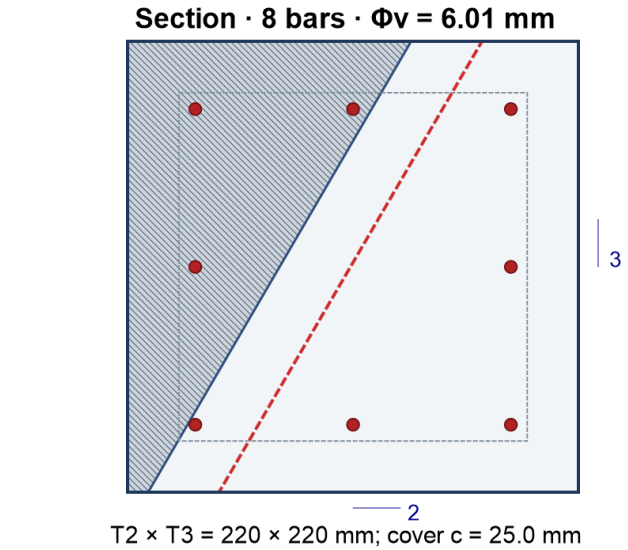
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 119.47 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.7699	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	149.7424°	Geometry at the check point
Normal vector n	(-0.863769; 0.503888)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	119.4664 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.863769 \cdot x_2 + 0.503888 \cdot x_3 = 30.9759$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.863769 \cdot x_2 + 0.503888 \cdot x_3 = 1.1093$ mm	Geometry at the check point
Compressed concrete area A_b	16,310.513 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-63.674; 31.736) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	187.571 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.953 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-11.943 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	122.731	0.62348	124.695	3.537	0.272	-0.272
2	0.000	-77.000	28.366	189.242	-0.93536	-187.072	-5.307	-0.409	0.000
3	77.000	-77.000	28.366	255.752	-2.49420	-210.000	-5.957	-0.459	-0.459
4	-77.000	77.000	28.366	45.133	2.44220	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	111.643	0.88336	176.673	5.012	-0.386	0.000
6	77.000	77.000	28.366	178.153	-0.67547	-135.095	-3.832	0.295	-0.295
7	-77.000	0.000	28.366	83.932	1.53284	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	216.952	-1.58484	-210.000	-5.957	0.000	-0.459
Σ N_{si}, M_{xsi}, M_{ysi}							-0.590	-1.144	-2.402

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	187.571	-5.953	-11.943	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-0.590	-1.144	-2.402	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**186.981**	**-7.097**	**-14.346**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	145.902 kN	From analysis results
M_2	-0.348 kN·m	From analysis results
M_3	-1.012 kN·m	From analysis results
M_{2s}	-1.751 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.751 kN·m	Including second-order magnification and accidental eccentricity

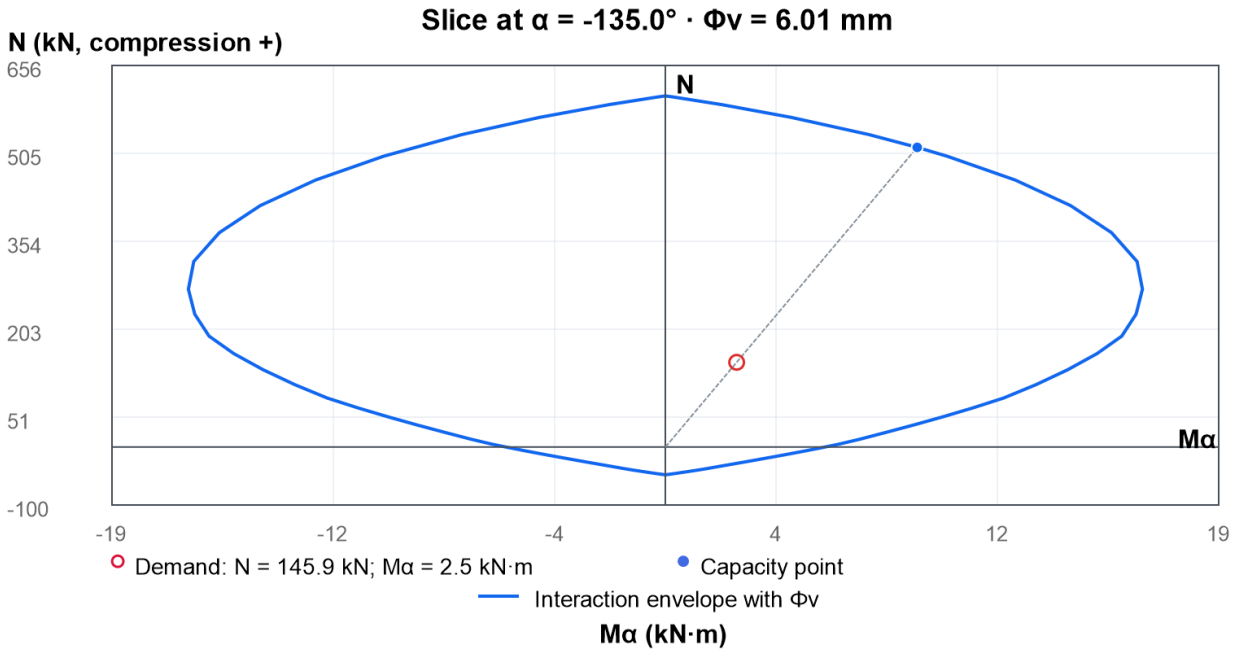
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	10.00	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2003	1.2003	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

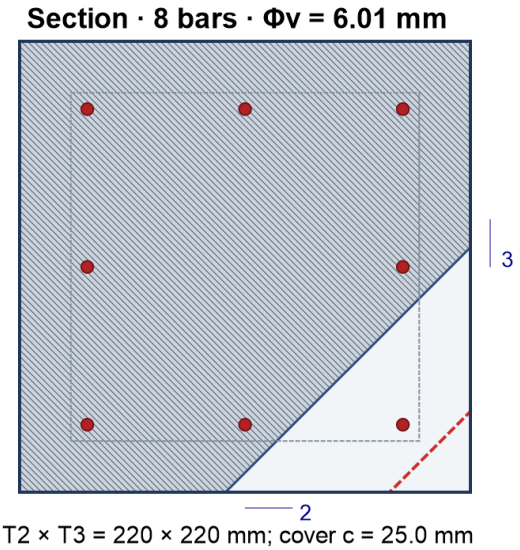
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 226.57 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.2829	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	134.9854°	Geometry at the check point
Normal vector n	(-0.706927; 0.707287)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	226.5690 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.706927 \cdot x_2 + 0.707287 \cdot x_3 = -71.0055$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.706927 \cdot x_2 + 0.707287 \cdot x_3 = -127.6477$ mm	Geometry at the check point
Compressed concrete area A_b	41,249.941 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-12.156; 12.159) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	474.374 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-5.768 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.766 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	155.591	1.57716	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	210.025	0.90446	180.892	5.131	0.395	0.000
3	77.000	-77.000	28.366	264.458	0.23176	46.352	1.315	0.101	0.101
4	-77.000	77.000	28.366	46.669	2.92325	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	101.102	2.25055	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	155.536	1.57785	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	101.130	2.25021	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	209.997	0.90480	180.961	5.133	0.000	0.395
Σ N_{si}, M_{xsi}, M_{ysi}							41.364	-0.421	-0.421

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	474.374	-5.768	-5.766	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	41.364	-0.421	-0.421	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**515.738**	**-6.189**	**-6.187**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	148.503 kN	From analysis results
M_2	5.276 kN·m	From analysis results
M_3	9.371 kN·m	From analysis results
M_{2s}	6.384 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.902 kN·m	Including second-order magnification and accidental eccentricity

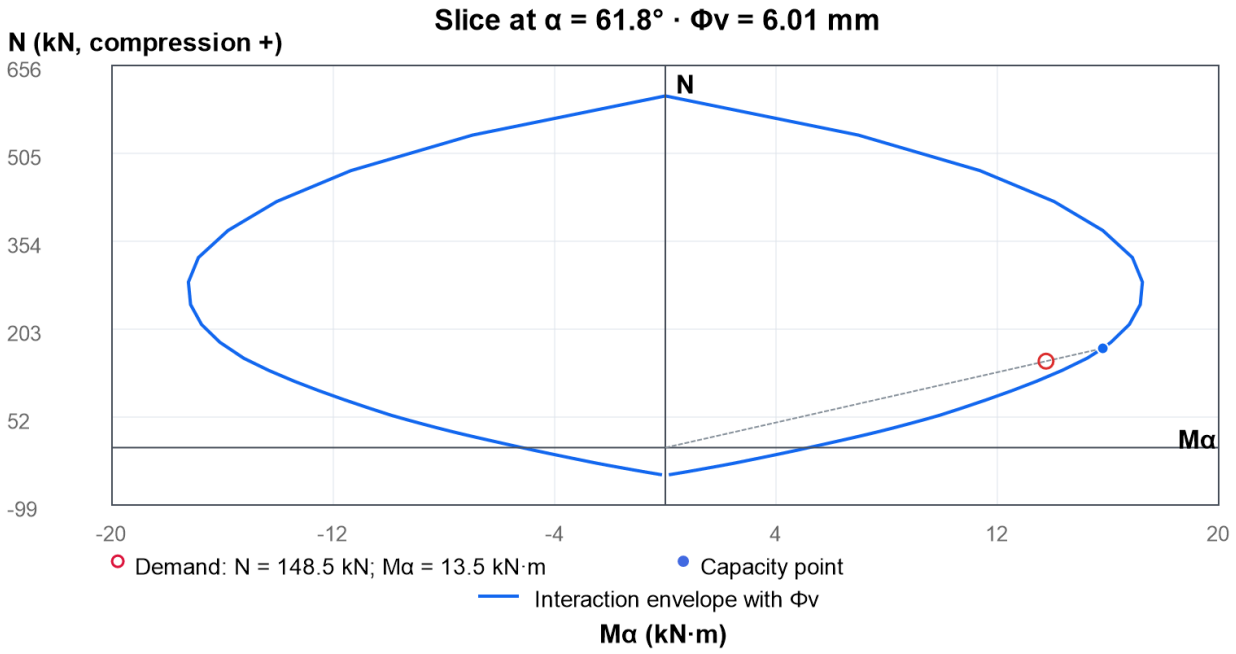
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	35.53	63.10	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.16	0.29	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16252	0.12781	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,013,745,597,965	827,393,049,110	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	855.41	698.17	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.2101	1.2702	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

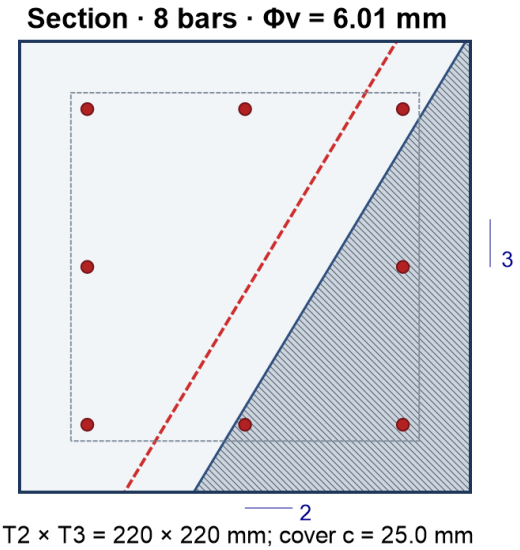
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 115.66 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.8702	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	328.8867°	Geometry at the check point
Normal vector n	(0.856147; -0.516732)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	115.6554 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.856147 \cdot x_2 - 0.516732 \cdot x_3 = 35.3613$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.856147 \cdot x_2 - 0.516732 \cdot x_3 = 6.4475$ mm	Geometry at the check point
Compressed concrete area A_b	15,113.369 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(64.958; -35.436) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	173.804 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	6.159 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	11.290 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	177.152	-0.78882	-157.764	-4.475	-0.345	0.345
2	0.000	-77.000	28.366	111.228	0.80718	161.435	4.579	0.353	0.000
3	77.000	-77.000	28.366	45.305	2.40317	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	256.728	-2.71536	-210.000	-5.957	0.459	0.459
5	0.000	77.000	28.366	190.805	-1.11936	-210.000	-5.957	0.459	0.000
6	77.000	77.000	28.366	124.882	0.47663	95.326	2.704	-0.208	0.208
7	-77.000	0.000	28.366	216.940	-1.75209	-210.000	-5.957	0.000	0.459
8	77.000	0.000	28.366	85.093	1.43990	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							-3.149	1.176	2.388

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	173.804	6.159	11.290	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-3.149	1.176	2.388	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**170.655**	**7.335**	**13.677**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	82.380 kN	From analysis results
M_2	9.393 kN·m	From analysis results
M_3	-8.555 kN·m	From analysis results
M_{2s}	10.768 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.755 kN·m	Including second-order magnification and accidental eccentricity

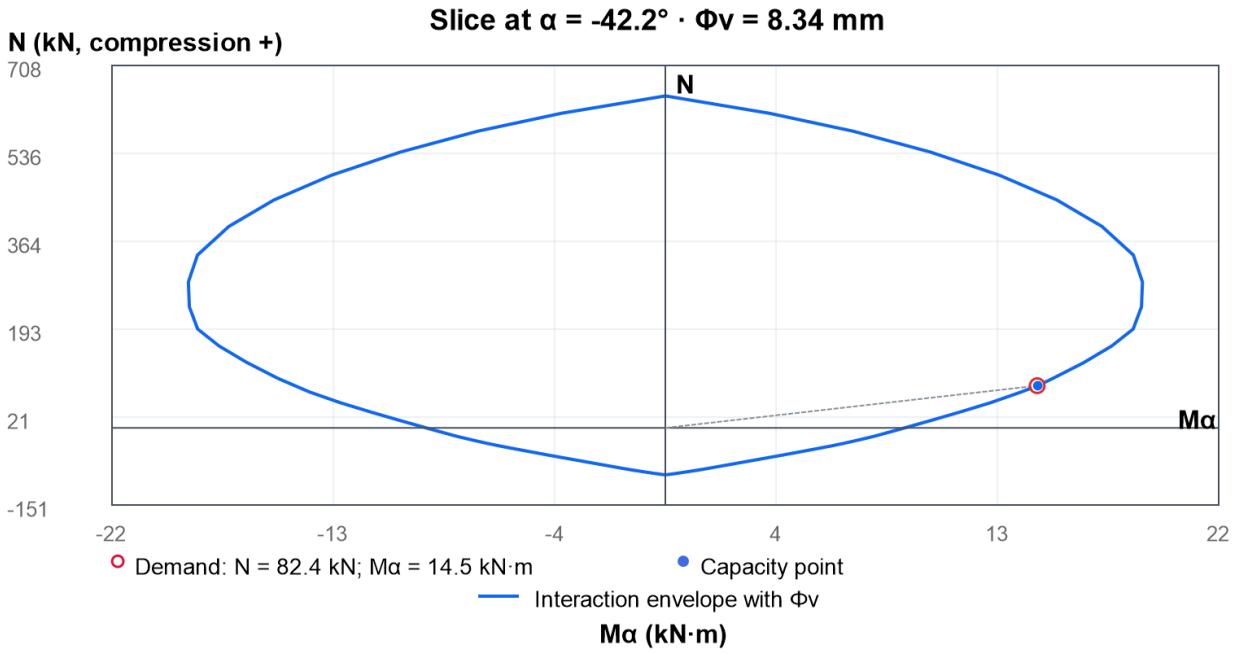
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	114.02	103.85	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.52	0.47	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.09166	0.09714	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,945,114	1,945,114	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	764,357,773,834	793,824,613,745	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	644.98	669.84	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.1464	1.1402	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

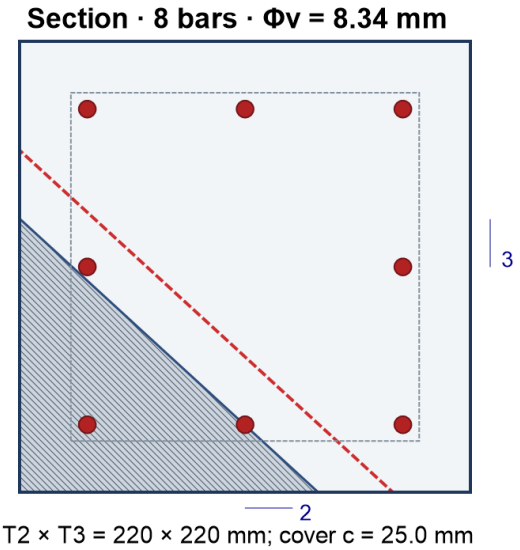
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 98.43 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	437.42 mm^2	Calculation results
Φ_v	8.3438 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9983	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	227.5067°	Geometry at the check point
Normal vector n	(-0.675504; -0.737356)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	98.4331 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.675504 \cdot x_2 - 0.737356 \cdot x_3 = 56.9816$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.675504 \cdot x_2 - 0.737356 \cdot x_3 = 32.3733$ mm	Geometry at the check point
Compressed concrete area A_b	9,726.277 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-61.427; -65.502) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	111.852 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.327 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.871 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.3438 mm / 54.678 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	54.678	46.624	2.17374	210.000	11.482	0.884	-0.884
2	0.000	-77.000	54.678	98.638	0.69416	138.833	7.591	0.585	0.000
3	77.000	-77.000	54.678	150.652	-0.78541	-157.082	-8.589	-0.661	-0.661
4	-77.000	77.000	54.678	160.177	-1.05636	-210.000	-11.482	0.884	0.884
5	0.000	77.000	54.678	212.191	-2.53593	-210.000	-11.482	0.884	0.000
6	77.000	77.000	54.678	264.205	-4.01550	-210.000	-11.482	0.884	-0.884
7	-77.000	0.000	54.678	103.401	0.55869	111.738	6.110	0.000	-0.470
8	77.000	0.000	54.678	207.428	-2.40045	-210.000	-11.482	0.000	-0.884
Σ N_{si}, M_{xsi}, M_{ysi}							-29.335	3.460	-2.900

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	111.852	7.327	-6.871	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-29.335	3.460	-2.900	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**82.517**	**10.786**	**-9.771**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,466 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	84.331 kN	From analysis results
M_2	1.050 kN·m	From analysis results
M_3	-1.488 kN·m	From analysis results
M_{2s}	1.162 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.646 kN·m	Including second-order magnification and accidental eccentricity

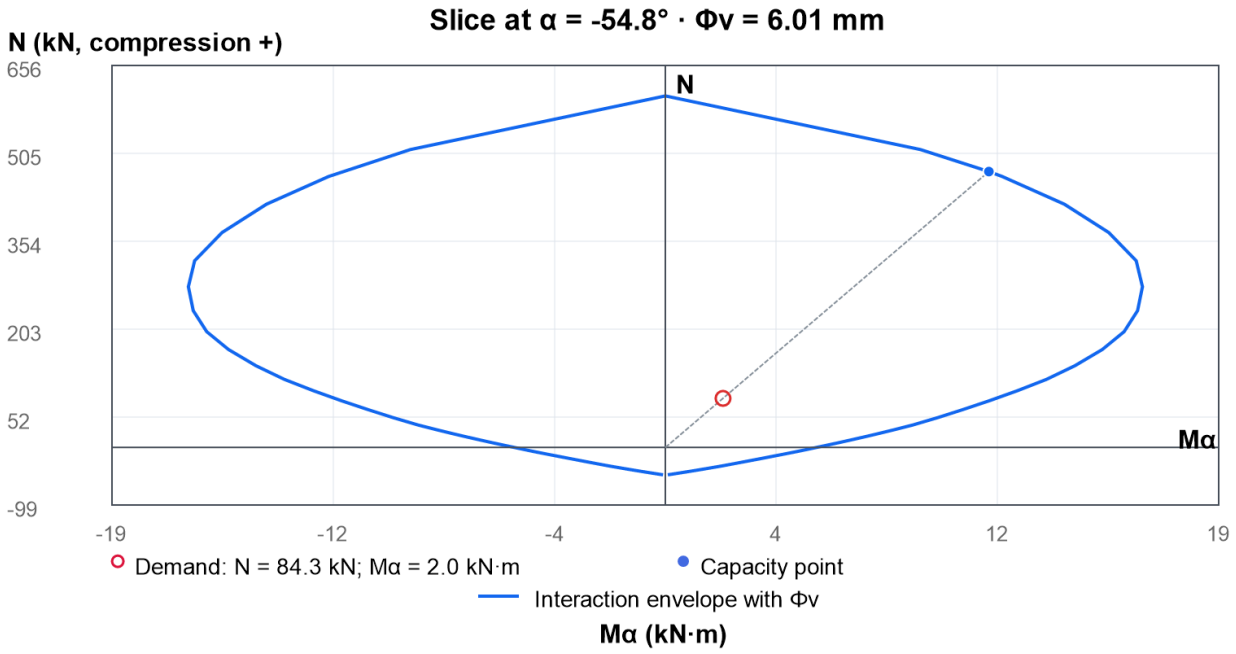
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	12.45	17.64	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	874.20	874.20	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1068	1.1068	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

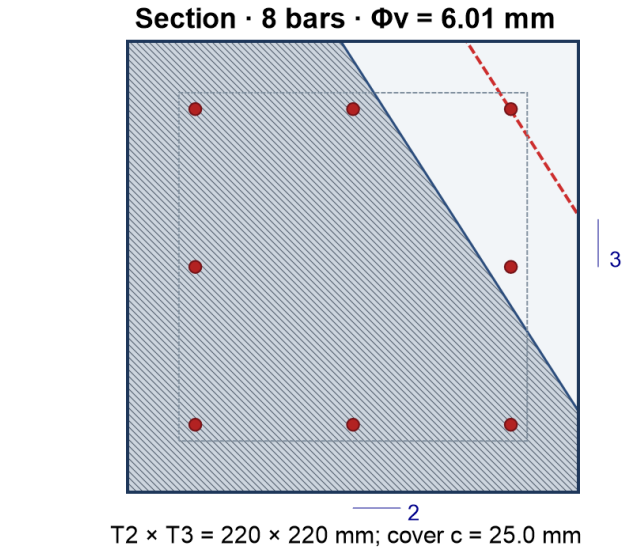
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 206.48 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1778	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	212.7160°	Geometry at the check point
Normal vector n	(-0.841359; -0.540476)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	206.4812 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.841359 \cdot x_2 - 0.540476 \cdot x_3 = -54.4793$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.841359 \cdot x_2 - 0.540476 \cdot x_3 = -106.0996$ mm	Geometry at the check point
Compressed concrete area A_b	37,942.626 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-19.668; -13.740) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	436.340 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	5.995 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.582 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	45.601	2.88163	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	110.385	2.00311	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	175.170	1.12460	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	128.834	1.75294	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	193.619	0.87442	174.885	4.961	-0.382	0.000
6	77.000	77.000	28.366	258.403	-0.00409	-0.818	-0.023	0.002	-0.002
7	-77.000	0.000	28.366	87.217	2.31729	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	216.787	0.56025	112.051	3.178	0.000	0.245
Σ N_{si}, M_{xsi}, M_{ysi}							37.901	0.537	-0.674

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	436.340	5.995	-8.582	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	37.901	0.537	-0.674	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**474.241**	**6.533**	**-9.257**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C10 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,420 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	86.932 kN	From analysis results
M_2	-10.074 kN·m	From analysis results
M_3	7.936 kN·m	From analysis results
M_{2s}	-11.648 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.047 kN·m	Including second-order magnification and accidental eccentricity

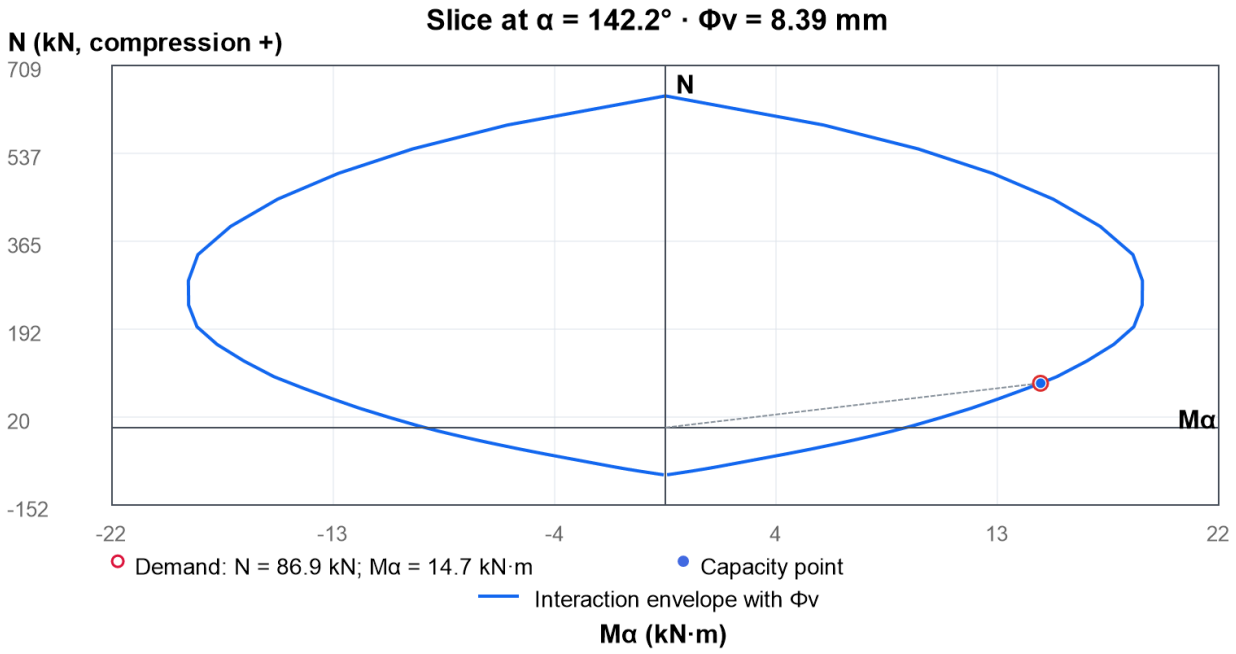
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,420.00	3,420.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,420.00	3,420.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	53.85	53.85	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	115.89	91.29	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.53	0.41	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.09072	0.10490	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,967,642	1,967,642	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	762,463,704,493	838,623,323,312	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	643.38	707.64	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1562	1.1401	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	53.85	53.85	Design settings

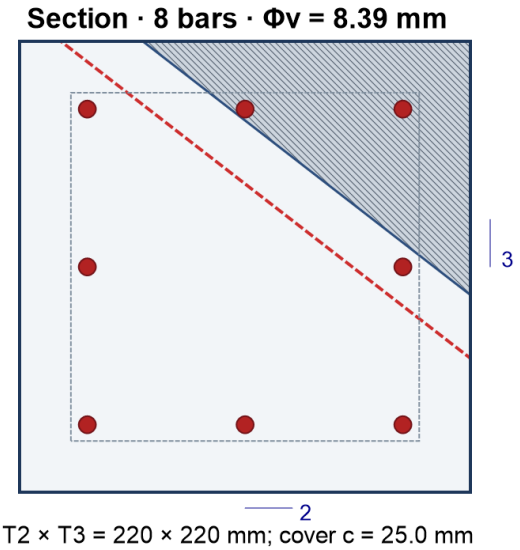
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 97.83 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	442.49 mm^2	Calculation results
Φ_v	8.3919 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9996	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	52.2596°	Geometry at the check point
Normal vector n	(0.612084; 0.790793)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	97.8254 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.612084 \cdot x_2 + 0.790793 \cdot x_3 = 56.4911$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.612084 \cdot x_2 + 0.790793 \cdot x_3 = 32.0347$ mm	Geometry at the check point
Compressed concrete area A_b	9,885.518 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(56.726; 68.765) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	113.683 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.817 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.449 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.3919 mm / 55.311 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	55.311	262.338	-4.00875	-210.000	-11.615	-0.894	0.894
2	0.000	-77.000	55.311	215.207	-2.65976	-210.000	-11.615	-0.894	0.000
3	77.000	-77.000	55.311	168.077	-1.31077	-210.000	-11.615	-0.894	-0.894
4	-77.000	77.000	55.311	140.556	-0.52305	-104.610	-5.786	0.446	0.446
5	0.000	77.000	55.311	93.425	0.82594	165.188	9.137	-0.704	0.000
6	77.000	77.000	55.311	46.295	2.17493	210.000	11.615	-0.894	0.894
7	-77.000	0.000	55.311	201.447	-2.26590	-210.000	-11.615	0.000	0.894
8	77.000	0.000	55.311	107.186	0.43208	86.416	4.780	0.000	0.368
Σ N_{si}, M_{xsi}, M_{ysi}							-26.716	-3.836	2.602

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	113.683	-7.817	6.449	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-26.716	-3.836	2.602	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**86.968**	**-11.653**	**9.051**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	63.352 kN	From analysis results
M_2	-13.309 kN·m	From analysis results
M_3	9.417 kN·m	From analysis results
M_{2s}	-14.515 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.175 kN·m	Including second-order magnification and accidental eccentricity

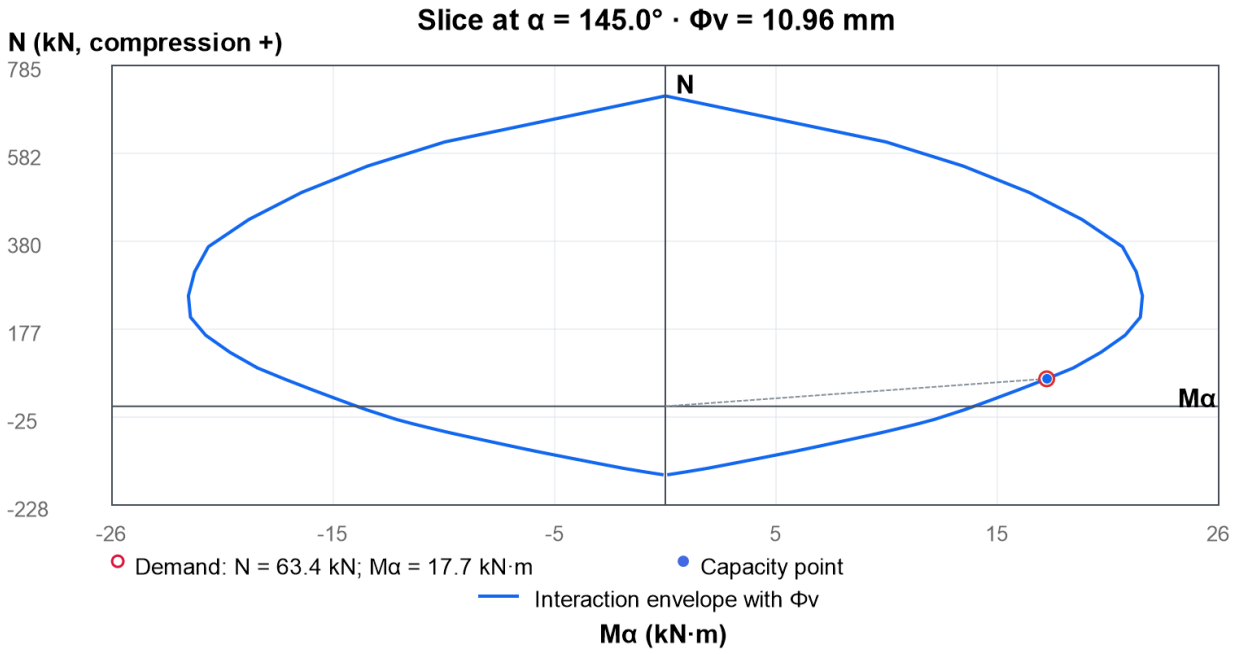
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	210.08	148.65	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.95	0.68	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.05977	0.07687	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,356,742	3,356,742	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	790,788,488,367	882,600,037,851	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	762.18	850.68	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0907	1.0805	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

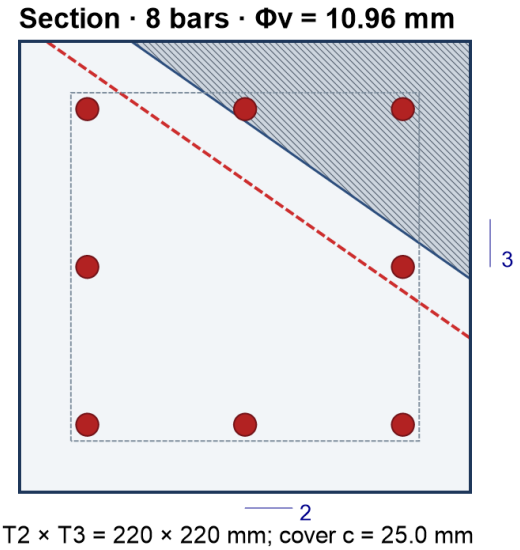
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 94.94 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	754.88 mm^2	Calculation results
Φ_v	10.9609 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9991	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	54.9925°	Geometry at the check point
Normal vector n	(0.573683; 0.819077)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	94.9429 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.573683 \cdot x_2 + 0.819077 \cdot x_3 = 58.2607$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.573683 \cdot x_2 + 0.819077 \cdot x_3 = 34.5250$ mm	Geometry at the check point
Compressed concrete area A_b	9,591.757 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(54.834; 71.362) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	110.305 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.872 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.049 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.9609 mm / 94.359 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	94.359	260.446	-4.18092	-210.000	-19.815	-1.526	1.526
2	0.000	-77.000	94.359	216.273	-2.87818	-210.000	-19.815	-1.526	0.000
3	77.000	-77.000	94.359	172.099	-1.57544	-210.000	-19.815	-1.526	-1.526
4	-77.000	77.000	94.359	134.308	-0.46094	-92.188	-8.699	0.670	0.670
5	0.000	77.000	94.359	90.135	0.84180	168.360	15.886	-1.223	0.000
6	77.000	77.000	94.359	45.961	2.14454	210.000	19.815	-1.526	1.526
7	-77.000	0.000	94.359	197.377	-2.32093	-210.000	-19.815	0.000	1.526
8	77.000	0.000	94.359	109.030	0.28455	56.910	5.370	0.000	0.413
Σ N_{si}, M_{xsi}, M_{ysi}							-46.889	-6.657	4.135

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	110.305	-7.872	6.049	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-46.889	-6.657	4.135	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**63.416**	**-14.528**	**10.183**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	65.177 kN	From analysis results
M_2	-2.140 kN·m	From analysis results
M_3	1.756 kN·m	From analysis results
M_{2s}	-2.290 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.879 kN·m	Including second-order magnification and accidental eccentricity

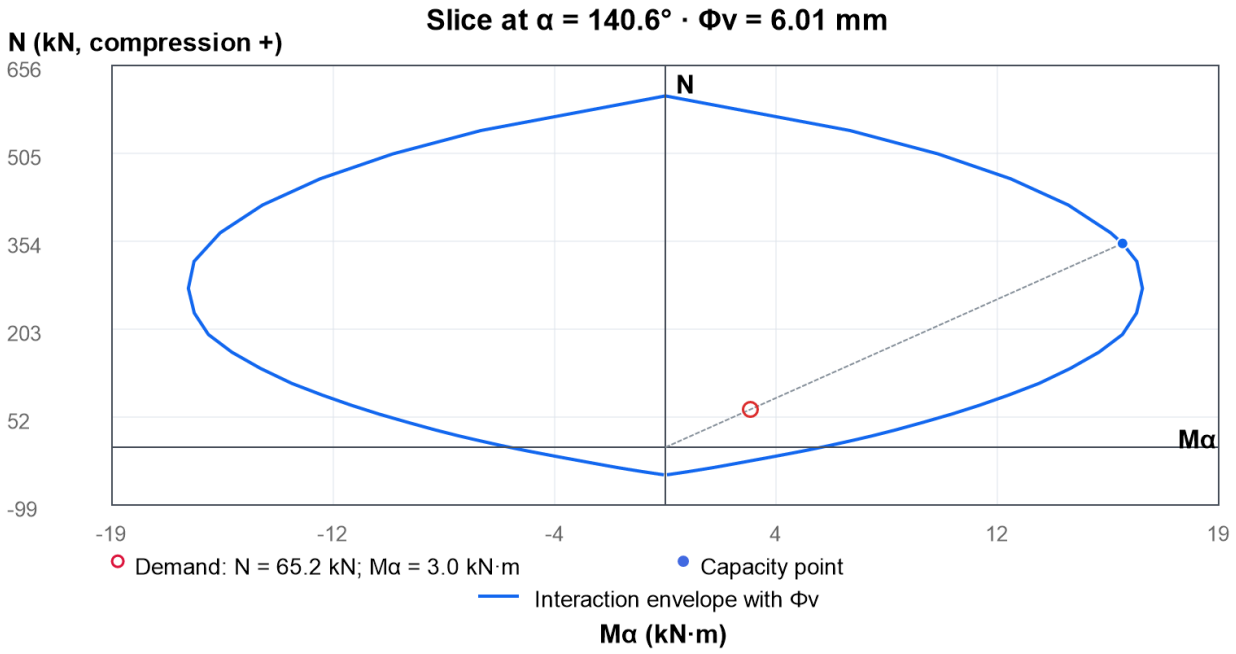
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	32.84	26.94	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0698	1.0698	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

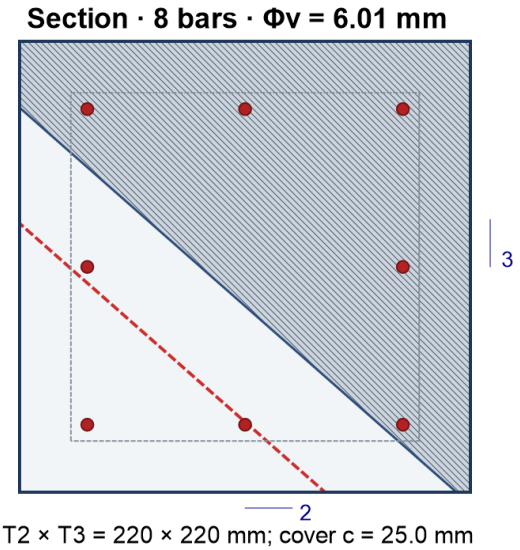
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 169.62 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1859	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	48.6498°	Geometry at the check point
Normal vector n	(0.660659; 0.750686)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	169.6158 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.660659 \cdot x_2 + 0.750686 \cdot x_3 = -14.3678$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.660659 \cdot x_2 + 0.750686 \cdot x_3 = -56.7718$ mm	Geometry at the check point
Compressed concrete area A_b	28,390.618 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(27.430; 33.438) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	326.492 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-10.917 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.956 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	263.922	-0.85679	-171.358	-4.861	-0.374	0.374
2	0.000	-77.000	28.366	213.051	-0.01702	-3.404	-0.097	-0.007	0.000
3	77.000	-77.000	28.366	162.180	0.82275	164.550	4.668	0.359	0.359
4	-77.000	77.000	28.366	148.316	1.05162	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	97.445	1.89139	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	46.574	2.73115	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	206.119	0.09741	19.483	0.553	0.000	-0.043
8	77.000	0.000	28.366	104.377	1.77695	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							24.091	-1.398	1.150

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	326.492	-10.917	8.956	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	24.091	-1.398	1.150	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**350.583**	**-12.316**	**10.105**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C1 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	67.611 kN	From analysis results
M_2	12.751 kN·m	From analysis results
M_3	-8.459 kN·m	From analysis results
M_{2s}	14.037 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.191 kN·m	Including second-order magnification and accidental eccentricity

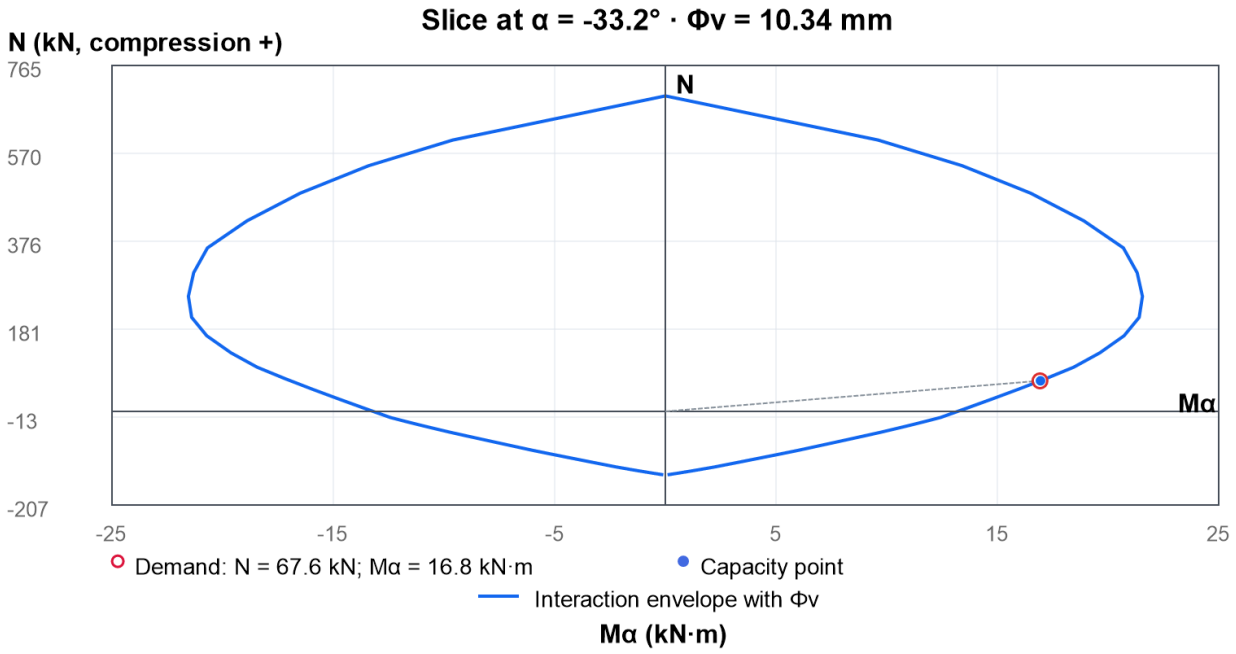
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	188.59	125.11	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.86	0.57	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.06481	0.08634	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,984,849	2,984,849	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	765,799,207,900	881,361,946,085	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	738.10	849.48	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1008	1.0865	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

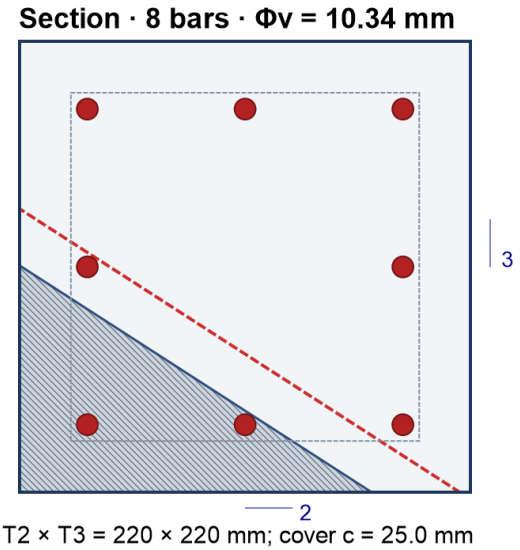
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 93.03 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	671.24 mm^2	Calculation results
Φ_v	10.3359 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9987	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	237.2228°	Geometry at the check point
Normal vector n	(-0.541373; -0.840782)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	93.0316 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.541373 \cdot x_2 - 0.840782 \cdot x_3 = 59.0055$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.541373 \cdot x_2 - 0.840782 \cdot x_3 = 35.7476$ mm	Geometry at the check point
Compressed concrete area A_b	9,507.151 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-52.719; -73.117) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	109.332 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.994 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.764 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.3359 mm / 83.905 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	83.905	45.611	2.12723	210.000	17.620	1.357	-1.357
2	0.000	-77.000	83.905	87.297	0.87260	174.520	14.643	1.128	0.000
3	77.000	-77.000	83.905	128.983	-0.38203	-76.406	-6.411	-0.494	-0.494
4	-77.000	77.000	83.905	175.092	-1.76979	-210.000	-17.620	1.357	1.357
5	0.000	77.000	83.905	216.777	-3.02441	-210.000	-17.620	1.357	0.000
6	77.000	77.000	83.905	258.463	-4.27904	-210.000	-17.620	1.357	-1.357
7	-77.000	0.000	83.905	110.351	0.17872	35.744	2.999	0.000	-0.231
8	77.000	0.000	83.905	193.723	-2.33054	-210.000	-17.620	0.000	-1.357
Σ N_{si}, M_{xsi}, M_{ysi}							-41.629	6.061	-3.438

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	109.332	7.994	-5.764	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-41.629	6.061	-3.438	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**67.703**	**14.055**	**-9.202**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	88.312 kN	From analysis results
M_2	9.206 kN·m	From analysis results
M_3	10.413 kN·m	From analysis results
M_{2s}	10.342 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.768 kN·m	Including second-order magnification and accidental eccentricity

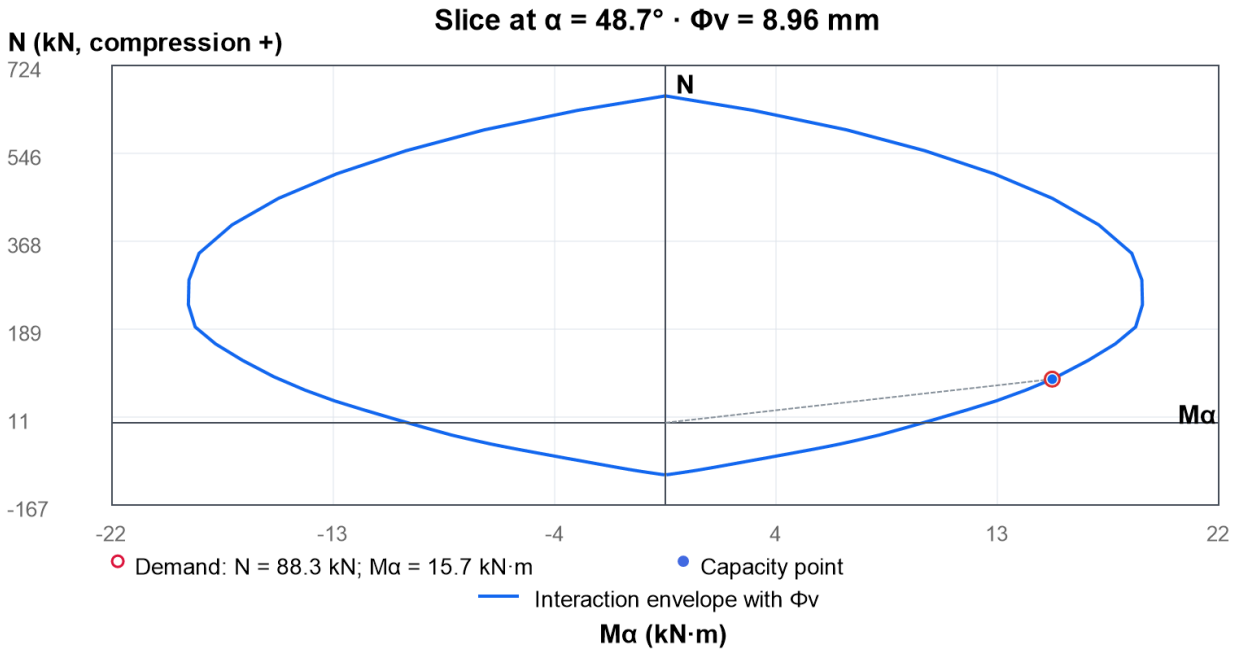
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	104.24	117.91	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.47	0.54	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.09692	0.08972	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,241,077	2,241,077	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	834,057,037,823	795,397,908,046	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	803.89	766.63	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.1234	1.1302	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

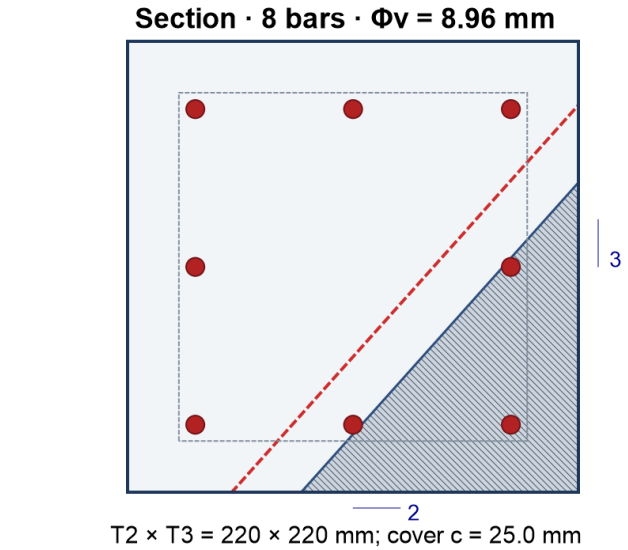
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 100.86 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	503.98 mm^2	Calculation results
Φ_v	8.9561 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9997	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	318.1566°	Geometry at the check point
Normal vector n	(0.744970; -0.667098)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	100.8609 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.744970 \cdot x_2 - 0.667098 \cdot x_3 = 54.4666$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.744970 \cdot x_2 - 0.667098 \cdot x_3 = 29.2514$ mm	Geometry at the check point
Compressed concrete area A_b	10,234.983 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(64.870; -59.602) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	117.702 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.015 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.635 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.9561 mm / 62.998 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	62.998	161.324	-0.97851	-195.702	-12.329	-0.949	0.949
2	0.000	-77.000	62.998	103.961	0.61394	122.788	7.735	0.596	0.000
3	77.000	-77.000	62.998	46.598	2.20639	210.000	13.229	1.019	1.019
4	-77.000	77.000	62.998	264.057	-3.83048	-210.000	-13.229	1.019	1.019
5	0.000	77.000	62.998	206.694	-2.23803	-210.000	-13.229	1.019	0.000
6	77.000	77.000	62.998	149.331	-0.64559	-129.117	-8.134	0.626	-0.626
7	-77.000	0.000	62.998	212.690	-2.40449	-210.000	-13.229	0.000	1.019
8	77.000	0.000	62.998	97.965	0.78040	156.080	9.833	0.000	0.757
Σ N_{si}, M_{xsi}, M_{ysi}							-29.354	3.329	4.136

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	117.702	7.015	7.635	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-29.354	3.329	4.136	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**88.348**	**10.344**	**11.771**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	90.138 kN	From analysis results
M_2	1.508 kN·m	From analysis results
M_3	1.599 kN·m	From analysis results
M_{2s}	1.657 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.757 kN·m	Including second-order magnification and accidental eccentricity

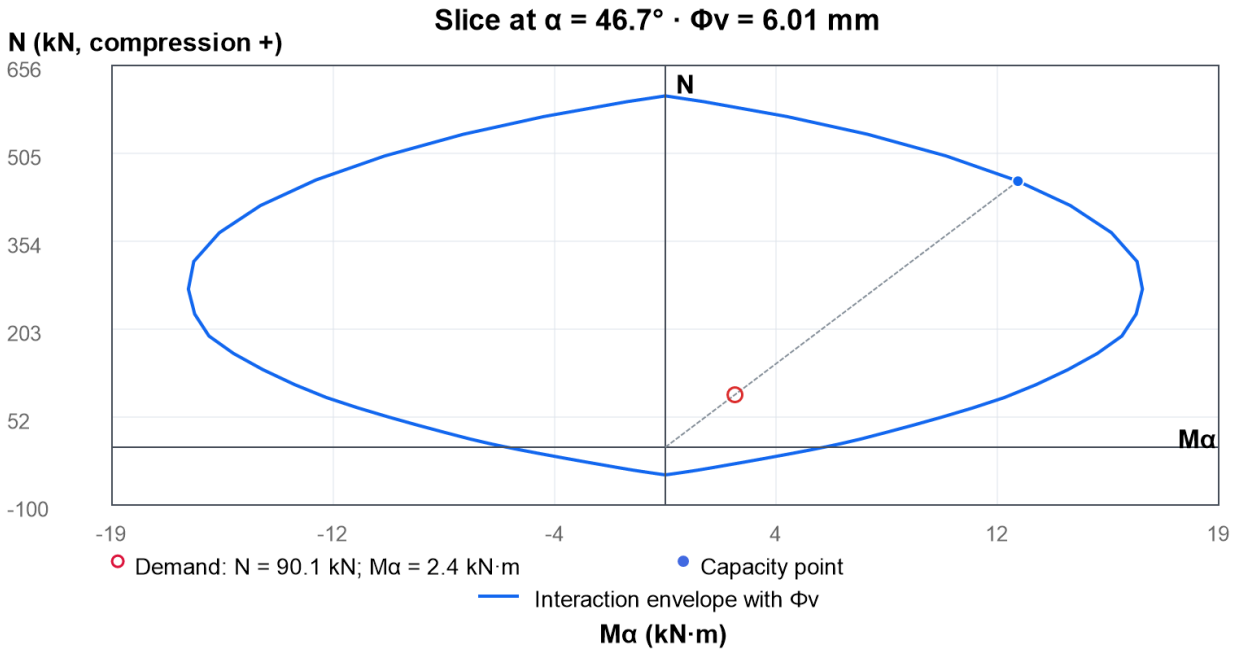
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	16.73	17.74	8.1.2.2.4; $e_0 = \max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0992	1.0992	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

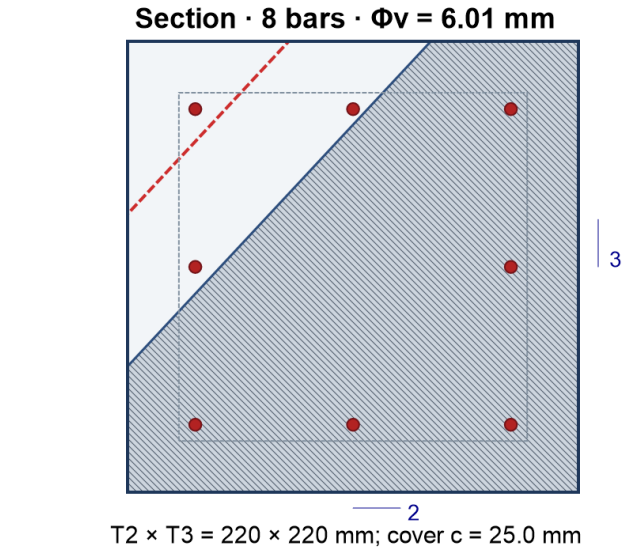
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 202.81 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1970	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	316.9797°	Geometry at the check point
Normal vector n	(0.731112; -0.682257)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	202.8087 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.731112 \cdot x_2 - 0.682257 \cdot x_3 = -47.3381$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.731112 \cdot x_2 - 0.682257 \cdot x_3 = -98.0403$ mm	Geometry at the check point
Compressed concrete area A_b	36,679.380 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(19.396; -18.268) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	421.813 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.706 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.182 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	159.233	1.30162	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	102.937	2.07884	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.641	2.85607	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	264.300	-0.14896	-29.791	-0.845	0.065	0.065
5	0.000	77.000	28.366	208.004	0.62827	125.654	3.564	-0.274	0.000
6	77.000	77.000	28.366	151.709	1.40549	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	211.766	0.57633	115.266	3.270	0.000	-0.252
8	77.000	0.000	28.366	99.175	2.13078	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							35.774	0.708	0.731

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	421.813	7.706	8.182	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	35.774	0.708	0.731	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**457.587**	**8.414**	**8.912**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C2 / C22	Model data
Dimensions	$T_2 \times T_3 = 220.0 \times 220.0$ mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	92.571 kN	From analysis results
M_2	-8.756 kN·m	From analysis results
M_3	-10.153 kN·m	From analysis results
M_{2s}	-9.894 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.562 kN·m	Including second-order magnification and accidental eccentricity

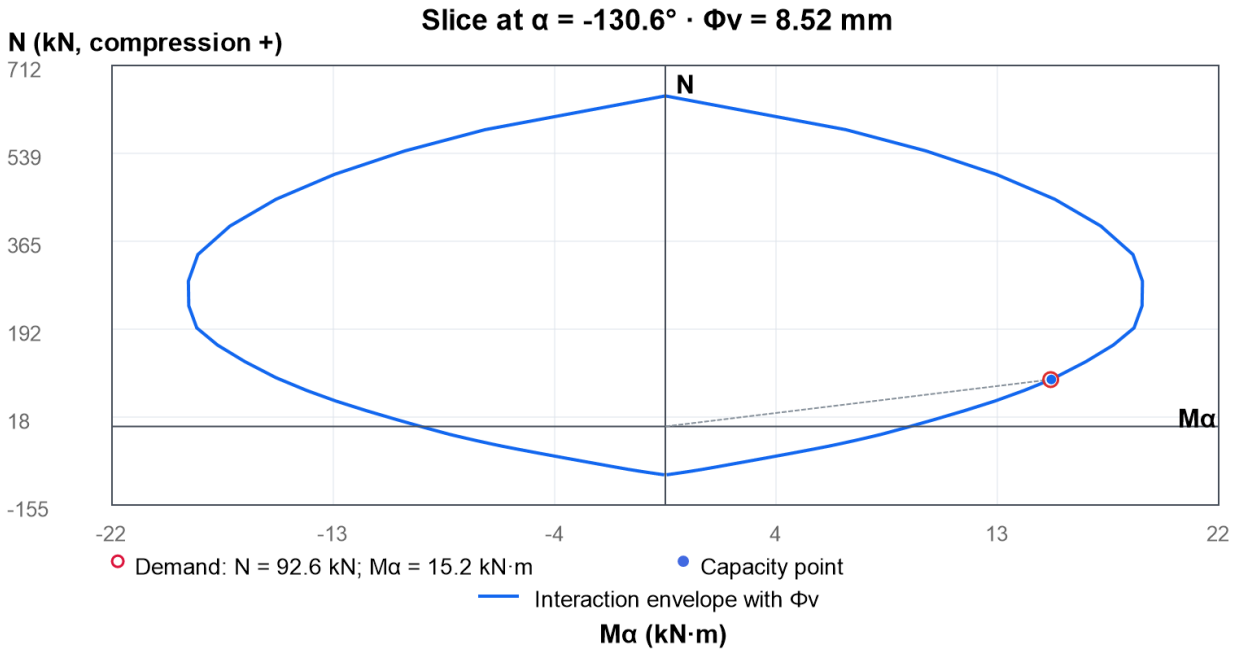
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\text{ mm})$
e_0 (mm)	94.59	109.68	8.1.2.2.4; $e_0 = \max(\lvert M\rvert/N; e_a)$
δ_e	0.43	0.50	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.10275	0.09392	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,027,935	2,027,935	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	835,495,358,925	788,123,348,541	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	805.27	759.62	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1299	1.1388	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

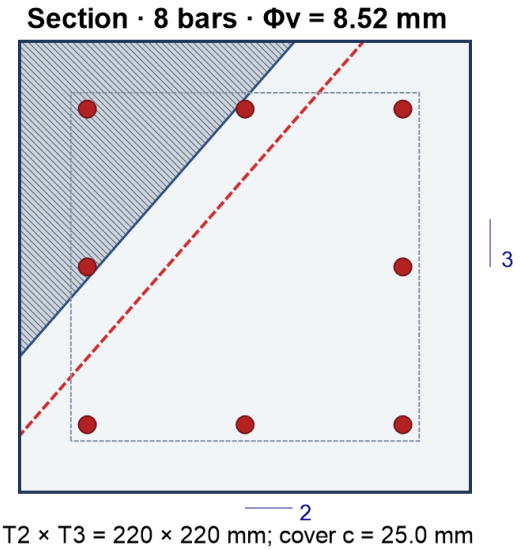
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 101.14 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	456.05 mm^2	Calculation results
Φ_v	8.5195 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9983	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	138.8858°	Geometry at the check point
Normal vector n	(-0.753400; 0.657562)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	101.1383 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.753400 \cdot x_2 + 0.657562 \cdot x_3 = 54.0676$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.753400 \cdot x_2 + 0.657562 \cdot x_3 = 28.7830$ mm	Geometry at the check point
Compressed concrete area A_b	10,323.775 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-65.253; 58.731) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	118.723 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.973 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.747 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.5195 mm / 57.006 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	57.006	147.826	-0.59255	-118.510	-6.756	-0.520	0.520
2	0.000	-77.000	57.006	205.838	-2.19860	-210.000	-11.971	-0.922	0.000
3	77.000	-77.000	57.006	263.850	-3.80465	-210.000	-11.971	-0.922	-0.922
4	-77.000	77.000	57.006	46.562	2.21094	210.000	11.971	-0.922	-0.922
5	0.000	77.000	57.006	104.574	0.60489	120.979	6.897	-0.531	0.000
6	77.000	77.000	57.006	162.585	-1.00116	-200.231	-11.414	0.879	-0.879
7	-77.000	0.000	57.006	97.194	0.80920	161.839	9.226	0.000	-0.710
8	77.000	0.000	57.006	213.218	-2.40290	-210.000	-11.971	0.000	-0.922
Σ N_{si}, M_{xsi}, M_{ysi}							-25.990	-2.938	-3.834

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	118.723	-6.973	-7.747	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-25.990	-2.938	-3.834	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**92.733**	**-9.910**	**-11.581**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	72.747 kN	From analysis results
M_2	2.592 kN·m	From analysis results
M_3	9.527 kN·m	From analysis results
M_{2s}	2.797 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	10.871 kN·m	Including second-order magnification and accidental eccentricity

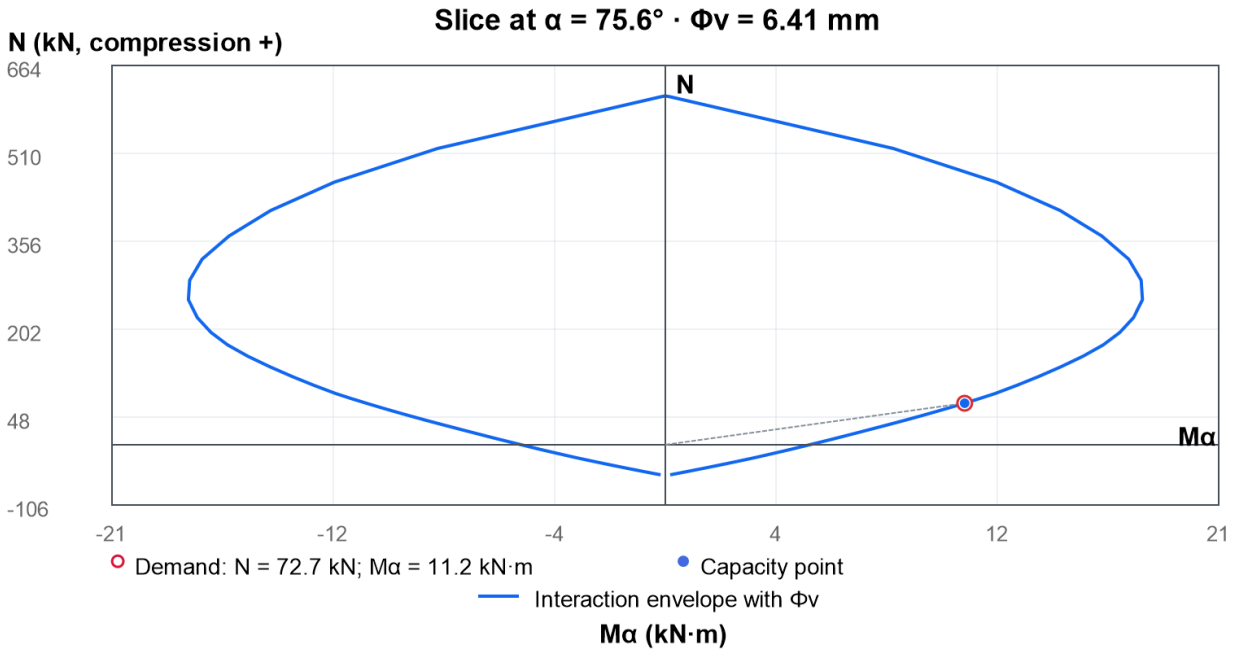
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	35.64	130.97	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.16	0.60	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16234	0.08377	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,148,643	1,148,643	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,032,334,530,479	610,518,840,762	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	994.99	588.44	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0789	1.1411	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

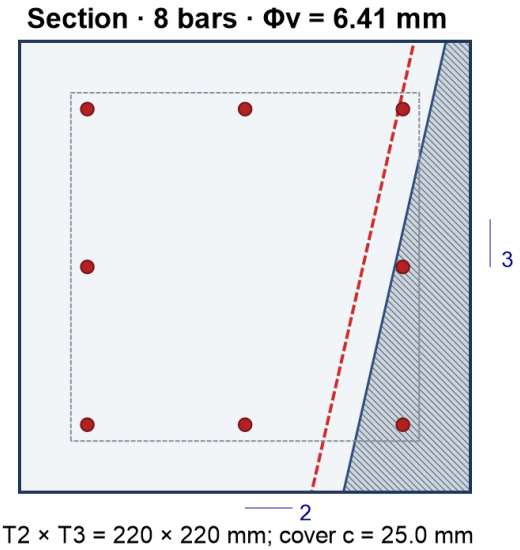
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 60.47 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	258.31 mm^2	Calculation results
Φ_v	6.4118 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9998	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	347.1916°	Geometry at the check point
Normal vector n	(0.975117; -0.221691)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	60.4665 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.975117 \cdot x_2 - 0.221691 \cdot x_3 = 71.1824$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.975117 \cdot x_2 - 0.221691 \cdot x_3 = 56.0658$ mm	Geometry at the check point
Compressed concrete area A_b	8,140.254 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(88.682; -24.782) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	93.613 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	2.320 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.302 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.4118 mm / 32.289 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	32.289	189.663	-5.28264	-210.000	-6.781	-0.522	0.522
2	0.000	-77.000	32.289	114.579	-1.80575	-210.000	-6.781	-0.522	0.000
3	77.000	-77.000	32.289	39.495	1.67113	210.000	6.781	0.522	0.522
4	-77.000	77.000	32.289	223.803	-6.86357	-210.000	-6.781	0.522	0.522
5	0.000	77.000	32.289	148.719	-3.38668	-210.000	-6.781	0.522	0.000
6	77.000	77.000	32.289	73.635	0.09020	18.041	0.583	-0.045	0.045
7	-77.000	0.000	32.289	206.733	-6.07311	-210.000	-6.781	0.000	0.522
8	77.000	0.000	32.289	56.565	0.88067	176.134	5.687	0.000	0.438
Σ N_{si}, M_{xsi}, M_{ysi}							-20.853	0.477	2.571

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	93.613	2.320	8.302	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-20.853	0.477	2.571	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**72.760**	**2.797**	**10.873**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	74.572 kN	From analysis results
M_2	0.162 kN·m	From analysis results
M_3	1.448 kN·m	From analysis results
M_{2s}	0.806 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.565 kN·m	Including second-order magnification and accidental eccentricity

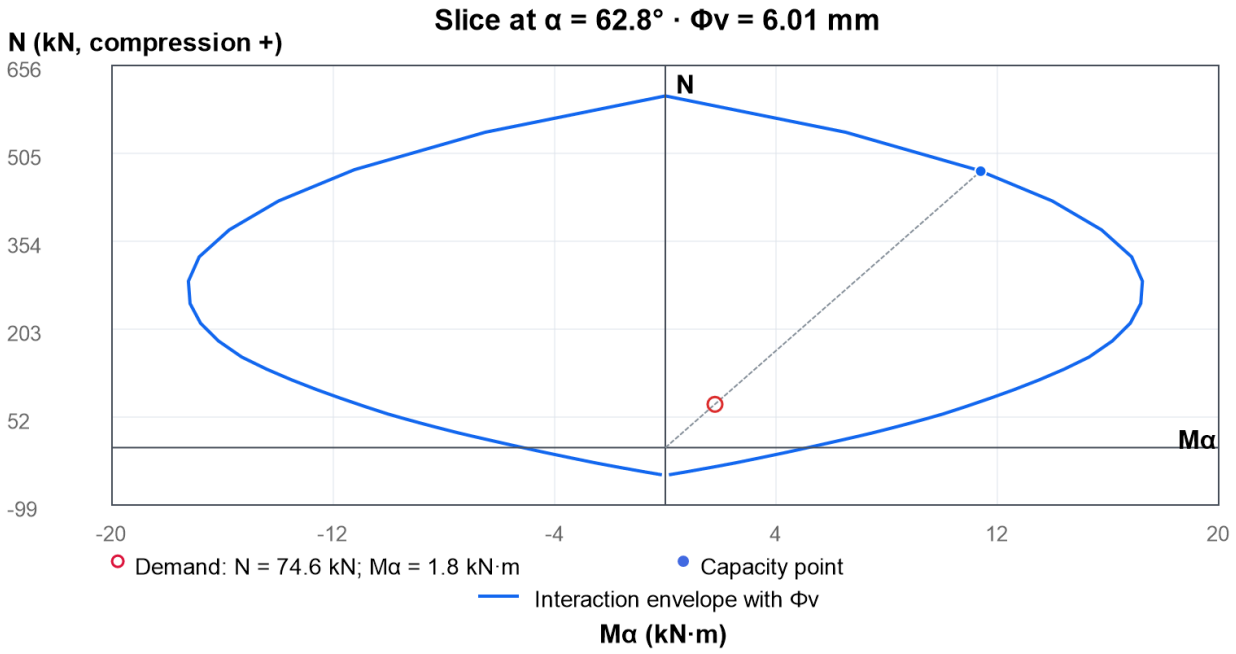
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	19.42	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0807	1.0807	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

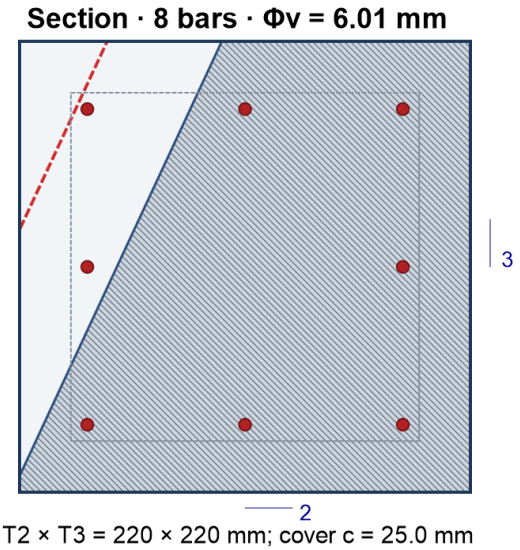
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 202.86 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1570	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	335.0466°	Geometry at the check point
Normal vector n	(0.906651; -0.421881)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	202.8575 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.906651 \cdot x_2 - 0.421881 \cdot x_3 = -56.7190$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.906651 \cdot x_2 - 0.421881 \cdot x_3 = -107.4334$ mm	Geometry at the check point
Compressed concrete area A_b	37,947.876 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(21.243; -10.838) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	436.401 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	4.730 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	9.270 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	183.466	0.96766	193.532	5.490	0.423	-0.423
2	0.000	-77.000	28.366	113.654	1.93126	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	43.842	2.89486	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	248.435	0.07090	14.179	0.402	-0.031	-0.031
5	0.000	77.000	28.366	178.623	1.03450	206.900	5.869	-0.452	0.000
6	77.000	77.000	28.366	108.811	1.99810	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	215.951	0.51928	103.856	2.946	0.000	-0.227
8	77.000	0.000	28.366	76.326	2.44648	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							38.535	0.399	0.696

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	436.401	4.730	9.270	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	38.535	0.399	0.696	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**474.935**	**5.128**	**9.966**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C3 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	77.006 kN	From analysis results
M_2	-3.079 kN·m	From analysis results
M_3	-9.325 kN·m	From analysis results
M_{2s}	-3.351 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-10.700 kN·m	Including second-order magnification and accidental eccentricity

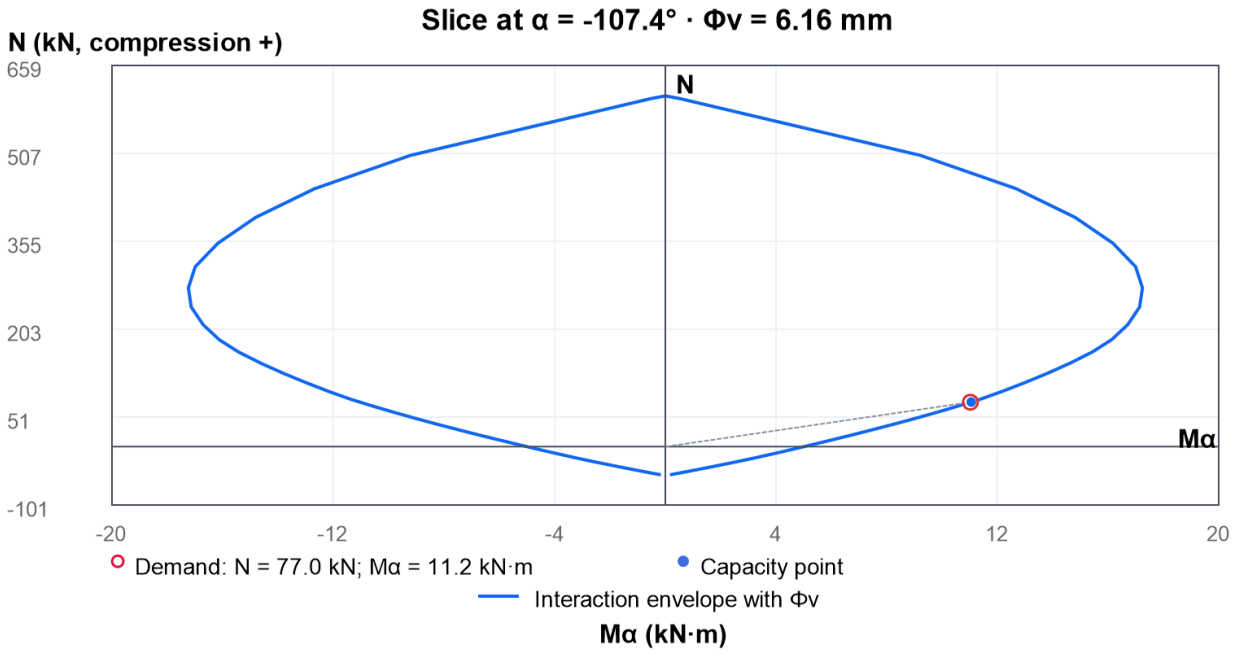
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	39.98	121.09	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.18	0.55	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.15569	0.08819	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,058,900	1,058,900	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	984,031,750,185	621,698,414,443	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	948.44	599.21	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0884	1.1475	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

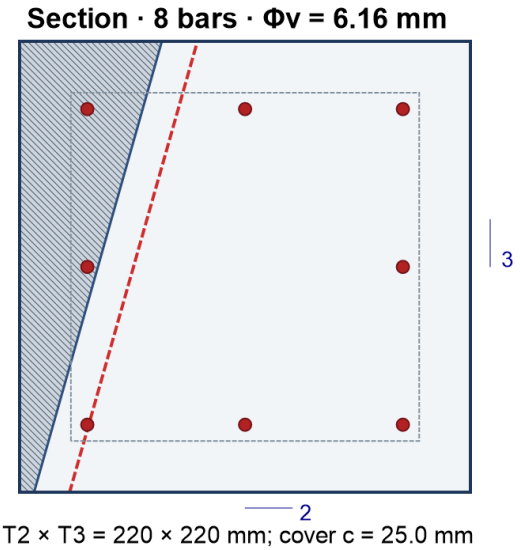
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 66.75 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	238.13 mm^2	Calculation results
Φ_v	6.1563 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9970	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	164.1736°	Geometry at the check point
Normal vector n	(-0.962093; 0.272723)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	66.7526 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.962093 \cdot x_2 + 0.272723 \cdot x_3 = 69.0771$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.962093 \cdot x_2 + 0.272723 \cdot x_3 = 52.3890$ mm	Geometry at the check point
Compressed concrete area A_b	8,404.254 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-86.657; 29.929) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	96.649 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-2.893 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.375 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.1563 mm / 29.766 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	29.766	82.748	0.02905	5.809	0.173	0.013	-0.013
2	0.000	-77.000	29.766	156.829	-3.07836	-210.000	-6.251	-0.481	0.000
3	77.000	-77.000	29.766	230.911	-6.18576	-210.000	-6.251	-0.481	-0.481
4	-77.000	77.000	29.766	40.749	1.79075	210.000	6.251	-0.481	-0.481
5	0.000	77.000	29.766	114.830	-1.31665	-210.000	-6.251	0.481	0.000
6	77.000	77.000	29.766	188.911	-4.42406	-210.000	-6.251	0.481	-0.481
7	-77.000	0.000	29.766	61.749	0.90990	181.979	5.417	0.000	-0.417
8	77.000	0.000	29.766	209.911	-5.30491	-210.000	-6.251	0.000	-0.481
Σ N_{si}, M_{xsi}, M_{ysi}							-19.414	-0.468	-2.356

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	96.649	-2.893	-8.375	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-19.414	-0.468	-2.356	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**77.235**	**-3.361**	**-10.731**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	36.717 kN	From analysis results
M_2	2.462 kN·m	From analysis results
M_3	8.335 kN·m	From analysis results
M_{2s}	2.576 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.030 kN·m	Including second-order magnification and accidental eccentricity

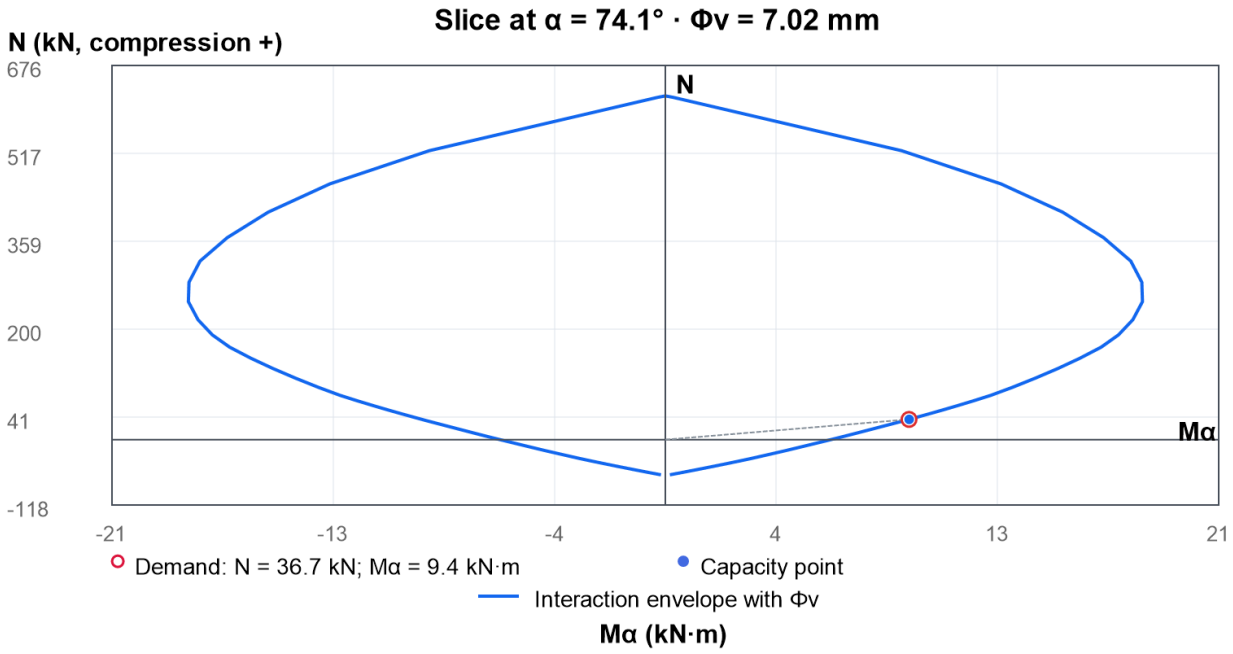
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	67.06	227.00	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.30	1.03	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.12401	0.05631	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,377,307	1,377,307	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	858,536,744,328	495,132,735,521	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	827.48	477.22	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0464	1.0834	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

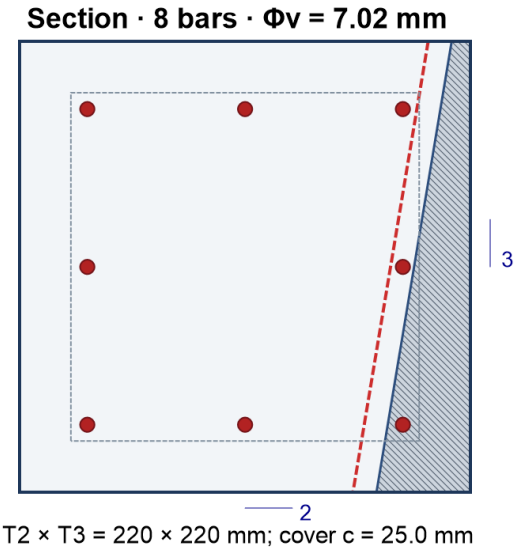
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 45.26 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	309.73 mm^2	Calculation results
Φ_v	7.0211 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	350.5257°	Geometry at the check point
Normal vector n	(0.986360; -0.164604)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	45.2636 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.986360 \cdot x_2 - 0.164604 \cdot x_3 = 81.3425$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis ε_s=0	$0.986360 \cdot x_2 - 0.164604 \cdot x_3 = 70.0266$ mm	Geometry at the check point
Compressed concrete area A_b	6,057.182 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(94.194; -24.447) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	69.658 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	1.703 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.561 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.0211 mm / 38.717 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	38.717	189.881	-8.24603	-210.000	-8.131	-0.626	0.626
2	0.000	-77.000	38.717	113.932	-3.54779	-210.000	-8.131	-0.626	0.000
3	77.000	-77.000	38.717	37.982	1.15045	210.000	8.131	0.626	0.626
4	-77.000	77.000	38.717	215.230	-9.81412	-210.000	-8.131	0.626	0.626
5	0.000	77.000	38.717	139.281	-5.11588	-210.000	-8.131	0.626	0.000
6	77.000	77.000	38.717	63.331	-0.41764	-83.528	-3.234	0.249	-0.249
7	-77.000	0.000	38.717	202.556	-9.03008	-210.000	-8.131	0.000	0.626
8	77.000	0.000	38.717	50.656	0.36640	73.281	2.837	0.000	0.218
Σ N_{si}, M_{xsi}, M_{ysi}							-32.919	0.875	2.474

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	69.658	1.703	6.561	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-32.919	0.875	2.474	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**36.739**	**2.578**	**9.035**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	38.543 kN	From analysis results
M_2	1.379 kN·m	From analysis results
M_3	0.989 kN·m	From analysis results
M_{2s}	1.436 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	1.028 kN·m	Including second-order magnification and accidental eccentricity

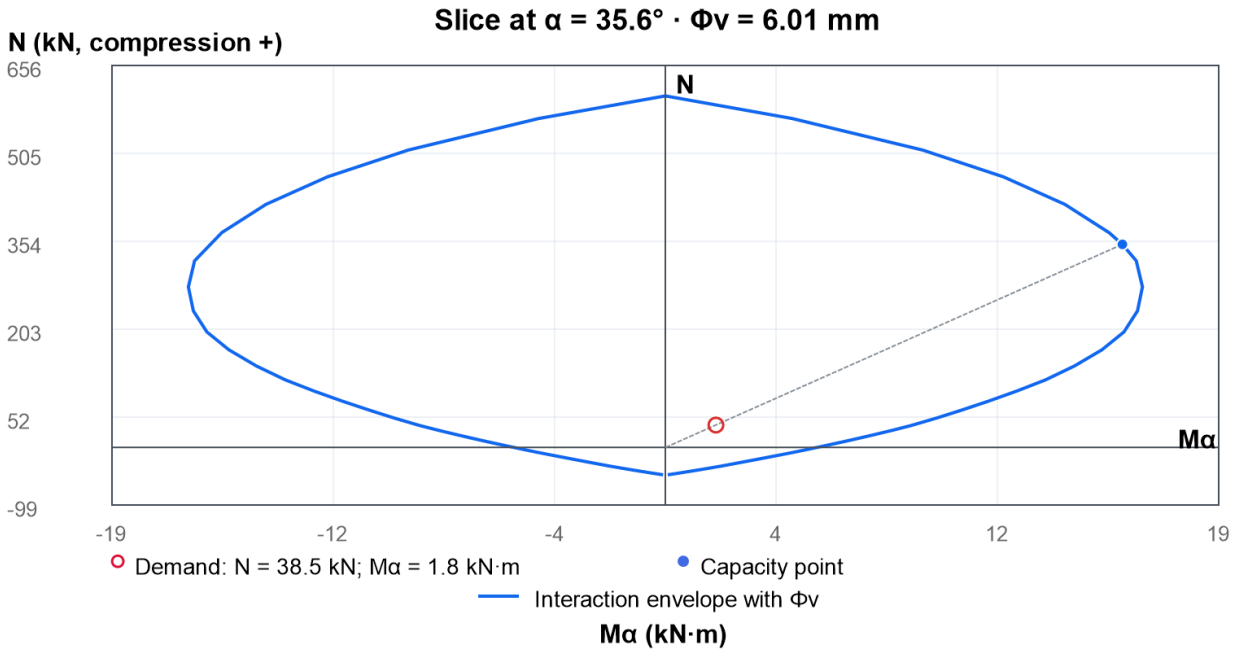
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	35.79	25.65	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.16	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1 + M_{L1}/M_L)$
k_b	0.16210	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3 + \delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma\ A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,011,508,388,457	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	974.92	998.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0412	1.0401	(44); $\eta = 1/(1 - N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

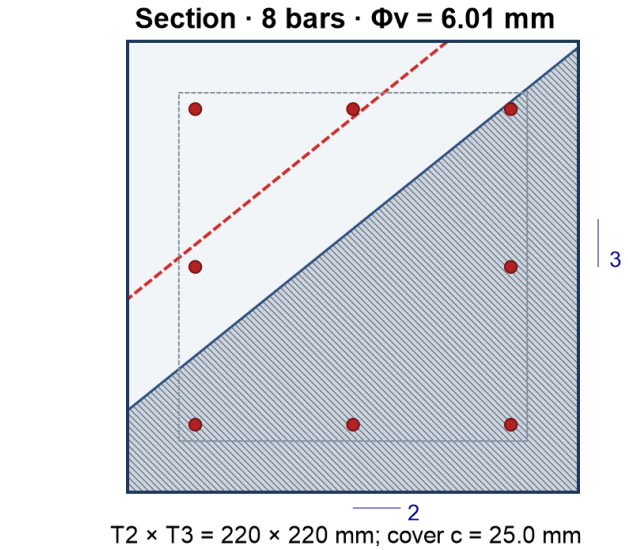
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 169.15 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1104	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	308.8491°	Geometry at the check point
Normal vector n	(0.627271; -0.778801)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	169.1522 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.627271 \cdot x_2 - 0.778801 \cdot x_3 = -14.4843$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.627271 \cdot x_2 - 0.778801 \cdot x_3 = -56.7723$ mm	Geometry at the check point
Compressed concrete area A_b	28,291.601 mm²	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(25.261; -35.528) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	325.353 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	11.559 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.219 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm²	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm²)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	143.000	1.13290	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	94.700	1.93241	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	46.400	2.73193	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	262.935	-0.85241	-170.481	-4.836	0.372	0.372
5	0.000	77.000	28.366	214.636	-0.05289	-10.579	-0.300	0.023	0.000
6	77.000	77.000	28.366	166.336	0.74662	149.324	4.236	-0.326	0.326
7	-77.000	0.000	28.366	202.968	0.14025	28.049	0.796	0.000	-0.061
8	77.000	0.000	28.366	106.368	1.73927	210.000	5.957	0.000	0.459
Σ N_{si}, M_{xsi}, M_{ysi}							23.723	1.445	1.096

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	325.353	11.559	8.219	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	23.723	1.445	1.096	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**349.077**	**13.004**	**9.315**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C4 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	40.976 kN	From analysis results
M_2	-0.064 kN·m	From analysis results
M_3	-8.806 kN·m	From analysis results
M_{2s}	-0.426 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.604 kN·m	Including second-order magnification and accidental eccentricity

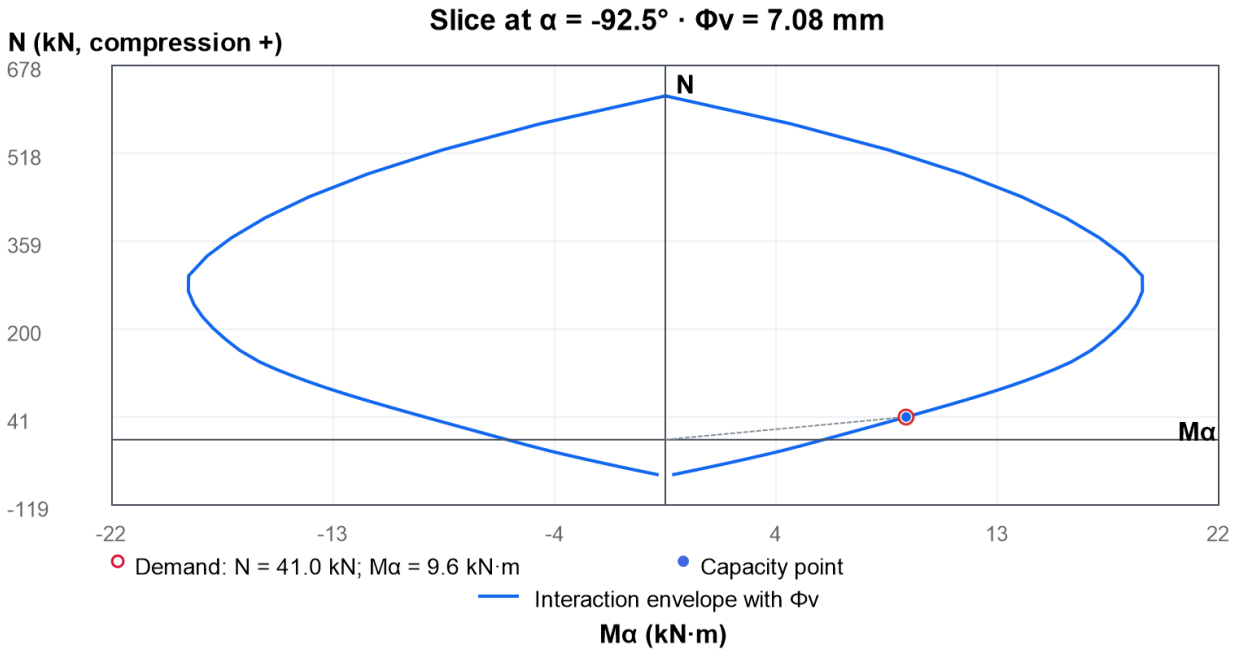
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	214.91	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.98	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.05874	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,401,761	1,401,761	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,090,974,264,273	511,572,556,789	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,051.51	493.07	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0405	1.0906	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

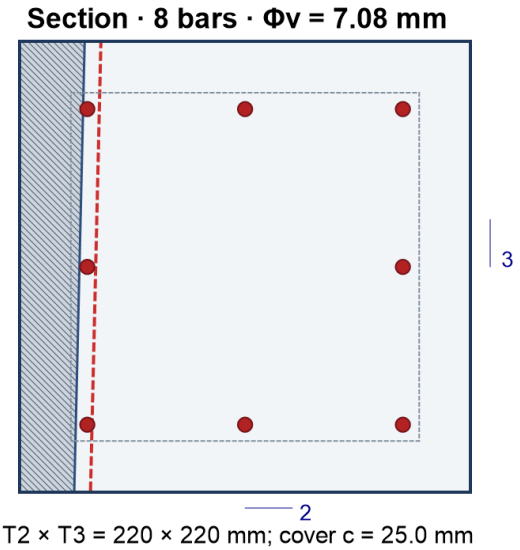
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 31.71 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	315.23 mm^2	Calculation results
Φ_v	7.0831 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	178.6756°	Geometry at the check point
Normal vector n	(-0.999733; 0.023113)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	31.7101 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.999733 \cdot x_2 + 0.023113 \cdot x_3 = 80.8030$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.999733 \cdot x_2 + 0.023113 \cdot x_3 = 72.8754$ mm	Geometry at the check point
Compressed concrete area A_b	6,418.598 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-95.375; 3.196) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	73.814 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-0.236 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.040 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	7.0831 mm / 39.404 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	39.404	37.313	0.20523	41.047	1.617	0.125	-0.125
2	0.000	-77.000	39.404	114.293	-6.59205	-210.000	-8.275	-0.637	0.000
3	77.000	-77.000	39.404	191.272	-13.38933	-210.000	-8.275	-0.637	-0.637
4	-77.000	77.000	39.404	33.754	0.51953	103.906	4.094	-0.315	-0.315
5	0.000	77.000	39.404	110.733	-6.27776	-210.000	-8.275	0.637	0.000
6	77.000	77.000	39.404	187.713	-13.07504	-210.000	-8.275	0.637	-0.637
7	-77.000	0.000	39.404	35.534	0.36238	72.476	2.856	0.000	-0.220
8	77.000	0.000	39.404	189.492	-13.23219	-210.000	-8.275	0.000	-0.637
Σ N_{si}, M_{xsi}, M_{ysi}							-32.807	-0.191	-2.571

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	73.814	-0.236	-7.040	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-32.807	-0.191	-2.571	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**41.007**	**-0.427**	**-9.611**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	62.927 kN	From analysis results
M_2	-13.163 kN·m	From analysis results
M_3	-9.085 kN·m	From analysis results
M_{2s}	-14.368 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-9.815 kN·m	Including second-order magnification and accidental eccentricity

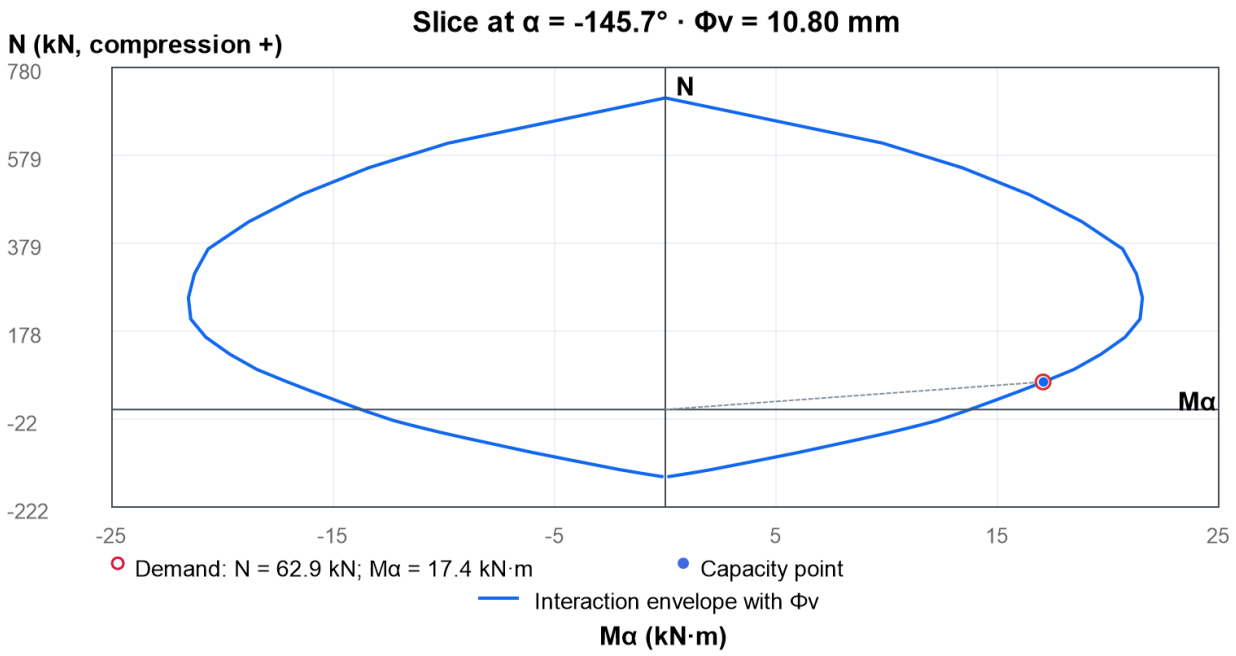
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	209.18	144.37	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.95	0.66	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.05996	0.07843	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	3,261,722	3,261,722	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	778,529,972,369	877,695,899,147	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	750.37	845.95	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0915	1.0804	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

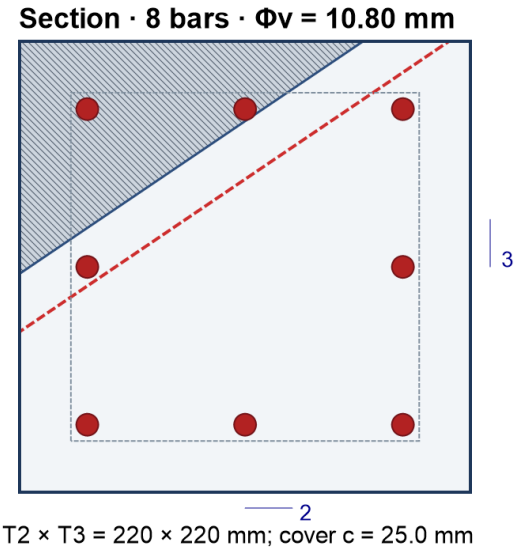
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 93.85 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	733.51 mm^2	Calculation results
Φ_v	10.8047 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9989	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	124.0778°	Geometry at the check point
Normal vector n	(-0.560318; 0.828278)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	93.8531 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.560318 \cdot x_2 + 0.828278 \cdot x_3 = 58.8924$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.560318 \cdot x_2 + 0.828278 \cdot x_3 = 35.4291$ mm	Geometry at the check point
Compressed concrete area A_b	9,489.795 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-54.167; 72.230) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	109.133 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-7.883 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-5.911 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.8047 mm / 91.688 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	91.688	173.378	-1.67255	-210.000	-19.255	-1.483	1.483
2	0.000	-77.000	91.688	216.523	-2.95971	-210.000	-19.255	-1.483	0.000
3	77.000	-77.000	91.688	259.667	-4.24688	-210.000	-19.255	-1.483	-1.483
4	-77.000	77.000	91.688	45.824	2.13290	210.000	19.255	-1.483	-1.483
5	0.000	77.000	91.688	88.968	0.84574	169.148	15.509	-1.194	0.000
6	77.000	77.000	91.688	132.113	-0.44143	-88.286	-8.095	0.623	-0.623
7	-77.000	0.000	91.688	109.601	0.23018	46.036	4.221	0.000	-0.325
8	77.000	0.000	91.688	195.890	-2.34415	-210.000	-19.255	0.000	-1.483
Σ N_{si}, M_{xsi}, M_{ysi}							-46.129	-6.501	-3.914

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	109.133	-7.883	-5.911	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-46.129	-6.501	-3.914	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**63.004**	**-14.384**	**-9.825**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	64.753 kN	From analysis results
M_2	-2.124 kN·m	From analysis results
M_3	-1.689 kN·m	From analysis results
M_{2s}	-2.272 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.806 kN·m	Including second-order magnification and accidental eccentricity

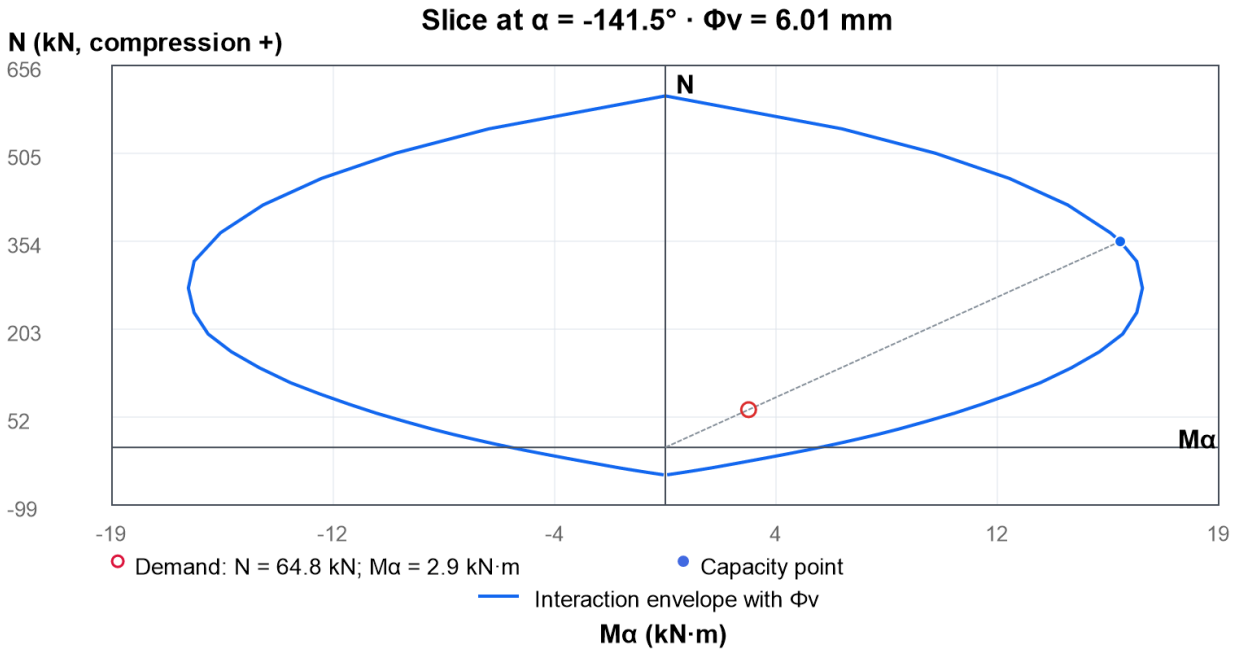
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	32.81	26.08	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0693	1.0693	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

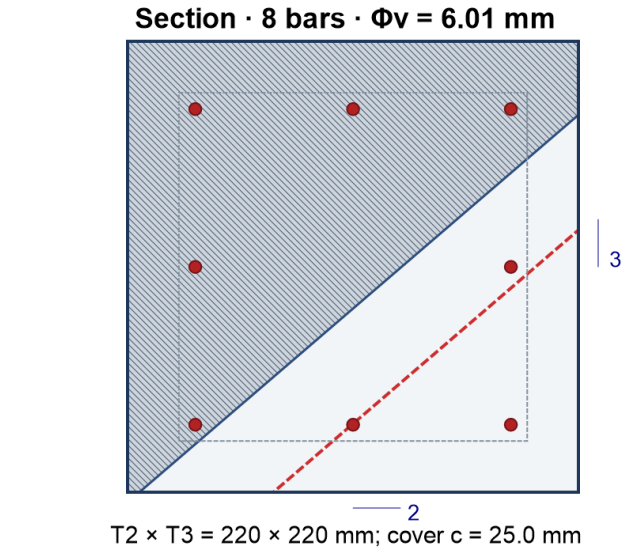
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 170.53 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1829	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	130.6713°	Geometry at the check point
Normal vector n	(-0.651719; 0.758460)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	170.5320 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.651719 \cdot x_2 + 0.758460 \cdot x_3 = -15.4122$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.651719 \cdot x_2 + 0.758460 \cdot x_3 = -58.0452$ mm	Geometry at the check point
Compressed concrete area A_b	28,656.867 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-26.555; 33.483) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	329.554 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-11.035 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.751 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	163.339	0.81811	163.621	4.641	0.357	-0.357
2	0.000	-77.000	28.366	213.521	-0.00585	-1.170	-0.033	-0.003	0.000
3	77.000	-77.000	28.366	263.704	-0.82980	-165.961	-4.708	-0.362	-0.362
4	-77.000	77.000	28.366	46.536	2.73592	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	96.718	1.91196	210.000	5.957	-0.459	0.000
6	77.000	77.000	28.366	146.901	1.08801	210.000	5.957	-0.459	0.459
7	-77.000	0.000	28.366	104.937	1.77701	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	205.302	0.12910	25.820	0.732	0.000	0.056
Σ N_{si}, M_{xsi}, M_{ysi}							24.461	-1.384	-1.122

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	329.554	-11.035	-8.751	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	24.461	-1.384	-1.122	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**354.015**	**-12.418**	**-9.873**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C6 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	67.186 kN	From analysis results
M_2	12.594 kN·m	From analysis results
M_3	8.173 kN·m	From analysis results
M_{2s}	13.876 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	8.878 kN·m	Including second-order magnification and accidental eccentricity

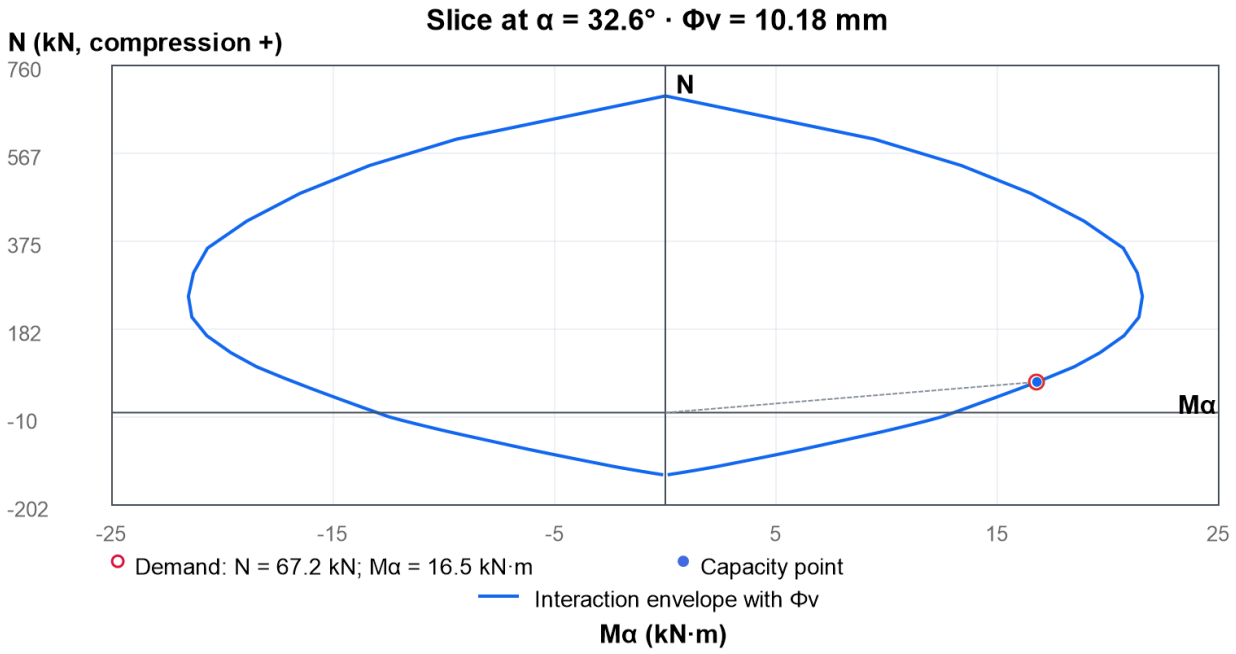
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	187.46	121.64	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.85	0.55	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.06510	0.08793	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,895,286	2,895,286	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	754,822,241,147	877,402,214,536	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	727.52	845.67	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.1017	1.0863	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

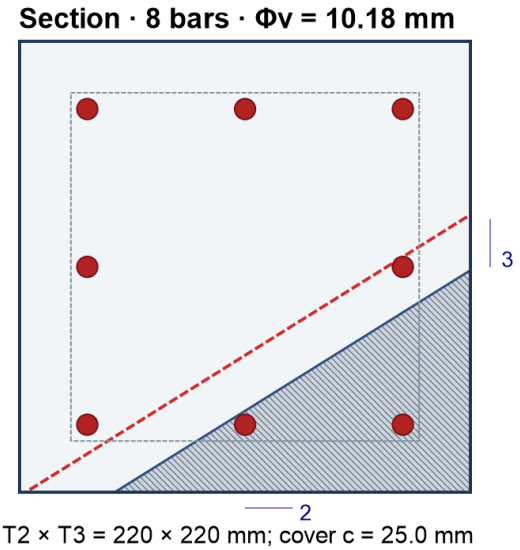
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 91.95 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	651.10 mm^2	Calculation results
Φ_v	10.1797 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9985	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	301.9650°	Geometry at the check point
Normal vector n	(0.529402; -0.848371)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	91.9534 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.529402 \cdot x_2 - 0.848371 \cdot x_3 = 59.6016$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.529402 \cdot x_2 - 0.848371 \cdot x_3 = 36.6133$ mm	Geometry at the check point
Compressed concrete area A_b	9,413.132 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(52.102; -73.871) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	108.251 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.997 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	5.640 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	10.1797 mm / 81.388 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	81.388	126.994	-0.36700	-73.401	-5.974	-0.460	0.460
2	0.000	-77.000	81.388	86.230	0.87427	174.853	14.231	1.096	0.000
3	77.000	-77.000	81.388	45.467	2.11554	210.000	17.091	1.316	1.316
4	-77.000	77.000	81.388	257.644	-4.34530	-210.000	-17.091	1.316	1.316
5	0.000	77.000	81.388	216.880	-3.10403	-210.000	-17.091	1.316	0.000
6	77.000	77.000	81.388	176.116	-1.86276	-210.000	-17.091	1.316	-1.316
7	-77.000	0.000	81.388	192.319	-2.35615	-210.000	-17.091	0.000	1.316
8	77.000	0.000	81.388	110.791	0.12639	25.277	2.057	0.000	0.158
Σ N_{si}, M_{xsi}, M_{ysi}							-40.960	5.900	3.250

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	108.251	7.997	5.640	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-40.960	5.900	3.250	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**67.291**	**13.897**	**8.891**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	89.499 kN	From analysis results
M_2	9.283 kN·m	From analysis results
M_3	-10.710 kN·m	From analysis results
M_{2s}	10.423 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-12.108 kN·m	Including second-order magnification and accidental eccentricity

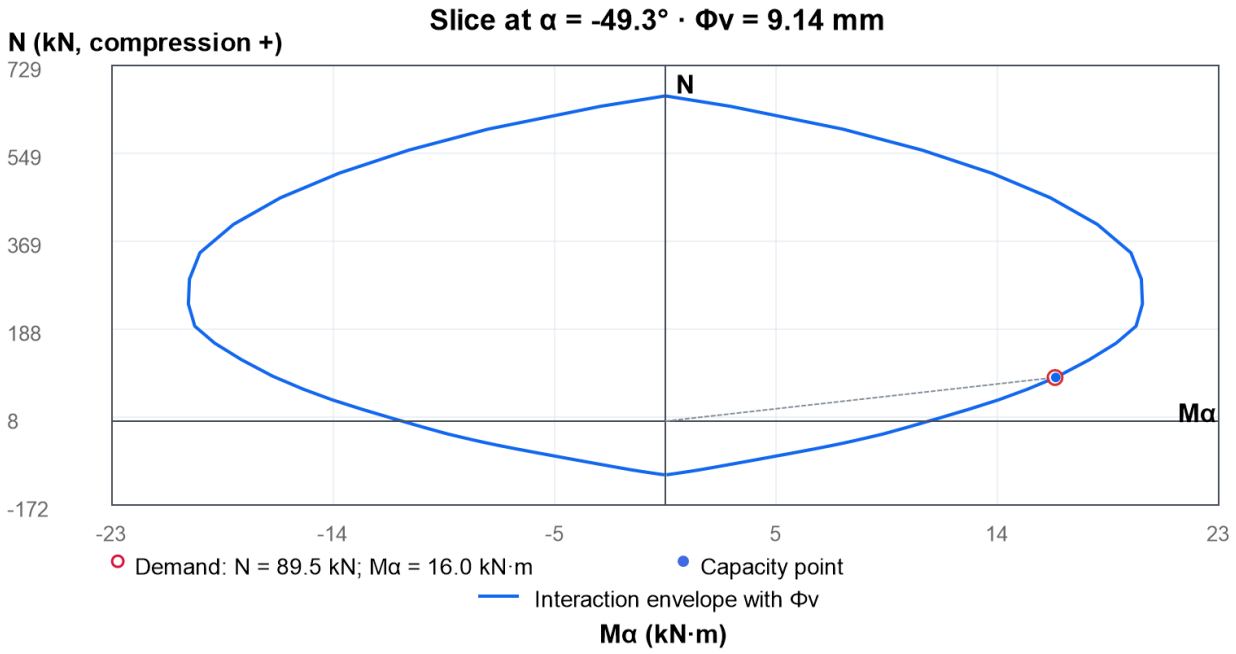
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	103.73	119.67	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.47	0.54	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.09722	0.08887	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	2,336,391	2,336,391	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	848,983,231,313	804,172,164,862	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	818.27	775.08	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1228	1.1305	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

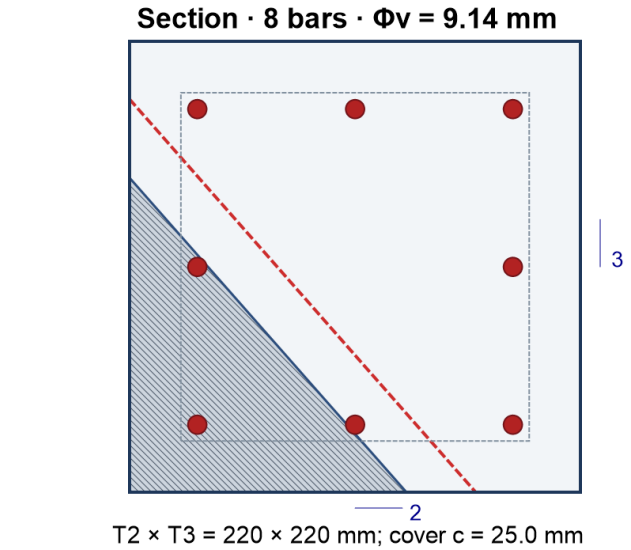
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 101.40 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	525.42 mm^2	Calculation results
Φ_v	9.1445 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9981	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	221.3741°	Geometry at the check point
Normal vector n	(-0.750410; -0.660972)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	101.3977 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.750410 \cdot x_2 - 0.660972 \cdot x_3 = 53.8544$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.750410 \cdot x_2 - 0.660972 \cdot x_3 = 28.5049$ mm	Geometry at the check point
Compressed concrete area A_b	10,364.403 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-64.959; -58.864) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	119.191 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.016 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.743 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	9.1445 mm / 65.677 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	65.677	46.576	2.21386	210.000	13.792	1.062	-1.062
2	0.000	-77.000	65.677	104.357	0.61828	123.655	8.121	0.625	0.000
3	77.000	-77.000	65.677	162.139	-0.97731	-195.461	-12.837	-0.988	-0.988
4	-77.000	77.000	65.677	148.365	-0.59697	-119.393	-7.841	0.604	0.604
5	0.000	77.000	65.677	206.147	-2.19255	-210.000	-13.792	1.062	0.000
6	77.000	77.000	65.677	263.929	-3.78813	-210.000	-13.792	1.062	-1.062
7	-77.000	0.000	65.677	97.470	0.80845	161.689	10.619	0.000	-0.818
8	77.000	0.000	65.677	213.034	-2.38272	-210.000	-13.792	0.000	-1.062
Σ N_{si}, M_{xsi}, M_{ysi}							-29.522	3.427	-4.388

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	119.191	7.016	-7.743	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-29.522	3.427	-4.388	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**89.668**	**10.443**	**-12.131**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	91.324 kN	From analysis results
M_2	1.521 kN·m	From analysis results
M_3	-1.574 kN·m	From analysis results
M_{2s}	1.674 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.733 kN·m	Including second-order magnification and accidental eccentricity

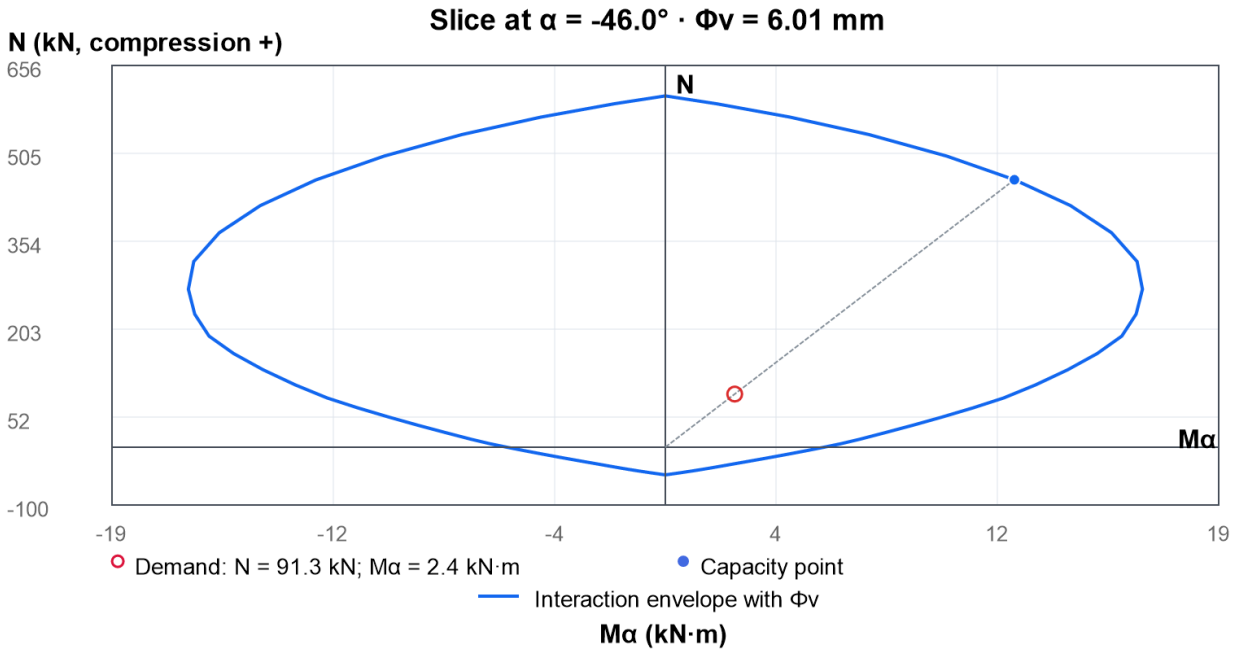
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	16.66	17.24	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.1007	1.1007	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

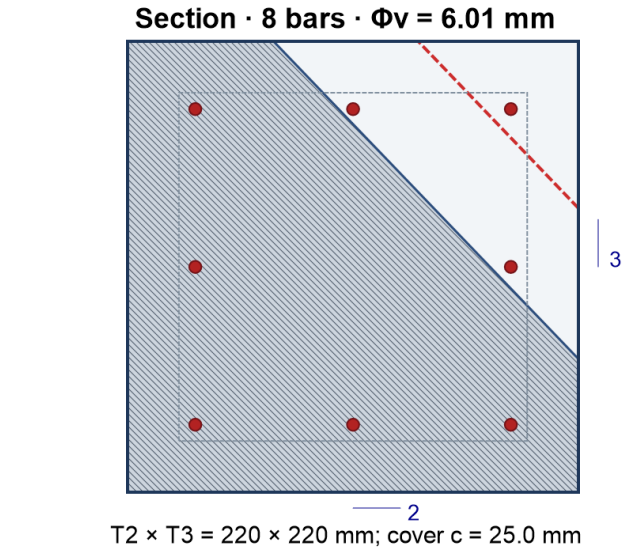
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 203.75 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1985	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	223.8328°	Geometry at the check point
Normal vector n	(-0.721364; -0.692556)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	203.7541 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.721364 \cdot x_2 - 0.692556 \cdot x_3 = -48.2228$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.721364 \cdot x_2 - 0.692556 \cdot x_3 = -99.1614$ mm	Geometry at the check point
Compressed concrete area A_b	36,875.350 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-18.881; -18.237) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	424.067 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	7.734 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.007 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.659	2.85880	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	102.204	2.09550	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	157.749	1.33220	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	153.313	1.39316	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	208.858	0.62986	125.972	3.573	-0.275	0.000
6	77.000	77.000	28.366	264.403	-0.13344	-26.688	-0.757	0.058	-0.058
7	-77.000	0.000	28.366	99.986	2.12598	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	211.076	0.59938	119.876	3.400	0.000	0.262
Σ N_{si}, M_{xsi}, M_{ysi}							36.002	0.701	-0.714

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	424.067	7.734	-8.007	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	36.002	0.701	-0.714	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**460.068**	**8.434**	**-8.721**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C7 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	93.758 kN	From analysis results
M_2	-8.829 kN·m	From analysis results
M_3	10.607 kN·m	From analysis results
M_{2s}	-9.963 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	12.084 kN·m	Including second-order magnification and accidental eccentricity

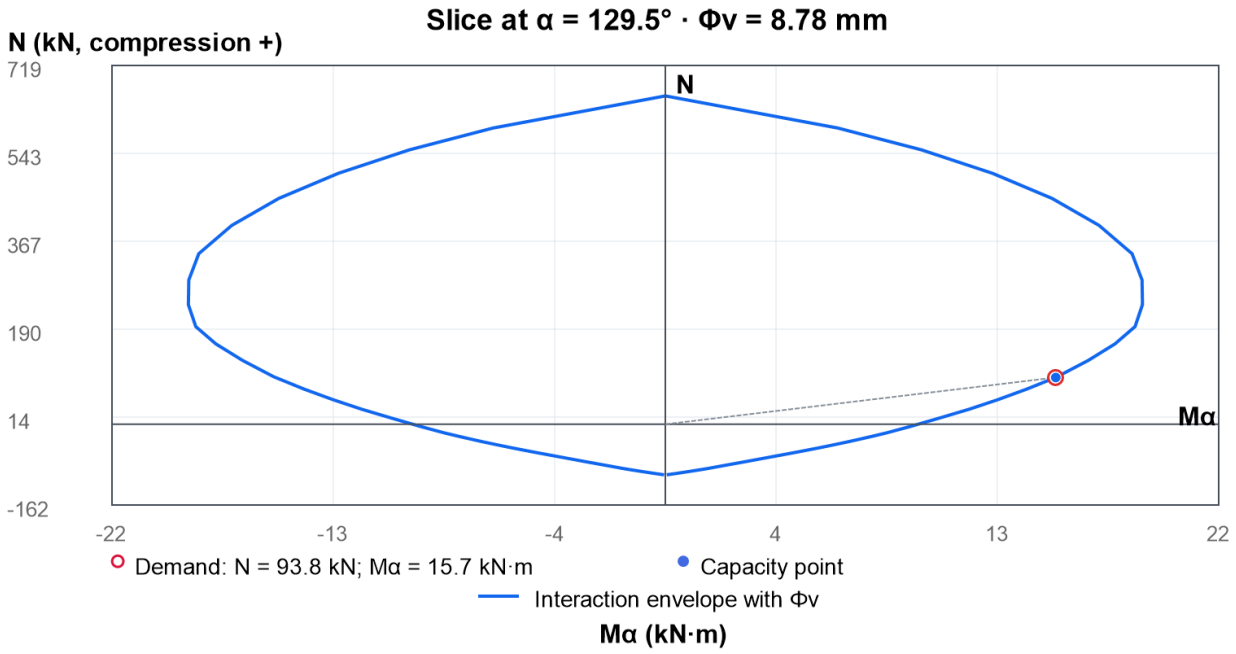
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	94.16	113.13	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.43	0.51	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.10302	0.09211	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	2,154,410	2,154,410	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	854,664,924,164	796,102,750,420	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	823.75	767.31	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.1284	1.1392	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

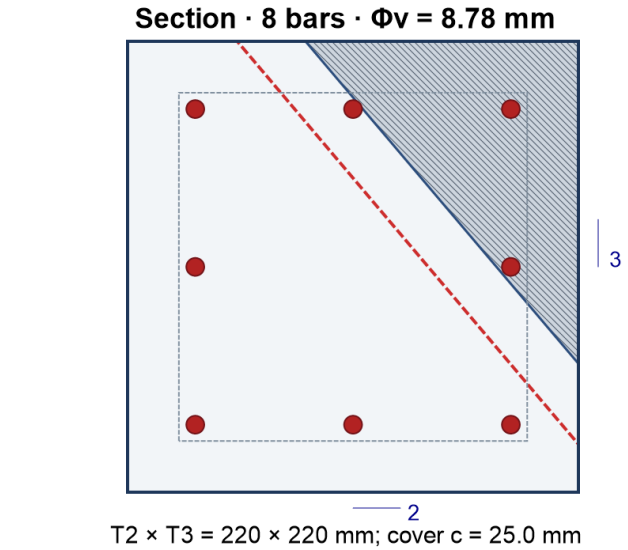
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 101.63 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	484.49 mm^2	Calculation results
Φ_v	8.7812 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9994	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	40.2602°	Geometry at the check point
Normal vector n	(0.763117; 0.646260)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	101.6259 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.763117 \cdot x_2 + 0.646260 \cdot x_3 = 53.4056$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.763117 \cdot x_2 + 0.646260 \cdot x_3 = 27.9991$ mm	Geometry at the check point
Compressed concrete area A_b	10,470.815 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(65.609; 57.583) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	120.414 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-6.934 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	7.900 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	8.7812 mm / 60.561 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	60.561	263.554	-3.76143	-210.000	-12.718	-0.979	0.979
2	0.000	-77.000	60.561	204.794	-2.14248	-210.000	-12.718	-0.979	0.000
3	77.000	-77.000	60.561	146.034	-0.52352	-104.704	-6.341	-0.488	-0.488
4	-77.000	77.000	60.561	164.029	-1.01934	-203.869	-12.347	0.951	0.951
5	0.000	77.000	60.561	105.269	0.59961	119.923	7.263	-0.559	0.000
6	77.000	77.000	60.561	46.509	2.21857	210.000	12.718	-0.979	0.979
7	-77.000	0.000	60.561	213.792	-2.39039	-210.000	-12.718	0.000	0.979
8	77.000	0.000	60.561	96.272	0.84753	169.505	10.265	0.000	0.790
Σ N_{si}, M_{xsi}, M_{ysi}							-26.595	-3.035	4.191

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	120.414	-6.934	7.900	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-26.595	-3.035	4.191	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**93.819**	**-9.968**	**12.091**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	74.603 kN	From analysis results
M_2	2.486 kN·m	From analysis results
M_3	-9.877 kN·m	From analysis results
M_{2s}	2.681 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-11.292 kN·m	Including second-order magnification and accidental eccentricity

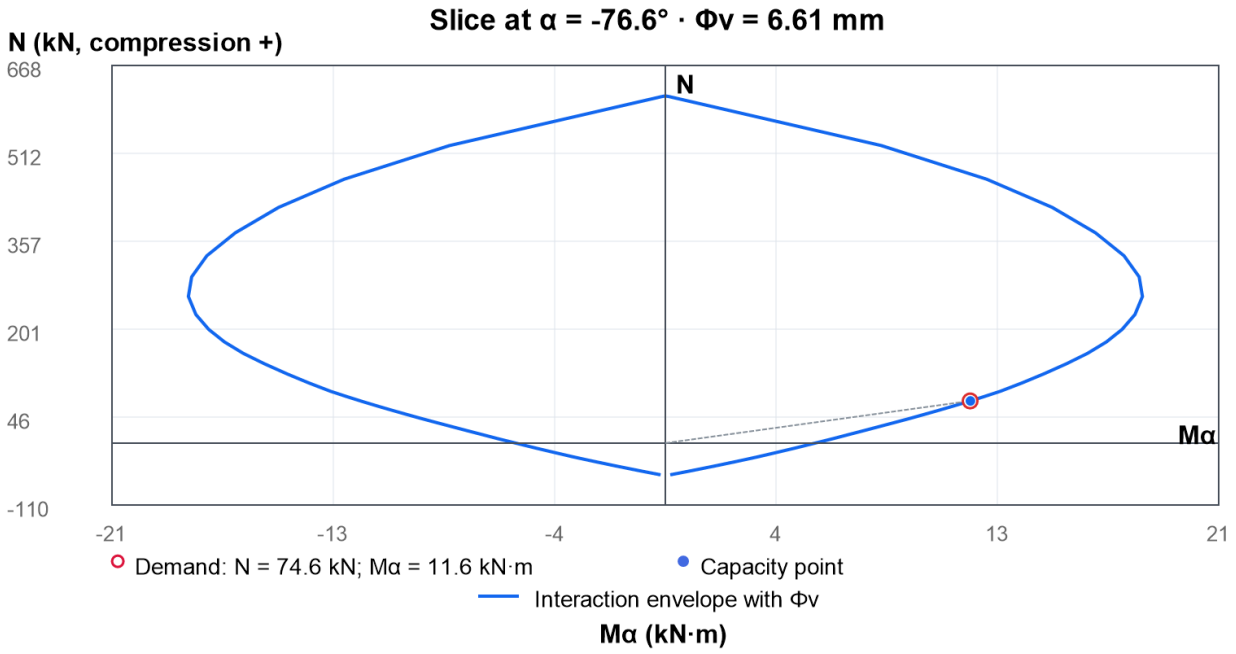
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	33.32	132.39	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.60	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16612	0.08317	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,222,559	1,222,559	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,062,976,940,783	617,637,353,386	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,024.53	595.30	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0785	1.1433	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

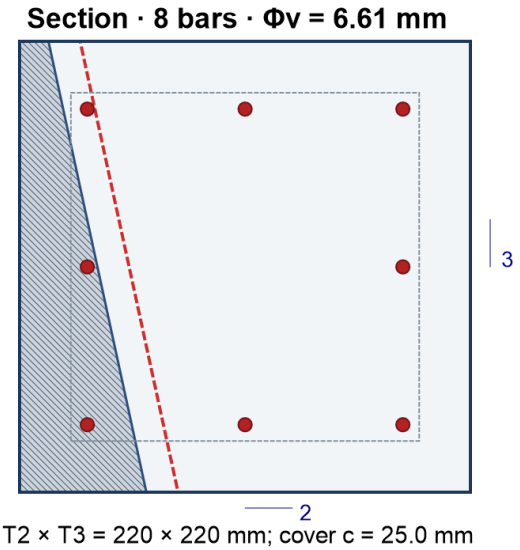
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 60.44 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	274.93 mm^2	Calculation results
Φ_v	6.6149 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	192.2526°	Geometry at the check point
Normal vector n	(-0.977221; -0.212222)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	60.4360 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.977221 \cdot x_2 - 0.212222 \cdot x_3 = 70.4028$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.977221 \cdot x_2 - 0.212222 \cdot x_3 = 55.2938$ mm	Geometry at the check point
Compressed concrete area A_b	8,350.353 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-88.516; -23.077) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	96.029 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	2.216 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.500 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.6149 mm / 34.367 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	34.367	39.252	1.68147	210.000	7.217	0.556	-0.556
2	0.000	-77.000	34.367	114.498	-1.80468	-210.000	-7.217	-0.556	0.000
3	77.000	-77.000	34.367	189.744	-5.29083	-210.000	-7.217	-0.556	-0.556
4	-77.000	77.000	34.367	71.934	0.16730	33.461	1.150	-0.089	-0.089
5	0.000	77.000	34.367	147.180	-3.31884	-210.000	-7.217	0.556	0.000
6	77.000	77.000	34.367	222.426	-6.80499	-210.000	-7.217	0.556	-0.556
7	-77.000	0.000	34.367	55.593	0.92439	184.878	6.354	0.000	-0.489
8	77.000	0.000	34.367	206.085	-6.04791	-210.000	-7.217	0.000	-0.556
Σ N_{si}, M_{xsi}, M_{ysi}							-21.364	0.467	-2.801

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	96.029	2.216	-8.500	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-21.364	0.467	-2.801	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**74.665**	**2.683**	**-11.301**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	76.428 kN	From analysis results
M_2	0.132 kN·m	From analysis results
M_3	-1.421 kN·m	From analysis results
M_{2s}	0.828 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-1.539 kN·m	Including second-order magnification and accidental eccentricity

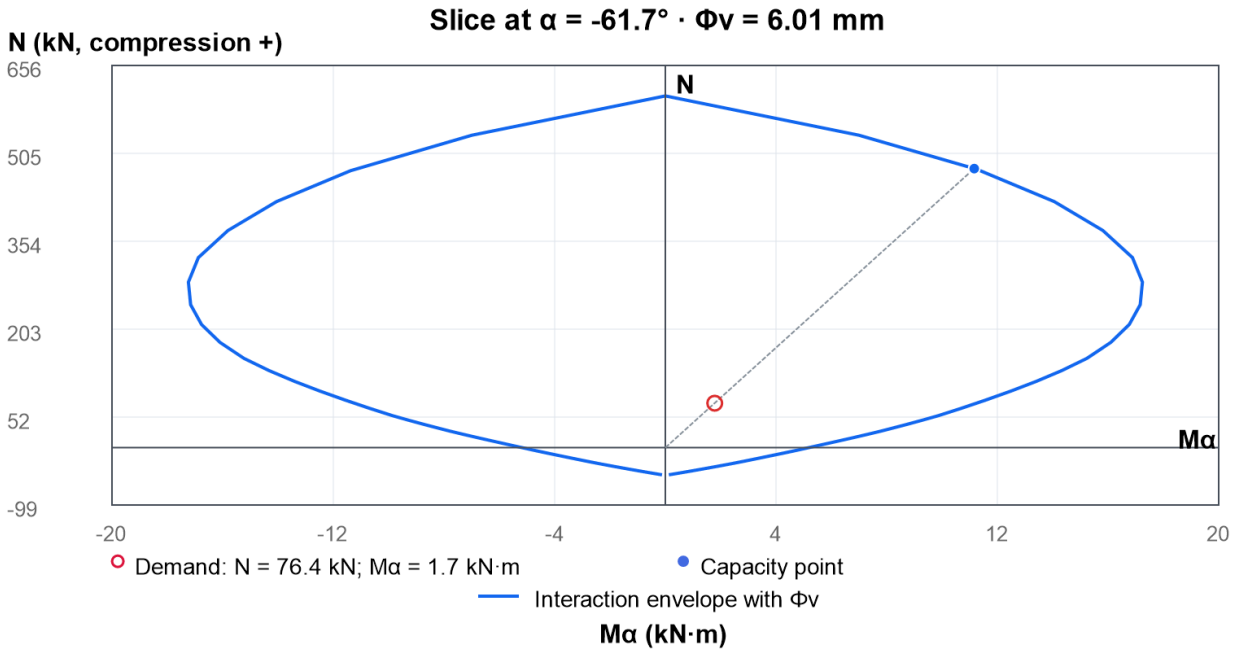
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	18.60	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.15	0.15	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.16667	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,036,002,898,901	1,036,002,898,901	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	998.53	998.53	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0829	1.0829	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

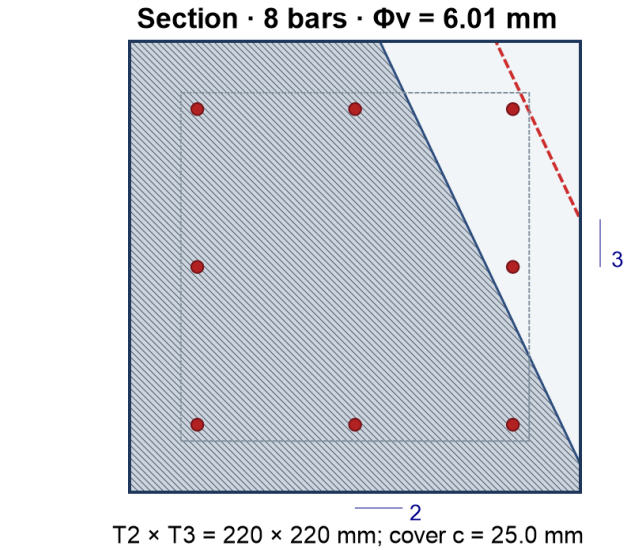
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 204.61 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1594	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	205.3756°	Geometry at the check point
Normal vector n	(-0.903518; -0.428550)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	204.6135 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.903518 \cdot x_2 - 0.428550 \cdot x_3 = -58.0860$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.903518 \cdot x_2 - 0.428550 \cdot x_3 = -109.2393$ mm	Geometry at the check point
Compressed concrete area A_b	38,299.471 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-20.405; -10.868) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	440.444 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	4.787 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-8.987 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	43.958	2.89846	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	113.529	1.94643	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	183.100	0.99440	198.879	5.642	0.434	0.434
4	-77.000	77.000	28.366	109.955	1.99534	210.000	5.957	-0.459	-0.459
5	0.000	77.000	28.366	179.526	1.04331	208.661	5.919	-0.456	0.000
6	77.000	77.000	28.366	249.097	0.09128	18.255	0.518	-0.040	0.040
7	-77.000	0.000	28.366	76.957	2.44690	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	216.098	0.54284	108.567	3.080	0.000	0.237
Σ N_{si}, M_{xsi}, M_{ysi}							38.986	0.397	-0.665

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	440.444	4.787	-8.987	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	38.986	0.397	-0.665	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**479.430**	**5.184**	**-9.652**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C8 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1} \cdot \gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0} \cdot \gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	78.862 kN	From analysis results
M_2	-3.007 kN·m	From analysis results
M_3	9.853 kN·m	From analysis results
M_{2s}	-3.271 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	11.324 kN·m	Including second-order magnification and accidental eccentricity

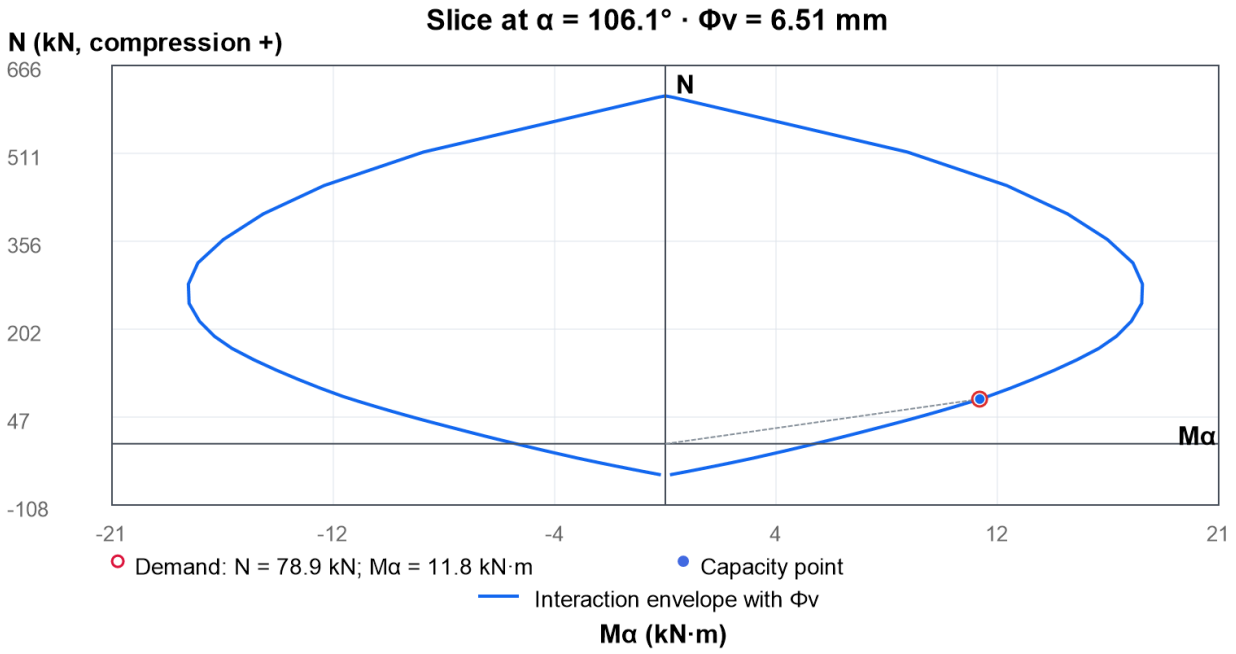
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu \cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0 = \mu \cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda = L_0/i$; $i = \sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a = \max(L/600; h/30; 10\ mm)$
e_0 (mm)	38.14	124.94	8.1.2.2.4; $e_0 = \max(\lvert M \rvert/N; e_a)$
δ_e	0.17	0.57	$\delta_e = e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L = \min(2; 1+M_{L1}/M_L)$
k_b	0.15845	0.08642	(47); $k_b = 0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b = \int r^2 dA_b$
I_s - reinforcement (mm^4)	1,185,313	1,185,313	$I_s = \Sigma A_{si} \cdot r_i^2$
D ($N \cdot mm^2$)	1,016,549,152,659	629,851,396,223	(46); $D = k_b E_b I_b + 0.7 E_s I_s$
N_{cr} (kN)	979.78	607.07	(45); $N_{cr} = \pi^2 D/L_0^2$
η	1.0875	1.1493	(44); $\eta = 1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta = 1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

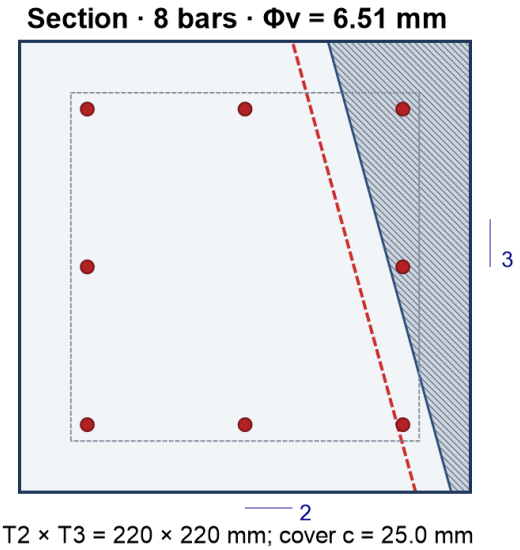
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 67.05 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	266.56 mm^2	Calculation results
Φ_v	6.5134 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9995	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	15.2932°	Geometry at the check point
Normal vector n	(0.964589; 0.263759)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; 110.000) mm	Geometry at the check point
Stress-block depth x	67.0470 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.964589 \cdot x_2 + 0.263759 \cdot x_3 = 68.0712$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.964589 \cdot x_2 + 0.263759 \cdot x_3 = 51.3094$ mm	Geometry at the check point
Compressed concrete area A_b	8,674.565 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(86.461; 27.971) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	99.757 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	-2.790 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	8.625 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.5134 mm / 33.320 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	33.320	229.701	-6.09271	-210.000	-6.997	-0.539	0.539
2	0.000	-77.000	33.320	155.428	-2.99093	-210.000	-6.997	-0.539	0.000
3	77.000	-77.000	33.320	81.154	0.11086	22.171	0.739	0.057	0.057
4	-77.000	77.000	33.320	189.082	-4.39640	-210.000	-6.997	0.539	0.539
5	0.000	77.000	33.320	114.809	-1.29461	-210.000	-6.997	0.539	0.000
6	77.000	77.000	33.320	40.535	1.80717	210.000	6.997	-0.539	0.539
7	-77.000	0.000	33.320	209.392	-5.24455	-210.000	-6.997	0.000	0.539
8	77.000	0.000	33.320	60.845	0.95901	191.803	6.391	0.000	0.492
Σ N_{si}, M_{xsi}, M_{ysi}							-20.859	-0.482	2.704

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	99.757	-2.790	8.625	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-20.859	-0.482	2.704	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**78.899**	**-3.272**	**11.329**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 0 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	35.805 kN	From analysis results
M_2	2.200 kN·m	From analysis results
M_3	-7.830 kN·m	From analysis results
M_{2s}	2.299 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-8.479 kN·m	Including second-order magnification and accidental eccentricity

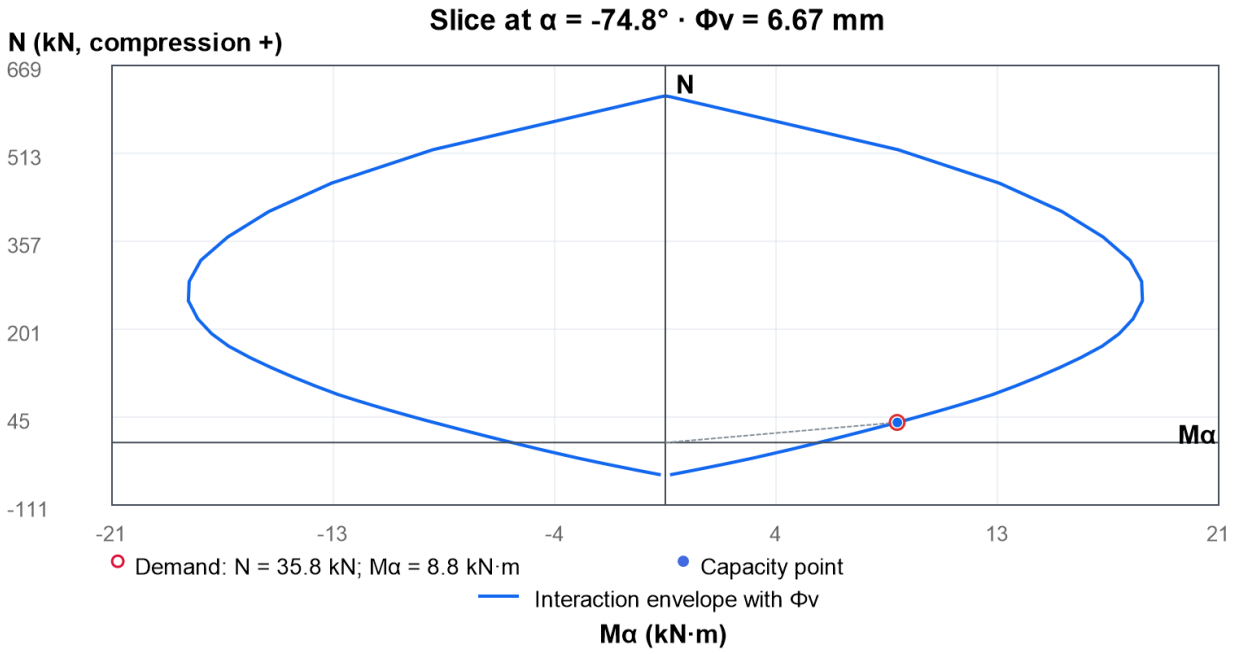
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	61.45	218.68	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.28	0.99	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.12946	0.05796	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,241,399	1,241,399	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	868,797,059,415	484,946,518,966	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	837.37	467.41	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0447	1.0830	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

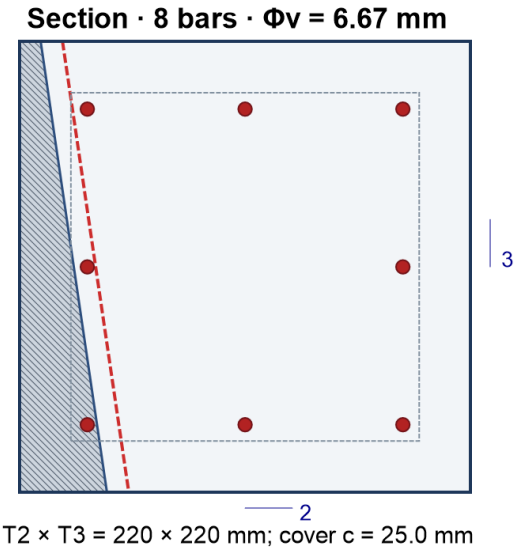
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 42.15 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	279.17 mm^2	Calculation results
Φ_v	6.6657 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9992	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	188.3649°	Geometry at the check point
Normal vector n	(-0.989362; -0.145477)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	42.1496 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.989362 \cdot x_2 - 0.145477 \cdot x_3 = 82.6826$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.989362 \cdot x_2 - 0.145477 \cdot x_3 = 72.1452$ mm	Geometry at the check point
Compressed concrete area A_b	5,814.226 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-95.136; -22.441) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	66.864 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	1.500 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-6.361 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.6657 mm / 34.896 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	34.896	37.450	1.01222	202.443	7.065	0.544	-0.544
2	0.000	-77.000	34.896	113.631	-4.04848	-210.000	-7.328	-0.564	0.000
3	77.000	-77.000	34.896	189.811	-9.10918	-210.000	-7.328	-0.564	-0.564
4	-77.000	77.000	34.896	59.853	-0.47604	-95.209	-3.322	0.256	0.256
5	0.000	77.000	34.896	136.034	-5.53674	-210.000	-7.328	0.564	0.000
6	77.000	77.000	34.896	212.215	-10.59744	-210.000	-7.328	0.564	-0.564
7	-77.000	0.000	34.896	48.651	0.26809	53.617	1.871	0.000	-0.144
8	77.000	0.000	34.896	201.013	-9.85331	-210.000	-7.328	0.000	-0.564
Σ N_{si}, M_{xsi}, M_{ysi}							-31.028	0.800	-2.125

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	66.864	1.500	-6.361	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-31.028	0.800	-2.125	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**35.836**	**2.300**	**-8.486**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 1,371 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	37.631 kN	From analysis results
M_2	1.321 kN·m	From analysis results
M_3	-0.917 kN·m	From analysis results
M_{2s}	1.373 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	-0.953 kN·m	Including second-order magnification and accidental eccentricity

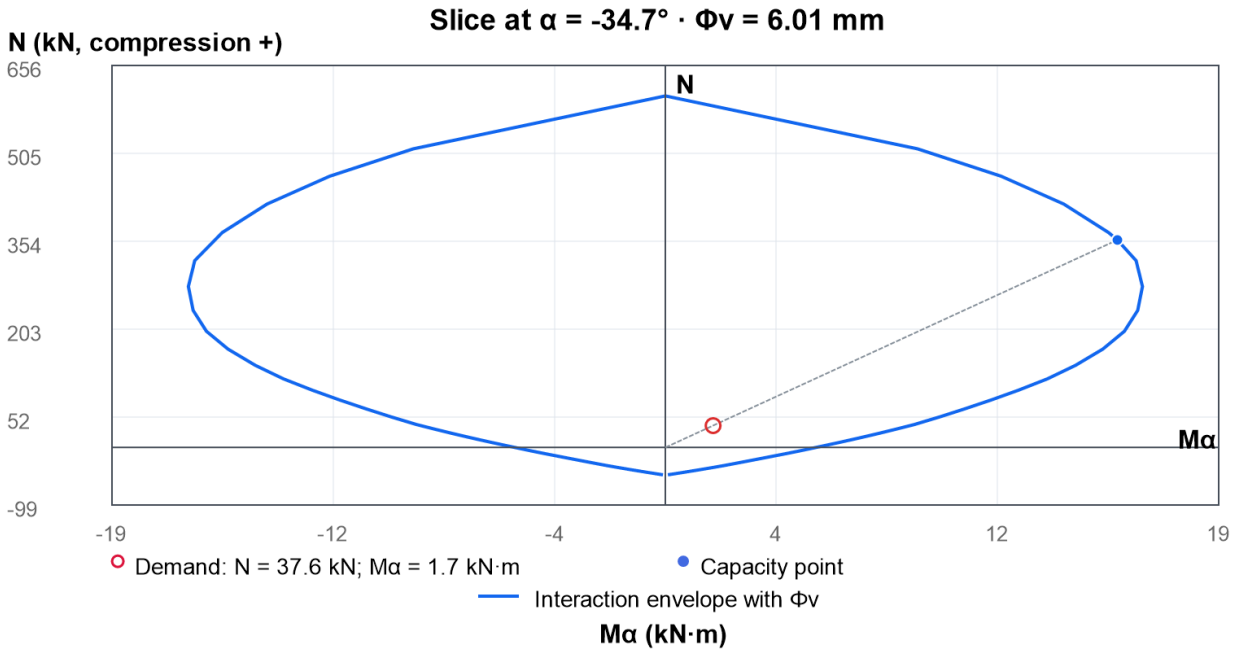
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	35.10	24.36	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.16	0.15	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16321	0.16667	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,009,108	1,009,108	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,017,429,041,246	1,036,002,898,901	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	980.63	998.53	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0399	1.0392	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

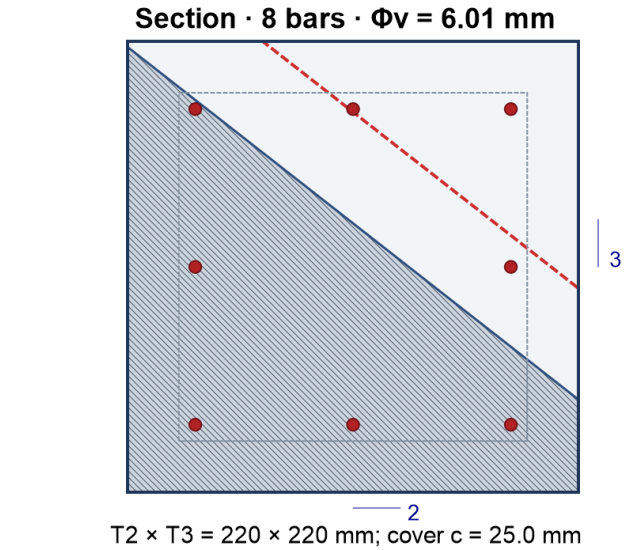
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 171.14 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	226.93 mm^2	Calculation results
Φ_v	6.0098 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.1055	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	231.9792°	Geometry at the check point
Normal vector n	(-0.615948; -0.787787)	Geometry at the check point
Compression vertex (x_2; x_3)	(-110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	171.1421 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$-0.615948 \cdot x_2 - 0.787787 \cdot x_3 = -16.7313$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$-0.615948 \cdot x_2 - 0.787787 \cdot x_3 = -59.5168$ mm	Geometry at the check point
Compressed concrete area A_b	28,872.434 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(-24.029; -34.987) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	332.033 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	11.617 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	-7.978 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.0098 mm / 28.366 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	28.366	46.323	2.74212	210.000	5.957	0.459	-0.459
2	0.000	-77.000	28.366	93.751	1.96617	210.000	5.957	0.459	0.000
3	77.000	-77.000	28.366	141.179	1.19021	210.000	5.957	0.459	0.459
4	-77.000	77.000	28.366	167.642	0.75726	151.452	4.296	-0.331	-0.331
5	0.000	77.000	28.366	215.070	-0.01870	-3.739	-0.106	0.008	0.000
6	77.000	77.000	28.366	262.498	-0.79465	-158.930	-4.508	0.347	-0.347
7	-77.000	0.000	28.366	106.983	1.74969	210.000	5.957	0.000	-0.459
8	77.000	0.000	28.366	201.839	0.19778	39.556	1.122	0.000	0.086
Σ N_{si}, M_{xsi}, M_{ysi}							24.632	1.401	-1.050

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	332.033	11.617	-7.978	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	24.632	1.401	-1.050	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**356.665**	**13.017**	**-9.029**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**

COLUMN REINFORCEMENT CALCULATION

One section and force case under TCVN 5574:2018

1. General information

Parameter / Formula	Value	Equation / Clause
Member / Section	C9 / C22	Model data
Dimensions	$T_2 \times T_3$ = 220.0 × 220.0 mm	Model data
Combination / Station	UCOMBO1 / 3,200 mm	Model data
Design code	TCVN 5574:2018	Design settings
Mode	Reinforcement design	Design settings

2. Materials and working-condition factors

Parameter / Formula	Value	Equation / Clause
Concrete / Longitudinal steel	B20 / CB240-T	Model data
Base R_b	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
γ_{b1}; γ_{b3}; $\gamma_b = \gamma_{b1}\cdot\gamma_{b3}$	1.00; 1.00; 1.0000	6.1.2.3
$R_b = R_{b,0}\cdot\gamma_b$	11.500 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2
R_s	210.000 MPa	TCVN 5574:2018, 6.1.2 / 6.2.2

3. Calculation forces

Parameter / Formula	Value	Notes
N	40.064 kN	From analysis results
M_2	0.148 kN·m	From analysis results
M_3	8.301 kN·m	From analysis results
M_{2s}	0.417 kN·m	Including second-order magnification and accidental eccentricity
M_{3s}	9.050 kN·m	Including second-order magnification and accidental eccentricity

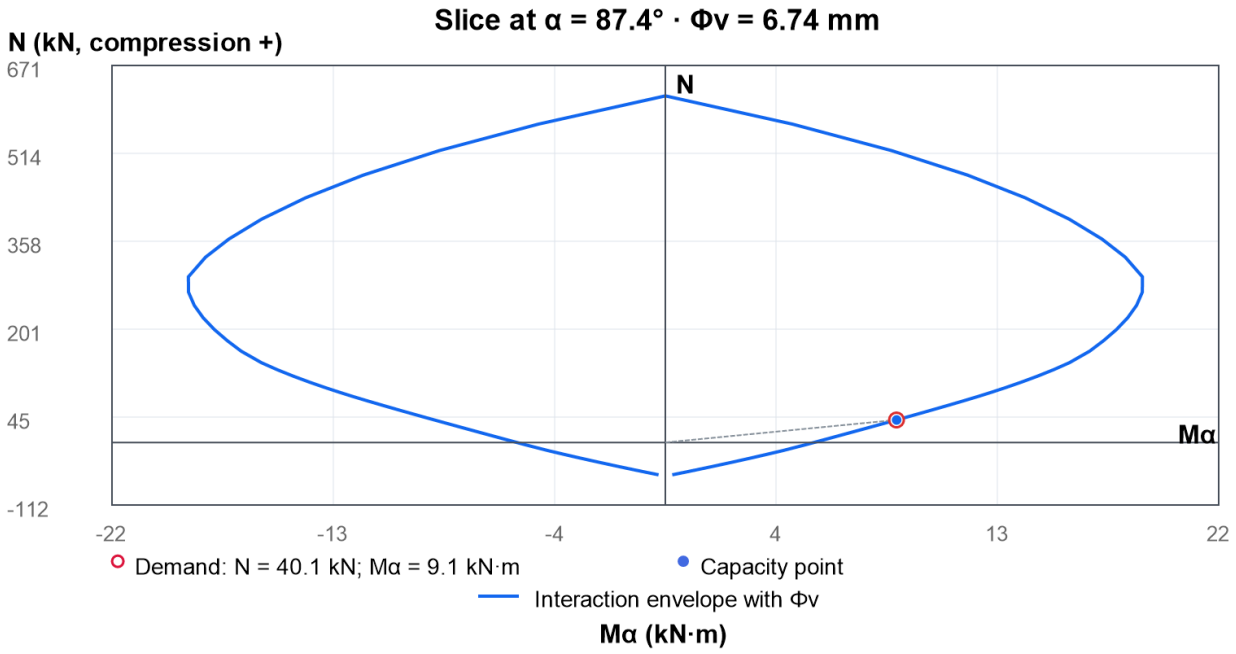
4. Second-order effects

Parameter	x direction (about axis 2)	y direction (about axis 3)	Equation / Clause
L (mm)	3,200.00	3,200.00	Model data
μ	1.000	1.000	Effective-length settings
L_x, $L_y = \mu\cdot L$ (mm)	3,200.00	3,200.00	8.1.2.4.4; $L_0=\mu\cdot L$
$\lambda = L_0/i$	50.39	50.39	$\lambda=L_0/i$; $i=\sqrt{(I_b/A_b)}$
e_a (mm)	10.00	10.00	8.1.2.2.4; $e_a=\max(L/600; h/30; 10\ mm)$
e_0 (mm)	10.00	207.19	8.1.2.2.4; $e_0=\max(\lvert M\rvert/N; e_a)$
δ_e	0.15	0.94	$\delta_e=e_0/h$; $0.15 \le \delta_e \le 1.5$
φ_L	2.00	2.00	(48); $\varphi_L=\min(2; 1+M_{L1}/M_L)$
k_b	0.16667	0.06040	(47); $k_b=0.15/[\varphi_L(0.3+\delta_e)]$
E_b (MPa)	27,500	27,500	6.1.3; E_b
E_s (MPa)	200,000	200,000	6.2.3; E_s
I_b - concrete (mm^4)	195,213,333	195,213,333	$I_b=\int r^2 dA_b$
I_s - reinforcement (mm^4)	1,270,990	1,270,990	$I_s=\Sigma\ A_{si}\cdot r_i^2$
D ($N\cdot mm^2$)	1,072,666,433,902	502,177,977,327	(46); $D=k_bE_bI_b+0.7E_sI_s$
N_{cr} (kN)	1,033.87	484.01	(45); $N_{cr}=\pi^2D/L_0^2$
η	1.0403	1.0902	(44); $\eta=1/(1-N/N_{cr})$; $\lambda \le 14$: $\eta=1$
Slenderness limit λ = 120.0	50.39	50.39	Design settings

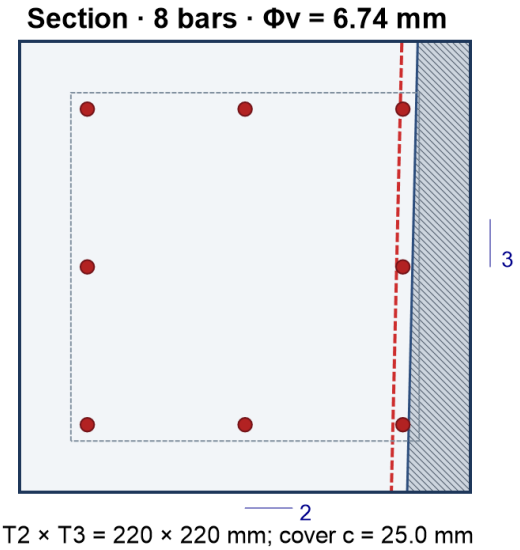
I_b and I_s are saved when D is calculated; r is the distance to the corresponding bending axis. M_{L1}/M_L is the long-term/total moment ratio; e_0 applies to statically indeterminate members with N > 0.

5. Interaction-diagram slice through the demand point

The N-M_α plane follows (M_{2s}, M_{3s}); the check point lies on the design-force ray.
From (31), (32): $\varepsilon_{s,el} = R_s/E_s = 0.001050$; $\xi_R = \beta/(1 + \varepsilon_{s,el}/\varepsilon_{b2})$; $\beta = 0.8$.
Individual bar strain from strain compatibility: $\varepsilon_{si} = \varepsilon_{b2}(1 - \beta \cdot d_i/x)$; $\varepsilon_{b2} = 0.00350$.



6. Section and reinforcement layout



T2 × T3 = 220 × 220 mm; cover c = 25.0 mm
Hatched compression region; stress-block depth x = 30.89 mm.
Neutral axis (red dashed line).

7. Reinforcement and verification results

Parameter / Formula	Value	Equation / Clause
Required A_s	285.82 mm^2	Calculation results
Φ_v	6.7447 mm	$A_s = n \cdot \pi \cdot \Phi_v^2/4$
Number of bars	8	Model data
Utilization E_d/R_d	0.9993	Demand / capacity point
Conclusion	Capacity check passed.	Capacity verification

DETAILED CAPACITY CALCULATION AT THE CHECK POINT

8. Neutral axis, compressed concrete and its N-M contribution

Parameter / Formula	Value	Equation / Clause
Normal angle θ_n	358.6640°	Geometry at the check point
Normal vector n	(0.999728; -0.023316)	Geometry at the check point
Compression vertex (x_2; x_3)	(110.000; -110.000) mm	Geometry at the check point
Stress-block depth x	30.8866 mm	Geometry at the check point
Factor $\beta = x/x_n$	0.800	Geometry at the check point
Stress-block boundary	$0.999728 \cdot x_2 - 0.023316 \cdot x_3 = 81.6482$ mm; compression: $n \cdot r \geq p_B$	Geometry at the check point
Neutral axis $\varepsilon_s=0$	$0.999728 \cdot x_2 - 0.023316 \cdot x_3 = 73.9265$ mm	Geometry at the check point
Compressed concrete area A_b	6,232.514 mm^2	Compressed-region geometry
Centroid $G_b(x_2;x_3)$	(95.796; -3.320) mm	Compressed-region geometry
R_b	11.500 MPa	Material / calculation settings
N_b	71.674 kN	$N_b=R_b \cdot A_b$
$M_{xb} = M_{2b}$	0.238 kN·m	$M_{2b}=-N_b \cdot x_{3b}$
$M_{yb} = M_{3b}$	6.866 kN·m	$M_{3b}=N_b \cdot x_{2b}$
Ultimate strain ε_{cu}	3.50000 ‰	Material / calculation settings
Elastic modulus E_s	200,000 MPa	Material / calculation settings
Φ_v / A_{si}	6.7447 mm / 35.728 mm^2	Material / calculation settings

$N_b=R_b \cdot A_b$; $M_{xb}=M_{2b}=-N_b \cdot y_b$; $M_{yb}=M_{3b}=N_b \cdot x_b$. Compression is positive; coordinates are measured from the section center.

8.1. All reinforcement at the current strain state

$d_i=p_{max}-n \cdot r_i$; $\varepsilon_{si}=\varepsilon_{cu}(1-\beta \cdot d_i/x)$; $\sigma_{si}=clip(E_s \cdot \varepsilon_{si},-R_s,+R_s)$; $N_{si}=\sigma_{si} \cdot A_{si}$; $M_{xsi}=M_{2si}=-N_{si} \cdot x_{3i}$; $M_{ysi}=M_{3si}=N_{si} \cdot x_{2i}$.

Steel stress follows the bilinear diagram in 6.2.4.2: $\sigma_s=E_s \cdot \varepsilon_s$ (17) in the elastic range; $|\sigma_s|=R_s$ (18) on the yield plateau. Stress follows the strain sign; compression is positive.

No.	x_2 (mm)	x_3 (mm)	A_{si} (mm^2)	d_i (mm)	ε_{si} (‰)	σ_{si} (MPa)	N_{si} (kN)	$M_{xsi}=M_{2si}$ (kN·m)	$M_{ysi}=M_{3si}$ (kN·m)
1	-77.000	-77.000	35.728	187.719	-13.51745	-210.000	-7.503	-0.578	0.578
2	0.000	-77.000	35.728	110.740	-6.53899	-210.000	-7.503	-0.578	0.000
3	77.000	-77.000	35.728	33.760	0.43948	87.896	3.140	0.242	0.242
4	-77.000	77.000	35.728	191.309	-13.84296	-210.000	-7.503	0.578	0.578
5	0.000	77.000	35.728	114.330	-6.86449	-210.000	-7.503	0.578	0.000
6	77.000	77.000	35.728	37.351	0.11397	22.794	0.814	-0.063	0.063
7	-77.000	0.000	35.728	189.514	-13.68020	-210.000	-7.503	0.000	0.578
8	77.000	0.000	35.728	35.556	0.27673	55.345	1.977	0.000	0.152
Σ N_{si}, M_{xsi}, M_{ysi}							-31.582	0.179	2.190

8.2. Capacity summary

Component	N (kN)	$M_x=M_2$ (kN·m)	$M_y=M_3$ (kN·m)	Equation / Clause
Concrete	71.674	0.238	6.866	$N_b=R_b \cdot A_b$; $M_b=N_b \cdot e$
Σ reinforcement	-31.582	0.179	2.190	Σ N_{si}; Σ M_{si}
Total concrete and reinforcement	**40.092**	**0.417**	**9.056**	**$N=N_b+\Sigma N_{si}$; $M=M_b+\Sigma M_{si}$**