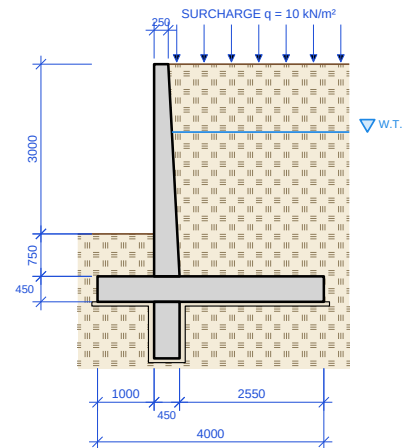


Project

Project	=	Cantilever Retaining Wall
Client	=	-
Location	=	-
Designed by / checked by	=	- / -

Design Input

Wall type	=	T-shaped cantilever
Height of wall above G.L.	=	3 m
Foundation depth	=	1.2 m
Stem top width	=	0.25 m
Stem bottom width	=	0.45 m
Footing base width	=	4 m
Footing thickness	=	0.45 m
Toe length	=	1 m
Heel length	=	2.550 m
Shear key (width × depth)	=	0.45 × 1 m
Density of soil (γ)	=	18 kN/m ³
Density of concrete (γ_c)	=	25 kN/m ³
Friction coefficient (μ)	=	0.5
Surcharge (q)	=	10 kN/m ²
Soil bearing capacity (SBC)	=	250 kN/m ²
Angle of repose (ϕ)	=	30°
Angle of inclined surface (θ)	=	0°
Concrete / steel	=	M25 / Fe 500
Seismic coefficient (α_h)	=	0.1
Overall result	=	All stability and design checks satisfied



Contents

1. Design summary
2. Design basis and assumptions
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5. Stability and base pressure
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7. Design of the base slab
8. Design of the shear key
9. Distribution steel and detailing
10. Bar bending schedule and quantities
11. Drawings (general arrangement, reinforcement details, BBS)

1. Design summary

All stability and design checks are satisfied.

Project	=	Cantilever Retaining Wall
Client	=	-
Location	=	-
Wall	=	Cantilever retaining wall, T-shaped (toe and heel), stem batter on the back face, with shear key
Heights	=	Retained height 3 m above the front ground, foundation depth 1.2 m, overall H = 4.200 m
Stem	=	250 mm at the top, 450 mm at the base
Base slab	=	4 m wide × 450 mm (toe 1 m, heel 2.550 m)
Backfill and loads	=	$\gamma = 18 \text{ kN/m}^3$, $\phi = 30^\circ$, slope $\theta = 0^\circ$, surcharge 10 kPa, water table 3 m above the base, seismic $\alpha_h = 0.1$
Materials	=	M25 concrete, Fe 500 reinforcement, cover 50 / 50 mm
Quantities (wall length 10 m)	=	Concrete 35.62 m ³ , reinforcement 1,323 kg (37 kg/m ³)
Report date	=	01 Nov 2026

Stability and bearing

Case	Check	Reference	Value	Limit	Status
Static case	Overturning (0.9 Mr / Mo)	IS 456 cl 20.1	2.01	≥ 1.4	OK
Static case	Sliding	IS 456 cl 20.2	2.21	≥ 1.4	OK
Static case	Maximum base pressure	IS 6403, IS 1893	97.6 kPa	$\leq 250 \text{ kPa}$	OK
Static case	Eccentricity	Middle third (no tension)	0.325 m	$\leq B/6 = 0.667 \text{ m}$	OK
Seismic case	Overturning (0.9 Mr / Mo)	IS 456 cl 20.1	1.58	≥ 1.2	OK
Seismic case	Sliding	IS 456 cl 20.2	1.56	≥ 1.2	OK
Seismic case	Maximum base pressure	IS 6403, IS 1893	128.0 kPa	$\leq 312 \text{ kPa}$	OK
Seismic case	Eccentricity	Middle third (no tension)	0.635 m	$\leq B/6 = 0.667 \text{ m}$	OK

Reinforcement

Mark	Member	Location	Bars	As,prov (mm ² /m)	Reference	Detailing	Status
B1	Base slab	Bottom face, transverse (toe)	12Ø @ 200 c/c	565	Annex G, cl 26.5, 40.2	Design	OK
B2	Base slab	Top face, transverse (heel)	16Ø @ 200 c/c	1,005	Annex G, cl 26.5, 40.2	Design	OK
S1/S2	Stem	Back (earth) face, vertical	12Ø @ 120 c/c	942	Annex G, cl 26.5, 40.2	Design	OK
K1	Shear key	Both faces, vertical (U-bars)	12Ø @ 200 c/c	565	Annex G, cl 26.5, 40.2	Design	OK
S4/S5	Stem	Horizontal, each face	8Ø @ 230 c/c	219	CI 26.5.2.1, 26.3.3	Design	OK
S3	Stem	Front face, vertical (nominal)	8Ø @ 230 c/c	219	CI 26.5.2.1, 26.3.3	Design	OK
B3/B4	Base slab	Longitudinal, each face	10Ø @ 290 c/c	271	CI 26.5.2.1, 26.3.3	Design	OK

2. Design basis and assumptions

Clause references are to IS 456:2000 (Plain and reinforced concrete - code of practice) unless stated otherwise. Verify the references against the code editions and amendments in force for the project.

- Design per metre run of wall; limit state method of IS 456 for the members.
- Earth pressure: Rankine's active pressure for a sloping backfill, acting parallel to the backfill surface on a vertical plane through the heel end (virtual back) for stability, and on the back of the stem for the stem design. Wall friction is ignored (conservative).
- Surcharge: a uniform load on the backfill giving a uniform lateral pressure $K_a \cdot q$. It is an imposed load: it drives the wall, but its weight over the heel is not counted as resisting overturning or sliding (it is included for the base pressure and the heel design).
- Stability (IS 456 cl 20.1, 20.2): only 0.9 times the restoring dead load is relied upon; factors of safety of 1.4 against overturning ($0.9 M_r / M_o$) and 1.4 against sliding are required (all earth pressure treated as the 1.4-factored imposed action, as is usual practice).
- Base pressure under characteristic loads (surcharge included) compared with the safe bearing capacity; where the resultant falls outside the middle third the no-tension (triangular) distribution is used.
- Soil above the toe is relied upon.
- Passive resistance in front of the base and of the shear key is relied upon with a mobilisation factor of 1.
- Water table behind the wall: submerged unit weight below it, full hydrostatic pressure and a triangular uplift under the base (zero at the toe).
- Seismic case (IS 1893): Mononobe-Okabe coefficient with $\alpha_h = 0.1$, $\alpha_v = 0.067$ (the larger of $(1 \pm \alpha_v)$); the dynamic increment acts at mid-height; inertia of the wall and of the soil over the heel added. Load factor 1.2 (IS 456 Table 18), minimum factor of safety 1.2, SBC increased by 25 %.
- Members: load factor 1.5 on all actions (IS 456 Table 18); the stem is a cantilever from the top of the base; toe and heel are cantilevers from the faces of the stem loaded by the base pressure, the slab and the soil (and surcharge) above.
- Shear: slabs without shear reinforcement, $\tau_v \leq k \cdot \tau_c$ (cl 40.2.1.1) at d from the face of the stem for the stem and toe, at the face for the heel (the support is in tension).
- Minimum and distribution steel 0.12 % of $b \cdot D$ (cl 26.5.2.1); spacing limits cl 26.3.3; development lengths cl 26.2.1 with the bond stresses of cl 26.2.1.1 (+60 % for deformed bars).

3. Input data

Geometry

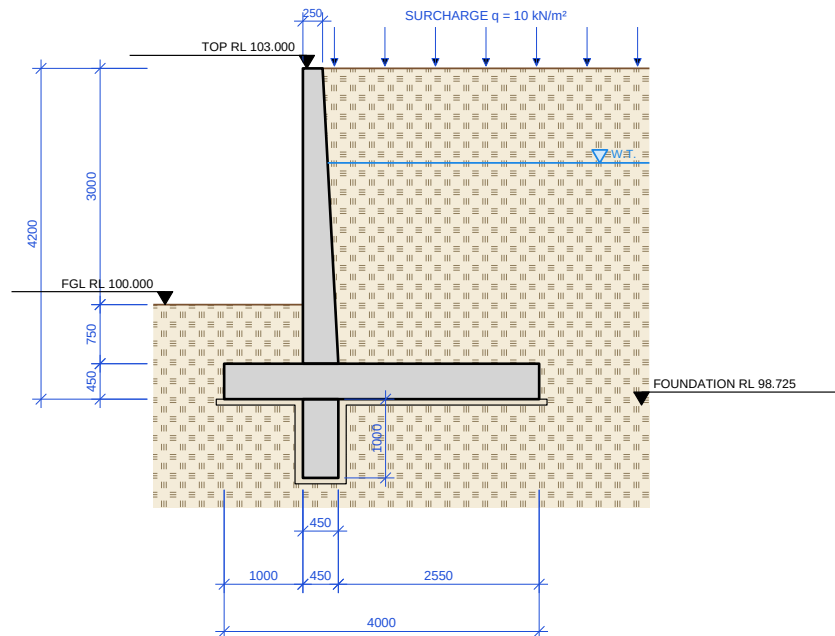
Item	Value	Reference
Wall type	T-shaped (toe and heel)	-
Retained height above the front ground	3 m	-
Depth of the base underside below the front ground	1.2 m	IS 1904
Overall height H	4.200 m	-
Stem thickness top / base	0.25 / 0.45 m	-
Batter	back face	-
Base width B / thickness	4 / 0.45 m	-
Toe / heel length	1 / 2.550 m	-
Shear key	0.45 m wide $\times$ 1 m deep under the stem	-
Front ground level	RL 100.000	-
Wall length (BBS, quantities)	10 m	-

Soil, water and loads

Item	Value	Reference
Unit weight of soil γ / saturated γ_{sat}	18 / 20 kN/m ³	IS 875 (Part 1)
Angle of internal friction ϕ	30°	Soil investigation
Backfill slope θ	0°	-
Surcharge q	10 kPa (imposed)	IS 875 (Part 2)
Coefficient of friction μ	0.5	Soil investigation
Safe bearing capacity	250 kPa	IS 6403
Water table behind the wall	3 m above the base underside	-
Seismic	$\alpha_h = 0.1$, $\alpha_v = 0.667 \alpha_h$	IS 1893

Materials and safety

Item	Value	Reference
Concrete	M25, $\gamma_c = 25$ kN/m ³	IS 456 Table 2, IS 875 (Part 1)
Reinforcement	Fe 500	IS 1786
Clear cover stem / base	50 / 50 mm	IS 456 Table 16, cl 26.4.2.2
Load factors	1.5 (static), 1.2 (seismic)	IS 456 Table 18
Required factors of safety	overturning 1.4, sliding 1.4, seismic 1.2	IS 456 cl 20.1, 20.2
Bar diameters (main / distribution)	12,16,20,25 / 8,10,12 mm	IS 456 cl 26.5.2.2
Bar spacing	100 to 250 mm (distribution ≤ 300)	IS 456 cl 26.3



Section of the wall

4. Earth pressure

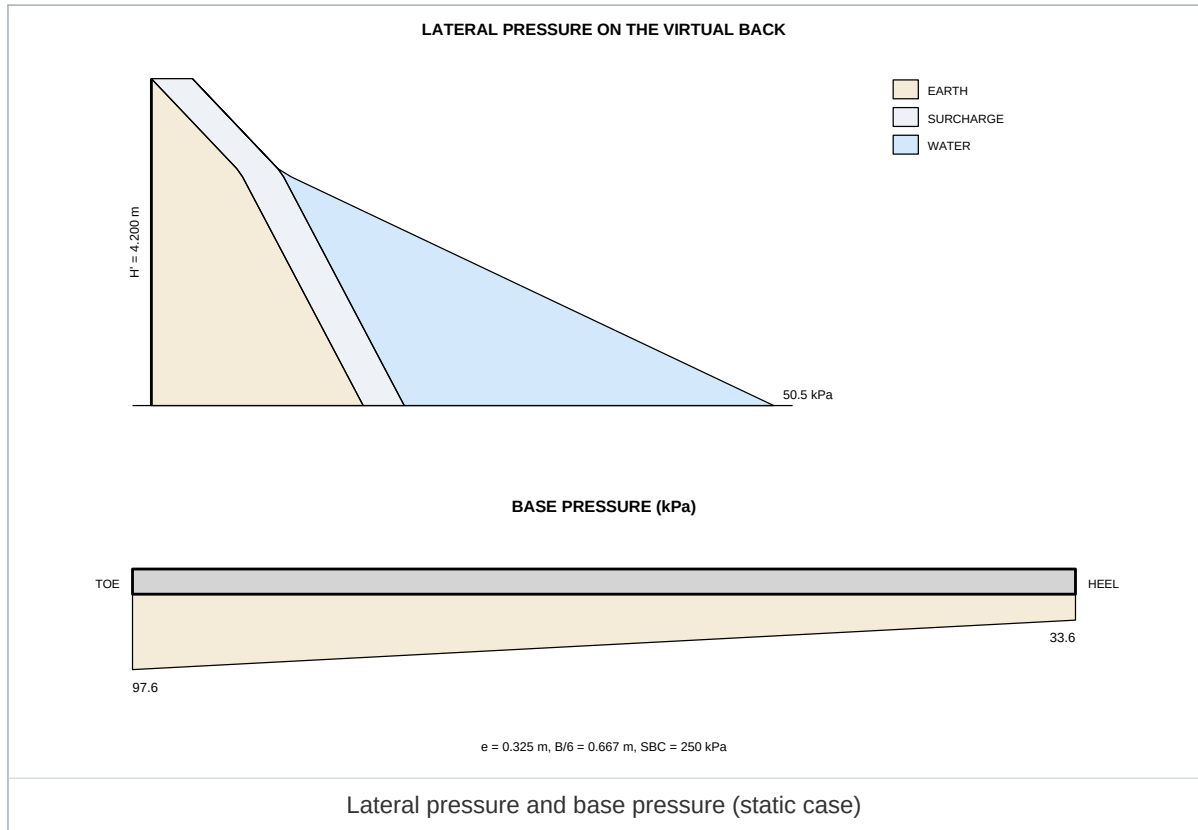
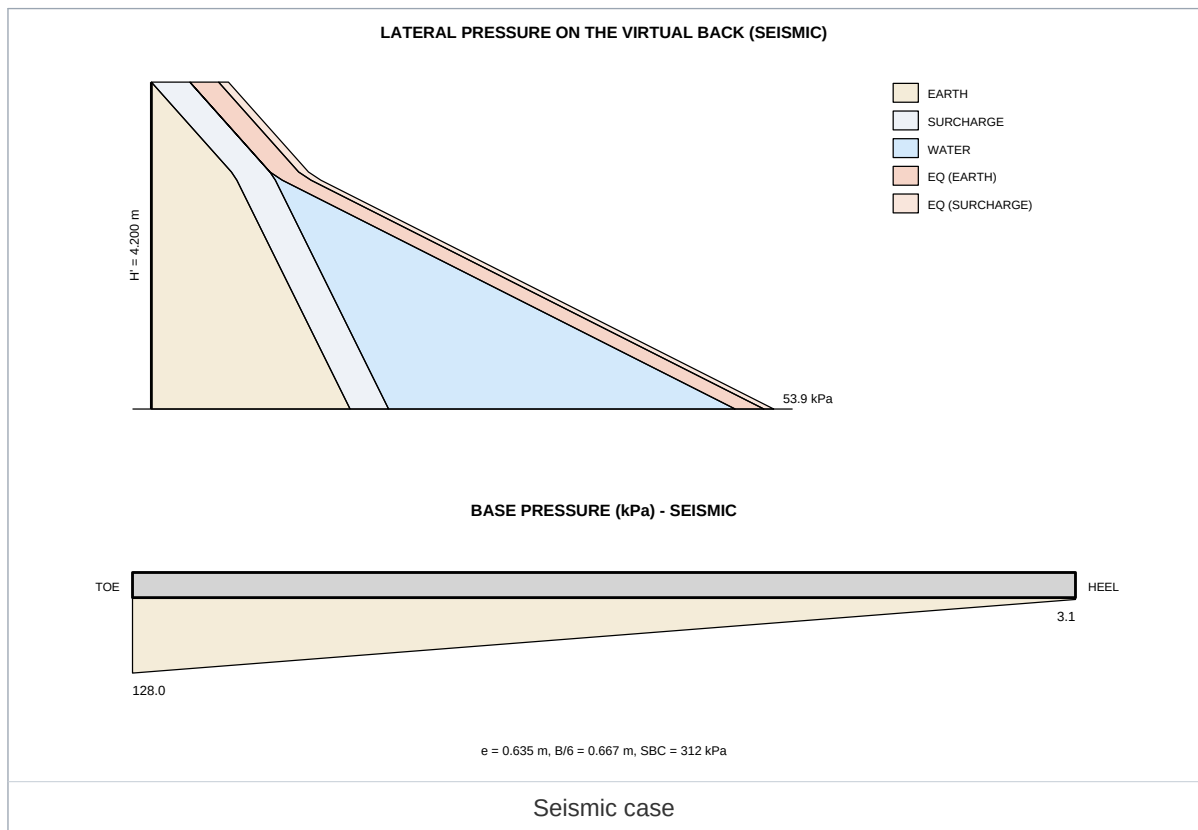
Earth pressure coefficients				OK
Reference	Description	Calculation	Result	Status
Rankine	Active pressure coefficient	$K_a = (1 - \sin \phi) / (1 + \sin \phi)$, $\phi = 30^\circ$, $\theta = 0^\circ$	0.3333	
Rankine	Passive pressure coefficient (level ground in front)	$K_p = (1 + \sin \phi) / (1 - \sin \phi)$	3.0000	
	Height of the virtual back	$H' = H + (B - x) \tan \theta = 4.200 + 2.750 \times 0.0000$	4.200 m	
IS 1893:1984 cl 8.1	Mononobe-Okabe coefficient	$\lambda = \tan^{-1}(\alpha h / (1 \pm \alpha v)) = 5.36^\circ$, $(1 \pm \alpha v) = 1.067$, $\delta = i = \theta$	$K_{ae} = 0.4184$	
	Dynamic increment coefficient	$\Delta K = K_{ae} - K_a$	0.0851	

Horizontal forces on the virtual back - static case

Force	Type	H (kN/m)	Height y (m)	Moment H·y (kNm/m)	Reference
Active earth pressure	Dead load / earth	40.92	1.517	62.09	Rankine (Ka)
Surcharge pressure	Surcharge (imposed)	14.00	2.100	29.40	Rankine (Ka)
Water pressure	Water	45.00	1.000	45.00	Hydrostatic
Passive resistance	Passive	-115.49	-0.394	- (sliding only)	Rankine (Kp)

Horizontal forces on the virtual back - seismic case

Force	Type	H (kN/m)	Height y (m)	Moment H·y (kNm/m)	Reference
Active earth pressure	Dead load / earth	40.92	1.517	62.09	Rankine (Ka)
Surcharge pressure	Surcharge (imposed)	14.00	2.100	29.40	Rankine (Ka)
Water pressure	Water	45.00	1.000	45.00	Hydrostatic
Dynamic increment (earth)	Seismic	10.44	2.100	21.93	IS 1893:1984 cl 8.1
Dynamic increment (surcharge)	Seismic	3.57	2.100	7.50	IS 1893:1984 cl 8.1
Inertia of the wall	Seismic	8.91	0.841	7.49	IS 1893
Inertia of the backfill over the heel	Seismic	19.22	2.306	44.33	IS 1893
Passive resistance	Passive	-115.49	-0.394	- (sliding only)	Rankine (Kp)



5. Stability and base pressure

Vertical forces (moments about the toe) - static case

Force	Type	V (kN/m)	Lever arm x (m)	Moment V·x (kNm/m)	Reference
Stem	Dead load / earth	32.81	1.180	38.71	IS 875 (Part 1)
Base slab	Dead load / earth	45.00	2.000	90.00	IS 875 (Part 1)
Shear key	Dead load / earth	11.25	1.225	13.78	IS 875 (Part 1)
Backfill over heel	Dead load / earth	192.23	2.676	514.30	IS 875 (Part 1)
Soil over toe	Dead load / earth	13.50	0.500	6.75	IS 875 (Part 1)
Surcharge on heel	Surcharge (imposed)	27.50	2.625	72.19	IS 875 (Part 2)
Uplift under base	Water	-60.00	2.667	-160.00	Hydrostatic
Total		262.29		575.73	

Overturning - static case				OK
Reference	Description	Calculation	Result	Status
	Restoring moment	$M_r = \sum V \cdot x$ of the dead loads (surcharge and seismic vertical forces excluded)	663.55 kNm/m	
	Overturning moment	$M_o = \sum H \cdot y + \text{uplift moment}$	296.49 kNm/m	
Cl. 20.1	Factor of safety	$0.9 M_r / M_o = 0.9 \times 663.55 / 296.49$	$2.01 \geq 1.4$	OK

Sliding - static case				OK
Reference	Description	Calculation	Result	Status
	Resisting vertical load	$\sum V = 294.79 - \text{uplift } 60.00$	234.79 kN/m	
Cl. 20.2	Friction ($0.9 \times \text{dead load}$)	$0.9 \mu \sum V = 0.9 \times 0.5 \times 234.79$	105.66 kN/m	
	Passive resistance	$1 \times \frac{1}{2} K_p \gamma (z^2 - z_1^2)$, $z = 0.750$ to 2.200 m	115.49 kN/m	
	Sliding force	$\sum H$	99.92 kN/m	
Cl. 20.2	Factor of safety	$(105.66 + 115.49) / 99.92$	$2.21 \geq 1.4$	OK

Base pressure - static case				OK
Reference	Description	Calculation	Result	Status
	Total vertical load (surcharge included)	$\sum V$	262.29 kN/m	
	Net moment about the toe	$\sum V \cdot x - \sum H \cdot y$	439.25 kNm/m	
	Position of the resultant	$x_{\square} = 439.25 / 262.29$	1.675 m	
	Eccentricity	$e = B/2 - x_{\square} = 2.000 - 1.675$	0.325 m	OK
	Base pressures	$q = \sum V / B (1 \pm 6e / B) = 262.29 / 4 (1 \pm 0.488)$	97.6 / 33.6 kPa	
	Bearing	$q_{\text{max}} \leq \text{allowable } 250 \text{ kPa}$	97.6 kPa	OK

Vertical forces (moments about the toe) - seismic case

Force	Type	V (kN/m)	Lever arm x (m)	Moment V·x (kNm/m)	Reference
Stem	Dead load / earth	32.81	1.180	38.71	IS 875 (Part 1)
Base slab	Dead load / earth	45.00	2.000	90.00	IS 875 (Part 1)
Shear key	Dead load / earth	11.25	1.225	13.78	IS 875 (Part 1)
Backfill over heel	Dead load / earth	192.23	2.676	514.30	IS 875 (Part 1)
Soil over toe	Dead load / earth	13.50	0.500	6.75	IS 875 (Part 1)
Surcharge on heel	Surcharge (imposed)	27.50	2.625	72.19	IS 875 (Part 2)
Uplift under base	Water	-60.00	2.667	-160.00	Hydrostatic

Force	Type	V (kN/m)	Lever arm x (m)	Moment V·x (kNm/m)	Reference
Total		262.29		575.73	

Overturning - seismic case					OK
Reference	Description	Calculation	Result	Status	
	Restoring moment	$M_r = \sum V \cdot x$ of the dead loads (surcharge and seismic vertical forces excluded)	663.55 kNm/m		
	Overturning moment	$M_o = \sum H \cdot y + \text{uplift moment}$	377.75 kNm/m		
Cl. 20.1	Factor of safety	$0.9 M_r / M_o = 0.9 \times 663.55 / 377.75$	1.58 $\geq$ 1.2	OK	

Sliding - seismic case					OK
Reference	Description	Calculation	Result	Status	
	Resisting vertical load	$\sum V = 294.79 - \text{uplift } 60.00$	234.79 kN/m		
Cl. 20.2	Friction (0.9 × dead load)	$0.9 \mu \sum V = 0.9 \times 0.5 \times 234.79$	105.66 kN/m		
	Passive resistance	$1 \times \frac{1}{2} K_p \gamma (z^2 - z_1^2)$, $z = 0.750$ to 2.200 m	115.49 kN/m		
	Sliding force	$\sum H$	142.07 kN/m		
Cl. 20.2	Factor of safety	$(105.66 + 115.49) / 142.07$	1.56 $\geq$ 1.2	OK	

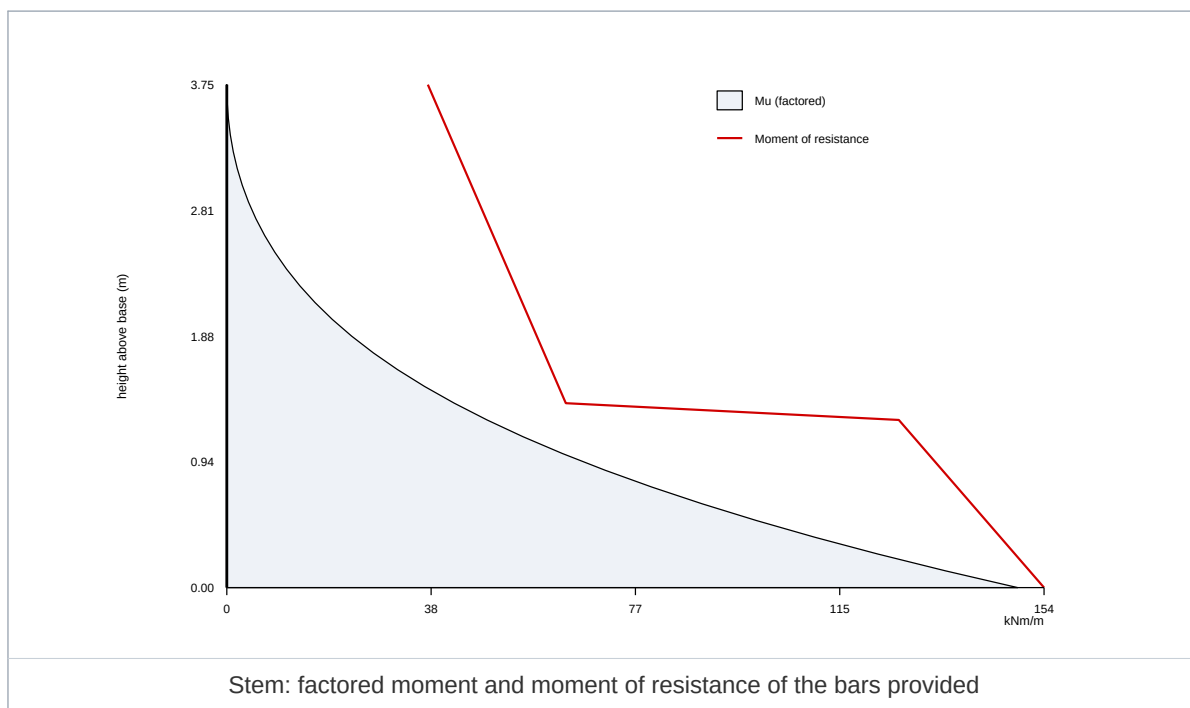
Base pressure - seismic case					OK
Reference	Description	Calculation	Result	Status	
	Total vertical load (surcharge included)	$\sum V$	262.29 kN/m		
	Net moment about the toe	$\sum V \cdot x - \sum H \cdot y$	357.99 kNm/m		
	Position of the resultant	$x_{\square} = 357.99 / 262.29$	1.365 m		
	Eccentricity	$e = B/2 - x_{\square} = 2.000 - 1.365$	0.635 m	OK	
	Base pressures	$q = \sum V / B (1 \pm 6e / B) = 262.29 / 4 (1 \pm 0.953)$	128.0 / 3.1 kPa		
	Bearing	$q_{\text{max}} \leq \text{allowable } 312 \text{ kPa}$	128.0 kPa	OK	

6. Design of the stem

Stem - main reinforcement at the base (earth face)					OK
Reference	Description	Calculation	Result	Status	
	Stem height above the base	$h_s = H - \text{base thickness}$	3.750 m		
	Moment at the base - earth pressure (static case)	$\int p(y) (y - y_0) dy$	45.36 kNm/m		
	Moment at the base - surcharge (static case)	$\int p(y) (y - y_0) dy$	23.44 kNm/m		
	Moment at the base - water pressure (static case)	$\int p(y) (y - y_0) dy$	27.64 kNm/m		
	Moment at the base - earth pressure (seismic case)	$\int p(y) (y - y_0) dy$	45.36 kNm/m		
	Moment at the base - surcharge (seismic case)	$\int p(y) (y - y_0) dy$	23.44 kNm/m		
	Moment at the base - water pressure (seismic case)	$\int p(y) (y - y_0) dy$	27.64 kNm/m		

Reference	Description	Calculation	Result	Status
	Moment at the base - dynamic increment (earth) (seismic case)	$\int p(y) (y - y_0) dy$	16.04 kNm/m	
	Moment at the base - dynamic increment (surcharge) (seismic case)	$\int p(y) (y - y_0) dy$	5.98 kNm/m	
	Moment at the base - inertia of the stem (seismic case)	$\alpha h \times \int w (y - y_0) dy$	5.57 kNm/m	
Table 18	Design moment	$M_u = \gamma f \times \Sigma M$ (seismic case governs)	148.83 kNm/m	
	Design shear at d above the base	$V_u = \gamma f \times \Sigma V$	93.03 kN/m	
	Effective depth	$d = D - \text{cover} - \phi/2 = 450 - \text{cover} - 6$	394 mm	
Annex G-1.1	Limiting moment	$M_{u,lim} = 0.36 f_{ck} b x_{u,max} (d - 0.42 x_{u,max})$, $x_{u,max}/d = 0.456$	515.1 kNm/m	OK
Annex G-1.1(b)	Steel required	$A_s = 0.5 f_{ck} f_y [1 - \sqrt{1 - 4.6 M_u / (f_{ck} b d^2)}] b d$	911 mm ² /m	
Cl. 26.5.2.1	Minimum steel	$0.12 \% \times 1000 \times 450$	540 mm ² /m	
	Steel provided	12Ø @ 120 c/c (design)	942 mm ² /m	OK
Cl. 26.5.1.1(b)	Maximum steel (4 % of b·D)	$\leq 4 \%$	0.21 %	OK
Cl. 26.3.3(b)(1)	Spacing of main bars	$\leq 3d = 1182, 300 \text{ mm}$	120 mm	OK
Cl. 26.3.2	Clear spacing between bars	$\geq 25 \text{ mm } (\phi, \text{ aggregate} + 5)$	108 mm	OK
Cl. 26.5.2.2	Bar diameter	$\leq D/8 = 56 \text{ mm}$	12 mm	OK
Cl. 40.2.1.1, Table 19	Shear without shear reinforcement	$\leq k \cdot \tau_c = 1.00 \times 0.352 = 0.352 \text{ N/mm}^2$ (pt = 0.239 %)	$\tau_v = 0.236 \text{ N/mm}^2$	OK
Cl. 40.2.3.1, Table 20	Maximum shear stress in a slab	$\leq \tau_{c,max} / 2 = 1.55 \text{ N/mm}^2$	$\tau_v = 0.236 \text{ N/mm}^2$	OK
Cl. 26.2.1, 26.2.2.1(b)	Anchorage of stem bars in the base	$\geq L_d = 583 \text{ mm}$	$382 + 8\phi + 300 = 778 \text{ mm}$	OK

Stem - curtailment and anchorage				OK
Reference	Description	Calculation	Result	Status
Cl. 26.2.1	Development length of the main bars	$L_d = \phi 0.87 f_y / (4 \tau_{bd})$, $\tau_{bd} = 2.24 \text{ N/mm}^2$	583 mm	
	Section where half the bars suffice	$M_u(y) \leq M_{u,R}$ of 12Ø @ 240 c/c	910 mm above the base	
Cl. 26.2.3.1	Cut-off of the alternate bars S2	theoretical + max(d, 12φ), $\geq L_d$ above the base	1300 mm above the base	
Cl. 26.2.3.2(a)	Shear at the cut-off	$\tau_v = 0.153 \leq 2/3 \times 0.290$		OK
	Curtailment	Alternate bars (S2) stop 1300 mm above the base: theoretical cut-off 910 mm + max(d, 12φ), and at least $L_d = 583 \text{ mm}$.		
Cl. 26.2.2.1(b)	Anchorage in the base	straight 382 + 90° bend 8φ + leg 300 towards the toe	$778 \geq 583 \text{ mm}$	OK



7. Design of the base slab

Base slab - bottom face (toe)				OK
Reference	Description	Calculation	Result	Status
	Toe moment at the front face of the stem (characteristic)	$\int (q + u - \text{slab} - \text{soil}) (x_0 - x) dx$	47.69 kNm/m	
Table 18	Design moment	Mu at the front face of stem (toe) (seismic case)	57.23 kNm/m	
	Design shear	Vu (toe at d from the face, heel at the face)	69.89 kN/m	
	Effective depth	$d = D - \text{cover} - \phi/2 = 450 - \text{cover} - 6$	394 mm	
Annex G-1.1	Limiting moment	$Mu, \text{lim} = 0.36 f_{ck} b x_{u, \text{max}} (d - 0.42 x_{u, \text{max}})$, $x_{u, \text{max}}/d = 0.456$	515.1 kNm/m	OK
Annex G-1.1(b)	Steel required	$A_s = 0.5 f_{ck}/f_y [1 - \sqrt{1 - 4.6 M_u / (f_{ck} b d^2)}] b d$	340 mm ² /m	
Cl. 26.5.2.1	Minimum steel	$0.12 \% \times 1000 \times 450$	540 mm ² /m	
	Steel provided	12Ø @ 200 c/c (design)	565 mm ² /m	OK
Cl. 26.5.1.1(b)	Maximum steel (4 % of b·D)	$\leq 4 \%$	0.13 %	OK
Cl. 26.3.3(b)(1)	Spacing of main bars	$\leq 3d = 1182, 300 \text{ mm}$	200 mm	OK
Cl. 26.3.2	Clear spacing between bars	$\geq 25 \text{ mm } (\phi, \text{ aggregate} + 5)$	188 mm	OK
Cl. 26.5.2.2	Bar diameter	$\leq D/8 = 56 \text{ mm}$	12 mm	OK
Cl. 40.2.1.1, Table 19	Shear without shear reinforcement	$\leq k \cdot \tau_c = 1.00 \times 0.290 = 0.290 \text{ N/mm}^2$ (pt = 0.144 %)	$\tau_v = 0.177 \text{ N/mm}^2$	OK
Cl. 40.2.3.1, Table 20	Maximum shear stress in a slab	$\leq \tau_{c, \text{max}} / 2 = 1.55 \text{ N/mm}^2$	$\tau_v = 0.177 \text{ N/mm}^2$	OK
Cl. 26.2.1	Development length beyond the front face of the stem, towards the heel	$\geq L_d = 583 \text{ mm}$	$2950 + 8\phi = 3046 \text{ mm}$	OK
Base slab - top face (heel)				OK

Reference	Description	Calculation	Result	Status
	Heel moment at the back face of the stem (characteristic)	$\int (\text{slab} + \text{soil} + \text{surcharge} - q - u) (x - x_0) dx$	131.92 kNm/m	
	Heel shear at the face (characteristic)	$\int (\text{downward} - \text{upward}) dx$	77.74 kN/m	
Table 18	Design moment	Mu at the back face of stem (heel) (seismic case)	158.30 kNm/m	
	Design shear	Vu (toe at d from the face, heel at the face)	93.29 kN/m	
	Effective depth	$d = D - \text{cover} - \phi/2 = 450 - \text{cover} - 8$	392 mm	
Annex G-1.1	Limiting moment	$M_{u,lim} = 0.36 f_{ck} b x_{u,max} (d - 0.42 x_{u,max}), x_{u,max}/d = 0.456$	509.9 kNm/m	OK
Annex G-1.1(b)	Steel required	$A_s = 0.5 f_{ck}/f_y [1 - \sqrt{1 - 4.6 M_u / (f_{ck} b d^2)}] b d$	978 mm ² /m	
Cl. 26.5.2.1	Minimum steel	$0.12 \% \times 1000 \times 450$	540 mm ² /m	
	Steel provided	16Ø @ 200 c/c (design)	1005 mm ² /m	OK
Cl. 26.5.1.1(b)	Maximum steel (4 % of b·D)	$\leq 4 \%$	0.22 %	OK
Cl. 26.3.3(b)(1)	Spacing of main bars	$\leq 3d = 1176, 300 \text{ mm}$	200 mm	OK
Cl. 26.3.2	Clear spacing between bars	$\geq 25 \text{ mm } (\phi, \text{ aggregate} + 5)$	184 mm	OK
Cl. 26.5.2.2	Bar diameter	$\leq D/8 = 56 \text{ mm}$	16 mm	OK
Cl. 40.2.1.1, Table 19	Shear without shear reinforcement	$\leq k \cdot \tau_c = 1.00 \times 0.363 = 0.363 \text{ N/mm}^2 \text{ (pt} = 0.256 \%)$	$\tau_v = 0.238 \text{ N/mm}^2$	OK
Cl. 40.2.3.1, Table 20	Maximum shear stress in a slab	$\leq \tau_{c,max} / 2 = 1.55 \text{ N/mm}^2$	$\tau_v = 0.238 \text{ N/mm}^2$	OK
Cl. 26.2.1	Development length beyond the back face of the stem, towards the toe	$\geq L_d = 777 \text{ mm}$	$1400 + 8\phi = 1528 \text{ mm}$	OK

8. Design of the shear key

Shear key				OK
Reference	Description	Calculation	Result	Status
	Passive force on the key (characteristic)	$1 \times K_p \gamma \int z dz \text{ over the key depth}$	91.80 kN/m	
	Moment at the root of the key	$\int p(z) (z - z_0) dz$	50.40 kNm/m	
Table 18	Design moment	$M_u = 1.5 \times 50.40$	75.60 kNm/m	
	Effective depth	$d = D - \text{cover} - \phi/2 = 450 - \text{cover} - 6$	394 mm	
Annex G-1.1	Limiting moment	$M_{u,lim} = 0.36 f_{ck} b x_{u,max} (d - 0.42 x_{u,max}), x_{u,max}/d = 0.456$	515.1 kNm/m	OK
Annex G-1.1(b)	Steel required	$A_s = 0.5 f_{ck}/f_y [1 - \sqrt{1 - 4.6 M_u / (f_{ck} b d^2)}] b d$	452 mm ² /m	
Cl. 26.5.2.1	Minimum steel	$0.12 \% \times 1000 \times 450$	540 mm ² /m	
	Steel provided	12Ø @ 200 c/c (design)	565 mm ² /m	OK
Cl. 26.5.1.1(b)	Maximum steel (4 % of b·D)	$\leq 4 \%$	0.13 %	OK
Cl. 26.3.3(b)(1)	Spacing of main bars	$\leq 3d = 1182, 300 \text{ mm}$	200 mm	OK
Cl. 26.3.2	Clear spacing between bars	$\geq 25 \text{ mm } (\phi, \text{ aggregate} + 5)$	188 mm	OK
Cl. 26.5.2.2	Bar diameter	$\leq D/8 = 56 \text{ mm}$	12 mm	OK
Cl. 40.2.1.1, Table 19	Shear without shear reinforcement	$\leq k \cdot \tau_c = 1.00 \times 0.290 = 0.290 \text{ N/mm}^2 \text{ (pt} = 0.144 \%)$	$\tau_v = 0.236 \text{ N/mm}^2$	OK

Reference	Description	Calculation	Result	Status
Cl. 40.2.3.1, Table 20	Maximum shear stress in a slab	$\leq \tau_{c,max} / 2 = 1.55 \text{ N/mm}^2$	$\tau_v = 0.236 \text{ N/mm}^2$	OK
Cl. 26.2.1, 26.2.2.1(b)	Anchorage of key bars in the base	$\geq L_d = 583 \text{ mm}$	$334 + 8\phi + \text{leg } 200 = 630 \text{ mm}$	OK

9. Distribution steel and detailing

Distribution and nominal steel

Mark	Location	Check	Value	Limit	Reference	Status
S4/S5	Horizontal, each face	Distribution steel	219 mm ² /m	$\geq 210 \text{ mm}^2/\text{m}$	Cl. 26.5.2.1	OK
S4/S5	Horizontal, each face	Spacing of distribution bars	230 mm	$\leq 5d = 1480, 450 \text{ mm}$	Cl. 26.3.3(b)(2)	OK
S4/S5	Horizontal, each face	Bar diameter	8 mm	$\leq D/8 = 44 \text{ mm}$	Cl. 26.5.2.2	OK
S3	Front face, vertical (nominal)	Distribution steel	219 mm ² /m	$\geq 210 \text{ mm}^2/\text{m}$	Cl. 26.5.2.1	OK
S3	Front face, vertical (nominal)	Spacing of distribution bars	230 mm	$\leq 5d = 1480, 450 \text{ mm}$	Cl. 26.3.3(b)(2)	OK
S3	Front face, vertical (nominal)	Bar diameter	8 mm	$\leq D/8 = 44 \text{ mm}$	Cl. 26.5.2.2	OK
B3/B4	Longitudinal, each face	Distribution steel	271 mm ² /m	$\geq 270 \text{ mm}^2/\text{m}$	Cl. 26.5.2.1	OK
B3/B4	Longitudinal, each face	Spacing of distribution bars	290 mm	$\leq 5d = 1975, 450 \text{ mm}$	Cl. 26.3.3(b)(2)	OK
B3/B4	Longitudinal, each face	Bar diameter	10 mm	$\leq D/8 = 56 \text{ mm}$	Cl. 26.5.2.2	OK

Development and lap lengths (M25, Fe 500; cl 26.2.1, 26.2.5.1)

Bar	Ld (mm)	Lap (mm)	Reference
8 mm	388	390	Cl 26.2.1, 26.2.5.1(c)
10 mm	485	490	Cl 26.2.1, 26.2.5.1(c)
12 mm	583	590	Cl 26.2.1, 26.2.5.1(c)
16 mm	777	780	Cl 26.2.1, 26.2.5.1(c)

10. Bar bending schedule and quantities

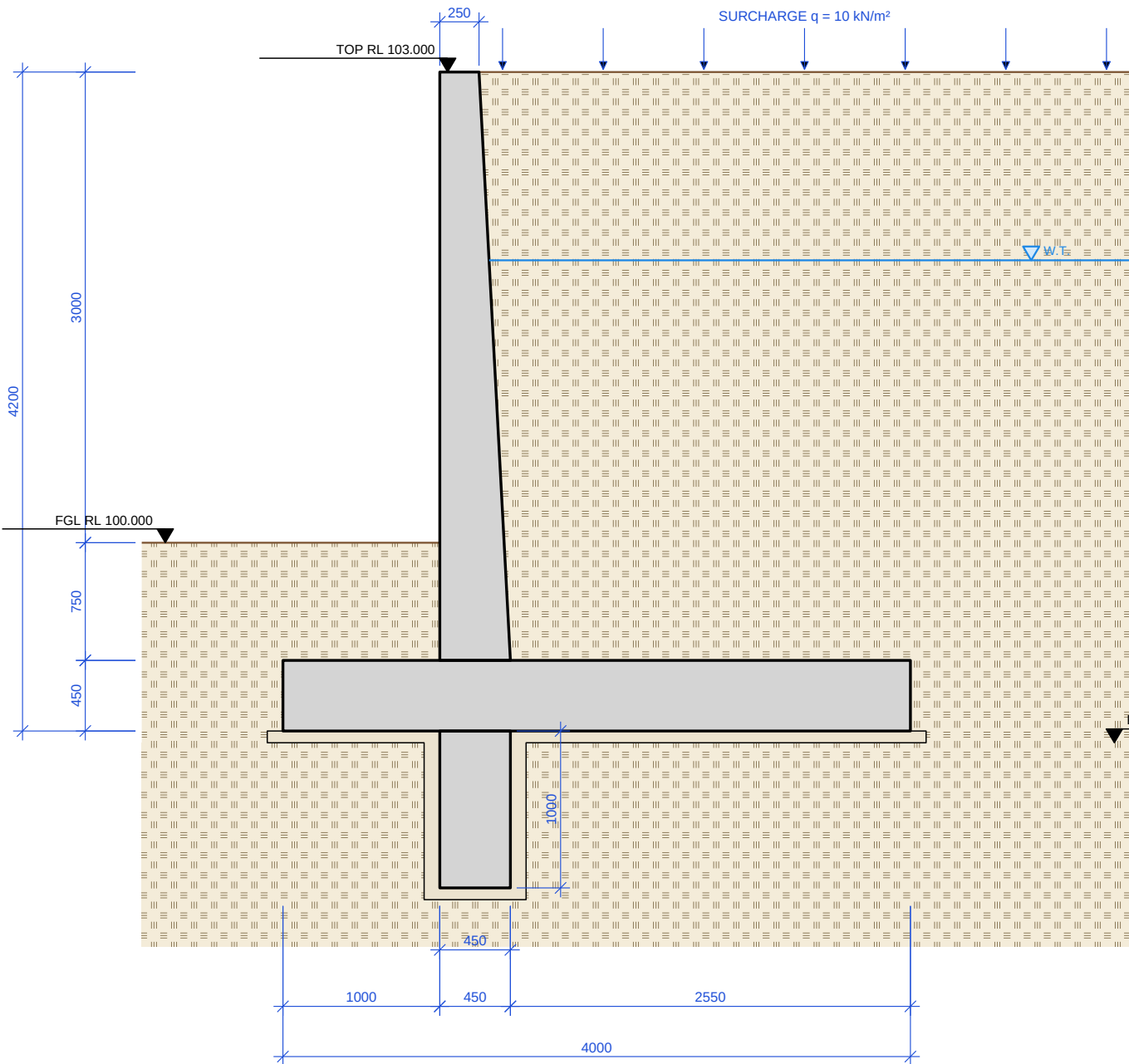
Bar bending schedule (10 m of wall) - IS 2502, cutting lengths with 2 ϕ deduction per 90° bend

Mark	Member	Description	Dia	Spacing	Nos	Length (m)	Weight (kg)
S1	Stem	Main bars, earth face (full height)	12	240	42	4.363	162.9
S2	Stem	Main bars, earth face (alternate, stop 1300 above base)	12	240	41	1.962	71.5
S3	Stem	Vertical bars, front face	8	230	44	4.212	73.2
S4	Stem	Horizontal bars, earth face	8	230	16	9.900	62.6
S5	Stem	Horizontal bars, front face	8	230	16	9.900	62.6
B1	Base slab	Transverse bars, bottom (toe), legs up	12	200	50	4.484	199.3
B2	Base slab	Transverse bars, top (heel), legs down	16	200	50	4.432	350.2
B3	Base slab	Longitudinal bars, bottom	10	290	14	9.900	85.6
B4	Base slab	Longitudinal bars, top	10	290	14	9.900	85.6
K1	Shear key	U-bars anchored in the base, legs bent along the top mat	12	200	50	3.278	145.7
K2	Shear key	Longitudinal bars	10	-	4	9.900	24.4

Mark	Member	Description	Dia	Spacing	Nos	Length (m)	Weight (kg)
		Total					1323.5

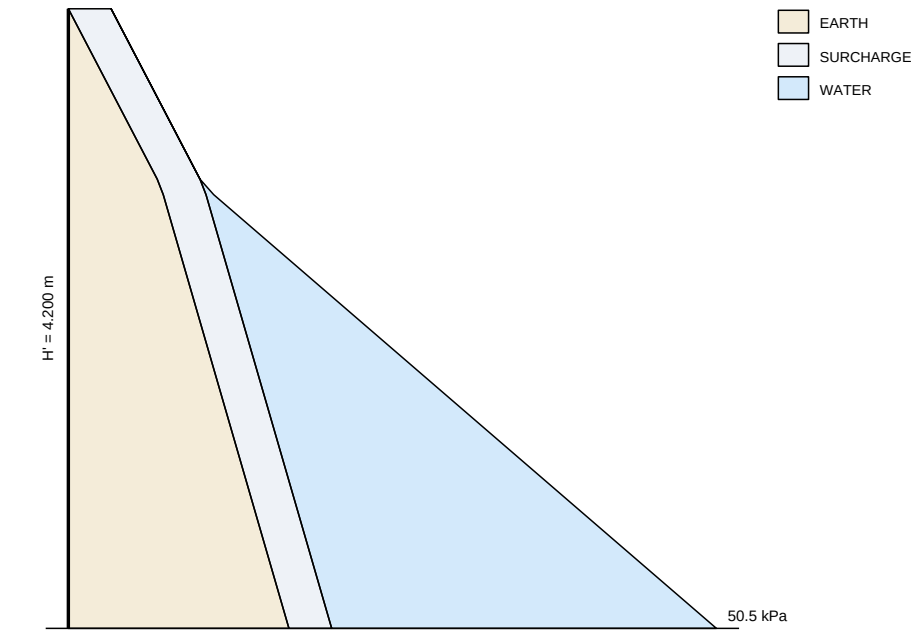
Quantities

Item	Quantity	Reference
RCC M25	35.62 m ³	IS 1200 (Part 2)
Reinforcement	1,323.5 kg	IS 1200 (Part 2)
Steel per m ³ of concrete	37.2 kg/m ³	-
Formwork	104.1 m ²	IS 1200 (Part 5)
PCC levelling course (75 mm)	3.00 m ³	IS 1200 (Part 2)
Excavation (to the base underside, vertical sides)	48.0 m ³	IS 1200 (Part 1)

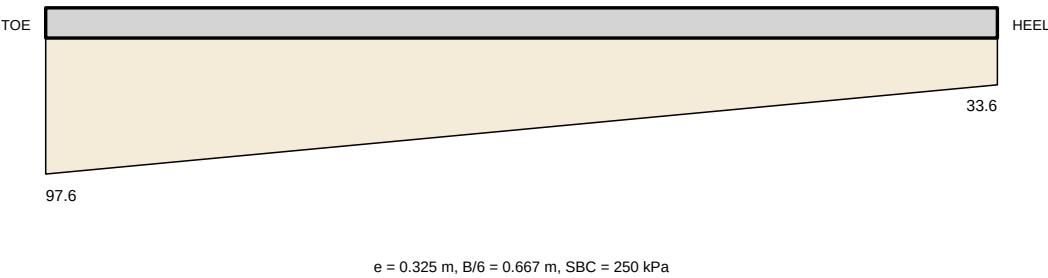


SECTION OF RETAINING WALL
SCALE 1:40

LATERAL PRESSURE ON THE VIRTUAL BACK



BASE PRESSURE (kPa)



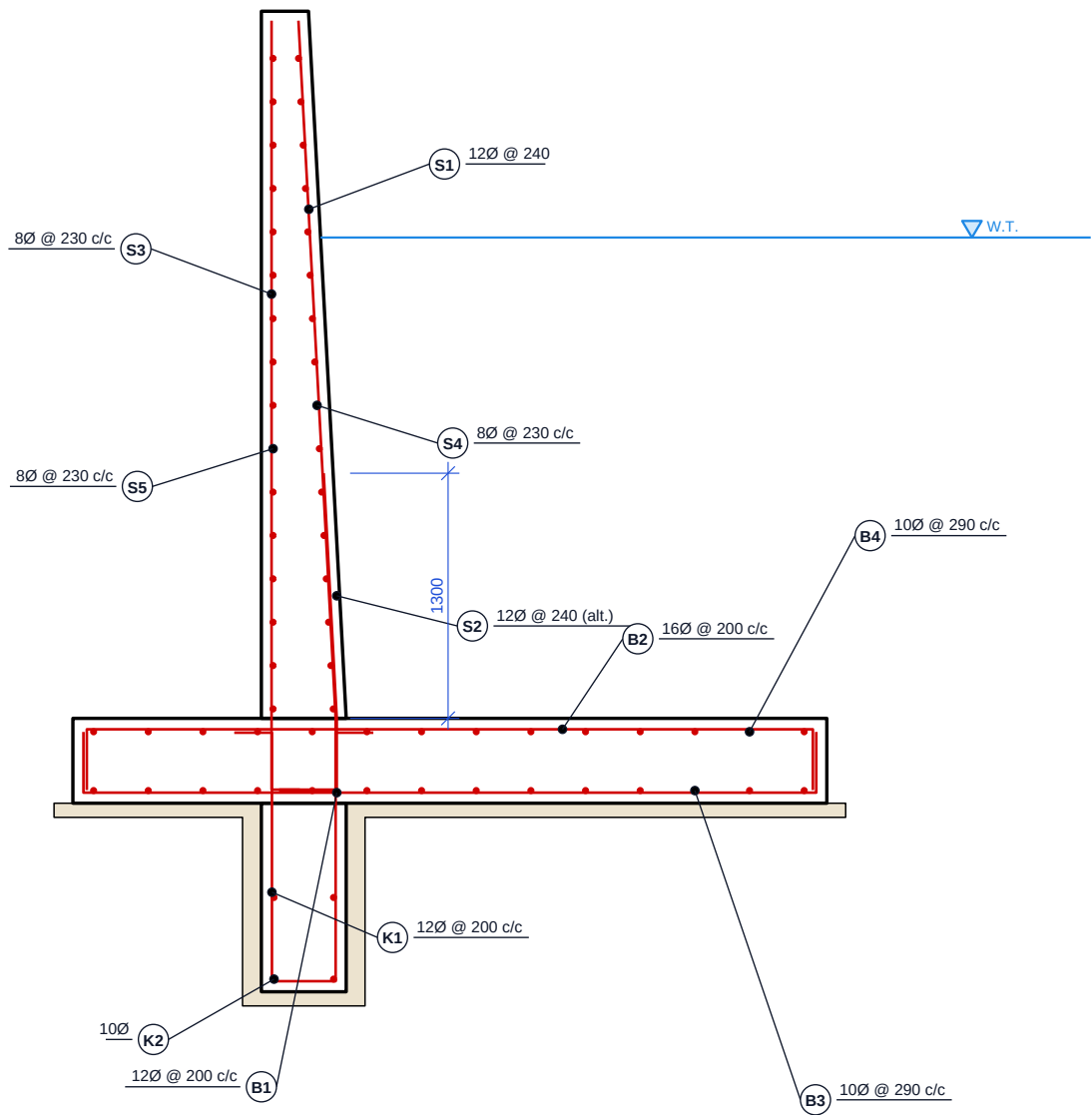
CHECK	VALUE	LIMIT	
Overturning	2.01	≥ 1.4	OK
Sliding	2.21	≥ 1.4	OK
Max. base pressure	97.6 kPa	≤ 250	OK
Eccentricity	0.325 m	≤ 0.667	OK
Overturning (EQ)	1.58	≥ 1.2	OK
Sliding (EQ)	1.56	≥ 1.2	OK
Max. base pressure (EQ)	128.0 kPa	≤ 312	OK
Eccentricity (EQ)	0.635 m	≤ 0.667	OK

NOTES

- All dimensions are in mm and levels in m unless noted.
- Water table behind the wall considered in design (backfill not drained).
- No weep holes: wall designed for full water pressure.
- Contraction joints at 8 to 10 m c/c; wall length considered 10 m.

Design: IS 456:2000, IS 1893 | Generated by nxstructural Retaining Wall Designer

<div><div><div>NX</div><div>Structural</div></div><div>CANTILEVER RETAINING WALL</div></div>				
GENERAL ARRANGEMENT				
CLIENT			STRUCTURE	
-			T-SHAPED CANTILEVER WALL, H = 4.20 m	
DESIGNED	CHECKED	DATE	SCALE	SHEET
-	-	01-11-2026	AS SHOWN	1 of 3



REINFORCEMENT DETAILS - SECTION
SCALE 1:40

REINFORCEMENT SCHEDULE

MARK	BARS	LOCATION
S1	12Ø @ 240	Stem, earth face
S2	12Ø @ 240 (alt.)	Stem, earth face (curtailed)
S3	8Ø @ 230 c/c	Stem, front face
S4	8Ø @ 230 c/c	Stem horizontal, earth face
S5	8Ø @ 230 c/c	Stem horizontal, front face
B1	12Ø @ 200 c/c	Base bottom (transverse)
B2	16Ø @ 200 c/c	Base top (transverse)
B3	10Ø @ 290 c/c	Base bottom (longitudinal)
B4	10Ø @ 290 c/c	Base top (longitudinal)
K1	12Ø @ 200 c/c	Shear key U-bars
K2	10Ø	Shear key longitudinal

NOTES

- Concrete M25, reinforcement Fe 500 (IS 1786).
- Clear cover: stem 50 mm, base 50 mm.
- Lap lengths (mm): 8Ø 390, 10Ø 490, 12Ø 590, 16Ø 780; laps staggered, not more than 50 % at a section.
- Stem bars bent at the bottom mat towards the toe, leg 300 mm (Ld = 583 mm).
- Alternate bars (S2) stop 1300 mm above the base: theoretical cut-off 910 mm + max(d, 12Ø), and at least Ld = 583 mm.
- S1 and S2 are placed alternately.

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<div><div><div>NX</div><div>Structural</div></div><div>CANTILEVER RETAINING WALL</div></div>				
REINFORCEMENT DETAILS				
CLIENT			STRUCTURE	
-			T-SHAPED CANTILEVER WALL, H = 4.20 m	
DESIGNED	CHECKED	DATE	SCALE	SHEET
-	-	01-11-2026	AS SHOWN	2 of 3

BAR BENDING SCHEDULE - RETAINING WALL (10 m LONG)

MARK	MEMBER	DESCRIPTION	SHAPE	DIMENSIONS (mm)	DIA	SPACING	NOS	CUT LEN (m)	TOTAL (m)	kg/m	WEIGHT (kg)
S1	Stem	Main bars, earth face (full height)		a=4087, b=300	12	240	42	4.363	183.3	0.889	162.9
S2	Stem	Main bars, earth face (alternate, stop 1300 above base)		a=1680, b=300	12	240	41	1.962	80.4	0.889	71.5
S3	Stem	Vertical bars, front face		a=4078, b=150	8	230	44	4.212	185.3	0.395	73.2
S4	Stem	Horizontal bars, earth face		a=9900	8	230	16	9.900	158.4	0.395	62.6
S5	Stem	Horizontal bars, front face		a=9900	8	230	16	9.900	158.4	0.395	62.6
B1	Base slab	Transverse bars, bottom (toe), legs up		a=3888, b=322	12	200	50	4.484	224.2	0.889	199.3
B2	Base slab	Transverse bars, top (heel), legs down		a=3852, b=322	16	200	50	4.432	221.6	1.580	350.2
B3	Base slab	Longitudinal bars, bottom		a=9900	10	290	14	9.900	138.6	0.617	85.6
B4	Base slab	Longitudinal bars, top		a=9900	10	290	14	9.900	138.6	0.617	85.6
K1	Shear key	U-bars anchored in the base, legs bent along the top mat		a=338, b=1318, c=200	12	200	50	3.278	163.9	0.889	145.7
K2	Shear key	Longitudinal bars		a=9900	10	-	4	9.900	39.6	0.617	24.4

STEEL ABSTRACT

DIAMETER (mm)	WEIGHT (kg)
8 mm	198.4
10 mm	195.6
12 mm	579.4
16 mm	350.2
TOTAL	1,323.5 kg (1.323 t)

NOTES / QUANTITIES

1. Cutting lengths deduct 2ϕ per 90° bend; bars over 12 m are lapped (IS 456 cl 26.2.5).
2. Concrete M25: 35.62 m³; steel 37.2 kg/m³.
3. Formwork 104.1 m²; PCC (75 mm) 3.00 m³.

Design: IS 456:2000, IS 1893 | Generated by nxstructural Retaining Wall Designer

<div><div><div>NX</div><div>Structural</div></div><div>CANTILEVER RETAINING WALL</div></div>				
BAR BENDING SCHEDULE				
CLIENT			STRUCTURE	
-			T-SHAPED CANTILEVER WALL, H = 4.20 m	
DESIGNED	CHECKED	DATE	SCALE	SHEET
-	-	01-11-2026	NTS	3 of 3