

Cantilever wall analysis

Input data

Project

Date : 25.1.2017 r/

Settings

Standard - EN 1997 - DA2

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)

Coefficients EN 1992-1-1 : standard

Wall analysis

Active earth pressure calculation : Coulomb

Passive earth pressure calculation : Caquot-Kerisel

Earthquake analysis : Mononobe-Okabe

Shape of earth wedge : Calculate as skew

Base key : The base key is considered as inclined footing bottom

Verification methodology : according to EN 1997

Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)			
Transient design situation			
		Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1,35 [-]	1,00 [-]
Variable actions :	$\gamma_Q =$	1,50 [-]	0,00 [-]
Water load :	$\gamma_w =$	1,35 [-]	

Partial factors for resistances (R)			
Transient design situation			
Partial factor on overturning :		$\gamma_{Re} =$	1,40 [-]
Partial factor on sliding resistance :		$\gamma_{Rh} =$	1,10 [-]
Partial factor on bearing capacity :		$\gamma_{Rv} =$	1,40 [-]

Material of structure

Unit weight $\gamma = 23,56 \text{ kN/m}^3$

Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 25/30

Cylinder compressive strength $f_{ck} = 25,00 \text{ MPa}$

Tensile strength $f_{ct} = 2,60 \text{ MPa}$

Longitudinal steel : B500

Yield strength $f_{yk} = 500,00 \text{ MPa}$

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	2,20
3	1,40	2,20
4	1,40	2,60
5	-0,25	2,60
6	-0,25	2,20
7	-0,25	0,00

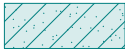
The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 1,21 m².

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Трошен камък		26,00	0,00	20,00	12,00	10,00

All soils are considered as cohesionless for at rest pressure analysis.

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	-	Трошен камък	

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 1,60 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		variable	5,00		0,00	2,00	on terrain
2	YES		variable	10,00		2,00	5,00	on terrain

No.	Name
1	Пешеходци
2	Автомобили

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Трошен камък
Soil thickness in front of structure $h = 1,00$ m
Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : transient
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1

Pressure at rest on front face of the structure - partial results

Layer No.	Thickness [m]	α [°]	Φ_d [°]	C_d [kPa]	γ [kN/m ³]	K_r	Comment
1	0,60	0,00	26,00	0,00	20,00	0,562	
2	0,00	0,00	26,00	0,00	20,00	0,562	
3	0,40	0,00	26,00	0,00	20,00	0,562	

Pressure at rest distribution on front face of the structure

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00	0,00	0,00	0,00
	0,60	12,00	0,00	6,74	6,74	0,00
2	0,60	12,00	0,00	6,74	6,74	0,00
	0,60	12,03	0,00	6,75	6,75	0,00
3	0,60	12,03	0,00	6,75	6,75	0,00
	1,00	20,00	0,00	11,23	11,23	0,00

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	φ_d [°]	c_d [kPa]	γ [kN/m ³]	δ_d [°]	K_a	Comment
1	1,60	32,00	26,00	0,00	20,00	26,00	0,737	
2	0,60	32,00	26,00	0,00	12,00	26,00	0,737	
3	0,40	0,00	26,00	0,00	12,00	10,00	0,359	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00	0,00	0,00	0,00
	1,60	32,00	0,00	23,58	12,49	20,00
2	1,60	32,00	0,00	23,58	12,49	20,00
	2,20	39,20	6,00	28,88	15,31	24,49
3	2,20	39,20	6,00	14,07	13,86	2,44
	2,60	44,00	10,00	15,80	15,56	2,74

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	1,60	0,00	0,00
3	2,20	6,00	0,00
4	2,60	10,00	0,00

Pressure profile due to surcharge - Пешеходци

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	0,00	0,00	0,00
3	0,02	0,00	0,00
4	0,02	0,91	1,46
5	1,60	0,89	1,42
6	2,20	0,88	1,41
7	2,20	1,77	0,31
8	2,60	1,75	0,31

Pressure profile due to surcharge - Автомобили

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
2	0,00	0,00	0,00
3	0,02	0,00	0,00
4	0,96	0,00	0,00
5	0,96	1,77	2,83
6	1,60	1,72	2,75
7	2,20	1,67	2,68
8	2,20	3,35	0,59
9	2,60	3,29	0,58

Forces acting on construction

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overturn.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,79	28,51	0,51	1,000	1,000	1,350
FF resistance	-5,62	-0,33	0,00	0,00	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,25	25,54	0,68	1,000	1,000	1,350
Active pressure	24,22	-0,92	30,38	1,20	1,350	1,350	1,350
Water pressure	5,00	-0,33	0,00	0,28	1,350	1,350	1,350
Uplift pressure	0,00	-2,60	0,00	0,25	1,000	1,000	1,000
Пешеходци	2,65	-1,15	3,24	0,99	1,500	1,500	1,500
Автомобили	3,46	-0,71	3,64	1,29	1,500	1,500	1,500
Пешеходци	0,00	-2,60	0,13	0,26	0,000	0,000	1,500

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 66,34$ kNm/m

Overturning moment $M_{ovr} = 38,64$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 46,73$ kN/m

Active horizontal force $H_{act} = 42,99$ kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 118,39 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	37,25	124,49	42,99	0,30	118,39
2	32,71	105,39	42,99	0,31	102,39

Bearing capacity of foundation soil check

Eccentricity verification

Max. eccentricity of normal force $e = 310,4$ mm

Maximum allowable eccentricity $e_{alw} = 544,5$ mm

Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification

Design bearing capacity of foundation soil $R = 250,00$ kPa

Partial factor on earth resistance $\gamma_{Rv} = 1,40$

Max. stress at footing bottom $\sigma = 118,39$ kPa

Bearing capacity of foundation soil $R_d = 178,57$ kPa

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1

Pressure at rest on front face of the structure - partial results

Layer No.	Thickness [m]	α [°]	φ_d [°]	c_d [kPa]	γ [kN/m ³]	K_r	Comment
1	0,60	0,00	26,00	0,00	20,00	0,562	

Pressure at rest distribution on front face of the structure

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00	0,00	0,00	0,00
	0,60	11,98	0,00	6,73	6,73	0,00

Pressure at rest behind the structure - partial results

Layer No.	Thickness [m]	α [°]	φ_d [°]	c_d [kPa]	γ [kN/m ³]	K_r	Comment
1	1,60	0,00	26,00	0,00	20,00	0,562	
2	0,60	0,00	26,00	0,00	12,00	0,562	

Pressure at rest distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00	0,00	0,00	0,00
	1,60	32,00	0,00	17,97	17,97	0,00
2	1,60	32,00	0,00	17,97	17,97	0,00
	2,20	39,19	5,99	22,01	22,01	0,00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	1,60	0,00	0,00
3	2,20	5,99	0,00

Pressure profile due to surcharge - Пешеходци

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	0,08	2,67	0,00
3	0,16	2,53	0,00
4	0,24	2,39	0,00
5	0,31	2,26	0,00
6	0,39	2,12	0,00
7	0,47	2,00	0,00

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
8	0,55	1,87	0,00
9	0,63	1,75	0,00
10	0,71	1,64	0,00
11	0,79	1,53	0,00
12	0,86	1,43	0,00
13	0,94	1,33	0,00
14	1,02	1,24	0,00
15	1,10	1,15	0,00
16	1,18	1,07	0,00
17	1,26	1,00	0,00
18	1,33	0,93	0,00
19	1,41	0,87	0,00
20	1,49	0,81	0,00
21	1,57	0,75	0,00
22	1,60	0,73	0,00
23	1,65	0,70	0,00
24	1,73	0,65	0,00
25	1,81	0,61	0,00
26	1,88	0,56	0,00
27	1,96	0,53	0,00
28	2,04	0,49	0,00
29	2,12	0,46	0,00
30	2,20	0,43	0,00

Pressure profile due to surcharge - Автомобили

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	0,08	0,20	0,00
3	0,16	0,40	0,00
4	0,24	0,59	0,00
5	0,31	0,78	0,00
6	0,39	0,97	0,00
7	0,47	1,15	0,00
8	0,55	1,31	0,00
9	0,63	1,47	0,00
10	0,71	1,62	0,00
11	0,79	1,76	0,00
12	0,86	1,89	0,00
13	0,94	2,00	0,00
14	1,02	2,11	0,00
15	1,10	2,20	0,00
16	1,18	2,29	0,00
17	1,26	2,36	0,00
18	1,33	2,42	0,00
19	1,41	2,48	0,00
20	1,49	2,53	0,00
21	1,57	2,56	0,00

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
22	1,60	2,58	0,00
23	1,65	2,60	0,00
24	1,73	2,62	0,00
25	1,81	2,64	0,00
26	1,88	2,65	0,00
27	1,96	2,66	0,00
28	2,04	2,66	0,00
29	2,12	2,65	0,00
30	2,20	2,65	0,00

Forces acting on construction

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0,00	-1,10	12,95	0,12	1,000	1,350	1,000
FF resistance	-2,01	-0,20	0,00	0,00	1,000	1,000	1,000
Pressure at rest	26,35	-0,75	0,00	0,25	1,350	1,000	1,350
Water pressure	1,79	-0,20	0,00	0,25	1,350	1,000	1,350
Uplift pressure	0,00	-2,20	0,00	0,25	1,000	1,000	1,000
Пешеходци	2,79	-1,40	0,00	0,25	1,500	0,000	1,500
Автомобили	4,15	-0,85	0,00	0,25	1,500	0,000	1,500

Wall stem check

Reinforcement and dimensions of the cross-section

Bar diameter = 12,0 mm

Number of bars = 5

Reinforcement cover = 30,0 mm

Cross-section width = 1,00 m

Cross-section depth = 0,25 m

Reinforcement ratio $\rho = 0,26 \% > 0,14 \% = \rho_{min}$

Position of neutral axis $x = 0,02 \text{ m} < 0,13 \text{ m} = x_{max}$

Ultimate shear force $V_{Rd} = 103,29 \text{ kN} > 46,39 \text{ kN} = V_{Ed}$

Ultimate moment $M_{Rd} = 50,80 \text{ kNm} > 37,86 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.