

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	1,30
3	0,60	1,30
4	0,60	1,60
5	-0,25	1,60
6	-0,25	1,30
7	-0,25	0,00

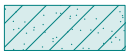
The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 0,58 m².

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 1,80 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
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 $h = 0,80$ 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	0,50	0,00	26,00	0,00	20,00	0,562	
2	0,00	0,00	26,00	0,00	20,00	0,562	
3	0,30	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
	0,50	10,00	0,00	5,62	5,62	0,00
2	0,50	10,00	0,00	5,62	5,62	0,00
	0,50	10,03	0,00	5,63	5,63	0,00
3	0,50	10,03	0,00	5,63	5,63	0,00
	0,80	16,00	0,00	8,99	8,99	0,00

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	φ_d [°]	c_d [kPa]	γ [kN/m³]	δ_d [°]	K_a	Comment
1	0,34	0,00	26,00	0,00	20,00	10,00	0,359	
2	0,96	32,00	26,00	0,00	20,00	26,00	0,737	
3	0,30	0,00	26,00	0,00	20,00	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
	0,34	6,80	0,00	2,44	2,40	0,42
2	0,34	6,80	0,00	5,01	2,65	4,25
	1,30	26,00	0,00	19,16	10,15	16,25
3	1,30	26,00	0,00	9,34	9,19	1,62
	1,60	32,00	0,00	11,49	11,31	2,00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	0,34	0,00	0,00
3	1,30	0,00	0,00
4	1,60	0,00	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	0,00	0,00	0,00
3	0,02	0,00	0,00
4	0,34	0,00	0,00
5	0,98	0,00	0,00
6	0,98	1,78	2,85
7	1,30	1,76	2,81
8	1,30	3,52	0,62
9	1,60	3,47	0,61

Forces acting on construction

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,60	13,67	0,26	1,000	1,000	1,350
FF resistance	-3,59	-0,27	0,00	0,00	1,000	1,000	1,000
Weight - earth wedge	0,00	-0,62	5,76	0,45	1,000	1,000	1,350
Active pressure	9,63	-0,54	10,45	0,62	1,350	1,350	1,350
Water pressure	0,00	-1,60	0,00	0,25	1,000	1,000	1,000
Пешеходци	1,98	-0,80	1,58	0,55	1,500	1,500	1,500
Автомобили	1,62	-0,26	1,10	0,77	1,500	1,500	1,500

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 12,43$ kNm/m

Overturning moment $M_{ovr} = 9,09$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 16,66$ kN/m

Active horizontal force $H_{act} = 14,80$ kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 94,20 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	8,41	44,36	14,80	0,19	94,20
2	7,65	37,56	14,80	0,20	84,89

Bearing capacity of foundation soil check

Eccentricity verification

Max. eccentricity of normal force $e = 203,8$ mm

Maximum allowable eccentricity $e_{alw} = 280,5$ 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 $\sigma = 94,20$ 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	0,50	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
	0,50	9,98	0,00	5,60	5,60	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	1,30	0,00	26,00	0,00	20,00	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
	1,30	25,98	0,00	14,59	14,59	0,00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	1,30	0,00	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	0,04	0,11	0,00
3	0,09	0,23	0,00
4	0,13	0,34	0,00
5	0,18	0,45	0,00
6	0,22	0,57	0,00
7	0,27	0,68	0,00
8	0,31	0,78	0,00
9	0,36	0,89	0,00
10	0,40	0,99	0,00
11	0,45	1,09	0,00
12	0,49	1,19	0,00
13	0,54	1,29	0,00
14	0,58	1,38	0,00
15	0,63	1,47	0,00
16	0,67	1,56	0,00
17	0,72	1,64	0,00
18	0,76	1,72	0,00
19	0,81	1,79	0,00

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
20	0,85	1,87	0,00
21	0,90	1,93	0,00
22	0,94	2,00	0,00
23	0,99	2,06	0,00
24	1,03	2,12	0,00
25	1,07	2,17	0,00
26	1,12	2,22	0,00
27	1,16	2,27	0,00
28	1,21	2,32	0,00
29	1,25	2,36	0,00
30	1,30	2,40	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	-0,65	7,65	0,12	1,000	1,350	1,000
FF resistance	-1,40	-0,17	0,00	0,00	1,000	1,000	1,000
Pressure at rest	9,47	-0,43	0,00	0,25	1,350	1,000	1,350
Water pressure	0,00	-1,30	0,00	0,25	1,000	1,000	1,000
Пешеходци	2,25	-0,75	0,00	0,25	1,500	0,000	1,500
Автомобили	1,82	-0,46	0,00	0,25	1,500	0,000	1,500

Wall stem check

Reinforcement and dimensions of the cross-section

Bar diameter = 10,0 mm

Number of bars = 5

Reinforcement cover = 30,0 mm

Cross-section width = 1,00 m

Cross-section depth = 0,25 m

Reinforcement ratio $\rho = 0,18 \% > 0,14 \% = \rho_{min}$

Position of neutral axis $x = 0,01 \text{ m} < 0,13 \text{ m} = x_{max}$

Ultimate shear force $V_{Rd} = 103,60 \text{ kN} > 17,50 \text{ kN} = V_{Ed}$

Ultimate moment $M_{Rd} = 35,83 \text{ kNm} > 9,09 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.