

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	2,00
3	1,00	2,00
4	1,00	2,30
5	-0,25	2,30
6	-0,25	2,00
7	-0,25	0,00

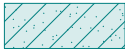
The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 0,88 m².

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 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	0,70	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	

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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
	0,70	14,00	0,00	7,86	7,86	0,00
2	0,70	14,00	0,00	7,86	7,86	0,00
	0,70	14,03	0,00	7,88	7,88	0,00
3	0,70	14,03	0,00	7,88	7,88	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	0,40	0,00	26,00	0,00	20,00	10,00	0,359	
2	1,40	32,00	26,00	0,00	20,00	26,00	0,737	
3	0,20	32,00	26,00	0,00	12,00	26,00	0,737	
4	0,30	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
	0,40	7,99	0,00	2,87	2,83	0,50
2	0,40	7,99	0,00	5,89	3,12	4,99
	1,80	36,00	0,00	26,52	14,06	22,49
3	1,80	36,00	0,00	26,52	14,06	22,49
	2,00	38,40	2,00	28,29	14,99	23,99
4	2,00	38,40	2,00	13,79	13,58	2,39
	2,30	42,00	5,00	15,08	14,85	2,62

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0,00	0,00	0,00
2	0,40	0,00	0,00
3	1,80	0,00	0,00
4	2,00	2,00	0,00
5	2,30	5,00	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	1,83	0,32
5	0,40	1,82	0,32
6	0,40	0,91	1,45
7	1,80	0,89	1,42
8	2,00	0,88	1,41
9	2,00	1,77	0,31

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Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
10	2,30	1,76	0,31

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	-0,81	20,62	0,34	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	-0,88	14,50	0,57	1,000	1,000	1,350
Active pressure	19,76	-0,79	24,75	0,87	1,350	1,350	1,350
Water pressure	1,25	-0,17	0,00	0,25	1,350	1,350	1,350
Uplift pressure	0,00	-2,30	0,00	0,25	1,000	1,000	1,000
Пешеходци	2,65	-1,17	2,51	0,74	1,500	1,500	1,500
Автомобили	2,80	-0,57	3,04	0,95	1,500	1,500	1,500

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 36,71$ kNm/m

Overturning moment $M_{ovr} = 26,49$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 34,07$ kN/m

Active horizontal force $H_{act} = 30,92$ kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 131,40 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	25,48	89,14	30,92	0,29	131,40
2	23,13	76,84	30,92	0,30	118,59

Bearing capacity of foundation soil check

Eccentricity verification

Max. eccentricity of normal force $e = 301,0$ mm

Maximum allowable eccentricity $e_{alw} = 412,5$ 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 $\sigma = 131,40$ 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/m³]	K_r	Comment
1	0,70	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
	0,70	14,00	0,00	7,86	7,86	0,00
2	0,70	14,00	0,00	7,86	7,86	0,00
	0,70	14,03	0,00	7,88	7,88	0,00
3	0,70	14,03	0,00	7,88	7,88	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/m³]	δ_d [°]	K_a	Comment
1	0,40	0,00	26,00	0,00	20,00	10,00	0,359	
2	1,40	32,00	26,00	0,00	20,00	26,00	0,737	
3	0,20	32,00	26,00	0,00	12,00	26,00	0,737	
4	0,30	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
	0,40	7,99	0,00	2,87	2,83	0,50
2	0,40	7,99	0,00	5,89	3,12	4,99
	1,80	36,00	0,00	26,52	14,06	22,49
3	1,80	36,00	0,00	26,52	14,06	22,49
	2,00	38,40	2,00	28,29	14,99	23,99
4	2,00	38,40	2,00	13,79	13,58	2,39
	2,30	42,00	5,00	15,08	14,85	2,62

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,15	7,07	0,75	1,350
Weight - earth wedge	0,00	-0,88	14,50	0,57	1,350
Active pressure	19,76	-0,79	24,75	0,87	1,350
Пешеходци	2,65	-1,17	2,51	0,74	1,500
Автомобили	2,80	-0,57	3,04	0,95	1,500
Contact tractions	0,00	0,00	-50,72	0,51	1,000
Gravity surch. 1	0,00	-2,30	0,03	0,25	1,500

Back wall jump 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 = 0,30 m
Reinforcement ratio $\rho = 0,15 \% > 0,14 \% = \rho_{min}$
Position of neutral axis $x = 0,01 \text{ m} < 0,16 \text{ m} = x_{max}$
Ultimate shear force $V_{Rd} = 118,47 \text{ kN} > 20,17 \text{ kN} = V_{Ed}$
Ultimate moment $M_{Rd} = 44,37 \text{ kNm} > 23,75 \text{ kNm} = M_{Ed}$

Cross-section is SATISFACTORY.