Gravity wall analysis

Input data

Project : Sanacija plazu na JP 947814 Okoška gora - Kangler pri hiši Okoška gora 28
Description : Kamnita zložba
Customer : Občina Oplotnica
Author : GEOING d.o.o.
Date : 01/04/2025

Settings

Slovenia - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Masonry (stone) wall : EN 1996-1-1 (EC6)

Wall analysis

Verification methodology : according to EN 1997
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0,333
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on overturning :	γ_{Rv} =	1,40	[–]
Partial factor on sliding resistance :	γ_{Rh} =	1,10	[–]
Partial factor on bearing capacity :	γ_{Re} =	1,40	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Anchors

Verification methodology : Limit states (LSD)

Reduction coefficients			
Reduction. coeff of steel strength :	γ_s =	1,35	[–]
Reduction coefficient of pull out resistance (soil) :	γ_e =	1,35	[–]
Reduction coefficient of pull out resistance (grouting) :	γ_c =	1,35	[–]

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Material of structure

Unit weight γ = 23,00 kN/m^3
Masonry : Category I
Mortar origin : Prescribed mortar

Masonry strength f_b = 2,00 MPa
Mortar strength f_m = 2,50 MPa

Parameters
Compressive strength f_k = 0,96 MPa
Shear strength f_{vko} = 0,10 MPa
Flexural tensile strength f_{xk} = 0,05 MPa
Partial factor γ_M = 2,20

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	5,25
3	0,00	6,02
4	-2,75	5,75
5	-2,75	5,25
6	-1,00	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 11,60 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Glina		19,00	1,00	19,00	9,00	19,00
2	Preperina		30,00	10,00	21,00	11,00	30,00
3	Hribina		34,00	30,00	23,00	13,00	34,00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Glina		cohesive	-	0,40	-	-
2	Preperina		cohesive	-	0,30	-	-
3	Hribina		cohesive	-	0,20	-	-

Soil parameters

Glina
Unit weight : γ = 19,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 19,00 °
Cohesion of soil : c_{ef} = 1,00 kPa
Angle of friction struc.-soil : δ = 19,00 °

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Soil : cohesive
Poisson's ratio : $\nu = 0,40$
Saturated unit weight : $\gamma_{sat} = 19,00$ kN/m^3

Preperina
Unit weight : $\gamma = 21,00$ kN/m^3
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 30,00$ °
Cohesion of soil : $c_{ef} = 10,00$ kPa
Angle of friction struc.-soil : $\delta = 30,00$ °
Soil : cohesive
Poisson's ratio : $\nu = 0,30$
Saturated unit weight : $\gamma_{sat} = 21,00$ kN/m^3

Hribina
Unit weight : $\gamma = 23,00$ kN/m^3
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 34,00$ °
Cohesion of soil : $c_{ef} = 30,00$ kPa
Angle of friction struc.-soil : $\delta = 34,00$ °
Soil : cohesive
Poisson's ratio : $\nu = 0,20$
Saturated unit weight : $\gamma_{sat} = 23,00$ kN/m^3

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3,70	0,00 .. 3,70	Glina	
2	0,90	3,70 .. 4,60	Preperina	
3	-	4,60 .. ∞	Hribina	

Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind construction has the slope 1: 4,33 (slope angle is 13,00 °).

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Glina
Soil thickness in front of structure $h = 3,50$ m

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.
Reduction of soil/soil friction angle : do not reduce

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Verification No. 1

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	-2,33	266,72	1,70	1,000	1,000	1,350
FF resistance	-74,66	-1,15	27,04	-0,67	1,000	1,000	1,350
Active pressure	88,38	-2,78	35,66	2,75	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 406,23 kNm/m
Overturning moment M_{ovr} = 245,11 kNm/m

Wall for overturning is SATISFACTORY

Check for slip

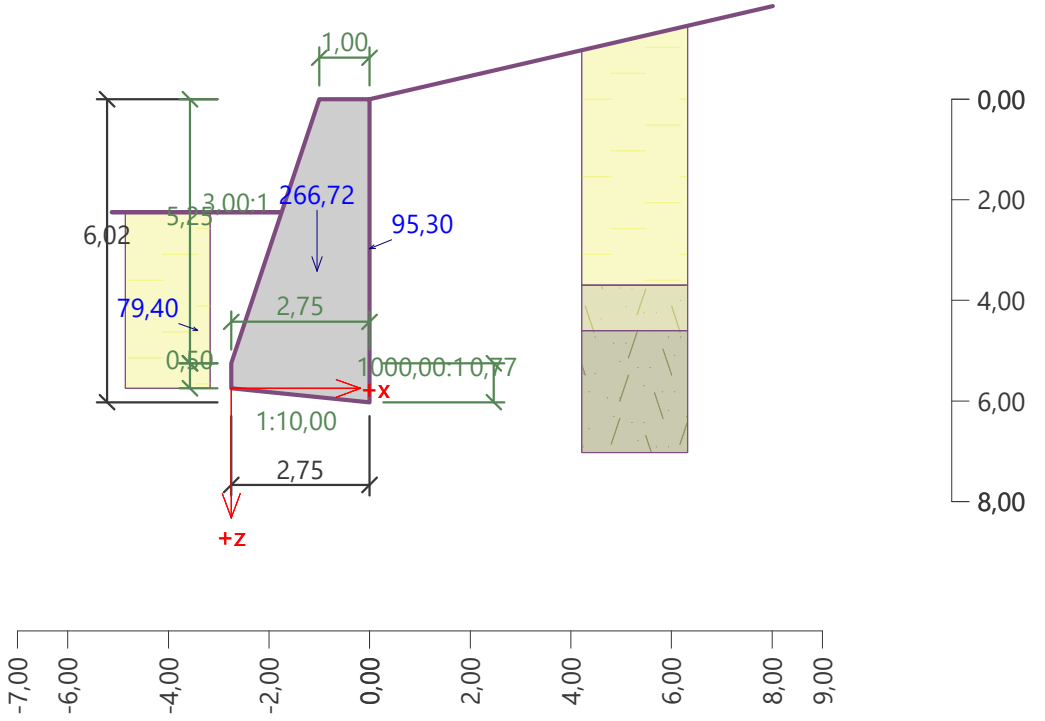
Resisting horizontal force H_{res} = 262,55 kN/m
Active horizontal force H_{act} = 10,41 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 194,92 kPa

Name : Verification	Stage - analysis : 1 - 1



Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	107,38	444,35	-25,78	0,088	194,92
2	152,50	344,65	10,14	0,161	183,52

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Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	79,54	329,15	-19,10

Verification of foundation soil

Stress in the footing bottom : trapezoid

Eccentricity verification

Max. eccentricity of normal force $e = 0,161$
Maximum allowable eccentricity $e_{alw} = 0,333$

Eccentricity of the normal force is SATISFACTORY

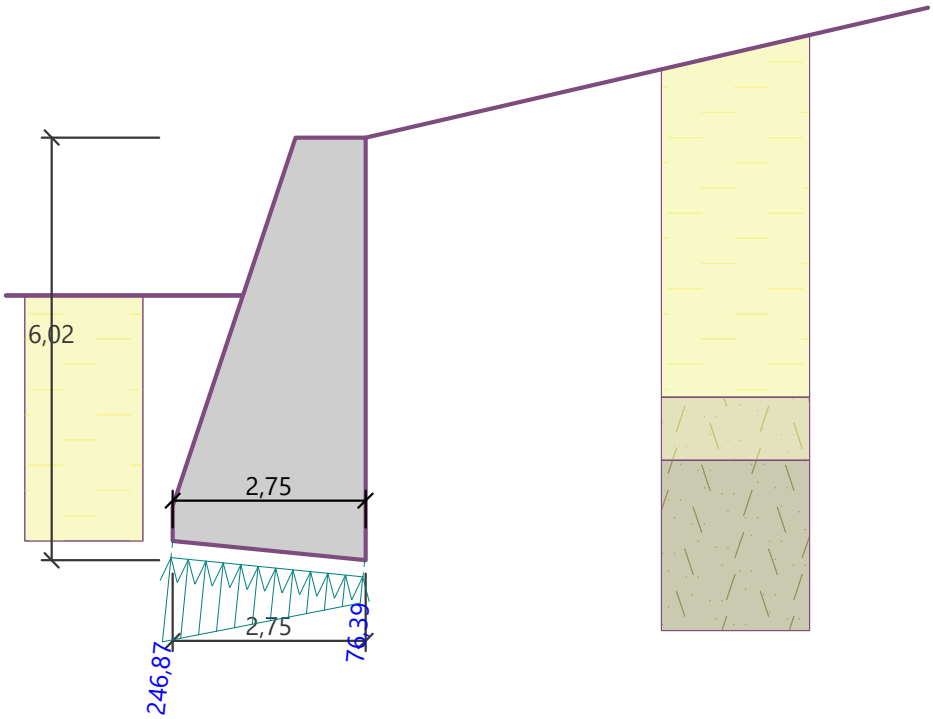
Verification of bearing capacity

Ultimate bearing capacity of found. soil $R = 350,00$ kPa
Partial factor on bearing capacity $\gamma_{Rv} = 1,40$
Max. stress at footing bottom $\sigma = 246,87$ kPa
Allowable bearing capacity of foundation soil $R_d = 250,00$ kPa

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - -1



Dimensioning No. 1

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	-0,05	2,31	0,52	1,000	1,000	1,000
Active pressure	0,00	-0,10	0,00	1,03	1,000	1,000	1,000

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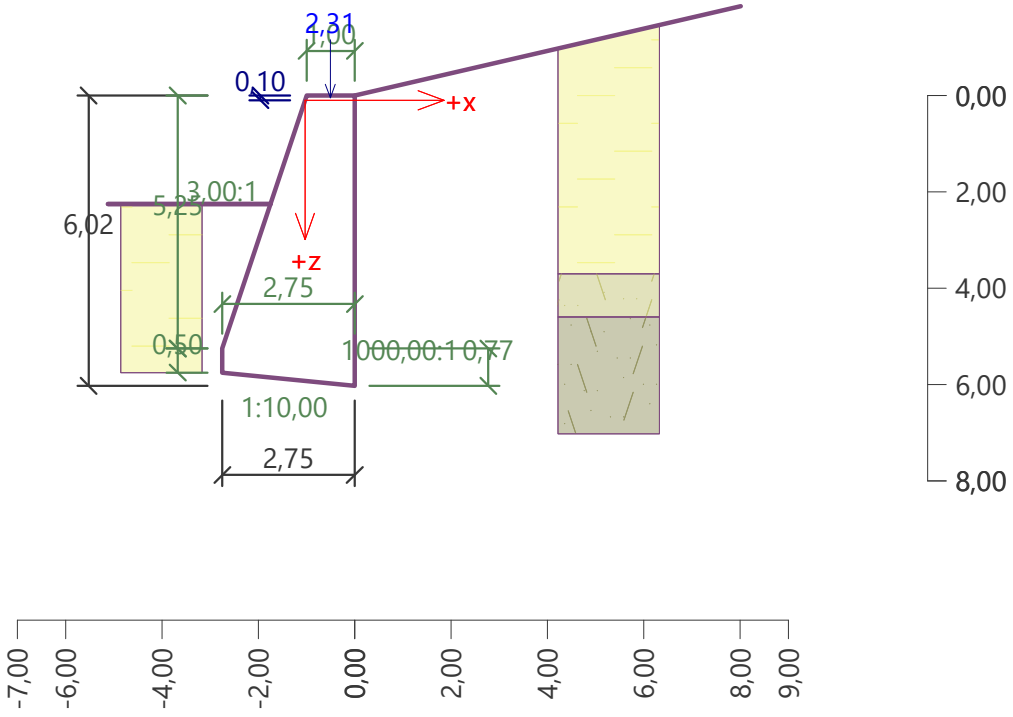
Wall check at the construction joint 0,10 m from the wall crest

Cross-section depth h = 1,03 m

Allowable eccentricity of cross section	e_{lim}	=	0,46	m	>	0,01	m	=	e
Ultimate compressive force	N_{Rd}	=	444,65	kN/m	>	2,31	kN/m	=	N_{Ed}
Ultimate moment	M_{Rd}	=	1,19	kNm/m	>	0,02	kNm/m	=	M_{Ed}

Cross-section bearing capacity is SATISFACTORY

Name : Dimensioning	Stage - analysis : 1 - 1



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