

Gravity wall analysis

Input data

Project

Date : 18.5.2021

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

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

Verification methodology : according to EN 1997

Design approach : 2 - reduction of actions and resistances

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

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	$\psi_0 =$	0,70 [-]	
Factor for frequent value :	$\psi_1 =$	0,50 [-]	
Factor for quasi-permanent value :	$\psi_2 =$	0,30 [-]	

Material of structure

Unit weight $\gamma = 23,00 \text{ kN/m}^3$

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

$f_{ctm} = 2,60 \text{ MPa}$

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	3,00
3	-1,35	2,90
4	-0,50	0,00

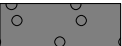


The origin [0,0] is located at the most upper right point of the wall.

Wall section area = 2,75 m².

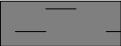

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Kamniti drobljenec		35,00	1,00	20,00	11,00	30,00
2	Melj-glina s preperino peščenjaka		35,00	5,00	19,00	10,00	30,00
3	Peščenjak – preperina/kamnina		35,00	20,00	22,00	12,00	30,00

Soil parameters to compute pressure at rest

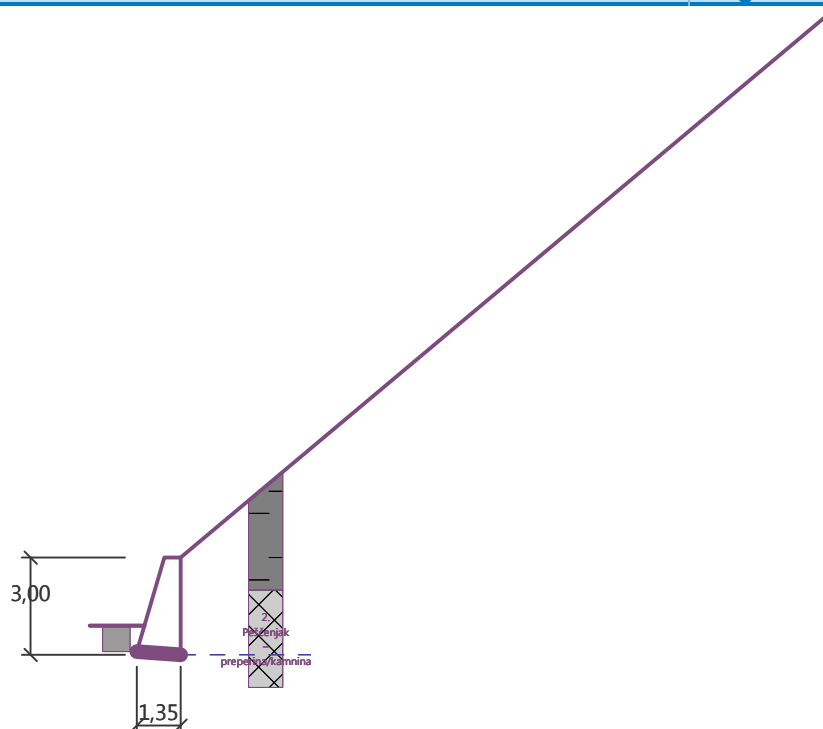
No.	Name	Pattern	Type calculation	Φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Kamniti drobljenec		cohesionless	35,00	-	-	-
2	Melj-glina s preperino peščenjaka		cohesive	-	0,30	-	-
3	Peščenjak – preperina/kamnina		cohesive	-	0,20	-	-

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1,00	0,00 .. 1,00	Melj-glina s preperino peščenjaka	
2	-	1,00 .. ∞	Peščenjak – preperina/kamnina	

Name : 1

Stage - analysis : 1 - 0



Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind construction has the slope 1: 1,19 (slope angle is 40,00 °).

Embankment height is 16,78 m, embankment length is 20,00 m.

Water influence

GWT behind the structure lies at a depth of 3,00 m

Uplift in foot. bottom due to different pressures is not considered.

Resistance on front face of the structure

Resistance on front face of the structure: not considered

Soil on front face of the structure - Kamniti drobljenec

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 : permanent

Verification No. 1 (Stage of construction 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	-1,20	63,25	0,86	1,000	1,000	1,350
Active pressure	29,94	-0,74	17,28	1,35	1,350	1,350	1,350
Water pressure	0,00	-2,90	0,00	1,35	1,000	1,000	1,350

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 61,17$ kNm/m

Overturning moment $M_{Ovr} = 30,05$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 79,50 \text{ kN/m}$

Active horizontal force $H_{act} = 33,91 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

Maximum stress in footing bottom : 83,25 kPa

Bearing capacity of foundation soil (Stage of construction 1)

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	0,86	111,41	32,07	0,006	83,25
2	4,87	89,33	33,70	0,040	71,77

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	0,64	82,52	23,76

Verification of foundation soil

Stress in the footing bottom : trapezoid

Eccentricity verification

Max. eccentricity of normal force $e = 0,040$

Maximum allowable eccentricity $e_{alw} = 0,333$

Eccentricity of the normal force is **SATISFACTORY**

Verification of bearing capacity

Bearing capacity of foundation soil $R = 400,00 \text{ kPa}$

Partial factor on bearing capacity $\gamma_{Rv} = 1,40$

Max. stress at footing bottom $\sigma = 85,35 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 285,71 \text{ kPa}$

Bearing capacity of foundation soil is **SATISFACTORY**

Overall verification - bearing capacity of found. soil is **SATISFACTORY**

Dimensioning No. 1 (Stage of construction 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	-1,03	46,95	0,75	1,000	1,000	1,000
Active pressure	15,86	-0,74	9,15	1,20	1,350	1,350	1,350
Water pressure	0,00	-2,40	0,00	1,20	1,000	1,000	1,000

Wall check at the construction joint 2,40 m from the wall crest

Cross-section depth $h = 1,20 \text{ m}$

Ultimate shear force $V_{Rd} = 797,82 \text{ kN/m} > 21,41 \text{ kN/m} = V_{Ed}$



Ultimate compressive force $N_{Rd} = 14967,27 \text{ kN/m} > 59,31 \text{ kN/m} = N_{Ed}$

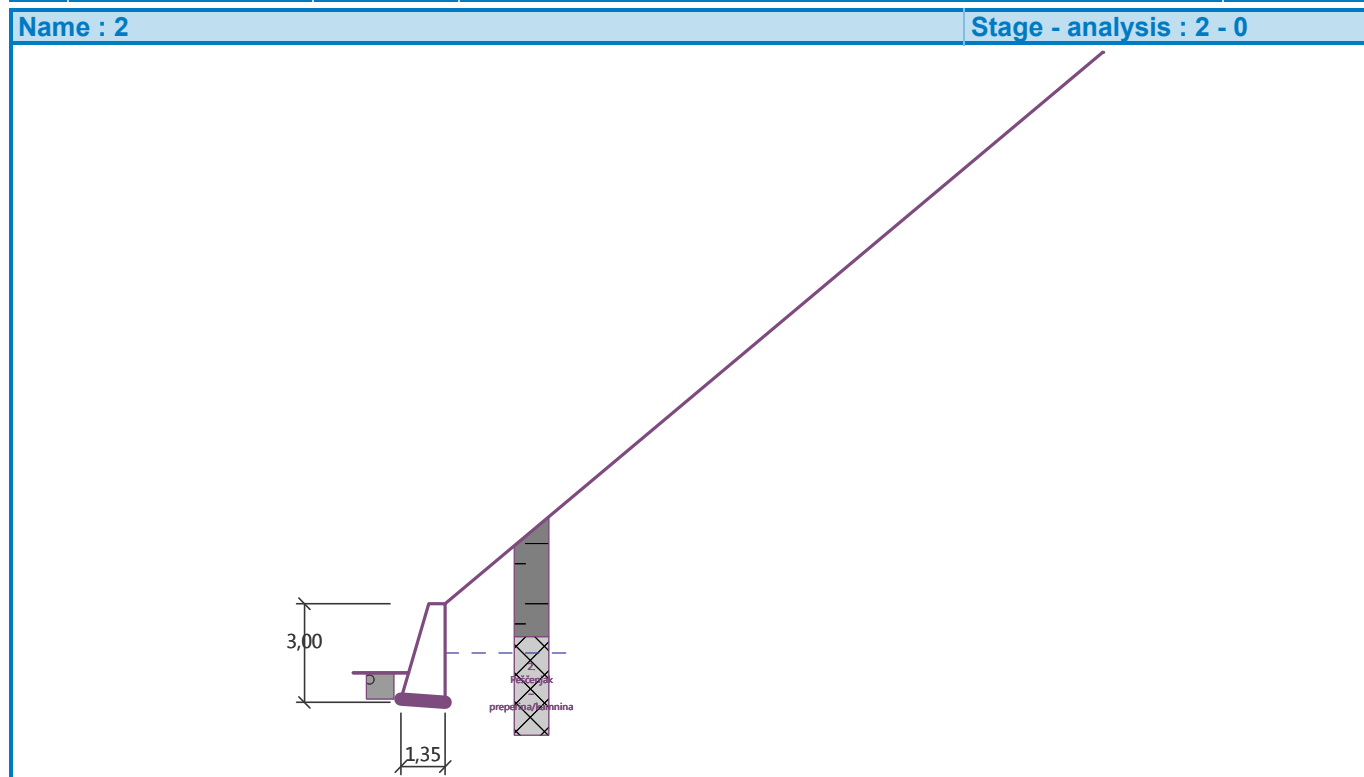
Ultimate moment $M_{Rd} = 245,91 \text{ kNm/m} > 2,38 \text{ kNm/m} = M_{Ed}$

Cross-section bearing capacity is **SATISFACTORY**

Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1,00	0,00 .. 1,00	Melj-glina s preperino peščenjaka	
2	-	1,00 .. ∞	Peščenjak – preperina/kamnina	



Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind construction has the slope 1: 1,19 (slope angle is 40,00 °).
Embankment height is 16,78 m, embankment length is 20,00 m.

Water influence

GWT behind the structure lies at a depth of 1,50 m
Uplift in foot. bottom due to different pressures is not considered.

Resistance on front face of the structure

Resistance on front face of the structure: not considered
Soil on front face of the structure - Kamniti drobljenec
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 : permanent

Verification No. 1 (Stage of construction 2)

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	-1,20	63,25	0,86	1,000	1,000	1,350
Active pressure	22,18	-0,86	12,81	1,35	1,350	1,350	1,350
Water pressure	11,25	-0,40	0,00	1,35	1,350	1,350	1,350
Uplift pressure	0,00	-2,90	0,00	1,35	1,000	1,000	1,350

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 55,35$ kNm/m

Overturning moment $M_{ovr} = 31,93$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 73,05$ kN/m

Active horizontal force $H_{act} = 39,06$ kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 86,65 kPa

Bearing capacity of foundation soil (Stage of construction 2)

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	7,06	105,73	37,20	0,049	86,65
2	11,07	83,65	38,83	0,098	76,81

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	5,23	78,32	27,55

Verification of foundation soil

Stress in the footing bottom : trapezoid

Eccentricity verification

Max. eccentricity of normal force $e = 0,098$

Maximum allowable eccentricity $e_{alw} = 0,333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Bearing capacity of foundation soil $R = 400,00$ kPa

Partial factor on bearing capacity $\gamma_{Rv} = 1,40$

Max. stress at footing bottom $\sigma = 101,57$ kPa

Bearing capacity of foundation soil $R_d = 285,71$ kPa

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

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	-1,03	46,95	0,75	1,000	1,000	1,000
Active pressure	13,08	-0,83	7,55	1,20	1,350	1,350	1,350
Water pressure	4,03	-0,30	0,00	1,20	1,350	1,350	1,350
Uplift pressure	0,00	-2,40	0,00	1,20	1,000	1,000	1,000

Wall check at the construction joint 2,40 m from the wall crest

Cross-section depth $h = 1,20$ m

Ultimate shear force $V_{Rd} = 797,12$ kN/m $> 23,09$ kN/m $= V_{Ed}$

Ultimate compressive force $N_{Rd} = 14588,70$ kN/m $> 57,14$ kN/m $= N_{Ed}$

Ultimate moment $M_{Rd} = 245,47$ kNm/m $> 3,10$ kNm/m $= M_{Ed}$

Cross-section bearing capacity is SATISFACTORY