

## 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	2,50
3	-1,20	2,40
4	-0,50	0,00

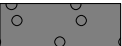


The origin [0,0] is located at the most upper right point of the wall.

Wall section area = 2,10 m<sup>2</sup>.

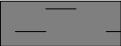

### Basic soil parameters

No.	Name	Pattern	$\Phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]	$\gamma_{su}$ [kN/m <sup>3</sup> ]	$\delta$ [°]
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

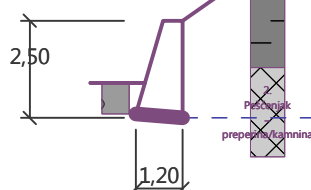
No.	Name	Pattern	Type calculation	$\Phi_{ef}$ [°]	$\nu$ [–]	OCR [–]	$K_r$ [–]
1	Kamniti drobljenec		cohesionless	35,00	-	-	-
2	Melj-glina s preperino peščenjaka		cohesive	-	0,30	-	-
3	Peščenjak – preperina/kamnina		cohesive	-	0,20	-	-

### Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1,20	0,00 .. 1,20	Melj-glina s preperino peščenjaka	
2	-	1,20 .. ∞	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: 1,43 (slope angle is 35,00 °).

Embankment height is 14,00 m, embankment length is 20,00 m.

## Water influence

GWT behind the structure lies at a depth of 2,50 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 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	-1,00	48,30	0,75	1,000	1,000	1,350
Active pressure	6,44	-1,16	3,72	1,20	1,350	1,350	1,350
Water pressure	0,00	-2,40	0,00	1,20	1,000	1,000	1,350

## Verification of complete wall

### Check for overturning stability

Resisting moment  $M_{res} = 30,26$  kNm/m

Overturning moment  $M_{Ovr} = 10,09$  kNm/m

**Wall for overturning is SATISFACTORY**

### Check for slip

Resisting horizontal force  $H_{res} = 56,07 \text{ kN/m}$

Active horizontal force  $H_{act} = 4,23 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

Maximum stress in footing bottom : 58,71 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	-2,43	70,70	2,79	0,000	58,71
2	0,15	53,85	4,19	0,002	44,93

#### Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-1,80	52,37	2,07

### Verification of foundation soil

Stress in the footing bottom : trapezoid

#### Eccentricity verification

Max. eccentricity of normal force  $e = 0,002$

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  $\sigma = 58,92 \text{ kPa}$

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	46,85	0,75	1,000	1,000	1,000
Active pressure	5,95	-1,26	3,43	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  $V_{Rd} = 793,05 \text{ kN/m} > 8,03 \text{ kN/m} = V_{Ed}$



Ultimate compressive force  $N_{Rd} = 14924,40 \text{ kN/m} > 51,49 \text{ kN/m} = N_{Ed}$

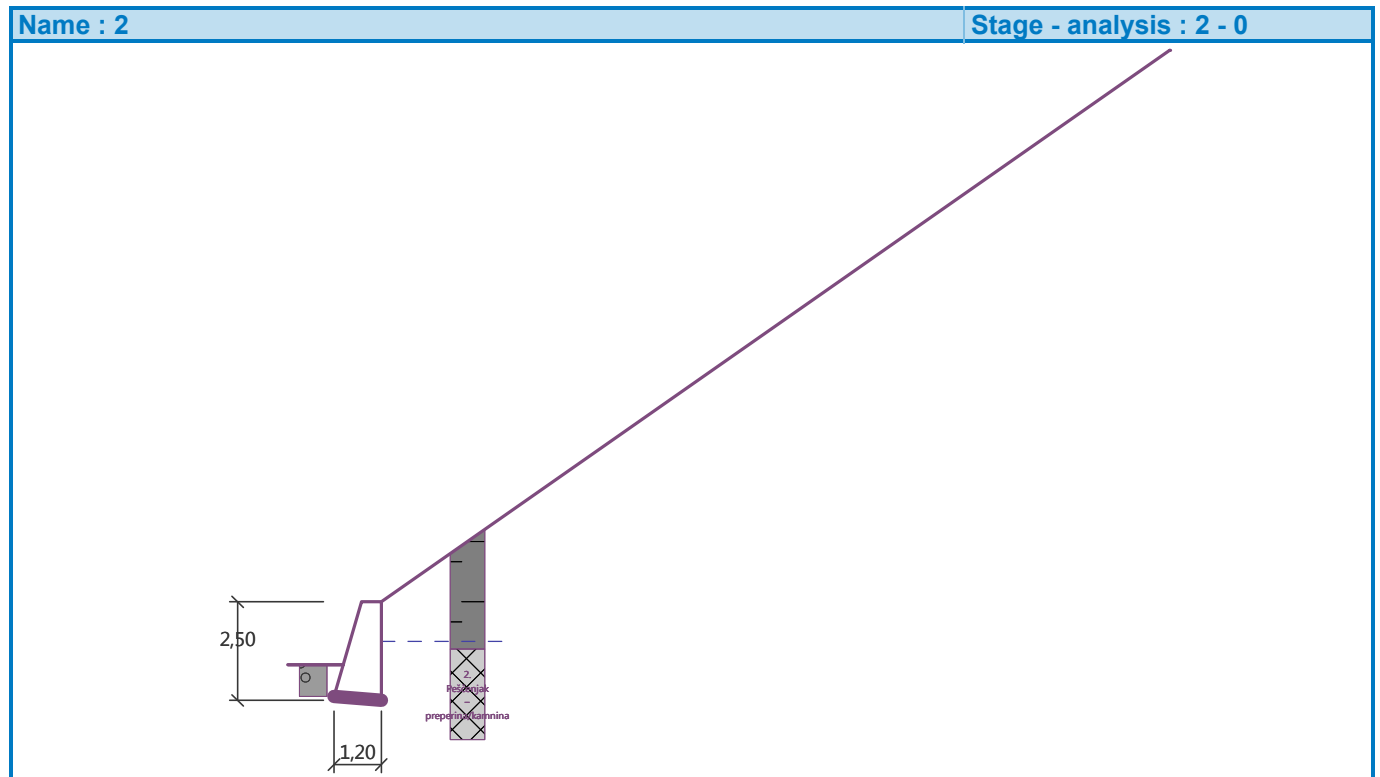
Ultimate moment  $M_{Rd} = 242,97 \text{ kNm/m} > 2,06 \text{ kNm/m} = M_{Ed}$

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	1,20	0,00 .. 1,20	Melj-glina s preperino peščenjaka	
2	-	1,20 .. ∞	Peščenjak – preperina/kamnina	



### Foundation

Type of foundation : soil from geological profile

### Terrain profile

Terrain behind construction has the slope 1: 1,43 (slope angle is 35,00 °).  
Embankment height is 14,00 m, embankment length is 20,00 m.

### Water influence

GWT behind the structure lies at a depth of 1,00 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 2)

### Forces acting on construction

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,00	48,30	0,75	1,000	1,000	1,350
Active pressure	4,78	-1,50	2,76	1,20	1,350	1,350	1,350
Water pressure	11,25	-0,40	0,00	1,20	1,350	1,350	1,350
Uplift pressure	0,00	-2,40	0,00	1,20	1,000	1,000	1,350

### Verification of complete wall

#### Check for overturning stability

Resisting moment  $M_{res} = 29,15$  kNm/m

Overturning moment  $M_{ovr} = 15,76$  kNm/m

**Wall for overturning is SATISFACTORY**

#### Check for slip

Resisting horizontal force  $H_{res} = 51,13$  kN/m

Active horizontal force  $H_{act} = 17,24$  kN/m

**Wall for slip is SATISFACTORY**

**Overall check - WALL is SATISFACTORY**

Maximum stress in footing bottom : 65,78 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	4,67	70,49	15,71	0,055	65,78
2	7,25	53,64	17,11	0,113	57,43

### Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	3,46	52,21	11,64

### Verification of foundation soil

Stress in the footing bottom : trapezoid

#### Eccentricity verification

Max. eccentricity of normal force  $e = 0,113$

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  $\sigma = 78,20$  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	46,85	0,75	1,000	1,000	1,000
Active pressure	4,78	-1,50	2,76	1,20	1,350	1,350	1,350
Water pressure	9,77	-0,47	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  $V_{Rd} = 792,75$  kN/m  $> 19,63$  kN/m  $= V_{Ed}$

Ultimate compressive force  $N_{Rd} = 12557,90$  kN/m  $> 50,58$  kN/m  $= N_{Ed}$

Ultimate moment  $M_{Rd} = 242,79$  kNm/m  $> 6,51$  kNm/m  $= M_{Ed}$

**Cross-section bearing capacity is SATISFACTORY**