

## Gravity wall analysis

### Input data

#### Project

Task : Ozurgeti, sayrdeni kedlis reporti

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#### Material of structure

Unit weight  $\gamma = 23.56 \text{ kN/m}^3$

Analysis of concrete structures carried out according to the standard SNiP 52-01-2003.

Concrete : B25

Compressive strength

$R_b = 14.50 \text{ MPa}$

Tensile strength

$R_{bt} = 1.05 \text{ MPa}$

Longitudinal steel : A500

Tensile strength

$R_s = 435.00 \text{ MPa}$



#### Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	7.50
3	-3.00	7.50
4	-1.50	2.50
5	-0.65	2.50
6	-0.40	0.00
7	-0.40	-0.50
8	0.00	-0.50

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

Wall section area = 12.76 m<sup>2</sup>.

#### Basic soil parameters

No.	Name	Pattern	$\varphi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]	$\gamma_{su}$ [kN/m <sup>3</sup> ]	$\delta$ [°]
1	Tixnari		18.00	15.00	19.00	10.00	0.00
2	kachar kenchnari		22.00	25.00	23.80	14.00	0.00

All soils are considered as cohesionless for at rest pressure analysis.

#### Soil parameters

##### Tixnari

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$

Stress-state : effective

Angle of internal friction :  $\varphi_{ef} = 18.00^\circ$

Cohesion of soil :  $c_{ef} = 15.00 \text{ kPa}$

Angle of friction struc.-soil :  $\delta = 0.00^\circ$

Soil : cohesionless

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Saturated unit weight :  $\gamma_{\text{sat}} = 20.00 \text{ kN/m}^3$ **kachar kenchnari**Unit weight :  $\gamma = 23.80 \text{ kN/m}^3$ 

Stress-state : effective

Angle of internal friction :  $\varphi_{\text{ef}} = 22.00^\circ$ Cohesion of soil :  $c_{\text{ef}} = 25.00 \text{ kPa}$ Angle of friction struc.-soil :  $\delta = 0.00^\circ$ 

Soil : cohesionless

Saturated unit weight :  $\gamma_{\text{sat}} = 24.00 \text{ kN/m}^3$ **Geological profile and assigned soils**

No.	Layer [m]	Assigned soil	Pattern
1	0.50	Tixnari	
2	3.39	Tixnari	
3	3.61	kachar kenchnari	
4	-	kachar kenchnari	

**Foundation**

Type of foundation : soil from geological profile

**Terrain profile**

Terrain behind the structure is flat.

**Water influence**

GWT behind the structure lies at a depth of 3.50 m

GWT in front of the structure lies at a depth of 3.50 m

Subgrade at the heel is not permeable.

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: at rest

Soil on front face of the structure - kachar kenchnari

Soil thickness in front of structure  $h = 2.88 \text{ m}$ 

Terrain in front of structure is flat.

**Settings of the stage of construction**

Design situation : permanent

**Verification No. 1****Forces acting on construction**

Name	$F_{\text{hor}}$ [kN/m]	App.Pt. z [m]	$F_{\text{vert}}$ [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-3.13	204.72	2.02	1.000

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Name	$F_{hor}$ [kN/m]	App.Pt. z [m]	$F_{vert}$ [kN/m]	App.Pt. x [m]	Design coefficient
FF resistance	-34.78	-0.96	16.68	0.29	1.000
Active pressure	50.03	-2.00	0.00	3.00	1.000
Water pressure	0.00	-7.50	0.00	3.00	1.000

### Verification of complete wall

#### Check for overturning stability

Resisting moment  $M_{res} = 418.10$  kNm/mOverturning moment  $M_{ovr} = 66.76$  kNm/m

Safety factor = 6.26 &gt; 1.50

**Wall for overturning is SATISFACTORY**

#### Check for slip

Resisting horizontal force  $H_{res} = 164.45$  kN/mActive horizontal force  $H_{act} = 15.25$  kN/m

Safety factor = 10.79 &gt; 1.50

**Wall for slip is SATISFACTORY**

**Overall check - WALL is SATISFACTORY**

### 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	-19.23	221.41	15.25	0.000	73.80

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

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-19.23	221.41	15.25

### Verification of foundation soil

#### Eccentricity verification

Max. eccentricity of normal force  $e = 0.000$ Maximum allowable eccentricity  $e_{alw} = 0.333$ 

**Eccentricity of the normal force is SATISFACTORY**

#### Verification of bearing capacity

Max. stress at footing bottom  $\sigma = 73.80$  kPaBearing capacity of foundation soil  $R_d = 350.00$  kPa

Safety factor = 4.74 &gt; 2.00

**Bearing capacity of foundation soil is SATISFACTORY**

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

## Dimensioning No. 1

### 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	-0.30	5.67	0.21	1.000
Active pressure	0.00	-0.10	0.00	0.41	1.000
Water pressure	0.00	-0.10	0.00	0.41	1.000

### Wall check at the construction joint 0.10 m from the wall crest

Cross-section depth  $h = 0.41$  m

Ultimate compressive force  $N_{ult} = 253.80$  kN/m  $> 5.67$  kN/m = N

Ultimate moment  $M_{ult} = -1.16$  kNm/m  $> -0.03$  kNm/m = M

**Cross-section bearing capacity is SATISFACTORY**

## Slope stability analysis

### Input data

#### Project

#### Settings

(input for current task)

#### Stability analysis

Earthquake analysis : Standard

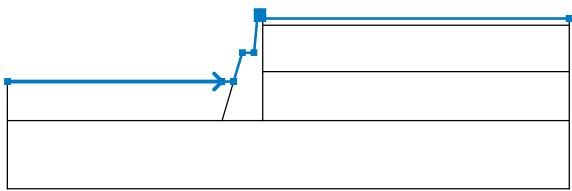
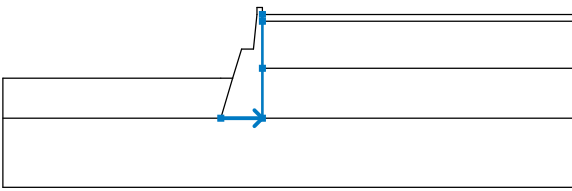
Verification methodology : Safety factors (ASD)

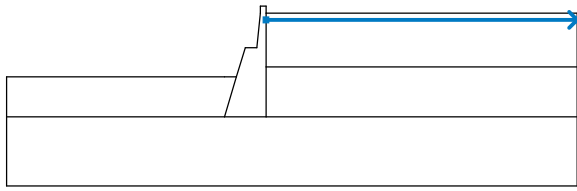
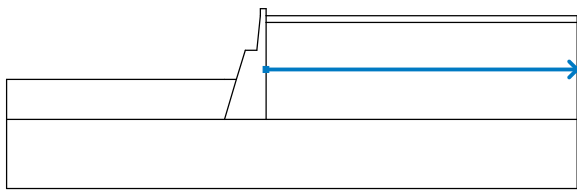
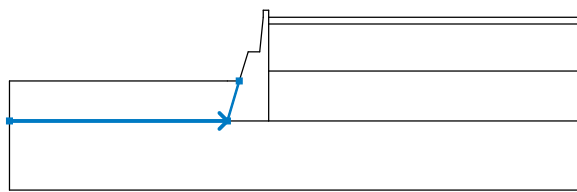
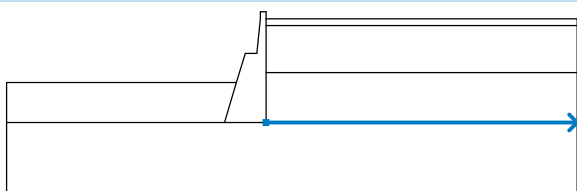
### Safety factors

#### Permanent design situation



Safety factor :  $SF_s = 1.50$  [-]

### Interface



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-18.75	-5.12	-3.00	-5.12	-2.14	-5.12
		-1.50	-3.00	-0.65	-3.00	-0.40	-0.50
		-0.40	0.00	0.00	0.00	0.00	-0.50
		22.50	-0.50				
2		-3.00	-8.00	0.00	-8.00	0.00	-4.39
		0.00	-1.00	0.00	-0.50		

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
3		0.00	-1.00	22.50	-1.00		
4		0.00	-4.39	22.50	-4.39		
5		-18.75	-8.00	-3.00	-8.00	-2.14	-5.12
6		0.00	-8.00	22.50	-8.00		

### Soil parameters - effective stress state

No.	Name	Pattern	$\Phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Tixnari		18.00	15.00	19.00
2	kachar kenchnari		22.00	25.00	23.80

### Soil parameters - uplift

No.	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Tixnari		20.00		
2	kachar kenchnari		24.00		

### Soil parameters

#### Tixnari

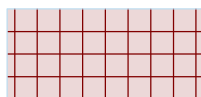
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Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Stress-state : effective  
 Angle of internal friction :  $\varphi_{ef} = 18.00^\circ$   
 Cohesion of soil :  $c_{ef} = 15.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

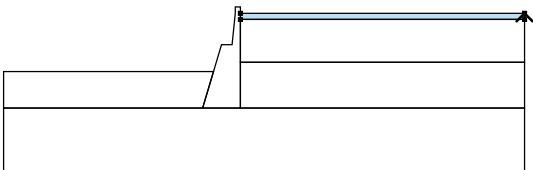
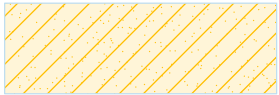
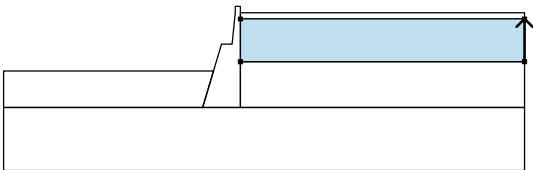
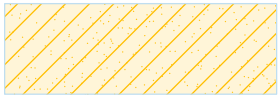
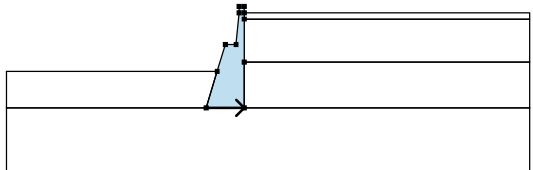
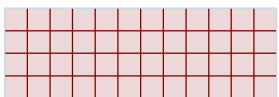
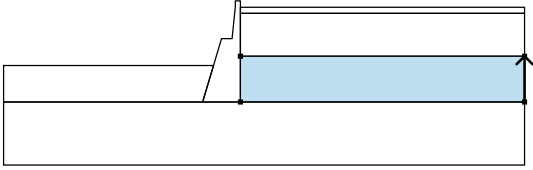

**kachar kenchnari**

Unit weight :  $\gamma = 23.80 \text{ kN/m}^3$   
 Stress-state : effective  
 Angle of internal friction :  $\varphi_{ef} = 22.00^\circ$   
 Cohesion of soil :  $c_{ef} = 25.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 24.00 \text{ kN/m}^3$

**Rigid bodies**

No.	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Wall material		23.56

**Assigning and surfaces**

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		22.50	-1.00	22.50	-0.50	Tixnari 
		0.00	-0.50	0.00	-1.00	
2		22.50	-4.39	22.50	-1.00	Tixnari 
		0.00	-1.00	0.00	-4.39	
3		-3.00	-8.00	0.00	-8.00	Wall material 
		0.00	-4.39	0.00	-1.00	
		0.00	-0.50	0.00	0.00	
		-0.40	0.00	-0.40	-0.50	
		-0.65	-3.00	-1.50	-3.00	
4		22.50	-8.00	22.50	-4.39	kachar kenchnari 
		0.00	-4.39	0.00	-8.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		-3.00	-8.00	-2.14	-5.12	kachar kenchnari
		-3.00	-5.12	-18.75	-5.12	
		-18.75	-8.00			
6		0.00	-8.00	-3.00	-8.00	kachar kenchnari
		-18.75	-8.00	-18.75	-13.00	
		22.50	-13.00	22.50	-8.00	

**Water**

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-18.75	-4.00	0.00	-4.00	0.05	-4.00
		22.50	-4.00				

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Settings of the stage of construction**

Design situation : permanent

**Results (Stage of construction 1)****Analysis 1****Circular slip surface**

Slip surface parameters							
Center :	x =	-1.77	[m]	Angles :	$\alpha_1 =$	-47.26	[°]
	z =	1.32	[m]		$\alpha_2 =$	78.94	[°]
Radius :	R =	9.49	[m]	Analysis of the slip surface without optimization.			

**Slope stability verification (all methods)**

Bishop : FS = 3.08 > 1.50 **ACCEPTABLE**  
 Fellenius / Petterson : FS = 2.78 > 1.50 **ACCEPTABLE**  
 Spencer : FS = 3.07 > 1.50 **ACCEPTABLE**  
 Janbu : FS = 3.07 > 1.50 **ACCEPTABLE**  
 Morgenstern-Price : FS = 3.07 > 1.50 **ACCEPTABLE**