



Sheeting structure design

Input data

Project

Date : 28.10.2015

Settings

Standard - safety factors

Excavations

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Verification methodology : Safety factors (ASD)

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Soil No. 1		29,00	5,00	18,00	10,00	17,50
2	Soil No. 2		15,00	5,00	20,50	10,50	15,00

Soil parameters

Soil No. 1

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 29,00^\circ$
Cohesion of soil : $c_{ef} = 5,00 \text{ kPa}$
Angle of friction struc.-soil : $\delta = 17,50^\circ$
Saturated unit weight : $\gamma_{sat} = 20,00 \text{ kN/m}^3$

Soil No. 2

Unit weight : $\gamma = 20,50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 15,00^\circ$
Cohesion of soil : $c_{ef} = 5,00 \text{ kPa}$
Angle of friction struc.-soil : $\delta = 15,00^\circ$
Saturated unit weight : $\gamma_{sat} = 20,50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1,50	Soil No. 2	
2	-	Soil No. 1	

Geometry of structure

Soil in front of wall is excavated to a depth of 4,00 m.

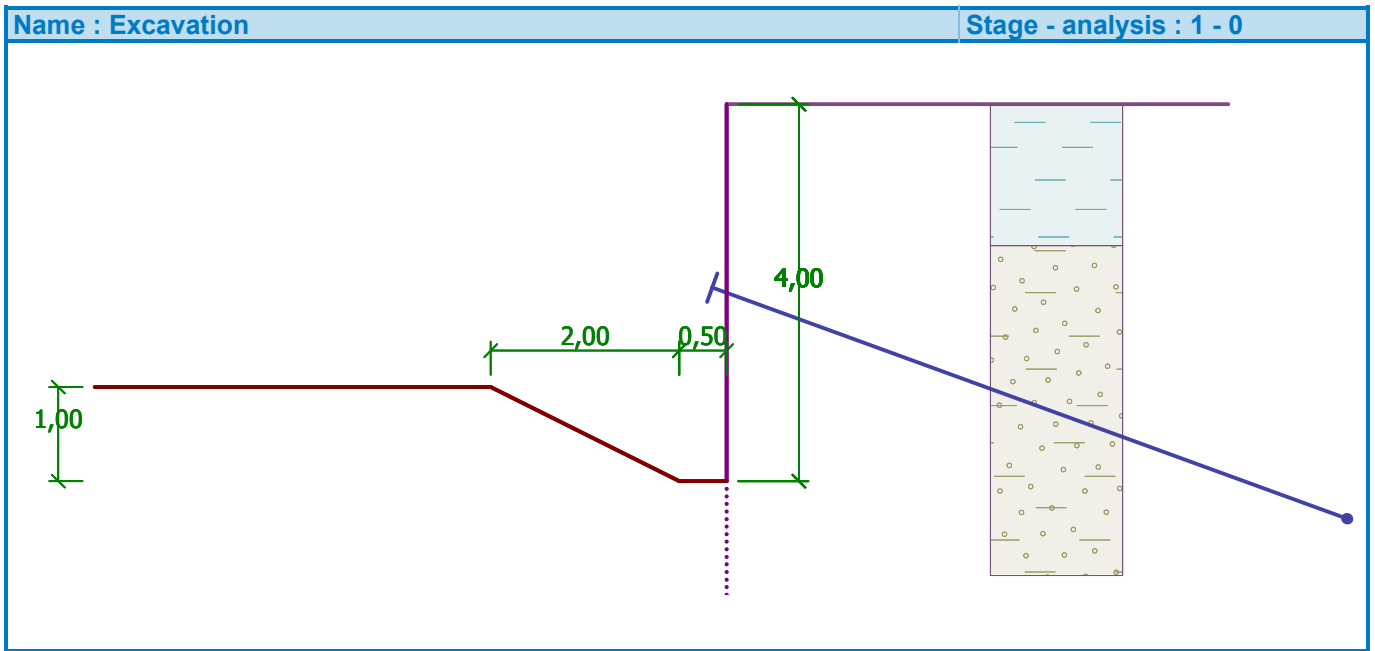
Ditch bottom shape

No.	Coordinate x [m]	Depth z [m]
1	0,00	0,00



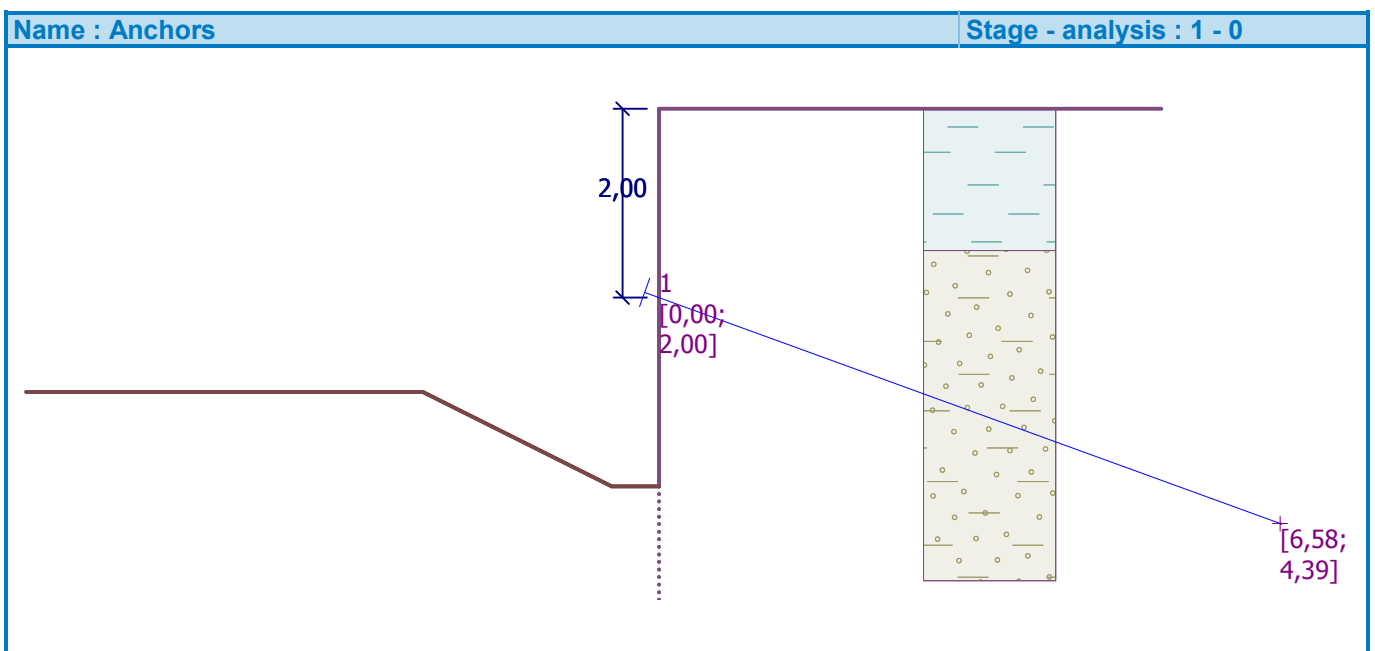
No.	Coordinate x [m]	Depth z [m]
2	-0,50	0,00
3	-2,50	-1,00
4	-3,50	-1,00

Origin [0,0] is located at the ditch bottom.
Positive coordinate +z has downward direction.



Input anchors

No.	New anchor	Depth z [m]	Length l [m]	Root l_k [m]	Slope α [°]	Spacing b [m]	Force F [kN]
1	Yes	2,00	7,00	0,01	20,00	1,00	0,00





Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Design of anchored sheeting wall fixed at heel

Coeff. of reduction of passive pressure = 1,00

A minimum dimensioning pressure was considered when computing the active pressure.

Computed depth of the zero-value point $u = 0,00$ m

Max. value of shear force = 23,04 kN/m
Max. value of moment = 6,55 kNm/m
Required depth of structure in soil = 0,72 m
Overall length of structure = 4,72 m

Anchor forces

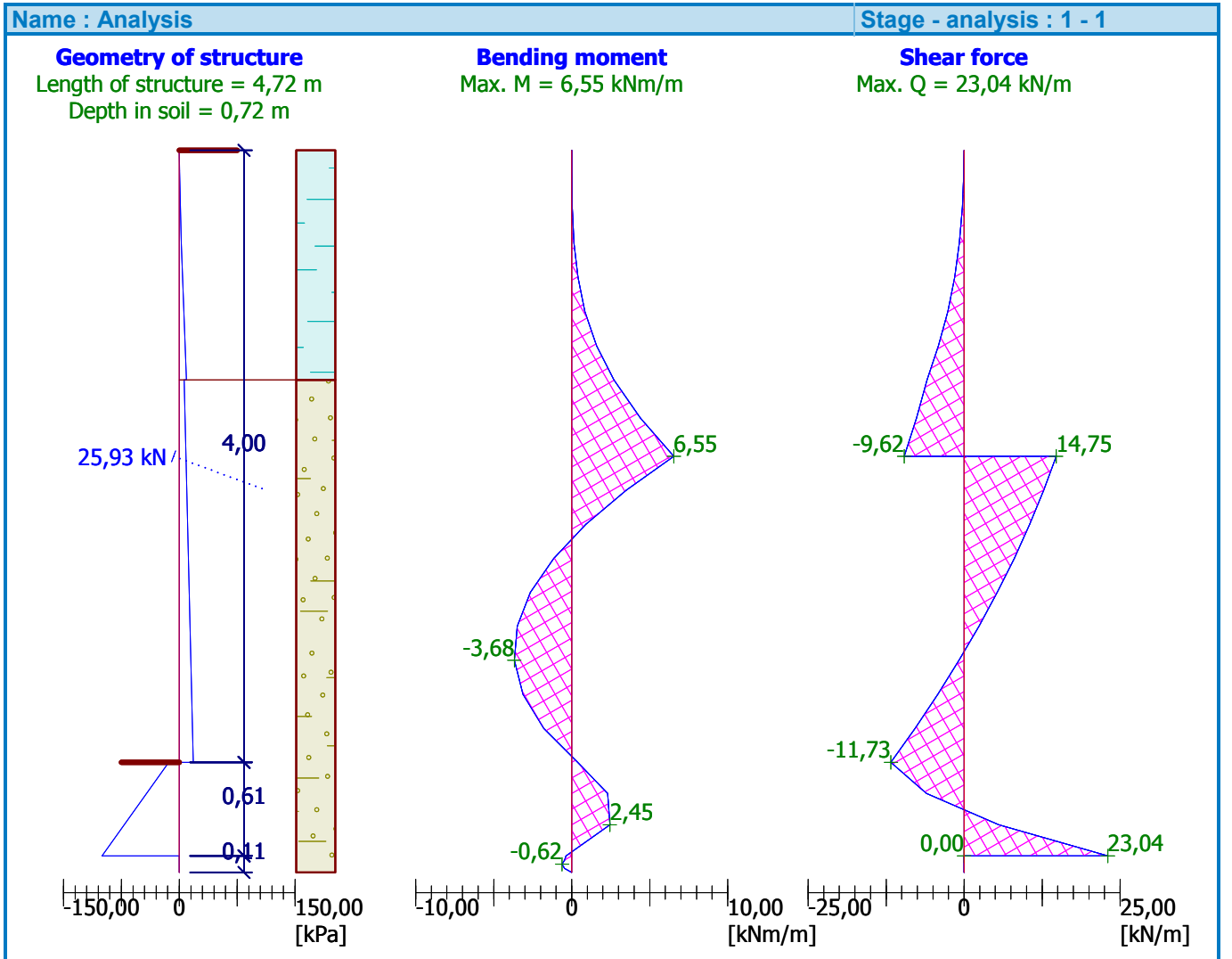
No.	Depth z [m]	Anchor force [kN]
1	2,00	25,93

Distribution of pressure and internal forces along the structure

Depth [m]	Total Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
0.00	0.00	0.00	0.00
0.13	0.55	-0.04	0.00
0.37	1.52	-0.28	0.03
0.61	2.49	-0.75	0.15
0.83	4.15	-1.50	0.40
1.05	5.82	-2.61	0.85
1.28	7.49	-4.10	1.59
1.50	9.15	-5.95	2.71
1.50	6.15	-5.95	2.71
1.75	7.33	-7.64	4.40
2.00	8.51	-9.62	6.55
2.00	8.51	14.75	6.55
2.22	9.56	12.74	3.49
2.44	10.61	10.50	0.91
2.67	11.66	8.02	-1.16
2.89	12.71	5.31	-2.64
3.11	13.77	2.37	-3.50
3.33	14.82	-0.81	-3.68
3.56	15.87	-4.21	-3.12
3.78	16.92	-7.86	-1.79
4.00	17.97	-11.73	0.39
4.00	-13.51	-11.73	0.39
4.20	-42.36	-6.03	2.30



Depth [m]	Total Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
4.41	-71.21	5.56	2.45
4.61	-100.06	23.04	-0.37



Verification No. 2

Design of anchored sheeting wall hinged at heel

Coeff. of reduction of passive pressure = 1,00

A minimum dimensioning pressure was considered when computing the active pressure.

Computed depth of the zero-value point $u = 0,00$ m

Max. value of shear force = 15,90 kN/m
 Max. value of moment = 6,55 kNm/m
 Required depth of structure in soil = 0,33 m
 Overall length of structure = 4,33 m



Anchor forces

No.	Depth z [m]	Anchor force [kN]
1	2,00	27,14

Distribution of pressure and internal forces along the structure

Depth [m]	Total Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
0.00	0.00	-0.00	-0.00
0.13	0.55	-0.04	0.00
0.37	1.52	-0.28	0.03
0.61	2.49	-0.75	0.15
0.83	4.15	-1.50	0.40
1.05	5.82	-2.61	0.85
1.28	7.49	-4.10	1.59
1.50	9.15	-5.95	2.71
1.50	6.15	-5.95	2.71
1.75	7.32	-7.64	4.40
2.00	8.48	-9.61	6.55
2.00	8.48	15.90	6.55
2.22	9.52	13.89	3.23
2.44	10.56	11.66	0.39
2.67	11.59	9.20	-1.93
2.89	12.63	6.51	-3.68
3.11	13.67	3.59	-4.81
3.33	14.70	0.44	-5.26
3.56	15.74	-2.95	-4.99
3.78	16.78	-6.56	-3.93
4.00	17.82	-10.40	-2.05
4.00	-13.66	-10.40	-2.05
4.16	-31.13	-6.72	-0.61
4.33	-48.61	0.00	0.00

Slope stability analysis

Input data

Project

Settings

Standard - safety factors

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		-15,00	-3,00	-3,50	-3,00	-1,50	-4,00
		-1,00	-4,00	-1,00	0,00	0,00	0,00
		15,00	0,00				
2		-1,00	-4,00	-1,00	-5,00	0,00	-5,00
		0,00	-1,50	0,00	0,00		
3		0,00	-1,50	15,00	-1,50		

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]
1	Soil No. 1		29,00	5,00	18,00
2	Soil No. 2		15,00	5,00	20,50

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [-]
1	Soil No. 1		20,00		
2	Soil No. 2		20,50		

Soil parameters

Soil No. 1

Unit weight : $\gamma = 18,00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 29,00^\circ$
 Cohesion of soil : $c_{ef} = 5,00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20,00 \text{ kN/m}^3$

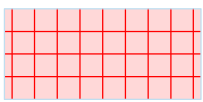
Soil No. 2

Unit weight : $\gamma = 20,50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 15,00^\circ$

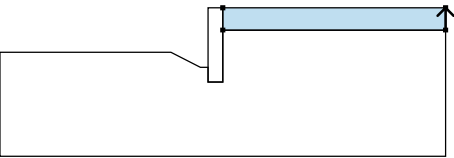

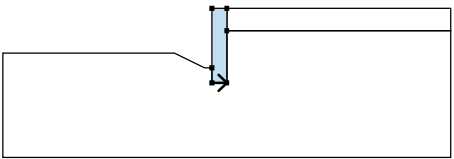
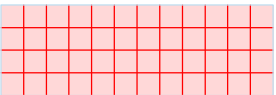
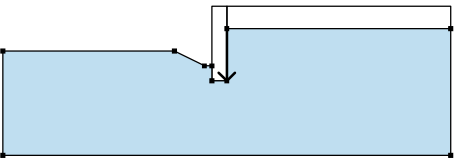



Cohesion of soil : $c_{ef} = 5,00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20,50 \text{ kN/m}^3$

Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Wall material		23,00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		15,00	-1,50	15,00	0,00	Soil No. 2 
		0,00	0,00	0,00	-1,50	
2		-1,00	-5,00	0,00	-5,00	Wall material 
		0,00	-1,50	0,00	0,00	
		-1,00	0,00	-1,00	-4,00	
3		0,00	-1,50	0,00	-5,00	Soil No. 1 
		-1,00	-5,00	-1,00	-4,00	
		-1,50	-4,00	-3,50	-3,00	
		-15,00	-3,00	-15,00	-10,00	
		15,00	-10,00	15,00	-1,50	

Anchors

No.	Origin		Length and slope / coordinates		Anchor spacing b [m]	Diameter / area d [mm] / A [mm ²]	Elastic modulus E [MPa]	Tensile strength F _c [kN]	Active in compress	Force F [kN]
	x [m]	z [m]	l [m] / x [m]	α [°] / z [m]						
1	-1,00	-2,00	l = 7,00	$\alpha = 20,00$	1,00	d =			No	0,00

Water

Water type : No water

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 =	-1,59	[m]	Angles :	$\alpha_1 =$	-52,35	[°]
	z =	0,50	[m]		$\alpha_2 =$	84,99	[°]
Radius :	R =	5,73	[m]				

The slip surface after optimization.

Slope stability verification (Bishop)

Sum of active forces : $F_a = 140,57$ kN/m

Sum of passive forces : $F_p = 368,85$ kN/m

Sliding moment : $M_a = 805,47$ kNm/m

Resisting moment : $M_p = 2113,50$ kNm/m

Factor of safety = 2,62 > 1,50

Slope stability ACCEPTABLE