Analysis of reinforced slopes

Input data

Project

Date : 21.10.2011

Geometry of structure

Embankment height h_n = 8,00 m
Embankment length l_n = 2,00 m
Cover thickness t_c = 0,20 m

Material

Cover material
Unit weight γ = 23,00 kN/m^3
Shear resistance R_s = 0,00 kPa

Types of reinforcements

Number	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T_{ult}[kN/m]	R_t[kN/m]	C_{ds}[–]	C_i[–]
1	Fortrac 110/30-20	Fortrac 110/30-20	———————	110,00	29,79	0,60	0,70

Reinforcement details

1. Fortrac 110/30-20
Short-term char. strength T_{ult} = 110,00 kN/m
Long-term design strength R_t = 29,79 kN/m
Overall coeff. of model uncertainty FS_{UNC} = 1,50

Calculate reduction factors
Life time : 120 years
Creep red. factor RF_{CR} = 1,83
Chemistry : pH 4.0-9.0
Durability red. factor RF_D = 1,14
Partical size : $D_{90} \leq 40$ mm
Installation damage red. factor RF_{ID} = 1,18

Reinforcement

Number	Number of reinforcements	Type of reinforcement	Spacing of reinforcements h_r[m]	Height of first reinforcement h[m]	Reinfor
1	6	Fortrac 110/30-20	0,80	0,80	identical le

Reinforcement details

Reinforcement No. 1
Reinforcement type : Fortrac 110/30-20
Number of reinforcements 6
Reinforcement geometry : identical length of reinforcements
Reinforcement length : 7,00 m

Reinforcement No.	Origin l_1[m]	End l_2[m]	Height from bottom h[m]	Length l[m]
1	-1,80	5,20	0,80	7,00
2	-1,60	5,40	1,60	7,00
3	-1,40	5,60	2,40	7,00
4	-1,20	5,80	3,20	7,00
5	-1,00	6,00	4,00	7,00
6	-0,80	6,20	4,80	7,00

Soil parameters

Třída F1, konzistence tuhá

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	29,00 °
Cohesion of soil :	c_{ef}	=	8,00 kPa
Angle of friction struc.-soil :	δ	=	10,00 °
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	-	Třída F1, konzistence tuhá	

Terrain profile

Terrain behind construction has the slope 1: 5,00 (slope angle is 11,31 °).

Water influence

Ground water table is not considered.

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Global settings

Active earth pressure calculation - Coulomb
Passive earth pressure calculation - Caqout-Kerisel

Settings of the stage of construction

Analysis carried out according to classical theory (safety factor)

Safety factor for slip	= 1,50
Safety factor for overturning	= 1,50
Factor of safety for bearing capacity	= 1,50
Factor of safety for sliding along reinforcement	= 1,50
Factor of safety for geo-reinforcement tearing	= 1,50
Factor of safety for geo-reinforcement pull-out	= 1,50

Stability analysis
Analysis carried out according to classical theory without reduction of input data.
Allowable safety factor = 1,50
Calculate skew shape of earth wedge.

Verification 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
Gravity force	0,00	-4,23	1112,72	4,52	1,000
Active pressure	151,45	-2,50	60,28	7,31	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 5470,99 kNm/m
Overturning moment M_{ovr} = 378,34 kNm/m

Safety factor = 14,46 > 1,50
Wall for overturning is SATISFACTORY

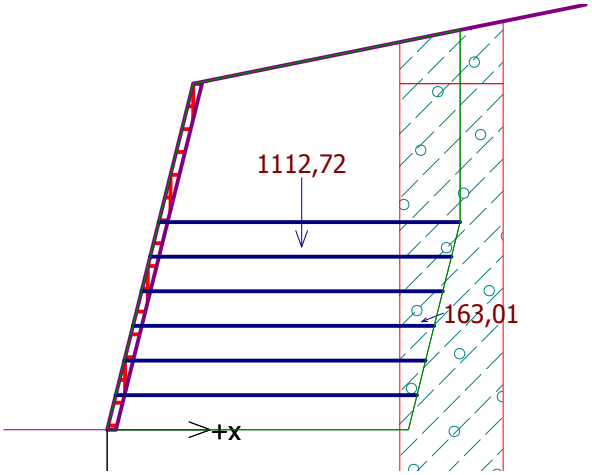
Check for slip
Resisting horizontal force H_{res} = 706,21 kN/m
Active horizontal force H_{act} = 151,45 kN/m

Safety factor = 4,66 > 1,50
Wall for slip is SATISFACTORY

Forces acting at the centre of footing bottom
Overall moment M = -987,15 kNm/m
Normal force N = 1173,00 kN/m
Shear force Q = 151,45 kN/m

Overall check - WALL is SATISFACTORY

Name : Verification	Stage : 1; Analysis : 1



Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

Number	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	-987,15	1173,00	151,45	0,00	167,57

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 0,0 mm
Maximum allowable eccentricity e_{alw} = 2310,0 mm

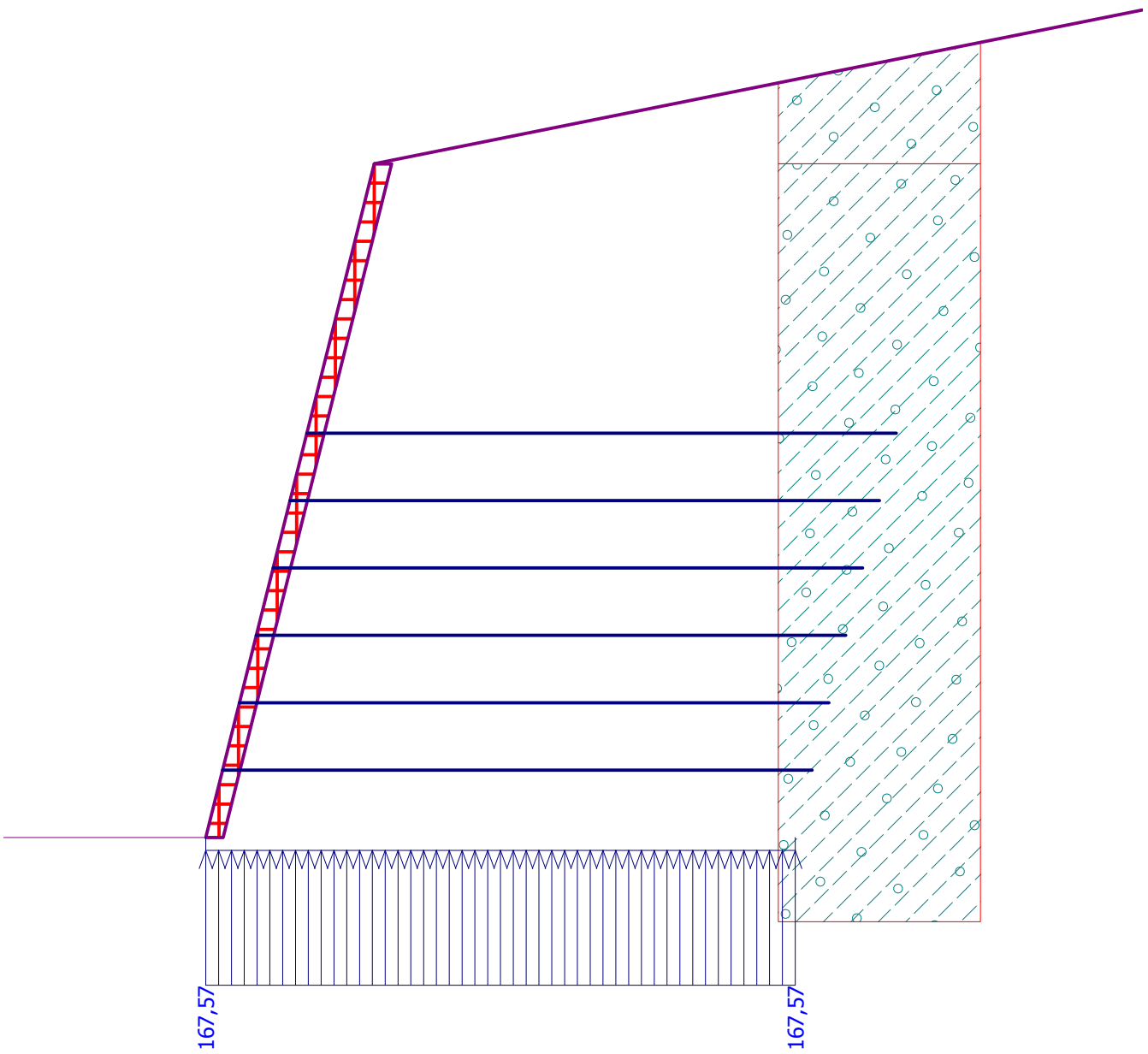
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 167,57 kPa
Bearing capacity of foundation soil R_d = 300,00 kPa

Safety factor = 1,79 > 1,50
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap. | **Stage : 1**



Analysis 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
Active pressure	126,61	-2,04	51,29	7,52	1,000
Gravity force	0,00	-3,98	1055,12	4,60	1,000
Reinforcement	-0,06	-0,80	0,00	7,20	1,000
Reinforcement	-0,11	-1,60	0,00	7,40	1,000
Reinforcement	-0,14	-2,40	0,00	7,60	1,000
Reinforcement	-0,16	-3,20	0,00	7,80	1,000
Reinforcement	-0,18	-4,00	0,00	8,00	1,000

Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)

Inclination of slip surface	=	76,00	°
Overall normal force acting on reinforcement	=	1106,41	kN/m
Coefficient of reduction of slip along geo-textile	=	0,60	
Wall resistance	=	0,00	kN/m
Overall bearing capacity of reinforcements	=	0,65	kN/m
Resistance along geo-reinforcement	=	367,98	kN/m

Check for slip:

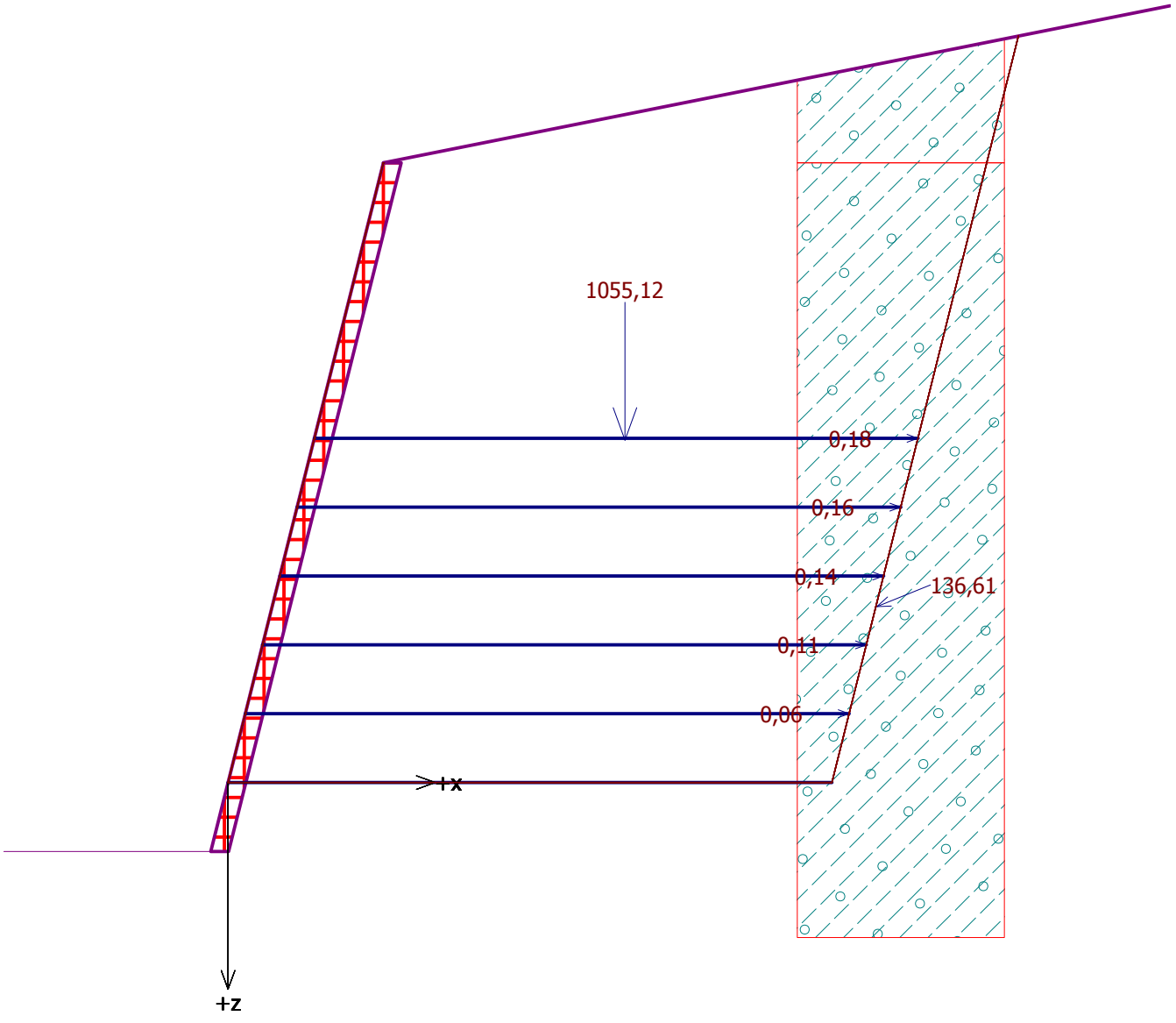
Resisting horizontal force H_{vzd} = 368,62 kN/m

Active horiz. force H_{pos} = 126,61 kN/m

Factor of safety = 2,91 > 1,50

Slip along geotextile is SATISFACTORY

Name : Internal stability | **Stage : 1; Analysis : 1**



Analysis No. 1

Slip surface parameters

(slip surface after optimization)
Center S = (-2,28;-5,00) m
Radius r = 13,76 m
Angle α_1 = -19,03 °
α_2 = 78,40 °

Slope stability check (Spencer)
FS = 1,53 > 1,50
Slope stability is SATISFACTORY

Name : Global stability	Stage : 1; Analysis : 1