

Slope stability analysis

Input data

Project

Task : IGP pro rekonstrukci náspu v km 72,250 – 72,320 na trati Blíževedly - Česká Lípa
Part : ŘEZ C-C'
Author : I. POUL
Date : 10.09.2021

Settings

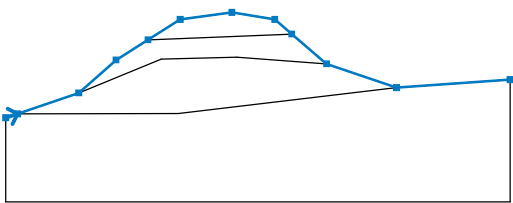
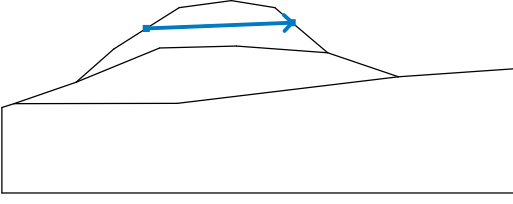
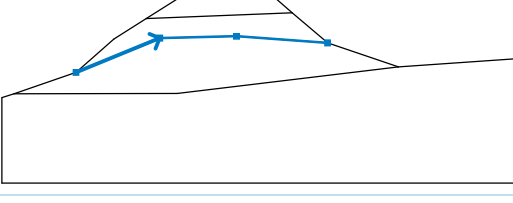
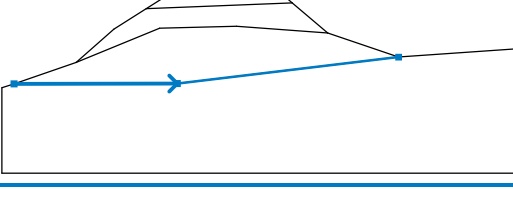
(input for current task)

Stability analysis

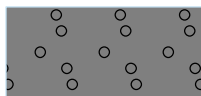
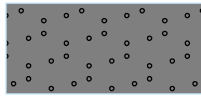


Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors		
Permanent design situation		
Safety factor :	$SF_s =$	1.30 [-]

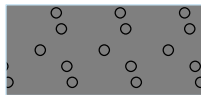
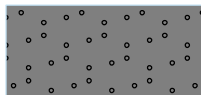


Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	0.00	0.71	0.23	4.34	1.48
		6.56	3.44	8.46	4.64	10.38	5.85
		13.45	6.27	16.00	5.85	17.01	4.98
		19.08	3.21	23.24	1.80	30.00	2.27
2		8.46	4.64	17.01	4.98		
3		4.34	1.48	9.25	3.49	13.74	3.60
		19.08	3.21				
4		0.71	0.23	10.27	0.25	23.24	1.80

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]
1	ŠTĚRK 32/63		40.00	3.00	22.00
2	ŠTĚRK 1/3		37.00	13.00	18.00
3	JÍL		20.00	23.00	19.40
4	JÍL - PORUŠENÝ		13.00	20.00	18.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [–]
1	ŠTĚRK 32/63		22.10		
2	ŠTĚRK 1/3		18.50		
3	JÍL		19.60		
4	JÍL - PORUŠENÝ		18.50		

Soil parameters

ŠTĚRK 32/63

Unit weight : $\gamma = 22.00$ kN/m³
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 40.00$ °
 Cohesion of soil : $c_{ef} = 3.00$ kPa
 Saturated unit weight : $\gamma_{sat} = 22.10$ kN/m³

ŠTĚRK 1/3

Unit weight : $\gamma = 18.00$ kN/m³
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 37.00$ °
 Cohesion of soil : $c_{ef} = 13.00$ kPa
 Saturated unit weight : $\gamma_{sat} = 18.50$ kN/m³

JÍL

Unit weight : $\gamma = 19.40$ kN/m³
 Stress-state : effective

Angle of internal friction : $\varphi_{ef} = 20.00^\circ$
Cohesion of soil : $c_{ef} = 23.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 19.60 \text{ kN/m}^3$

JÍL - PORUŠENÝ

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\varphi_{ef} = 13.00^\circ$
Cohesion of soil : $c_{ef} = 20.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.01	4.98	16.00	5.85	ŠTĚRK 32/63
		13.45	6.27	10.38	5.85	
		8.46	4.64			
2		9.25	3.49	13.74	3.60	ŠTĚRK 1/3
		19.08	3.21	17.01	4.98	
		8.46	4.64	6.56	3.44	
		4.34	1.48			
3		10.27	0.25	23.24	1.80	JÍL - PORUŠENÝ
		19.08	3.21	13.74	3.60	
		9.25	3.49	4.34	1.48	
		0.71	0.23			
4		10.27	0.25	0.71	0.23	JÍL
		0.00	0.00	0.00	-5.00	
		30.00	-5.00	30.00	2.27	
		23.24	1.80			

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters						
Center :	x =	5.14 [m]	Angles :	$\alpha_1 =$	-18.14 [°]	
	z =	9.90 [m]		$\alpha_2 =$	67.29 [°]	
Radius :	R =	9.66 [m]				
The slip surface after optimization.						

Slope stability verification (Bishop)

Sum of active forces : $F_a = 220.60$ kN/m

Sum of passive forces : $F_p = 401.26$ kN/m

Sliding moment : $M_a = 2131.02$ kNm/m

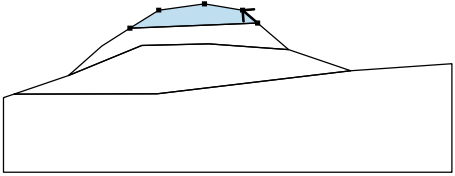
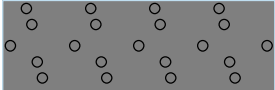
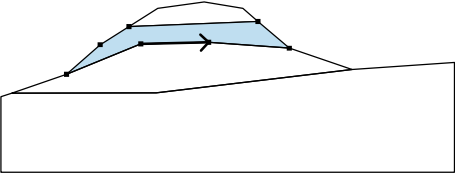
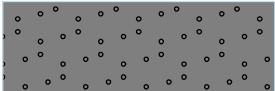
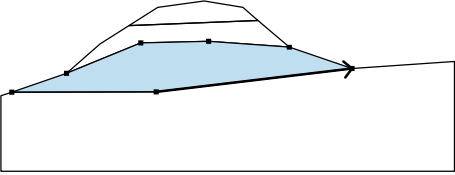

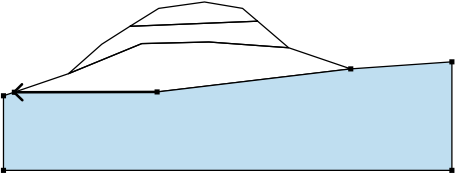

Resisting moment : $M_p = 3876.20$ kNm/m

Factor of safety = 1.82 > 1.30

Slope stability ACCEPTABLE

Input data (Stage of construction 2)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.01	4.98	16.00	5.85	ŠTĚRK 32/63 
		13.45	6.27	10.38	5.85	
		8.46	4.64			
2		9.25	3.49	13.74	3.60	ŠTĚRK 1/3 
		19.08	3.21	17.01	4.98	
		8.46	4.64	6.56	3.44	
		4.34	1.48			
3		10.27	0.25	23.24	1.80	JÍL - PORUŠENÝ 
		19.08	3.21	13.74	3.60	
		9.25	3.49	4.34	1.48	
		0.71	0.23			
4		10.27	0.25	0.71	0.23	JÍL 
		0.00	0.00	0.00	-5.00	
		30.00	-5.00	30.00	2.27	
		23.24	1.80			

Surcharge

No.	Surcharge		Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude		
	new	change								q, q ₁ , f, F	q ₂	unit
1	Yes		strip	permanent	on terrain	x = 11.00	l = 3.50		0.00	120.00		kN/m ²

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	6.78 [m]	Angles :	α_1 =	-25.84 [°]
	z =	8.35 [m]		α_2 =	73.73 [°]
Radius :	R =	8.04 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : $F_a = 526.97$ kN/m

Sum of passive forces : $F_p = 567.79$ kN/m

Sliding moment : $M_a = 4236.85$ kNm/m

Resisting moment : $M_p = 4565.07$ kNm/m

Factor of safety = 1.08 < 1.30

Slope stability NOT ACCEPTABLE

