

## Slope stability analysis

### Input data

#### Project

Task : IGP pro rekonstrukci náspu v km 71,250 – 71,280 na trati Blíževedly - Česká Lípa  
Part : ŘEZ A-A'  
Author : I. POUL  
Date : 10.09.2021

#### Settings

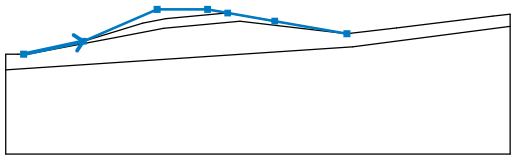
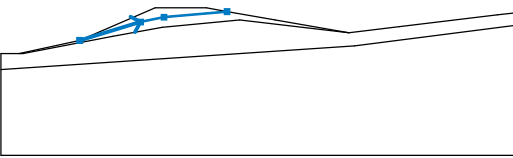
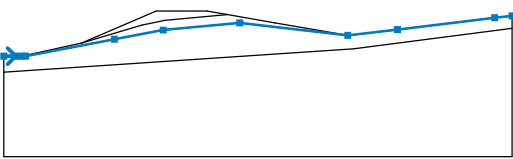
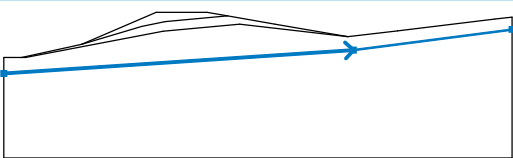
(input for current task)

#### Stability analysis

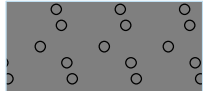
Earthquake analysis : Standard  
Verification methodology : Safety factors (ASD)

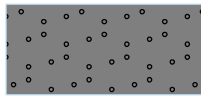


Safety factors		
Permanent design situation		
Safety factor :	$SF_s =$	1.30 [-]

#### Interface

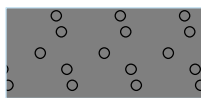
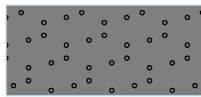


No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		1.06	0.23	4.60	1.00	9.00	2.90
		12.00	2.90	13.20	2.68	16.00	2.20
		20.30	1.45				
2		4.60	1.00	8.14	2.07	9.52	2.35
		13.20	2.68				
3		0.00	0.23	0.71	0.23	1.06	0.23
		1.29	0.23	6.53	1.23	9.41	1.77
		13.93	2.19	20.30	1.45	23.24	1.80
		28.97	2.49	30.00	2.61		
4		0.00	-0.71	20.64	0.67	30.00	1.88

#### Soil parameters - effective stress state

No.	Name	Pattern	$\Phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m³]
1	ŠTĚRK 32/63		40.00	3.00	22.00

No.	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
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	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	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/m<sup>3</sup>  
 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/m<sup>3</sup>

##### ŠTĚRK 1/3

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 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/m<sup>3</sup>

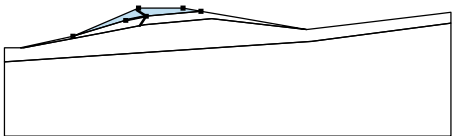
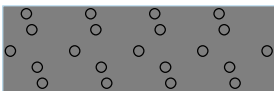
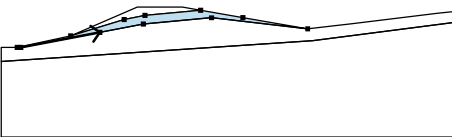
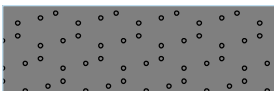
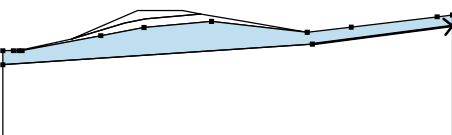

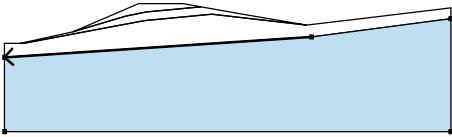

##### JÍL

Unit weight :  $\gamma = 19.40$  kN/m<sup>3</sup>  
 Stress-state : effective  
 Angle of internal friction :  $\phi_{ef} = 20.00$  °  
 Cohesion of soil :  $c_{ef} = 23.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 19.60$  kN/m<sup>3</sup>

### JÍL - PORUŠENÝ

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

### Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		8.14	2.07	9.52	2.35	ŠTĚRK 32/63 
		13.20	2.68	12.00	2.90	
		9.00	2.90	4.60	1.00	
2		1.29	0.23	6.53	1.23	ŠTĚRK 1/3 
		9.41	1.77	13.93	2.19	
		20.30	1.45	16.00	2.20	
		13.20	2.68	9.52	2.35	
		8.14	2.07	4.60	1.00	
3		1.06	0.23			JÍL - PORUŠENÝ 
		20.64	0.67	30.00	1.88	
		30.00	2.61	28.97	2.49	
		23.24	1.80	20.30	1.45	
		13.93	2.19	9.41	1.77	
		6.53	1.23	1.29	0.23	
		1.06	0.23	0.71	0.23	
4		0.00	0.23	0.00	-0.71	JÍL 
		20.64	0.67	0.00	-0.71	
		0.00	-5.71	30.00	-5.71	
		30.00	1.88			

### 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 =	5.38 [m]	Angles :	$\alpha_1$ =	-29.84 [°]	
	z =	5.93 [m]		$\alpha_2$ =	61.10 [°]	
Radius :	R =	6.27 [m]				
The slip surface after optimization.						

#### Slope stability verification (Bishop)

Sum of active forces :  $F_a = 63.37$  kN/m

Sum of passive forces :  $F_p = 244.82$  kN/m

Sliding moment :  $M_a = 397.35$  kNm/m

Resisting moment :  $M_p = 1535.03$  kNm/m

Factor of safety = 3.86 > 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		8.14	2.07	9.52	2.35	ŠTĚRK 32/63 
		13.20	2.68	12.00	2.90	
		9.00	2.90	4.60	1.00	
2		1.29	0.23	6.53	1.23	ŠTĚRK 1/3 
		9.41	1.77	13.93	2.19	
		20.30	1.45	16.00	2.20	
		13.20	2.68	9.52	2.35	
		8.14	2.07	4.60	1.00	
3		1.06	0.23			JÍL - PORUŠENÝ 
		20.64	0.67	30.00	1.88	
		30.00	2.61	28.97	2.49	
		23.24	1.80	20.30	1.45	
		13.93	2.19	9.41	1.77	
		6.53	1.23	1.29	0.23	
		1.06	0.23	0.71	0.23	
4		0.00	0.23	0.00	-0.71	JÍL 
		20.64	0.67	0.00	-0.71	
		0.00	-5.71	30.00	-5.71	
		30.00	1.88			

### Surcharge

No.	Surcharge		Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope $\alpha$ [°]	Magnitude		
	new	change								q, q <sub>1</sub> , f, F	q <sub>2</sub>	unit
1	Yes		strip	permanent	on terrain	x = 9.00	l = 3.50		0.00	120.00		kN/m <sup>2</sup>

### 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 =	7.46	[m]	Angles :	$\alpha_1$ =	-37.55 [°]
	z =	4.95	[m]		$\alpha_2$ =	65.86 [°]
Radius :	R =	5.04	[m]			
The slip surface after optimization.						

#### Slope stability verification (Bishop)

Sum of active forces :  $F_a = 274.35$  kN/m

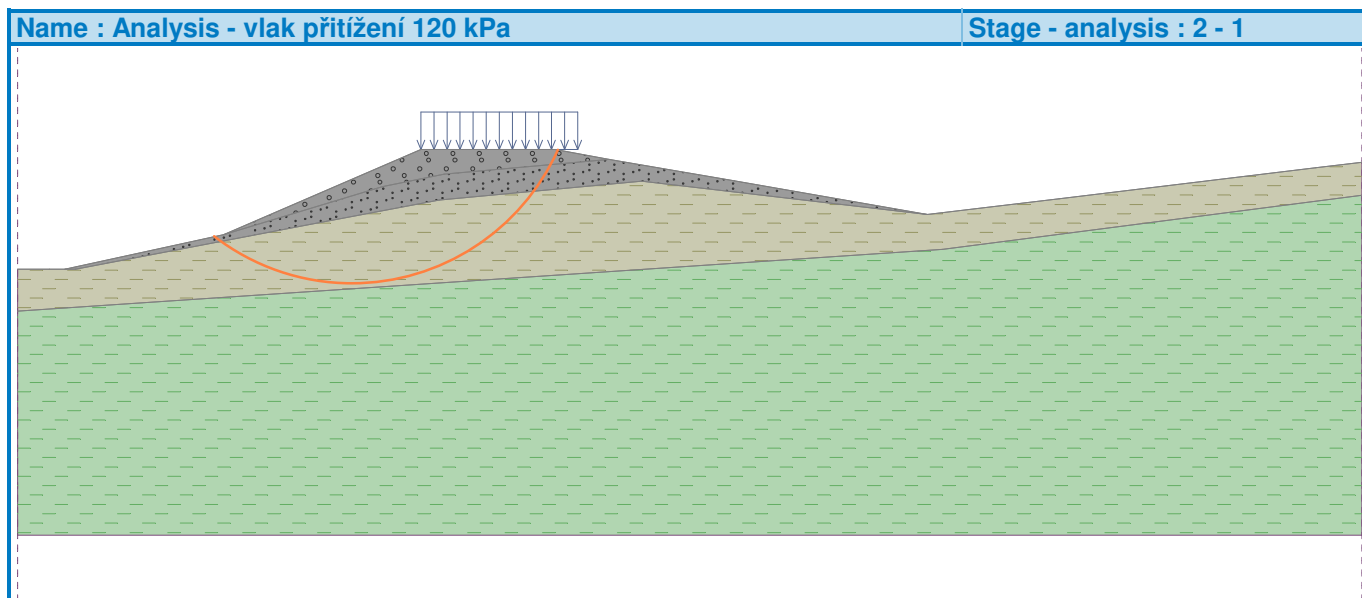
Sum of passive forces :  $F_p = 353.02$  kN/m

Sliding moment :  $M_a = 1382.71$  kNm/m

Resisting moment :  $M_p = 1779.23$  kNm/m

Factor of safety = 1.29 < 1.30

**Slope stability NOT ACCEPTABLE**



Name : Analysis - zatížení vlaku 120 kPa

Stage - analysis : 2 - 1

