

## Slope stability analysis

### Input data

#### Project

Task : IGHG podrobný průzkum: Bytová výstavba Kamenný vrch II - I. etapa  
Part : ŘEZ D-D (vrcholové parametry)  
Author : I. POUL  
Date : 13.02.2020

#### Settings

(input for current task)

#### Stability analysis

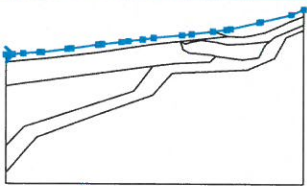
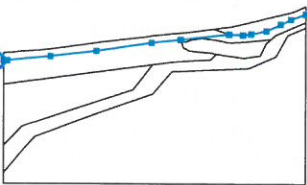
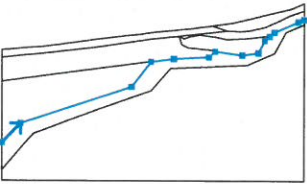
Earthquake analysis : Standard  
Verification methodology : according to EN 1997  
Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

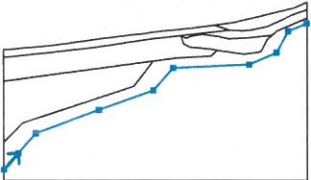
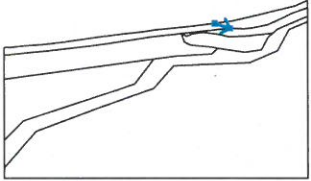
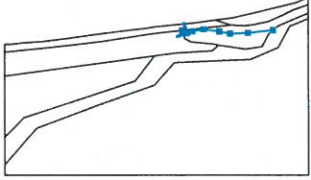
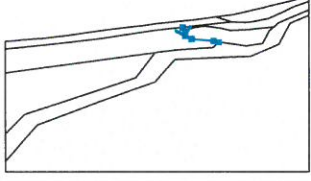
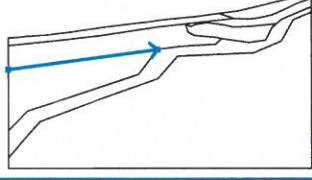
Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1,35 [-]	1,00 [-]	1,00 [-]	1,00 [-]
Variable actions :	$\gamma_Q =$	1,50 [-]	0,00 [-]	1,30 [-]	0,00 [-]
Water load :	$\gamma_w =$			1,00 [-]	





Partial factors for soil parameters (M)		
Permanent design situation		
Partial factor on internal friction :	$\gamma_\phi =$	1,25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1,25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1,40 [-]



### Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0,00	33,90	3,62	34,15	8,54	34,63
		16,19	35,13	17,03	35,17	29,28	36,73
		30,93	36,94	43,51	38,77	44,67	38,90
		45,45	39,01	54,49	40,07	57,83	40,50
		64,38	41,28	69,47	42,08	82,77	43,39
		87,29	43,89	97,34	45,16	103,81	45,98
		105,75	46,35	119,16	49,51	120,00	49,71
		134,24	53,15	140,15	55,76		
2		0,00	30,43	1,77	30,55	21,94	32,56
		43,26	35,06	68,62	38,90	81,98	40,36
		104,54	42,85	110,84	42,58	114,71	43,02
		121,81	44,56	128,52	47,52	133,23	49,82
		140,15	52,34				
3		0,00	-8,98	8,97	0,00	60,16	16,92
		69,06	28,67	79,66	30,01	95,81	30,87
		98,70	33,48	111,28	31,78	118,94	32,88
		121,86	38,58	124,07	40,53	126,29	42,48
		137,42	47,21	140,15	48,31		





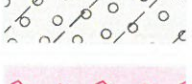

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
4		0,00	-21,67	6,82	-13,98	14,92	-4,85
		44,03	6,06	69,15	15,06	78,28	25,42
		113,56	27,00	126,26	32,49	131,68	42,31
		140,15	45,88				
5		97,34	45,16	104,54	42,85		
6		81,98	40,36	84,28	39,19	86,78	40,06
		91,84	41,00	99,32	39,98	104,15	38,92
		112,52	39,29	124,07	40,53		
7		81,98	40,36	83,22	36,50	86,12	35,05
		96,31	34,15	98,70	33,48		
8		0,00	19,31	69,06	28,67		

#### Soil parameters - effective stress state

No.	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	SVAHOVINA - prach		30,00	5,00	18,00
2	SVAHOVINA - suť		35,00	5,00	18,00
3	PROLUVIUM 1		19,00	24,00	19,00
4	PROLUVIUM 2		25,00	21,00	20,50

No.	Name	Pattern	$\varphi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
5	SKÁLA 1		40,00	5,00	21,00
6	SKÁLA 2		45,00	10,00	21,00

#### Soil parameters - uplift

No.	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	SVAHOVINA - prach		19,00		
2	SVAHOVINA - sut'		19,00		
3	PROLUVIUM 1		20,00		
4	PROLUVIUM 2		21,00		
5	SKÁLA 1		22,00		
6	SKÁLA 2		22,00		

#### Soil parameters

##### SVAHOVINA - prach

Unit weight :  $\gamma = 18,00 \text{ kN/m}^3$   
 Stress-state : effective  
 Angle of internal friction :  $\varphi_{ef} = 30,00^\circ$   
 Cohesion of soil :  $c_{ef} = 5,00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 19,00 \text{ kN/m}^3$

##### SVAHOVINA - sut'

Unit weight :  $\gamma = 18,00 \text{ kN/m}^3$   
 Stress-state : effective  
 Angle of internal friction :  $\varphi_{ef} = 35,00^\circ$   
 Cohesion of soil :  $c_{ef} = 5,00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 19,00 \text{ kN/m}^3$

##### PROLUVIUM 1

Unit weight :  $\gamma = 19,00 \text{ kN/m}^3$   
 Stress-state : effective  
 Angle of internal friction :  $\varphi_{ef} = 19,00^\circ$   
 Cohesion of soil :  $c_{ef} = 24,00 \text{ kPa}$



Saturated unit weight :  $\gamma_{\text{sat}} = 20,00 \text{ kN/m}^3$

### PROLUVIUM 2

Unit weight :  $\gamma = 20,50 \text{ kN/m}^3$   
Stress-state : effective  
Angle of internal friction :  $\varphi_{\text{ef}} = 25,00^\circ$   
Cohesion of soil :  $c_{\text{ef}} = 21,00 \text{ kPa}$   
Saturated unit weight :  $\gamma_{\text{sat}} = 21,00 \text{ kN/m}^3$

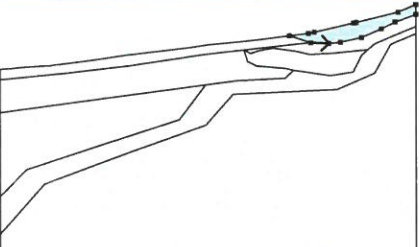

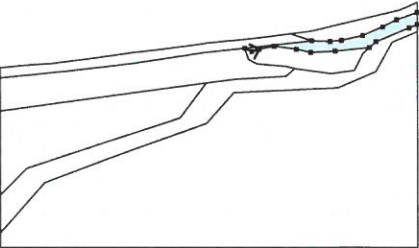

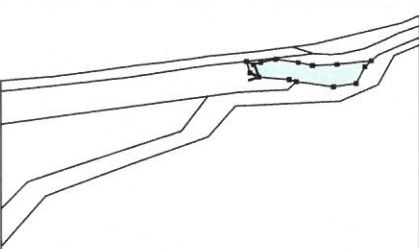

### SKÁLA 1

Unit weight :  $\gamma = 21,00 \text{ kN/m}^3$   
Stress-state : effective  
Angle of internal friction :  $\varphi_{\text{ef}} = 40,00^\circ$   
Cohesion of soil :  $c_{\text{ef}} = 5,00 \text{ kPa}$   
Saturated unit weight :  $\gamma_{\text{sat}} = 22,00 \text{ kN/m}^3$

### SKÁLA 2

Unit weight :  $\gamma = 21,00 \text{ kN/m}^3$   
Stress-state : effective  
Angle of internal friction :  $\varphi_{\text{ef}} = 45,00^\circ$   
Cohesion of soil :  $c_{\text{ef}} = 10,00 \text{ kPa}$   
Saturated unit weight :  $\gamma_{\text{sat}} = 22,00 \text{ kN/m}^3$

### Assigning and surfaces

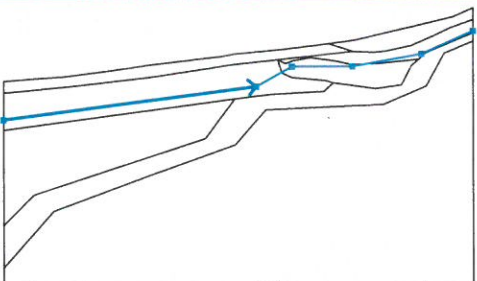
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		104,54	42,85	110,84	42,58	SVAHOVINA - suť 
		114,71	43,02	121,81	44,56	
		128,52	47,52	133,23	49,82	
		140,15	52,34	140,15	55,76	
		134,24	53,15	120,00	49,71	
		119,16	49,51	105,75	46,35	
		103,81	45,98	97,34	45,16	
2		84,28	39,19	86,78	40,06	PROLUVIUM 1 
		91,84	41,00	99,32	39,98	
		104,15	38,92	112,52	39,29	
		124,07	40,53	126,29	42,48	
		137,42	47,21	140,15	48,31	
		140,15	52,34	133,23	49,82	
		128,52	47,52	121,81	44,56	
		114,71	43,02	110,84	42,58	
3		104,54	42,85	81,98	40,36	PROLUVIUM 2 
		83,22	36,50	86,12	35,05	
		96,31	34,15	98,70	33,48	
		111,28	31,78	118,94	32,88	
		121,86	38,58	124,07	40,53	
		112,52	39,29	104,15	38,92	
		99,32	39,98	91,84	41,00	
		86,78	40,06	84,28	39,19	
		81,98	40,36			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		97,34	45,16	87,29	43,89	SVAHOVINA - prach 
		82,77	43,39	69,47	42,08	
		64,38	41,28	57,83	40,50	
		54,49	40,07	45,45	39,01	
		44,67	38,90	43,51	38,77	
		30,93	36,94	29,28	36,73	
		17,03	35,17	16,19	35,13	
		8,54	34,63	3,62	34,15	
		0,00	33,90	0,00	30,43	
		1,77	30,55	21,94	32,56	
		43,26	35,06	68,62	38,90	
		81,98	40,36	104,54	42,85	
		69,06	28,67	79,66	30,01	
		95,81	30,87	98,70	33,48	
5		96,31	34,15	86,12	35,05	PROLUVIUM 1 
		83,22	36,50	81,98	40,36	
		68,62	38,90	43,26	35,06	
		21,94	32,56	1,77	30,55	
		0,00	30,43	0,00	19,31	
		0,00	19,31	0,00	-8,98	PROLUVIUM 2 
		8,97	0,00	60,16	16,92	
6		69,06	28,67			
7		6,82	-13,98	14,92	-4,85	SKÁLA 1 
		44,03	6,06	69,15	15,06	
		78,28	25,42	113,56	27,00	
		126,26	32,49	131,68	42,31	
		140,15	45,88	140,15	48,31	
		137,42	47,21	126,29	42,48	
		124,07	40,53	121,86	38,58	
		118,94	32,88	111,28	31,78	
		98,70	33,48	95,81	30,87	
		79,66	30,01	69,06	28,67	
		60,16	16,92	8,97	0,00	
		0,00	-8,98	0,00	-21,67	
8		131,68	42,31	126,26	32,49	SKÁLA 2 
		113,56	27,00	78,28	25,42	
		69,15	15,06	44,03	6,06	
		14,92	-4,85	6,82	-13,98	
		0,00	-21,67	0,00	-26,67	
		140,15	-26,67	140,15	45,88	



## Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0,00	22,47	75,46	32,42	86,24	38,33
		104,36	38,39	124,89	42,10	140,15	48,96

## 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)

#### Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
12,16	34,87	12,45	34,69	23,78	27,75	60,57	32,56	78,76	37,43
90,84	44,23	91,09	44,37						
Analysis of the slip surface without optimization.									

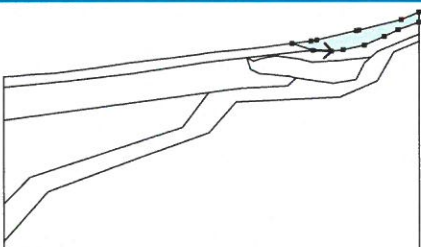

## Slope stability verification (Sarma)

Utilization : 25,4 %

**Slope stability ACCEPTABLE**

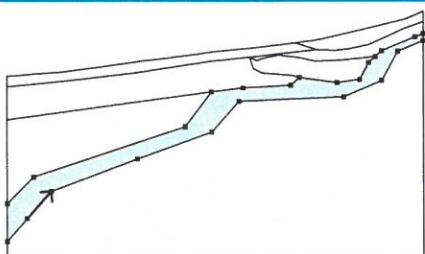

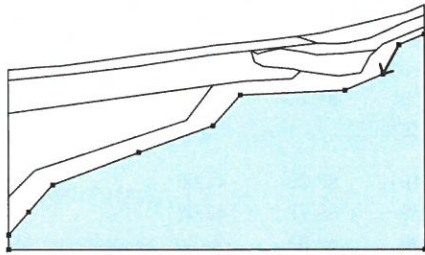

## Input data (Stage of construction 2)

### Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		104,54	42,85	110,84	42,58	SVAHOVINA - suť 
		114,71	43,02	121,81	44,56	
		128,52	47,52	133,23	49,82	
		140,15	52,34	140,15	55,76	
		134,24	53,15	120,00	49,71	
		119,16	49,51	105,75	46,35	
		103,81	45,98	97,34	45,16	

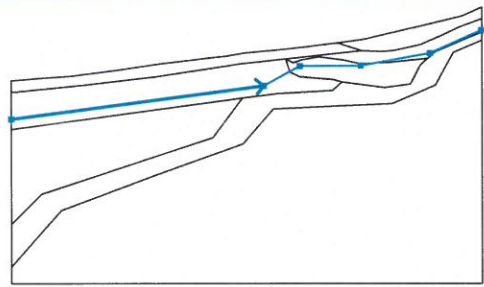
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		84,28	39,19	86,78	40,06	PROLUVIUM 1 
		91,84	41,00	99,32	39,98	
		104,15	38,92	112,52	39,29	
		124,07	40,53	126,29	42,48	
		137,42	47,21	140,15	48,31	
		140,15	52,34	133,23	49,82	
		128,52	47,52	121,81	44,56	
		114,71	43,02	110,84	42,58	
		104,54	42,85	81,98	40,36	
3		83,22	36,50	86,12	35,05	PROLUVIUM 2 
		96,31	34,15	98,70	33,48	
		111,28	31,78	118,94	32,88	
		121,86	38,58	124,07	40,53	
		112,52	39,29	104,15	38,92	
		99,32	39,98	91,84	41,00	
		86,78	40,06	84,28	39,19	
		81,98	40,36			
4		97,34	45,16	87,29	43,89	SVAHOVINA - prach 
		82,77	43,39	69,47	42,08	
		64,38	41,28	57,83	40,50	
		54,49	40,07	45,45	39,01	
		44,67	38,90	43,51	38,77	
		30,93	36,94	29,28	36,73	
		17,03	35,17	16,19	35,13	
		8,54	34,63	3,62	34,15	
		0,00	33,90	0,00	30,43	
		1,77	30,55	21,94	32,56	
		43,26	35,06	68,62	38,90	
5		81,98	40,36	104,54	42,85	PROLUVIUM 1 
		69,06	28,67	79,66	30,01	
		95,81	30,87	98,70	33,48	
		96,31	34,15	86,12	35,05	
		83,22	36,50	81,98	40,36	
		68,62	38,90	43,26	35,06	
		21,94	32,56	1,77	30,55	
6		0,00	19,31	0,00	-8,98	PROLUVIUM 2 
		8,97	0,00	60,16	16,92	
		69,06	28,67			



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		6,82	-13,98	14,92	-4,85	SKÁLA 1 
		44,03	6,06	69,15	15,06	
		78,28	25,42	113,56	27,00	
		126,26	32,49	131,68	42,31	
		140,15	45,88	140,15	48,31	
		137,42	47,21	126,29	42,48	
		124,07	40,53	121,86	38,58	
		118,94	32,88	111,28	31,78	
		98,70	33,48	95,81	30,87	
		79,66	30,01	69,06	28,67	
		60,16	16,92	8,97	0,00	
		0,00	-8,98	0,00	-21,67	
8		131,68	42,31	126,26	32,49	SKÁLA 2 
		113,56	27,00	78,28	25,42	
		69,15	15,06	44,03	6,06	
		14,92	-4,85	6,82	-13,98	
		0,00	-21,67	0,00	-26,67	
		140,15	-26,67	140,15	45,88	

#### Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0,00	22,47	75,46	32,42	86,24	38,33
		104,36	38,39	124,89	42,10	140,15	48,96

#### 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)

##### Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
73,28	42,46	73,54	42,44	94,61	41,14	110,95	41,62	124,47	45,05
Analysis of the slip surface without optimization.									



Coordinates of slip surface points [m]							
x	z	x	z	x	z	x	z
134,63	53,08	135,32	53,63				
Analysis of the slip surface without optimization.							

### Slope stability verification (Sarma)

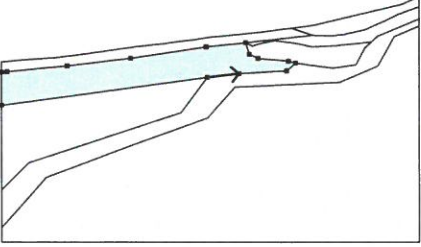

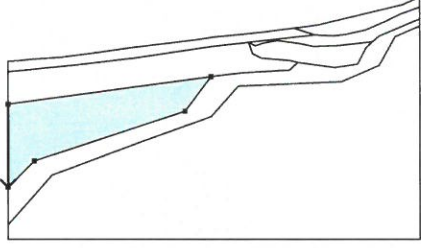
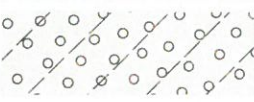
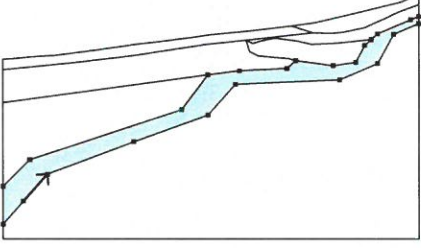

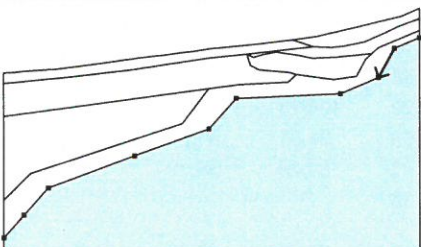

Utilization : 32,8 %

**Slope stability ACCEPTABLE**

### Input data (Stage of construction 3)

#### Assigning and surfaces

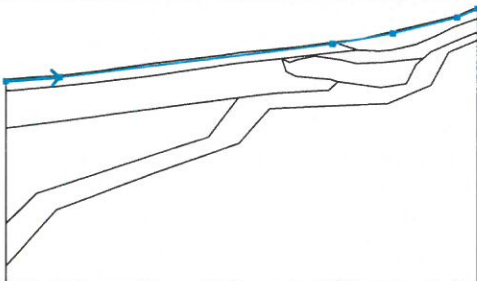
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		104,54	42,85	110,84	42,58	SVAHOVINA - suť 
		114,71	43,02	121,81	44,56	
		128,52	47,52	133,23	49,82	
		140,15	52,34	140,15	55,76	
		134,24	53,15	120,00	49,71	
		119,16	49,51	105,75	46,35	
		103,81	45,98	97,34	45,16	
2		84,28	39,19	86,78	40,06	PROLUVIUM 1 
		91,84	41,00	99,32	39,98	
		104,15	38,92	112,52	39,29	
		124,07	40,53	126,29	42,48	
		137,42	47,21	140,15	48,31	
		140,15	52,34	133,23	49,82	
		128,52	47,52	121,81	44,56	
3		114,71	43,02	110,84	42,58	PROLUVIUM 2 
		104,54	42,85	81,98	40,36	
		83,22	36,50	86,12	35,05	
		96,31	34,15	98,70	33,48	
		111,28	31,78	118,94	32,88	
		121,86	38,58	124,07	40,53	
		112,52	39,29	104,15	38,92	
4		99,32	39,98	91,84	41,00	SVAHOVINA - prach 
		86,78	40,06	84,28	39,19	
		81,98	40,36			
		97,34	45,16	87,29	43,89	
		82,77	43,39	69,47	42,08	
		64,38	41,28	57,83	40,50	
		54,49	40,07	45,45	39,01	
		44,67	38,90	43,51	38,77	
		30,93	36,94	29,28	36,73	
		17,03	35,17	16,19	35,13	
		8,54	34,63	3,62	34,15	
		0,00	33,90	0,00	30,43	
		1,77	30,55	21,94	32,56	
		43,26	35,06	68,62	38,90	
		81,98	40,36	104,54	42,85	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		69,06	28,67	79,66	30,01	PROLUVIUM 1 
		95,81	30,87	98,70	33,48	
		96,31	34,15	86,12	35,05	
		83,22	36,50	81,98	40,36	
		68,62	38,90	43,26	35,06	
		21,94	32,56	1,77	30,55	
		0,00	30,43	0,00	19,31	
6		0,00	19,31	0,00	-8,98	PROLUVIUM 2 
		8,97	0,00	60,16	16,92	
		69,06	28,67			
7		6,82	-13,98	14,92	-4,85	SKÁLA 1 
		44,03	6,06	69,15	15,06	
		78,28	25,42	113,56	27,00	
		126,26	32,49	131,68	42,31	
		140,15	45,88	140,15	48,31	
		137,42	47,21	126,29	42,48	
		124,07	40,53	121,86	38,58	
		118,94	32,88	111,28	31,78	
		98,70	33,48	95,81	30,87	
		79,66	30,01	69,06	28,67	
		60,16	16,92	8,97	0,00	
		0,00	-8,98	0,00	-21,67	
8		131,68	42,31	126,26	32,49	SKÁLA 2 
		113,56	27,00	78,28	25,42	
		69,15	15,06	44,03	6,06	
		14,92	-4,85	6,82	-13,98	
		0,00	-21,67	0,00	-26,67	
		140,15	-26,67	140,15	45,88	

## Water

Water type : GWT



No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0,00	33,25	15,88	34,62	97,09	44,64
		115,00	47,93	134,15	52,67	140,15	55,28

#### Tensile crack

Tensile crack not input.

#### Earthquake

Earthquake not included.

#### Settings of the stage of construction

Design situation : permanent

#### Results (Stage of construction 3)

##### Analysis 1 (stage 3)

##### Polygonal slip surface

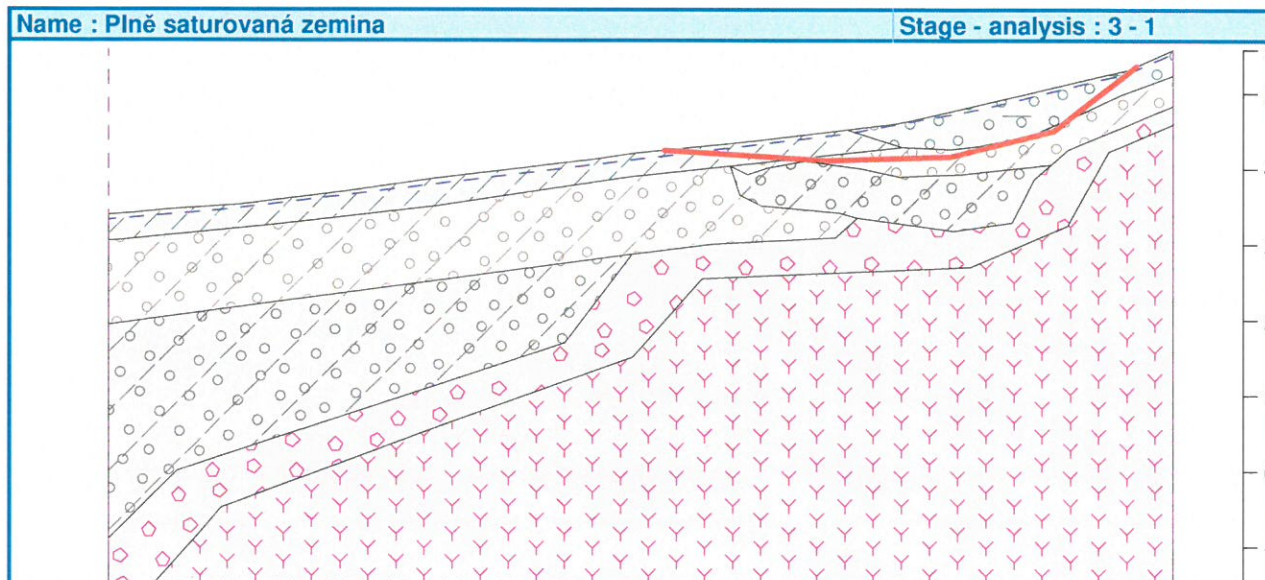
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
73,28	42,46	73,54	42,44	94,61	41,14	110,95	41,62	124,47	45,05
134,63	53,08	135,32	53,63						

Analysis of the slip surface without optimization.

#### Slope stability verification (Sarma)

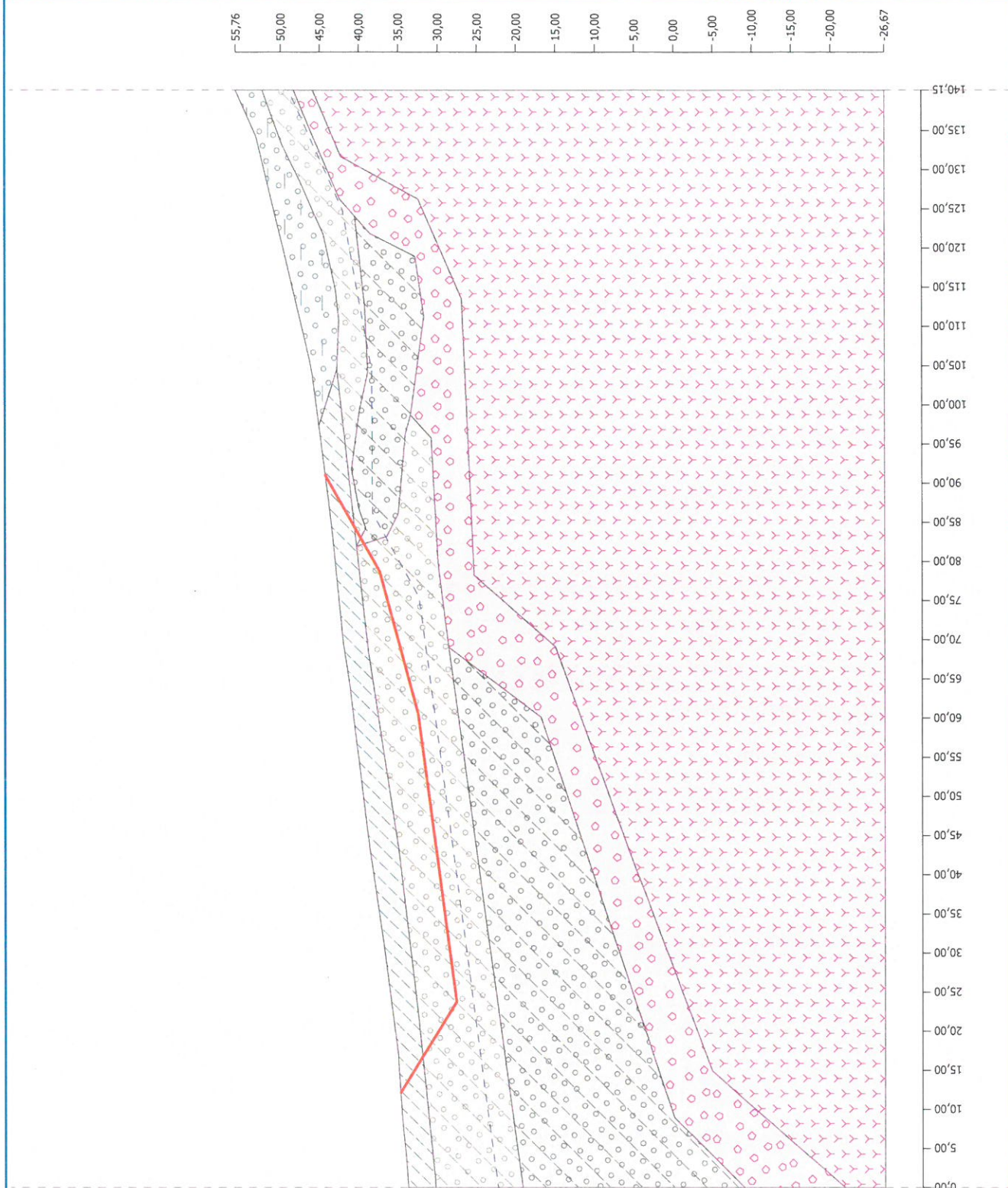
Utilization : 47,0 %

**Slope stability ACCEPTABLE**



Name :

Stage - analysis : 1 - 1



Analysis of the slip surface without optimization.

**Slope stability verification (Sarma)**

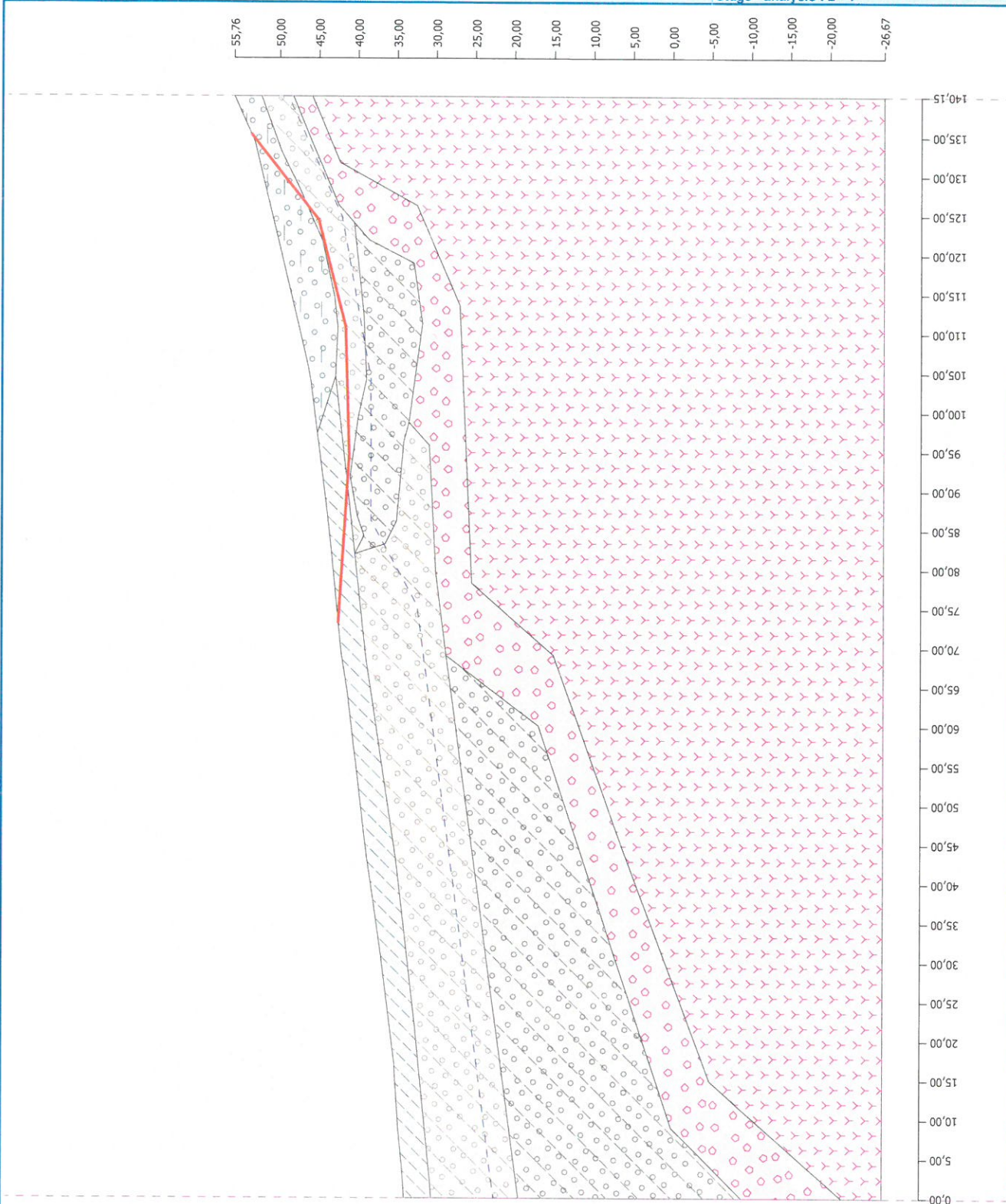
Utilization : 25,4 %

**Slope stability ACCEPTABLE**



Name :

Stage - analysis : 2 - 1



Analysis of the slip surface without optimization.

**Slope stability verification (Sarma)**

Utilization : 32,8 %

**Slope stability ACCEPTABLE**

