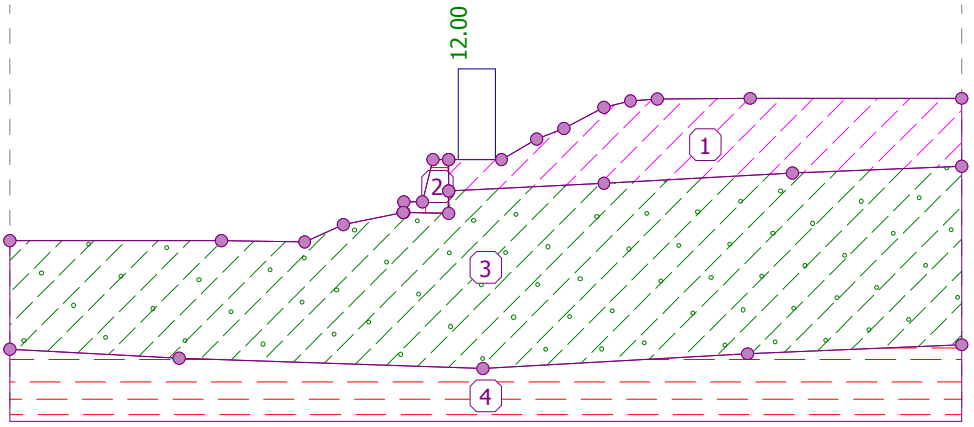
Slope stability analysis

Input data

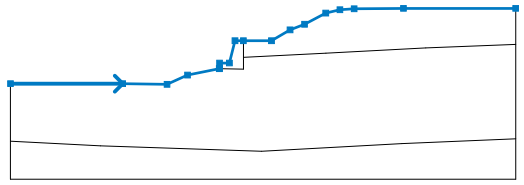
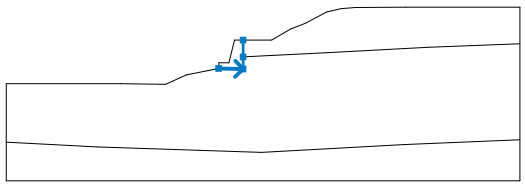
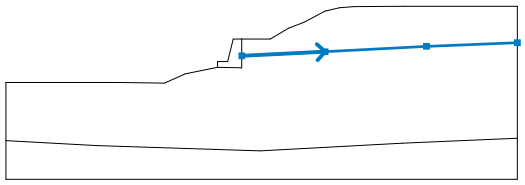
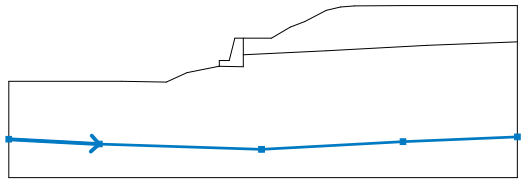
Project

Date : 11/3/2005

Name : Project | **Stage : 1**

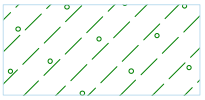
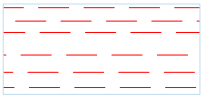


Interface

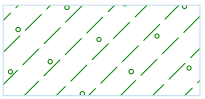
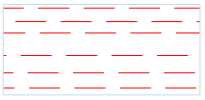
Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-20.00	115.32	0.00	115.32	7.89	115.20
		11.54	116.85	17.20	117.99	17.25	118.00
		17.25	119.00	19.00	119.00	20.00	122.98
		21.50	122.98	26.50	122.98	29.80	124.92
		32.39	125.92	36.16	127.92	38.69	128.51
		41.22	128.69	50.00	128.75	70.00	128.75
2		17.20	117.99	21.50	117.90	21.50	120.02
		21.50	122.98				
3		21.50	120.02	36.18	120.75	53.99	121.70
		70.00	122.34				
4		-20.00	105.06	-3.99	104.21	24.73	103.26
		49.75	104.63	70.00	105.48		

Soil parameters - effective stress state

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Soil No. 1		21.00	12.00	20.00

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
2	Soil No. 2		26.50	16.00	18.00
3	Soil No. 3		40.00	50.00	19.00

Soil parameters - uplift

Number	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Soil No. 1		22.00		
2	Soil No. 2		18.00		
3	Soil No. 3		22.00		

Soil parameters

Soil No. 1

Unit weight : γ = 20.00 kN/m^3
Angle of internal friction : φ_{ef} = 21.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

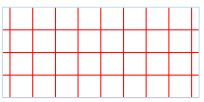
Soil No. 2

Unit weight : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 26.50 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m^3

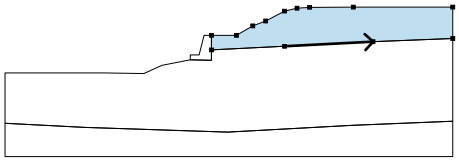
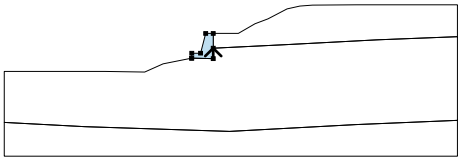
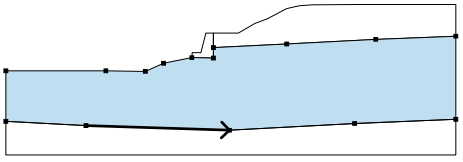
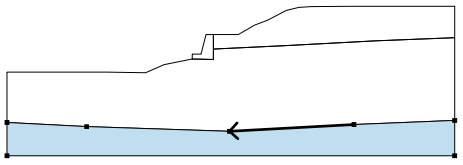
Soil No. 3

Unit weight : γ = 19.00 kN/m^3
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 50.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

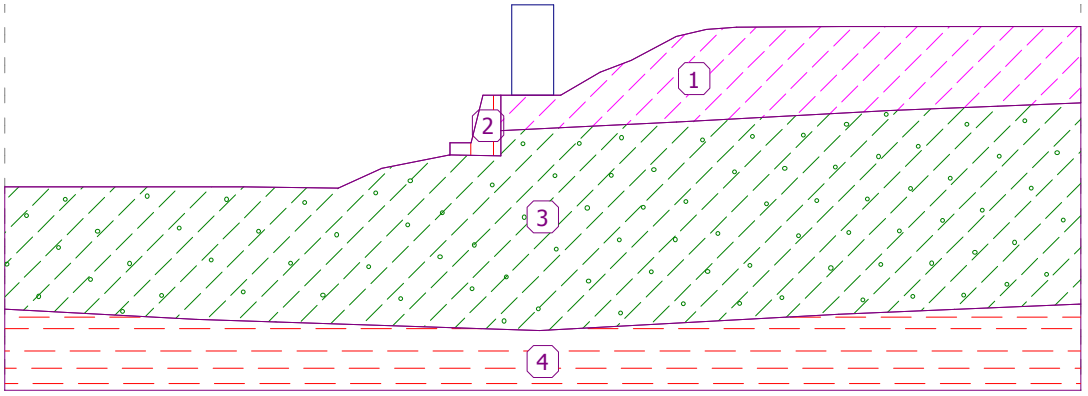
Rigid bodies

Number	Name	Sample	γ [kN/m^3]
1	Rigid body No. 1		25.00

Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		36.18	120.75	53.99	121.70	Soil No. 1
		70.00	122.34	70.00	128.75	
		50.00	128.75	41.22	128.69	
		38.69	128.51	36.16	127.92	
		32.39	125.92	29.80	124.92	
		26.50	122.98	21.50	122.98	
		21.50	120.02			
2		21.50	117.90	21.50	120.02	Rigid body No. 1
		21.50	122.98	20.00	122.98	
		19.00	119.00	17.25	119.00	
		17.25	118.00	17.20	117.99	
3		-3.99	104.21	24.73	103.26	Soil No. 2
		49.75	104.63	70.00	105.48	
		70.00	122.34	53.99	121.70	
		36.18	120.75	21.50	120.02	
		21.50	117.90	17.20	117.99	
		11.54	116.85	7.89	115.20	
		0.00	115.32	-20.00	115.32	
		-20.00	105.06			
4		49.75	104.63	24.73	103.26	Soil No. 3
		-3.99	104.21	-20.00	105.06	
		-20.00	98.26	70.00	98.26	
		70.00	105.48			

Name : Soils and assignment — Stage : 1



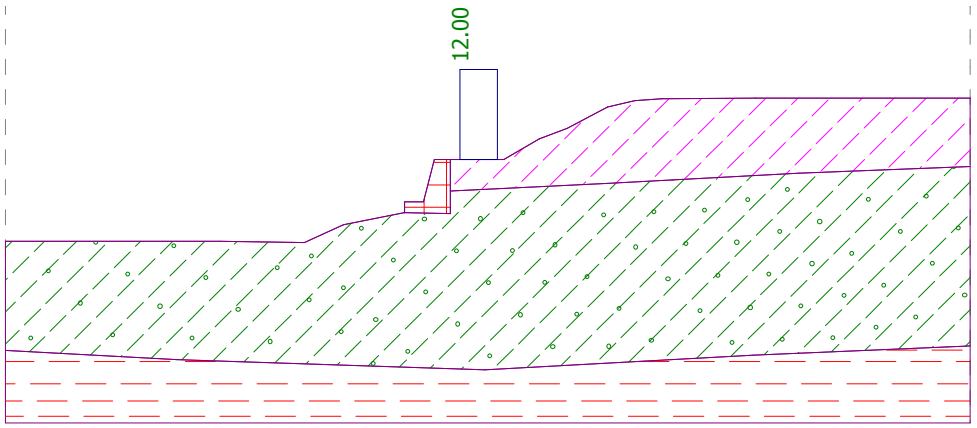
Surcharge

Number	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	Magnitude q_2	Magnitude unit
1	strip	permanent	on terrain	x = 22.40	l = 3.50		0.00	12.00		kN/m^2

Surcharges

Number	Name
1	Surcharge No. 1

Name : Surcharge	Stage : 1



Water
Water type : No water

Tensile crack
Tensile crack not inputted.

Earthquake
Earthquake not included.

Global settings
Verification methodology : Analysis according to EN 1997
Input of patial factors : Standard
Design approach : 1 - reduction of actions and materials
Number of combination : 1

Partial factors on actions (F)	Fact.	Combination 1 [–]		Combination 2 [–]	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions	γ_G	1.35	1.00	1.00	1.00
Variable actions	γ_Q	1.50	0.00	1.30	0.00

Partial factors for soil parameters (M)	Fact.	Combination 1 [–]	Combination 2 [–]
Partial factor for intenal friction	$\gamma_{m\phi}$	1.00	1.25
Partial factor for effective cohesion	γ_{mc}	1.00	1.25
Partial factor for undrained shear strength	γ_{mcu}	1.00	1.40

Partial factors for variable actions	Fact.	[–]
Factor for combination value	ψ_0	0.70
Factor for frequent value	ψ_1	0.50
Factor for quasi-permanent value	ψ_2	0.30

Analysis type : in effective parameters

Settings of the stage of construction
Combination : basic

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters							
Center :	x =	10.91	[m]	Angles :	α_1 =	-4.25	[°]
	z =	157.17	[m]		α_2 =	47.42	[°]
Radius :	R =	42.08	[m]				
Specified slip surface.							

Slope stability verification (Bishop)
Analysis was not performed.

Analysis 2 (stage 1)

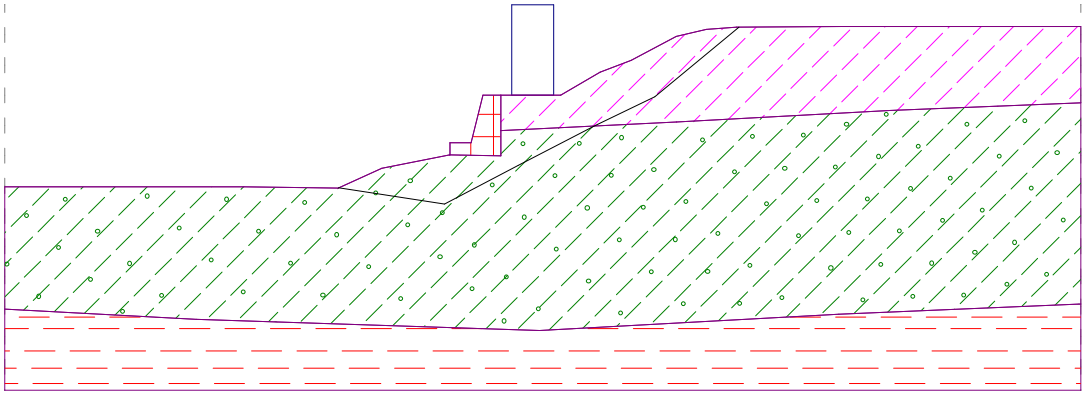
Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
7.93	115.22	16.78	113.87	22.94	117.10	29.45	120.47	34.37	122.87
41.40	128.69								
The slip surface after optimization.									

Slope stability verification (Sarma)
Utilization : 66.0 %

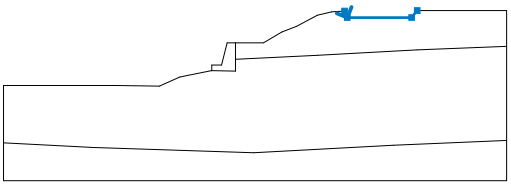
Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 2

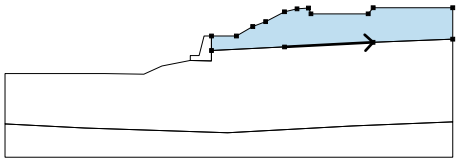
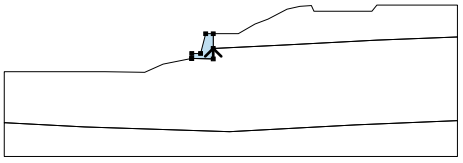
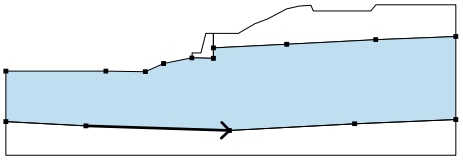
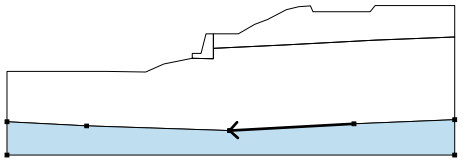


Input data (Stage of construction 2)

Earth cut

Number	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		41.00	128.67	41.50	127.50	53.00	127.50
		54.00	128.75				

Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		36.18	120.75	53.99	121.70	Soil No. 1
		70.00	122.34	70.00	128.75	
		54.00	128.75	53.00	127.50	
		41.50	127.50	41.00	128.67	
		38.69	128.51	36.16	127.92	
		32.39	125.92	29.80	124.92	
		26.50	122.98	21.50	122.98	
		21.50	120.02			
2		21.50	117.90	21.50	120.02	Rigid body No. 1
		21.50	122.98	20.00	122.98	
		19.00	119.00	17.25	119.00	
		17.25	118.00	17.20	117.99	
3		-3.99	104.21	24.73	103.26	Soil No. 2
		49.75	104.63	70.00	105.48	
		70.00	122.34	53.99	121.70	
		36.18	120.75	21.50	120.02	
		21.50	117.90	17.20	117.99	
		11.54	116.85	7.89	115.20	
		0.00	115.32	-20.00	115.32	
		-20.00	105.06			
4		49.75	104.63	24.73	103.26	Soil No. 3
		-3.99	104.21	-20.00	105.06	
		-20.00	98.26	70.00	98.26	
		70.00	105.48			

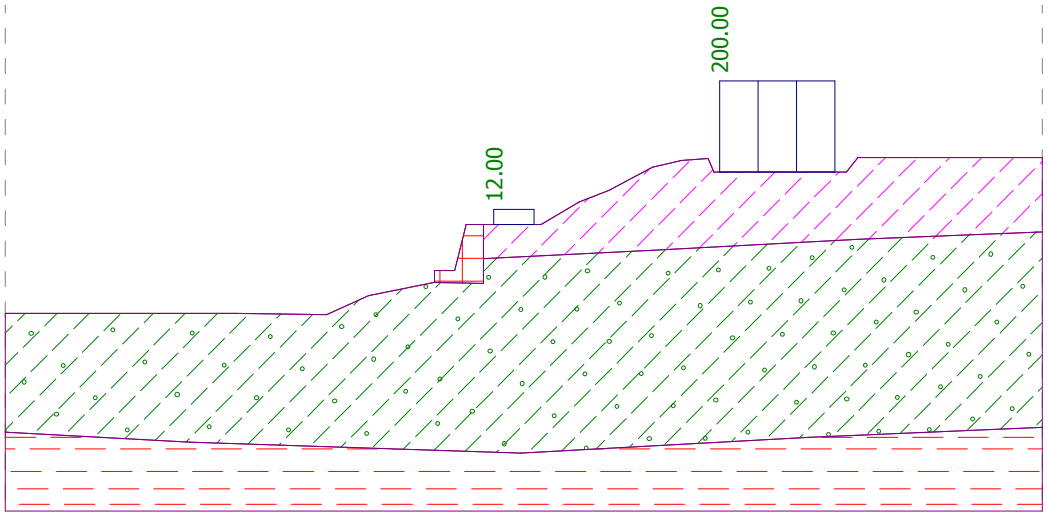
Surcharge

Number	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 22.40	l = 3.50		0.00	12.00		kN/m^2
2	Yes		strip	permanent	on terrain	x = 42.00	l = 10.00		0.00	200.00		kN/m^2

Surcharges

Number	Name
1	Surcharge No. 1
2	Pøitížení - stavba

Name : Surcharge	Stage : 2



Water
Water type : No water

Tensile crack
Tensile crack not inputted.

Earthquake
Earthquake not included.

Settings of analysis
Combination : basic

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	14.56	[m]	Angles :	α_1 =	-7.57	[°]
	z =	166.63	[m]		α_2 =	41.04	[°]
Radius :	R =	51.88	[m]				
Specified slip surface.							

Slope stability verification (all methods)
Bishop : Analysis was not performed.
Fellenius / Petterson : Analysis was not performed.
Spencer : Analysis was not performed.

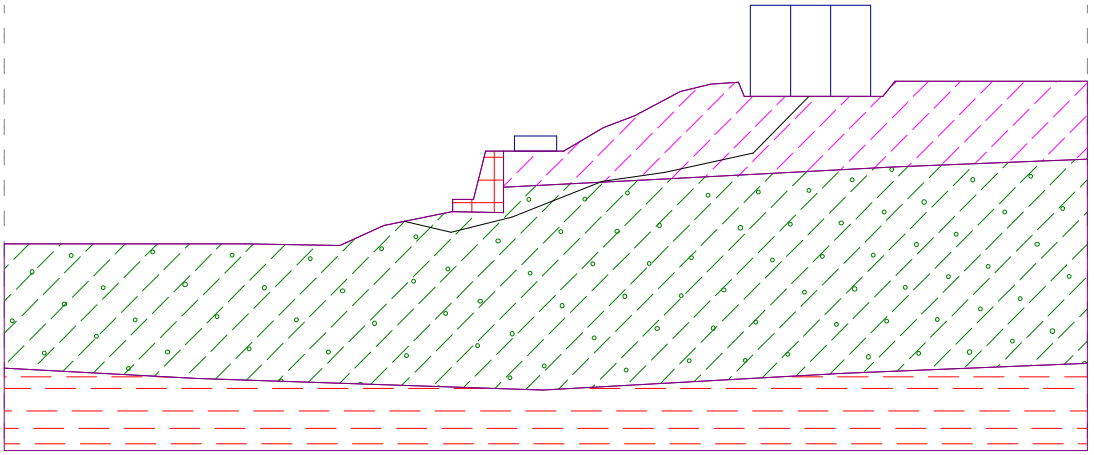
Analysis 2 (stage 2)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
13.25	117.19	17.12	116.28	22.19	117.53	29.68	120.48	34.90	121.24
42.23	122.83	46.85	127.50						
Specified slip surface.									

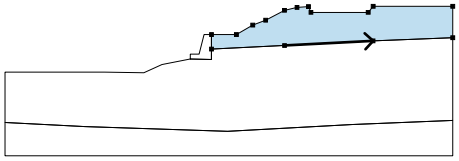
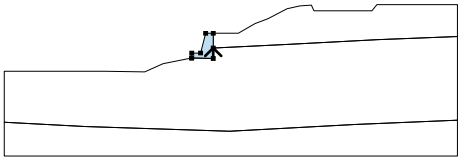
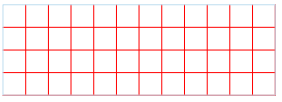
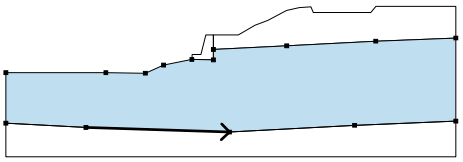
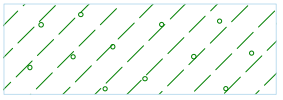
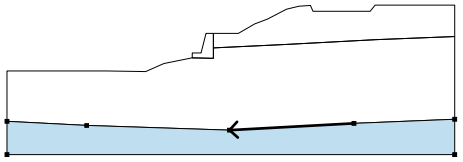
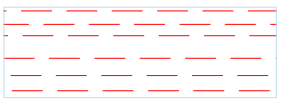
Slope stability verification (all methods)
Sarma : Analysis was not performed.
Spencer : Analysis was not performed.

Name : Analysis | **Stage - analysis : 2 - 2**



Input data (Stage of construction 3)

Assigning and surfaces

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		36.18	120.75	53.99	121.70	Soil No. 1
		70.00	122.34	70.00	128.75	
		54.00	128.75	53.00	127.50	
		41.50	127.50	41.00	128.67	
		38.69	128.51	36.16	127.92	
		32.39	125.92	29.80	124.92	
		26.50	122.98	21.50	122.98	
		21.50	120.02			
2		21.50	117.90	21.50	120.02	Rigid body No. 1
		21.50	122.98	20.00	122.98	
		19.00	119.00	17.25	119.00	
		17.25	118.00	17.20	117.99	
3		-3.99	104.21	24.73	103.26	Soil No. 2
		49.75	104.63	70.00	105.48	
		70.00	122.34	53.99	121.70	
		36.18	120.75	21.50	120.02	
		21.50	117.90	17.20	117.99	
		11.54	116.85	7.89	115.20	
		0.00	115.32	-20.00	115.32	
		-20.00	105.06			
4		49.75	104.63	24.73	103.26	Soil No. 3
		-3.99	104.21	-20.00	105.06	
		-20.00	98.26	70.00	98.26	
		70.00	105.48			

Anchors

Number	Anchor		Origin		Length and slope / coordinates		Anchor spacing	Diameter / area	Elastic modulus	Break force	Active	Force
	new	post-stre	x [m]	z [m]	l [m] / x [m]	α [°] / z [m]	b [m]	d [mm] / A [mm²]	E [MPa]	F_c [kN]	in compres	F [kN]
1	Yes		29.14	124.53	l = 17.00	α = 35.00	1.00	d =			No	120.00
2	Yes		33.52	126.52	l = 17.00	α = 35.00	1.00	d =			No	120.00

Surcharge

Number	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 22.40	l = 3.50		0.00	12.00		kN/m²
2	No	No	strip	permanent	on terrain	x = 42.00	l = 10.00		0.00	200.00		kN/m²

Surcharges

Number	Name
1	Surcharge No. 1
2	Pøitížení - stavba

Water
Water type : No water

Tensile crack
Tensile crack not inputted.

Earthquake
Earthquake not included.

Settings of analysis
Combination : basic

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters							
Center :	x =	16.44	[m]	Angles :	α_1 =	-10.54	[°]
	z =	161.21	[m]		α_2 =	43.92	[°]
Radius :	R =	46.80	[m]				
Specified slip surface.							

Slope stability verification (all methods)
Bishop : Analysis was not performed.
Fellenius / Petterson : Analysis was not performed.
Spencer : Analysis was not performed.

Analysis 2 (stage 3)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
13.07	117.16	17.12	116.15	22.19	117.53	29.86	120.48	36.40	121.48
42.18	122.20	47.63	127.50						
Specified slip surface.									

Slope stability verification (all methods)
Sarma : Analysis was not performed.
Spencer : Analysis was not performed.

Name : Analysis | **Stage - analysis : 3 - 2**