Slope stability analysis

Input data

Project

Task : Vukovski vrh 7
Part : P-5
Description : Piloti fi80/1.6m' + sidra 4T15S (25stopinj)
Customer : Občina Pesnica
Author : GEOING d.o.o.
Date : 22.4.2022

Settings

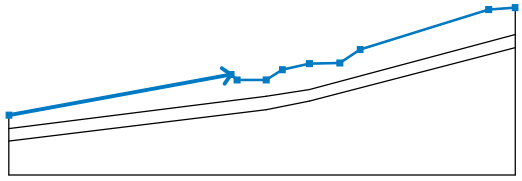
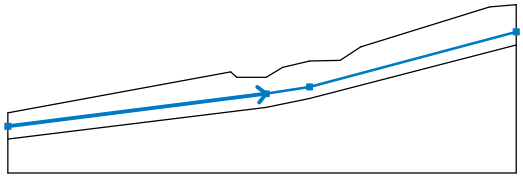
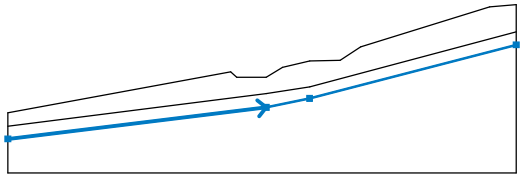
Slovenia - EN 1997 (19)

Stability analysis

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

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1,50	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0,00	4,40	32,80	10,40	33,70	9,60
		38,00	9,60	40,40	11,10	44,40	12,00
		48,90	12,10	51,90	14,10	70,90	20,00
		74,80	20,30				
2		0,00	2,40	38,00	7,20	44,40	8,20
		74,80	16,30				
3		0,00	0,55	38,00	5,20	44,40	6,50
		74,80	14,40				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Glina		17,50	0,00	19,00
2	Preperina		30,00	10,00	21,00
3	Hribina		40,00	80,00	22,00

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Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Glina		19,00		
2	Preperina		21,00		
3	Hribina		22,00		

Soil parameters

Glina

Unit weight :	γ =	19,00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	17,50 °
Cohesion of soil :	c_{ef} =	0,00 kPa
Saturated unit weight :	γ_{sat} =	19,00 kN/m^3

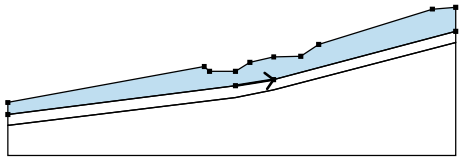
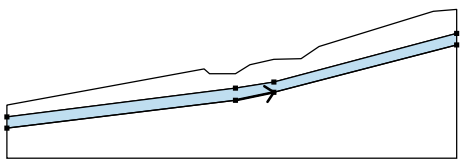
Preperina

Unit weight :	γ =	21,00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	30,00 °
Cohesion of soil :	c_{ef} =	10,00 kPa
Saturated unit weight :	γ_{sat} =	21,00 kN/m^3

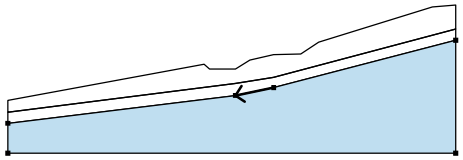
Hribina

Unit weight :	γ =	22,00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	40,00 °
Cohesion of soil :	c_{ef} =	80,00 kPa
Saturated unit weight :	γ_{sat} =	22,00 kN/m^3

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		38,00	7,20	44,40	8,20	Glina
		74,80	16,30	74,80	20,30	
		70,90	20,00	51,90	14,10	
		48,90	12,10	44,40	12,00	
		40,40	11,10	38,00	9,60	
		33,70	9,60	32,80	10,40	
		0,00	4,40	0,00	2,40	
2		38,00	5,20	44,40	6,50	Preperina
		74,80	14,40	74,80	16,30	
		44,40	8,20	38,00	7,20	
		0,00	2,40	0,00	0,55	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
3		44,40	6,50	38,00	5,20	Hribina
		0,00	0,55	0,00	-4,45	
		74,80	-4,45	74,80	14,40	

Anchors

No.	Origin		Free length	Root length	Slope	Anchor spacing	Force
	x [m]	z [m]	l [m]	l_k [m]	α [°]	b [m]	F [kN]
1	43,51	11,80	9,00	9,00	25,00	3,20	400,00

Anti-Slide piles

No.	Point		Length	Pile spacing	Cross-section	Pile bearing capacity			
	x [m]	z [m]	l [m]	b [m]	[m]	Distribution along the pile	Max. bearing capacity V_u [kN]	Gradient K [–]	Passive force direction
1	44,00	12,50	8,00	1,60	d = 0,80	linear	300,00	0,50	perpendicular to pile

Surcharge

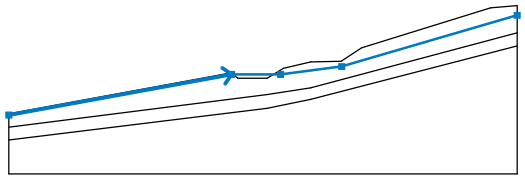
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude		
								q, q_1, f, F	q_2	unit
1	strip	permanent	on terrain	x = 44,50	l = 3,00		0,00	15,00		kN/m^2

Surcharges

No.	Name
1	Zasip

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0,00	4,20	32,80	10,19	40,00	10,19
		48,98	11,34	74,80	18,88		

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

Polygonal slip surface

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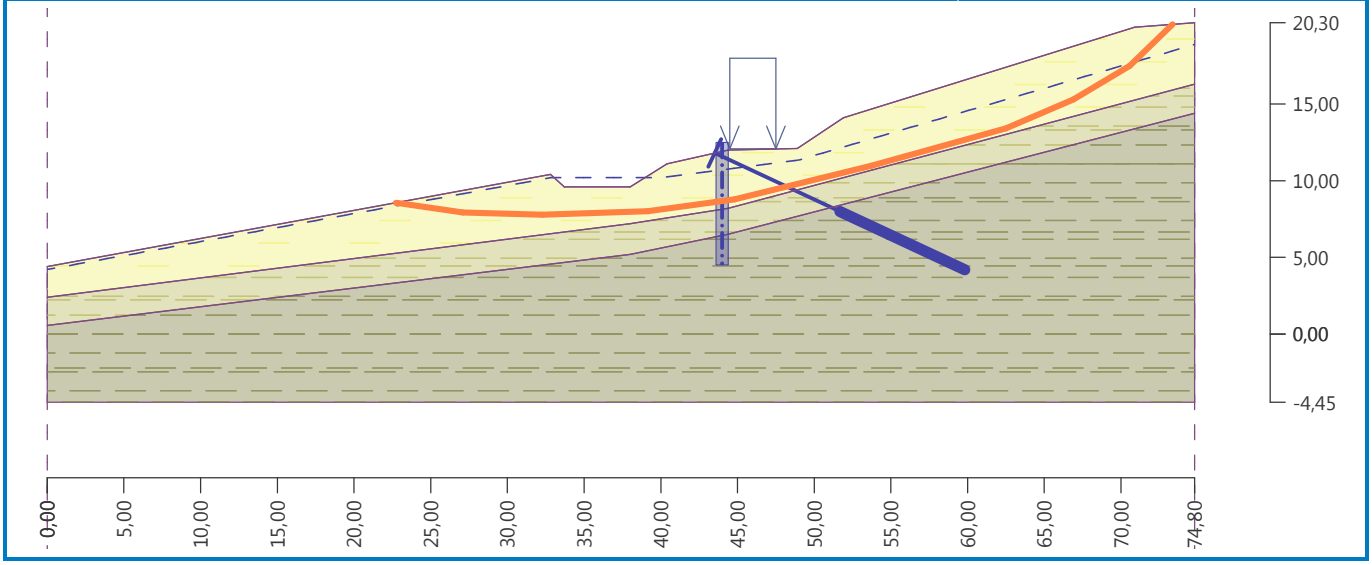
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
22,73	8,56	22,79	8,55	27,10	7,93	32,27	7,77	39,16	8,00
44,80	8,79	53,73	10,98	62,50	13,41	66,89	15,29	70,57	17,48
73,36	20,19								
Analysis of the slip surface without optimization.									

The forces acting on the pile

Anti-Slide Pile No. 1 (44,00; 12,50 [m])
- Horizontal active force: 270,99 kN/m
- Horizontal passive force: 142,81 kN/m
- Depth of slip surface: 3,23 m
- The length of pile below terrain: 7,41 m

Slope stability verification (Morgenstern-Price)
Factor of safety = 1,78 > 1,50
Slope stability ACCEPTABLE

Name : Analysis | **Stage - analysis : 1 - 1**



Piles verification 1

Anti-Slide pile : Anti-Slide Pile No. 1 (44,00; 12,50 [m])
Analysis : Calculation 1 (slip surface polygonal)
Method : Morgenstern-Price

Analysis of anti-slide pile

Input data

Settings

Slovenia - EN 1997 (19)

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard
Steel structures : EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section : γ_{M0} = 1,00

Pressure analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Modulus of subsoil reaction : standard

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Consider reduction of the modulus of subsoil reaction for a braced sheeting
Verification methodology : according to EN 1997
Design approach : 2 - reduction of actions and resistances

Partial factors on actions (A)					
Permanent design situation					
		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]		

Partial factors for resistances (R)			
Permanent design situation			
Partial factor on earth resistance :	γ_{Re} =	1,40	[–]

Anchors

Verification methodology : Limit states (LSD)

Reduction coefficients			
Reduction. coeff of steel strength :	γ_s =	1,35	[–]
Reduction coefficient of pull out resistance (soil) :	γ_e =	1,35	[–]
Reduction coefficient of pull out resistance (grouting) :	γ_c =	1,35	[–]

Geometry of structure

Structure length = 7,41 m

Cross-section name : Pile curtain d = 0,80 m; a = 1,60 m
Material of pile : concrete
Computed coefficient of pressure reduction below the ditch = 0,96
Area of cross-section A = 3,14E-01 m^2/m
Moment of inertia I = 1,26E-02 m^4/m
Elastic modulus E = 33000,00 MPa
Shear modulus G = 13750,00 MPa

Input pressure acting on structure

Depth of slip surface h_{s1} = 3,23 m

Active horizontal force T = 270,99 kN/m
Passive horizontal force P = 142,81 kN/m

Distribution of active force : triangle
Distribution of passive force : as active force

Material of structure

Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ctm} = 2,90 MPa
Elasticity modulus E_{cm} = 33000,00 MPa
Shear modulus G = 13750,00 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Transverse steel: B500
Yield strength f_{yk} = 500,00 MPa

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Modulus of reaction

Modulus of subsoil reaction is computed by method Schmitt.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	Glina		17,50	0,00	19,00	9,00	17,50
2	Preperina		30,00	10,00	21,00	11,00	30,00
3	Hribina		40,00	80,00	22,00	12,00	40,00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Glina		cohesionless	17,50	-	-	-
2	Preperina		cohesive	-	0,25	-	-
3	Hribina		cohesive	-	0,20	-	-

Parameters of soils to compute modulus of subsoil reaction (Schmitt)

No.	Name	Pattern	ν [–]	E_{oed} [MPa]	E_{def} [MPa]
1	Glina		0,40	3,00	-
2	Preperina		0,25	40,00	-
3	Hribina		0,20	80,00	-

Soil parameters

Glina

Unit weight : γ = 19,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 17,50 °
Cohesion of soil : c_{ef} = 0,00 kPa
Angle of friction struc.-soil : δ = 17,50 °
Soil : cohesionless
Oedometric modulus : E_{oed} = 3,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m^3

Preperina

Unit weight : γ = 21,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 30,00 °
Cohesion of soil : c_{ef} = 10,00 kPa
Angle of friction struc.-soil : δ = 30,00 °
Soil : cohesive

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Poisson's ratio : ν = 0,25
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 21,00 kN/m^3

Hribina
Unit weight : γ = 22,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 40,00 °
Cohesion of soil : c_{ef} = 80,00 kPa
Angle of friction struc.-soil : δ = 40,00 °
Soil : cohesive
Poisson's ratio : ν = 0,20
Oedometric modulus : E_{oed} = 80,00 MPa
Saturated unit weight : γ_{sat} = 22,00 kN/m^3

Pile fixed into the rock

Length of wall in the rock l = 3,00 m
Bearing capacity of rock R = 3000,00 kPa

Geological profile and assigned soils

Position information
Terrain elevation = 11,91 m
Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Altitude [m]	Assigned soil	Pattern
1	3,80	0,00 .. 3,80	11,91 .. 8,11	Glina	
2	1,70	3,80 .. 5,50	8,11 .. 6,41	Preperina	
3	-	5,50 .. ∞	6,41 .. -	Hribina	

Excavation

Soil in front of wall is excavated to a depth of 1,15 m.

Ditch bottom shape

No.	Coordinate x [m]	Depth z [m]
1	0,00	0,00
2	-3,20	0,72
3	-5,60	2,22
4	-9,90	2,22
5	-10,80	1,42
6	-43,60	7,42
7	-44,60	7,42

Origin [0,0] is located at the ditch bottom.
Positive coordinate +z has downward direction.

Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0,00	0,00
2	0,10	-0,09

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No.	Coordinate x [m]	Depth z [m]
3	4,50	-0,19
4	7,50	-2,19
5	26,50	-8,09
6	30,40	-8,39
7	31,40	-8,39

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

GWT behind the structure lies at a depth of 1,16 m
GWT in front of the structure lies at a depth of 1,26 m
Subgrade at the heel is not permeable.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m2]	Mag.2 [kN/m2]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		permanent	15,00		0,10	3,00	on terrain

No.	Name
1	Zasip

Input anchors

No.	New anchor	Depth z [m]	Name	Post-stressing	Force F [kN]
1	Yes	1,15	4T15S (user defined)		330,00

List of the new anchors

4T15S (user defined)
Anchor type : prestressed bar
Production set : user defined

Depth :	z	=	1,15	m
Free length :	l	=	9,50	m
Root length :	l_k	=	9,00	m
Slope :	α	=	25,00	°
Spacing :	b	=	3,20	m
Area of cross-section :	A	=	600,00	mm2
Elasticity modulus :	E	=	210000,00	MPa
Pre-stressing force :	F	=	330,00	kN
Design strength of material :	f_u	=	1775,00	MPa

Pull out resistance (soil) : calculate from effective stress

Diameter of root :	d	=	152,0	mm

Pull out resistance (grouting) : calculate from concrete strength
Standard for concrete structures : EN 1992-1-1 (EC2)

Concrete strength in compression :	f_{ck}	=	37,00	MPa
Coefficient of cohesion :	η_1	=	0,70	

Global settings

Number of FEs to discretize wall = 40
Analysis of depending pressures : reduce according to analysis settings
Minimum dimensioning pressure is considered as $\sigma_{a,min} = 0{,}20\sigma_z$

Settings of the stage of construction

Design situation : permanent

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Analysis results

Pressure above the slip surface

Depth [m]	Passive pressure [kPa]	Active pressure [kPa]
0	0,00	0,00
1,15	0,00	59,66
1,15	0,00	59,66
3,23	137,18	167,69

Distribution of pressures acting on the structure (in front and behind the wall)

Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.01	0.01	0.01
0.03	0.00	0.00	0.00	1.58	1.58	1.58
0.14	0.00	0.00	0.00	7.21	7.21	7.21
0.42	0.00	0.00	0.00	22.01	22.01	22.01
0.67	0.00	0.00	0.00	34.95	34.95	34.95
0.72	0.00	0.00	0.00	37.36	37.36	37.36
0.77	0.00	0.00	0.00	39.98	39.98	39.98
0.79	0.00	0.00	0.00	41.02	41.02	41.02
1.15	0.00	0.00	0.00	59.66	59.66	59.66
1.16	0.00	0.00	0.00	59.52	59.52	59.52
1.23	0.00	0.00	0.00	58.56	58.56	58.56
1.26	0.00	0.00	0.00	58.12	58.12	58.12
1.35	0.00	0.00	0.00	56.90	56.90	56.90
1.42	0.00	0.00	0.00	55.88	55.88	55.88
2.02	0.00	0.00	0.00	47.47	47.47	47.47
2.15	0.00	0.00	0.00	45.71	45.71	45.71
2.22	0.00	0.00	0.00	44.68	44.68	44.68
2.46	0.00	0.00	0.00	41.34	41.34	41.34
2.69	0.00	0.00	0.00	38.03	38.03	38.03
2.71	0.00	0.00	0.00	37.77	37.77	37.77
2.77	0.00	0.00	0.00	37.01	37.01	37.01
3.12	0.00	0.00	0.00	32.10	32.10	32.10
3.23	0.00	0.00	0.00	30.51	30.51	30.51
3.23	-6.45	-6.45	-6.45	41.64	41.64	74.94
3.33	-6.73	-6.73	-6.73	42.57	42.57	76.48
3.37	-6.84	-6.84	-6.84	42.93	42.93	77.08
3.80	-8.10	-8.10	-8.10	47.05	47.05	83.90
3.80	0.00	-6.60	-64.92	8.76	17.79	259.02
4.04	0.00	-7.30	-69.64	9.88	18.44	284.04
4.41	0.00	-8.36	-76.83	11.59	19.48	322.13
4.41	0.00	-8.36	-2997.58	10.04	19.48	3803.05
4.57	0.00	-6.91	-2997.58	8.55	8.55	3809.83
4.72	0.00	-5.62	-2997.58	7.23	7.23	3815.81
4.74	0.00	-5.41	-2997.58	7.02	7.02	3816.78
5.08	0.00	-2.31	-2997.58	3.83	3.83	3831.22

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
5.09	0.00	-2.30	-2997.58	3.82	3.82	3831.26
5.34	0.00	0.00	-2997.58	1.46	1.46	3841.96
5.39	0.00	0.00	-2997.58	1.02	1.02	3843.95
5.50	0.00	0.00	-2997.58	0.00	0.00	3848.59
5.50	0.00	0.00	-4377.70	0.00	0.00	6428.64
6.06	0.00	0.00	-4377.70	0.00	0.00	6490.47
6.74	0.00	0.00	-4377.70	0.00	0.00	6564.49
7.11	0.00	0.00	-4377.70	0.00	0.00	6605.22
7.41	0.00	0.00	-4377.70	0.00	0.00	6638.51

Distributions of the modulus of subsoil reaction and internal forces on the structure

Depth [m]	kh,p [MN/m3]	kh,z [MN/m3]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
0.00	0.00	0.00	-5.16	0.00	0.00	0.00
0.19	0.00	0.00	-5.00	9.61	-0.89	0.05
0.37	0.00	0.00	-4.85	19.22	-3.56	0.44
0.56	0.00	0.00	-4.69	28.83	-8.01	1.48
0.74	0.00	0.00	-4.53	38.45	-14.24	3.52
0.93	0.00	0.00	-4.37	48.06	-22.26	6.87
1.11	0.00	0.00	-4.22	57.67	-32.05	11.87
1.14	0.00	0.00	-4.19	59.25	-33.83	12.88
1.16	0.00	0.00	-4.18	59.55	58.68	12.68
1.30	0.00	0.00	-4.06	57.61	50.55	5.10
1.48	0.00	0.00	-3.90	55.02	40.12	-3.29
1.67	0.00	0.00	-3.75	52.42	30.17	-9.79
1.85	0.00	0.00	-3.59	49.83	20.70	-14.49
2.04	0.00	0.00	-3.44	47.23	11.71	-17.49
2.22	0.00	0.00	-3.28	44.64	3.20	-18.86
2.41	0.00	0.00	-3.12	42.04	-4.83	-18.70
2.59	0.00	0.00	-2.95	39.45	-12.38	-17.10
2.78	0.00	0.00	-2.79	36.85	-19.44	-14.15
2.96	0.00	0.00	-2.63	34.26	-26.03	-9.93
3.15	0.00	0.00	-2.46	31.66	-32.14	-4.53
3.22	0.00	0.00	-2.39	30.62	-34.47	-2.04
3.24	0.00	0.00	-2.38	35.24	-34.99	-1.48
3.33	0.00	0.00	-2.29	35.87	-38.35	1.98
3.52	0.00	0.00	-2.13	37.09	-45.11	9.71
3.71	0.00	0.00	-1.96	38.32	-52.10	18.71
3.89	0.00	0.00	-1.80	-57.50	-50.32	28.47
4.08	36.84	0.00	-1.64	-57.73	-39.37	36.51
4.26	36.84	0.00	-1.48	-51.59	-29.25	42.84
4.45	36.84	0.00	-1.33	-47.19	-20.10	47.40
4.63	36.84	0.00	-1.18	-41.69	-11.87	50.35
4.82	36.84	0.00	-1.03	-36.34	-4.64	51.86
5.00	36.84	0.00	-0.89	-31.15	1.60	52.13
5.19	36.84	0.00	-0.75	-26.12	6.91	51.33
5.37	36.84	0.00	-0.62	-21.52	11.32	49.63
5.56	92.83	0.00	-0.49	-45.17	17.82	46.91

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Depth [m]	kh,p [MN/m3]	kh,z [MN/m3]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
5.74	92.83	0.00	-0.36	-33.51	25.11	42.90
5.93	92.83	0.00	-0.24	-22.18	30.26	37.74
6.11	92.83	0.00	-0.12	-11.14	33.34	31.82
6.30	92.83	0.00	-0.00	-0.35	34.40	25.51
6.48	0.00	92.83	0.11	10.25	33.48	19.19
6.67	0.00	92.83	0.22	20.70	30.62	13.22
6.85	0.00	92.83	0.33	31.05	25.82	7.97
7.04	0.00	92.83	0.45	41.34	19.12	3.78
7.22	0.00	92.83	0.56	51.59	10.51	1.00
7.41	0.00	92.83	0.67	61.84	-0.00	0.00

Maximum shear force = 59,16 kN/m
Maximum moment = 52,13 kNm/m
Maximum displacement = 5,2 mm
Displacement in the depth of slip surface = 2,4 mm

Verification of rock bearing capacity

Bearing capacity of rock R = 3000,00 kPa
Partial factor on rock bearing capacity γ_{Rr} = 1,40
Max. stress σ = 123,69 kPa
Design bearing capacity of rock R_d = 2142,86 kPa

Bearing capacity of rock is SATISFACTORY

Anchors forces

No.	Depth [m]	Displacement [mm]	Anchor force [kN]
1	1,15	-4,2	330,00

Terrain settlement behind the structure

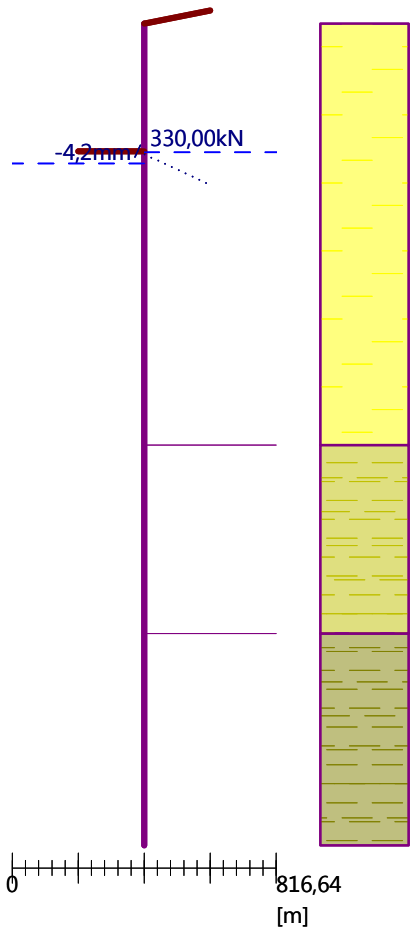
Terrain settlement δ_{max} = 3,3 mm

	Coordinate x [m]	Settlement z [mm]
1	0,00	2,2
2	0,62	3,2
3	1,24	3,9
4	1,86	4,3
5	2,47	4,5
6	3,09	4,4
7	3,71	4,0
8	4,33	3,4
9	4,95	2,5
10	5,57	1,4
11	6,18	0,0
12	6,18	0,0

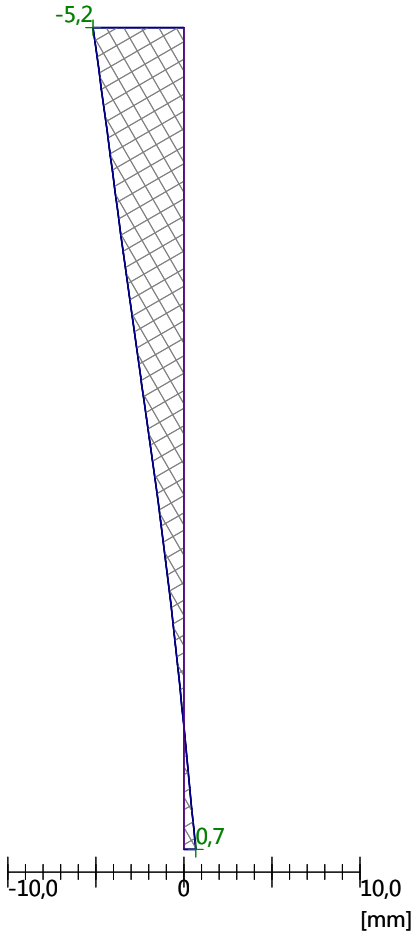
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Name : Analysis	Stage - analysis : 1 - -1

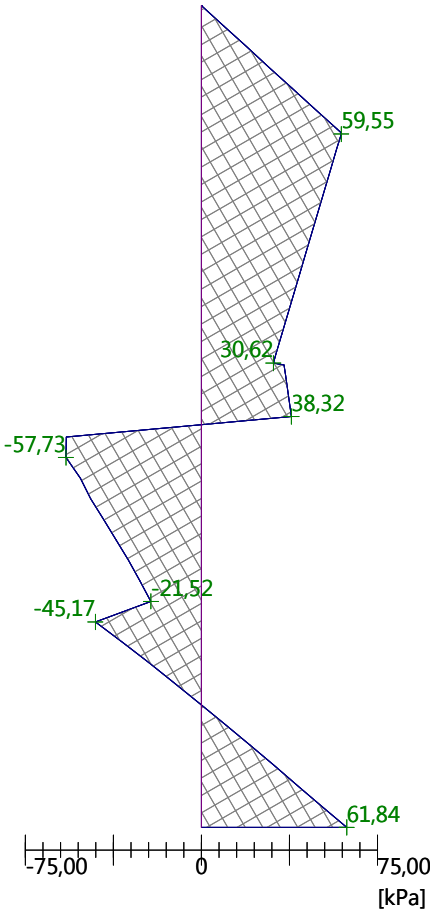
Geometry of structure
Length of structure = 7,41m



Displacement of structure
Max. disp. = 5,2 mm



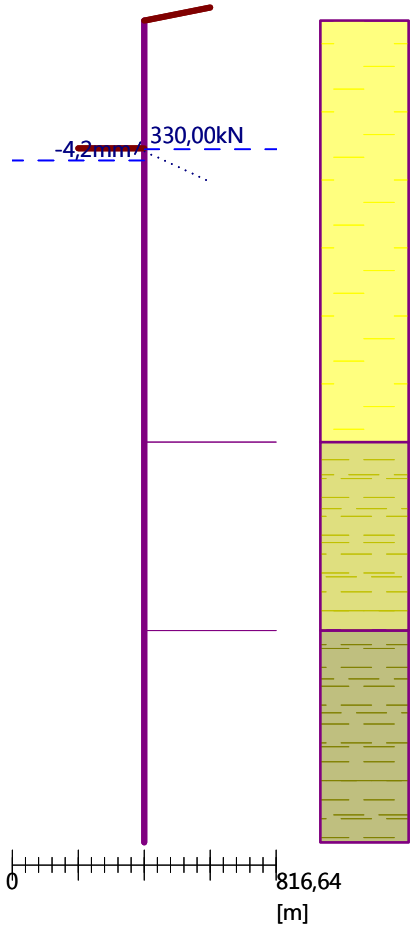
Pressure acting on structure
Max. pressure = 61,84 kPa



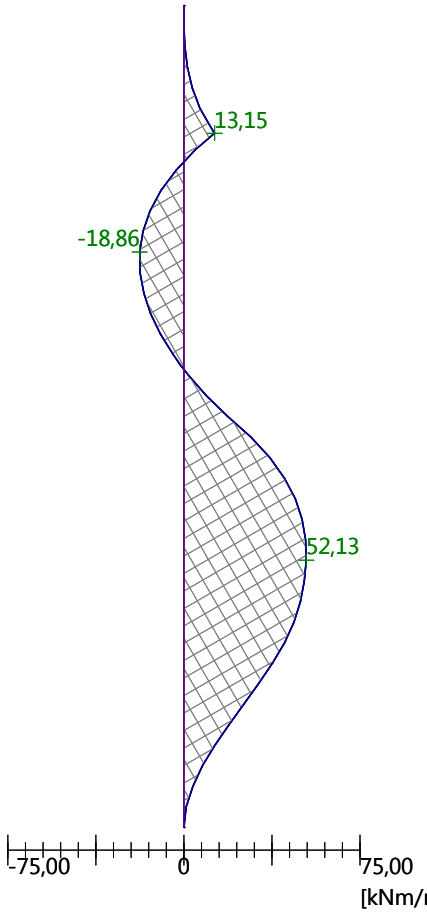
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Name : Analysis	Stage - analysis : 1 - -1

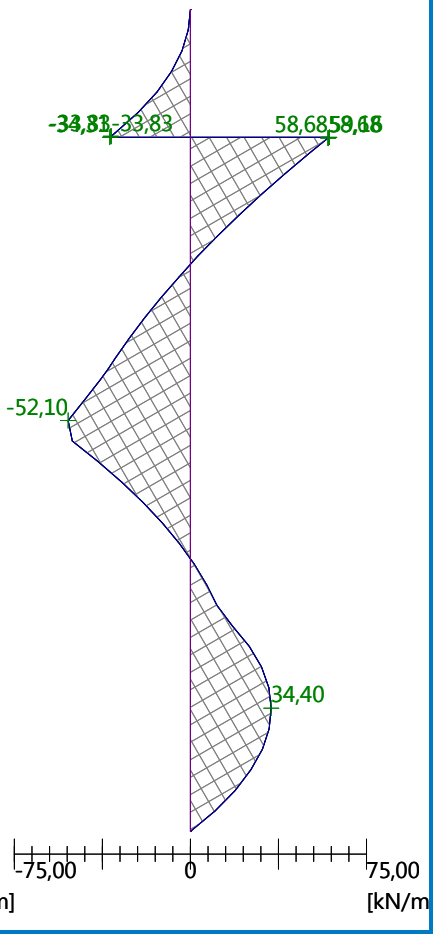
Geometry of structure
Length of structure = 7,41m



Bending moment
Max. M = 52,13 kNm/m

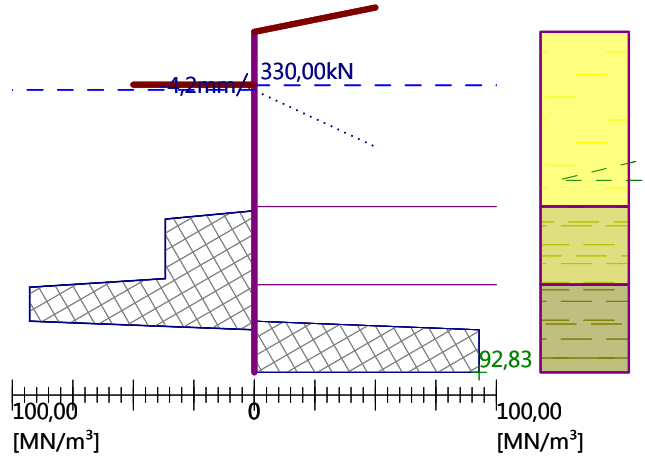


Shear force
Max. Q = 59,16 kN/m

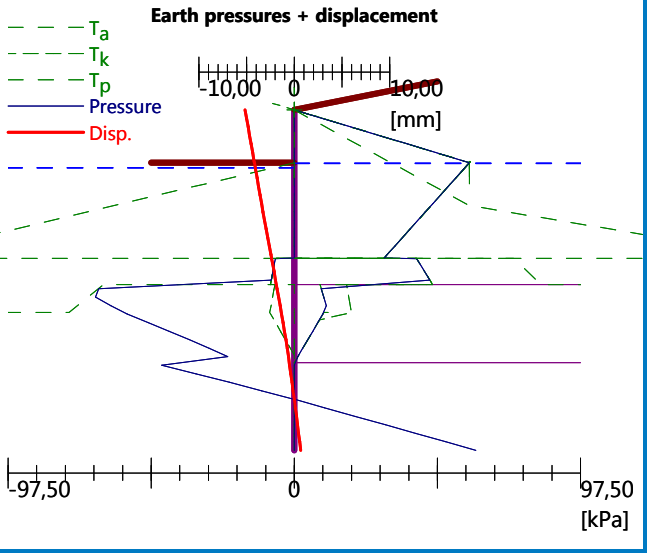


Name : Analysis	Stage - analysis : 1 - -1

Modulus of subsoil reaction
Length of structure = 7,41m



Earth pressures + displacement



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Dimensioning No. 1

	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
0.00	-5.16	-5.16	0.00	0.00	0.00	0.00
0.19	-5.00	-5.00	-0.89	-0.89	0.05	0.05
0.37	-4.85	-4.85	-3.56	-3.56	0.44	0.44
0.56	-4.69	-4.69	-8.01	-8.01	1.48	1.48
0.74	-4.53	-4.53	-14.24	-14.24	3.52	3.52
0.93	-4.37	-4.37	-22.26	-22.26	6.87	6.87
1.11	-4.22	-4.22	-32.05	-32.05	11.87	11.87
1.14	-4.19	-4.19	-33.83	-33.83	12.88	12.88
1.14	-4.19	-4.19	-33.83	-33.83	12.88	12.88
1.15	-4.18	-4.18	-34.31	-34.31	13.15	13.15
1.15	-4.18	-4.18	59.16	59.16	13.15	13.15
1.16	-4.18	-4.18	58.68	58.68	12.68	12.68
1.16	-4.18	-4.18	58.68	58.68	12.68	12.68
1.30	-4.06	-4.06	50.55	50.55	5.10	5.10
1.48	-3.90	-3.90	40.12	40.12	-3.29	-3.29
1.67	-3.75	-3.75	30.17	30.17	-9.79	-9.79
1.85	-3.59	-3.59	20.70	20.70	-14.49	-14.49
2.04	-3.44	-3.44	11.71	11.71	-17.49	-17.49
2.22	-3.28	-3.28	3.20	3.20	-18.86	-18.86
2.41	-3.12	-3.12	-4.83	-4.83	-18.70	-18.70
2.59	-2.95	-2.95	-12.38	-12.38	-17.10	-17.10
2.78	-2.79	-2.79	-19.44	-19.44	-14.15	-14.15
2.96	-2.63	-2.63	-26.03	-26.03	-9.93	-9.93
3.15	-2.46	-2.46	-32.14	-32.14	-4.53	-4.53
3.22	-2.39	-2.39	-34.47	-34.47	-2.04	-2.04
3.24	-2.38	-2.38	-34.99	-34.99	-1.48	-1.48
3.33	-2.29	-2.29	-38.35	-38.35	1.98	1.98
3.52	-2.13	-2.13	-45.11	-45.11	9.71	9.71
3.71	-1.96	-1.96	-52.10	-52.10	18.71	18.71
3.89	-1.80	-1.80	-50.32	-50.32	28.47	28.47
4.08	-1.64	-1.64	-39.37	-39.37	36.51	36.51
4.26	-1.48	-1.48	-29.25	-29.25	42.84	42.84
4.45	-1.33	-1.33	-20.10	-20.10	47.40	47.40
4.63	-1.18	-1.18	-11.87	-11.87	50.35	50.35
4.82	-1.03	-1.03	-4.64	-4.64	51.86	51.86
5.00	-0.89	-0.89	1.60	1.60	52.13	52.13
5.19	-0.75	-0.75	6.91	6.91	51.33	51.33
5.37	-0.62	-0.62	11.32	11.32	49.63	49.63
5.56	-0.49	-0.49	17.82	17.82	46.91	46.91
5.74	-0.36	-0.36	25.11	25.11	42.90	42.90
5.93	-0.24	-0.24	30.26	30.26	37.74	37.74
6.11	-0.12	-0.12	33.34	33.34	31.82	31.82
6.30	-0.00	-0.00	34.40	34.40	25.51	25.51
6.48	0.11	0.11	33.48	33.48	19.19	19.19
6.67	0.22	0.22	30.62	30.62	13.22	13.22
6.85	0.33	0.33	25.82	25.82	7.97	7.97

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	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
7.04	0.45	0.45	19.12	19.12	3.78	3.78
7.22	0.56	0.56	10.51	10.51	1.00	1.00
7.41	0.67	0.67	-0.00	-0.00	0.00	0.00

Maximum values of internal forces

Maximum displacement = -5,2 mm
Minimum displacement = 0,7 mm
Maximum bending moment = 52,13 kNm/m
Minimum bending moment = -18,86 kNm/m
Maximum shear force = 59,16 kN/m

Verification of RC cross section (Pile curtain d = 0,80 m; a = 1,60 m)

All construction stages are taken into the analysis.
Reduct. coefficient of bearing capacity = 1,00

Verification of cross section in bending:

Reinforcement - 12 pc bars 20,0 mm; cover 80,0 mm
Type of structure (reinforcement ratio) : beam
Reinforcement ratio ρ = 0,375 % > 0,151 % = ρ_{min}
Load : M_{Ed} = 83,41 kNm
Bearing capacity : M_{Rd} = 500,27 kNm
Designed pile reinforcement is SATISFACTORY

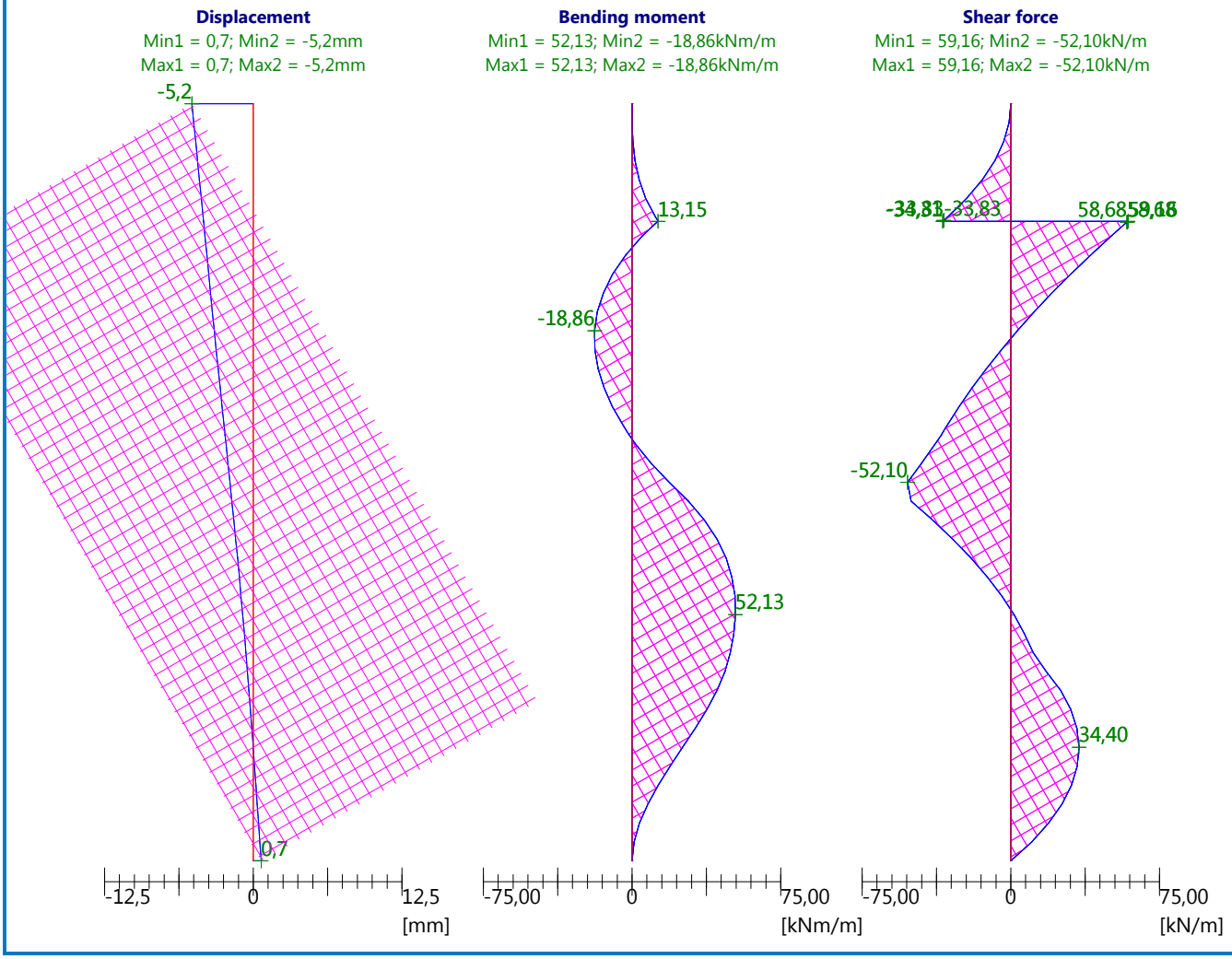
Verification of cross section in shear:

Shear reinf. - profile 10,0 mm; spacing 250,0 mm
A_{sw} = 628,3 mm^2
Ultimate shear force: V_{Rd} = 393,38 kN > 94,65 kN = V_{Ed}
Cross-section is SATISFACTORY.
only minimal shear reinforcement

Overall verification: Cross-section is SATISFACTORY

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Name : Dimensioning	Stage - analysis : 1 - 1



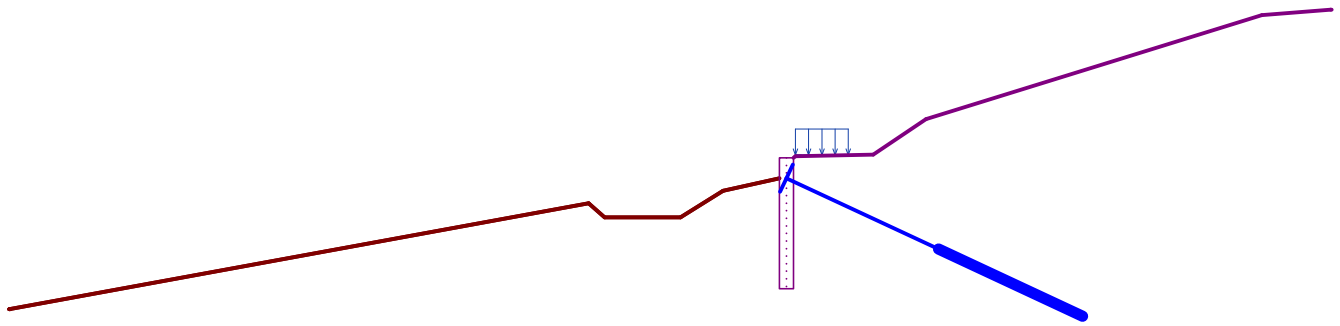
Verification of anchors

Anchor with max. utilization - Nr. 1.
Utilization is 95,83 %
Anchors bearing capacity is SATISFACTORY

No.	Depth z [m]	Max. force F [kN]	Anchor strength R_t [kN]	Pull-out res. (soil) R_e [kN]	Pull-out res. (grouting) R_c [kN]	Verification
1	1,15	330,00	788,89	344,36	755,90	is satisfied

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Name : Anchors Verification	Stage - analysis : 1 - -1



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