

Analysis of anti-slide pile

Input data

Project

Task : Zemeljski plaz pod hišo Fošt 19
 Description : Zagatna stena (h=5.0 m)
 Customer : Občina Oplotnica
 Author : GEOING d.o.o.
 Date : 11/03/2026

Settings

(input for current task)

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 : $\gamma_{M0} = 1,00$

Pressure analysis

Active earth pressure calculation : Coulomb
 Passive earth pressure calculation : Caquot-Kerisel
 Earthquake analysis : Mononobe-Okabe
 Modulus of subsoil reaction : standard
 Consider reduction of the modulus of subsoil reaction for a braced sheeting
 Verification methodology : Safety factors (ASD)

Anchors

Verification methodology : Limit states (LSD)

Reduction coefficients			
Reduction. coeff of steel strength :	$\gamma_s =$	1,35	[-]
Reduction coefficient of pull out resistance (soil) :	$\gamma_e =$	1,35	[-]
Reduction coefficient of pull out resistance (grouting) :	$\gamma_c =$	1,35	[-]

Geometry of structure

Structure length = 5,00 m

Cross-section name : I-section : I(IPN) 200; a = 1,00 m
 Computed coefficient of pressure reduction below the ditch = 0,64
 Area of cross-section A = 3,34E-03 m²/m
 Moment of inertia I = 2,14E-05 m⁴/m
 Elastic modulus E = 210000,00 MPa
 Shear modulus G = 81000,00 MPa
 Sectional modulus W = 2,132E-04 m³/m
 Plastic sectional modulus $W_{pl} = 2,481E-04$ m³/m

Forces above the slip surface

Depth of slip surface $h_{s1} = 3,50$ m

Input of active horizontal force : residual active force
 Input of passive horizontal force : residual passive force

Active horizontal force T = 0,00 kN/m
 Passive horizontal force P = 0,00 kN/m

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

Material of structure

Structural steel: EN 10025 : Fe 360

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Yield strength $f_y = 235,00 \text{ MPa}$
 Elasticity modulus $E = 210000,00 \text{ MPa}$
 Shear modulus $G = 81000,00 \text{ MPa}$

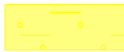
Modulus of reaction

Modulus of subsoil reaction is computed by method Schmitt.

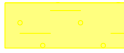
Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Glina		23,00	0,00	19,00	9,00	21,00
2	Preperina		28,00	10,00	21,00	11,00	28,00
3	Hribina		34,00	30,00	22,00	12,00	34,00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [-]	OCR [-]	K_r [-]
1	Glina		cohesive	-	0,40	-	-
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	2,00	-
2	Preperina		0,25	25,00	-
3	Hribina		0,20	50,00	-

Soil parameters**Glina**

Unit weight : $\gamma = 19,00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 23,00^\circ$
 Cohesion of soil : $c_{ef} = 0,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 21,00^\circ$
 Soil : cohesive
 Poisson's ratio : $\nu = 0,40$
 Oedometric modulus : $E_{oed} = 2,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 19,00 \text{ kN/m}^3$

Preperina

Unit weight : $\gamma = 21,00 \text{ kN/m}^3$
 Stress-state : effective

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Angle of internal friction : $\varphi_{ef} = 28,00^\circ$
 Cohesion of soil : $c_{ef} = 10,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 28,00^\circ$
 Soil : cohesive
 Poisson's ratio : $\nu = 0,25$
 Oedometric modulus : $E_{oed} = 25,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 21,00 \text{ kN/m}^3$

Hribina

Unit weight : $\gamma = 22,00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 34,00^\circ$
 Cohesion of soil : $c_{ef} = 30,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 34,00^\circ$
 Soil : cohesive
 Poisson's ratio : $\nu = 0,20$
 Oedometric modulus : $E_{oed} = 50,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 22,00 \text{ kN/m}^3$

Pile fixed into the rock

Length of wall in the rock $l = 1,00 \text{ m}$
 Bearing capacity of rock $R = 2000,00 \text{ kPa}$

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3,90	0,00 .. 3,90	Glina	
2	0,30	3,90 .. 4,20	Preperina	
3	-	4,20 .. ∞	Hribina	

Excavation

Soil in front of wall is excavated to a depth of 2,20 m.
 Soil slope in front of structure $\beta = -23,00^\circ$

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		permanent	11,00		0,50	4,00	on terrain

Global settings

Number of FEs to discretize wall = 40
 Minimum dimensioning pressure is considered as $\sigma_{a,min} = 0,20\sigma_z$

Settings of the stage of construction

Design situation : permanent

Analysis results

Pressure above the slip surface

Depth [m]	Passive pressure [kPa]	Active pressure [kPa]
0	0,00	0,00
2,20	0,00	0,00
2,20	0,00	0,00
3,50	0,00	0,00

Distribution of pressures acting on the structure (in front and behind the wall) - above slip surface

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	0.00	0.00	0.00
0.21	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.91	0.00	0.00	0.00	0.00	0.00	0.00
1.14	0.00	0.00	0.00	0.00	0.00	0.00
1.36	0.00	0.00	0.00	0.00	0.00	0.00
1.59	0.00	0.00	0.00	0.00	0.00	0.00
1.82	0.00	0.00	0.00	0.00	0.00	0.00
2.05	0.00	0.00	0.00	0.00	0.00	0.00
2.20	0.00	0.00	0.00	0.00	0.00	0.00
2.20	0.00	0.00	0.00	0.00	0.00	0.00
2.27	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.00	0.00	0.00	0.00	0.00	0.00
2.73	0.00	0.00	0.00	0.00	0.00	0.00
2.95	0.00	0.00	0.00	0.00	0.00	0.00
3.18	0.00	0.00	0.00	0.00	0.00	0.00
3.41	0.00	0.00	0.00	0.00	0.00	0.00
3.50	0.00	0.00	0.00	0.00	0.00	0.00

Distribution of pressures acting on the structure (in front and behind the wall) - below the slip surface

Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
3.50	-4.28	-8.39	-22.53	17.35	28.15	146.33
3.64	-4.73	-9.27	-24.89	17.92	31.03	152.02
3.86	-5.47	-10.74	-28.83	18.88	32.70	161.53
3.90	-5.59	-10.97	-29.46	19.03	32.97	163.05
3.90	0.00	-5.56	-61.58	9.56	17.29	257.79
3.94	0.00	-3.18	-62.81	5.47	9.89	260.59
4.00	0.00	0.00	-64.45	0.00	0.00	264.34
4.00	Rock	Rock	Rock	Rock	Rock	Rock
4.09	Rock	Rock	Rock	Rock	Rock	Rock
4.20	Rock	Rock	Rock	Rock	Rock	Rock
4.20	Rock	Rock	Rock	Rock	Rock	Rock
4.32	Rock	Rock	Rock	Rock	Rock	Rock

Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
4.55	Rock	Rock	Rock	Rock	Rock	Rock
4.77	Rock	Rock	Rock	Rock	Rock	Rock
5.00	Rock	Rock	Rock	Rock	Rock	Rock

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

Depth [m]	kh,p [MN/m ³]	kh,z [MN/m ³]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
0.00	0.00	0.00	-4.38	0.00	-0.00	-0.00
0.25	0.00	0.00	-4.13	0.00	-0.00	0.00
0.50	0.00	0.00	-3.88	0.00	-0.00	0.00
0.75	0.00	0.00	-3.64	0.00	-0.00	0.00
1.00	0.00	0.00	-3.39	0.00	0.00	-0.00
1.25	0.00	0.00	-3.14	0.00	-0.00	-0.00
1.50	0.00	0.00	-2.90	0.00	0.00	-0.00
1.75	0.00	0.00	-2.65	0.00	-0.00	-0.00
2.00	0.00	0.00	-2.40	0.00	-0.00	0.00
2.20	0.00	0.00	-2.21	0.00	0.00	-0.00
2.20	0.00	0.00	-2.20	0.00	-0.00	0.00
2.25	0.00	0.00	-2.15	0.00	-0.00	0.00
2.50	0.00	0.00	-1.91	0.00	-0.00	0.00
2.75	0.00	0.00	-1.66	0.00	-0.00	0.00
3.00	0.00	0.00	-1.41	0.00	-0.00	0.00
3.25	0.00	0.00	-1.17	0.00	-0.00	0.00
3.50	0.00	0.00	-0.93	0.00	-0.00	0.00
3.50	2.04	2.04	-0.92	17.91	-0.03	-0.00
3.75	2.04	2.04	-0.68	19.11	-4.58	0.56
4.00	59.07	0.00	-0.44	-25.92	-6.42	2.16
4.25	148.85	0.00	-0.23	-34.46	0.05	2.99
4.50	148.85	0.00	-0.06	-9.47	5.43	2.17
4.75	0.00	148.85	0.07	11.12	5.16	0.74
5.00	0.00	148.85	0.20	30.05	0.00	0.00

Maximum shear force = 7,01 kN/m
 Maximum moment = 2,99 kNm/m
 Maximum displacement = 4,4 mm
 Displacement in the depth of slip surface = 0,9 mm

Verification of rock bearing capacity

Max. stress $\sigma = 382,87$ kPa

Design bearing capacity of rock $R_d = 2000,00$ kPa

Safety factor = 5,22 > 1,00

Bearing capacity of rock is SATISFACTORY

Terrain settlement behind the structure

Terrain settlement $\delta_{\max} = 2,8$ mm

	Coordinate x [m]	Settlement z [mm]
1	0,00	2,1
2	0,45	2,9

	Coordinate x [m]	Settlement z [mm]
3	0,91	3,5
4	1,36	3,8
5	1,82	3,9
6	2,27	3,8
7	2,73	3,5
8	3,18	3,0
9	3,64	2,2
10	4,09	1,2
11	4,55	0,0
12	4,55	0,0

Name : Analysis

Stage - analysis : 1 - -1

Geometry of structure

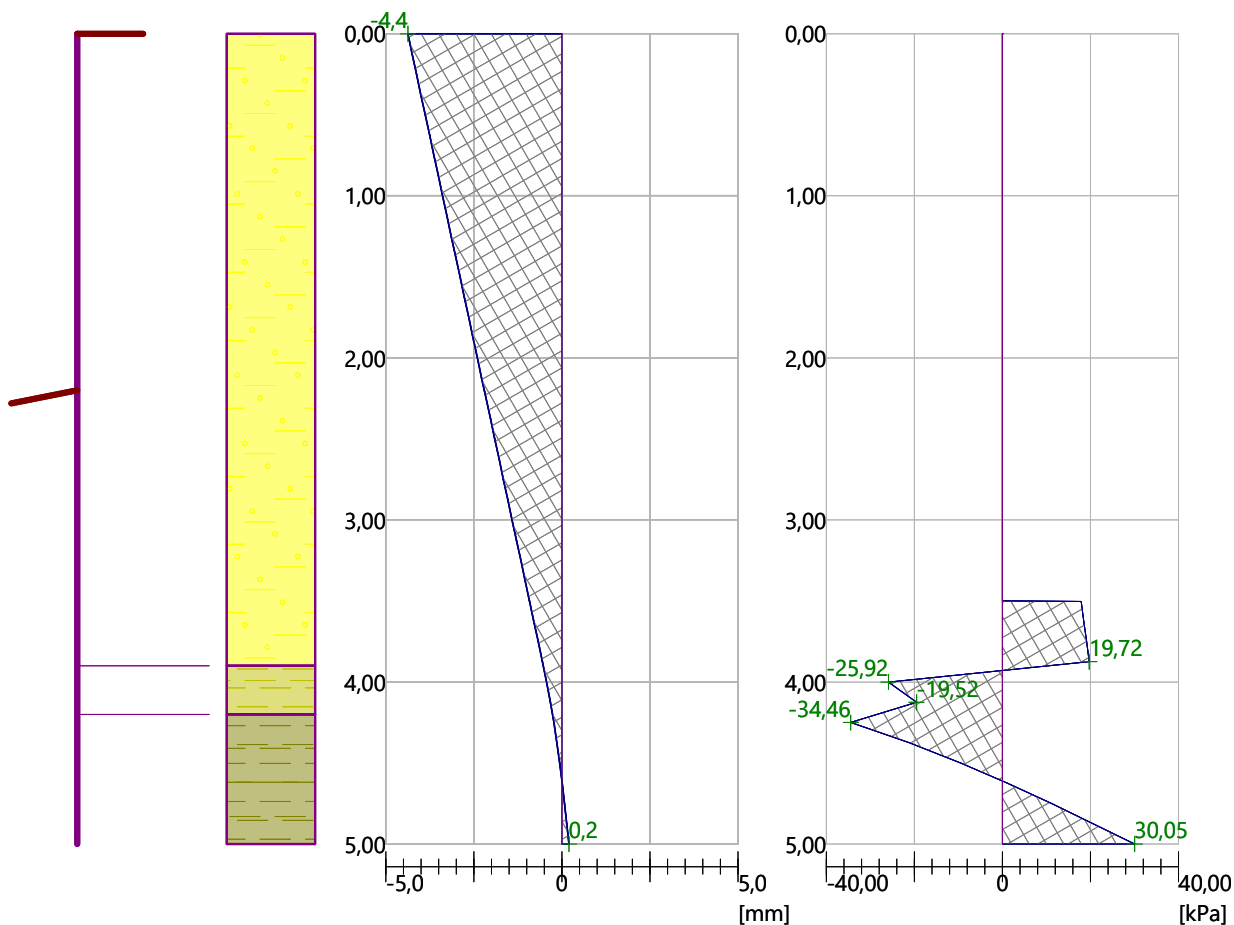
Length of structure = 5,00m

Displacement of structure

Max. disp. = 4,4 mm

Pressure acting on structure

Max. pressure = 34,46 kPa

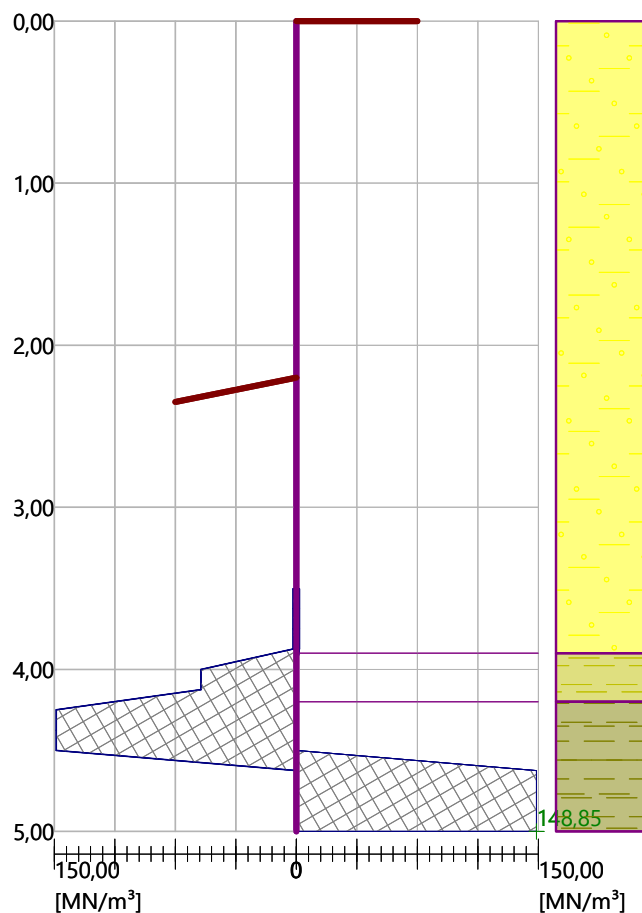


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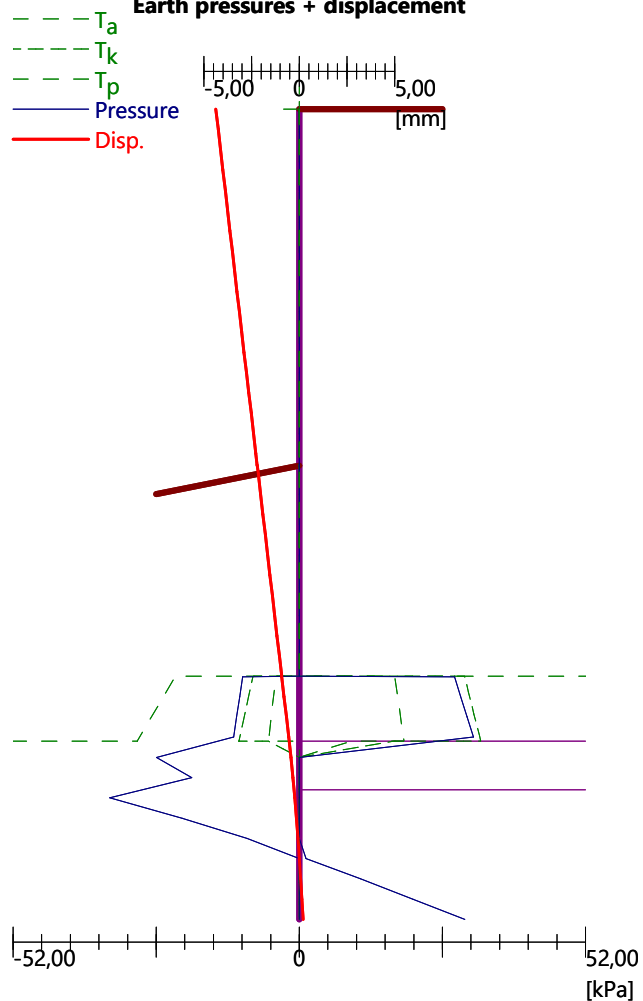
Stage - analysis : 1 - -1

Modulus of subsoil reaction

Length of structure = 5,00m



Earth pressures + displacement

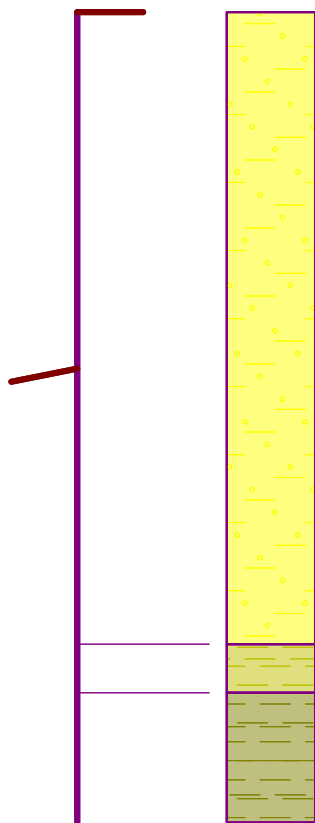


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Stage - analysis : 1 - -1

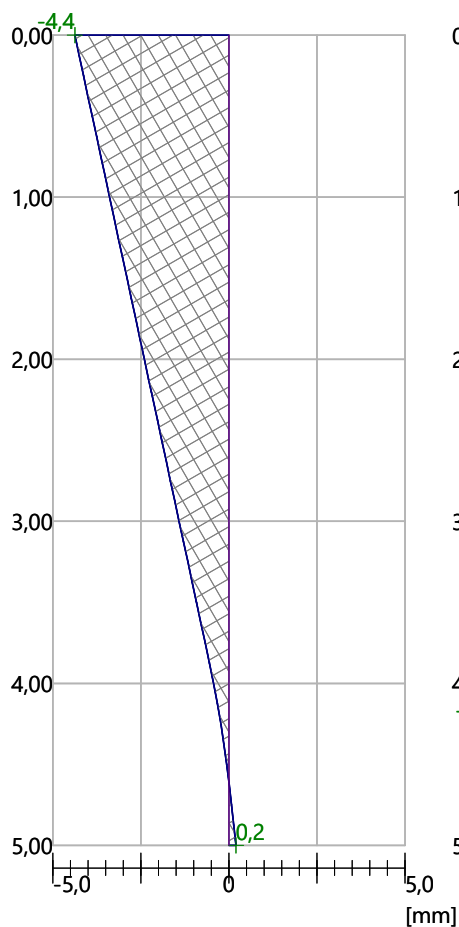
Geometry of structure

Length of structure = 5,00m



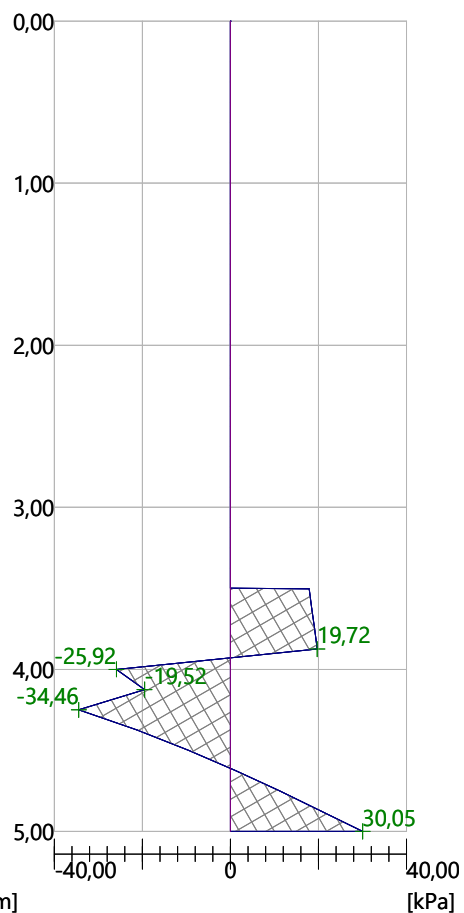
Displacement of structure

Max. disp. = 4,4 mm



Pressure acting on structure

Max. pressure = 34,46 kPa

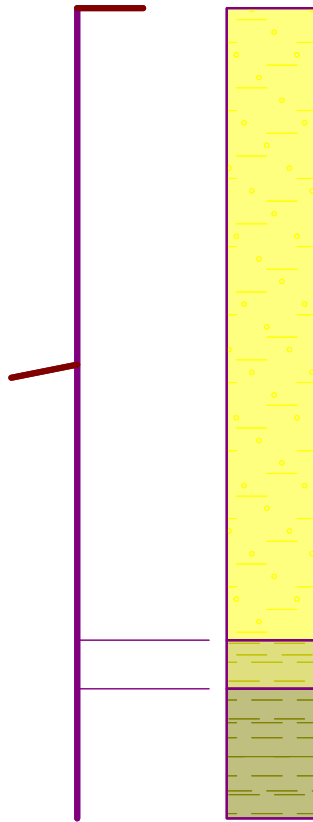


Name : Analysis

Stage - analysis : 1 - -1

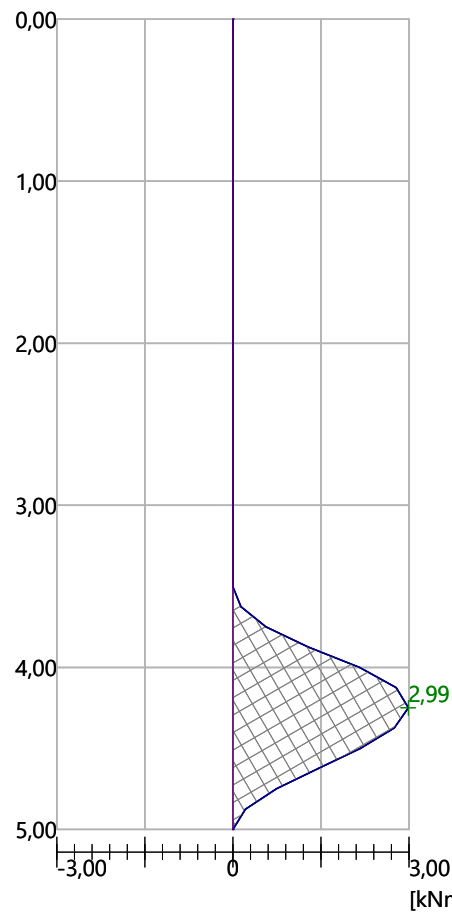
Geometry of structure

Length of structure = 5,00m



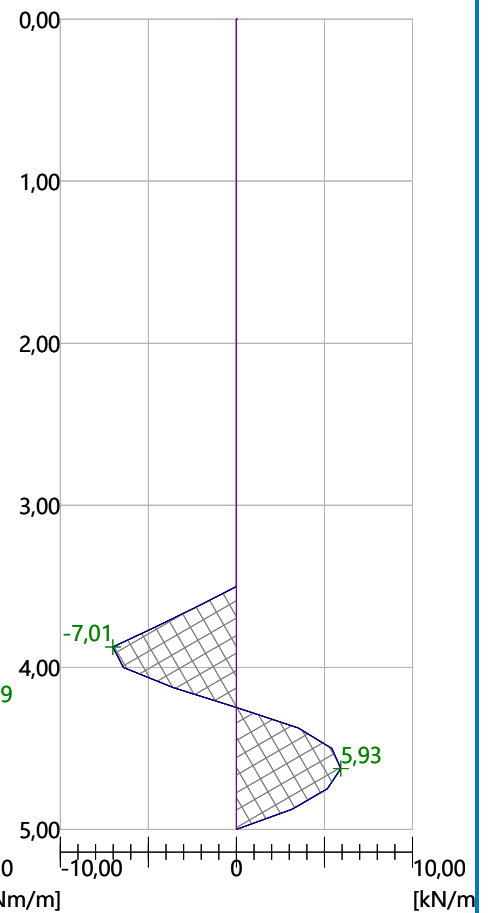
Bending moment

Max. M = 2,99 kNm/m



Shear force

Max. Q = 7,01 kN/m

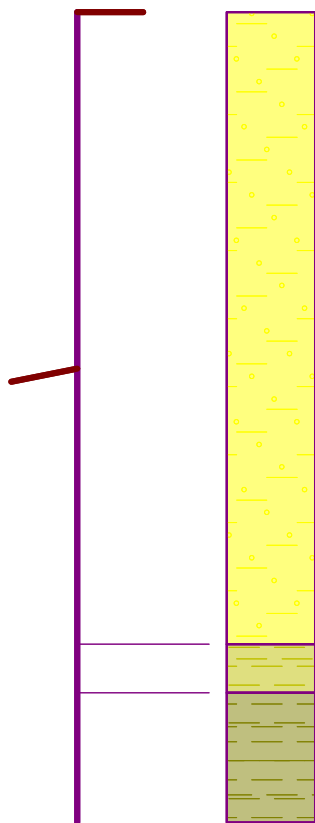


Name : Analysis

Stage - analysis : 1 - -1

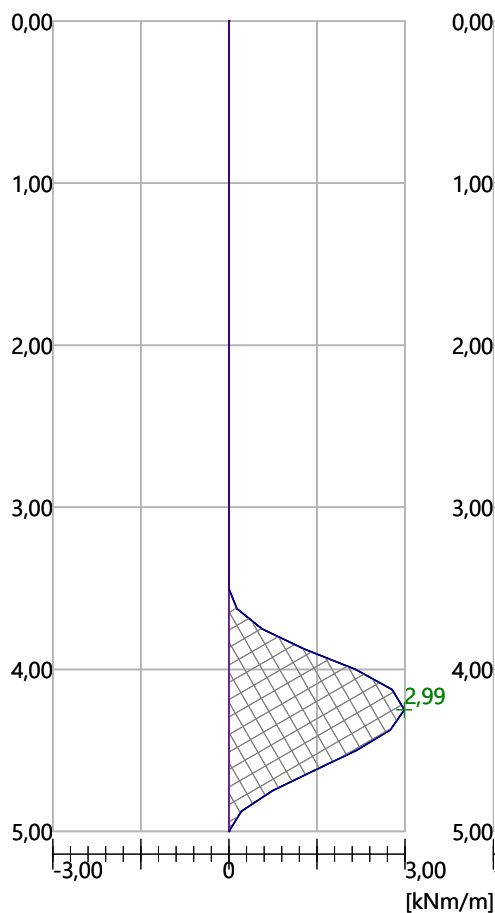
Geometry of structure

Length of structure = 5,00m



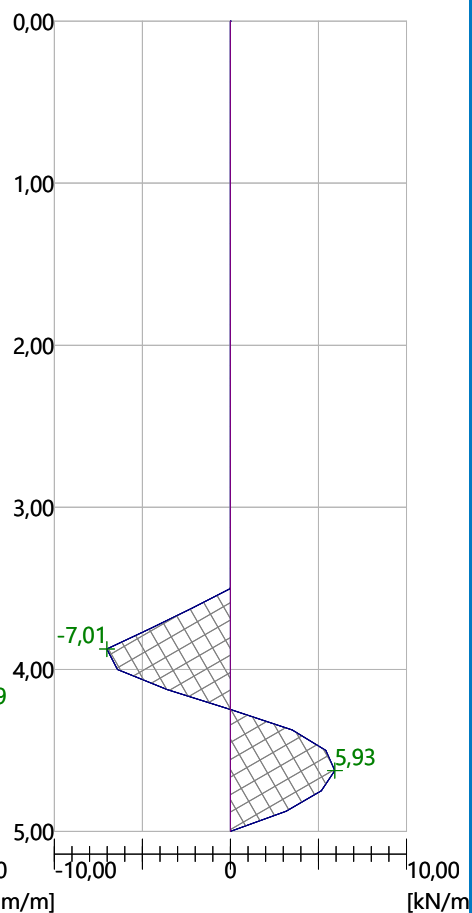
Bending moment

Max. M = 2,99 kNm/m

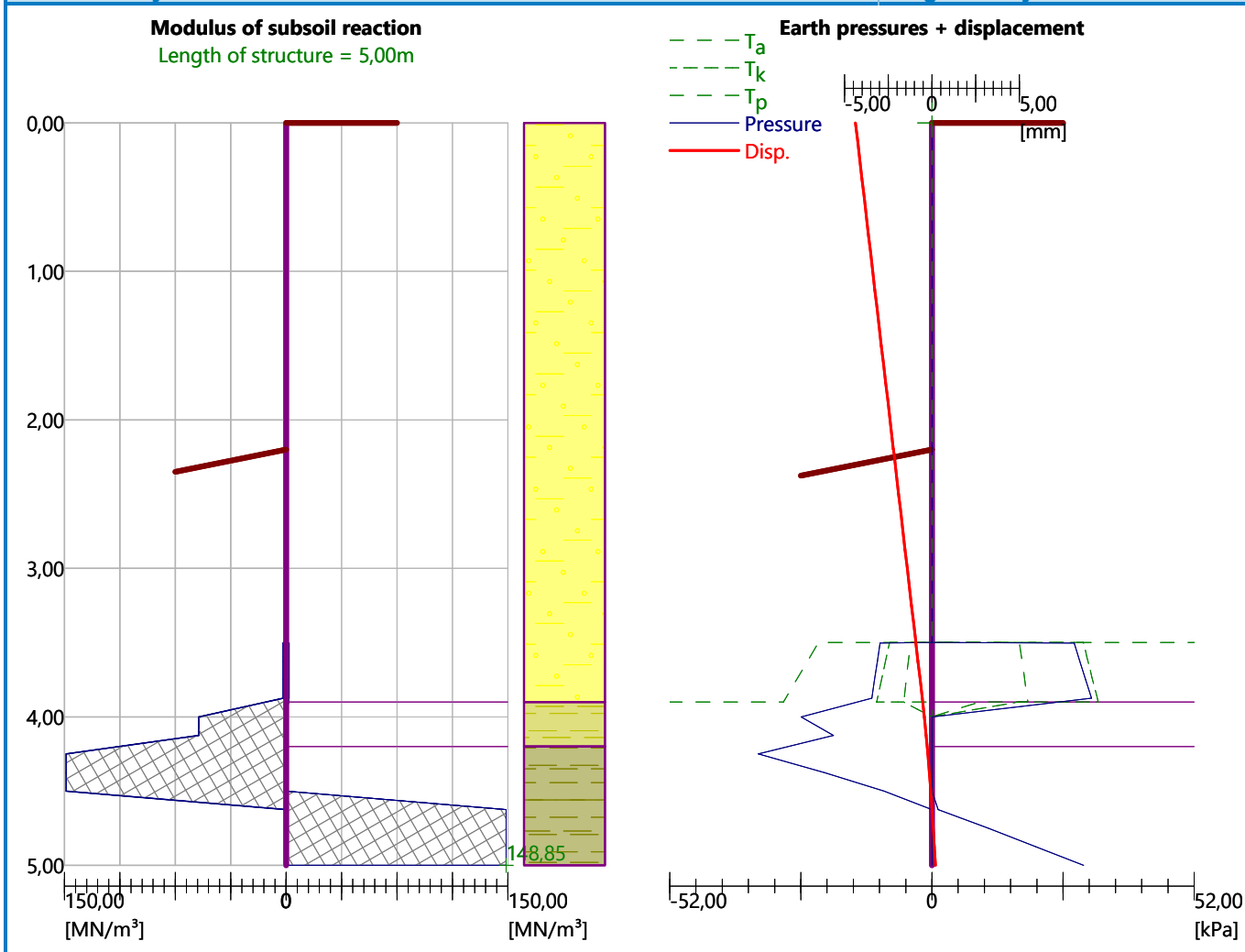


Shear force

Max. Q = 7,01 kN/m



Stage - analysis : 1 - -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	-4.38	-4.38	-0.00	-0.00	-0.00	-0.00
0.25	-4.13	-4.13	-0.00	-0.00	0.00	0.00
0.50	-3.88	-3.88	-0.00	-0.00	0.00	0.00
0.75	-3.64	-3.64	-0.00	-0.00	0.00	0.00
1.00	-3.39	-3.39	0.00	0.00	-0.00	-0.00
1.25	-3.14	-3.14	-0.00	-0.00	-0.00	-0.00
1.50	-2.90	-2.90	0.00	0.00	-0.00	-0.00
1.75	-2.65	-2.65	-0.00	-0.00	-0.00	-0.00
2.00	-2.40	-2.40	-0.00	-0.00	0.00	0.00
2.20	-2.21	-2.21	0.00	0.00	-0.00	-0.00
2.20	-2.20	-2.20	-0.00	-0.00	0.00	0.00
2.25	-2.15	-2.15	-0.00	-0.00	0.00	0.00
2.50	-1.91	-1.91	-0.00	-0.00	0.00	0.00
2.75	-1.66	-1.66	-0.00	-0.00	0.00	0.00
3.00	-1.41	-1.41	-0.00	-0.00	0.00	0.00
3.25	-1.17	-1.17	-0.00	-0.00	0.00	0.00

	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
3.50	-0.93	-0.93	-0.00	-0.00	0.00	0.00
3.50	-0.92	-0.92	-0.03	-0.03	-0.00	-0.00
3.75	-0.68	-0.68	-4.58	-4.58	0.56	0.56
4.00	-0.44	-0.44	-6.42	-6.42	2.16	2.16
4.25	-0.23	-0.23	0.05	0.05	2.99	2.99
4.50	-0.06	-0.06	5.43	5.43	2.17	2.17
4.75	0.07	0.07	5.16	5.16	0.74	0.74
5.00	0.20	0.20	0.00	0.00	0.00	0.00

Maximum values of internal forces

Maximum displacement = -4,4 mm
 Minimum displacement = 0,2 mm
 Maximum bending moment = 2,99 kNm/m
 Minimum bending moment = 0,00 kNm/m
 Maximum shear force = 7,01 kN/m

Verification of steel section according to EN 1993-1-1

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

Internal forces per 1 I-section

$M_{\max} = 2,99 \text{ kNm}; \quad Q = 0,05 \text{ kN}$
 $Q_{\max} = 7,01 \text{ kN}; \quad M = 1,28 \text{ kNm}$

Verification of max. moment $M_{\max} + Q$:

Verification of bending:

$M_{\max}/M_{c,Rd} = 0,060 \leq 1$ **Is satisfactory**

Verification of shear:

$Q/V_{c,Rd} = 0,000 \leq 1$ **Is satisfactory**

Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 12,38 \text{ MPa}$

Shear stress $\tau_{Ed} = 0,03 \text{ MPa}$

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,003 \leq 1$ **Is satisfactory**

Verification of max. shear force $Q_{\max} + M$:

Verification of bending:

$M/M_{c,Rd} = 0,026 \leq 1$ **Is satisfactory**

Verification of shear:

$Q_{\max}/V_{c,Rd} = 0,040 \leq 1$ **Is satisfactory**

Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 5,32 \text{ MPa}$

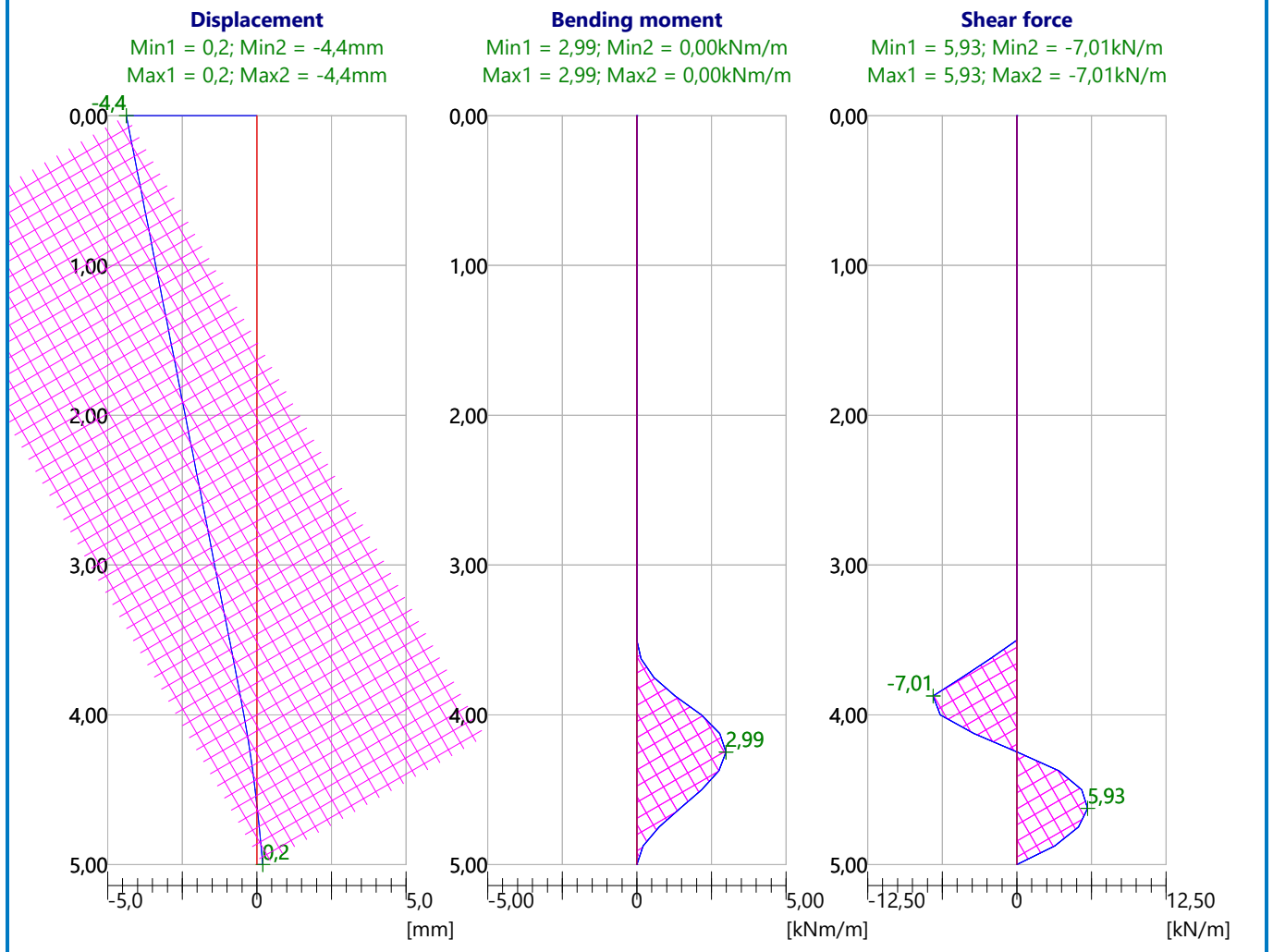
Shear stress $\tau_{Ed} = 4,19 \text{ MPa}$

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,001 \leq 1$ **Is satisfactory**

Cross section is SATISFACTORY

Name : Dimensioning

Stage - analysis : 1 - 1



Name : Dimensioning

Stage - analysis : 1 - 1

