

Sheeting structure verification

Input data (Stage of construction 1)

Settings

(input for current task)

Materials and standards

Concrete structures :	EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 :	standard
Circle pile shear :	simplified method
Steel structures :	EN 1993-1-1 (EC3)
Partial factor on bearing capacity of steel cross section :	$\gamma_{M0} = 1,00$
Timber structures :	EN 1995-1-1 (EC5)
Partial factor for timber property :	$\gamma_M = 1,30$
Modif. factor of load duration and moisture content :	$k_{mod} = 0,50$
Coeff. of effective width for shear stress :	$k_{cr} = 0,67$

Pressure analysis

Verification methodology :	according to EN 1997
Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Caquot-Kerisel
Analysis method :	dependent pressures
Earthquake analysis :	Mononobe-Okabe
Modulus of subsoil reaction :	standard
Consider reduction of the modulus of subsoil reaction for a braced sheeting	
Design approach :	2 - reduction of actions and resistances

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

Partial factors for resistances (R)			
Permanent design situation			
Reduction coeff. of internal stability of anchors :	$\gamma_{Ris} =$	1,30 [-]	
Partial factor on earth resistance :	$\gamma_{Re} =$	1,40 [-]	

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	$\psi_0 =$	0,70 [-]	
Factor for frequent value :	$\psi_1 =$	0,50 [-]	
Factor for quasi-permanent value :	$\psi_2 =$	0,30 [-]	

Anchors

Verification methodology : Limit states (LSD)

Reduction coefficients			
Reduction. coeff of steel strength :	$\gamma_s =$	1,10 [-]	
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 = 12,00 m

Cross-section name : Sheet pile : LARSEN 604 n

Area of cross-section $A = 1,57E-02 \text{ m}^2/\text{m}$

Moment of inertia $I = 3,04E-04 \text{ m}^4/\text{m}$

Sectional modulus $W = 1,600E-03 \text{ m}^3/\text{m}$

Plastic sectional modulus $W_{pl} = 1,862E-03 \text{ m}^3/\text{m}$

Material of structure

Structural steel: EN 10248-1 : S 240 GP

Yield strength $f_y = 240,00 \text{ MPa}$


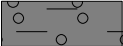

Elasticity modulus $E = 210000,00 \text{ MPa}$

Shear modulus $G = 81000,00 \text{ MPa}$


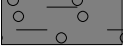
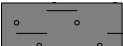
Modulus of reaction

Modulus of subsoil reaction is computed by method Schmitt.


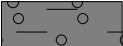

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Glina		16,20	2,80	18,00	10,00	11,00
2	Zameljen prod		34,00	1,00	19,00	11,00	22,50
3	Siva zbita peščena		30,00	8,00	19,00	11,00	20,00

Soil parameters to compute pressure at rest

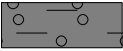

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [-]	OCR [-]	K_r [-]
1	Glina		cohesive	-	0,30	-	-
2	Zameljen prod		cohesionless	34,00	-	-	-
3	Siva zbita peščena		cohesive	-	0,30	-	-

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

No.	Name	Pattern	ν [-]	E_{oed} [MPa]	E_{def} [MPa]
1	Glina		0,30	-	5,00
2	Zameljen prod		0,30	-	15,00
3	Siva zbita peščena		0,30	-	18,00

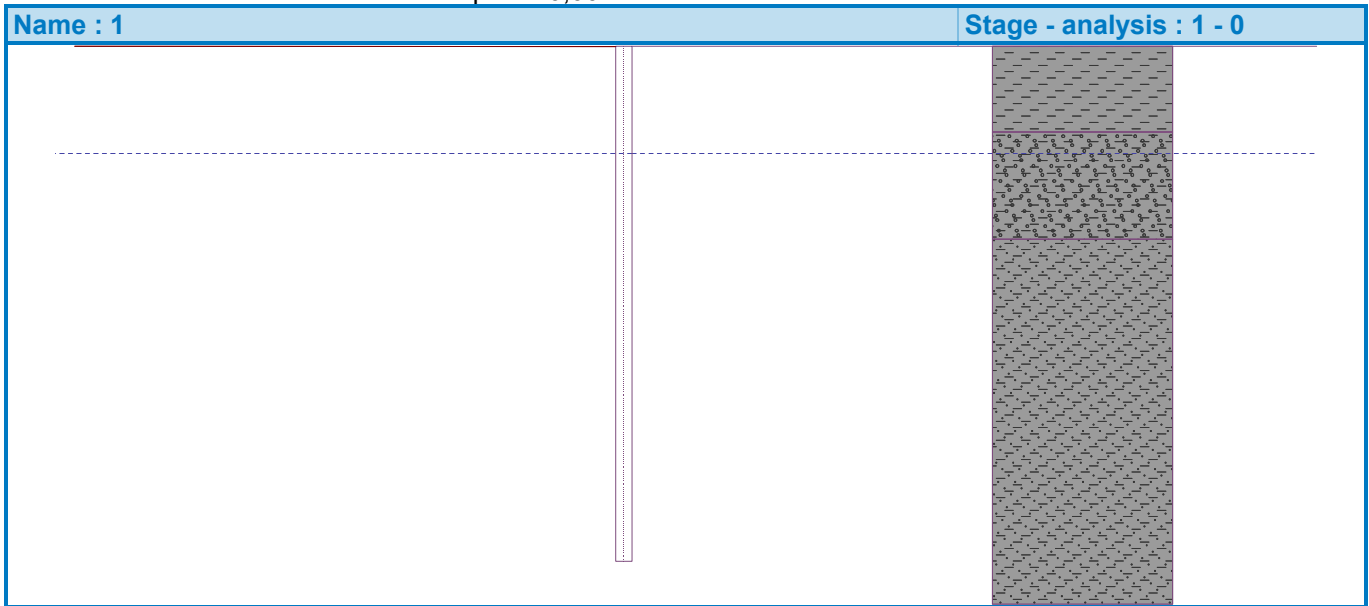
Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2,00	0,00 .. 2,00	Glina	

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
2	2,50	2,00 .. 4,50	Zameljen prod	
3	-	4,50 .. ∞	Siva zbita peščena	

Excavation

Soil in front of wall is excavated to a depth of 0,00 m.



Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 2,50 m

GWT in front of the structure lies at a depth of 2,50 m

Subgrade at the heel is permeable.

Hydraulic gradient = 0,00

Global settings

Number of FEs to discretize wall = 100

Analysis of depending pressures : reduce according to analysis settings

Minimum pressure is considered as $\sigma_{a,min} = 0,20\sigma_z$

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 1)

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
0.01	0.00	0.00	-5.90	0.04	0.08	6.18
0.40	0.00	-3.04	-17.13	1.45	3.12	17.41
0.41	0.00	-3.12	-17.41	1.57	3.22	17.70
2.00	-15.35	-15.35	-62.61	19.32	19.32	62.89
2.00	-10.23	-15.79	-184.95	10.29	15.87	185.86
2.50	-13.25	-19.98	-233.03	13.30	20.06	233.94

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
4.50	-20.22	-29.68	-344.37	20.28	29.75	345.29
4.50	-15.44	-28.85	-272.58	15.51	28.93	273.24
12.00	-46.55	-64.21	-575.83	46.62	64.29	576.49

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	-0.08	0.00	0.00	-0.00
0.01	6.68	0.00	-0.08	-0.53	0.00	-0.00
0.60	6.68	6.68	-0.07	-0.40	0.48	-0.15
1.20	6.68	6.68	-0.06	1.23	0.23	-0.41
1.80	6.68	0.00	-0.04	2.98	-1.01	-0.23
2.40	28.89	28.89	-0.03	-1.58	-0.81	0.50
3.00	28.89	28.89	-0.02	-0.83	-0.09	0.74
3.60	28.89	28.89	-0.01	-0.32	0.24	0.68
4.20	28.89	28.89	-0.00	-0.02	0.34	0.50
4.80	36.84	36.84	0.00	0.08	0.30	0.31
5.40	36.84	36.84	0.00	0.16	0.22	0.15
6.00	36.84	36.84	0.00	0.08	0.13	0.05
6.60	36.84	36.84	0.00	0.08	0.06	-0.01
7.20	36.84	36.84	-0.00	0.05	0.01	-0.03
7.80	36.84	36.84	-0.00	0.02	-0.01	-0.03
8.40	36.84	36.84	-0.00	0.00	-0.01	-0.02
9.00	36.84	36.84	-0.00	-0.00	-0.01	-0.01
9.60	36.84	36.84	-0.00	-0.01	-0.01	-0.01
10.20	36.84	36.84	-0.00	-0.01	-0.01	-0.00
10.80	36.84	36.84	-0.00	-0.00	-0.00	-0.00
11.40	36.84	36.84	-0.00	-0.00	-0.00	-0.00
12.00	36.84	36.84	-0.00	0.00	-0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 1,47 kN/m
Maximum moment = 0,75 kNm/m
Maximum displacement = 0,1 mm

Terrain settlement behind the structure


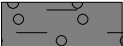
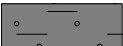
Terrain settlement $\delta_{\max} = 0,0$ mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	0,0
2	0,86	0,0
3	1,72	0,0
4	2,58	0,0
5	3,44	0,0
6	4,30	0,0
7	5,16	0,0
8	6,02	0,0
9	6,88	0,0
10	7,74	0,0

	Coordinates x [m]	Settlement z [mm]
11	8,60	0,0
12	8,60	0,0

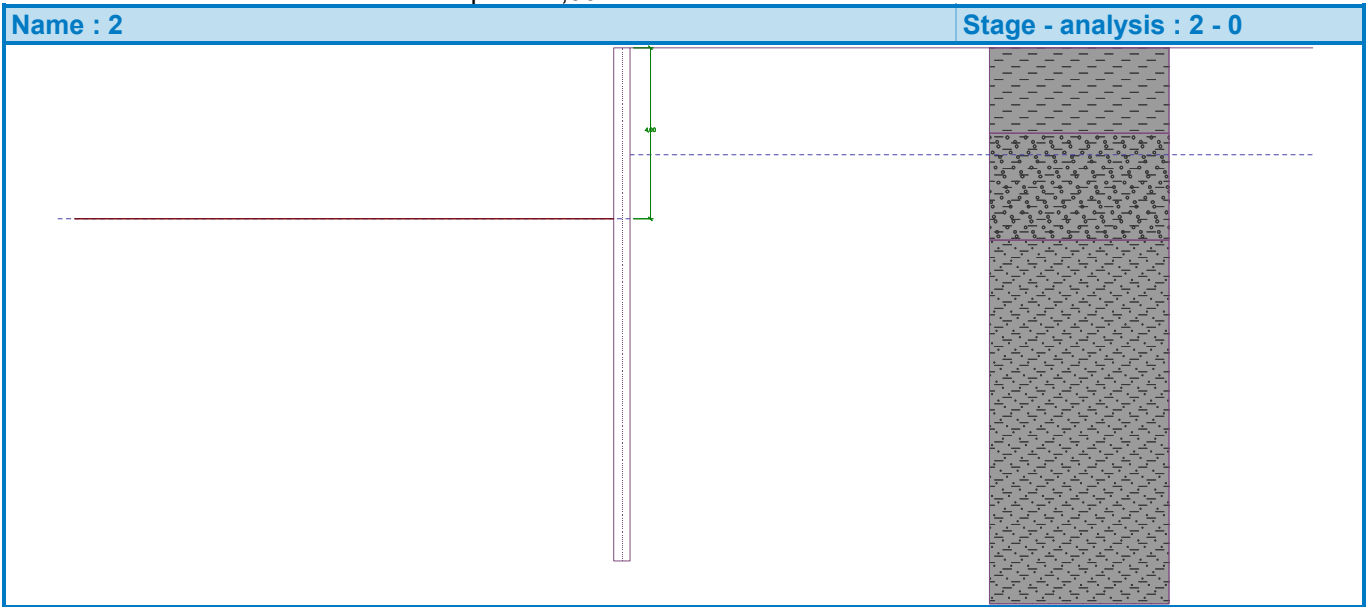
Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2,00	0,00 .. 2,00	Glina	
2	2,50	2,00 .. 4,50	Zameljen prod	
3	-	4,50 .. ∞	Siva zbita peščena	

Excavation

Soil in front of wall is excavated to a depth of 4,00 m.



Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 2,50 m
GWT in front of the structure lies at a depth of 4,00 m
Subgrade at the heel is permeable.
Hydraulic gradient = 0,09

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 2)

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	5.90
0.40	0.00	0.00	0.00	1.45	3.12	17.41

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
2.00	0.00	0.00	0.00	19.32	19.32	62.89
2.00	0.00	0.00	0.00	10.29	15.87	185.86
2.50	0.00	0.00	0.00	13.30	20.06	233.94
4.00	0.00	0.00	0.00	39.19	42.90	334.67
4.00	0.00	-0.00	-3.66	39.19	42.90	334.68
4.35	0.00	-1.57	-21.65	39.62	44.07	355.24
4.50	-0.48	-2.24	-29.32	39.81	44.57	364.01
4.50	0.00	-2.17	-43.77	35.14	43.73	289.59
6.60	0.00	-11.31	-122.13	39.22	50.47	378.38
12.00	-20.65	-34.78	-323.39	49.69	67.78	606.42

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	-72.69	0.00	-0.00	0.00
0.60	0.00	0.00	-65.44	3.65	-0.81	0.14
1.20	0.00	0.00	-58.20	10.37	-5.01	1.69
1.80	0.00	0.00	-50.96	17.09	-13.25	6.96
2.40	0.00	0.00	-43.77	12.70	-21.30	17.53
3.00	0.00	0.00	-36.68	21.93	-31.42	33.05
3.60	0.00	0.00	-29.78	32.29	-47.68	56.47
4.00	0.00	0.00	-25.39	39.12	-61.82	78.06
4.00	0.00	0.00	-25.30	35.34	-62.12	78.56
4.20	0.00	0.00	-23.20	25.52	-68.09	91.35
4.80	0.00	0.00	-17.14	-19.24	-69.33	134.19
5.40	0.00	0.00	-11.83	-40.44	-51.43	171.06
6.00	0.00	0.00	-7.49	-61.65	-20.80	193.36
6.60	0.00	0.00	-4.22	-82.85	22.55	193.47
7.20	36.84	0.00	-2.03	-48.32	68.71	164.59
7.80	36.84	1.84	-0.76	8.40	81.95	117.85
8.40	36.84	1.84	-0.15	31.12	69.07	71.87
9.00	36.84	1.84	0.04	37.94	47.78	36.61
9.60	36.84	1.84	0.02	36.53	25.17	14.78
10.20	36.84	0.00	-0.09	16.01	11.11	4.63
10.80	36.84	0.00	-0.23	9.51	3.43	0.46
11.40	36.84	0.00	-0.37	2.85	-0.28	-0.28
12.00	36.84	0.00	-0.51	-3.77	0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 81,95 kN/m
Maximum moment = 196,58 kNm/m
Maximum displacement = 72,7 mm

Terrain settlement behind the structure

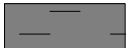
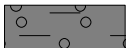

Terrain settlement δ_{\max} = 32,4 mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	36,6
2	0,86	44,6

	Coordinates x [m]	Settlement z [mm]
3	1,72	50,0
4	2,58	52,8
5	3,44	53,0
6	4,30	50,7
7	5,16	45,7
8	6,02	38,2
9	6,88	28,0
10	7,74	15,3
11	8,60	0,0
12	8,60	0,0

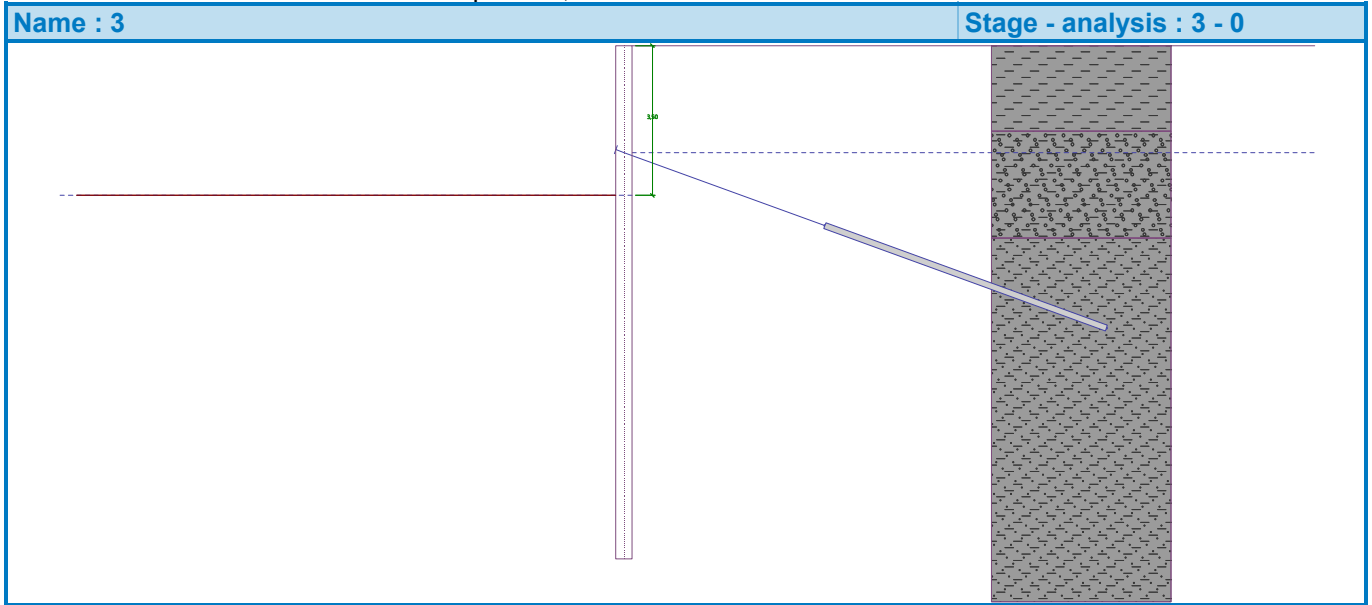
Input data (Stage of construction 3)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2,00	0,00 .. 2,00	Glina	
2	2,50	2,00 .. 4,50	Zameljen prod	
3	-	4,50 .. ∞	Siva zbita peščena	

Excavation

Soil in front of wall is excavated to a depth of 3,50 m.



Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 2,50 m

GWT in front of the structure lies at a depth of 3,50 m

Subgrade at the heel is permeable.

Hydraulic gradient = 0,06

Input anchors

No.	New anchor	Depth z [m]	Name	Post-stressing	Force F [kN]
1	Yes	2,50	Anchor No. : 1 (user-defined)		30,00

List of the new anchors

Anchor No. : 1 (user-defined)

Anchor type : prestressed bar

Production set : user-defined

Depth : $z = 2,50$ m
 Free length : $l = 5,00$ m
 Root length : $l_k = 7,00$ m
 Slope : $\alpha = 20,00^\circ$
 Spacing : $b = 1,20$ m
 Area of cross-section : $A = 791,00$ mm²
 Elasticity modulus : $E = 210000,00$ MPa
 Pre-stressing force : $F = 30,00$ kN
 Tension strength : $R_t = 500,00$ kN
 Pull out resistance (soil) : calculate from bond strength
 Diameter of root : $d = 140,0$ mm
 Bond strength : $f = 150,00$ kPa
 Pull out resistance (grouting) : calculate from concrete strength
 Standard for concrete structures : EN 1992-1-1 (EC2)
 Concrete strength in compression : $f_{ck} = 20,00$ MPa
 Coefficient of cohesion : $\eta_1 = 1,00$

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 3)

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	5.90
0.40	0.00	0.00	0.00	1.45	3.12	17.41
2.00	0.00	0.00	0.00	19.32	19.32	62.89
2.00	0.00	0.00	0.00	10.29	15.87	185.86
2.50	0.00	0.00	0.00	13.30	20.06	233.94
3.50	0.00	0.00	0.00	30.47	35.15	299.57
3.50	0.00	-0.00	-3.66	30.47	35.15	299.57
3.84	0.00	-1.57	-21.65	31.17	36.48	319.19
4.50	-2.18	-4.60	-56.52	32.54	39.07	357.21
4.50	0.00	-4.48	-63.52	27.84	38.23	283.63
6.03	0.00	-11.31	-122.13	32.07	43.99	347.19
12.00	-23.53	-38.05	-351.45	48.61	66.55	595.89

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	0.33	-72.31	0.13	-0.00	0.00
0.60	0.00	0.33	-65.03	5.17	-1.49	0.30
1.20	0.00	6.68	-57.75	13.35	-6.90	1.82
1.80	0.00	6.68	-50.49	20.26	-16.99	8.80
2.40	0.00	28.89	-43.28	26.92	-30.58	20.91

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Depth [m]	kh,p [MN/m ³]	kh,z [MN/m ³]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
2.50	0.00	28.89	-42.08	27.73	-33.31	24.12
2.50	0.00	28.89	-42.08	27.73	-9.82	24.12
2.52	0.00	28.89	-41.85	27.89	-10.37	24.32
3.00	0.00	28.89	-36.19	35.94	-25.71	32.92
3.48	0.00	28.89	-30.66	43.85	-44.88	49.80
3.50	0.00	28.89	-30.39	40.35	-45.92	50.89
3.60	0.00	28.89	-29.30	35.38	-49.55	55.49
4.20	0.00	28.89	-22.74	4.48	-61.54	89.87
4.80	0.00	36.84	-16.69	-29.84	-82.01	132.42
5.40	0.00	36.84	-11.39	-51.39	-57.73	175.11
6.00	0.00	36.84	-7.07	-73.81	-20.30	199.30
6.60	0.00	36.84	-3.87	-97.44	30.93	196.91
7.20	36.84	36.84	-1.76	-35.79	72.40	163.56
7.80	36.84	36.84	-0.56	4.38	80.32	116.57
8.40	36.84	36.84	-0.03	29.16	70.46	70.60
9.00	36.84	36.84	0.11	38.51	49.09	34.46
9.60	36.84	36.84	0.04	33.06	27.17	11.75
10.20	36.84	36.84	-0.10	22.30	10.45	0.79
10.80	36.84	36.84	-0.25	10.91	0.52	-2.16
11.40	36.84	36.84	-0.39	0.27	-2.80	-1.15
12.00	36.84	0.00	-0.52	-8.64	0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 85,33 kN/m
Maximum moment = 202,00 kNm/m
Maximum displacement = 72,3 mm

Anchors forces

No.	Depth [m]	Displacement [mm]	Anchor force [kN]
1	2,50	-42,1	30,00




Terrain settlement behind the structure

Terrain settlement $\delta_{\max} = 31,8$ mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	36,4
2	0,86	44,2
3	1,72	49,5
4	2,58	52,2
5	3,44	52,4
6	4,30	50,0
7	5,16	45,1
8	6,02	37,6
9	6,88	27,6
10	7,74	15,1
11	8,60	0,0
12	8,60	0,0

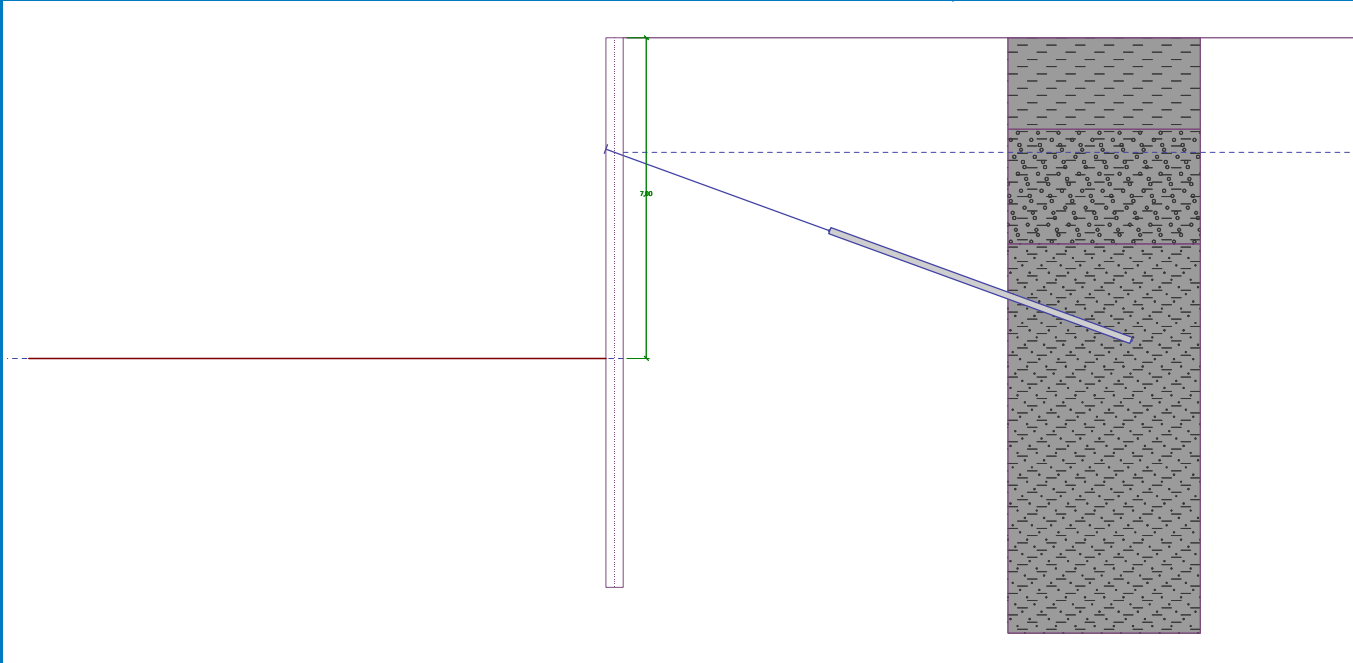
Input data (Stage of construction 4)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2,00	0,00 .. 2,00	Glina	
2	2,50	2,00 .. 4,50	Zameljen prod	
3	-	4,50 .. ∞	Siva zbita peščena	

Excavation

Soil in front of wall is excavated to a depth of 7,00 m.

Name : 4	Stage - analysis : 4 - 0
	

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 2,50 m

GWT in front of the structure lies at a depth of 7,00 m

Subgrade at the heel is permeable.

Hydraulic gradient = 0,31

Input anchors

No.	New anchor	Depth z [m]	Name	Post-stressing	Force F [kN]
1	No	2,50	Anchor No. : 1 (user-defined)		331,64

Settings of the stage of construction

Design situation : permanent

Analysis results (Stage of construction 4)

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	5.90
0.40	0.00	0.00	0.00	1.45	3.12	17.41
2.00	0.00	0.00	0.00	19.32	19.32	62.89
2.00	0.00	0.00	0.00	10.29	15.87	185.86
2.50	0.00	0.00	0.00	13.30	20.06	233.94
4.50	0.00	0.00	0.00	49.25	52.49	390.99
4.50	0.00	0.00	0.00	44.85	51.59	310.34
7.00	0.00	0.00	0.00	91.89	91.89	457.80
7.00	0.00	-0.00	-25.13	91.89	91.89	457.81
10.34	0.00	-11.31	-122.13	69.07	81.89	609.56
12.00	-4.94	-16.92	-170.26	57.74	76.92	684.86

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	-21.09	5.90	0.00	-0.00
0.60	0.00	0.00	-28.19	23.00	-8.67	2.09
1.20	0.00	0.00	-35.30	40.09	-27.60	12.45
1.80	0.00	0.00	-42.49	57.19	-56.78	37.26
2.40	0.00	0.00	-49.89	12.70	-72.81	77.92
2.50	0.00	0.00	-51.16	13.50	-74.12	85.26
2.50	0.00	0.00	-51.16	13.50	185.58	85.26
2.52	0.00	0.00	-51.42	13.66	185.31	81.55
2.52	0.00	0.00	-51.42	13.66	185.31	81.55
3.00	0.00	0.00	-57.66	22.29	176.68	-5.49
3.60	0.00	0.00	-65.39	33.07	160.07	-106.84
4.20	0.00	0.00	-72.53	43.86	136.99	-196.28
4.80	0.00	0.00	-78.57	50.49	108.72	-270.13
5.40	0.00	0.00	-83.09	61.78	75.04	-325.59
6.00	0.00	0.00	-85.79	73.08	34.58	-358.82
6.60	0.00	0.00	-86.48	84.37	-12.65	-365.74
7.00	0.00	0.00	-85.81	91.82	-47.54	-353.92
7.00	0.00	0.00	-85.79	66.62	-48.17	-353.53
7.20	0.00	0.00	-85.12	59.59	-60.54	-342.86
7.80	0.00	0.00	-81.84	38.08	-89.84	-297.10
8.40	0.00	0.00	-76.89	16.56	-106.23	-237.63
9.00	0.00	0.00	-70.60	-4.95	-109.72	-172.20
9.60	0.00	0.00	-63.33	-26.46	-100.29	-108.55
10.20	0.00	0.00	-55.46	-47.98	-77.96	-54.43
10.80	0.00	0.00	-47.26	-69.49	-42.72	-17.58
11.40	1.84	0.00	-38.96	-24.82	-12.13	-3.37
12.00	1.84	0.00	-30.63	-15.61	0.00	0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 185,58 kN/m
Maximum moment = 366,65 kNm/m

Maximum displacement = 86,5 mm

Anchors forces

No.	Depth [m]	Displacement [mm]	Anchor force [kN]
1	2,50	-51,2	331,64

Terrain settlement behind the structure

Terrain settlement $\delta_{\max} = 129,8$ mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	25,9
2	0,86	70,0
3	1,72	103,7
4	2,58	127,1
5	3,44	140,1
6	4,30	142,7
7	5,16	134,9
8	6,02	116,8
9	6,88	88,2
10	7,74	49,3
11	8,60	0,0
12	8,60	0,0

Dimensioning No. 1 (Stage of construction 4)

Failure by heave

Favourable weight of soil $\sigma_{\text{stb}} = 85,50$ kPa

Unfavourable water pressure $u_{\text{dst}} = 60,75$ kPa

Verification of failure by heave is **SATISFACTORY**

Verification of failure by piping

Critical hydraulic gradient $i_c = 0,73$

Hydraulic gradient $i = 0,31$

Verification of failure by piping is **SATISFACTORY**

Dimensioning No. 1

Distribution of forces on construction

	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	-72.69	-0.08	-0.00	0.00	-0.00	0.00
0.01	-72.62	-0.08	-0.05	-0.00	0.00	0.00
0.01	-72.52	-0.08	-0.11	0.00	-0.00	0.01
0.60	-65.44	-0.07	-8.67	0.48	-0.15	2.09
1.20	-58.20	-0.06	-27.60	0.23	-0.41	12.45
1.80	-50.96	-0.04	-56.78	-1.01	-0.23	37.26
2.40	-49.89	-0.03	-72.81	-0.81	0.50	77.92
2.50	-51.16	-0.03	-74.12	-0.66	0.57	85.26
2.50	-51.16	-0.03	-22.61	185.58	0.57	85.26
2.52	-51.42	-0.03	-22.88	185.31	0.58	81.55
2.52	-51.42	-0.03	-22.88	185.31	0.58	81.55
3.00	-57.66	-0.02	-31.42	176.68	-5.49	33.05
3.48	-63.88	-0.01	-44.88	163.91	-87.40	50.97

	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	-64.08	-0.01	-45.58	163.40	-89.99	51.71
3.50	-64.18	-0.01	-45.92	163.14	-91.28	52.07
3.50	-64.18	-0.01	-45.92	163.14	-91.28	52.07
3.60	-65.39	-0.01	-49.55	160.07	-106.84	56.47
4.00	-70.20	-0.00	-61.82	145.54	-167.38	78.06
4.00	-70.20	-0.00	-61.82	145.54	-167.38	78.06
4.00	-70.29	-0.00	-62.12	145.21	-168.54	78.56
4.00	-70.29	-0.00	-62.12	145.21	-168.54	78.56
4.20	-72.53	-0.00	-68.09	136.99	-196.28	91.35
4.80	-78.57	0.00	-82.01	108.72	-270.13	134.19
5.40	-83.09	0.00	-57.73	75.04	-325.59	175.11
6.00	-85.79	0.00	-20.80	34.58	-358.82	199.30
6.60	-86.48	0.00	-12.65	30.93	-365.74	196.91
7.00	-85.81	-0.00	-47.54	62.90	-353.92	177.51
7.00	-85.81	-0.00	-47.54	62.90	-353.92	177.51
7.00	-85.79	-0.00	-48.17	63.33	-353.53	177.03
7.00	-85.79	-0.00	-48.17	63.33	-353.53	177.03
7.20	-85.12	-0.00	-60.54	72.40	-342.86	164.59
7.80	-81.84	-0.00	-89.84	81.95	-297.10	117.85
8.40	-76.89	-0.00	-106.23	70.46	-237.63	71.87
9.00	-70.60	0.11	-109.72	49.09	-172.20	36.61
9.60	-63.33	0.04	-100.29	27.17	-108.55	14.78
10.20	-55.46	-0.00	-77.96	11.11	-54.43	4.63
10.80	-47.26	-0.00	-42.72	3.43	-17.58	0.46
11.40	-38.96	-0.00	-12.13	-0.00	-3.37	-0.00
12.00	-30.63	-0.00	-0.00	0.00	-0.00	0.00

Maximum values of internal forces

Maximum displacement = -86,5 mm
 Minimum displacement = 0,1 mm
 Maximum bending moment = 202,00 kNm/m
 Minimum bending moment = -366,65 kNm/m
 Maximum shear force = 185,58 kN/m

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

All construction stages are taken into the analysis.
 Partial factor on load = 1,00

Internal forces per 1 m of wall

$M_{\max} = 366,65 \text{ kNm/m}; \quad Q = 2,66 \text{ kN/m}$
 $Q_{\max} = 185,58 \text{ kN/m}; \quad M = 85,26 \text{ kNm/m}$

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

Verification of bending:

$M_{\max}/M_{c,Rd} = 0,955 \leq 1$ **Is satisfactory**

Verification of shear:

$Q/V_{c,Rd} = 0,004 \leq 1$ **Is satisfactory**

Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 217,10 \text{ MPa}$

Shear stress $\tau_{Ed} = 0,35 \text{ MPa}$

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,818 \leq 1$ **Is satisfactory**

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

Verification of bending:

$M/M_{c,Rd} = 0,222 \leq 1$ **Is satisfactory**

Verification of shear:

$Q_{\max}/V_{c,Rd} = 0,250 \leq 1$ **Is satisfactory**

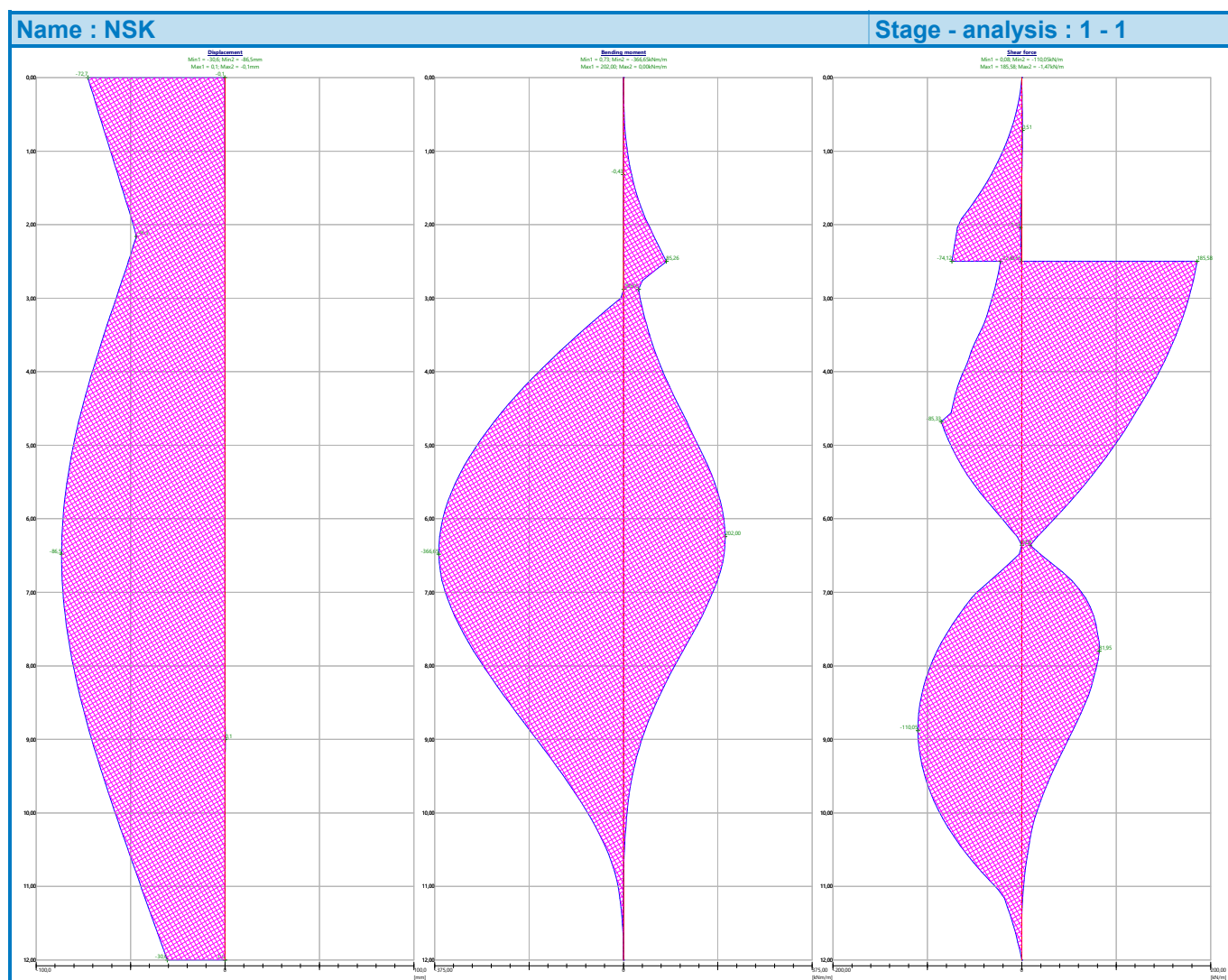
Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 50,48$ MPa

Shear stress $\tau_{Ed} = 24,17$ MPa

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,075 \leq 1$ **Is satisfactory**

Cross section is SATISFACTORY



Verification of anchors

Anchor	Stage	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	4	2,50	331,64	454,55	342,08	639,91	is satisfactory (96,95 %)

Anchor with max. utilization - Nr. 1. (Stage 4; z = 2,50 m)

Utilization is 96,95 %

Anchors bearing capacity is SATISFACTORY