

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 :	$\gamma_s =$	1,15 [-]	
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 = 10,00 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 $f_y = 240,00 \text{ MPa}$


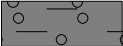

Elasticity modulus $E = 210000,00 \text{ MPa}$

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


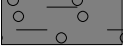
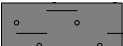
Modulus of reaction

Modulus of subsoil reaction is computed by method Schmitt.


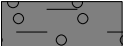

Basic soil parameters

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

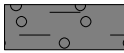
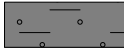
No.	Name	Pattern	Type calculation	Φ_{ef} [°]	ν [-]	OCR [-]	K_r [-]
1	Glina		cohesive	-	0,30	-	-
2	Zameljen prod		cohesionless	34,00	-	-	-
3	Siva zbita peščena		cohesive	-	0,30	-	-

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

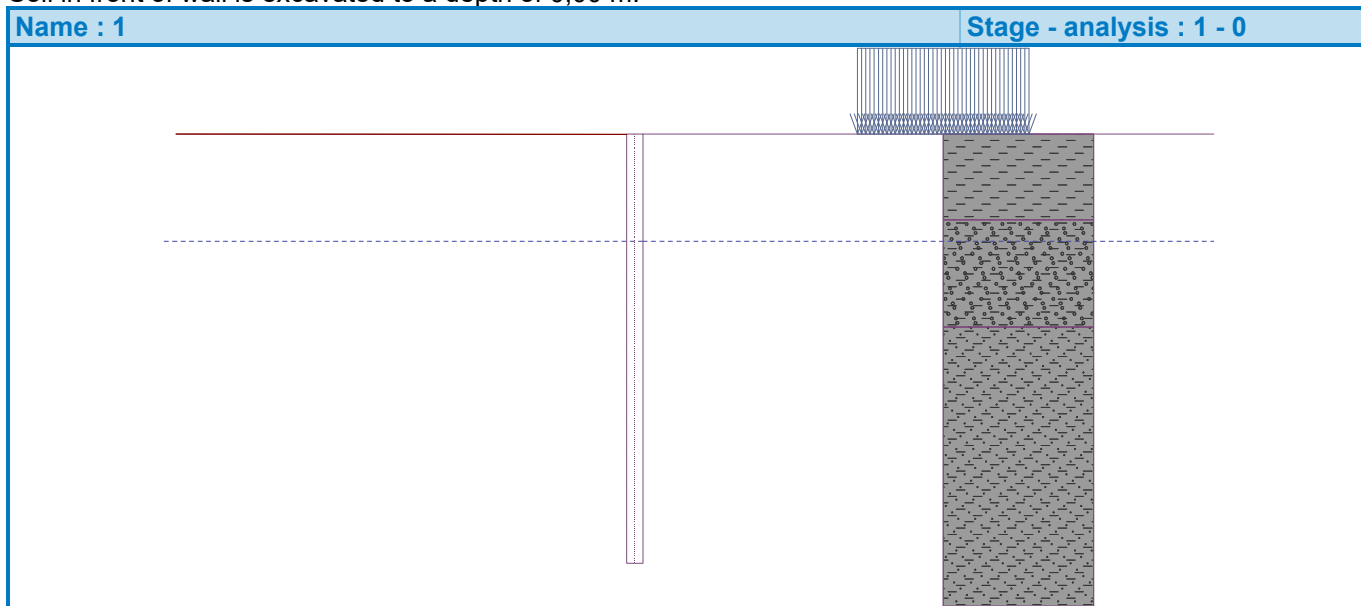
Geological profile and assigned soils

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

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		variable	20,00		5,00	4,00	on terrain

No.	Name
1	Prometna obtežba

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	0.10	6.18
0.40	0.00	-3.01	-17.01	1.44	3.98	17.30
0.41	0.00	-3.12	-17.41	1.56	4.12	17.70
0.80	-3.74	-6.09	-28.41	5.70	7.93	28.70
1.20	-7.61	-9.18	-39.81	9.99	11.79	40.09
1.45	-10.05	-11.13	-47.01	12.70	14.16	47.29
1.45	-10.05	-11.13	-47.01	24.65	24.65	47.29
1.60	-11.48	-12.27	-51.21	26.29	26.29	51.49
2.00	-15.35	-15.35	-62.61	30.75	30.75	62.89
2.00	-10.23	-15.79	-184.95	15.68	19.62	185.86
2.40	-12.64	-19.14	-223.41	17.97	23.40	224.32
2.50	-13.25	-19.98	-233.03	18.54	24.32	233.94
2.50	-13.25	-19.98	-233.03	18.54	24.32	233.94
2.80	-14.29	-21.43	-249.73	19.49	25.99	250.64
3.20	-15.69	-23.37	-272.00	20.76	28.11	272.91
3.60	-17.08	-25.31	-294.27	22.03	30.14	295.18
4.00	-18.48	-27.25	-316.54	23.30	32.08	317.45
4.40	-19.87	-29.19	-338.81	24.57	33.96	339.72
4.50	-20.22	-29.68	-344.37	24.88	34.42	345.29
4.50	-15.44	-28.85	-272.58	20.98	33.59	273.24
4.80	-16.68	-30.27	-284.71	22.10	34.92	285.37
5.20	-18.34	-32.15	-300.88	23.60	36.65	301.55
5.60	-20.00	-34.04	-317.06	25.10	38.36	317.72
6.00	-21.66	-35.92	-333.23	26.60	40.05	333.89
6.40	-23.32	-37.81	-349.40	28.09	41.73	350.06
6.80	-24.98	-39.69	-365.58	29.59	43.41	366.24
7.20	-26.64	-41.58	-381.75	31.09	45.09	382.41
7.60	-28.30	-43.47	-397.92	32.59	46.78	398.58
8.00	-29.96	-45.35	-414.10	34.09	48.46	414.76
8.40	-31.62	-47.24	-430.27	35.59	50.16	430.93
8.80	-33.28	-49.12	-446.44	37.08	51.87	447.10
9.20	-34.94	-51.01	-462.62	38.58	53.58	463.28
9.60	-36.60	-52.89	-478.79	40.08	55.31	479.45
10.00	-38.26	-54.78	-494.96	41.58	57.05	495.62

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	-0.27	0.00	-0.00	-0.00
0.01	6.68	0.00	-0.27	-1.80	0.01	-0.00
0.50	6.68	6.68	-0.26	-2.26	1.18	-0.28
1.00	6.68	6.68	-0.24	-1.01	1.99	-1.10
1.50	6.68	0.00	-0.22	12.20	1.60	-2.16
2.00	28.89	0.00	-0.19	9.81	-4.76	-1.36

Depth [m]	kh,p [MN/m³]	kh,z [MN/m³]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
2.50	28.89	28.89	-0.16	-4.94	-2.70	0.66
3.00	28.89	28.89	-0.13	-2.86	-0.77	1.48
3.50	28.89	28.89	-0.10	-1.24	0.23	1.58
4.00	28.89	28.89	-0.09	-0.12	0.56	1.36
4.50	36.84	36.84	-0.07	-0.55	0.48	1.10
5.00	36.84	36.84	-0.06	-0.02	0.61	0.81
5.50	36.84	36.84	-0.06	0.24	0.54	0.52
6.00	36.84	36.84	-0.05	0.31	0.40	0.28
6.50	36.84	36.84	-0.05	0.28	0.25	0.12
7.00	36.84	36.84	-0.05	0.21	0.13	0.03
7.50	36.84	36.84	-0.04	0.13	0.05	-0.02
8.00	36.84	36.84	-0.04	0.06	0.00	-0.03
8.50	36.84	36.84	-0.04	0.02	-0.02	-0.02
9.00	36.84	36.84	-0.04	-0.01	-0.02	-0.01
9.50	36.84	36.84	-0.03	-0.02	-0.01	-0.00
10.00	36.84	36.84	-0.03	-0.02	-0.00	0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 4,96 kN/m
Maximum moment = 2,25 kNm/m
Maximum displacement = 0,3 mm


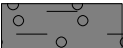
Terrain settlement behind the structure

Terrain settlement δ_{max} = 0,2 mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	0,2
2	0,75	0,2
3	1,49	0,2
4	2,24	0,3
5	2,99	0,3
6	3,73	0,3
7	4,48	0,2
8	5,23	0,2
9	5,97	0,1
10	6,72	0,1
11	7,47	0,0
12	7,47	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	

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
1.45	0.00	0.00	0.00	12.70	14.16	47.29
1.45	0.00	0.00	0.00	24.65	24.65	47.29
1.67	0.00	0.00	0.00	27.04	27.04	53.39
2.00	0.00	0.00	0.00	30.75	30.75	62.89
2.00	0.00	0.00	0.00	15.68	19.62	185.86
2.08	0.00	0.00	0.00	16.16	20.42	193.87
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.92	0.00	0.00	0.00	25.58	30.92	261.62
3.33	0.00	0.00	0.00	32.62	37.39	289.30
3.50	0.00	0.00	0.00	35.44	39.95	300.37
3.50	0.00	-0.00	-3.66	35.44	39.96	300.38
3.75	0.00	-1.13	-16.67	35.77	40.88	314.92
3.85	0.00	-1.57	-21.65	35.90	41.23	320.49
4.17	-1.05	-3.02	-38.36	36.32	42.37	339.16
4.50	-2.13	-4.53	-55.71	36.76	43.51	358.56
4.50	0.00	-4.41	-62.94	32.94	42.67	284.54
4.58	0.00	-4.78	-66.09	33.10	42.94	288.03
5.00	0.00	-6.61	-81.84	33.91	44.25	305.52
5.42	0.00	-8.45	-97.60	34.72	45.53	323.00
5.83	0.00	-10.29	-113.35	35.52	46.78	340.48
6.07	0.00	-11.31	-122.13	35.97	47.47	350.23
6.25	-0.72	-12.12	-129.10	36.33	48.02	357.97
6.67	-2.33	-13.96	-144.85	37.14	49.26	375.45
7.08	-3.95	-15.80	-160.61	37.95	50.49	392.93
7.50	-5.56	-17.63	-176.36	38.75	51.73	410.42
7.92	-7.18	-19.47	-192.11	39.56	52.98	427.90
8.33	-8.80	-21.31	-207.87	40.37	54.23	445.38
8.75	-10.41	-23.14	-223.62	41.18	55.49	462.87
9.17	-12.03	-24.98	-239.37	41.98	56.76	480.35
9.58	-13.65	-26.82	-255.13	42.79	58.05	497.83
10.00	-15.26	-28.65	-270.88	43.60	59.34	515.31

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	-59.79	0.00	-0.00	0.00
0.50	0.00	0.00	-54.40	2.48	-0.48	0.08
1.00	0.00	0.00	-49.01	7.84	-3.07	0.85
1.50	0.00	0.00	-43.62	25.18	-8.93	3.61
2.00	0.00	0.00	-38.25	30.75	-22.91	11.45
2.50	0.00	0.00	-32.93	18.54	-32.22	25.34
3.00	0.00	0.00	-27.71	26.99	-43.60	44.12
3.50	0.00	0.00	-22.70	35.37	-59.07	69.41
3.50	0.00	0.00	-22.62	31.58	-59.33	69.88
4.00	0.00	0.00	-17.89	6.42	-68.76	102.16
4.50	0.00	0.00	-13.51	-18.95	-65.62	136.29

Depth [m]	kh,p [MN/m³]	kh,z [MN/m³]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
5.00	0.00	0.00	-9.67	-47.93	-46.69	164.86
5.50	0.00	0.00	-6.48	-65.87	-18.24	181.47
6.00	0.00	0.00	-3.98	-83.80	19.18	181.61
6.50	36.84	0.00	-2.19	-57.27	59.21	161.24
7.00	36.84	0.00	-1.03	-15.70	76.58	126.43
7.50	36.84	1.84	-0.37	19.98	73.83	88.02
8.00	36.84	1.84	-0.04	31.71	60.46	54.20
8.50	36.84	1.84	0.06	35.13	43.50	28.14
9.00	36.84	1.84	0.06	34.19	26.05	10.78
9.50	36.84	1.84	0.00	31.52	9.59	1.92
10.00	36.84	0.00	-0.06	12.84	0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 77,99 kN/m
Maximum moment = 183,81 kNm/m
Maximum displacement = 59,8 mm



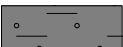
Terrain settlement behind the structure

Terrain settlement δ_{\max} = 28,9 mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	29,9
2	0,75	37,3
3	1,49	42,4
4	2,24	45,2
5	2,99	45,7
6	3,73	43,8
7	4,48	39,7
8	5,23	33,2
9	5,97	24,5
10	6,72	13,4
11	7,47	0,0
12	7,47	0,0

Input data (Stage of construction 3)

Geological profile and assigned soils

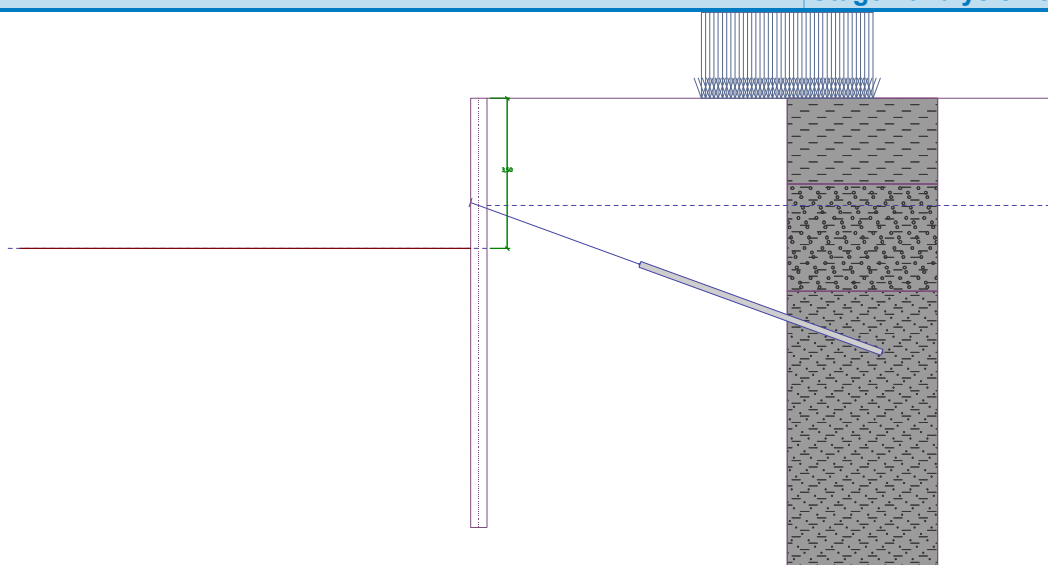
No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	2,00	0,00 .. 2,00	Glina	
2	2,50	2,00 .. 4,50	Zameljen prod	
3	-	4,50 .. ∞	Siva zbita peščena	

Excavation

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

Name : 3

Stage - analysis : 3 - 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 3,50 m

Subgrade at the heel is permeable.

Hydraulic gradient = 0,07

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	No	variable	20,00		5,00	4,00	on terrain

No.	Name
1	Prometna obtežba

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 : $l = 4,00$ m

Root length : $l_k = 6,00$ 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
0.00	0.00	0.00	0.00	0.00	0.00	5.90
0.40	0.00	0.00	0.00	1.45	4.02	17.41
0.42	0.00	0.00	0.00	1.59	4.15	17.77
0.83	0.00	0.00	0.00	6.06	8.25	29.65
1.25	0.00	0.00	0.00	10.52	12.27	41.52
1.45	0.00	0.00	0.00	12.70	14.16	47.29
1.45	0.00	0.00	0.00	24.65	24.65	47.29
1.67	0.00	0.00	0.00	27.04	27.04	53.39
2.00	0.00	0.00	0.00	30.75	30.75	62.89
2.00	0.00	0.00	0.00	15.68	19.62	185.86
2.08	0.00	0.00	0.00	16.16	20.42	193.87
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.92	0.00	0.00	0.00	25.58	30.92	261.62
3.33	0.00	0.00	0.00	32.62	37.39	289.30
3.50	0.00	0.00	0.00	35.44	39.95	300.37
3.50	0.00	-0.00	-3.66	35.44	39.96	300.38
3.75	0.00	-1.13	-16.67	35.77	40.88	314.92
3.85	0.00	-1.57	-21.65	35.90	41.23	320.49
4.17	-1.05	-3.02	-38.36	36.32	42.37	339.16
4.50	-2.13	-4.53	-55.71	36.76	43.51	358.56
4.50	0.00	-4.41	-62.94	32.94	42.67	284.54
4.58	0.00	-4.78	-66.09	33.10	42.94	288.03
5.00	0.00	-6.61	-81.84	33.91	44.25	305.52
5.42	0.00	-8.45	-97.60	34.72	45.53	323.00
5.83	0.00	-10.29	-113.35	35.52	46.78	340.48
6.07	0.00	-11.31	-122.13	35.97	47.47	350.23
6.25	-0.72	-12.12	-129.10	36.33	48.02	357.97
6.67	-2.33	-13.96	-144.85	37.14	49.26	375.45
7.08	-3.95	-15.80	-160.61	37.95	50.49	392.93
7.50	-5.56	-17.63	-176.36	38.75	51.73	410.42
7.92	-7.18	-19.47	-192.11	39.56	52.98	427.90
8.33	-8.80	-21.31	-207.87	40.37	54.23	445.38
8.75	-10.41	-23.14	-223.62	41.18	55.49	462.87
9.17	-12.03	-24.98	-239.37	41.98	56.76	480.35
9.58	-13.65	-26.82	-255.13	42.79	58.05	497.83
10.00	-15.26	-28.65	-270.88	43.60	59.34	515.31

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	-59.42	0.12	0.00	0.00
0.50	0.00	0.33	-54.03	4.97	-1.27	0.22
1.00	0.00	6.68	-48.64	10.28	-4.90	1.20
1.50	0.00	6.68	-43.26	27.57	-11.97	5.19
2.00	0.00	0.00	-37.91	62.89	-28.80	15.23
2.50	0.00	28.89	-32.61	27.67	-43.25	32.17
2.50	0.00	28.89	-32.61	27.67	-19.76	32.17
3.00	0.00	28.89	-27.44	34.63	-35.36	45.87
3.50	0.00	28.89	-22.50	41.23	-54.19	68.00
3.50	0.00	28.89	-22.42	37.41	-54.51	68.43
4.00	0.00	28.89	-17.74	10.56	-66.42	99.04
4.50	0.00	36.84	-13.42	-15.46	-64.88	132.37
5.00	0.00	36.84	-9.62	-45.74	-47.39	161.03
5.50	0.00	36.84	-6.44	-64.47	-19.86	178.29
6.00	0.00	36.84	-3.96	-82.76	16.92	179.45
6.50	36.84	36.84	-2.17	-55.31	56.17	160.41
7.00	36.84	36.84	-1.01	-13.65	72.51	127.39
7.50	36.84	36.84	-0.34	9.52	72.85	90.58
8.00	36.84	36.84	-0.03	31.14	61.90	56.44
8.50	36.84	36.84	0.06	36.76	44.42	29.75
9.00	36.84	36.84	0.02	33.59	26.60	12.06
9.50	36.84	36.84	-0.06	26.74	11.43	2.70
10.00	36.84	36.84	-0.16	18.96	0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 74,06 kN/m
 Maximum moment = 181,21 kNm/m
 Maximum displacement = 59,4 mm

Anchors forces

No.	Depth [m]	Displacement [mm]	Anchor force [kN]
1	2,50	-32,6	30,00

Terrain settlement behind the structure




Terrain settlement δ_{\max} = 28,6 mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	29,8
2	0,75	37,1
3	1,49	42,1
4	2,24	44,9
5	2,99	45,3
6	3,73	43,5
7	4,48	39,4
8	5,23	33,0
9	5,97	24,3
10	6,72	13,3

	Coordinates x [m]	Settlement z [mm]
11	7,47	0,0
12	7,47	0,0

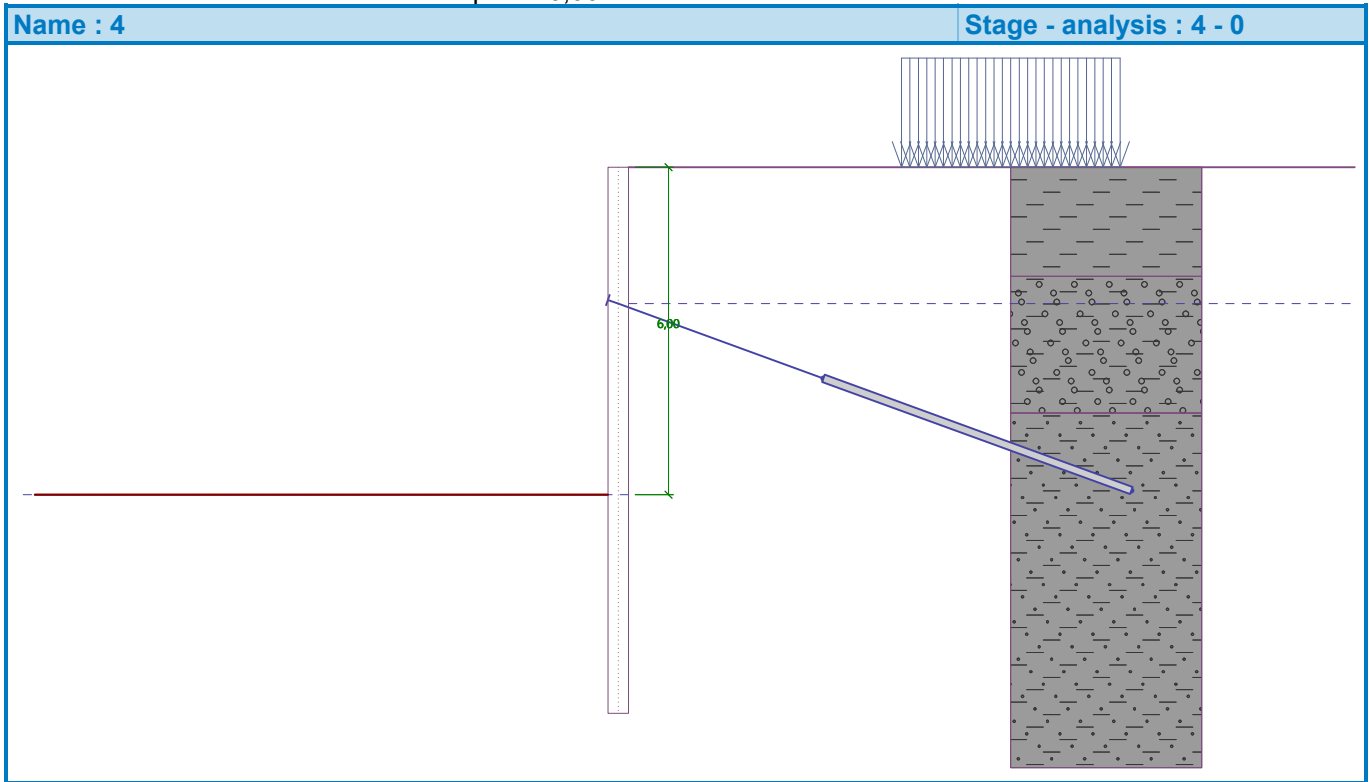
Input data (Stage of construction 4)

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 6,00 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 6,00 m

Subgrade at the heel is permeable.

Hydraulic gradient = 0,30

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	No	No	variable	20,00		5,00	4,00	on terrain

No.	Name
1	Prometna obtežba

Input anchors

No.	New anchor	Depth z [m]	Name	Post-stressing	Force F [kN]
1	No	2,50	Anchor No. : 1 (user-defined)		267,90

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
0.00	0.00	0.00	0.00	0.00	0.00	5.90
0.40	0.00	0.00	0.00	1.45	4.02	17.41
0.42	0.00	0.00	0.00	1.59	4.15	17.77
0.83	0.00	0.00	0.00	6.06	8.25	29.65
1.25	0.00	0.00	0.00	10.52	12.27	41.52
1.45	0.00	0.00	0.00	12.70	14.16	47.29
1.45	0.00	0.00	0.00	24.65	24.65	47.29
1.67	0.00	0.00	0.00	27.04	27.04	53.39
2.00	0.00	0.00	0.00	30.75	30.75	62.89
2.00	0.00	0.00	0.00	15.68	19.62	185.86
2.08	0.00	0.00	0.00	16.16	20.42	193.87
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.50	0.00	0.00	0.00	18.54	24.32	233.94
2.92	0.00	0.00	0.00	25.89	31.34	266.53
3.33	0.00	0.00	0.00	33.24	38.25	299.12
3.75	0.00	0.00	0.00	40.59	45.05	331.71
4.17	0.00	0.00	0.00	47.93	51.77	364.31
4.50	0.00	0.00	0.00	53.81	57.10	390.38
4.50	0.00	0.00	0.00	50.27	56.20	309.90
4.58	0.00	0.00	0.00	51.80	57.52	314.80
5.00	0.00	0.00	0.00	59.47	64.05	339.28
5.42	0.00	0.00	0.00	67.14	70.55	363.77
5.83	0.00	0.00	0.00	74.80	77.03	388.25
6.00	0.00	0.00	0.00	77.87	79.62	398.05
6.00	0.00	-0.00	-25.13	77.87	79.62	398.05
6.25	0.00	-0.85	-32.44	76.14	78.81	409.39
6.67	0.00	-2.27	-44.63	73.26	77.46	428.29
7.08	0.00	-3.69	-56.81	70.38	76.10	447.20
7.50	0.00	-5.11	-69.00	67.50	74.75	466.10
7.92	0.00	-6.54	-81.19	64.61	73.41	485.00
8.33	0.00	-7.96	-93.37	61.73	72.07	503.91
8.75	0.00	-9.38	-105.56	58.85	70.74	522.81
9.17	0.00	-10.80	-117.74	55.96	69.43	541.72
9.32	0.00	-11.31	-122.13	54.92	68.96	548.53
9.58	-0.80	-12.22	-129.93	53.08	68.12	560.62

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Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
10.00	-2.05	-13.64	-142.12	50.20	66.83	579.53

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	-35.31	5.90	-0.00	-0.00
0.50	0.00	0.00	-35.82	20.15	-6.51	1.33
1.00	0.00	0.00	-36.33	34.40	-20.15	7.70
1.50	0.00	0.00	-36.87	48.64	-40.91	22.67
2.00	0.00	1.44	-37.51	31.83	-61.51	48.83
2.50	0.00	0.00	-38.34	18.54	-70.86	82.12
2.50	0.00	0.00	-38.34	18.54	138.92	82.12
3.00	0.00	0.00	-39.43	27.36	127.45	15.34
3.50	0.00	0.00	-40.57	36.18	111.56	-44.60
4.00	0.00	0.00	-41.55	45.00	91.27	-95.49
4.50	0.00	0.00	-42.16	53.81	66.57	-135.13
5.00	0.00	0.00	-42.24	59.47	38.96	-161.67
5.50	0.00	0.00	-41.69	68.67	6.92	-173.33
6.00	0.00	0.00	-40.48	77.80	-29.40	-167.94
6.00	0.00	0.00	-40.46	52.60	-29.92	-167.70
6.50	0.00	0.00	-38.60	34.66	-51.56	-147.13
7.00	0.00	0.00	-36.15	16.58	-64.37	-117.77
7.50	0.00	0.00	-33.25	-1.51	-68.14	-84.26
8.00	0.00	0.00	-30.01	-19.59	-62.87	-51.14
8.50	0.00	0.00	-26.57	-37.67	-48.55	-22.90
9.00	0.00	0.00	-23.04	-55.75	-25.20	-4.09
9.50	1.84	0.00	-19.49	5.82	3.25	0.84
10.00	1.84	0.00	-15.94	7.19	0.00	-0.00

Maximum values of internal forces acting on the structure

Maximum shear force = 138,92 kN/m
Maximum moment = 173,67 kNm/m
Maximum displacement = 42,3 mm

Anchors forces

No.	Depth [m]	Displacement [mm]	Anchor force [kN]
1	2,50	-38,3	267,90

Terrain settlement behind the structure

Terrain settlement δ_{\max} = 68,0 mm

	Coordinates x [m]	Settlement z [mm]
1	0,00	25,6
2	0,75	47,5
3	1,49	64,0
4	2,24	75,0
5	2,99	80,6
6	3,73	80,8
7	4,48	75,5

	Coordinates x [m]	Settlement z [mm]
8	5,23	64,8
9	5,97	48,6
10	6,72	27,0
11	7,47	0,0
12	7,47	0,0

Dimensioning No. 1 (Stage of construction 4)

Failure by heave

Favourable weight of soil $\sigma_{\text{stb}} = 68,40 \text{ kPa}$

Unfavourable water pressure $u_{\text{dst}} = 47,25 \text{ kPa}$

Verification of failure by heave is SATISFACTORY

Verification of failure by piping

Critical hydraulic gradient $i_c = 0,73$

Hydraulic gradient $i = 0,30$

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	-59.79	-0.27	-0.00	0.00	-0.00	0.00
0.01	-59.72	-0.27	-0.04	-0.00	0.00	0.00
0.01	-59.64	-0.27	-0.10	0.01	-0.00	0.00
0.50	-54.40	-0.26	-6.51	1.18	-0.28	1.33
1.00	-49.01	-0.24	-20.15	1.99	-1.10	7.70
1.50	-43.62	-0.22	-40.91	1.60	-2.16	22.67
2.00	-38.25	-0.19	-61.51	-4.76	-1.36	48.83
2.50	-38.34	-0.16	-70.86	-2.70	0.66	82.12
2.50	-38.34	-0.16	-32.22	138.92	0.66	82.12
3.00	-39.43	-0.13	-43.60	127.45	1.48	45.87
3.50	-40.57	-0.10	-59.07	111.70	-44.14	69.41
3.50	-40.57	-0.10	-59.07	111.70	-44.14	69.41
3.50	-40.57	-0.10	-59.20	111.56	-44.60	69.64
3.50	-40.58	-0.10	-59.33	111.42	-45.04	69.88
3.50	-40.58	-0.10	-59.33	111.42	-45.04	69.88
4.00	-41.55	-0.09	-68.76	91.27	-95.49	102.16
4.50	-42.16	-0.07	-65.62	66.57	-135.13	136.29
5.00	-42.24	-0.06	-47.39	38.96	-161.67	164.86
5.50	-41.69	-0.06	-19.86	6.92	-173.33	181.47
6.00	-40.48	-0.05	-29.40	18.85	-167.94	181.67
6.00	-40.48	-0.05	-29.40	18.85	-167.94	181.67
6.00	-40.47	-0.05	-29.66	19.18	-167.82	181.61
6.00	-40.46	-0.05	-29.92	19.52	-167.70	181.51
6.00	-40.46	-0.05	-29.92	19.52	-167.70	181.51
6.50	-38.60	-0.05	-51.56	59.21	-147.13	161.24
7.00	-36.15	-0.05	-64.37	76.58	-117.77	127.39
7.50	-33.25	-0.04	-68.14	73.83	-84.26	90.58
8.00	-30.01	-0.03	-62.87	61.90	-51.14	56.44

	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
8.50	-26.57	0.06	-48.55	44.42	-22.90	29.75
9.00	-23.04	0.06	-25.20	26.60	-4.09	12.06
9.50	-19.49	0.00	-0.01	11.43	-0.00	2.70
10.00	-15.94	-0.03	-0.00	0.00	-0.00	0.00

Maximum values of internal forces

Maximum displacement = -59,8 mm
 Minimum displacement = 0,1 mm
 Maximum bending moment = 183,81 kNm/m
 Minimum bending moment = -173,67 kNm/m
 Maximum shear force = 138,92 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

$M_{\max} = 183,81 \text{ kNm/m}; \quad Q = 3,13 \text{ kN/m}$
 $Q_{\max} = 138,92 \text{ kN/m}; \quad M = 82,12 \text{ kNm/m}$

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

Verification of bending:

$M_{\max}/M_{c,Rd} = 0,479 \leq 1$ **Is satisfactory**

Verification of shear:

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

Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 108,84 \text{ MPa}$

Shear stress $\tau_{Ed} = 0,41 \text{ MPa}$

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,206 \leq 1$ **Is satisfactory**

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

Verification of bending:

$M/M_{c,Rd} = 0,214 \leq 1$ **Is satisfactory**

Verification of shear:

$Q_{\max}/V_{c,Rd} = 0,187 \leq 1$ **Is satisfactory**

Verification of plane state of stress:

Normal stress $\sigma_{x,Ed} = 48,62 \text{ MPa}$

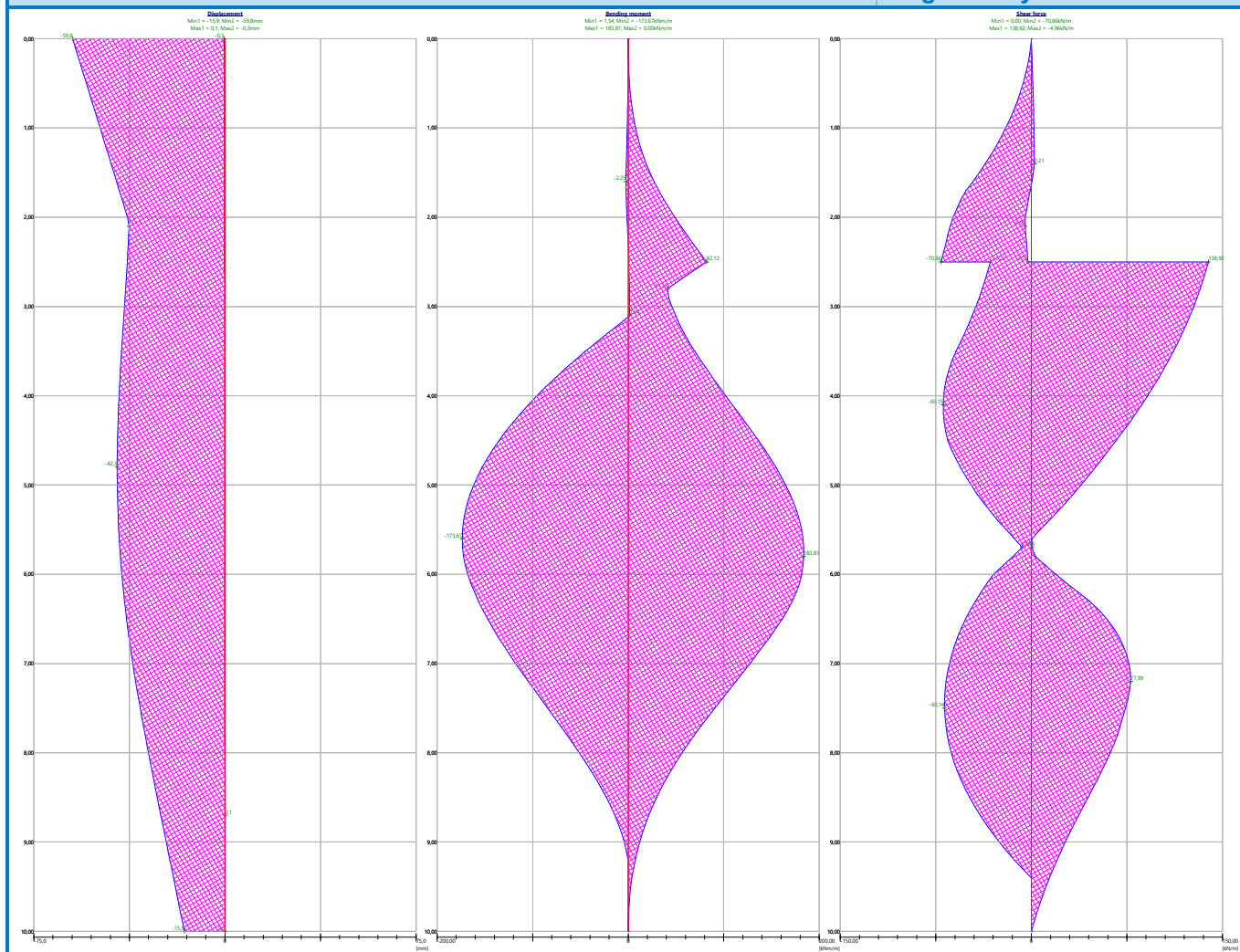
Shear stress $\tau_{Ed} = 18,10 \text{ MPa}$

Verification: $(\sigma_{x,Ed}/(f_y/\gamma_{M0}))^2 + 3*(\tau_{Ed}/(f_y/\gamma_{M0}))^2 = 0,058 \leq 1$ **Is satisfactory**

Cross section is SATISFACTORY

Name : NSK

Stage - analysis : 1 - 1



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	267,90	434,78	293,22	548,50	is satisfactory (91,37 %)

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

Utilization is 91,37 %

Anchors bearing capacity is SATISFACTORY