



Analysis of anti-slide pile

Input data

Project

Date : 28.10.2015

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

Excavations

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)

Geometry of structure

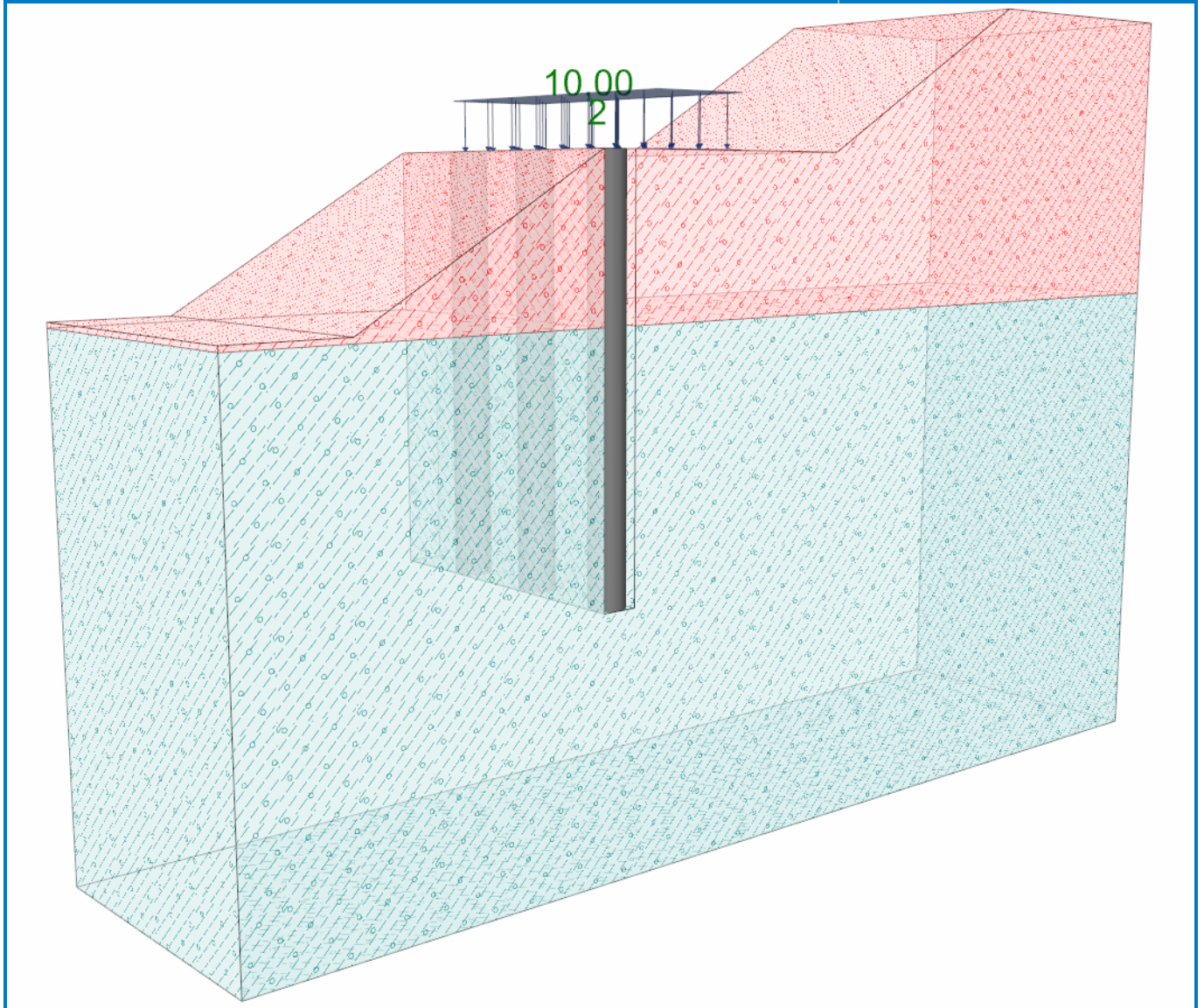
Structure length = 8,00 m

Cross-section name : Pile curtain d = 0,70 m; a = 2,00 m
Computed coefficient of pressure reduction below the ditch = 0,76
Area of cross-section A = 1,92E-01 m²/m
Moment of inertia I = 5,89E-03 m⁴/m
Elastic modulus E = 30000,00 MPa
Shear modulus G = 12500,00 MPa





Name : Geometry

Stage - analysis : 1 - 0





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

No.	Name	Pattern	ν [-]	E_{oed} [MPa]	E_{def} [MPa]
1	Soil No. 1		0,35	24,00	-
2	Soil No. 2		0,35	15,00	-

Soil parameters


Soil No. 1

Unit weight : $\gamma = 23,00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 31,00^\circ$
 Cohesion of soil : $c_{ef} = 4,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 12,00^\circ$
 Soil : cohesionless
 Oedometric modulus : $E_{oed} = 24,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 23,00 \text{ kN/m}^3$

Soil No. 2

Unit weight : $\gamma = 21,00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 28,00^\circ$
 Cohesion of soil : $c_{ef} = 6,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 12,00^\circ$
 Soil : cohesionless
 Oedometric modulus : $E_{oed} = 15,00 \text{ MPa}$
 Saturated unit weight : $\gamma_{sat} = 22,00 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,00	Soil No. 2	
2	-	Soil No. 1	

Excavation

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

Ditch bottom shape

No.	Coordinate x [m]	Depth z [m]
1	0,00	0,00
2	-0,01	0,00
3	-5,01	2,89
4	-6,01	2,89

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	5,00	0,00
3	10,00	-2,89
4	15,00	-2,89
5	15,01	-2,88
6	16,01	-2,88

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

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	10,00		0,50	2,00	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	7,11	23,53
3,40	7,11	23,53

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

Depth [m]	T _{a,p} [kPa]	T _{k,p} [kPa]	T _{p,p} [kPa]	T _{a,z} [kPa]	T _{k,z} [kPa]	T _{p,z} [kPa]
0.00	-0.00	-0.00	-0.00	16.42	16.42	16.42
0.00	-0.00	-0.00	-0.00	16.42	16.42	16.42
0.02	-0.00	0.00	0.00	16.42	16.42	16.42
0.11	0.00	0.00	0.00	16.42	16.42	16.42
0.27	0.00	0.00	0.00	16.42	16.42	16.42
0.36	0.00	0.00	0.00	16.42	16.42	16.42
0.45	0.00	0.00	0.00	16.42	16.42	16.42
0.52	-0.00	-0.00	-0.00	16.42	16.42	16.42
0.73	0.00	0.00	0.00	16.42	16.42	16.42
0.79	-0.00	0.00	0.00	16.42	16.42	16.42
0.93	0.00	0.00	0.00	16.42	16.42	16.42
0.94	-0.00	0.00	0.00	16.42	16.42	16.42
1.09	0.00	0.00	0.00	16.42	16.42	16.42



Depth [m]	Ta,p [kPa]	Tk,p [kPa]	Tp,p [kPa]	Ta,z [kPa]	Tk,z [kPa]	Tp,z [kPa]
1.20	-0.00	0.00	0.00	16.42	16.42	16.42
1.45	0.00	0.00	0.00	16.42	16.42	16.42
1.82	0.00	0.00	0.00	16.42	16.42	16.42
2.18	0.00	0.00	0.00	16.42	16.42	16.42
2.55	0.00	0.00	0.00	16.42	16.42	16.42
2.66	0.00	0.00	0.00	16.42	16.42	16.42
2.89	-0.00	-0.00	-0.00	16.42	16.42	16.42
2.91	0.00	0.00	0.00	16.42	16.42	16.42
3.00	-0.00	-0.00	-0.00	16.42	16.42	16.42
3.27	0.00	0.00	0.00	16.42	16.42	16.42
3.40	-0.00	-0.00	-0.00	16.42	16.42	16.42
3.40	-9.71	-20.72	-100.11	14.43	27.15	269.69
3.64	-10.61	-22.29	-107.06	15.58	29.12	289.01
3.96	-11.85	-24.43	-116.59	17.15	31.83	315.49
3.96	-11.85	-24.43	-116.59	15.65	31.83	315.49
4.00	-12.00	-24.69	-117.77	15.85	32.16	318.74
4.20	-12.76	-26.00	-123.61	16.85	33.83	334.96
4.30	-13.13	-26.65	-126.48	17.35	34.65	355.30
4.36	-13.39	-27.09	-132.00	17.69	35.22	369.32
4.73	-14.78	-29.50	-161.72	19.53	38.28	444.97
5.09	-16.17	-31.90	-191.45	21.36	41.36	520.61
5.45	-17.56	-34.30	-221.18	23.20	44.44	596.25
5.82	-18.95	-36.70	-250.85	25.04	47.51	671.74
5.82	-18.95	-36.71	-250.91	25.04	47.52	671.83
6.07	-19.91	-38.37	-271.53	26.31	49.66	701.78
6.12	-20.11	-38.72	-275.82	26.78	50.11	708.02
6.12	-20.12	-38.73	-275.91	26.79	50.12	492.38
6.18	-20.34	-39.11	-280.64	27.30	50.61	497.11
6.55	-21.73	-41.51	-310.37	30.52	53.70	526.84
6.91	-23.12	-43.92	-340.10	33.73	56.79	556.57
7.25	-24.40	-46.14	-367.60	36.71	59.66	584.07
7.25	-24.40	-46.14	-367.60	36.71	59.68	584.07
7.27	-24.51	-46.32	-369.83	36.95	60.04	586.30
7.64	-25.90	-48.72	-399.56	40.16	64.79	616.03
8.00	-27.29	-51.13	-429.29	43.38	69.53	645.76

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	-12.65	16.42	0.00	0.00
0.02	0.00	0.00	-12.60	16.42	-0.30	0.00
0.20	0.00	0.00	-12.10	16.42	-3.28	0.33
0.40	0.00	0.00	-11.55	16.42	-6.57	1.31
0.60	0.00	0.00	-11.00	16.42	-9.85	2.96
0.80	0.00	0.00	-10.45	16.42	-13.14	5.26
1.00	0.00	0.00	-9.90	16.42	-16.42	8.21
1.20	0.00	0.00	-9.35	16.42	-19.71	11.82
1.40	0.00	0.00	-8.80	16.42	-22.99	16.10



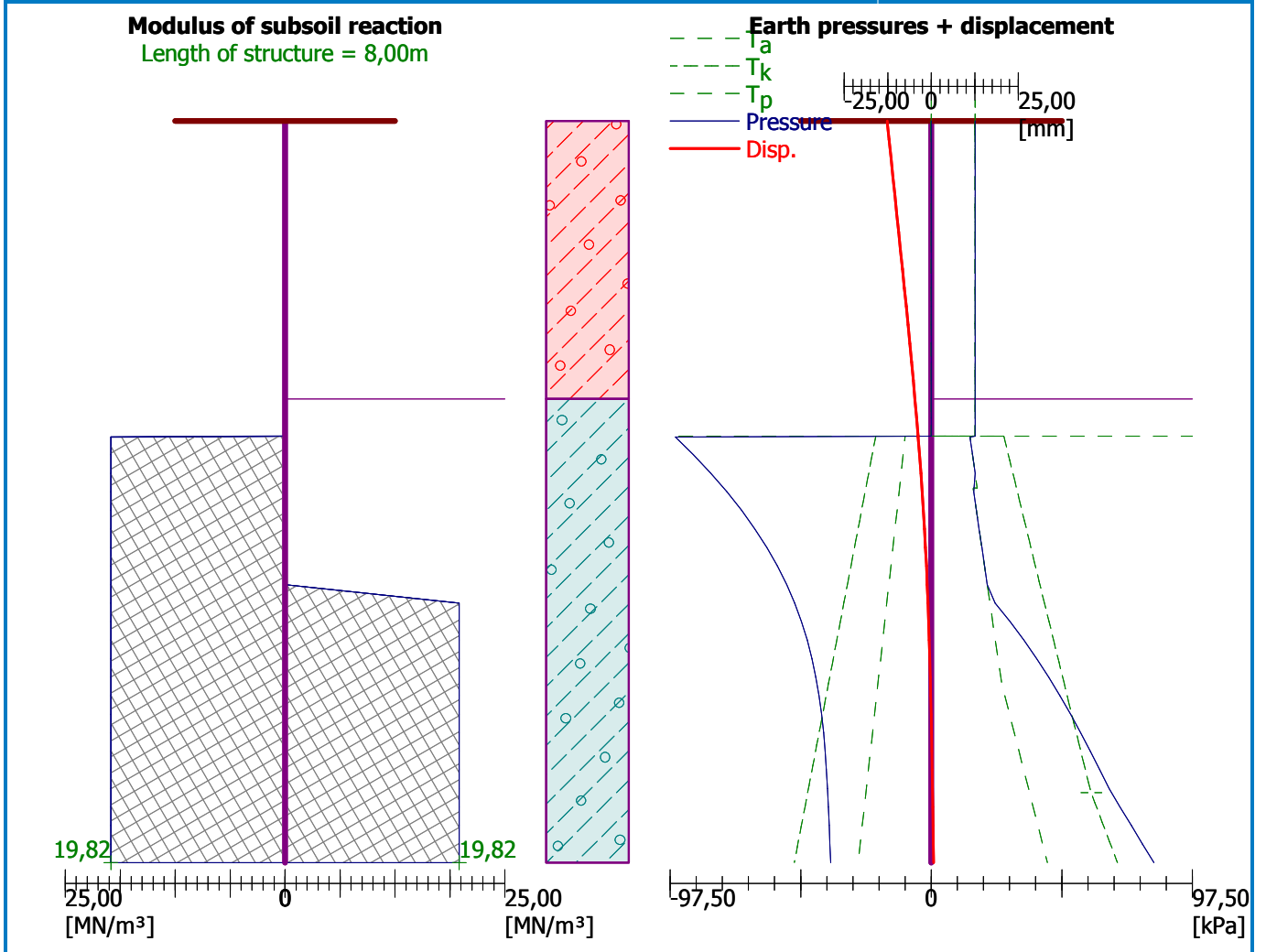
Depth [m]	kh,p [MN/m ³]	kh,z [MN/m ³]	Displacement [mm]	Pressure [kPa]	Shear Force [kN/m]	Moment [kNm/m]
1.60	0.00	0.00	-8.26	16.42	-26.28	21.02
1.80	0.00	0.00	-7.73	16.42	-29.56	26.61
2.00	0.00	0.00	-7.20	16.42	-32.85	32.85
2.20	0.00	0.00	-6.67	16.42	-36.13	39.74
2.40	0.00	0.00	-6.16	16.42	-39.42	47.30
2.60	0.00	0.00	-5.66	16.42	-42.70	55.51
2.80	0.00	0.00	-5.16	16.42	-45.99	64.38
3.00	0.00	0.00	-4.69	16.42	-49.27	73.91
3.20	0.00	0.00	-4.23	16.42	-52.56	84.09
3.39	0.00	0.00	-3.81	16.42	-55.71	94.48
3.41	19.82	0.00	-3.77	-81.04	-55.58	95.37
3.60	19.82	0.00	-3.37	-73.41	-40.76	104.60
3.80	19.82	0.00	-2.97	-65.93	-26.83	111.33
4.00	19.82	0.00	-2.60	-60.44	-14.21	115.42
4.20	19.82	0.00	-2.26	-53.93	-2.78	117.10
4.40	19.82	0.00	-1.94	-47.95	7.40	116.62
4.60	19.82	0.00	-1.65	-42.49	16.44	114.22
4.80	19.82	0.00	-1.39	-37.54	24.43	110.11
5.00	19.82	0.00	-1.14	-33.08	31.49	104.51
5.20	19.82	19.82	-0.93	-27.11	37.71	97.47
5.40	19.82	19.82	-0.73	-19.01	42.31	89.44
5.60	19.82	19.82	-0.56	-11.71	45.37	80.64
5.80	19.82	19.82	-0.40	-5.13	47.04	71.38
6.00	19.82	19.82	-0.26	0.80	47.46	61.91
6.20	19.82	19.82	-0.13	6.19	46.76	52.47
6.40	19.82	19.82	-0.02	11.10	45.02	43.27
6.60	19.82	19.82	0.08	15.63	42.34	34.52
6.80	19.82	19.82	0.18	19.85	38.79	26.39
7.00	19.82	19.82	0.27	23.82	34.42	19.06
7.20	19.82	19.82	0.36	27.63	29.27	12.68
7.40	19.82	19.82	0.44	32.06	23.30	7.40
7.60	19.82	19.82	0.52	36.59	16.44	3.41
7.80	19.82	19.82	0.60	41.09	8.67	0.88
8.00	19.82	19.82	0.69	45.58	0.00	-0.00

Maximum shear force = 55,84 kN/m
Maximum moment = 117,10 kNm/m
Maximum displacement = 12,7 mm



Name : Analysis

Stage - analysis : 1 - -1



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	-12.65	-12.65	0.00	0.00	0.00	0.00
0.02	-12.60	-12.60	-0.30	-0.30	0.00	0.00
0.20	-12.10	-12.10	-3.28	-3.28	0.33	0.33
0.40	-11.55	-11.55	-6.57	-6.57	1.31	1.31
0.60	-11.00	-11.00	-9.85	-9.85	2.96	2.96
0.80	-10.45	-10.45	-13.14	-13.14	5.26	5.26
1.00	-9.90	-9.90	-16.42	-16.42	8.21	8.21
1.20	-9.35	-9.35	-19.71	-19.71	11.82	11.82
1.40	-8.80	-8.80	-22.99	-22.99	16.10	16.10
1.60	-8.26	-8.26	-26.28	-26.28	21.02	21.02
1.80	-7.73	-7.73	-29.56	-29.56	26.61	26.61
2.00	-7.20	-7.20	-32.85	-32.85	32.85	32.85
2.20	-6.67	-6.67	-36.13	-36.13	39.74	39.74
2.40	-6.16	-6.16	-39.42	-39.42	47.30	47.30
2.60	-5.66	-5.66	-42.70	-42.70	55.51	55.51
2.80	-5.16	-5.16	-45.99	-45.99	64.38	64.38



	Disp. min [mm]	Disp. max [mm]	Shear force min. [kN/m]	Shear force max [kN/m]	Moment min. [kNm/m]	Moment max. [kNm/m]
3.00	-4.69	-4.69	-49.27	-49.27	73.91	73.91
3.20	-4.23	-4.23	-52.56	-52.56	84.09	84.09
3.39	-3.81	-3.81	-55.71	-55.71	94.48	94.48
3.40	-3.79	-3.79	-55.84	-55.84	94.93	94.93
3.40	-3.79	-3.79	-55.84	-55.84	94.93	94.93
3.41	-3.77	-3.77	-55.58	-55.58	95.37	95.37
3.41	-3.77	-3.77	-55.58	-55.58	95.37	95.37
3.60	-3.37	-3.37	-40.76	-40.76	104.60	104.60
3.80	-2.97	-2.97	-26.83	-26.83	111.33	111.33
4.00	-2.60	-2.60	-14.21	-14.21	115.42	115.42
4.20	-2.26	-2.26	-2.78	-2.78	117.10	117.10
4.40	-1.94	-1.94	7.40	7.40	116.62	116.62
4.60	-1.65	-1.65	16.44	16.44	114.22	114.22
4.80	-1.39	-1.39	24.43	24.43	110.11	110.11
5.00	-1.14	-1.14	31.49	31.49	104.51	104.51
5.20	-0.93	-0.93	37.71	37.71	97.47	97.47
5.40	-0.73	-0.73	42.31	42.31	89.44	89.44
5.60	-0.56	-0.56	45.37	45.37	80.64	80.64
5.80	-0.40	-0.40	47.04	47.04	71.38	71.38
6.00	-0.26	-0.26	47.46	47.46	61.91	61.91
6.20	-0.13	-0.13	46.76	46.76	52.47	52.47
6.40	-0.02	-0.02	45.02	45.02	43.27	43.27
6.60	0.08	0.08	42.34	42.34	34.52	34.52
6.80	0.18	0.18	38.79	38.79	26.39	26.39
7.00	0.27	0.27	34.42	34.42	19.06	19.06
7.20	0.36	0.36	29.27	29.27	12.68	12.68
7.40	0.44	0.44	23.30	23.30	7.40	7.40
7.60	0.52	0.52	16.44	16.44	3.41	3.41
7.80	0.60	0.60	8.67	8.67	0.88	0.88
8.00	0.69	0.69	0.00	0.00	-0.00	-0.00

Maximum values of internal forces

Maximum displacement = -12,7 mm
 Minimum displacement = 0,7 mm
 Maximum bending moment = 117,10 kNm/m
 Minimum bending moment = 0,00 kNm/m
 Maximum shear force = 47,46 kN/m

Verification of RC cross section (Pile curtain $d = 0,70$ m; $a = 2,00$ m)

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

Dimensioning of reinforcement:

Reinforcement - 6 pc bars 30,0 mm; covering 40,0 mm
 Type of structure (reinforcement ratio) : beam

Reinforcement ratio $\rho = 0,551 \% > 0,130 \% = \rho_{min}$

Load : $N_{Ed} = 0,00$ kN (tension) ; $M_{Ed} = 234,20$ kNm
 Bearing capacity : $N_{Rd} = 0,00$ kN; $M_{Rd} = 454,62$ kNm



Designed pile reinforcement is **SATISFACTORY**

Verification of shear reinforcement:

Ultimate shear force: $V_{Rd} = 128,14 \text{ kN} > 111,68 \text{ kN} = V_{Ed}$

Cross-section is **SATISFACTORY**.

Cross-section is **SATISFACTORY**

