Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

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Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		-22.85	-11.78	0.0	13.2	
1	EC7(NL)-Step 6.2		-14.87	-9.21	0.0	13.1	
1	EC7(NL)-Step 6.3		-22.85	-11.78	0.0	13.2	
1	EC7(NL)-Step 6.4		-14.87	-9.21	0.0	13.1	
1	EC7(NL)-Step 6.5	6.4	-22.85	-11.78	0.0	13.2	
1	EC7(NL)-Step 6.5 x 1.000		-22.85	-11.78			
2	EC7(NL)-Step 6.1						(D)*
2	EC7(NL)-Step 6.2						(D)*
2	EC7(NL)-Step 6.3		-8.99	-7.39	0.0	12.1	
2	EC7(NL)-Step 6.4		-13.06	-9.92	0.0	12.1	
2	EC7(NL)-Step 6.5	2.3	-8.99	-7.39	0.0	12.1	
2	EC7(NL)-Step 6.5 x 1.000		-8.99	-7.39			
3	EC7(NL)-Step 6.1						(D)*
3	EC7(NL)-Step 6.2						(D)*
3	EC7(NL)-Step 6.3		-8.99	-7.39	11.3	12.1	
3	EC7(NL)-Step 6.4		-8.99	-7.39	11.3	12.1	
3	EC7(NL)-Step 6.5	2.3	-8.99	-7.39	11.3	12.1	
3	EC7(NL)-Step 6.5 x 1.000		-8.99	-7.39			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		86.62	79.95	12.6	14.2	
4	EC7(NL)-Step 6.4		75.31	79.90	12.7	14.5	
4	EC7(NL)-Step 6.5	-20.5	86.62	79.95	12.6	14.2	
4	EC7(NL)-Step 6.5 x 1.000		86.62	79.95			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		106.77	86.31	15.0	16.9	
5	EC7(NL)-Step 6.4		98.36	82.14	15.0	17.0	
5	EC7(NL)-Step 6.5	-23.2	106.77	86.31	15.0	16.9	
5	EC7(NL)-Step 6.5 x 1.000		106.77	86.31			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		164.92	117.20	20.4	23.3	
6	EC7(NL)-Step 6.4		159.61	114.50	20.9	23.8	
6	EC7(NL)-Step 6.5	-20.4	164.92	117.20	20.4	23.3	
6	EC7(NL)-Step 6.5 x 1.000		164.92	117.20			
7	EC7(NL)-Step 6.1						(D)*
7	EC7(NL)-Step 6.2						(D)*
7	EC7(NL)-Step 6.3		-350.41	248.31	43.7	48.4	
7	EC7(NL)-Step 6.4		-350.41	241.99	43.5	48.5	
7	EC7(NL)-Step 6.5	15.3	-271.35	207.89	27.3	31.0	
7	EC7(NL)-Step 6.5 x 1.200		-325.62	249.47			
8	EC7(NL)-Step 6.1						(D)*
8	EC7(NL)-Step 6.2						(D)*
8	EC7(NL)-Step 6.3		-330.65	248.93	50.7	55.0	
8	EC7(NL)-Step 6.4		-330.65	233.28	50.1	54.5	
8	EC7(NL)-Step 6.5	14.4	-276.90	217.70	26.7	30.6	
8	EC7(NL)-Step 6.5 x 1.200		-332.28	261.24			
9	EC7(NL)-Step 6.1						(D)*
9	EC7(NL)-Step 6.2						(D)*
9	EC7(NL)-Step 6.3		-435.17	251.29	40.9	45.4	
9	EC7(NL)-Step 6.4		-435.17	248.35	40.9	45.5	
9	EC7(NL)-Step 6.5	26.1	-336.79	218.18	28.0	32.0	
9	EC7(NL)-Step 6.5 x 1.200		-404.14	261.81			
10	EC7(NL)-Step 6.1						(D)*
10	EC7(NL)-Step 6.2						(D)*

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
10	EC7(NL)-Step 6.3		-472.02	251.99	43.8	47.5	
10	EC7(NL)-Step 6.4		-472.02	247.78	43.7	47.4	
10	EC7(NL)-Step 6.5	31.8	-359.89	217.81	31.2	35.0	
10	EC7(NL)-Step 6.5 x 1.200		-431.87	261.38			
11	EC7(NL)-Step 6.1						(D)*
11	EC7(NL)-Step 6.2						(D)*
11	EC7(NL)-Step 6.3		-434.89	332.49	42.5	46.8	
11	EC7(NL)-Step 6.4		-410.68	**352.62**	42.3	46.9	
11	EC7(NL)-Step 6.5	29.8	-347.84	288.95	28.9	33.1	
11	EC7(NL)-Step 6.5 x 1.200		-417.41	346.74			
12	EC7(NL)-Step 6.1						(D)*
12	EC7(NL)-Step 6.2						(D)*
12	EC7(NL)-Step 6.3		-361.36	302.87	**54.0**	58.6	
12	EC7(NL)-Step 6.4		-358.69	270.66	**54.0**	**58.8**	
12	EC7(NL)-Step 6.5	24.7	-329.58	246.55	34.3	38.3	
12	EC7(NL)-Step 6.5 x 1.200		-395.50	295.87			
13	EC7(NL)-Step 6.1						(D)*
13	EC7(NL)-Step 6.2						(D)*
13	EC7(NL)-Step 6.3		-303.90	198.00	39.2	43.6	
13	EC7(NL)-Step 6.4		-310.27	220.50	38.7	43.1	
13	EC7(NL)-Step 6.5	23.2	-303.87	197.25	24.7	29.2	
13	EC7(NL)-Step 6.5 x 1.200		-364.65	236.70			
14	EC7(NL)-Step 6.1						(D)*
14	EC7(NL)-Step 6.2						(D)*
14	EC7(NL)-Step 6.3		-484.76	294.31	47.3	51.3	
14	EC7(NL)-Step 6.4		-451.58	275.69	47.0	50.9	
14	EC7(NL)-Step 6.5	41.7	-419.76	269.86	31.5	35.7	
14	EC7(NL)-Step 6.5 x 1.200		**-503.72**	323.84			
15	EC7(NL)-Step 6.1						(D)*
15	EC7(NL)-Step 6.2						(D)*
15	EC7(NL)-Step 6.3		-453.25	301.09	47.7	52.1	
15	EC7(NL)-Step 6.4		-441.32	292.39	47.8	52.2	
15	EC7(NL)-Step 6.5	41.1	-416.39	279.76	30.8	35.1	
15	EC7(NL)-Step 6.5 x 1.200		-499.66	335.71			
16	EC7(NL)-Step 6.1						(D)*
16	EC7(NL)-Step 6.2						(D)*
16	EC7(NL)-Step 6.3		-284.60	168.46	37.9	42.4	
16	EC7(NL)-Step 6.4		-284.60	168.25	38.0	42.5	
16	EC7(NL)-Step 6.5	**54.4**	-221.60	142.30	29.0	33.2	
16	EC7(NL)-Step 6.5 x 1.200		-265.93	170.76			

Max		**54.4**	**-503.72**	**352.62**	**54.0**	**58.8**	

Stage nr.	Verification type	Vertical balance
1	EC7(NL)-Step 6.1	Upwards
1	EC7(NL)-Step 6.2	Upwards
1	EC7(NL)-Step 6.3	Upwards
1	EC7(NL)-Step 6.4	Upwards
1	EC7(NL)-Step 6.5	Upwards
1	EC7(NL)-Step 6.5 x 1.000	
2	EC7(NL)-Step 6.1	
2	EC7(NL)-Step 6.2	
2	EC7(NL)-Step 6.3	Upwards
2	EC7(NL)-Step 6.4	Upwards
2	EC7(NL)-Step 6.5	Upwards
2	EC7(NL)-Step 6.5 x 1.000	
3	EC7(NL)-Step 6.1	
3	EC7(NL)-Step 6.2	
3	EC7(NL)-Step 6.3	Upwards
3	EC7(NL)-Step 6.4	Upwards
3	EC7(NL)-Step 6.5	Upwards
3	EC7(NL)-Step 6.5 x 1.000	

Stage nr.	Verification type	Vertical balance
4	EC7(NL)-Step 6.1	
4	EC7(NL)-Step 6.2	
4	EC7(NL)-Step 6.3	Sufficient
4	EC7(NL)-Step 6.4	Sufficient
4	EC7(NL)-Step 6.5	Sufficient
4	EC7(NL)-Step 6.5 x 1.000	
5	EC7(NL)-Step 6.1	
5	EC7(NL)-Step 6.2	
5	EC7(NL)-Step 6.3	Sufficient
5	EC7(NL)-Step 6.4	Sufficient
5	EC7(NL)-Step 6.5	Sufficient
5	EC7(NL)-Step 6.5 x 1.000	
6	EC7(NL)-Step 6.1	
6	EC7(NL)-Step 6.2	
6	EC7(NL)-Step 6.3	Sufficient
6	EC7(NL)-Step 6.4	Sufficient
6	EC7(NL)-Step 6.5	Sufficient
6	EC7(NL)-Step 6.5 x 1.000	
7	EC7(NL)-Step 6.1	
7	EC7(NL)-Step 6.2	
7	EC7(NL)-Step 6.3	Sufficient
7	EC7(NL)-Step 6.4	Sufficient
7	EC7(NL)-Step 6.5	Sufficient
7	EC7(NL)-Step 6.5 x 1.200	
8	EC7(NL)-Step 6.1	
8	EC7(NL)-Step 6.2	
8	EC7(NL)-Step 6.3	Sufficient
8	EC7(NL)-Step 6.4	Sufficient
8	EC7(NL)-Step 6.5	Sufficient
8	EC7(NL)-Step 6.5 x 1.200	
9	EC7(NL)-Step 6.1	
9	EC7(NL)-Step 6.2	
9	EC7(NL)-Step 6.3	Sufficient
9	EC7(NL)-Step 6.4	Sufficient
9	EC7(NL)-Step 6.5	Sufficient
9	EC7(NL)-Step 6.5 x 1.200	
10	EC7(NL)-Step 6.1	
10	EC7(NL)-Step 6.2	
10	EC7(NL)-Step 6.3	Sufficient
10	EC7(NL)-Step 6.4	Sufficient
10	EC7(NL)-Step 6.5	Sufficient
10	EC7(NL)-Step 6.5 x 1.200	
11	EC7(NL)-Step 6.1	
11	EC7(NL)-Step 6.2	
11	EC7(NL)-Step 6.3	Sufficient
11	EC7(NL)-Step 6.4	Sufficient
11	EC7(NL)-Step 6.5	Sufficient
11	EC7(NL)-Step 6.5 x 1.200	
12	EC7(NL)-Step 6.1	
12	EC7(NL)-Step 6.2	
12	EC7(NL)-Step 6.3	Sufficient
12	EC7(NL)-Step 6.4	Sufficient
12	EC7(NL)-Step 6.5	Sufficient
12	EC7(NL)-Step 6.5 x 1.200	
13	EC7(NL)-Step 6.1	
13	EC7(NL)-Step 6.2	
13	EC7(NL)-Step 6.3	Sufficient
13	EC7(NL)-Step 6.4	Sufficient
13	EC7(NL)-Step 6.5	Sufficient
13	EC7(NL)-Step 6.5 x 1.200	
14	EC7(NL)-Step 6.1	
14	EC7(NL)-Step 6.2	
14	EC7(NL)-Step 6.3	Sufficient
14	EC7(NL)-Step 6.4	Sufficient

Stage nr.	Verification type	Vertical balance
14	EC7(NL)-Step 6.5	Sufficient
14	EC7(NL)-Step 6.5 x 1.200	
15	EC7(NL)-Step 6.1	
15	EC7(NL)-Step 6.2	
15	EC7(NL)-Step 6.3	Sufficient
15	EC7(NL)-Step 6.4	Sufficient
15	EC7(NL)-Step 6.5	Sufficient
15	EC7(NL)-Step 6.5 x 1.200	
16	EC7(NL)-Step 6.1	
16	EC7(NL)-Step 6.2	
16	EC7(NL)-Step 6.3	Upwards
16	EC7(NL)-Step 6.4	Upwards
16	EC7(NL)-Step 6.5	Upwards
16	EC7(NL)-Step 6.5 x 1.200	

Summary		Upwards/Sufficient

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut Anker Ø101.6x28 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
3	EC7(NL)-Step 6.1			(D)*			
3	EC7(NL)-Step 6.2			(D)*			
3	EC7(NL)-Step 6.3	0.00					
3	EC7(NL)-Step 6.4	0.00					
3	EC7(NL)-Step 6.5	0.00					
3	EC7(NL)-Step 6.5 x 1.000	0.00					
4	EC7(NL)-Step 6.1			(D)*			
4	EC7(NL)-Step 6.2			(D)*			
4	EC7(NL)-Step 6.3	100.00	Elastic				
4	EC7(NL)-Step 6.4	100.00	Elastic				
4	EC7(NL)-Step 6.5	100.00	Elastic				
4	EC7(NL)-Step 6.5 x 1.000	100.00	Elastic				
5	EC7(NL)-Step 6.1			(D)*			
5	EC7(NL)-Step 6.2			(D)*			
5	EC7(NL)-Step 6.3	107.66	Elastic				
5	EC7(NL)-Step 6.4	103.23	Elastic				
5	EC7(NL)-Step 6.5	107.66	Elastic				
5	EC7(NL)-Step 6.5 x 1.000	107.66	Elastic				
6	EC7(NL)-Step 6.1			(D)*			
6	EC7(NL)-Step 6.2			(D)*			
6	EC7(NL)-Step 6.3	184.93	Elastic				
6	EC7(NL)-Step 6.4	181.71	Elastic				
6	EC7(NL)-Step 6.5	184.93	Elastic				
6	EC7(NL)-Step 6.5 x 1.000	184.93	Elastic				
7	EC7(NL)-Step 6.1			(D)*			
7	EC7(NL)-Step 6.2			(D)*			
7	EC7(NL)-Step 6.3	477.87	Elastic				
7	EC7(NL)-Step 6.4	470.38	Elastic				
7	EC7(NL)-Step 6.5	389.71	Elastic				
7	EC7(NL)-Step 6.5 x 1.200	467.65	Elastic				
8	EC7(NL)-Step 6.1			(D)*			
8	EC7(NL)-Step 6.2			(D)*			
8	EC7(NL)-Step 6.3	465.03	Elastic				
8	EC7(NL)-Step 6.4	446.47	Elastic				
8	EC7(NL)-Step 6.5	399.97	Elastic				
8	EC7(NL)-Step 6.5 x 1.200	479.96	Elastic				

Stage nr.	Verification type	Anchor/strut Anker Ø101.6x28 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
9	EC7(NL)-Step 6.1			(D)*			
9	EC7(NL)-Step 6.2			(D)*			
9	EC7(NL)-Step 6.3	509.13	Elastic				
9	EC7(NL)-Step 6.4	505.65	Elastic				
9	EC7(NL)-Step 6.5	423.39	Elastic				
9	EC7(NL)-Step 6.5 x 1.200	508.06	Elastic				
10	EC7(NL)-Step 6.1			(D)*			
10	EC7(NL)-Step 6.2			(D)*			
10	EC7(NL)-Step 6.3	566.09	Elastic				
10	EC7(NL)-Step 6.4	561.11	Elastic				
10	EC7(NL)-Step 6.5	468.03	Elastic				
10	EC7(NL)-Step 6.5 x 1.200	561.63	Elastic				
11	EC7(NL)-Step 6.1			(D)*			
11	EC7(NL)-Step 6.2			(D)*			
11	EC7(NL)-Step 6.3	243.06	Elastic				
11	EC7(NL)-Step 6.4	322.49	Elastic				
11	EC7(NL)-Step 6.5	323.09	Elastic				
11	EC7(NL)-Step 6.5 x 1.200	387.71	Elastic				
12	EC7(NL)-Step 6.1			(D)*			
12	EC7(NL)-Step 6.2			(D)*			
12	EC7(NL)-Step 6.3	631.03	Elastic				
12	EC7(NL)-Step 6.4	543.73	Elastic				
12	EC7(NL)-Step 6.5	521.05	Elastic				
12	EC7(NL)-Step 6.5 x 1.200	625.26	Elastic				
13	EC7(NL)-Step 6.1			(D)*			
13	EC7(NL)-Step 6.2			(D)*			
13	EC7(NL)-Step 6.3	443.96	Elastic				
13	EC7(NL)-Step 6.4	478.00	Elastic				
13	EC7(NL)-Step 6.5	446.63	Elastic				
13	EC7(NL)-Step 6.5 x 1.200	535.96	Elastic				
14	EC7(NL)-Step 6.1			(D)*			
14	EC7(NL)-Step 6.2			(D)*			
14	EC7(NL)-Step 6.3	648.01	Elastic				
14	EC7(NL)-Step 6.4	596.46	Elastic				
14	EC7(NL)-Step 6.5	586.44	Elastic				
14	EC7(NL)-Step 6.5 x 1.200	703.73	Elastic				
15	EC7(NL)-Step 6.1			(D)*			
15	EC7(NL)-Step 6.2			(D)*			
15	EC7(NL)-Step 6.3	627.28	Elastic				
15	EC7(NL)-Step 6.4	609.94	Elastic				
15	EC7(NL)-Step 6.5	589.54	Elastic				
15	EC7(NL)-Step 6.5 x 1.200	**707.45**	Elastic				
16	EC7(NL)-Step 6.1						(D)*
16	EC7(NL)-Step 6.2						(D)*
16	EC7(NL)-Step 6.3				**337.76**	Elastic	
16	EC7(NL)-Step 6.4				337.50	Elastic	
16	EC7(NL)-Step 6.5				277.53	Elastic	
16	EC7(NL)-Step 6.5 x 1.200				333.04	Elastic	

Max		**707.45**			**337.76**		

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

The force is in the direction of the anchor.

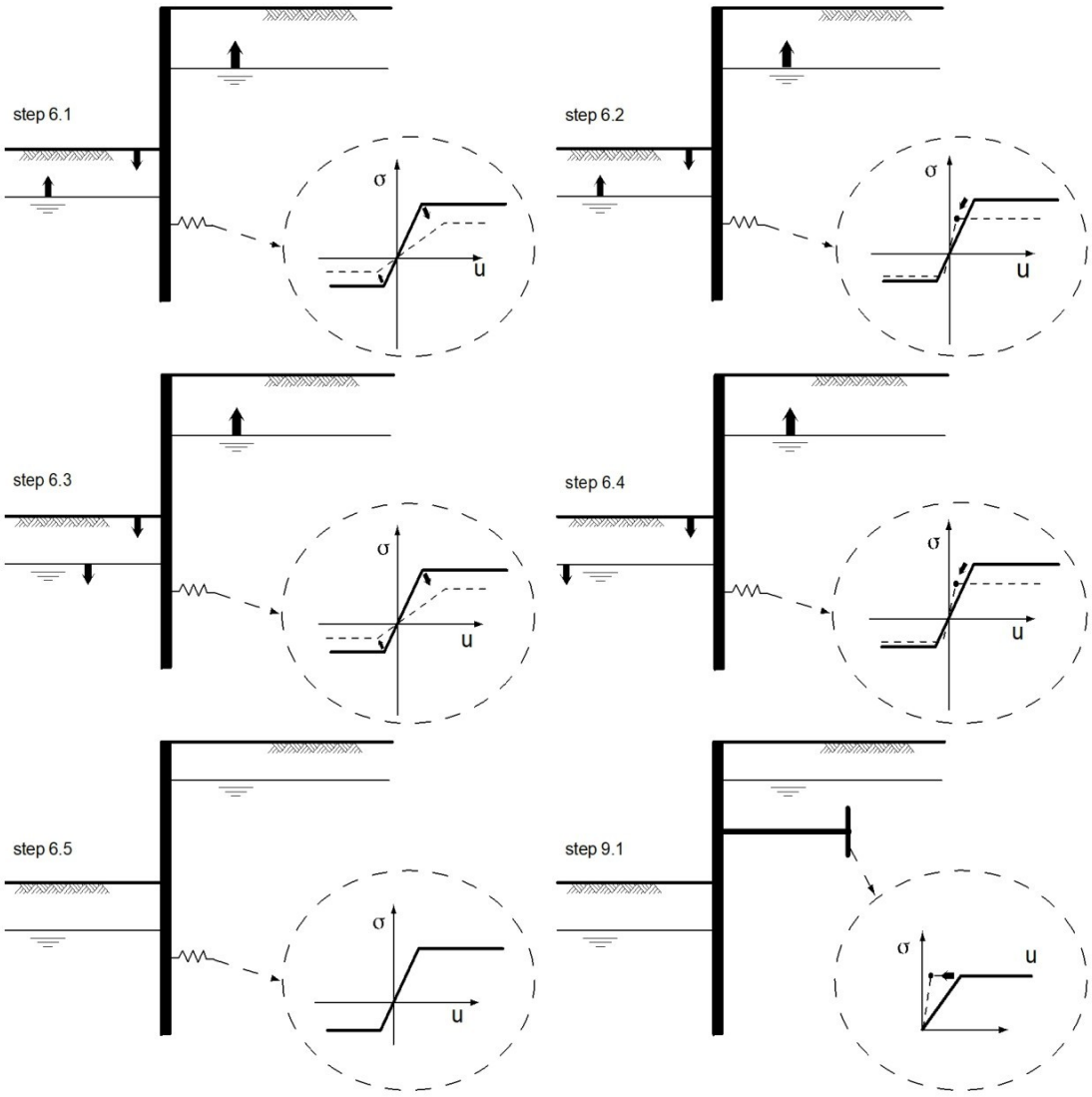
2.3 Overall Stability per Stage

Stage name	Stability factor [-]
B - Aanbrengen nieuwe damwand	4.27
B - Bodem reductie	4.37
B - Aanbrengen ankers	4.37
B - Voorspannen ankers	4.14
B - Aanvulling tussen damwanden	3.57
B - Aanvullen + Bodembescherming	2.90
G - Terrein + Opslag_psi0	1.49
G - Terrein_psi0 + Opslag	1.31
G - Terrein_psi0 + Opslag_psi0 + Haalpen	1.47
G - Opslag_psi0 + Kraan + Haalpen_psi0	1.50
G - Terrein_psi0 + Opslag_psi0 + IJs	1.73
G - Terrein_psi0 + Opslag_psi0 - val ELW	1.38
G - Terrein_psi0 + Opslag_psi0 - MHW	1.61
G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW	1.36
G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW	1.36
G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0	1.75

2.4 Warnings

Vertical balance:
The resultant vertical friction force is directed upward in stage 1,2,3,16 because the friction force on the passive side exceeds that on the active side. This might be prevented by reducing the friction angle Delta on the passive side.

2.5 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	Yes
Number of construction stages	16
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	16.50 m
Level top side	22.50 m
Number of sections	1
q_b;max	15.00 MPa
Xi factor	0.93

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 26 -700 (S3...	6.00	22.50	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 26 -700 (S3...	1.2541E+05	0.79	9.9075E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 26 -700 (S3...	923.00	1.00	1.00	0.77	710.71

3.2.4 Properties for Vertical Balance

Section name	From [m]	To [m]	Height [mm]	Section area [cm²/m']
AZ 26 -700 (S3...	6.00	22.50	460.00	187.00

3.3 Calculation Options

First stage represents initial situation	No
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B - Aanbrengen nieuwe damwand

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	2: B - Bodem reductie
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	

- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	3: B - Aanbrengen ankers
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	4: B - Voorspannen ankers
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	5: B - Aanvulling tussen damwanden
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	

- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	6: B - Aanvullen + Bodembescherming
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	7: G - Terrein + Opslag_psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900

- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	8: G - Terrein_psi0 + Opslag
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	

- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	9: G - Terrein_psi0 + Opslag_psi0 + Haalpen
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	10: G - Opslag_psi0 + Kraan + Haalpen_psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined

Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	11: G - Terrein_psi0 + Opslag_psi0 + IJs
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	12: G - Terrein_psi0 + Opslag_psi0 - val ELW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	

- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	13: G - Terrein_psi0 + Opslag_psi0 - MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200

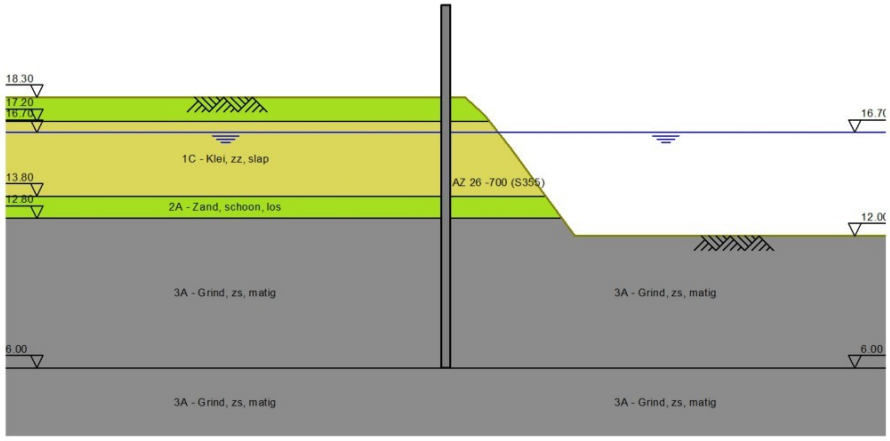
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	14: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	15: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000

Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	16: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

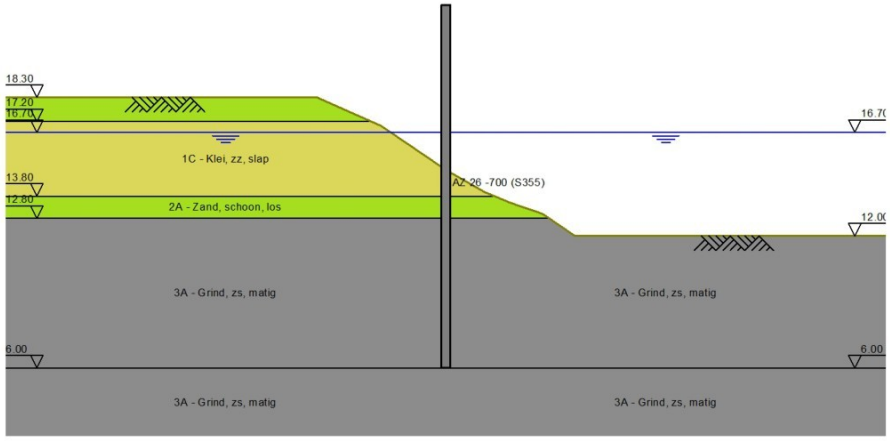
4 Outline Stage 1: B - Aanbrengen nieuwe damwand

Outline - Stage 1: B - Aanbrengen nieuwe damwand



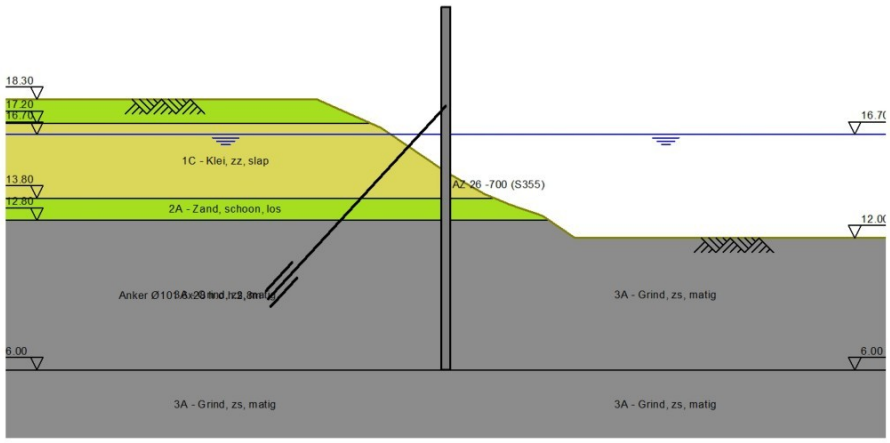
5 Outline Stage 2: B - Bodem reductie

Outline - Stage 2: B - Bodem reductie



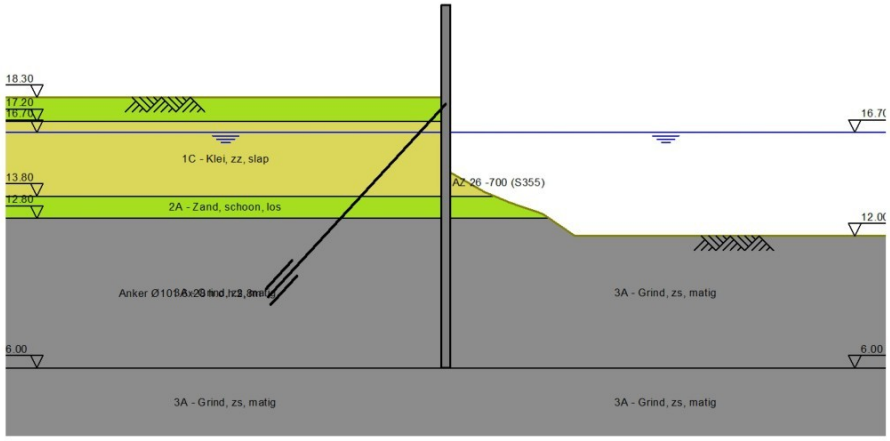
6 Outline Stage 3: B - Aanbrengen ankers

Outline - Stage 3: B - Aanbrengen ankers



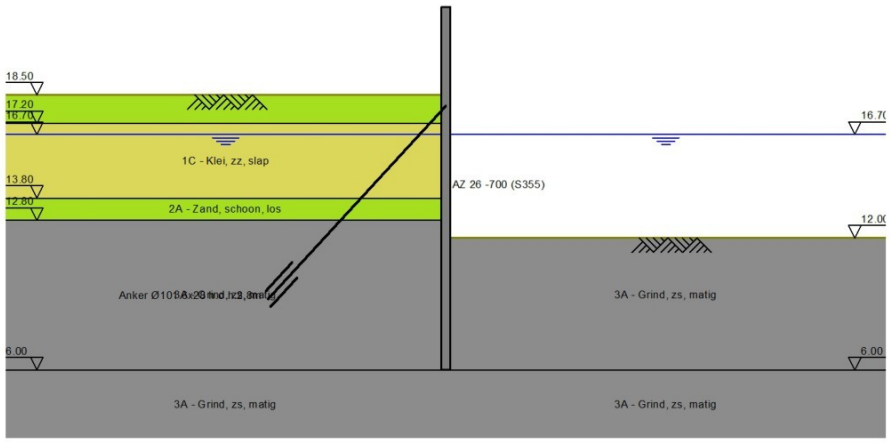
7 Outline Stage 4: B - Voorspannen ankers

Outline - Stage 4: B - Voorspannen ankers



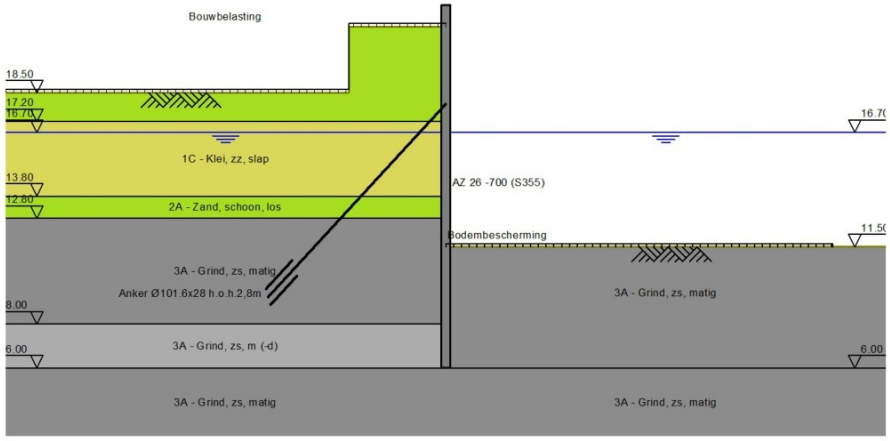
8 Outline Stage 5: B - Aanvulling tussen damwanden

Outline - Stage 5: B - Aanvulling tussen damwanden



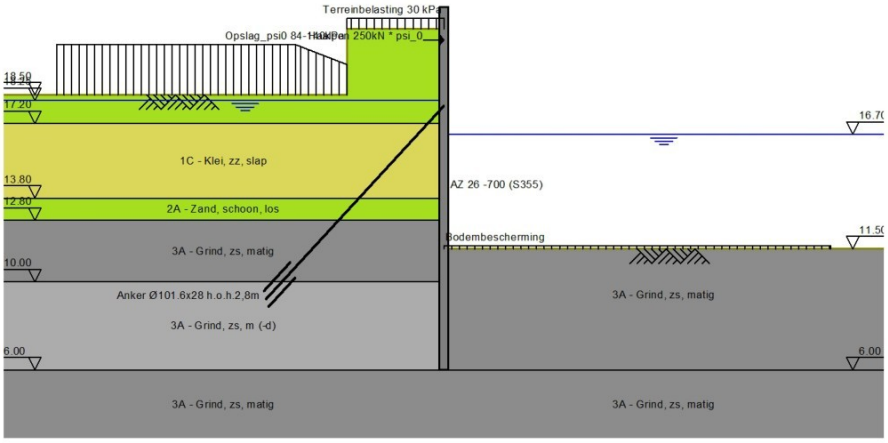
9 Outline Stage 6: B - Aanvullen + Bodembescherming

Outline - Stage 6: B - Aanvullen + Bodembescherming



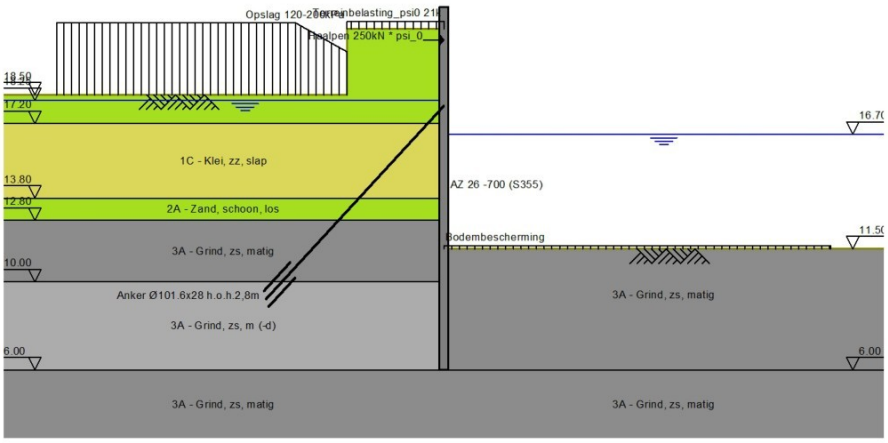
10 Outline Stage 7: G - Terrein + Opslag_psi0

Outline - Stage 7: G - Terrein + Opslag_psi0



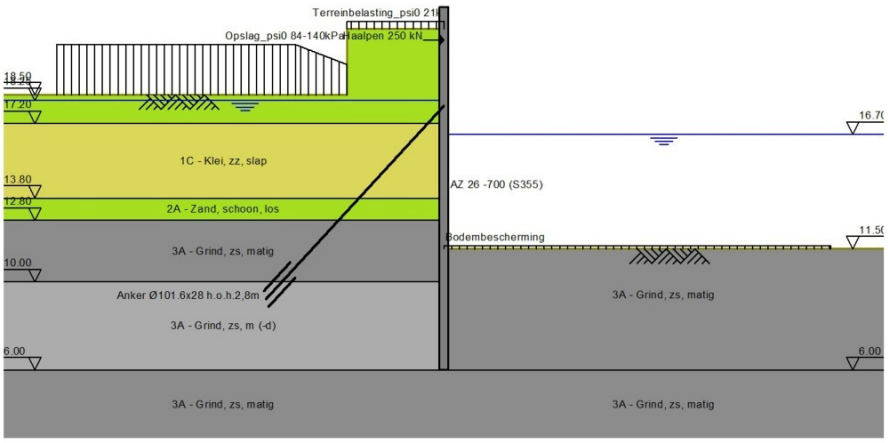
11 Outline Stage 8: G - Terrein_psi0 + Opslag

Outline - Stage 8: G - Terrein_psi0 + Opslag

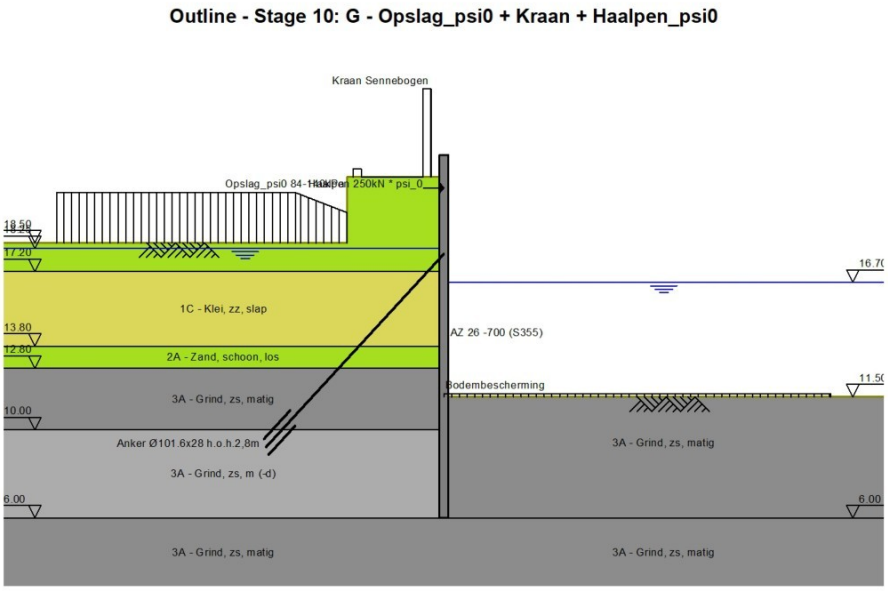


12 Outline Stage 9: G - Terrein_psi0 + Opslag_psi0 + Haalpen

Outline - Stage 9: G - Terrein_psi0 + Opslag_psi0 + Haalpen

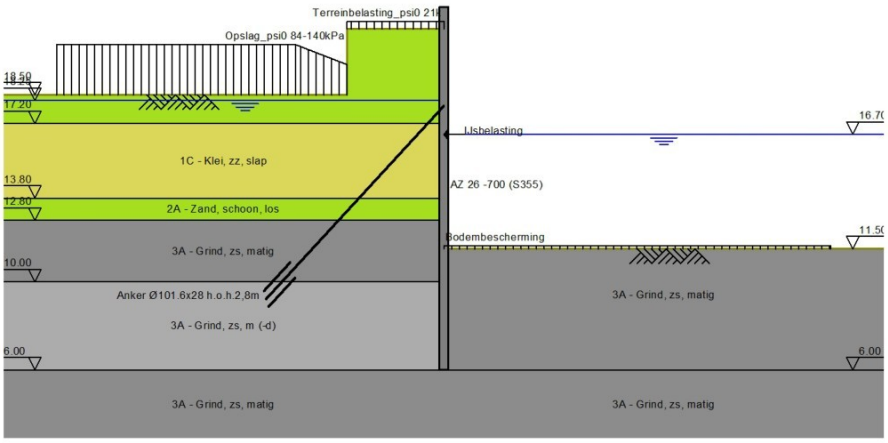


13 Outline Stage 10: G - Opslag_psi0 + Kraan + Haalpen_psi0



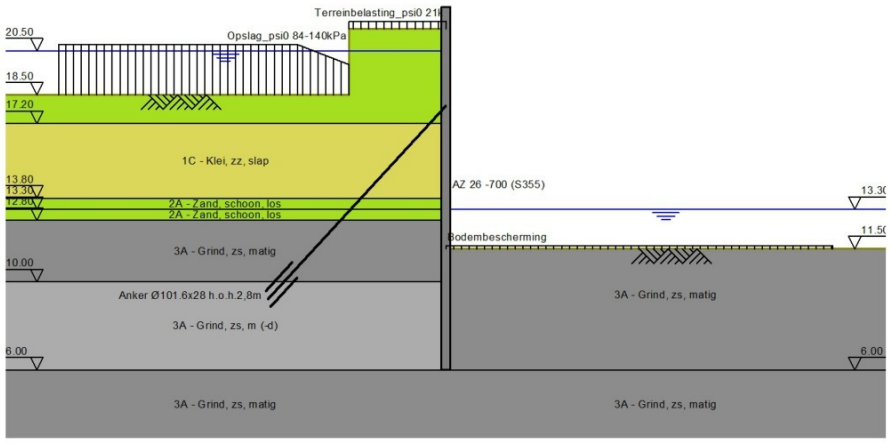
14 Outline Stage 11: G - Terrein_psi0 + Opslag_psi0 + IJs

Outline - Stage 11: G - Terrein_psi0 + Opslag_psi0 + IJs



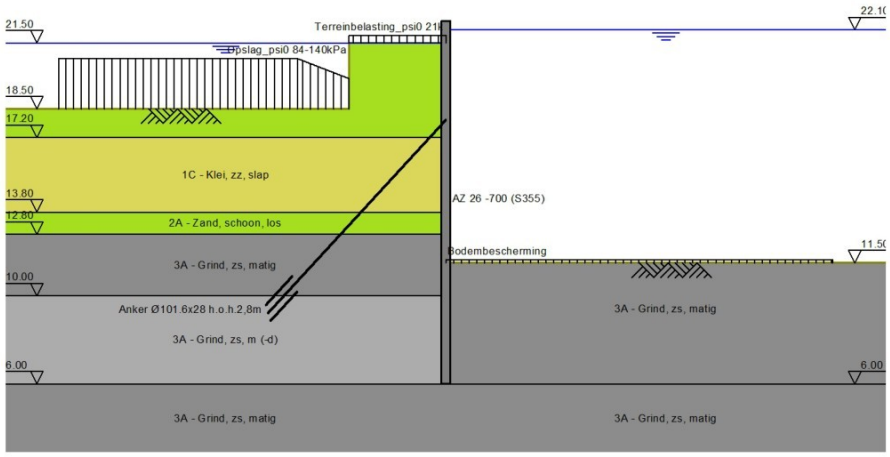
15 Outline Stage 12: G - Terrein_psi0 + Opslag_psi0 - val ELW

Outline - Stage 12: G - Terrein_psi0 + Opslag_psi0 - val ELW



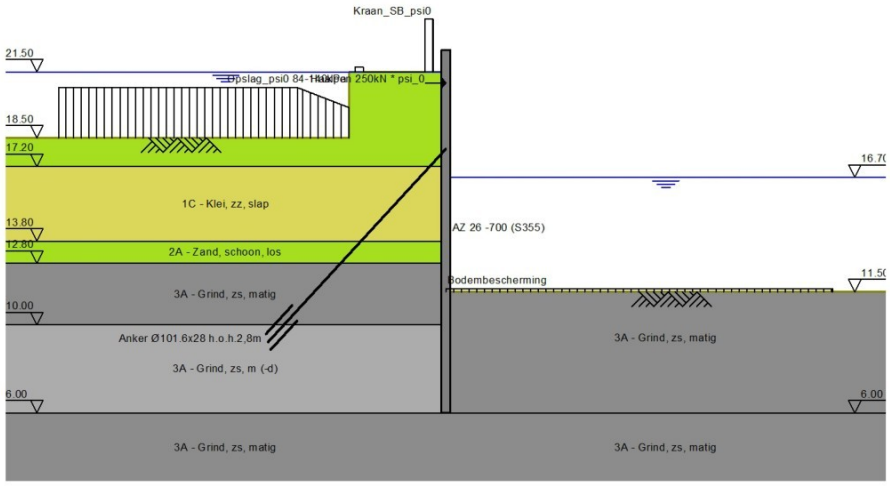
16 Outline Stage 13: G - Terrein_psi0 + Opslag_psi0 - MHW

Outline - Stage 13: G - Terrein_psi0 + Opslag_psi0 - MHW



17 Outline Stage 14: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

Outline - Stage 14: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

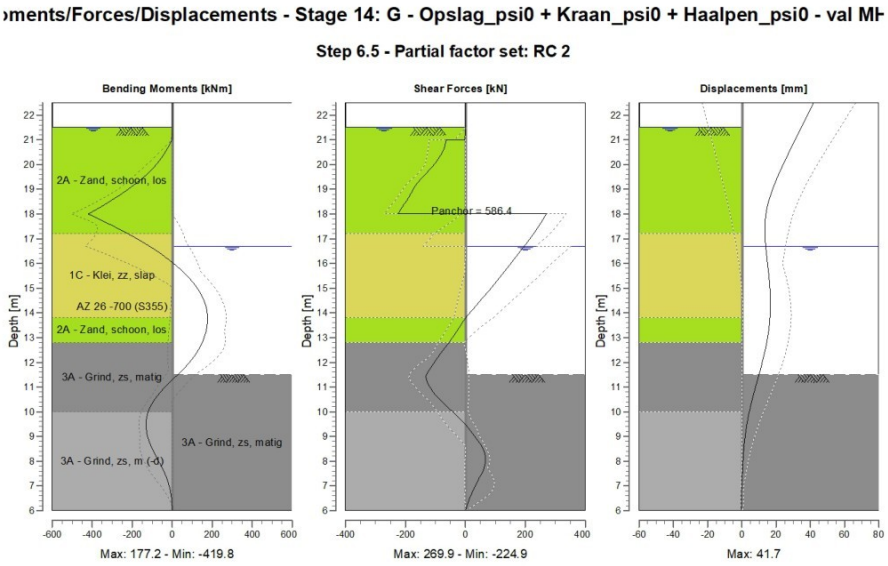


18 Step 6.5 Stage 14: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

18.1 Calculation Results

Number of iterations: 4

18.1.1 Charts of Moments, Forces and Displacements



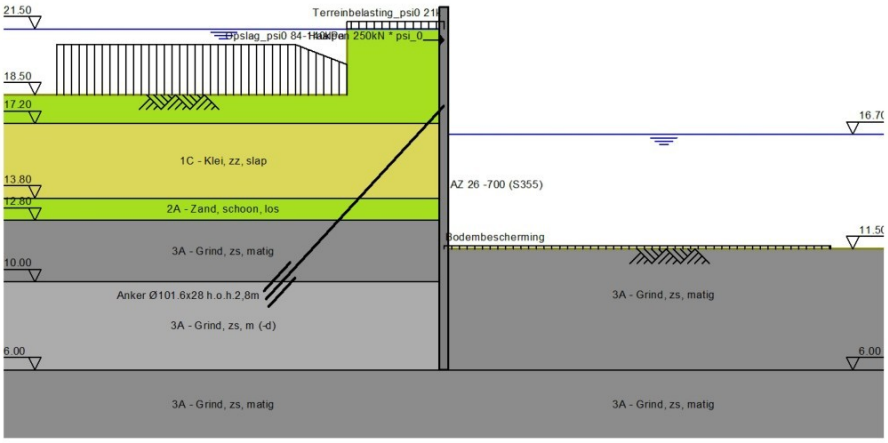
18.1.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	22.50	0.00	0.00	**41.7**
1	22.10	0.00	0.00	38.9
2	22.10	0.00	0.00	38.9
2	21.50	0.00	0.00	34.6
3	21.50	0.00	-0.04	34.6
3	21.00	-0.27	-1.58	31.0
4	21.00	-0.28	-64.07	31.0
4	20.50	-34.97	-76.81	27.5
5	20.50	-34.97	-76.81	27.5
5	19.83	-98.26	-116.23	22.9
6	19.83	-98.26	-116.22	22.9
6	19.17	-192.65	-165.96	18.8
7	19.17	-192.64	-166.00	18.8
7	18.50	-313.76	-197.45	15.5
8	18.50	-313.76	-197.44	15.5
8	18.30	-354.57	-209.83	14.8
9	18.30	-354.57	-209.83	14.8
9	18.25	-365.13	-212.30	14.6
10	18.25	-365.13	-212.30	14.6
10	18.00	**-419.76**	-224.86	14.0
11	18.00	**-419.76**	**269.86**	14.0
11	17.20	-220.75	226.91	13.4

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
12	17.20	-220.75	226.96	13.4
12	16.70	-114.74	196.60	13.9
13	16.70	-114.74	196.59	13.9
13	16.13	-13.76	159.80	14.7
14	16.13	-13.76	159.80	14.7
14	15.57	66.34	122.93	15.6
15	15.57	66.34	122.93	15.6
15	15.00	125.54	85.92	16.3
16	15.00	125.54	85.92	16.3
16	14.40	164.02	42.89	16.6
17	14.40	164.02	42.89	16.6
17	13.80	177.17	0.81	16.3
18	13.80	177.17	0.82	16.3
18	13.30	170.66	-26.87	15.6
19	13.30	170.66	-26.86	15.6
19	12.80	150.31	-54.54	14.5
20	12.80	150.30	-54.45	14.5
20	12.00	86.37	-103.75	11.9
21	12.00	86.38	-103.61	11.9
21	11.50	27.83	-130.17	9.9
22	11.50	27.82	-130.04	9.9
22	11.00	-35.80	-118.73	7.9
23	11.00	-35.80	-118.67	7.9
23	10.50	-87.66	-86.08	6.0
24	10.50	-87.66	-86.01	6.0
24	10.00	-120.10	-42.81	4.3
25	10.00	-120.10	-42.75	4.3
25	9.33	-130.09	10.37	2.5
26	9.33	-130.10	10.51	2.5
26	8.67	-109.16	51.18	1.3
27	8.67	-109.15	51.25	1.3
27	8.00	-67.59	66.82	0.6
28	8.00	-67.59	66.75	0.6
28	7.33	-28.23	46.24	0.1
29	7.33	-28.24	46.17	0.1
29	6.67	-6.15	19.77	-0.2
30	6.67	-6.15	19.77	-0.2
30	6.00	0.00	0.00	-0.4
Max		**-419.76**	**269.86**	**41.7**
Max, minor nodes incl.		-419.76	269.86	41.7

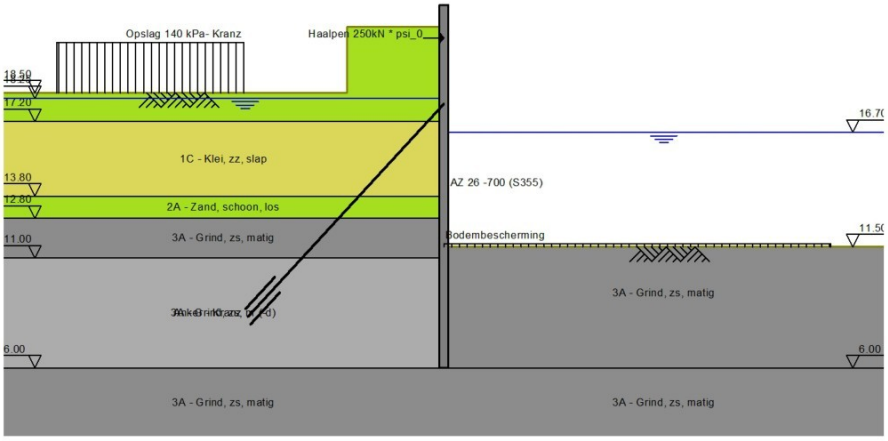
19 Outline Stage 15: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW

Outline - Stage 15: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW



20 Outline Stage 16: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0

Outline - Stage 16: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	13-3-2026
Time of report:	10:58:51
Report with version:	23.1.1.40517
Date of calculation:	9-3-2026
Time of calculation:	15:02:01
Calculated with version:	23.1.1.40517
File name:	Sectie_1b_Kade Besix NAP+11,50_revB
Project identification:	Alexanderhaven Roermond Damwand Kade Besix

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1						(D)*
1	EC7(NL)-Step 6.2						(D)*
1	EC7(NL)-Step 6.3		-19.41	-12.29	0.0	14.4	
1	EC7(NL)-Step 6.4		-16.33	9.92	0.0	14.4	
1	EC7(NL)-Step 6.5	5.4	-19.41	-12.29	0.0	14.4	
1	EC7(NL)-Step 6.5 x 1.000		-19.41	-12.29			
2	EC7(NL)-Step 6.1						(D)*
2	EC7(NL)-Step 6.2						(D)*
2	EC7(NL)-Step 6.3		-72.91	33.88	0.0	16.3	
2	EC7(NL)-Step 6.4		-65.00	34.12	0.0	16.2	
2	EC7(NL)-Step 6.5	26.2	-72.91	33.88	0.0	16.3	
2	EC7(NL)-Step 6.5 x 1.000		-72.91	33.88			
3	EC7(NL)-Step 6.1						(D)*
3	EC7(NL)-Step 6.2						(D)*
3	EC7(NL)-Step 6.3		-72.91	33.88	13.6	16.3	
3	EC7(NL)-Step 6.4		-72.91	33.88	13.6	16.3	
3	EC7(NL)-Step 6.5	26.2	-72.91	33.88	13.6	16.3	
3	EC7(NL)-Step 6.5 x 1.000		-72.91	33.88			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		88.72	84.32	14.4	17.2	
4	EC7(NL)-Step 6.4		80.00	84.32	14.2	17.1	
4	EC7(NL)-Step 6.5	-11.5	88.72	84.32	14.4	17.2	
4	EC7(NL)-Step 6.5 x 1.000		88.72	84.32			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		166.52	130.98	21.3	24.4	
5	EC7(NL)-Step 6.4		151.27	113.91	21.8	25.0	
5	EC7(NL)-Step 6.5	11.4	166.52	130.98	21.3	24.4	
5	EC7(NL)-Step 6.5 x 1.000		166.52	130.98			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		-350.42	264.84	47.1	51.7	
6	EC7(NL)-Step 6.4		-350.42	241.09	46.5	51.3	
6	EC7(NL)-Step 6.5	23.3	-271.35	224.05	28.1	32.1	
6	EC7(NL)-Step 6.5 x 1.200		-325.62	268.86			
7	EC7(NL)-Step 6.1						(D)*
7	EC7(NL)-Step 6.2						(D)*
7	EC7(NL)-Step 6.3		-357.38	276.53	**58.6**	**63.1**	
7	EC7(NL)-Step 6.4		-330.66	247.67	58.1	62.9	
7	EC7(NL)-Step 6.5	22.4	-277.20	237.11	31.9	35.8	
7	EC7(NL)-Step 6.5 x 1.200		-332.64	284.53			
8	EC7(NL)-Step 6.1						(D)*
8	EC7(NL)-Step 6.2						(D)*
8	EC7(NL)-Step 6.3		-435.17	268.04	47.7	52.0	
8	EC7(NL)-Step 6.4		-435.17	263.22	47.8	52.3	
8	EC7(NL)-Step 6.5	33.9	-336.79	234.63	30.3	34.5	
8	EC7(NL)-Step 6.5 x 1.200		-404.15	281.55			
9	EC7(NL)-Step 6.1						(D)*
9	EC7(NL)-Step 6.2						(D)*
9	EC7(NL)-Step 6.3		-469.88	262.34	44.9	48.7	
9	EC7(NL)-Step 6.4		-469.88	258.50	44.9	48.8	
9	EC7(NL)-Step 6.5	39.3	-358.33	231.97	31.7	35.7	
9	EC7(NL)-Step 6.5 x 1.200		-429.99	278.36			
10	EC7(NL)-Step 6.1						(D)*
10	EC7(NL)-Step 6.2						(D)*

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
10	EC7(NL)-Step 6.3		-417.89	334.51	48.6	52.7	
10	EC7(NL)-Step 6.4		-378.59	344.56	48.4	52.8	
10	EC7(NL)-Step 6.5	37.9	-331.55	294.01	31.4	35.8	
10	EC7(NL)-Step 6.5 x 1.200		-397.86	**352.81**			
11	EC7(NL)-Step 6.1						(D)*
11	EC7(NL)-Step 6.2						(D)*
11	EC7(NL)-Step 6.3		-379.70	290.83	57.0	61.4	
11	EC7(NL)-Step 6.4		-369.28	271.73	57.2	61.8	
11	EC7(NL)-Step 6.5	32.2	-327.73	256.70	35.2	39.3	
11	EC7(NL)-Step 6.5 x 1.200		-393.27	308.04			
12	EC7(NL)-Step 6.1						(D)*
12	EC7(NL)-Step 6.2						(D)*
12	EC7(NL)-Step 6.3		-315.21	206.88	41.8	46.3	
12	EC7(NL)-Step 6.4		-313.17	226.08	41.9	46.5	
12	EC7(NL)-Step 6.5	32.6	-311.07	204.12	28.2	32.7	
12	EC7(NL)-Step 6.5 x 1.200		-373.28	244.95			
13	EC7(NL)-Step 6.1						(D)*
13	EC7(NL)-Step 6.2						(D)*
13	EC7(NL)-Step 6.3		-475.66	299.20	51.2	55.4	
13	EC7(NL)-Step 6.4		-450.24	277.99	50.9	55.3	
13	EC7(NL)-Step 6.5	48.7	-411.43	273.01	32.5	36.8	
13	EC7(NL)-Step 6.5 x 1.200		**-493.71**	327.61			
14	EC7(NL)-Step 6.1						(D)*
14	EC7(NL)-Step 6.2						(D)*
14	EC7(NL)-Step 6.3		-455.21	310.49	52.5	57.0	
14	EC7(NL)-Step 6.4		-438.55	296.25	52.6	57.2	
14	EC7(NL)-Step 6.5	48.1	-408.87	285.45	32.4	36.8	
14	EC7(NL)-Step 6.5 x 1.200		-490.65	342.54			
15	EC7(NL)-Step 6.1						(D)*
15	EC7(NL)-Step 6.2						(D)*
15	EC7(NL)-Step 6.3		-284.38	176.43	40.7	45.2	
15	EC7(NL)-Step 6.4		-284.38	175.80	41.0	45.6	
15	EC7(NL)-Step 6.5	**62.1**	-221.31	147.09	30.5	34.7	
15	EC7(NL)-Step 6.5 x 1.200		-265.58	176.51			

Max		**62.1**	**-493.71**	**352.81**	**58.6**	**63.1**	

Stage nr.	Verification type	Vertical balance
1	EC7(NL)-Step 6.1	
1	EC7(NL)-Step 6.2	
1	EC7(NL)-Step 6.3	Upwards
1	EC7(NL)-Step 6.4	Upwards
1	EC7(NL)-Step 6.5	Upwards
1	EC7(NL)-Step 6.5 x 1.000	
2	EC7(NL)-Step 6.1	
2	EC7(NL)-Step 6.2	
2	EC7(NL)-Step 6.3	Upwards
2	EC7(NL)-Step 6.4	Upwards
2	EC7(NL)-Step 6.5	Upwards
2	EC7(NL)-Step 6.5 x 1.000	
3	EC7(NL)-Step 6.1	
3	EC7(NL)-Step 6.2	
3	EC7(NL)-Step 6.3	Upwards
3	EC7(NL)-Step 6.4	Upwards
3	EC7(NL)-Step 6.5	Upwards
3	EC7(NL)-Step 6.5 x 1.000	
4	EC7(NL)-Step 6.1	
4	EC7(NL)-Step 6.2	
4	EC7(NL)-Step 6.3	Sufficient
4	EC7(NL)-Step 6.4	Sufficient
4	EC7(NL)-Step 6.5	Sufficient
4	EC7(NL)-Step 6.5 x 1.000	

Stage nr.	Verification type	Vertical balance
5	EC7(NL)-Step 6.1	
5	EC7(NL)-Step 6.2	
5	EC7(NL)-Step 6.3	Sufficient
5	EC7(NL)-Step 6.4	Sufficient
5	EC7(NL)-Step 6.5	Sufficient
5	EC7(NL)-Step 6.5 x 1.000	
6	EC7(NL)-Step 6.1	
6	EC7(NL)-Step 6.2	
6	EC7(NL)-Step 6.3	Sufficient
6	EC7(NL)-Step 6.4	Sufficient
6	EC7(NL)-Step 6.5	Sufficient
6	EC7(NL)-Step 6.5 x 1.200	
7	EC7(NL)-Step 6.1	
7	EC7(NL)-Step 6.2	
7	EC7(NL)-Step 6.3	Sufficient
7	EC7(NL)-Step 6.4	Sufficient
7	EC7(NL)-Step 6.5	Sufficient
7	EC7(NL)-Step 6.5 x 1.200	
8	EC7(NL)-Step 6.1	
8	EC7(NL)-Step 6.2	
8	EC7(NL)-Step 6.3	Sufficient
8	EC7(NL)-Step 6.4	Sufficient
8	EC7(NL)-Step 6.5	Sufficient
8	EC7(NL)-Step 6.5 x 1.200	
9	EC7(NL)-Step 6.1	
9	EC7(NL)-Step 6.2	
9	EC7(NL)-Step 6.3	Sufficient
9	EC7(NL)-Step 6.4	Sufficient
9	EC7(NL)-Step 6.5	Sufficient
9	EC7(NL)-Step 6.5 x 1.200	
10	EC7(NL)-Step 6.1	
10	EC7(NL)-Step 6.2	
10	EC7(NL)-Step 6.3	Sufficient
10	EC7(NL)-Step 6.4	Sufficient
10	EC7(NL)-Step 6.5	Sufficient
10	EC7(NL)-Step 6.5 x 1.200	
11	EC7(NL)-Step 6.1	
11	EC7(NL)-Step 6.2	
11	EC7(NL)-Step 6.3	Sufficient
11	EC7(NL)-Step 6.4	Sufficient
11	EC7(NL)-Step 6.5	Sufficient
11	EC7(NL)-Step 6.5 x 1.200	
12	EC7(NL)-Step 6.1	
12	EC7(NL)-Step 6.2	
12	EC7(NL)-Step 6.3	Sufficient
12	EC7(NL)-Step 6.4	Sufficient
12	EC7(NL)-Step 6.5	Sufficient
12	EC7(NL)-Step 6.5 x 1.200	
13	EC7(NL)-Step 6.1	
13	EC7(NL)-Step 6.2	
13	EC7(NL)-Step 6.3	Sufficient
13	EC7(NL)-Step 6.4	Sufficient
13	EC7(NL)-Step 6.5	Sufficient
13	EC7(NL)-Step 6.5 x 1.200	
14	EC7(NL)-Step 6.1	
14	EC7(NL)-Step 6.2	
14	EC7(NL)-Step 6.3	Sufficient
14	EC7(NL)-Step 6.4	Sufficient
14	EC7(NL)-Step 6.5	Sufficient
14	EC7(NL)-Step 6.5 x 1.200	
15	EC7(NL)-Step 6.1	
15	EC7(NL)-Step 6.2	
15	EC7(NL)-Step 6.3	Sufficient
15	EC7(NL)-Step 6.4	Sufficient

Stage nr.	Verification type	Vertical balance
15	EC7(NL)-Step 6.5	Upwards
15	EC7(NL)-Step 6.5 x 1.200	

Summary		Upwards/Sufficient

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut Anker Ø101,6x28 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
3	EC7(NL)-Step 6.1			(D)*			
3	EC7(NL)-Step 6.2			(D)*			
3	EC7(NL)-Step 6.3	0.00					
3	EC7(NL)-Step 6.4	0.00					
3	EC7(NL)-Step 6.5	0.00					
3	EC7(NL)-Step 6.5 x 1.000	0.00					
4	EC7(NL)-Step 6.1			(D)*			
4	EC7(NL)-Step 6.2			(D)*			
4	EC7(NL)-Step 6.3	100.00	Elastic				
4	EC7(NL)-Step 6.4	100.00	Elastic				
4	EC7(NL)-Step 6.5	100.00	Elastic				
4	EC7(NL)-Step 6.5 x 1.000	100.00	Elastic				
5	EC7(NL)-Step 6.1			(D)*			
5	EC7(NL)-Step 6.2			(D)*			
5	EC7(NL)-Step 6.3	201.28	Elastic				
5	EC7(NL)-Step 6.4	181.00	Elastic				
5	EC7(NL)-Step 6.5	201.28	Elastic				
5	EC7(NL)-Step 6.5 x 1.000	201.28	Elastic				
6	EC7(NL)-Step 6.1			(D)*			
6	EC7(NL)-Step 6.2			(D)*			
6	EC7(NL)-Step 6.3	497.48	Elastic				
6	EC7(NL)-Step 6.4	469.32	Elastic				
6	EC7(NL)-Step 6.5	408.88	Elastic				
6	EC7(NL)-Step 6.5 x 1.200	490.66	Elastic				
7	EC7(NL)-Step 6.1			(D)*			
7	EC7(NL)-Step 6.2			(D)*			
7	EC7(NL)-Step 6.3	508.12	Elastic				
7	EC7(NL)-Step 6.4	463.53	Elastic				
7	EC7(NL)-Step 6.5	422.89	Elastic				
7	EC7(NL)-Step 6.5 x 1.200	507.47	Elastic				
8	EC7(NL)-Step 6.1			(D)*			
8	EC7(NL)-Step 6.2			(D)*			
8	EC7(NL)-Step 6.3	528.99	Elastic				
8	EC7(NL)-Step 6.4	523.27	Elastic				
8	EC7(NL)-Step 6.5	442.88	Elastic				
8	EC7(NL)-Step 6.5 x 1.200	531.46	Elastic				
9	EC7(NL)-Step 6.1			(D)*			
9	EC7(NL)-Step 6.2			(D)*			
9	EC7(NL)-Step 6.3	576.66	Elastic				
9	EC7(NL)-Step 6.4	572.11	Elastic				
9	EC7(NL)-Step 6.5	483.50	Elastic				
9	EC7(NL)-Step 6.5 x 1.200	580.20	Elastic				
10	EC7(NL)-Step 6.1			(D)*			
10	EC7(NL)-Step 6.2			(D)*			
10	EC7(NL)-Step 6.3	292.62	Elastic				
10	EC7(NL)-Step 6.4	372.38	Elastic				
10	EC7(NL)-Step 6.5	347.60	Elastic				
10	EC7(NL)-Step 6.5 x 1.200	417.12	Elastic				

Stage nr.	Verification type	Anchor/strut Anker Ø101,6x28 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
11	EC7(NL)-Step 6.1			(D)*			
11	EC7(NL)-Step 6.2			(D)*			
11	EC7(NL)-Step 6.3	604.23	Elastic				
11	EC7(NL)-Step 6.4	545.50	Elastic				
11	EC7(NL)-Step 6.5	513.31	Elastic				
11	EC7(NL)-Step 6.5 x 1.200	615.97	Elastic				
12	EC7(NL)-Step 6.1			(D)*			
12	EC7(NL)-Step 6.2			(D)*			
12	EC7(NL)-Step 6.3	449.09	Elastic				
12	EC7(NL)-Step 6.4	479.83	Elastic				
12	EC7(NL)-Step 6.5	447.63	Elastic				
12	EC7(NL)-Step 6.5 x 1.200	537.15	Elastic				
13	EC7(NL)-Step 6.1			(D)*			
13	EC7(NL)-Step 6.2			(D)*			
13	EC7(NL)-Step 6.3	636.63	Elastic				
13	EC7(NL)-Step 6.4	598.17	Elastic				
13	EC7(NL)-Step 6.5	574.47	Elastic				
13	EC7(NL)-Step 6.5 x 1.200	689.36	Elastic				
14	EC7(NL)-Step 6.1			(D)*			
14	EC7(NL)-Step 6.2			(D)*			
14	EC7(NL)-Step 6.3	628.89	Elastic				
14	EC7(NL)-Step 6.4	602.98	Elastic				
14	EC7(NL)-Step 6.5	584.78	Elastic				
14	EC7(NL)-Step 6.5 x 1.200	**701.74**	Elastic				
15	EC7(NL)-Step 6.1						(D)*
15	EC7(NL)-Step 6.2						(D)*
15	EC7(NL)-Step 6.3				**347.13**	Elastic	
15	EC7(NL)-Step 6.4				346.39	Elastic	
15	EC7(NL)-Step 6.5				283.09	Elastic	
15	EC7(NL)-Step 6.5 x 1.200				339.71	Elastic	
Max		**701.74**			**347.13**		

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

The force is in the direction of the anchor.

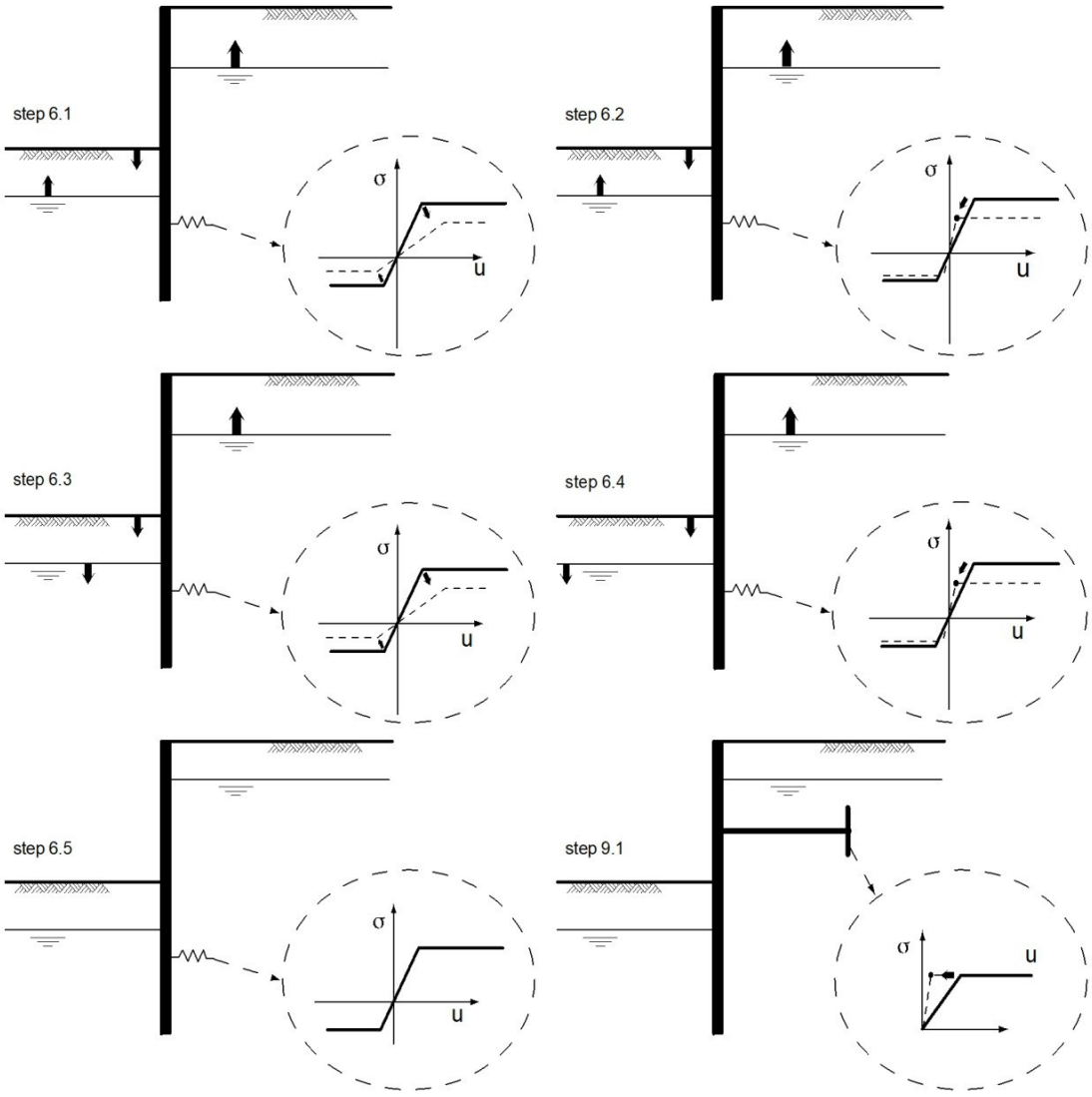
2.3 Overall Stability per Stage

Stage name	Stability factor [-]
B - Aanbrengen nieuwe damwand	3.92
B - Aanvulling tussen damwanden	3.91
B - Aanbrengen ankers	3.91
B - Voorspannen ankers	3.92
B - Aanvullen + Bodembescherming	2.72
G - Terrein + Opslag_psi0	1.39
G - Terrein_psi0 + Opslag	1.24
G - Terrein_psi0 + Opslag_psi0 + Haalpen	1.37
G - Opslag_psi0 + Kraan + Haalpen_psi0	1.39
G - Terrein_psi0 + Opslag_psi0 + IJs	1.58
G - Terrein_psi0 + Opslag_psi0 - val ELW	1.33
G - Terrein_psi0 + Opslag_psi0 - MHW	1.52
G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW	1.31
G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW	1.31
G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val ...	1.52

2.4 Warnings

Vertical balance:
The resultant vertical friction force is directed upward in stage 1,2,3,15 because the friction force on the passive side exceeds that on the active side. This might be prevented by reducing the friction angle Delta on the passive side.

2.5 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	Yes
Number of construction stages	15
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	16.50 m
Level top side	22.50 m
Number of sections	1
q_b;max	15.00 MPa
Xi factor	0.93

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 26 -700 (S3...	6.00	22.50	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 26 -700 (S3...	1.2541E+05	0.79	9.9075E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 26 -700 (S3...	923.00	1.00	1.00	0.77	710.71

3.2.4 Properties for Vertical Balance

Section name	From [m]	To [m]	Height [mm]	Section area [cm²/m']
AZ 26 -700 (S3...	6.00	22.50	460.00	187.00

3.3 Calculation Options

First stage represents initial situation	No
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B - Aanbrengen nieuwe damwand

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	2: B - Aanvulling tussen damwanden
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	

- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	3: B - Aanbrengen ankers
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	4: B - Voorspannen ankers
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	5: B - Aanvullen + Bodembescherming
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	

- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	6: G - Terrein + Opslag_psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	7: G - Terrein_psi0 + Opslag
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined

- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	8: G - Terrein_psi0 + Opslag_psi0 + Haalpen
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined

Verification of stage	9: G - Opslag_psi0 + Kraan + Haalpen_psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	10: G - Terrein_psi0 + Opslag_psi0 + IJs
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	

- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	11: G - Terrein_psi0 + Opslag_psi0 - val ELW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	12: G - Terrein_psi0 + Opslag_psi0 - MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000

- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	13: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200

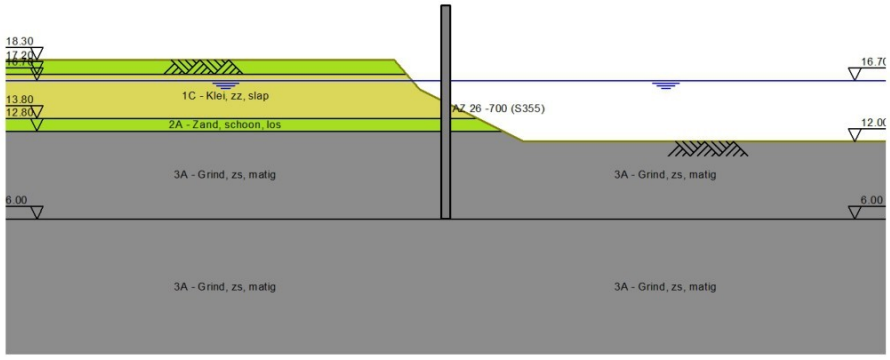
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	14: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	15: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val M
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000

Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

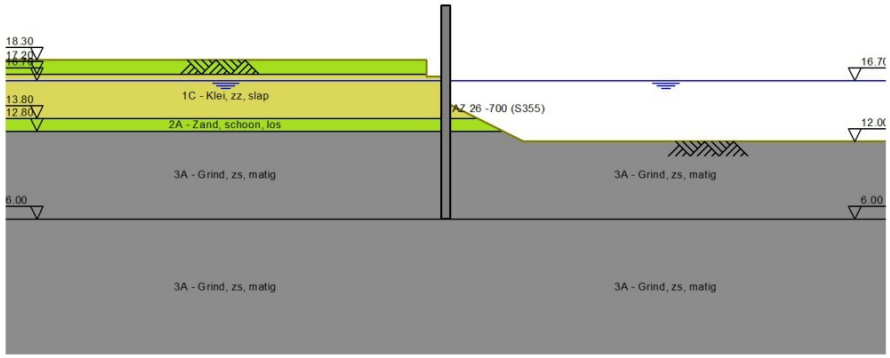
4 Outline Stage 1: B - Aanbrengen nieuwe damwand

Outline - Stage 1: B - Aanbrengen nieuwe damwand



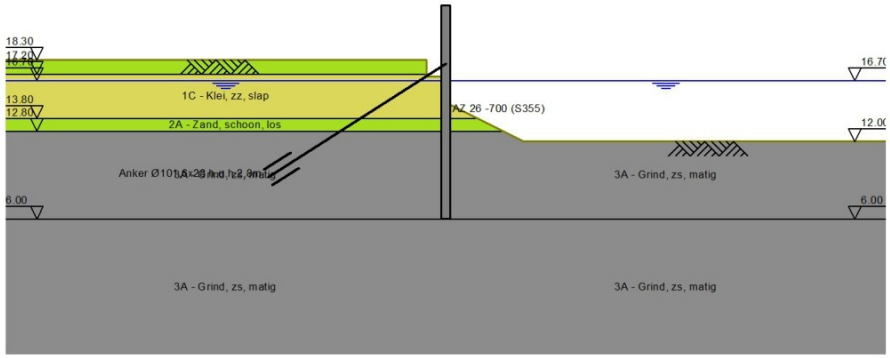
5 Outline Stage 2: B - Aanvulling tussen damwanden

Outline - Stage 2: B - Aanvulling tussen damwanden



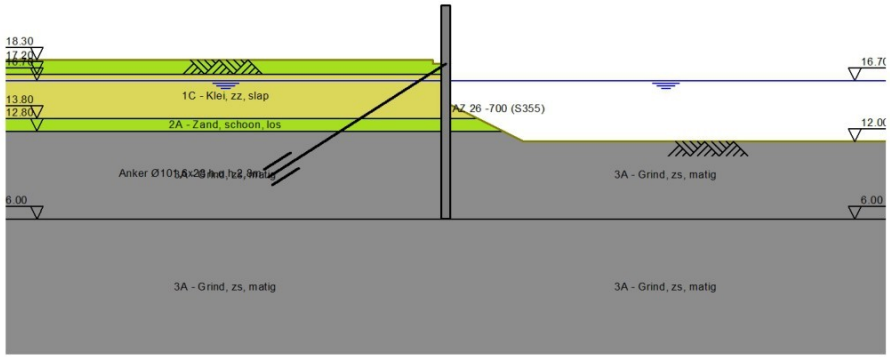
6 Outline Stage 3: B - Aanbrengen ankers

Outline - Stage 3: B - Aanbrengen ankers



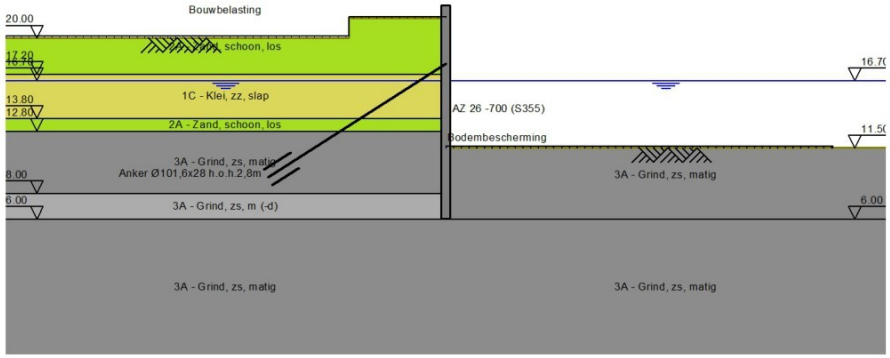
7 Outline Stage 4: B - Voorspannen ankers

Outline - Stage 4: B - Voorspannen ankers



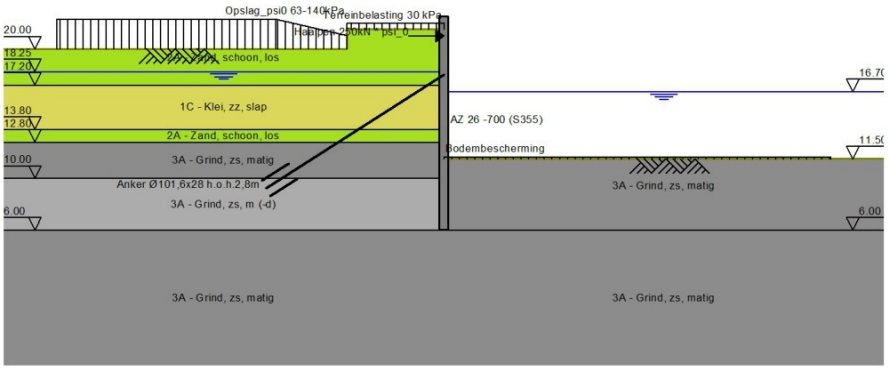
8 Outline Stage 5: B - Aanvullen + Bodembescherming

Outline - Stage 5: B - Aanvullen + Bodembescherming



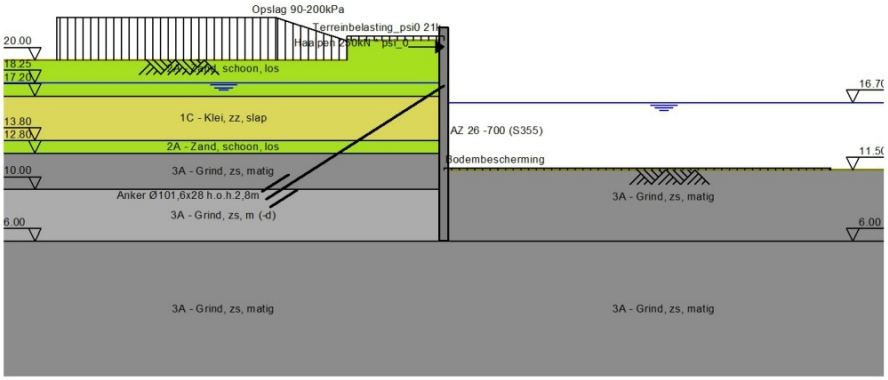
9 Outline Stage 6: G - Terrein + Opslag_psi0

Outline - Stage 6: G - Terrein + Opslag_psi0



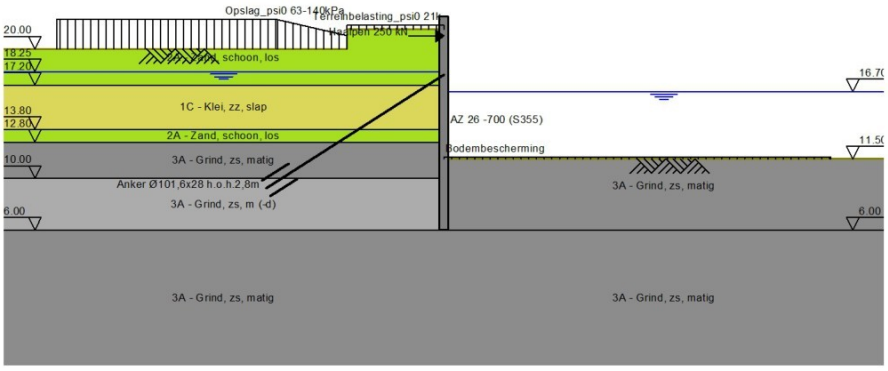
10 Outline Stage 7: G - Terrein_psi0 + Opslag

Outline - Stage 7: G - Terrein_psi0 + Opslag



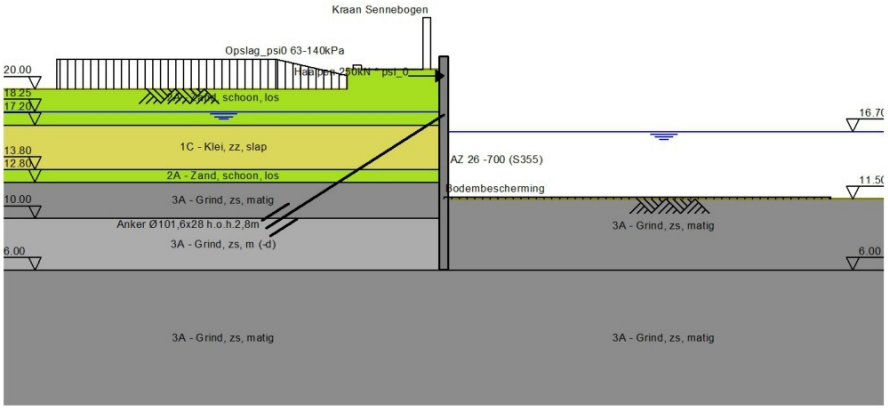
11 Outline Stage 8: G - Terrein_psi0 + Opslag_psi0 + Haalpen

Outline - Stage 8: G - Terrein_psi0 + Opslag_psi0 + Haalpen



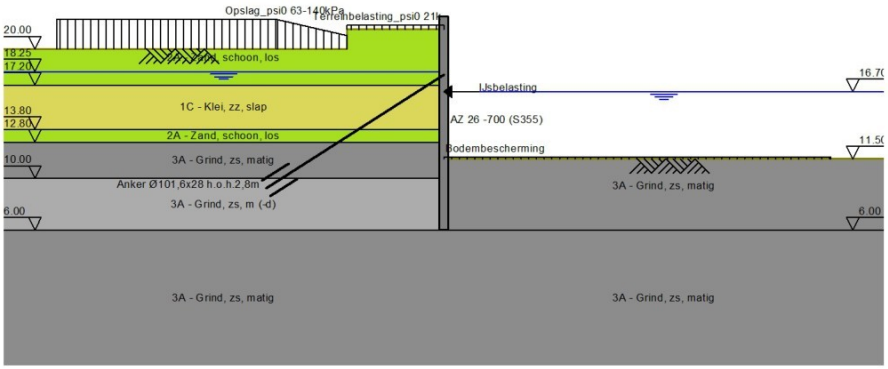
12 Outline Stage 9: G - Opslag_psi0 + Kraan + Haalpen_psi0

Outline - Stage 9: G - Opslag_psi0 + Kraan + Haalpen_psi0



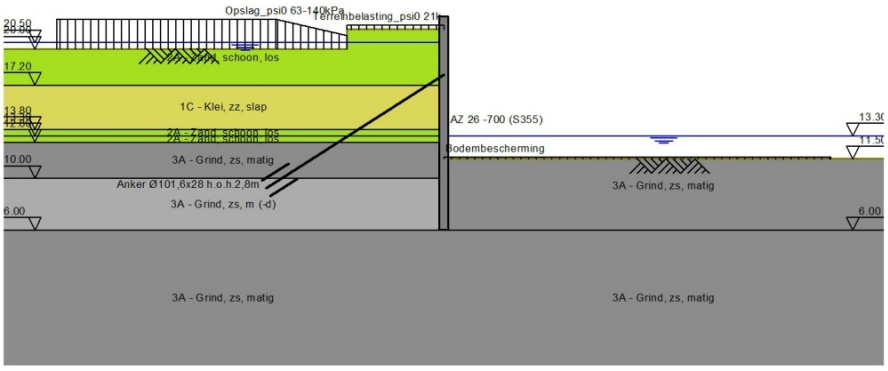
13 Outline Stage 10: G - Terrein_psi0 + Opslag_psi0 + IJs

Outline - Stage 10: G - Terrein_psi0 + Opslag_psi0 + IJs



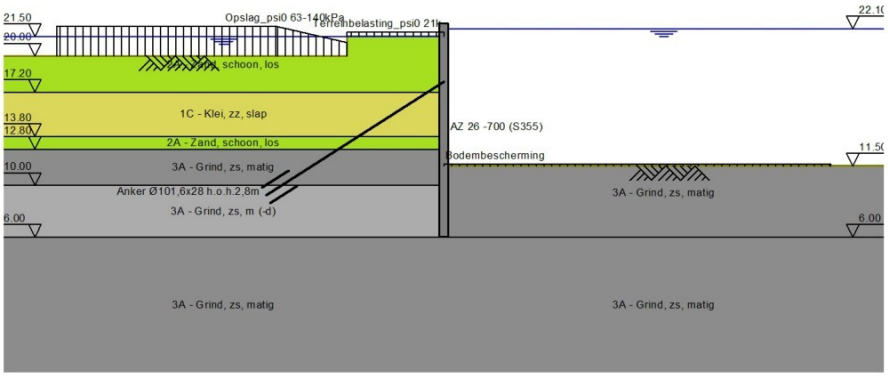
14 Outline Stage 11: G - Terrein_psi0 + Opslag_psi0 - val ELW

Outline - Stage 11: G - Terrein_psi0 + Opslag_psi0 - val ELW



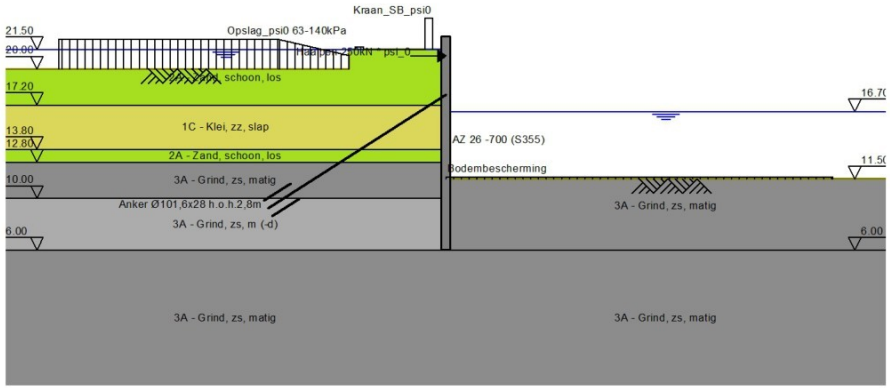
15 Outline Stage 12: G - Terrein_psi0 + Opslag_psi0 - MHW

Outline - Stage 12: G - Terrein_psi0 + Opslag_psi0 - MHW



16 Outline Stage 13: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

Outline - Stage 13: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

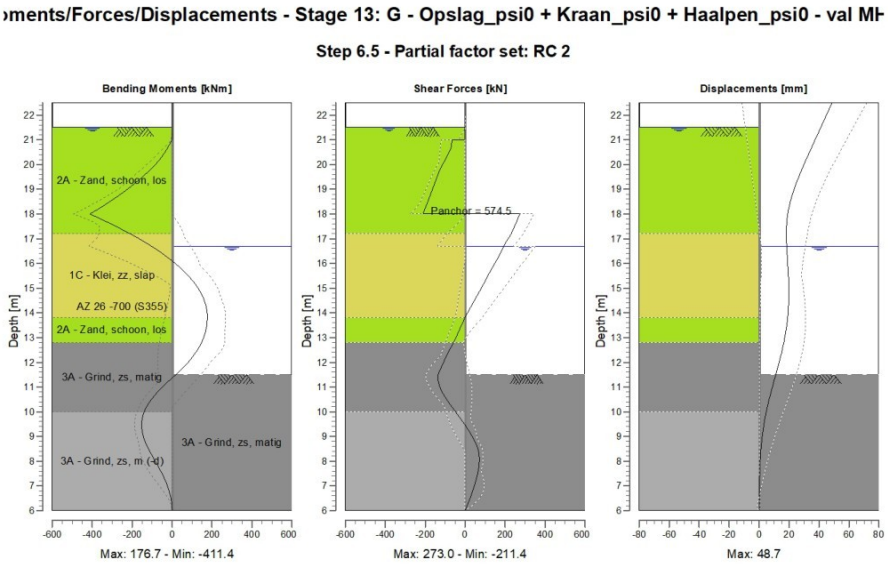


17 Step 6.5 Stage 13: G - Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

17.1 Calculation Results

Number of iterations: 3

17.1.1 Charts of Moments, Forces and Displacements



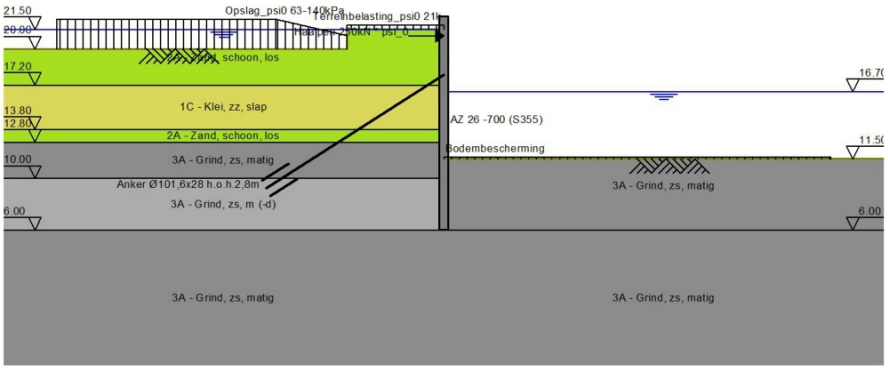
17.1.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	22.50	0.00	0.00	**48.7**
1	22.10	0.00	0.00	45.7
2	22.10	0.00	0.00	45.7
2	21.50	0.00	0.00	41.1
3	21.50	0.00	-0.03	41.1
3	21.00	-0.29	-2.07	37.3
4	21.00	-0.28	-64.53	37.3
4	20.50	-35.57	-81.08	33.5
5	20.50	-35.58	-81.00	33.5
5	19.75	-114.51	-129.34	28.1
6	19.75	-114.52	-129.40	28.1
6	19.00	-224.34	-163.53	23.3
7	19.00	-224.34	-163.51	23.3
7	18.25	-360.15	-199.08	19.8
8	18.25	-360.14	-198.94	19.8
8	18.00	**-411.43**	-211.45	19.1
9	18.00	-411.42	**273.01**	19.1
9	17.20	-209.83	230.20	18.2
10	17.20	-209.84	230.16	18.2
10	17.00	-165.33	214.84	18.2
11	17.00	-165.33	214.84	18.2
11	16.70	-104.27	193.37	18.4

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
12	16.70	-104.27	193.38	18.4
12	16.13	-4.43	157.38	18.9
13	16.13	-4.43	157.38	18.9
13	15.57	73.42	118.22	19.5
14	15.57	73.42	118.23	19.5
14	15.00	129.83	80.84	19.8
15	15.00	129.83	80.86	19.8
15	14.40	165.57	38.88	19.7
16	14.40	165.57	38.88	19.7
16	13.80	176.74	-1.63	19.0
17	13.80	176.75	-1.64	19.0
17	13.30	168.89	-29.78	17.9
18	13.30	168.89	-29.77	17.9
18	12.80	146.99	-57.76	16.4
19	12.80	146.99	-57.69	16.4
19	12.15	95.29	-100.12	14.0
20	12.15	95.28	-99.88	14.0
20	11.50	18.39	-135.82	11.1
21	11.50	18.36	-135.42	11.1
21	10.75	-78.49	-112.00	7.7
22	10.75	-78.48	-111.79	7.7
22	10.00	-139.65	-48.07	4.7
23	10.00	-139.65	-47.96	4.7
23	9.33	-151.99	10.25	2.8
24	9.33	-151.98	10.41	2.8
24	8.67	-128.88	56.03	1.4
25	8.67	-128.86	56.20	1.4
25	8.00	-84.30	70.75	0.7
26	8.00	-84.31	70.73	0.7
26	7.33	-40.61	57.34	0.3
27	7.33	-40.60	57.17	0.3
27	6.67	-10.71	31.46	0.1
28	6.67	-10.72	31.48	0.1
28	6.00	0.00	0.00	0.0
Max		**-411.43**	**273.01**	**48.7**
Max, minor nodes incl.		-411.43	273.01	48.7

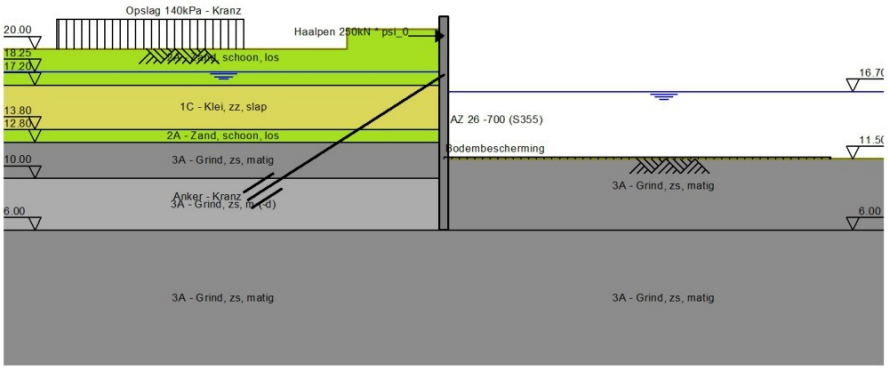
18 Outline Stage 14: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW

Outline - Stage 14: G - Opslag_psi0 + Terrein_psi0 + Haalpen_psi0 - val MHW



19 Outline Stage 15: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW

Outline - Stage 15: G - Kranz Opslag_psi0 + Kraan_psi0 + Haalpen_psi0 - val MHW



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	28-3-2025
Time of report:	13:56:34
Report with version:	23.1.1.40517
Date of calculation:	28-3-2025
Time of calculation:	13:51:08
Calculated with version:	23.1.1.40517
File name:	Sectie_2_Kade Besix NAP+11,50 v8_revA
Project identification:	Integraalplan Willem-Alexanderhaven Definitief ontwerp zichtjaar 2125 Talud 01

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		13.03	12.98	0.0	35.7	
1	EC7(NL)-Step 6.2		7.77	10.74	0.0	35.5	
1	EC7(NL)-Step 6.3		28.46	16.43	0.0	39.0	
1	EC7(NL)-Step 6.4		18.54	13.25	0.0	38.6	
1	EC7(NL)-Step 6.5	-0.5	-6.75	9.57	0.0	29.9	
1	EC7(NL)-Step 6.5 x 1.200		-8.11	11.49			
2	EC7(NL)-Step 6.1		-28.24	18.54	31.1	35.0	
2	EC7(NL)-Step 6.2		-19.78	16.86	30.8	35.0	
2	EC7(NL)-Step 6.3		-34.82	24.35	33.4	37.7	
2	EC7(NL)-Step 6.4		-24.29	19.07	33.0	37.8	
2	EC7(NL)-Step 6.5	-0.5	-6.75	9.57	25.2	29.9	
2	EC7(NL)-Step 6.5 x 1.200		-8.11	11.49			
3	EC7(NL)-Step 6.1		103.18	-57.27	37.5	43.9	
3	EC7(NL)-Step 6.2		88.83	-58.87	37.8	44.3	
3	EC7(NL)-Step 6.3		140.99	-76.68	40.2	47.1	
3	EC7(NL)-Step 6.4		133.70	-83.24	40.9	48.0	
3	EC7(NL)-Step 6.5	-2.9	-31.42	-54.81	29.9	35.3	
3	EC7(NL)-Step 6.5 x 1.200		-37.70	-65.77			
4	EC7(NL)-Step 6.1		-149.94	-164.86	64.6	69.9	
4	EC7(NL)-Step 6.2		-134.82	-159.95	65.4	71.3	
4	EC7(NL)-Step 6.3		-178.17	-176.39	69.6	74.7	
4	EC7(NL)-Step 6.4		-162.78	-171.45	71.9	77.3	
4	EC7(NL)-Step 6.5	-14.0	84.28	-113.66	40.6	47.0	
4	EC7(NL)-Step 6.5 x 1.200		101.14	-136.40			
5	EC7(NL)-Step 6.1		-149.95	-165.50	81.8	85.1	
5	EC7(NL)-Step 6.2		-139.30	-160.81	84.8	88.0	
5	EC7(NL)-Step 6.3		-179.23	-182.14	85.8	88.7	
5	EC7(NL)-Step 6.4		-171.67	-180.25	**88.9**	**91.4**	
5	EC7(NL)-Step 6.5	-13.1	86.95	-122.63	44.2	50.5	
5	EC7(NL)-Step 6.5 x 1.200		104.34	-147.16			
6	EC7(NL)-Step 6.1		203.24	-153.38	59.5	63.7	
6	EC7(NL)-Step 6.2		203.24	-150.62	59.8	64.4	
6	EC7(NL)-Step 6.3		203.24	-158.14	61.1	66.0	
6	EC7(NL)-Step 6.4		203.24	-155.92	61.1	66.2	
6	EC7(NL)-Step 6.5	-33.9	154.07	-122.03	41.6	48.0	
6	EC7(NL)-Step 6.5 x 1.200		184.89	-146.44			
7	EC7(NL)-Step 6.1		176.87	-147.18	78.3	81.3	
7	EC7(NL)-Step 6.2		166.43	-136.85	78.5	81.9	
7	EC7(NL)-Step 6.3		186.03	-154.38	82.4	85.3	
7	EC7(NL)-Step 6.4		179.25	-149.12	83.8	87.0	
7	EC7(NL)-Step 6.5	-32.8	153.41	-132.30	45.1	51.4	
7	EC7(NL)-Step 6.5 x 1.200		184.09	-158.76			
8	EC7(NL)-Step 6.1		160.40	-157.22	63.8	68.5	
8	EC7(NL)-Step 6.2		160.19	-154.31	63.5	68.6	
8	EC7(NL)-Step 6.3		169.82	-167.55	68.1	73.0	
8	EC7(NL)-Step 6.4		168.54	-164.31	68.6	73.9	
8	EC7(NL)-Step 6.5	**-39.2**	258.44	-239.03	43.8	49.3	
8	EC7(NL)-Step 6.5 x 1.200		**310.12**	**-286.84**			
9	EC7(NL)-Step 6.1		176.43	-205.02	70.1	74.6	
9	EC7(NL)-Step 6.2		175.01	-188.64	70.5	75.8	
9	EC7(NL)-Step 6.3		173.47	-203.22	70.2	74.7	
9	EC7(NL)-Step 6.4		171.86	-185.26	70.6	75.8	
9	EC7(NL)-Step 6.5	-33.3	144.79	-138.24	41.4	46.3	
9	EC7(NL)-Step 6.5 x 1.200		173.75	-165.88			
10	EC7(NL)-Step 6.1						(D)*
10	EC7(NL)-Step 6.2						(D)*

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
10	EC7(NL)-Step 6.3		153.15	-112.86	63.3	68.0	
10	EC7(NL)-Step 6.4		152.18	-121.41	63.2	67.9	
10	EC7(NL)-Step 6.5	-33.8	148.42	-101.39	41.7	47.7	
10	EC7(NL)-Step 6.5 x 1.200		178.10	-121.67			
11	EC7(NL)-Step 6.1		180.65	-196.44	71.0	75.8	
11	EC7(NL)-Step 6.2		170.45	-190.78	72.9	78.0	
11	EC7(NL)-Step 6.3		194.76	-210.87	75.6	80.1	
11	EC7(NL)-Step 6.4		186.62	-206.44	79.2	83.4	
11	EC7(NL)-Step 6.5	-33.8	146.14	-151.52	45.5	51.8	
11	EC7(NL)-Step 6.5 x 1.200		175.37	-181.82			
12	EC7(NL)-Step 6.1		115.42	-93.83	58.3	64.1	
12	EC7(NL)-Step 6.2		114.81	-91.25	58.8	64.9	
12	EC7(NL)-Step 6.3		118.05	-103.53	60.5	66.6	
12	EC7(NL)-Step 6.4		124.45	-101.15	61.1	67.4	
12	EC7(NL)-Step 6.5	-38.4	70.37	-62.30	41.9	48.5	
12	EC7(NL)-Step 6.5 x 1.200		84.44	-74.76			
Max		**-39.2**	**310.12**	**-286.84**	**88.9**	**91.4**	

Stage nr.	Verification type	Vertical balance
1	EC7(NL)-Step 6.1	Upwards
1	EC7(NL)-Step 6.2	Upwards
1	EC7(NL)-Step 6.3	Upwards
1	EC7(NL)-Step 6.4	Upwards
1	EC7(NL)-Step 6.5	Upwards
1	EC7(NL)-Step 6.5 x 1.200	
2	EC7(NL)-Step 6.1	Upwards
2	EC7(NL)-Step 6.2	Upwards
2	EC7(NL)-Step 6.3	Upwards
2	EC7(NL)-Step 6.4	Upwards
2	EC7(NL)-Step 6.5	Upwards
2	EC7(NL)-Step 6.5 x 1.200	
3	EC7(NL)-Step 6.1	Upwards
3	EC7(NL)-Step 6.2	Upwards
3	EC7(NL)-Step 6.3	Upwards
3	EC7(NL)-Step 6.4	Upwards
3	EC7(NL)-Step 6.5	Sufficient
3	EC7(NL)-Step 6.5 x 1.200	
4	EC7(NL)-Step 6.1	Sufficient
4	EC7(NL)-Step 6.2	Sufficient
4	EC7(NL)-Step 6.3	Sufficient
4	EC7(NL)-Step 6.4	Sufficient
4	EC7(NL)-Step 6.5	Upwards
4	EC7(NL)-Step 6.5 x 1.200	
5	EC7(NL)-Step 6.1	Upwards
5	EC7(NL)-Step 6.2	Upwards
5	EC7(NL)-Step 6.3	Upwards
5	EC7(NL)-Step 6.4	Upwards
5	EC7(NL)-Step 6.5	Upwards
5	EC7(NL)-Step 6.5 x 1.200	
6	EC7(NL)-Step 6.1	Sufficient
6	EC7(NL)-Step 6.2	Sufficient
6	EC7(NL)-Step 6.3	Sufficient
6	EC7(NL)-Step 6.4	Sufficient
6	EC7(NL)-Step 6.5	Sufficient
6	EC7(NL)-Step 6.5 x 1.200	
7	EC7(NL)-Step 6.1	Upwards
7	EC7(NL)-Step 6.2	Upwards
7	EC7(NL)-Step 6.3	Upwards
7	EC7(NL)-Step 6.4	Upwards
7	EC7(NL)-Step 6.5	Sufficient
7	EC7(NL)-Step 6.5 x 1.200	

Stage nr.	Verification type	Vertical balance
8	EC7(NL)-Step 6.1	Sufficient
8	EC7(NL)-Step 6.2	Sufficient
8	EC7(NL)-Step 6.3	Sufficient
8	EC7(NL)-Step 6.4	Sufficient
8	EC7(NL)-Step 6.5	Sufficient
8	EC7(NL)-Step 6.5 x 1.200	
9	EC7(NL)-Step 6.1	Upwards
9	EC7(NL)-Step 6.2	Upwards
9	EC7(NL)-Step 6.3	Upwards
9	EC7(NL)-Step 6.4	Upwards
9	EC7(NL)-Step 6.5	Upwards
9	EC7(NL)-Step 6.5 x 1.200	
10	EC7(NL)-Step 6.1	
10	EC7(NL)-Step 6.2	
10	EC7(NL)-Step 6.3	Sufficient
10	EC7(NL)-Step 6.4	Sufficient
10	EC7(NL)-Step 6.5	Sufficient
10	EC7(NL)-Step 6.5 x 1.200	
11	EC7(NL)-Step 6.1	Sufficient
11	EC7(NL)-Step 6.2	Sufficient
11	EC7(NL)-Step 6.3	Sufficient
11	EC7(NL)-Step 6.4	Sufficient
11	EC7(NL)-Step 6.5	Sufficient
11	EC7(NL)-Step 6.5 x 1.200	
12	EC7(NL)-Step 6.1	Upwards
12	EC7(NL)-Step 6.2	Upwards
12	EC7(NL)-Step 6.3	Upwards
12	EC7(NL)-Step 6.4	Upwards
12	EC7(NL)-Step 6.5	Upwards
12	EC7(NL)-Step 6.5 x 1.200	

Summary		Upwards/Sufficient

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut Anker 101.6*17.5 h.o.h...			Anchor/strut Kranz Anker Check		
		Force [kN]	State	Status	Force [kN]	State	Status
2	EC7(NL)-Step 6.1	12.06	Elastic				
2	EC7(NL)-Step 6.2	6.89	Elastic				
2	EC7(NL)-Step 6.3	15.18	Elastic				
2	EC7(NL)-Step 6.4	9.57	Elastic				
2	EC7(NL)-Step 6.5	0.00					
2	EC7(NL)-Step 6.5 x 1.200	0.00					
3	EC7(NL)-Step 6.1	100.00	Elastic				
3	EC7(NL)-Step 6.2	100.00	Elastic				
3	EC7(NL)-Step 6.3	100.00	Elastic				
3	EC7(NL)-Step 6.4	100.00	Elastic				
3	EC7(NL)-Step 6.5	100.00	Elastic				
3	EC7(NL)-Step 6.5 x 1.200	120.00	Elastic				
4	EC7(NL)-Step 6.1	287.68	Elastic				
4	EC7(NL)-Step 6.2	281.85	Elastic				
4	EC7(NL)-Step 6.3	301.34	Elastic				
4	EC7(NL)-Step 6.4	295.49	Elastic				
4	EC7(NL)-Step 6.5	208.09	Elastic				
4	EC7(NL)-Step 6.5 x 1.200	249.70	Elastic				
5	EC7(NL)-Step 6.1	293.66	Elastic				
5	EC7(NL)-Step 6.2	285.31	Elastic				

Stage nr.	Verification type	Anchor/strut Anker 101.6*17.5 h.o.h...			Anchor/strut Kranz Anker Check		
		Force [kN]	State	Status	Force [kN]	State	Status
5	EC7(NL)-Step 6.3	320.99	Elastic				
5	EC7(NL)-Step 6.4	317.68	Elastic				
5	EC7(NL)-Step 6.5	216.98	Elastic				
5	EC7(NL)-Step 6.5 x 1.200	260.38	Elastic				
6	EC7(NL)-Step 6.1	335.60	Elastic				
6	EC7(NL)-Step 6.2	332.32	Elastic				
6	EC7(NL)-Step 6.3	341.24	Elastic				
6	EC7(NL)-Step 6.4	338.61	Elastic				
6	EC7(NL)-Step 6.5	266.78	Elastic				
6	EC7(NL)-Step 6.5 x 1.200	320.14	Elastic				
7	EC7(NL)-Step 6.1	303.24	Elastic				
7	EC7(NL)-Step 6.2	286.50	Elastic				
7	EC7(NL)-Step 6.3	315.69	Elastic				
7	EC7(NL)-Step 6.4	306.21	Elastic				
7	EC7(NL)-Step 6.5	271.81	Elastic				
7	EC7(NL)-Step 6.5 x 1.200	326.17	Elastic				
8	EC7(NL)-Step 6.1	297.01	Elastic				
8	EC7(NL)-Step 6.2	292.02	Elastic				
8	EC7(NL)-Step 6.3	312.46	Elastic				
8	EC7(NL)-Step 6.4	306.07	Elastic				
8	EC7(NL)-Step 6.5	154.67	Elastic				
8	EC7(NL)-Step 6.5 x 1.200	185.60	Elastic				
9	EC7(NL)-Step 6.1	383.93	Elastic				
9	EC7(NL)-Step 6.2	354.23	Elastic				
9	EC7(NL)-Step 6.3	380.80	Elastic				
9	EC7(NL)-Step 6.4	349.10	Elastic				
9	EC7(NL)-Step 6.5	282.59	Elastic				
9	EC7(NL)-Step 6.5 x 1.200	339.11	Elastic				
10	EC7(NL)-Step 6.1			(D)*			
10	EC7(NL)-Step 6.2			(D)*			
10	EC7(NL)-Step 6.3	247.26	Elastic				
10	EC7(NL)-Step 6.4	264.03	Elastic				
10	EC7(NL)-Step 6.5	236.95	Elastic				
10	EC7(NL)-Step 6.5 x 1.200	284.33	Elastic				
11	EC7(NL)-Step 6.1	383.82	Elastic				
11	EC7(NL)-Step 6.2	365.64	Elastic				
11	EC7(NL)-Step 6.3	**406.10**	Elastic				
11	EC7(NL)-Step 6.4	390.20	Elastic				
11	EC7(NL)-Step 6.5	306.74	Elastic				
11	EC7(NL)-Step 6.5 x 1.200	368.09	Elastic				
12	EC7(NL)-Step 6.1				155.77	Elastic	
12	EC7(NL)-Step 6.2				152.20	Elastic	
12	EC7(NL)-Step 6.3				**167.98**	Elastic	
12	EC7(NL)-Step 6.4				163.91	Elastic	
12	EC7(NL)-Step 6.5				110.31	Elastic	
12	EC7(NL)-Step 6.5 x 1.200				132.37	Elastic	
Max		**406.10**			**167.98**		

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

The force is in the direction of the anchor.

2.3 Overall Stability per Stage

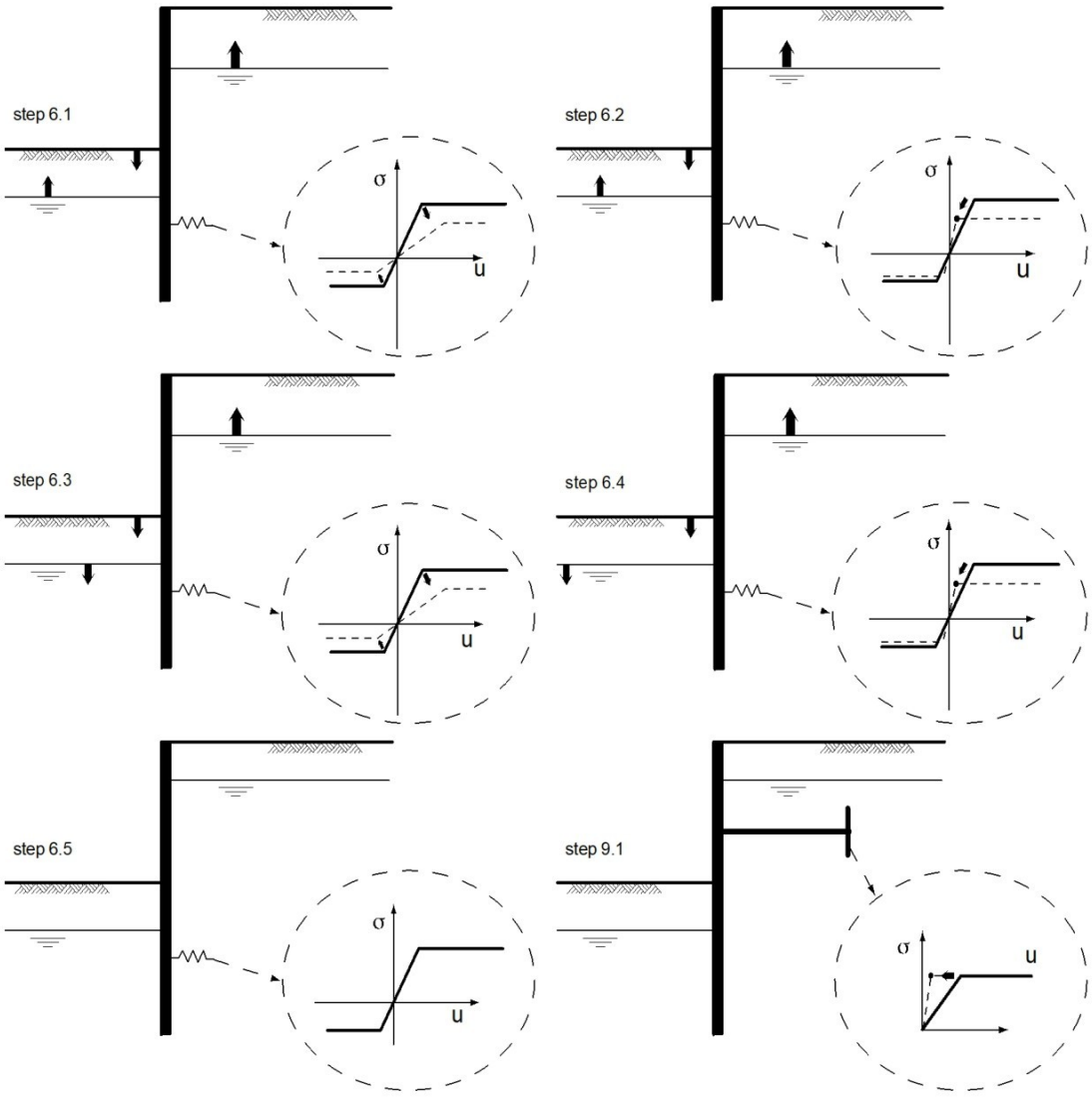
Stage name	Stability factor [-]
B_aanbrengen damwand	1.76
B_aanbreng anker	1.76
B_aanvul mv + voorspan	1.76
GLW_terrein+opslag*psi0	1.17
GLW_terrein*psi0+opslag	1.05
GLW_kraan+opslag*psi0	1.18
GLW_kraan*psi0+opslag	1.05
GLW_(terrein+opslag)*psi0 + ijs	1.40
ELW	1.19
MHW	1.28
val na MHW	1.10
KRANZ	1.53

2.4 Warnings

Phi values:
In the profile(s) below, the difference between the highest and lowest phi in the materials is more than 15 degrees. According to Cur-166 article 4.5.8 a Culmann calculation with straight slip surfaces is not allowed. Either reduce your phi's or try a Ka, Ko, Kp calculation.
Profile(s):
T01_algm_act_aanvul mv
T01_algm_GLW_act
T01_algm_MHW_act
T01_algm_MHW val_act

Vertical balance:
The resultant vertical friction force is directed upward in stage 1,2,3,4,5,7,9,12 because the friction force on the passive side exceeds that on the active side. This might be prevented by reducing the friction angle Delta on the passive side.

2.5 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	Yes
Number of construction stages	12
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	14.40 m
Level top side	22.40 m
Number of sections	1
q_b;max	15.00 MPa
Xi factor	0.91

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 18 -700 (S3...	8.00	22.40	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 18 -700 (S3...	7.9380E+04	0.71	5.6360E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 18 -700 (S3...	639.00	1.00	1.00	0.71	453.69

3.2.4 Properties for Vertical Balance

Section name	From [m]	To [m]	Height [mm]	Section area [cm²/m']
AZ 18 -700 (S3...	8.00	22.40	420.00	139.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B_aanbrengen damwand

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	2: B_aanbreng anker
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300

Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	3: B_aanvul mv + voorspan
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	4: GLW_terrein+opslag*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	5: GLW_terrein*psi0+opslag
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m

Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	6: GLW_kraan+opslag*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	7: GLW_kraan*psi0+opslag
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900

- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	8: GLW_(terrein+opslag)*psi0 + ijs
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	

- Partial factor base resistance (gamma_b)	1.200
Verification of stage	9: ELW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	10: MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined

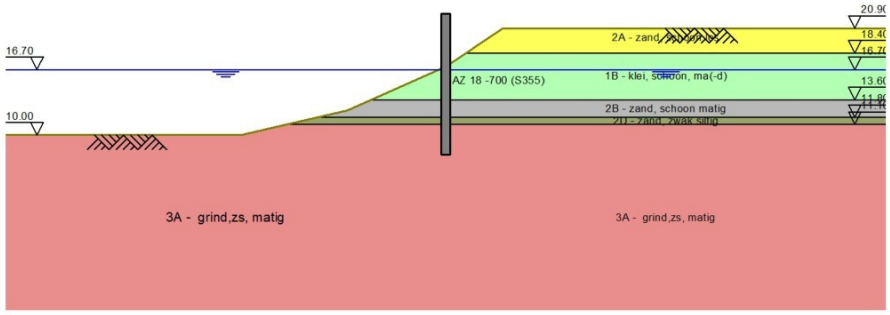
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	11: val na MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	12: KRANZ
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	

- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

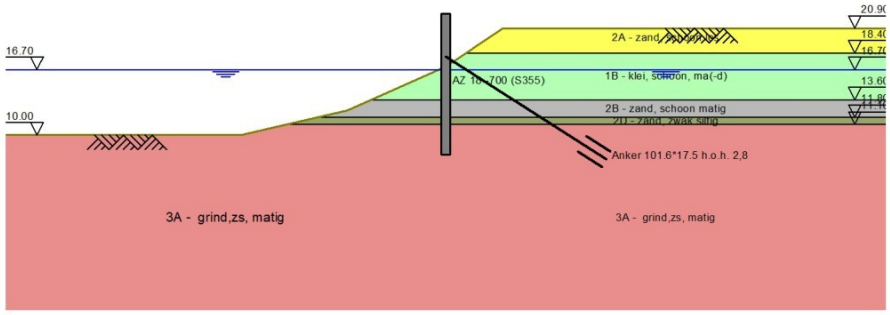
4 Outline Stage 1: B_aanbrengen damwand

Outline - Stage 1: B_aanbrengen damwand



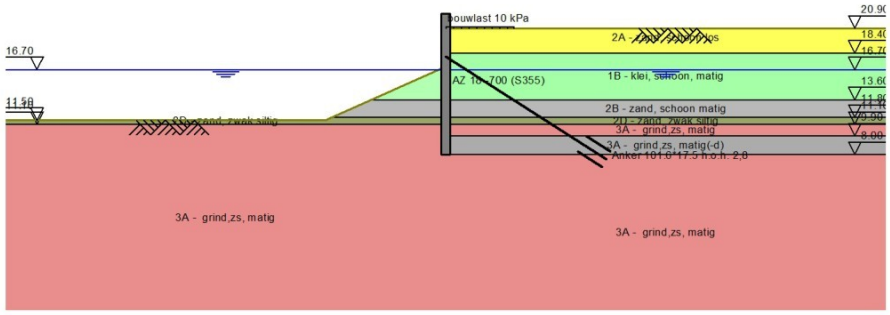
5 Outline Stage 2: B_aanbreng anker

Outline - Stage 2: B_aanbreng anker



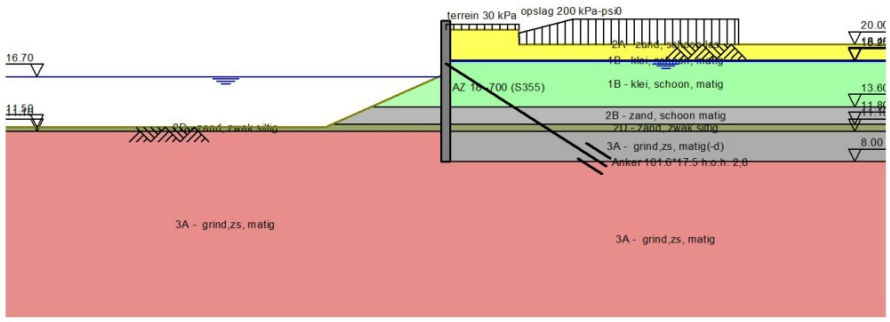
6 Outline Stage 3: B_aanvul mv + voorspan

Outline - Stage 3: B_aanvul mv + voorspan



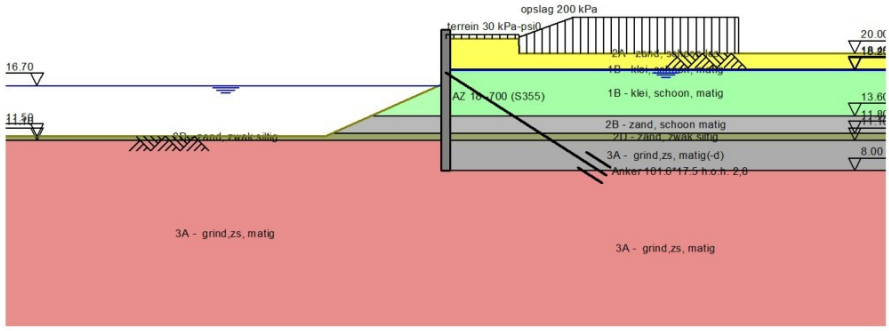
7 Outline Stage 4: GLW_terrein+opslag*psi0

Outline - Stage 4: GLW_terrein+opslag*psi0



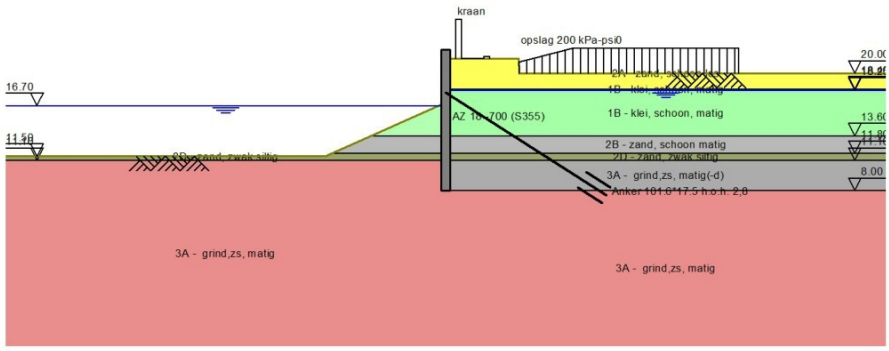
8 Outline Stage 5: GLW_terrein*psi0+opslag

Outline - Stage 5: GLW_terrein*psi0+opslag



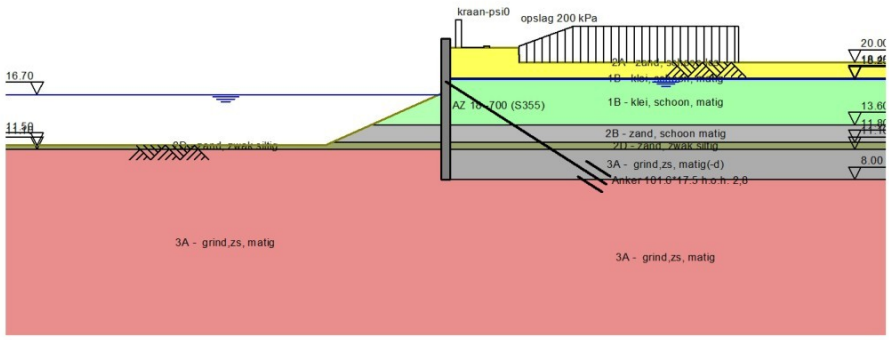
9 Outline Stage 6: GLW_kraan+opslag*psi0

Outline - Stage 6: GLW_kraan+opslag*psi0



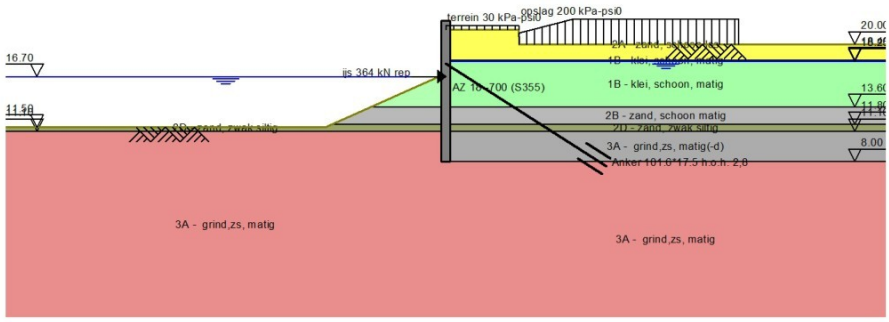
10 Outline Stage 7: GLW_kraan*psi0+opslag

Outline - Stage 7: GLW_kraan*psi0+opslag



11 Outline Stage 8: GLW_(terrein+opslag)*psi0 + ijs

Outline - Stage 8: GLW_(terrein+opslag)*psi0 + ijs

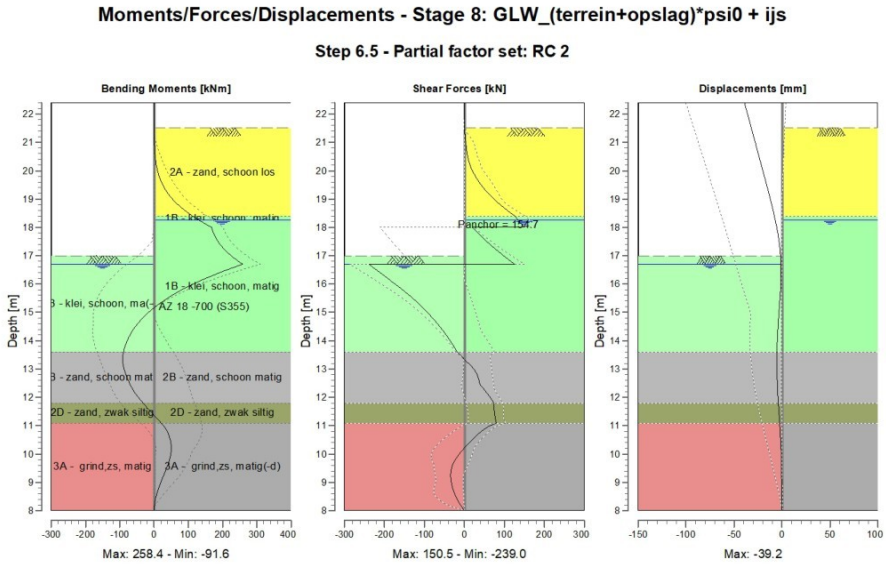


12 Step 6.5 Stage 8: GLW_(terrein+opslag)*psi0 + ijs

12.1 Calculation Results

Number of iterations: 3

12.1.1 Charts of Moments, Forces and Displacements



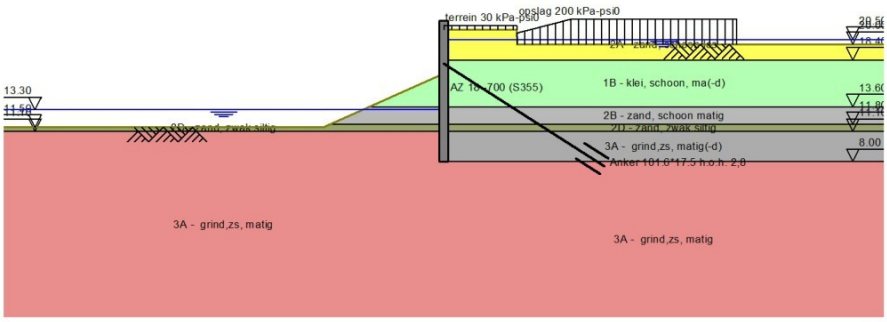
12.1.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	22.40	0.00	0.00	**-39.2**
1	22.10	0.00	0.00	-36.8
2	22.10	0.00	0.00	-36.8
2	21.50	0.00	0.00	-32.0
3	21.50	0.00	0.01	-32.0
3	20.90	1.04	4.03	-27.2
4	20.90	1.04	4.02	-27.2
4	20.50	3.40	8.06	-24.0
5	20.50	3.40	8.03	-24.0
5	19.80	14.71	27.51	-18.4
6	19.80	14.71	27.50	-18.4
6	19.10	46.50	66.61	-13.0
7	19.10	46.50	66.60	-13.0
7	18.40	112.75	126.38	-8.0
8	18.40	112.75	126.37	-8.0
8	18.25	132.33	134.83	-7.1
9	18.25	132.33	134.83	-7.1
9	18.00	167.97	150.50	-5.6
10	18.00	167.97	20.06	-5.6
10	17.50	186.70	55.94	-3.2
11	17.50	186.70	55.94	-3.2
11	17.00	224.96	98.04	-1.6

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
12	17.00	224.96	98.03	-1.6
12	16.70	**258.44**	124.95	-1.1
13	16.70	**258.44**	**-239.03**	-1.1
13	16.08	128.36	-180.87	-1.3
14	16.08	128.36	-180.86	-1.3
14	15.46	33.73	-125.84	-2.3
15	15.46	33.73	-125.84	-2.3
15	14.84	-30.21	-82.05	-3.6
16	14.84	-30.21	-82.04	-3.6
16	14.22	-69.64	-46.40	-4.7
17	14.22	-69.64	-46.40	-4.7
17	13.60	-89.32	-18.25	-5.3
18	13.60	-89.32	-18.25	-5.3
18	13.30	-91.61	2.00	-5.4
19	13.30	-91.61	1.98	-5.4
19	12.80	-81.97	31.82	-5.2
20	12.80	-81.97	31.78	-5.2
20	12.30	-62.98	48.00	-4.7
21	12.30	-62.97	47.99	-4.7
21	11.80	-32.26	73.16	-3.9
22	11.80	-32.27	73.12	-3.9
22	11.10	20.71	79.65	-2.6
23	11.10	20.70	79.84	-2.6
23	10.50	47.46	20.10	-1.6
24	10.50	47.47	20.03	-1.6
24	9.90	47.28	-18.12	-0.8
25	9.90	47.27	-18.22	-0.8
25	9.27	28.85	-34.35	-0.4
26	9.27	28.85	-34.32	-0.4
26	8.63	8.93	-25.52	-0.1
27	8.63	8.93	-25.51	-0.1
27	8.00	0.00	0.00	0.0
Max		**258.44**	**-239.03**	**-39.2**
Max, minor nodes incl.		258.44	-239.03	-39.2

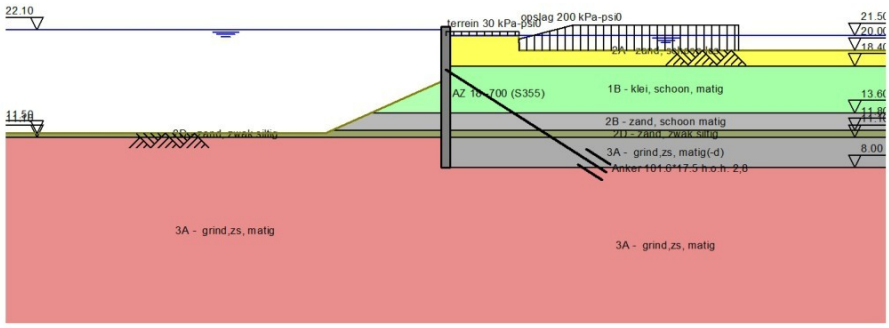
13 Outline Stage 9: ELW

Outline - Stage 9: ELW



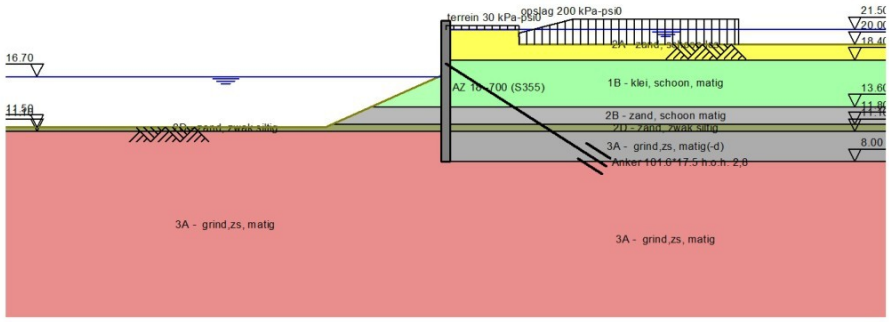
14 Outline Stage 10: MHW

Outline - Stage 10: MHW



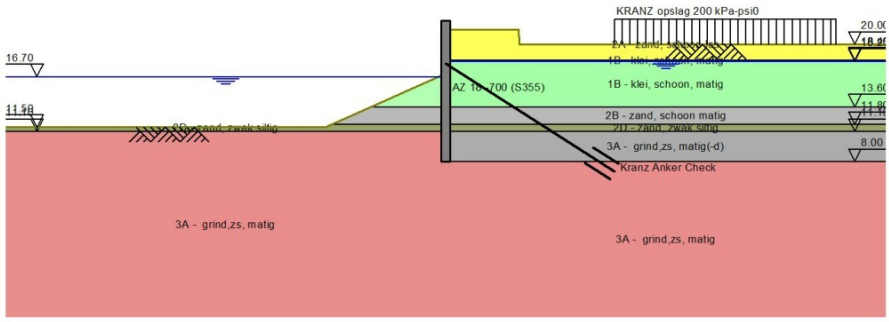
15 Outline Stage 11: val na MHW

Outline - Stage 11: val na MHW



16 Outline Stage 12: KRANZ

Outline - Stage 12: KRANZ



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	13-3-2026
Time of report:	11:04:31
Report with version:	23.1.1.40517
Date of calculation:	9-3-2026
Time of calculation:	15:24:03
Calculated with version:	23.1.1.40517
File name:	Sectie_3_Kade Besix NAP+11,50 v8_revB
Project identification:	Integraalplan Willem-Alexanderhaven Definitief ontwerp zichtjaar 2125 Talud 02

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		13.02	8.51	0.0	26.4	
1	EC7(NL)-Step 6.2		9.99	8.40	0.0	26.4	
1	EC7(NL)-Step 6.3		34.36	17.34	0.0	28.6	
1	EC7(NL)-Step 6.4		29.29	17.09	0.0	28.6	
1	EC7(NL)-Step 6.5	-0.3	-5.34	-3.40	0.0	22.7	
1	EC7(NL)-Step 6.5 x 1.200		-6.41	-4.08			
2	EC7(NL)-Step 6.1		-54.80	-49.77	27.2	30.6	
2	EC7(NL)-Step 6.2		-39.51	-43.39	27.5	31.4	
2	EC7(NL)-Step 6.3		-63.80	-53.96	28.4	32.1	
2	EC7(NL)-Step 6.4		-47.43	-47.36	28.6	32.9	
2	EC7(NL)-Step 6.5	-3.4	22.32	-31.93	23.1	26.9	
2	EC7(NL)-Step 6.5 x 1.200		26.78	-38.31			
3	EC7(NL)-Step 6.1		-59.16	-59.82	28.6	32.6	
3	EC7(NL)-Step 6.2		-55.11	-59.01	28.5	32.6	
3	EC7(NL)-Step 6.3		-57.41	-59.82	30.1	34.8	
3	EC7(NL)-Step 6.4		-57.48	-59.82	29.9	34.6	
3	EC7(NL)-Step 6.5	-3.2	36.06	-50.85	23.8	27.8	
3	EC7(NL)-Step 6.5 x 1.200		43.27	-61.03			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		-265.52	-169.11	46.9	50.6	
4	EC7(NL)-Step 6.4		-244.76	-163.20	49.0	53.2	
4	EC7(NL)-Step 6.5	-13.8	-181.54	-130.54	25.9	28.8	
4	EC7(NL)-Step 6.5 x 1.200		-217.85	-156.65			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		-500.55	-319.39	73.6	76.8	
5	EC7(NL)-Step 6.4		-497.95	-316.66	76.3	79.3	
5	EC7(NL)-Step 6.5	-21.2	271.29	-216.42	35.0	38.7	
5	EC7(NL)-Step 6.5 x 1.200		325.55	-259.70			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		460.51	-310.62	72.1	75.5	
6	EC7(NL)-Step 6.4		456.92	-308.23	75.2	78.3	
6	EC7(NL)-Step 6.5	-29.5	336.73	-225.15	35.0	38.7	
6	EC7(NL)-Step 6.5 x 1.200		404.07	-270.19			
7	EC7(NL)-Step 6.1						(D)*
7	EC7(NL)-Step 6.2						(D)*
7	EC7(NL)-Step 6.3		**-604.31**	-358.36	84.3	86.4	
7	EC7(NL)-Step 6.4		593.72	-359.30	**85.5**	**87.5**	
7	EC7(NL)-Step 6.5	-26.9	328.63	-234.87	38.7	42.4	
7	EC7(NL)-Step 6.5 x 1.200		394.36	-281.85			
8	EC7(NL)-Step 6.1						(D)*
8	EC7(NL)-Step 6.2						(D)*
8	EC7(NL)-Step 6.3		492.75	-279.11	65.7	69.4	
8	EC7(NL)-Step 6.4		470.75	-274.25	68.8	72.5	
8	EC7(NL)-Step 6.5	-35.6	375.95	-230.54	38.1	41.9	
8	EC7(NL)-Step 6.5 x 1.200		451.14	-276.65			
9	EC7(NL)-Step 6.1						(D)*
9	EC7(NL)-Step 6.2						(D)*
9	EC7(NL)-Step 6.3		507.21	-275.00	69.0	72.5	
9	EC7(NL)-Step 6.4		504.25	-271.22	71.7	75.2	
9	EC7(NL)-Step 6.5	-36.9	388.23	-236.34	38.2	41.9	
9	EC7(NL)-Step 6.5 x 1.200		465.88	-283.61			
10	EC7(NL)-Step 6.1						(D)*
10	EC7(NL)-Step 6.2						(D)*

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
10	EC7(NL)-Step 6.3		549.92	-315.61	82.5	84.8	
10	EC7(NL)-Step 6.4		574.99	-316.53	83.9	86.1	
10	EC7(NL)-Step 6.5	-33.9	376.59	-247.67	39.5	43.3	
10	EC7(NL)-Step 6.5 x 1.200		451.91	-297.20			
11	EC7(NL)-Step 6.1						(D)*
11	EC7(NL)-Step 6.2						(D)*
11	EC7(NL)-Step 6.3		449.08	-309.53	72.3	75.6	
11	EC7(NL)-Step 6.4		483.01	-310.45	74.9	78.0	
11	EC7(NL)-Step 6.5	-29.4	503.22	-358.67	38.7	42.5	
11	EC7(NL)-Step 6.5 x 1.200		603.86	**-430.41**			
12	EC7(NL)-Step 6.1						(D)*
12	EC7(NL)-Step 6.2						(D)*
12	EC7(NL)-Step 6.3		-587.06	-388.93	81.9	84.3	
12	EC7(NL)-Step 6.4		-576.44	-387.73	85.4	87.4	
12	EC7(NL)-Step 6.5	-28.0	346.13	-267.25	40.5	44.5	
12	EC7(NL)-Step 6.5 x 1.200		415.36	-320.70			
13	EC7(NL)-Step 6.1						(D)*
13	EC7(NL)-Step 6.2						(D)*
13	EC7(NL)-Step 6.3		-534.02	-336.62	81.0	83.4	
13	EC7(NL)-Step 6.4		-506.76	-337.58	84.1	86.3	
13	EC7(NL)-Step 6.5	-28.2	345.11	-261.67	41.1	45.2	
13	EC7(NL)-Step 6.5 x 1.200		414.13	-314.00			
14	EC7(NL)-Step 6.1						(D)*
14	EC7(NL)-Step 6.2						(D)*
14	EC7(NL)-Step 6.3		341.59	-213.03	59.2	63.4	
14	EC7(NL)-Step 6.4		344.67	-230.20	61.9	66.1	
14	EC7(NL)-Step 6.5	-27.3	319.65	-220.44	36.0	40.2	
14	EC7(NL)-Step 6.5 x 1.200		383.58	-264.53			
15	EC7(NL)-Step 6.1						(D)*
15	EC7(NL)-Step 6.2						(D)*
15	EC7(NL)-Step 6.3		577.92	-385.75	75.6	78.6	
15	EC7(NL)-Step 6.4		554.81	-381.80	78.9	81.6	
15	EC7(NL)-Step 6.5	-33.1	375.72	-284.34	38.8	43.0	
15	EC7(NL)-Step 6.5 x 1.200		450.87	-341.21			
16	EC7(NL)-Step 6.1						(D)*
16	EC7(NL)-Step 6.2						(D)*
16	EC7(NL)-Step 6.3		524.06	-340.87	73.9	77.0	
16	EC7(NL)-Step 6.4		519.54	-338.21	77.5	80.4	
16	EC7(NL)-Step 6.5	-37.1	397.64	-282.60	38.8	42.9	
16	EC7(NL)-Step 6.5 x 1.200		477.17	-339.12			
17	EC7(NL)-Step 6.1						(D)*
17	EC7(NL)-Step 6.2						(D)*
17	EC7(NL)-Step 6.3		-306.49	-224.52	61.8	65.9	
17	EC7(NL)-Step 6.4		-286.72	-220.35	67.6	71.4	
17	EC7(NL)-Step 6.5	**-53.4**	221.37	-163.01	36.7	40.8	
17	EC7(NL)-Step 6.5 x 1.200		265.65	-195.62			
Max		**-53.4**	**-604.31**	**-430.41**	**85.5**	**87.5**	

Stage nr.	Verification type	Vertical balance
1	EC7(NL)-Step 6.1	Sufficient
1	EC7(NL)-Step 6.2	Sufficient
1	EC7(NL)-Step 6.3	Upwards
1	EC7(NL)-Step 6.4	Upwards
1	EC7(NL)-Step 6.5	Upwards
1	EC7(NL)-Step 6.5 x 1.200	
2	EC7(NL)-Step 6.1	Sufficient
2	EC7(NL)-Step 6.2	Sufficient
2	EC7(NL)-Step 6.3	Sufficient
2	EC7(NL)-Step 6.4	Sufficient
2	EC7(NL)-Step 6.5	Sufficient
2	EC7(NL)-Step 6.5 x 1.200	

Stage nr.	Verification type	Vertical balance
3	EC7(NL)-Step 6.1	Upwards
3	EC7(NL)-Step 6.2	Upwards
3	EC7(NL)-Step 6.3	Upwards
3	EC7(NL)-Step 6.4	Upwards
3	EC7(NL)-Step 6.5	Upwards
3	EC7(NL)-Step 6.5 x 1.200	
4	EC7(NL)-Step 6.1	
4	EC7(NL)-Step 6.2	
4	EC7(NL)-Step 6.3	Upwards
4	EC7(NL)-Step 6.4	Upwards
4	EC7(NL)-Step 6.5	Upwards
4	EC7(NL)-Step 6.5 x 1.200	
5	EC7(NL)-Step 6.1	
5	EC7(NL)-Step 6.2	
5	EC7(NL)-Step 6.3	Sufficient
5	EC7(NL)-Step 6.4	Upwards
5	EC7(NL)-Step 6.5	Upwards
5	EC7(NL)-Step 6.5 x 1.200	
6	EC7(NL)-Step 6.1	
6	EC7(NL)-Step 6.2	
6	EC7(NL)-Step 6.3	Sufficient
6	EC7(NL)-Step 6.4	Upwards
6	EC7(NL)-Step 6.5	Upwards
6	EC7(NL)-Step 6.5 x 1.200	
7	EC7(NL)-Step 6.1	
7	EC7(NL)-Step 6.2	
7	EC7(NL)-Step 6.3	Sufficient
7	EC7(NL)-Step 6.4	Sufficient
7	EC7(NL)-Step 6.5	Upwards
7	EC7(NL)-Step 6.5 x 1.200	
8	EC7(NL)-Step 6.1	
8	EC7(NL)-Step 6.2	
8	EC7(NL)-Step 6.3	Sufficient
8	EC7(NL)-Step 6.4	Sufficient
8	EC7(NL)-Step 6.5	Upwards
8	EC7(NL)-Step 6.5 x 1.200	
9	EC7(NL)-Step 6.1	
9	EC7(NL)-Step 6.2	
9	EC7(NL)-Step 6.3	Sufficient
9	EC7(NL)-Step 6.4	Upwards
9	EC7(NL)-Step 6.5	Upwards
9	EC7(NL)-Step 6.5 x 1.200	
10	EC7(NL)-Step 6.1	
10	EC7(NL)-Step 6.2	
10	EC7(NL)-Step 6.3	Sufficient
10	EC7(NL)-Step 6.4	Sufficient
10	EC7(NL)-Step 6.5	Upwards
10	EC7(NL)-Step 6.5 x 1.200	
11	EC7(NL)-Step 6.1	
11	EC7(NL)-Step 6.2	
11	EC7(NL)-Step 6.3	Sufficient
11	EC7(NL)-Step 6.4	Sufficient
11	EC7(NL)-Step 6.5	Upwards
11	EC7(NL)-Step 6.5 x 1.200	
12	EC7(NL)-Step 6.1	
12	EC7(NL)-Step 6.2	
12	EC7(NL)-Step 6.3	Sufficient
12	EC7(NL)-Step 6.4	Sufficient
12	EC7(NL)-Step 6.5	Upwards
12	EC7(NL)-Step 6.5 x 1.200	
13	EC7(NL)-Step 6.1	
13	EC7(NL)-Step 6.2	
13	EC7(NL)-Step 6.3	Sufficient
13	EC7(NL)-Step 6.4	Sufficient

Stage nr.	Verification type	Vertical balance
13	EC7(NL)-Step 6.5	Upwards
13	EC7(NL)-Step 6.5 x 1.200	
14	EC7(NL)-Step 6.1	
14	EC7(NL)-Step 6.2	
14	EC7(NL)-Step 6.3	Sufficient
14	EC7(NL)-Step 6.4	Sufficient
14	EC7(NL)-Step 6.5	Sufficient
14	EC7(NL)-Step 6.5 x 1.200	
15	EC7(NL)-Step 6.1	
15	EC7(NL)-Step 6.2	
15	EC7(NL)-Step 6.3	Sufficient
15	EC7(NL)-Step 6.4	Sufficient
15	EC7(NL)-Step 6.5	Upwards
15	EC7(NL)-Step 6.5 x 1.200	
16	EC7(NL)-Step 6.1	
16	EC7(NL)-Step 6.2	
16	EC7(NL)-Step 6.3	Sufficient
16	EC7(NL)-Step 6.4	Sufficient
16	EC7(NL)-Step 6.5	Sufficient
16	EC7(NL)-Step 6.5 x 1.200	
17	EC7(NL)-Step 6.1	
17	EC7(NL)-Step 6.2	
17	EC7(NL)-Step 6.3	Upwards
17	EC7(NL)-Step 6.4	Upwards
17	EC7(NL)-Step 6.5	Upwards
17	EC7(NL)-Step 6.5 x 1.200	

Summary		Upwards/Sufficient

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut Anker Ø114,3x25 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
2	EC7(NL)-Step 6.1	79.05	Elastic				
2	EC7(NL)-Step 6.2	71.48	Elastic				
2	EC7(NL)-Step 6.3	84.02	Elastic				
2	EC7(NL)-Step 6.4	76.20	Elastic				
2	EC7(NL)-Step 6.5	56.89	Elastic				
2	EC7(NL)-Step 6.5 x 1.200	68.27	Elastic				
3	EC7(NL)-Step 6.1	100.00	Elastic				
3	EC7(NL)-Step 6.2	100.00	Elastic				
3	EC7(NL)-Step 6.3	100.00	Elastic				
3	EC7(NL)-Step 6.4	100.00	Elastic				
3	EC7(NL)-Step 6.5	100.00	Elastic				
3	EC7(NL)-Step 6.5 x 1.200	120.00	Elastic				
4	EC7(NL)-Step 6.1			(D)*			
4	EC7(NL)-Step 6.2			(D)*			
4	EC7(NL)-Step 6.3	287.60	Elastic				
4	EC7(NL)-Step 6.4	276.89	Elastic				
4	EC7(NL)-Step 6.5	217.20	Elastic				
4	EC7(NL)-Step 6.5 x 1.200	260.64	Elastic				
5	EC7(NL)-Step 6.1			(D)*			
5	EC7(NL)-Step 6.2			(D)*			
5	EC7(NL)-Step 6.3	571.99	Elastic				
5	EC7(NL)-Step 6.4	564.45	Elastic				
5	EC7(NL)-Step 6.5	399.71	Elastic				
5	EC7(NL)-Step 6.5 x 1.200	479.66	Elastic				

Stage nr.	Verification type	Anchor/strut Anker Ø114,3x25 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
6	EC7(NL)-Step 6.1			(D)*			
6	EC7(NL)-Step 6.2			(D)*			
6	EC7(NL)-Step 6.3	588.93	Elastic				
6	EC7(NL)-Step 6.4	584.42	Elastic				
6	EC7(NL)-Step 6.5	431.56	Elastic				
6	EC7(NL)-Step 6.5 x 1.200	517.88	Elastic				
7	EC7(NL)-Step 6.1			(D)*			
7	EC7(NL)-Step 6.2			(D)*			
7	EC7(NL)-Step 6.3	699.66	Elastic				
7	EC7(NL)-Step 6.4	706.02	Elastic				
7	EC7(NL)-Step 6.5	446.58	Elastic				
7	EC7(NL)-Step 6.5 x 1.200	535.89	Elastic				
8	EC7(NL)-Step 6.1			(D)*			
8	EC7(NL)-Step 6.2			(D)*			
8	EC7(NL)-Step 6.3	605.65	Elastic				
8	EC7(NL)-Step 6.4	591.09	Elastic				
8	EC7(NL)-Step 6.5	488.41	Elastic				
8	EC7(NL)-Step 6.5 x 1.200	586.09	Elastic				
9	EC7(NL)-Step 6.1			(D)*			
9	EC7(NL)-Step 6.2			(D)*			
9	EC7(NL)-Step 6.3	583.44	Elastic				
9	EC7(NL)-Step 6.4	577.82	Elastic				
9	EC7(NL)-Step 6.5	483.34	Elastic				
9	EC7(NL)-Step 6.5 x 1.200	580.00	Elastic				
10	EC7(NL)-Step 6.1			(D)*			
10	EC7(NL)-Step 6.2			(D)*			
10	EC7(NL)-Step 6.3	663.00	Elastic				
10	EC7(NL)-Step 6.4	671.83	Elastic				
10	EC7(NL)-Step 6.5	496.94	Elastic				
10	EC7(NL)-Step 6.5 x 1.200	596.33	Elastic				
11	EC7(NL)-Step 6.1			(D)*			
11	EC7(NL)-Step 6.2			(D)*			
11	EC7(NL)-Step 6.3	618.82	Elastic				
11	EC7(NL)-Step 6.4	627.27	Elastic				
11	EC7(NL)-Step 6.5	351.26	Elastic				
11	EC7(NL)-Step 6.5 x 1.200	421.51	Elastic				
12	EC7(NL)-Step 6.1			(D)*			
12	EC7(NL)-Step 6.2			(D)*			
12	EC7(NL)-Step 6.3	**783.89**	Elastic				
12	EC7(NL)-Step 6.4	762.42	Elastic				
12	EC7(NL)-Step 6.5	528.52	Elastic				
12	EC7(NL)-Step 6.5 x 1.200	634.23	Elastic				
13	EC7(NL)-Step 6.1			(D)*			
13	EC7(NL)-Step 6.2			(D)*			
13	EC7(NL)-Step 6.3	683.50	Elastic				
13	EC7(NL)-Step 6.4	696.03	Elastic				
13	EC7(NL)-Step 6.5	537.29	Elastic				
13	EC7(NL)-Step 6.5 x 1.200	644.74	Elastic				
14	EC7(NL)-Step 6.1			(D)*			
14	EC7(NL)-Step 6.2			(D)*			
14	EC7(NL)-Step 6.3	468.44	Elastic				
14	EC7(NL)-Step 6.4	501.76	Elastic				
14	EC7(NL)-Step 6.5	467.47	Elastic				
14	EC7(NL)-Step 6.5 x 1.200	560.96	Elastic				
15	EC7(NL)-Step 6.1			(D)*			
15	EC7(NL)-Step 6.2			(D)*			
15	EC7(NL)-Step 6.3	776.04	Elastic				
15	EC7(NL)-Step 6.4	752.54	Elastic				
15	EC7(NL)-Step 6.5	562.58	Elastic				
15	EC7(NL)-Step 6.5 x 1.200	675.10	Elastic				
16	EC7(NL)-Step 6.1			(D)*			
16	EC7(NL)-Step 6.2			(D)*			

Stage nr.	Verification type	Anchor/strut Anker Ø114,3x25 h.o.h.2..			Anchor/strut Anker - Kranz		
		Force [kN]	State	Status	Force [kN]	State	Status
16	EC7(NL)-Step 6.3	710.91	Elastic				
16	EC7(NL)-Step 6.4	704.74	Elastic				
16	EC7(NL)-Step 6.5	583.10	Elastic				
16	EC7(NL)-Step 6.5 x 1.200	699.72	Elastic				
17	EC7(NL)-Step 6.1						(D)*
17	EC7(NL)-Step 6.2						(D)*
17	EC7(NL)-Step 6.3				**404.22**	Elastic	
17	EC7(NL)-Step 6.4				399.27	Elastic	
17	EC7(NL)-Step 6.5				302.02	Elastic	
17	EC7(NL)-Step 6.5 x 1.200				362.42	Elastic	
Max		**783.89**			**404.22**		

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

The force is in the direction of the anchor.

2.3 Overall Stability per Stage

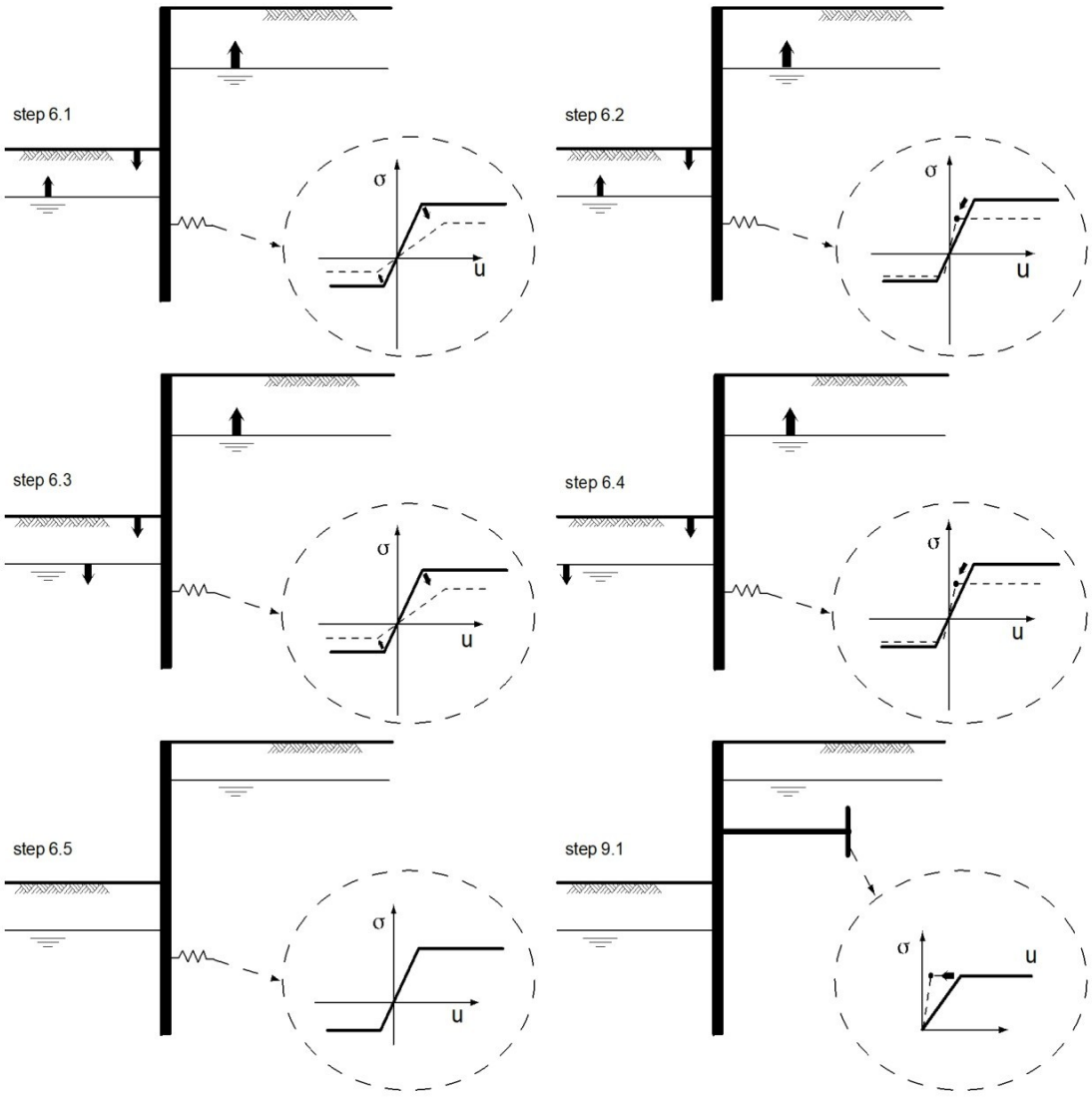
Stage name	Stability factor [-]
B_aanbrengen damwand	2.12
B_aanbreng anker	2.09
B_aanvul mv + voorspan	2.03
B_nieuwe bodem + bodembescherming	2.18
GLW_terrein+opslag*psi0+haalpen*psi0	1.32
GLW_terrein*psi0+opslag*psi0+haalpen	1.31
GLW_terrein*psi0+opslag+haalpen*psi0	1.18
GLW_kraan+opslag*psi0+haalpen*psi0	1.33
GLW_kraan*psi0+opslag*psi0+haalpen	1.31
GLW_kraan*psi0+opslag+haalpen*psi0	1.18
GLW_(terrein+opslag+haalpen)*psi0 + ijs	1.46
ELW met TB	1.28
ELW met KB	1.28
MHW	1.45
val na MHW met TB	1.26
val na MHW met KB	1.26
GLW_KRANZ - opslag*psi0+haalpen*psi0	1.42

2.4 Warnings

Phi values:
In the profile(s) below, the difference between the highest and lowest phi in the materials is more than 15 degrees. According to Cur-166 article 4.5.8 a Culmann calculation with straight slip surfaces is not allowed. Either reduce your phi's or try a Ka, Ko, Kp calculation.
Profile(s):
T02_algm
T02_algm_act_aanvul mv
T02_algm_GLW_act (2)
T02_algm_ELW_act
T02_algm_MHW_act
T02_algm_MHW val_act

Vertical balance:
The resultant vertical friction force is directed upward in stage 1,3,4,5,6,7,8,9,10,11,12,13,15,17 because the friction force on the passive side exceeds that on the active side. This might be prevented by reducing the friction angle Delta on the passive side.

2.5 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	Yes
Number of construction stages	17
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	16.90 m
Level top side	22.40 m
Number of sections	1
q_b;max	15.00 MPa
Xi factor	0.93

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 26 -700 (S3...	5.50	22.40	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 26 -700 (S3...	1.2541E+05	1.00	1.2541E+05	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 26 -700 (S3...	923.00	1.00	1.00	1.00	923.00

3.2.4 Properties for Vertical Balance

Section name	From [m]	To [m]	Height [mm]	Section area [cm²/m']
AZ 26 -700 (S3...	5.50	22.40	460.00	187.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B_aanbrengen damwand

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	2: B_aanbreng anker
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300

Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	3: B_aanvul mv + voorspan
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	4: B_nieuwe bodem + bodembescherming
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0

	RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.050
- Delta (wall friction angle)*	1.050
- Modulus of low representative subgrade reaction	1.300
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.15 m
- Raise in phreatic line on passive side**	0.15 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.300
- Tangent phi	1.200
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	5: GLW_terrein+opslag*psi0+haalpen*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m

- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	6: GLW_terrein*psi0+opslag*psi0+haalpen
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	7: GLW_terrein*psi0+opslag+haalpen*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	

- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	8: GLW_kraan+opslag*psi0+haalpen*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000

Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	9: GLW_kraan*psi0+opslag*psi0+haalpen
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	10: GLW_kraan*psi0+opslag+haalpen*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined

- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	11: GLW_(terrein+opslag+haalpen)*psi0 + ijs
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	12: ELW met TB
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	13: ELW met KB
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m

Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	14: MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	15: val na MHW met TB
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900

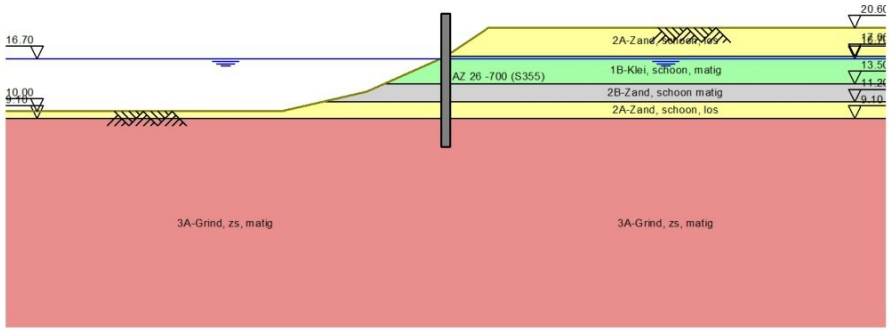
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	16: val na MHW met KB
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	

- Partial factor base resistance (gamma_b)	1.200
Verification of stage	17: GLW_KRANZ - opslag*psi0+haalpen*psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

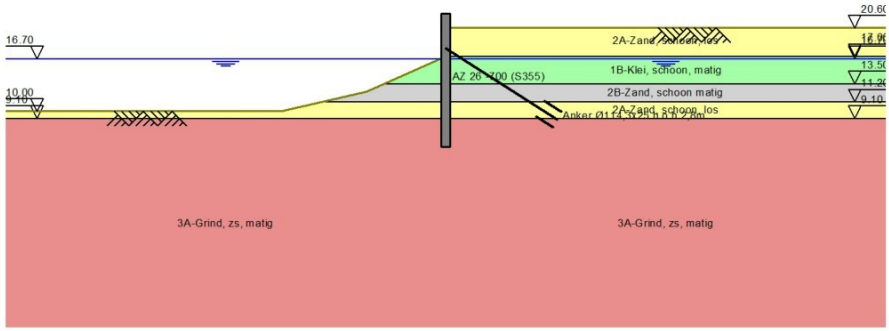
4 Outline Stage 1: B_aanbrengen damwand

Outline - Stage 1: B_aanbrengen damwand



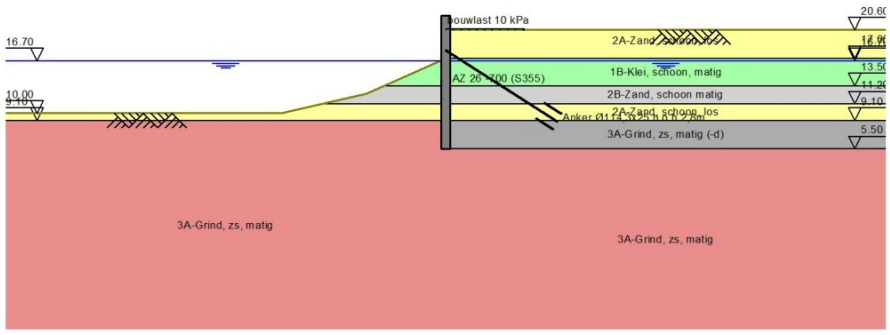
5 Outline Stage 2: B_aanbreng anker

Outline - Stage 2: B_aanbreng anker



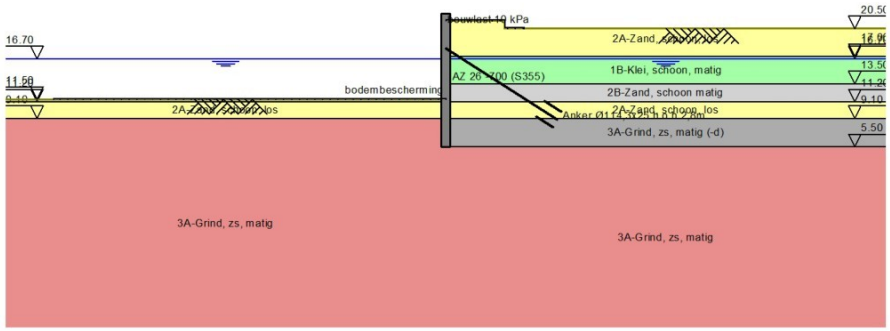
6 Outline Stage 3: B_aanvul mv + voorspan

Outline - Stage 3: B_aanvul mv + voorspan



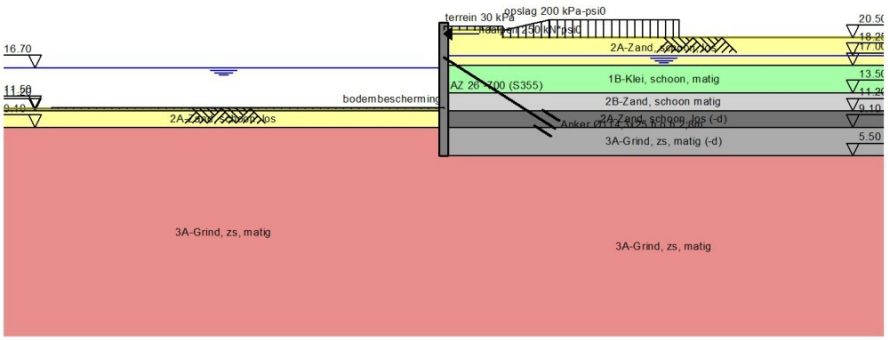
7 Outline Stage 4: B_nieuwe bodem + bodembescherming

Outline - Stage 4: B_nieuwe bodem + bodembescherming



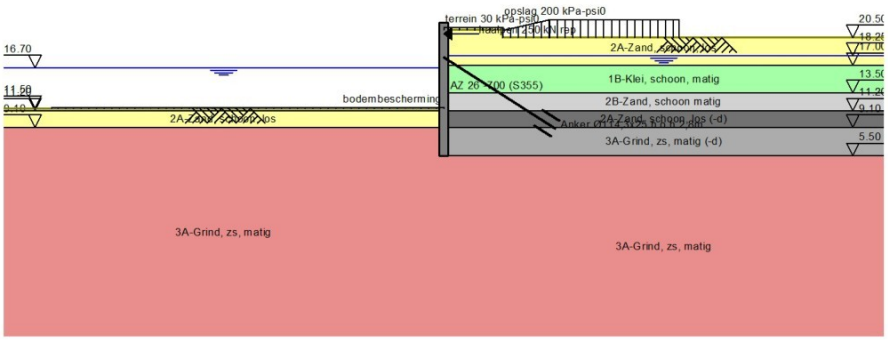
8 Outline Stage 5: GLW_terrein+opslag*psi0+haalpen*psi0

Outline - Stage 5: GLW_terrein+opslag*psi0+haalpen*psi0



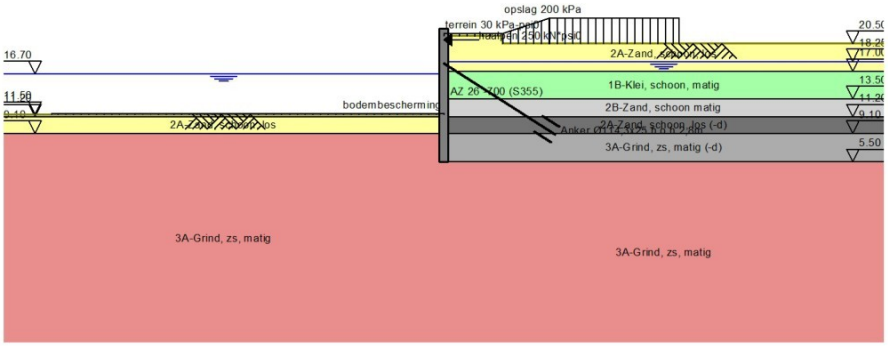
9 Outline Stage 6: GLW_terrein*psi0+opslag*psi0+haalpen

Outline - Stage 6: GLW_terrein*psi0+opslag*psi0+haalpen



10 Outline Stage 7: GLW_terrein*psi0+opslag+haalpen*psi0

Outline - Stage 7: GLW_terrein*psi0+opslag+haalpen*psi0

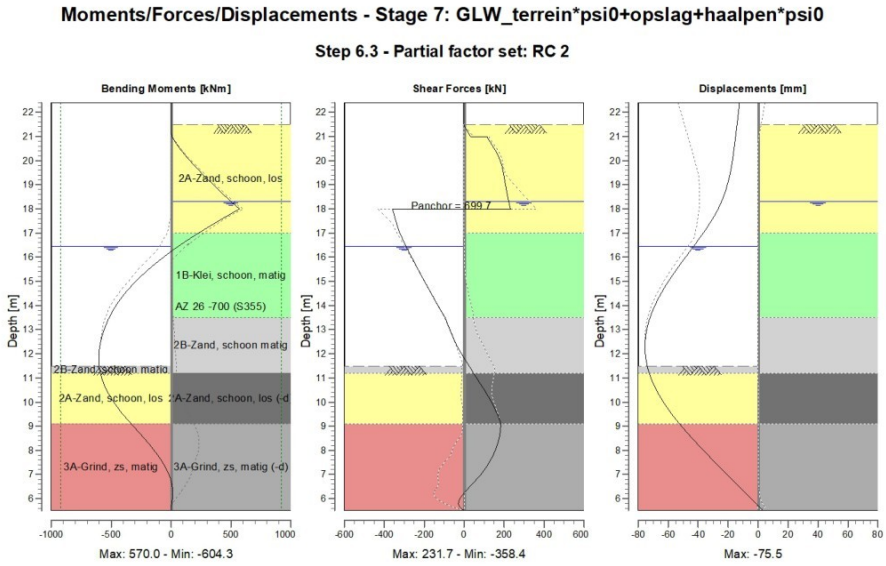


11 Step 6.3 Stage 7: GLW_terrein*psi0+opslag+haalpen*psi0

11.1 Calculation Results

Number of iterations: 5

11.1.1 Charts of Moments, Forces and Displacements



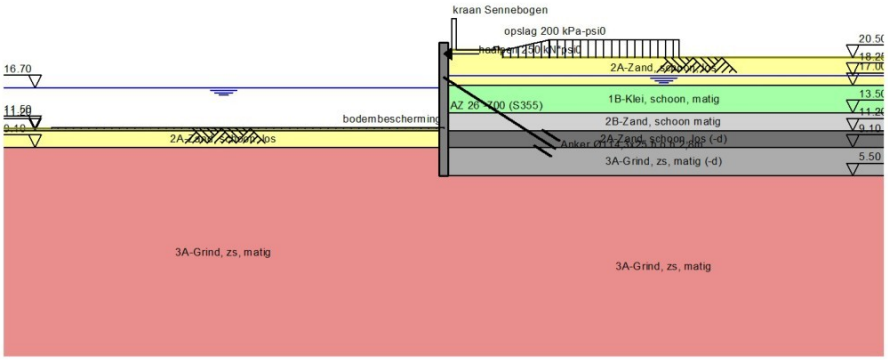
11.1.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	22.40	0.00	0.00	-12.4
1	22.10	0.00	0.00	-13.0
2	22.10	0.00	0.00	-13.0
2	21.50	0.00	0.00	-14.1
3	21.50	0.00	0.06	-14.1
3	21.00	7.12	31.83	-15.1
4	21.00	7.12	113.08	-15.1
4	20.90	18.80	120.48	-15.3
5	20.90	18.80	120.48	-15.3
5	20.60	58.35	143.32	-15.8
6	20.60	58.35	143.35	-15.8
6	20.50	73.06	150.70	-16.0
7	20.50	73.07	150.64	-16.0
7	19.77	199.36	189.24	-17.8
8	19.77	199.38	189.06	-17.8
8	19.03	344.64	205.86	-20.4
9	19.03	344.63	205.81	-20.4
9	18.30	501.81	223.34	-24.5
10	18.30	501.81	223.34	-24.5
10	18.25	513.01	224.66	-24.8
11	18.25	513.01	224.66	-24.8
11	18.00	570.04	231.72	-26.7

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
12	18.00	570.04	**-358.36**	-26.7
12	17.50	394.86	-341.82	-31.3
13	17.50	394.86	-341.82	-31.3
13	17.00	228.76	-322.05	-36.7
14	17.00	228.76	-322.05	-36.7
14	16.70	134.64	-305.21	-40.1
15	16.70	134.64	-305.20	-40.1
15	16.45	60.19	-290.26	-43.1
16	16.45	60.19	-290.39	-43.1
16	15.71	-137.04	-244.21	-51.9
17	15.71	-137.04	-244.48	-51.9
17	14.97	-299.76	-196.53	-60.1
18	14.97	-299.76	-196.81	-60.1
18	14.24	-426.69	-147.12	-67.0
19	14.24	-426.69	-147.41	-67.0
19	13.50	-516.54	-96.00	-72.1
20	13.50	-516.54	-96.15	-72.1
20	13.30	-534.79	-86.33	-73.1
21	13.30	-534.79	-86.33	-73.1
21	12.70	-577.62	-56.31	-75.1
22	12.70	-577.62	-56.32	-75.1
22	12.10	**-601.51**	-20.44	**-75.4**
23	12.10	**-601.51**	-20.44	**-75.4**
23	11.50	-600.43	24.55	-74.0
24	11.50	-600.42	24.56	-74.0
24	11.49	-600.18	25.33	-74.0
25	11.49	-600.18	25.33	-74.0
25	11.20	-589.72	46.18	-72.7
26	11.20	-589.72	46.18	-72.7
26	10.80	-564.99	77.21	-70.2
27	10.80	-564.99	77.21	-70.2
27	10.23	-508.70	120.40	-65.6
28	10.23	-508.70	120.40	-65.6
28	9.67	-429.90	156.46	-59.6
29	9.67	-429.89	156.40	-59.6
29	9.10	-333.07	183.92	-52.5
30	9.10	-333.05	183.71	-52.5
30	8.38	-204.03	171.19	-42.3
31	8.38	-204.02	171.06	-42.3
31	7.66	-92.11	136.26	-31.2
32	7.66	-92.09	136.06	-31.2
32	6.94	-13.53	77.98	-19.8
33	6.94	-13.50	77.99	-19.8
33	6.22	13.65	-1.07	-8.3
34	6.22	13.67	-1.54	-8.3
34	5.50	-0.03	-0.57	3.2
Max		**-601.51**	**-358.36**	**-75.4**
Max, minor nodes incl.		-604.31	-358.36	-75.5

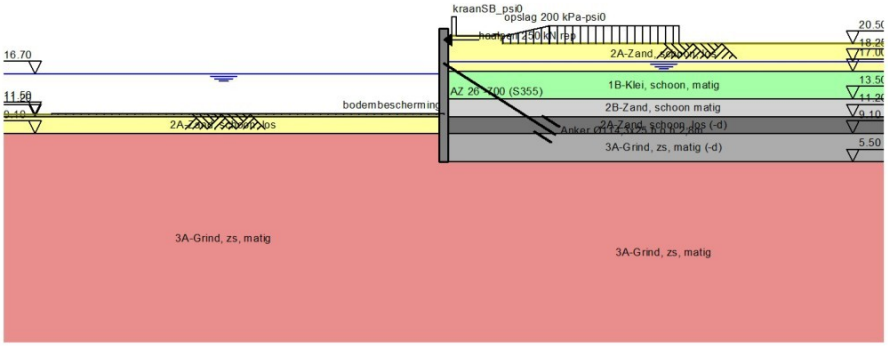
12 Outline Stage 8: GLW_kraan+opslag*psi0+haalpen*psi0

Outline - Stage 8: GLW_kraan+opslag*psi0+haalpen*psi0



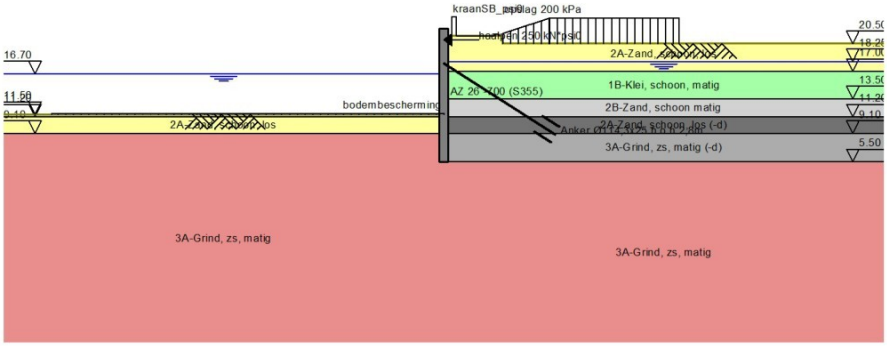
13 Outline Stage 9: GLW_kraan*psi0+opslag*psi0+haalpen

Outline - Stage 9: GLW_kraan*psi0+opslag*psi0+haalpen



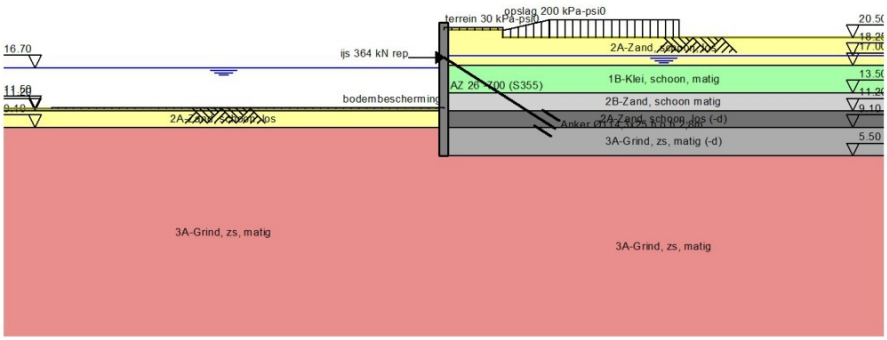
14 Outline Stage 10: GLW_kraan*psi0+opslag+haalpen*psi0

Outline - Stage 10: GLW_kraan*psi0+opslag+haalpen*psi0



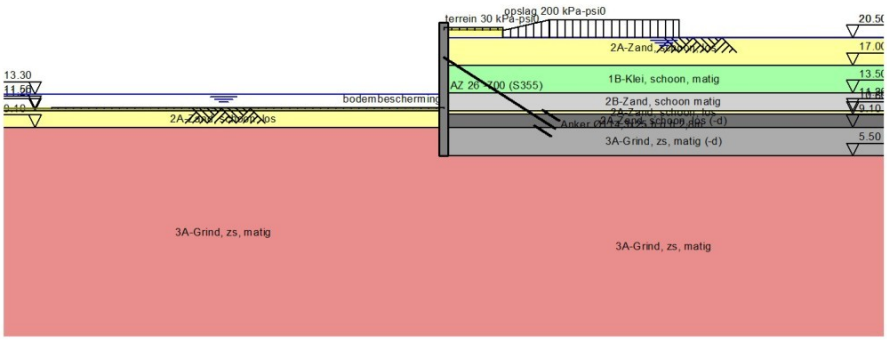
15 Outline Stage 11: GLW_(terrein+opslag+haalpen)*psi0 + ijs

Outline - Stage 11: GLW_(terrein+opslag+haalpen)*psi0 + ijs



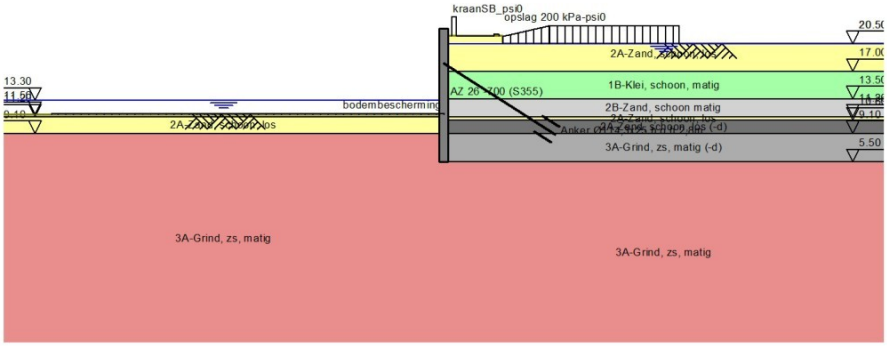
16 Outline Stage 12: ELW met TB

Outline - Stage 12: ELW met TB



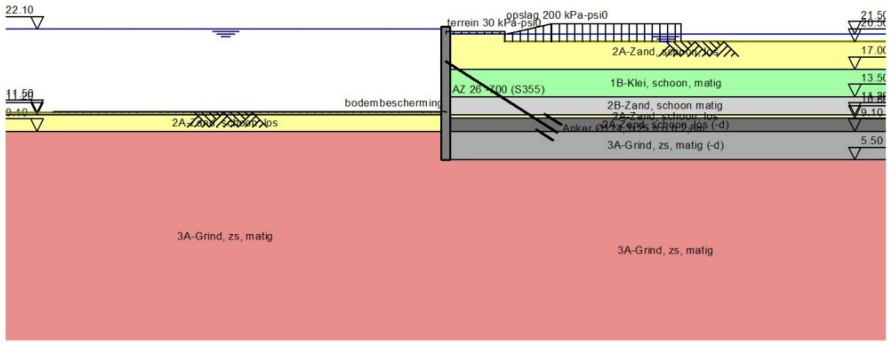
17 Outline Stage 13: ELW met KB

Outline - Stage 13: ELW met KB



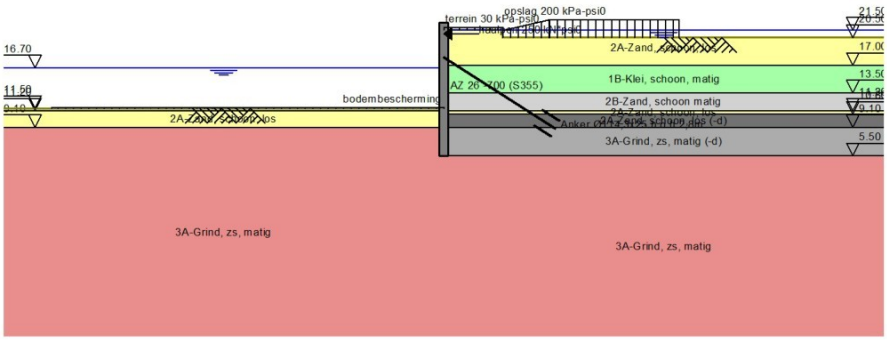
18 Outline Stage 14: MHW

Outline - Stage 14: MHW



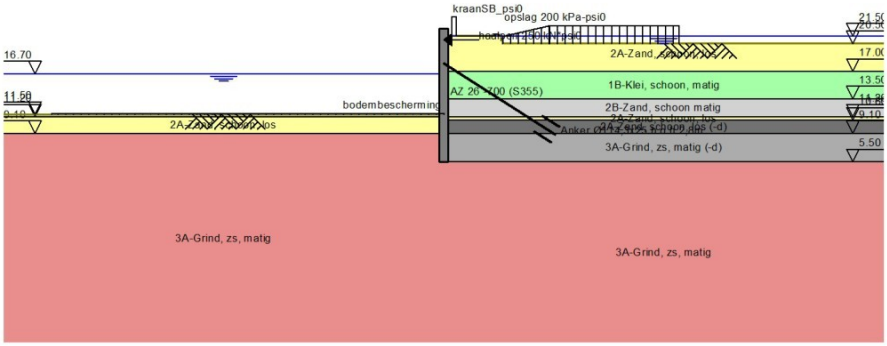
19 Outline Stage 15: val na MHW met TB

Outline - Stage 15: val na MHW met TB



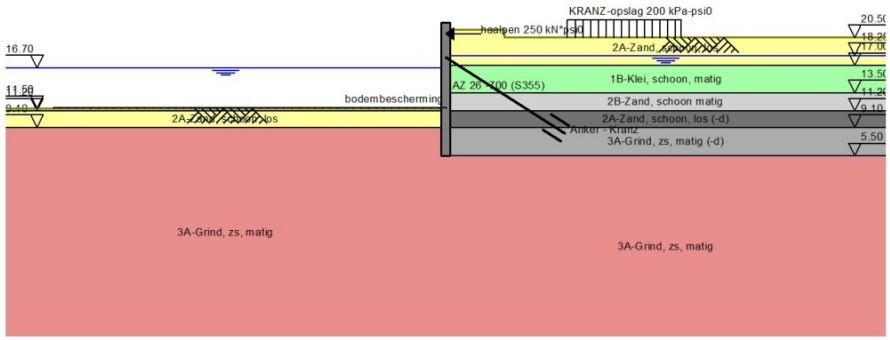
20 Outline Stage 16: val na MHW met KB

Outline - Stage 16: val na MHW met KB



21 Outline Stage 17: GLW_KRANZ - opslag*psi0+haalpen*psi0

Outline - Stage 17: GLW_KRANZ - opslag*psi0+haalpen*psi0



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	23-4-2025
Time of report:	13:55:43
Report with version:	23.1.1.40517
Date of calculation:	31-3-2025
Time of calculation:	12:02:14
Calculated with version:	23.1.1.40517
File name:	4_Logistieke_kade_Koopmans_revA
Project identification:	Kaden Alexanderhaven Roermond Toetsingsberekening kade Willem-Alexander

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		43.75	-20.02	0.0	24.1	
1	EC7(NL)-Step 6.2		41.28	-23.54	0.0	24.0	
1	EC7(NL)-Step 6.3		43.75	-20.02	0.0	24.1	
1	EC7(NL)-Step 6.4		41.28	-23.54	0.0	24.0	
1	EC7(NL)-Step 6.5	-15.7	43.75	-20.02	0.0	24.1	
1	EC7(NL)-Step 6.5 x 1.000		43.75	-20.02			
2	EC7(NL)-Step 6.1		42.52	25.21	27.3	31.5	
2	EC7(NL)-Step 6.2		45.95	26.13	27.4	31.7	
2	EC7(NL)-Step 6.3		42.52	25.21	27.3	31.5	
2	EC7(NL)-Step 6.4		45.95	26.13	27.4	31.7	
2	EC7(NL)-Step 6.5	-15.7	42.52	25.21	27.3	31.5	
2	EC7(NL)-Step 6.5 x 1.000		42.52	25.21			
3	EC7(NL)-Step 6.1		-80.36	-70.53	29.4	33.7	
3	EC7(NL)-Step 6.2		-67.50	-68.89	29.5	34.0	
3	EC7(NL)-Step 6.3		-80.36	-70.53	29.4	33.7	
3	EC7(NL)-Step 6.4		-67.50	-68.89	29.5	34.0	
3	EC7(NL)-Step 6.5	5.2	-80.36	-70.53	29.4	33.7	
3	EC7(NL)-Step 6.5 x 1.000		-80.36	-70.53			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		-126.50	-108.66	30.6	33.8	
4	EC7(NL)-Step 6.4		-121.88	-103.27	31.1	34.5	
4	EC7(NL)-Step 6.5	-10.4	-126.50	-108.66	30.6	33.8	
4	EC7(NL)-Step 6.5 x 1.000		-126.50	-108.66			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		351.13	-237.90	61.2	65.0	
5	EC7(NL)-Step 6.4		351.13	-233.57	65.5	69.3	
5	EC7(NL)-Step 6.5	-36.7	272.01	-180.05	37.1	40.8	
5	EC7(NL)-Step 6.5 x 1.200		326.42	-216.06			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		435.80	-230.83	55.4	59.4	
6	EC7(NL)-Step 6.4		435.80	-227.88	57.5	61.6	
6	EC7(NL)-Step 6.5	-48.0	337.38	-189.34	36.7	40.4	
6	EC7(NL)-Step 6.5 x 1.200		404.85	-227.21			
7	EC7(NL)-Step 6.1						(D)*
7	EC7(NL)-Step 6.2						(D)*
7	EC7(NL)-Step 6.3		**465.86**	-354.09	54.7	58.4	
7	EC7(NL)-Step 6.4		430.76	**-376.38**	56.9	60.9	
7	EC7(NL)-Step 6.5	-45.0	371.80	-312.07	38.5	42.4	
7	EC7(NL)-Step 6.5 x 1.200		446.16	-374.48			
8	EC7(NL)-Step 6.1						(D)*
8	EC7(NL)-Step 6.2						(D)*
8	EC7(NL)-Step 6.3		363.49	-259.33	69.5	72.9	
8	EC7(NL)-Step 6.4		361.56	-255.72	**74.3**	**77.5**	
8	EC7(NL)-Step 6.5	-40.3	301.04	-201.68	43.2	47.2	
8	EC7(NL)-Step 6.5 x 1.200		361.25	-242.01			
9	EC7(NL)-Step 6.1						(D)*
9	EC7(NL)-Step 6.2						(D)*
9	EC7(NL)-Step 6.3		307.79	-167.54	46.3	50.7	
9	EC7(NL)-Step 6.4		310.49	-176.08	46.2	50.7	
9	EC7(NL)-Step 6.5	-39.6	313.63	-167.62	39.5	43.6	
9	EC7(NL)-Step 6.5 x 1.200		376.36	-201.14			
10	EC7(NL)-Step 6.1						(D)*
10	EC7(NL)-Step 6.2						(D)*

Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
10	EC7(NL)-Step 6.3		407.43	-251.56	59.4	63.4	
10	EC7(NL)-Step 6.4		385.41	-245.71	63.3	67.3	
10	EC7(NL)-Step 6.5	-46.1	327.45	-209.87	42.4	46.4	
10	EC7(NL)-Step 6.5 x 1.200		392.94	-251.84			
11	EC7(NL)-Step 6.1						(D)*
11	EC7(NL)-Step 6.2						(D)*
11	EC7(NL)-Step 6.3		284.99	-170.16	53.8	58.1	
11	EC7(NL)-Step 6.4		284.99	-167.79	56.2	60.5	
11	EC7(NL)-Step 6.5	**-66.8**	221.89	-134.41	41.3	45.3	
11	EC7(NL)-Step 6.5 x 1.200		266.27	-161.29			
Max		**-66.8**	**465.86**	**-376.38**	**74.3**	**77.5**	

Stage nr.	Verification type	Vertical balance
1	EC7(NL)-Step 6.1	Upwards
1	EC7(NL)-Step 6.2	Upwards
1	EC7(NL)-Step 6.3	Upwards
1	EC7(NL)-Step 6.4	Upwards
1	EC7(NL)-Step 6.5	Upwards
1	EC7(NL)-Step 6.5 x 1.000	
2	EC7(NL)-Step 6.1	Sufficient
2	EC7(NL)-Step 6.2	Sufficient
2	EC7(NL)-Step 6.3	Sufficient
2	EC7(NL)-Step 6.4	Sufficient
2	EC7(NL)-Step 6.5	Sufficient
2	EC7(NL)-Step 6.5 x 1.000	
3	EC7(NL)-Step 6.1	Sufficient
3	EC7(NL)-Step 6.2	Sufficient
3	EC7(NL)-Step 6.3	Sufficient
3	EC7(NL)-Step 6.4	Sufficient
3	EC7(NL)-Step 6.5	Sufficient
3	EC7(NL)-Step 6.5 x 1.000	
4	EC7(NL)-Step 6.1	
4	EC7(NL)-Step 6.2	
4	EC7(NL)-Step 6.3	Sufficient
4	EC7(NL)-Step 6.4	Sufficient
4	EC7(NL)-Step 6.5	Sufficient
4	EC7(NL)-Step 6.5 x 1.000	
5	EC7(NL)-Step 6.1	
5	EC7(NL)-Step 6.2	
5	EC7(NL)-Step 6.3	Sufficient
5	EC7(NL)-Step 6.4	Sufficient
5	EC7(NL)-Step 6.5	Sufficient
5	EC7(NL)-Step 6.5 x 1.200	
6	EC7(NL)-Step 6.1	
6	EC7(NL)-Step 6.2	
6	EC7(NL)-Step 6.3	Sufficient
6	EC7(NL)-Step 6.4	Sufficient
6	EC7(NL)-Step 6.5	Sufficient
6	EC7(NL)-Step 6.5 x 1.200	
7	EC7(NL)-Step 6.1	
7	EC7(NL)-Step 6.2	
7	EC7(NL)-Step 6.3	Sufficient
7	EC7(NL)-Step 6.4	Sufficient
7	EC7(NL)-Step 6.5	Sufficient
7	EC7(NL)-Step 6.5 x 1.200	
8	EC7(NL)-Step 6.1	
8	EC7(NL)-Step 6.2	
8	EC7(NL)-Step 6.3	Sufficient
8	EC7(NL)-Step 6.4	Sufficient
8	EC7(NL)-Step 6.5	Sufficient
8	EC7(NL)-Step 6.5 x 1.200	

Stage nr.	Verification type	Vertical balance
9	EC7(NL)-Step 6.1	
9	EC7(NL)-Step 6.2	
9	EC7(NL)-Step 6.3	Sufficient
9	EC7(NL)-Step 6.4	Sufficient
9	EC7(NL)-Step 6.5	Sufficient
9	EC7(NL)-Step 6.5 x 1.200	
10	EC7(NL)-Step 6.1	
10	EC7(NL)-Step 6.2	
10	EC7(NL)-Step 6.3	Sufficient
10	EC7(NL)-Step 6.4	Sufficient
10	EC7(NL)-Step 6.5	Sufficient
10	EC7(NL)-Step 6.5 x 1.200	
11	EC7(NL)-Step 6.1	
11	EC7(NL)-Step 6.2	
11	EC7(NL)-Step 6.3	Sufficient
11	EC7(NL)-Step 6.4	Upwards
11	EC7(NL)-Step 6.5	Upwards
11	EC7(NL)-Step 6.5 x 1.200	

Summary		Upwards/Sufficient

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut Ankers Ø101.6 x 22.2 h...			Anchor/strut Kranz Ø101.6 x 22.2 h.o..		
		Force [kN]	State	Status	Force [kN]	State	Status
2	EC7(NL)-Step 6.1	17.65	Elastic				
2	EC7(NL)-Step 6.2	16.34	Elastic				
2	EC7(NL)-Step 6.3	17.65	Elastic				
2	EC7(NL)-Step 6.4	16.34	Elastic				
2	EC7(NL)-Step 6.5	17.65	Elastic				
2	EC7(NL)-Step 6.5 x 1.000	17.65	Elastic				
3	EC7(NL)-Step 6.1	100.00	Elastic				
3	EC7(NL)-Step 6.2	100.00	Elastic				
3	EC7(NL)-Step 6.3	100.00	Elastic				
3	EC7(NL)-Step 6.4	100.00	Elastic				
3	EC7(NL)-Step 6.5	100.00	Elastic				
3	EC7(NL)-Step 6.5 x 1.000	100.00	Elastic				
4	EC7(NL)-Step 6.1			(D)*			
4	EC7(NL)-Step 6.2			(D)*			
4	EC7(NL)-Step 6.3	182.03	Elastic				
4	EC7(NL)-Step 6.4	171.78	Elastic				
4	EC7(NL)-Step 6.5	182.03	Elastic				
4	EC7(NL)-Step 6.5 x 1.000	182.03	Elastic				
5	EC7(NL)-Step 6.1			(D)*			
5	EC7(NL)-Step 6.2			(D)*			
5	EC7(NL)-Step 6.3	469.68	Elastic				
5	EC7(NL)-Step 6.4	464.55	Elastic				
5	EC7(NL)-Step 6.5	360.57	Elastic				
5	EC7(NL)-Step 6.5 x 1.200	432.68	Elastic				
6	EC7(NL)-Step 6.1			(D)*			
6	EC7(NL)-Step 6.2			(D)*			
6	EC7(NL)-Step 6.3	488.53	Elastic				
6	EC7(NL)-Step 6.4	485.04	Elastic				
6	EC7(NL)-Step 6.5	392.65	Elastic				
6	EC7(NL)-Step 6.5 x 1.200	471.17	Elastic				
7	EC7(NL)-Step 6.1			(D)*			
7	EC7(NL)-Step 6.2			(D)*			

Stage nr.	Verification type	Anchor/strut Ankers Ø101.6 x 22.2 h...			Anchor/strut Kranz Ø101.6 x 22.2 h.o..		
		Force [kN]	State	Status	Force [kN]	State	Status
7	EC7(NL)-Step 6.3	220.00	Elastic				
7	EC7(NL)-Step 6.4	294.51	Elastic				
7	EC7(NL)-Step 6.5	272.51	Elastic				
7	EC7(NL)-Step 6.5 x 1.200	327.01	Elastic				
8	EC7(NL)-Step 6.1			(D)*			
8	EC7(NL)-Step 6.2			(D)*			
8	EC7(NL)-Step 6.3	527.42	Elastic				
8	EC7(NL)-Step 6.4	511.92	Elastic				
8	EC7(NL)-Step 6.5	423.03	Elastic				
8	EC7(NL)-Step 6.5 x 1.200	507.64	Elastic				
9	EC7(NL)-Step 6.1			(D)*			
9	EC7(NL)-Step 6.2			(D)*			
9	EC7(NL)-Step 6.3	377.03	Elastic				
9	EC7(NL)-Step 6.4	395.05	Elastic				
9	EC7(NL)-Step 6.5	379.73	Elastic				
9	EC7(NL)-Step 6.5 x 1.200	455.68	Elastic				
10	EC7(NL)-Step 6.1			(D)*			
10	EC7(NL)-Step 6.2			(D)*			
10	EC7(NL)-Step 6.3	531.74	Elastic				
10	EC7(NL)-Step 6.4	516.62	Elastic				
10	EC7(NL)-Step 6.5	444.08	Elastic				
10	EC7(NL)-Step 6.5 x 1.200	**532.90**	Elastic				
11	EC7(NL)-Step 6.1						(D)*
11	EC7(NL)-Step 6.2						(D)*
11	EC7(NL)-Step 6.3				**342.37**	Elastic	
11	EC7(NL)-Step 6.4				339.56	Elastic	
11	EC7(NL)-Step 6.5				270.65	Elastic	
11	EC7(NL)-Step 6.5 x 1.200				324.78	Elastic	
Max		**532.90**			**342.37**		

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

The force is in the direction of the anchor.

2.3 Overall Stability per Stage

Stage name	Stability factor [-]
B - Aanbrengen damwand	2.24
B - Aanbrengen anker	2.09
B - Aanvulling_fase1 + Voorspannen	1.99
B - Aanvulling + Afwerking	2.18
G - H: Terrein ULS - N: haalpen, opslag	1.51
G - H: Haalpen - N: KB x psi0, opslag x psi0 (1)	1.55
G - Terrein_psi0 + Opslag_psi0 en IJsbelasting ULS	1.89
G - Terrein_psi0 + Haalpen_psi0 valELW	1.45
G - Opslag_psi0 MHW	2.03
G - Terrein_psi0+Opslag_psi0+bolder_psi0 valMHW	1.51
G - KRANZ - H: Opslag - N: Haalpen x psi0	1.65

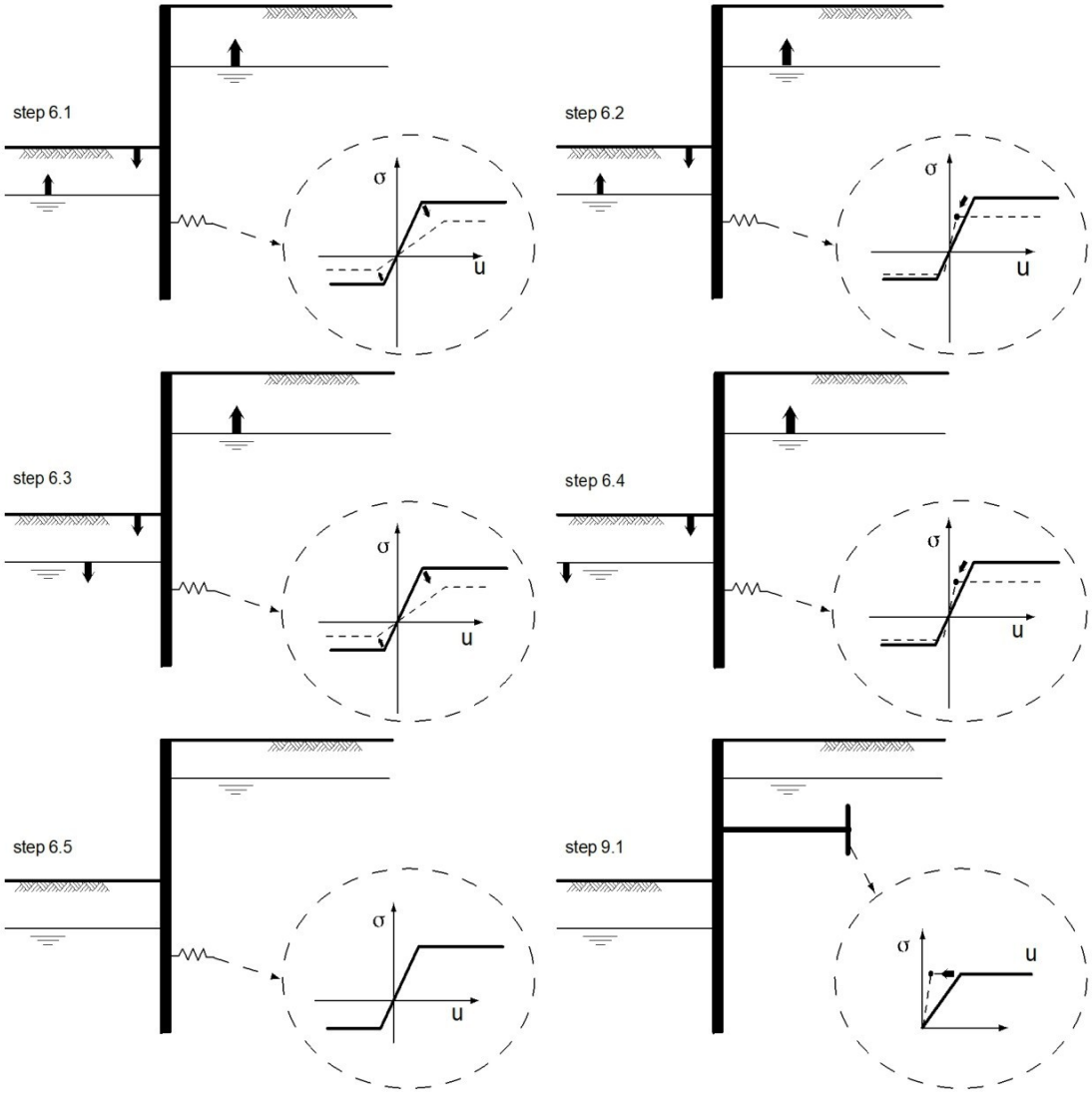
2.4 Warnings

Phi values:
In the profile(s) below, the difference between the highest and lowest phi in the materials is more than 15 degrees. According to Cur-166 article 4.5.8 a Culmann calculation with straight slip surfaces is not allowed. Either reduce your phi's or try a Ka, Ko, Kp calculation.
Profile(s):

ALGMEEN
ALGMEEN - F4
ULS - gebruiksfase
valELW
MHW
valMHW

Vertical balance:
The resultant vertical friction force is directed upward in stage 1,11 because the friction force on the passive side exceeds that on the active side. This might be prevented by reducing the friction angle Delta on the passive side.

2.5 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	Yes
Number of construction stages	11
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	15.30 m
Level top side	22.30 m
Number of sections	1
q_b;max	12.50 MPa
Xi factor	1.18

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 26 -700 (S3...	7.00	22.30	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 26 -700 (S3...	1.2541E+05	0.80	1.0033E+05	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 26 -700 (S3...	923.00	1.00	1.00	0.79	729.17

3.2.4 Properties for Vertical Balance

Section name	From [m]	To [m]	Height [mm]	Section area [cm²/m']
AZ 26 -700 (S3...	7.00	22.30	460.00	187.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B - Aanbrengen damwand

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	2: B - Aanbrengen anker
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	

- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	3: B - Aanvulling_fase1 + Voorspannen
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	4: B - Aanvulling + Afwerking
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.200
Verification of stage	5: G - H: Terrein ULS - N: haalpen, opslag
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200

Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	6: G - H: Haalpen - N: KB x psi0, opslag x psi0 (1)
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	7: G - Terrein_psi0 + Opslag_psi0 en IJsbelasting ULS
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000

Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	8: G - Terrein_psi0 + Haalpen_psi0 valELW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined

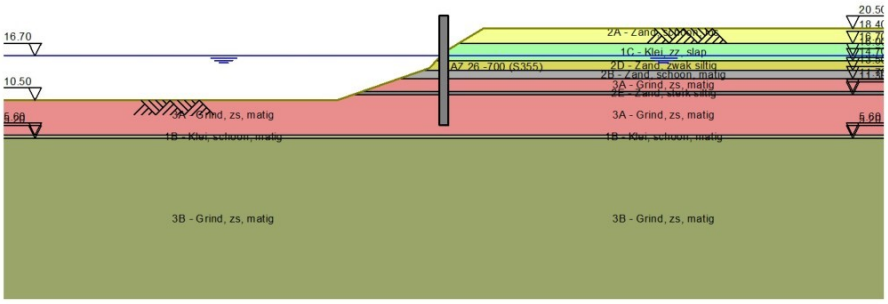
Verification of stage	9: G - Opslag_psi0 MHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	10: G - Terrein_psi0+Opslag_psi0+bolder_psi0 valMHW
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %

- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined
Verification of stage	11: G - KRANZ - H: Opslag - N: Haalpen x psi0
Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.01 m User defined
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.220 User defined

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

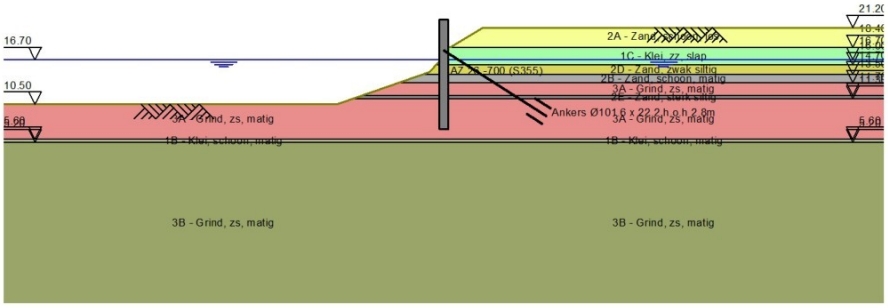
4 Outline Stage 1: B - Aanbrengen damwand

Outline - Stage 1: B - Aanbrengen damwand



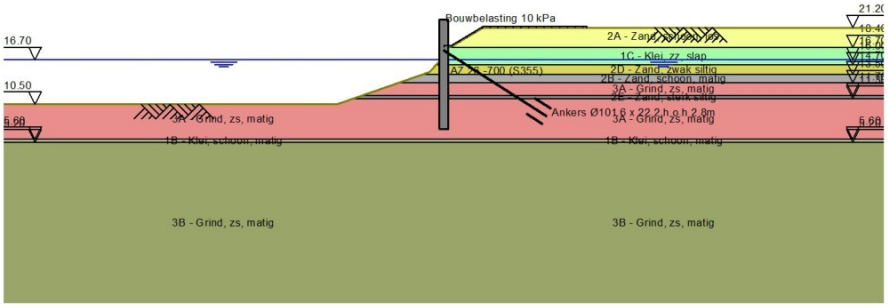
5 Outline Stage 2: B - Aanbrengen anker

Outline - Stage 2: B - Aanbrengen anker



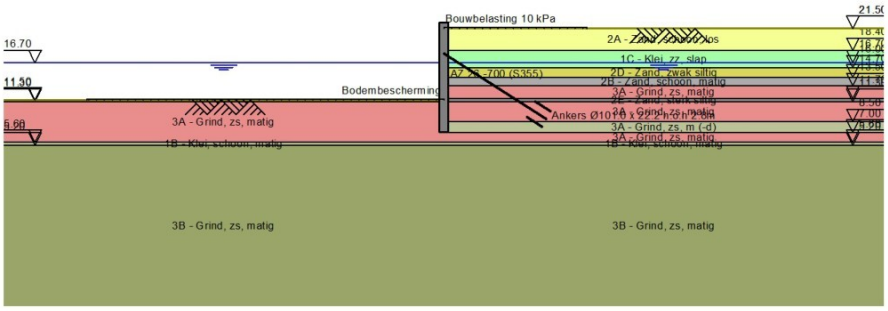
6 Outline Stage 3: B - Aanvulling_fase1 + Voorspannen

Outline - Stage 3: B - Aanvulling_fase1 + Voorspannen



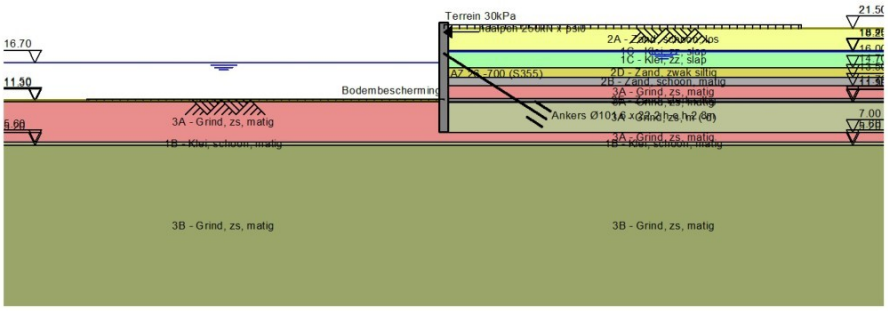
7 Outline Stage 4: B - Aanvulling + Afwerking

Outline - Stage 4: B - Aanvulling + Afwerking



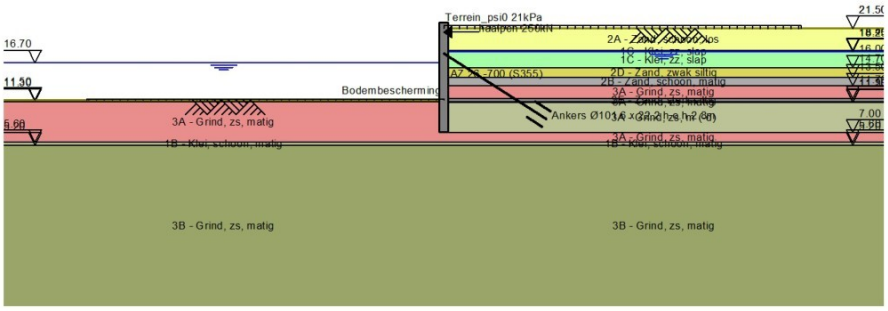
8 Outline Stage 5: G - H: Terrein ULS - N: haalpen, opslag

Outline - Stage 5: G - H: Terrein ULS - N: haalpen, opslag



9 Outline Stage 6: G - H: Haalpen - N: KB x psi0, opslag x psi0 (1)

Outline - Stage 6: G - H: Haalpen - N: KB x psi0, opslag x psi0 (1)

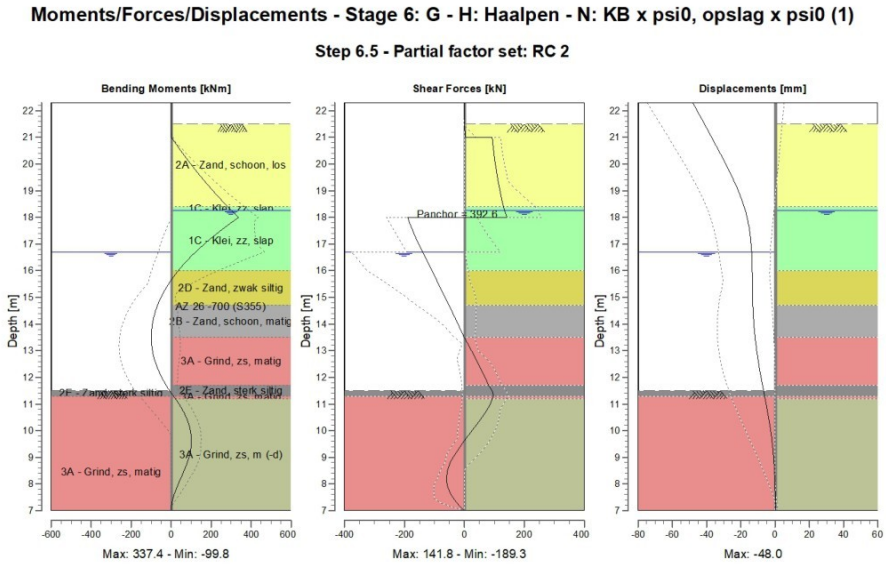


10 Step 6.5 Stage 6: G - H: Haalpen - N: KB x psi0, opslag x psi0 (1)

10.1 Calculation Results

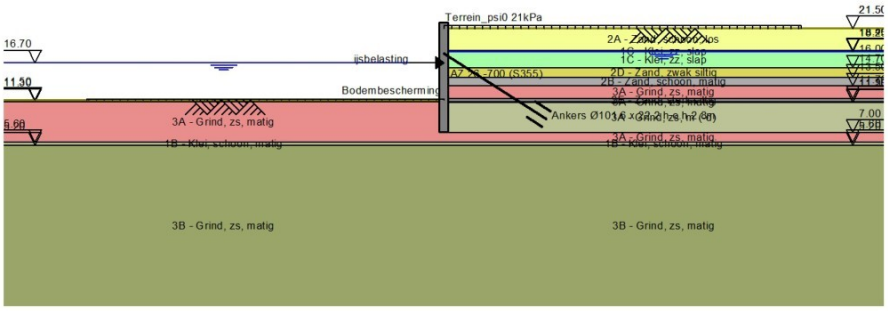
Number of iterations: 4

10.1.1 Charts of Moments, Forces and Displacements



11 Outline Stage 7: G - Terrein_psi0 + Opslag_psi0 en IJsbelasting ULS

Outline - Stage 7: G - Terrein_psi0 + Opslag_psi0 en IJsbelasting ULS

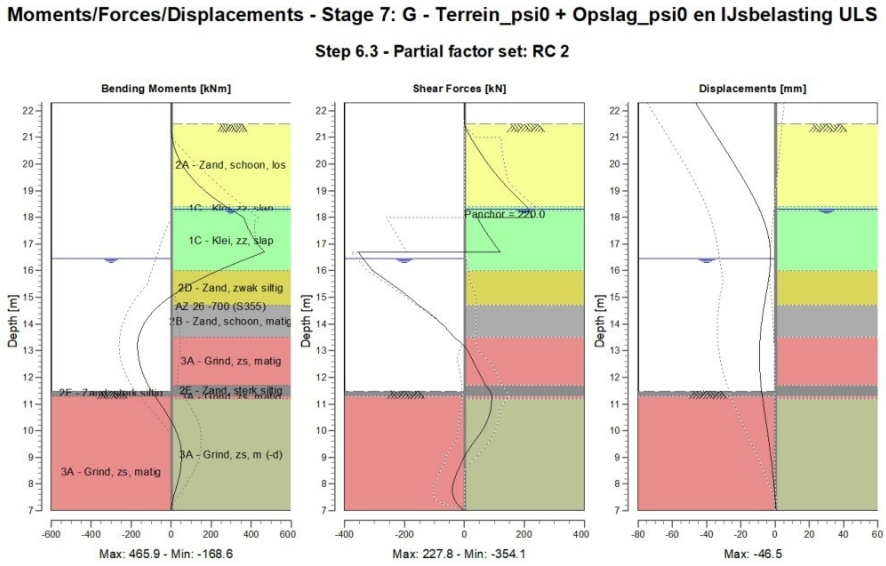


12 Step 6.3 Stage 7: G - Terrein_psi0 + Opslag_psi0 en IJsbelasting ULS

12.1 Calculation Results

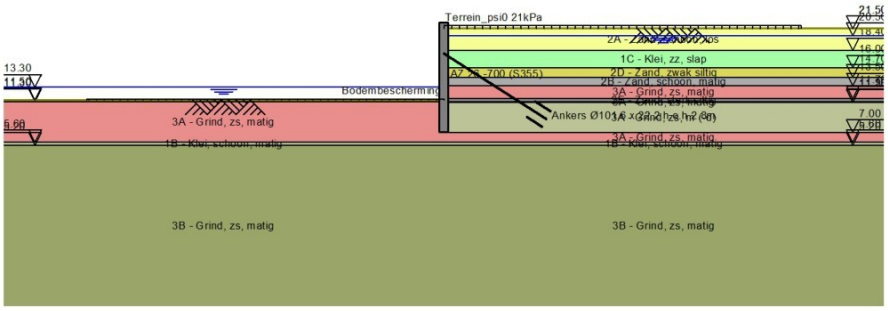
Number of iterations: 4

12.1.1 Charts of Moments, Forces and Displacements



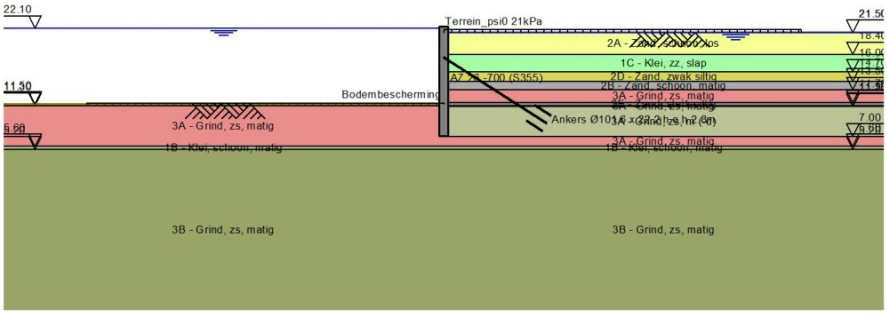
13 Outline Stage 8: G - Terrein_psi0 + Haalpen_psi0 valELW

Outline - Stage 8: G - Terrein_psi0 + Haalpen_psi0 valELW



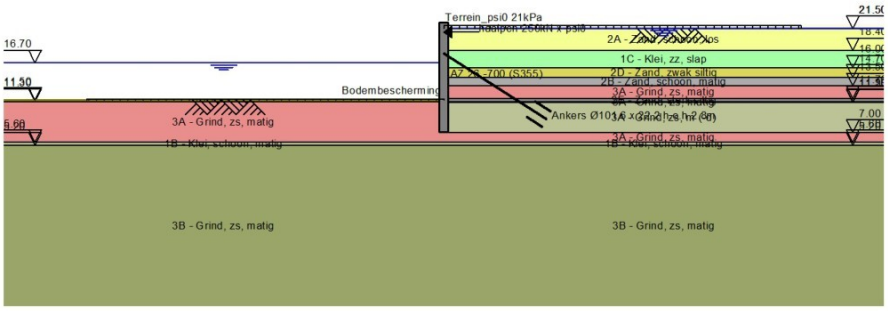
14 Outline Stage 9: G - Opslag_psi0 MHW

Outline - Stage 9: G - Opslag_psi0 MHW



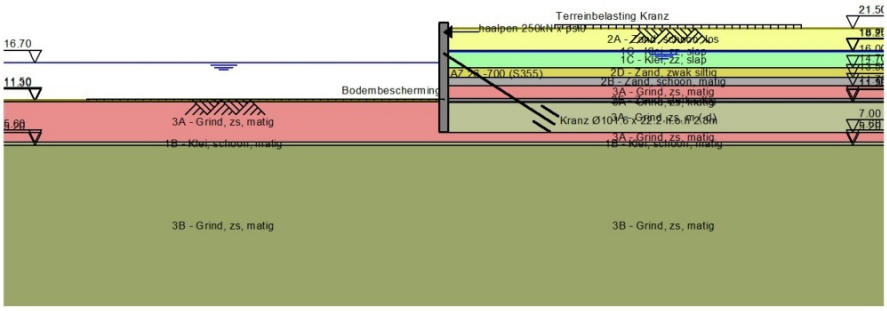
15 Outline Stage 10: G - Terrein_psi0+Opslag_psi0+bolder_psi0 valMHW

Outline - Stage 10: G - Terrein_psi0+Opslag_psi0+bolder_psi0 valMHW



16 Outline Stage 11: G - KRANZ - H: Opslag - N: Haalpen x psi0

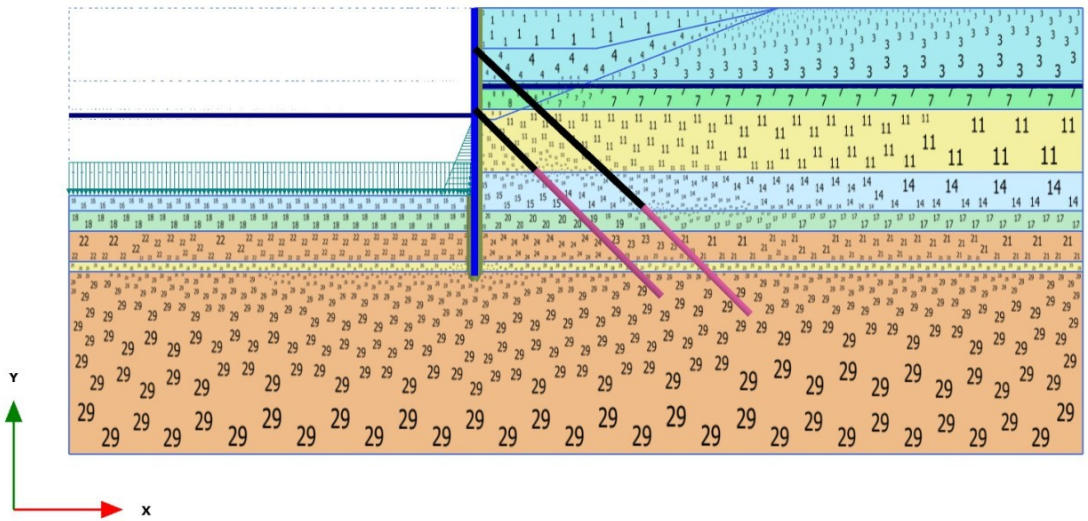
Outline - Stage 11: G - KRANZ - H: Opslag - N: Haalpen x psi0



End of Report

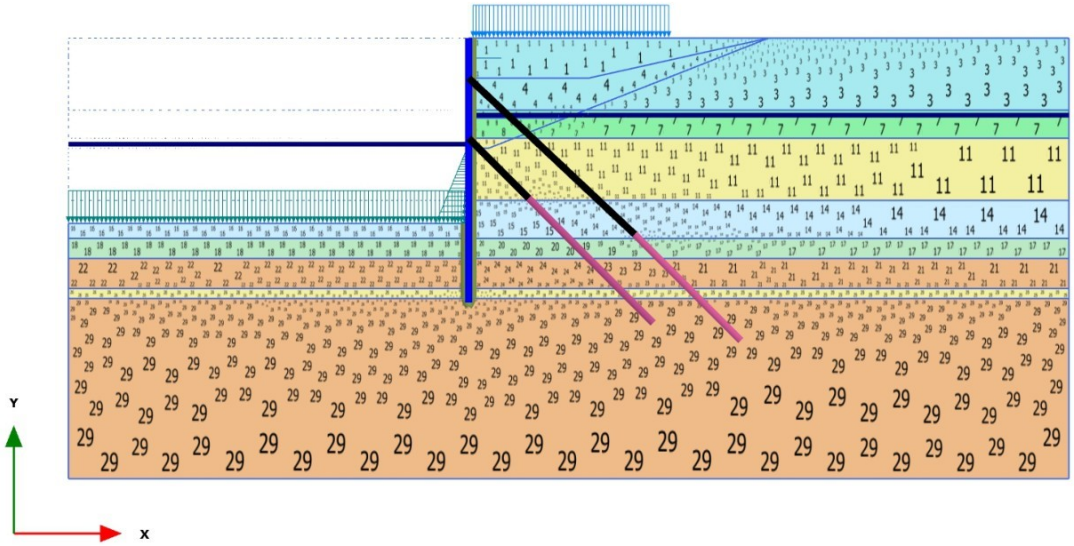
PLAXIS Report

1.1.1.1 Calculation results, 10. Waterpeilverschil [Phase_10] (10/90), Connectivity plot



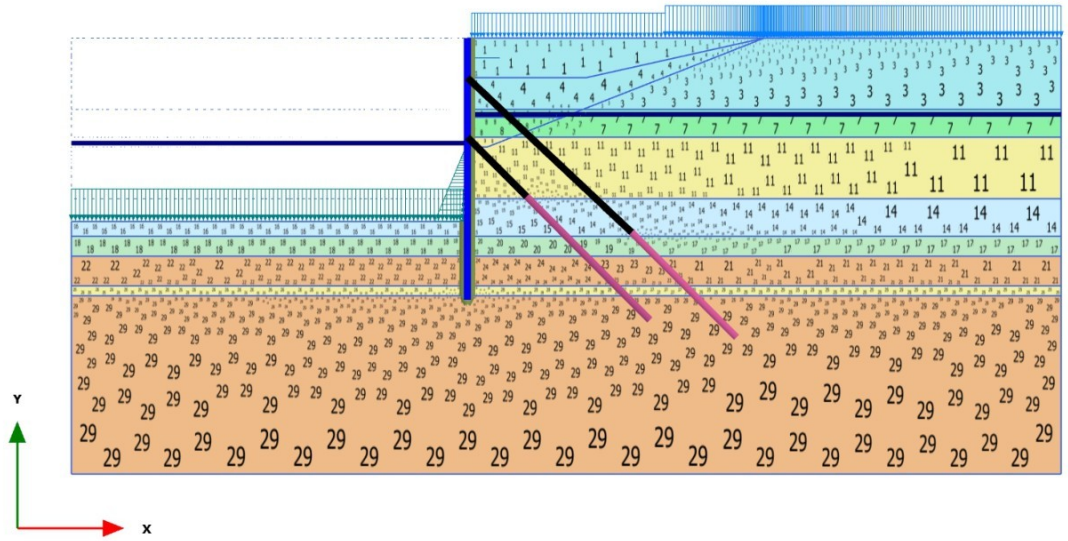
Connectivity plot

1.1.1.2 Calculation results, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Connectivity plot



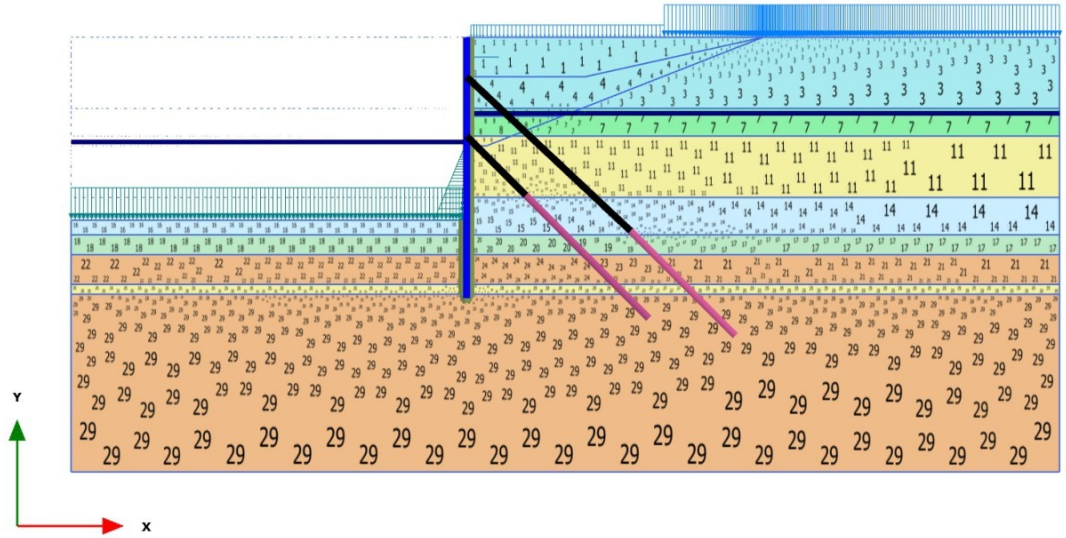
Connectivity plot

1.1.1.3 Calculation results, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Connectivity plot



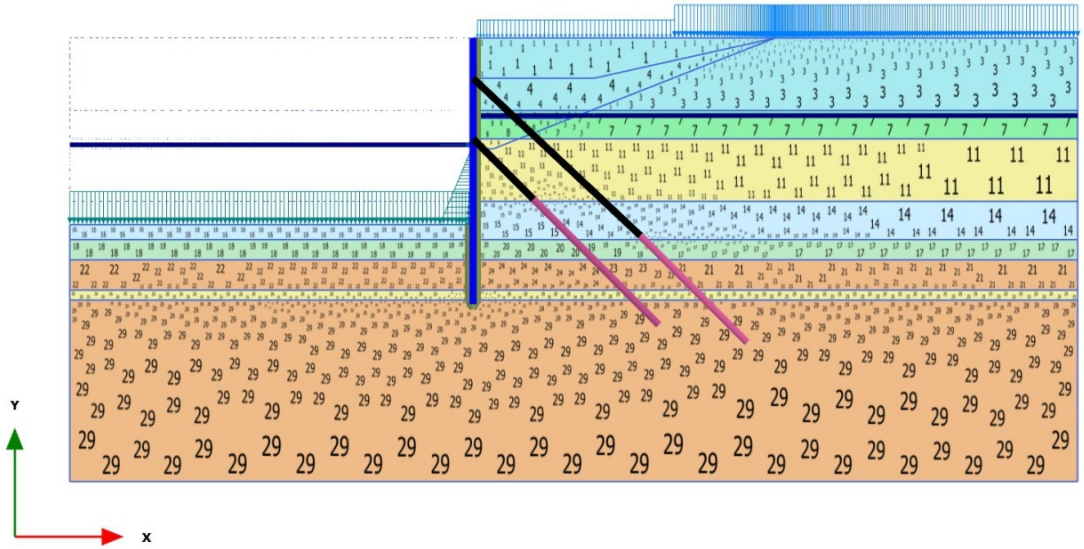
Connectivity plot

1.1.1.4 Calculation results, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Connectivity plot



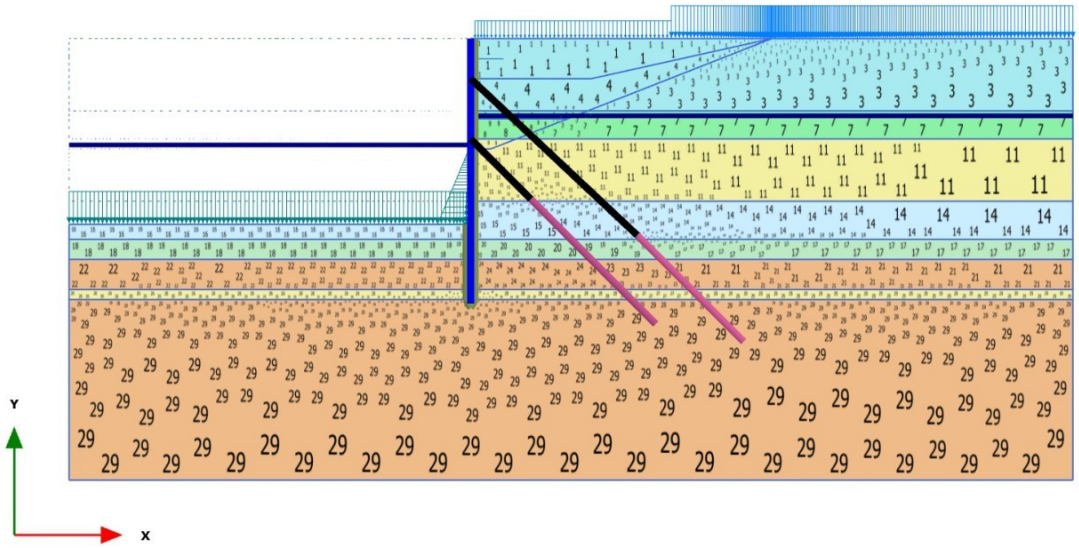
Connectivity plot

1.1.1.5 Calculation results, 14. SLS KAR: H: Ijs + opslag + TB [Phase_14] (14/760), Connectivity plot



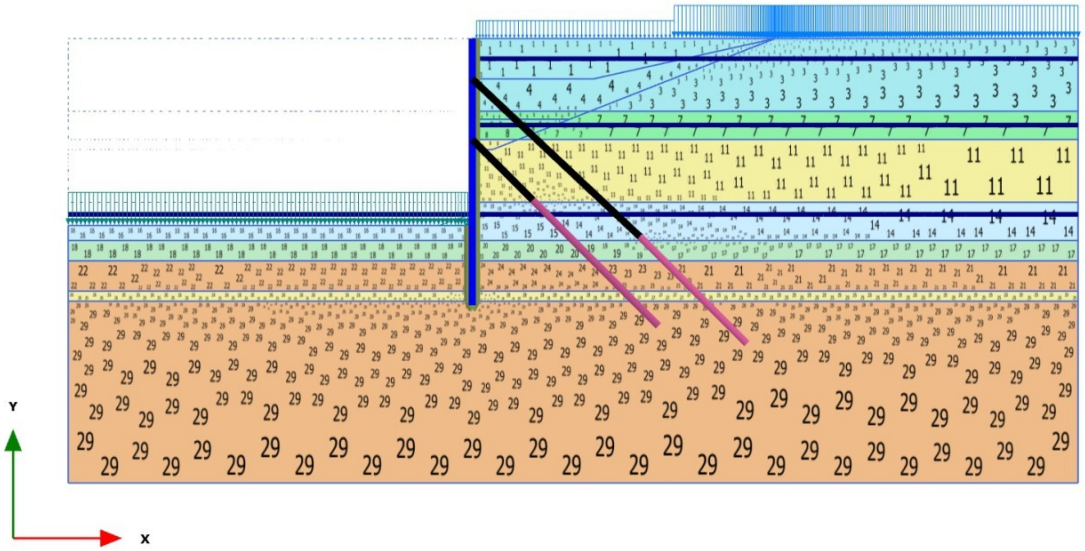
Connectivity plot

1.1.1.6 Calculation results, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Connectivity plot



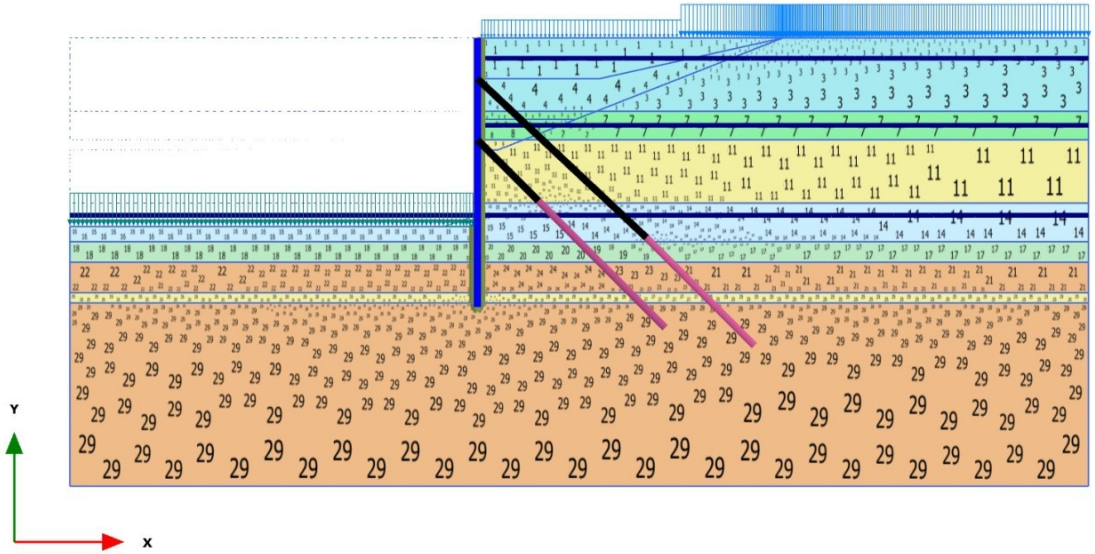
Connectivity plot

1.1.1.7 Calculation results, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Connectivity plot



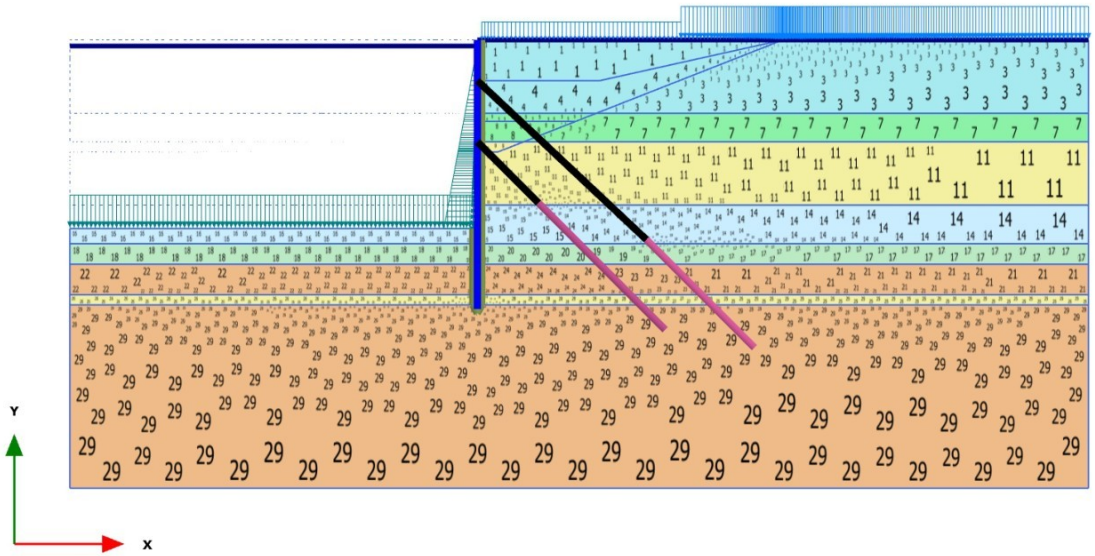
Connectivity plot

1.1.1.8 Calculation results, 16.2 ULS A2 [Phase_36] (36/1382), Connectivity plot



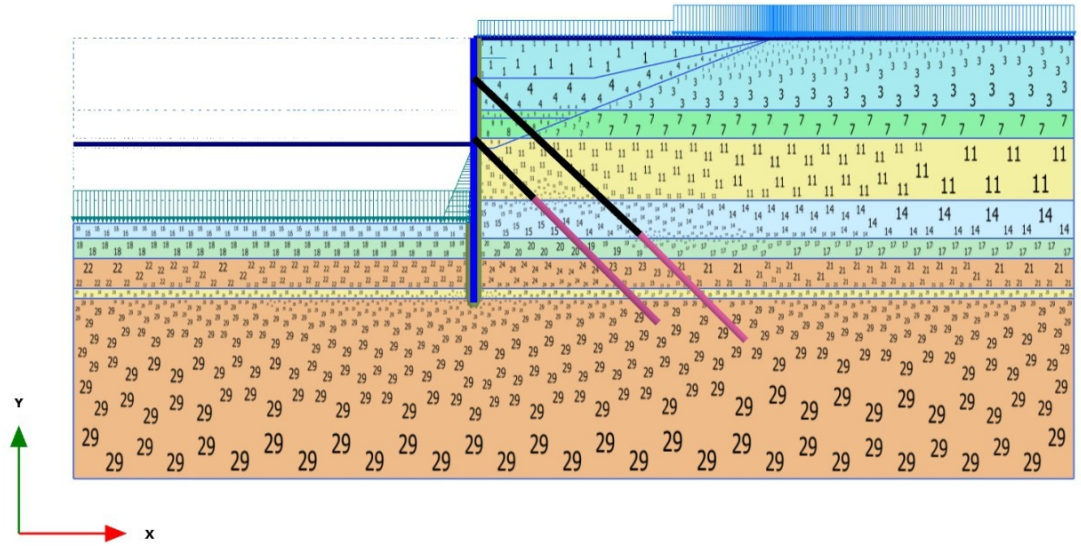
Connectivity plot

1.1.1.9 Calculation results, 17: ALS: MHW [Phase_17] (17/1389), Connectivity plot



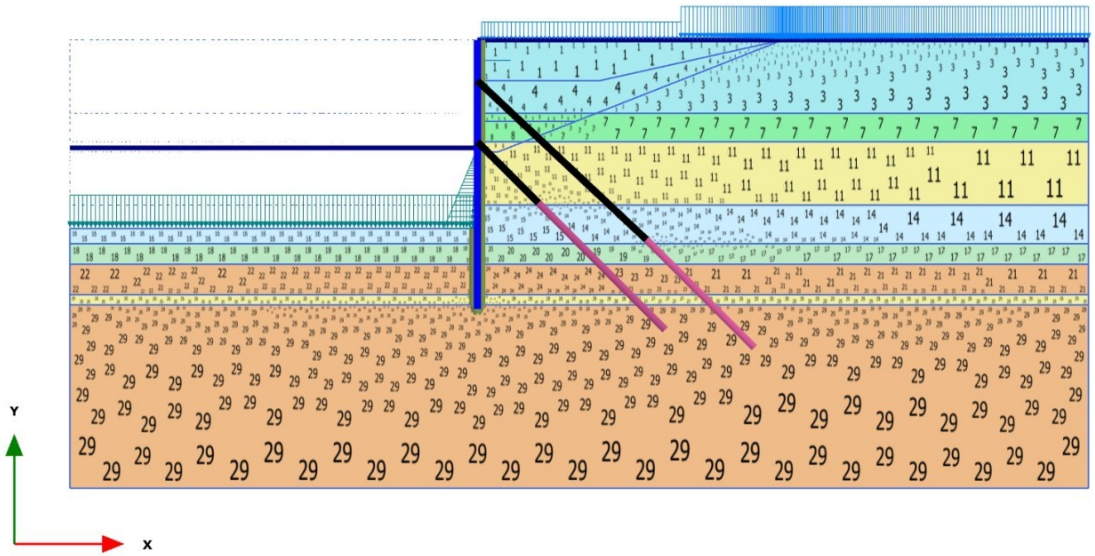
Connectivity plot

1.1.1.10 Calculation results, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Connectivity plot



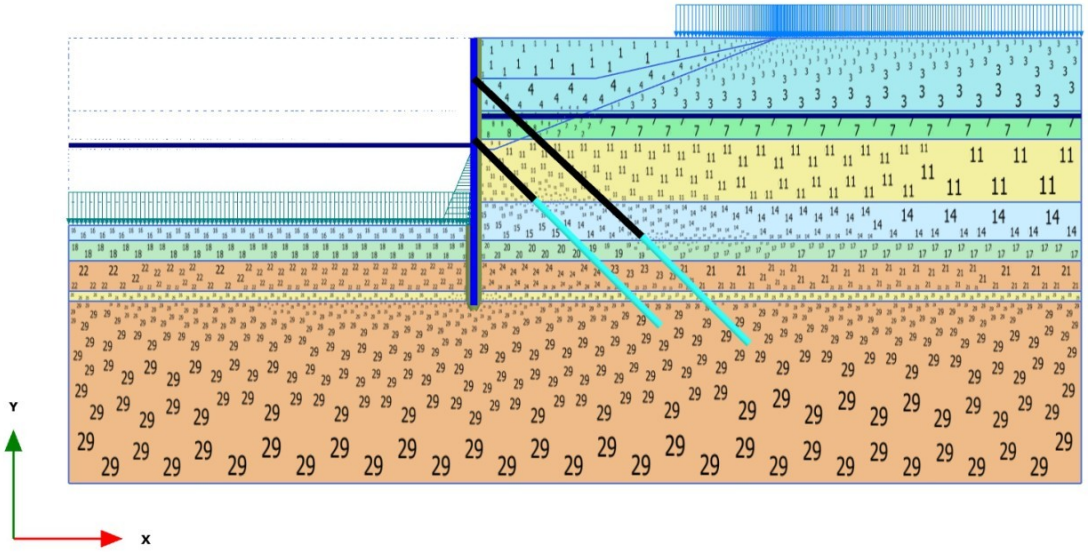
Connectivity plot

1.1.1.11 Calculation results, 18.2 ULS A2 [Phase_38] (38/1687), Connectivity plot



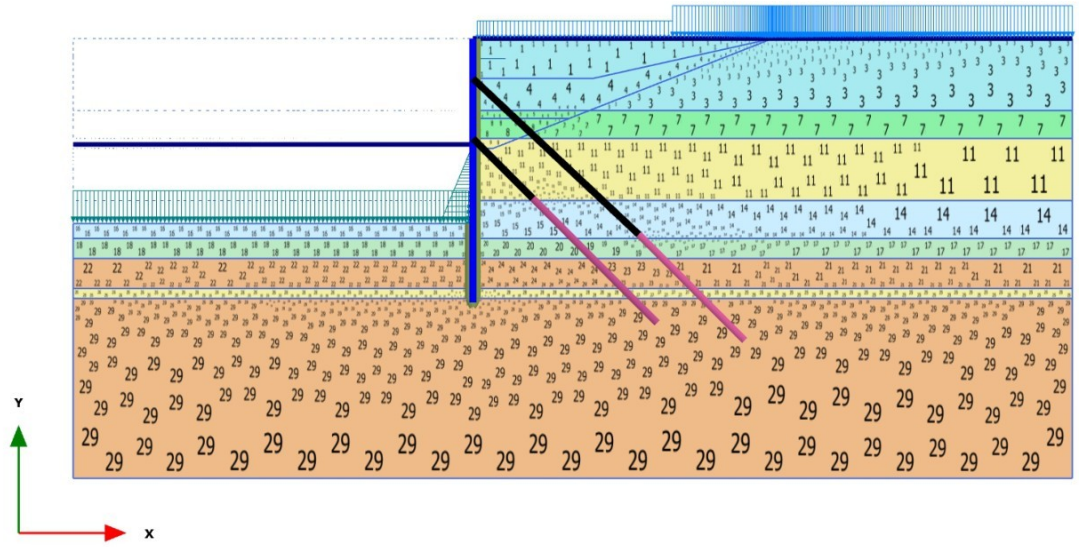
Connectivity plot

1.1.1.12 Calculation results, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Connectivity plot



Connectivity plot

1.1.1.13 Calculation results, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Connectivity plot



Connectivity plot

1.1.2.1.1.1 Materials - Soil and interfaces - Hardening Soil (1/2)

Identification number		1	2	3	4	5
Identification		2A. Zand, schoon, los	1D. Klei, zz, matig	2E. Zand, sterk siltig/kleiig	2B. Zand, schoon, matig	3A. Grind, vast
Soil model		Hardening Soil	Hardening Soil	Hardening Soil	Hardening Soil	Hardening Soil
Drainage type		Drained	Drained	Drained	Drained	Drained
Colour						
Comments						
γ_unsat	kN/m³	17.00	18.00	18.00	18.00	18.00
γ_sat	kN/m³	19.00	18.00	20.00	20.00	20.00
e_init		0.5000	0.5000	0.5000	0.5000	0.5000
n_init		0.3333	0.3333	0.3333	0.3333	0.3333
Input method		SDOF equivalent	SDOF equivalent	SDOF equivalent	SDOF equivalent	SDOF equivalent
Rayleigh α		0.000	0.000	0.000	0.000	0.000
Rayleigh β		0.000	0.000	0.000	0.000	0.000
ξ_1	%	0.000	0.000	0.000	0.000	0.000
ξ_2	%	0.000	0.000	0.000	0.000	0.000
f_1	Hz	0.1000	0.1000	0.1000	0.1000	0.1000
f_2	Hz	1.000	1.000	1.000	1.000	1.000
E_50^ref	kN/m²	15.00E3	3000	15.00E3	45.00E3	75.00E3
E_oed^ref	kN/m²	15.00E3	3000	15.00E3	45.00E3	75.00E3
E_ur^ref	kN/m²	45.00E3	9000	45.00E3	135.0E3	225.0E3
v_ur		0.2000	0.2000	0.2000	0.2000	0.2000

Identification number		1	2	3	4	5
Use alternatives		False	False	False	False	False
C_c		0.02303	0.1151	0.02303	7.675E-3	4.605E-3
C_s		0.01382	0.05595	0.01196	4.976E-3	3.240E-3
e_init		0.5000	0.5000	0.5000	0.5000	0.5000
power (m)		0.5000	0.5000	0.5000	0.5000	0.5000
p_ref	kN/m²	100.0	100.0	100.0	100.0	100.0
c'_ref	kN/m²	0.000	5.000	0.000	0.000	0.000
φ' (phi)	°	30.00	22.50	25.00	32.50	35.00
ψ (psi)	°	0.000	0.000	0.000	2.500	5.000
c'_inc	kN/m²/m	0.000	0.000	0.000	0.000	0.000
y_ref	m	0.000	0.000	0.000	0.000	0.000
Dilatancy cut-off		False	False	False	False	False
e_min		1.000E-9	1.000E-9	1.000E-9	1.000E-9	1.000E-9
e_max		999.0	999.0	999.0	999.0	999.0
Tension cut-off		True	True	True	True	True
Tensile strength	kN/m²	0.000	0.000	0.000	0.000	0.000
Use defaults		True	True	True	True	True
K_0^nc		0.5000	0.6173	0.5774	0.4627	0.4264
R_f		0.9000	0.9000	0.9000	0.9000	0.9000
Determination		v-undrained definition	v-undrained definition	v-undrained definition	v-undrained definition	v-undrained definition
v_u definition method		Direct	Direct	Direct	Direct	Direct
v_u,equivalent (nu)		0.4950	0.4950	0.4950	0.4950	0.4950
Skempton B		0.9866	0.9866	0.9866	0.9866	0.9866
K_w,ref/n	kN/m²	1.844E6	368.7E3	1.844E6	5.531E6	9.219E6

Identification number		**1**	**2**	**3**	**4**	**5**
Classification type		Standard	Standard	Standard	Standard	Standard
Soil class (Standard)		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 µm	%	10.00	10.00	10.00	10.00	10.00
2 µm - 50 µm	%	13.00	13.00	13.00	13.00	13.00
50 µm - 2 mm	%	77.00	77.00	77.00	77.00	77.00
Use defaults		False	False	False	False	False
k_x	m/day	0.000	0.000	0.000	0.000	0.000
k_y	m/day	0.000	0.000	0.000	0.000	0.000
Void ratio dependency		False	False	False	False	False
c_k		1000E12	1000E12	1000E12	1000E12	1000E12
n_init		0.3333	0.3333	0.3333	0.3333	0.3333
-ψ_unsat	m	10.00E3	10.00E3	10.00E3	10.00E3	10.00E3
c_s	kJ/t/K	0.000	0.000	0.000	0.000	0.000
λ_s	kW/m/K	0.000	0.000	0.000	0.000	0.000
ρ_s	t/m³	2.600	2.600	2.600	2.600	2.600
Thermal expansion type		Isotropic	Isotropic	Isotropic	Isotropic	Isotropic
α_sv	1/K	0.000	0.000	0.000	0.000	0.000
Phase change		False	False	False	False	False
D_v	m²/day	0.000	0.000	0.000	0.000	0.000
f_Tv		0.000	0.000	0.000	0.000	0.000
Stiffness determination		Derived	Derived	Derived	Derived	Derived
Strength determination		Manual	Manual	Manual	Manual	Manual
R_inter		0.9000	0.9000	0.9000	0.9000	0.9000
Consider gap closure		True	True	True	True	True

Identification number		**1**	**2**	**3**	**4**	**5**
δ_inter	m	0.000	0.000	0.000	0.000	0.000
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m³/day/m	0.000	0.000	0.000	0.000	0.000
R_thermal	m² K/kW	0.000	0.000	0.000	0.000	0.000
K_0 determination		Automatic	Automatic	Automatic	Automatic	Automatic
K_0,x		0.5000	0.6173	0.5774	0.4627	0.4264
K_0,z		0.5000	0.6173	0.5774	0.4627	0.4264
POP	kN/m²	0.000	0.000	0.000	0.000	0.000
OCR		1.000	1.000	1.000	1.000	1.000

1.1.2.1.1.2 Materials - Soil and interfaces - Hardening Soil (2/2)

Identification number		**6**	**7**
Identification		test	2D- Zand, zwak siltig
Soil model		Hardening Soil	Hardening Soil
Drainage type		Drained	Drained
Colour			
Comments			
γ_unsat	kN/m³	17.00	18.00
γ_sat	kN/m³	19.00	20.00
e_init		0.5000	0.5000
n_init		0.3333	0.3333
Input method		SDOF equivalent	SDOF equivalent
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
ξ_1	%	0.000	0.000
ξ_2	%	0.000	0.000
f_1	Hz	0.1000	0.1000

Identification number		6	7
f_2	Hz	1.000	1.000
E_50^ref	kN/m²	30.00E3	35.00E3
E_oed^ref	kN/m²	30.00E3	35.00E3
E_ur^ref	kN/m²	60.00E3	105.0E3
v_ur		0.2000	0.2000
Use alternatives		False	False
C_c		0.01151	9.868E-3
C_s		0.01036	5.422E-3
e_init		0.5000	0.5000
power (m)		0.5000	0.5000
p_ref	kN/m²	100.0	100.0
c'_ref	kN/m²	0.000	0.000
φ' (phi)	°	30.00	27.00
ψ (psi)	°	0.000	0.000
c'_inc	kN/m²/m	0.000	0.000
y_ref	m	0.000	0.000
Dilatancy cut-off		False	False
e_min		1.000E-9	1.000E-9
e_max		999.0	999.0

Identification number		6	7
Tension cut-off		True	True
Tensile strength	kN/m²	0.000	0.000
Use defaults		True	True
K_0^nc		0.5000	0.5460
R_f		0.9000	0.9000
Determination		v-undrained definition	v-undrained definition
v_u definition method		Direct	Direct
v_u,equivalent (nu)		0.4950	0.4950
Skempton B		0.9866	0.9866
K_w,ref/n	kN/m²	2.458E6	4.302E6
Classification type		Standard	Standard
Soil class (Standard)		Coarse	Coarse
< 2 µm	%	10.00	10.00
2 µm - 50 µm	%	13.00	13.00
50 µm - 2 mm	%	77.00	77.00
Use defaults		False	False
k_x	m/day	0.000	0.000
k_y	m/day	0.000	0.000
Void ratio dependency		False	False

Identification number		6	7
c_k		1000E12	1000E12
n_init		0.3333	0.3333
-ψ_unsat	m	10.00E3	10.00E3
c_s	kJ/t/K	0.000	0.000
λ_s	kW/m/K	0.000	0.000
ρ_s	t/m³	2.600	2.600
Thermal expansion type		Isotropic	Isotropic
α_sv	1/K	0.000	0.000
Phase change		False	False
D_v	m²/day	0.000	0.000
f_Tv		0.000	0.000
Stiffness determination		Derived	Derived
Strength determination		Rigid	Manual
R_inter		1.000	0.9000
Consider gap closure		True	True
δ_inter	m	0.000	0.000
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m³/day/m	0.000	0.000
R_thermal	m² K/kW	0.000	0.000

Identification number		**6**	**7**
K_0 determination		Automatic	Automatic
K_0,x		0.5000	0.5460
K_0,z		0.5000	0.5460
POP	kN/m²	0.000	0.000
OCR		1.000	1.000

1.1.2.2 Materials - Plates

Identification number		**1**	**2**
Identification		AZ-26	dummy
Material type		Elastic	Elastic
Colour			
Comments			
w	kN/m/m	1.550	0.000
Input method		SDOF equivalent	SDOF equivalent
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
ξ_1	%	0.000	0.000
ξ_2	%	0.000	0.000
f_1	Hz	0.1000	0.1000
f_2	Hz	1.000	1.000
Prevent punching		False	False
Isotropic		True	True
EA_1	kN/m	4.158E6	100.0E6
EA_2	kN/m	4.158E6	100.0E6

Identification number		1	2
E_1	kN/m²	7.169E6	91.29E6
E_2	kN/m²	7.169E6	91.29E6
EI	kN m²/m	116.6E3	10.00E6
v (nu)		0.000	0.000
d	m	0.5800	1.095
c	kJ/t/K	0.000	0.000
λ	kW/m/K	0.000	0.000
ρ	t/m³	0.000	0.000
α	1/K	0.000	0.000
A_eff,T	m²	0.000	0.000

1.1.2.3 Materials - Anchors

Identification number		**1**
Identification		7T15.2
Material type		Elastic
Colour		
Comments		E = 200 GPa, A = 980 mm2
L_spacing	m	2.520
EA	kN	196.0E3
c	kJ/t/K	0.000
λ	kW/m/K	0.000
ρ	t/m³	0.000
α	1/K	0.000
A_eff,T	m²	0.000

1.1.2.4 Materials - Geogrids

Identification number		**1**
Identification		Groutprop
Material type		Elastic
Colour		
Comments		
Isotropic		True
EA_1	kN/m	77.78E3
EA_2	kN/m	77.78E3
c	kJ/t/K	0.000
λ	kW/m/K	0.000
ρ	t/m³	0.000
α	1/K	0.000
A_eff,T	m²	0.000

1.1.2.5 Materials - Embedded beams

Identification number		**1**	**2**	**3**	**4**
Identification		Groutlichaam boven	Groutlichaam onder	Groutlichaam Kranz	Groutlichaam Kranz
Material type		Elastic	Elastic	Elastic	Elastic
Colour					
Comments					
γ	kN/m³	0.000	0.000	0.000	0.000
Input method		SDOF equivalent	SDOF equivalent	SDOF equivalent	SDOF equivalent
Rayleigh α		0.000	0.000	0.000	0.000
Rayleigh β		0.000	0.000	0.000	0.000
ξ_1	%	0.000	0.000	0.000	0.000
ξ_2	%	0.000	0.000	0.000	0.000
f_1	Hz	0.1000	0.1000	0.1000	0.1000
f_2	Hz	1.000	1.000	1.000	1.000
L_spacing	m	2.520	2.520	2.520	2.520
Cross section type		Predefined	Predefined	Predefined	Predefined
Predefined cross section type		Solid circular beam	Solid circular beam	Solid circular beam	Solid circular beam
Diameter	m	0.2000	0.2000	0.2000	0.2000

Identification number		**1**	**2**	**3**	**4**
A	m²	0.03142	0.03142	0.03142	0.03142
I	m	0.07854E-3	0.07854E-3	0.07854E-3	0.07854E-3
E	kN/m²	10.00E6	10.00E6	10.00E6	10.00E6
Axial skin resistance		Linear	Linear	Linear	Linear
T_skin, start, max	kN/m	150.0	130.0	220.0	300.0
T_skin, end, max	kN/m	150.0	130.0	220.0	300.0
Lateral resistance		Unlimited	Unlimited	Unlimited	Unlimited
F_max	kN	0.000	0.000	0.000	0.000
Default values		True	True	True	True
Axial stiffness factor		0.3738	0.3738	0.3738	0.3738
Lateral stiffness factor		0.3738	0.3738	0.3738	0.3738
Base stiffness factor		3.738	3.738	3.738	3.738

1.1.3.1 Calculation results, Node-to-node anchor, 10. Waterpeilverschil [Phase_10] (10/90), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	608.399	0.000	620.274
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	608.399	0.000	620.274
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	592.565	0.000	621.670
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	592.565	0.000	621.670

1.1.3.2 Calculation results, Node-to-node anchor, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	741.914	0.000	741.914
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	741.914	0.000	741.914
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	629.241	0.000	629.241
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	629.241	0.000	629.241

1.1.3.3 Calculation results, Node-to-node anchor, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	743.224	0.000	743.225
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	743.224	0.000	743.225
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	645.597	0.000	645.597
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	645.597	0.000	645.597

1.1.3.4 Calculation results, Node-to-node anchor, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	720.118	0.000	720.118
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	720.118	0.000	720.118
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	642.887	0.000	642.887
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	642.887	0.000	642.887

1.1.3.5 Calculation results, Node-to-node anchor, 14. SLS KAR: H: IJs + opslag + TB [Phase_14] (14/760), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	491.442	0.000	620.274
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	491.442	0.000	620.274
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	386.113	0.000	621.670
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	386.113	0.000	621.670

1.1.3.6 Calculation results, Node-to-node anchor, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	768.359	0.000	768.359
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	768.359	0.000	768.359
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	653.833	0.000	653.833
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	653.833	0.000	653.833

1.1.3.7 Calculation results, Node-to-node anchor, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	635.112	0.000	635.112
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	635.112	0.000	635.112
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	609.409	0.000	621.670
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	609.409	0.000	621.670

1.1.3.8 Calculation results, Node-to-node anchor, 16.2 ULS A2 [Phase_36] (36/1382), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	657.321	0.000	657.321
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	657.321	0.000	657.321
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	601.998	0.000	621.670
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	601.998	0.000	621.670

1.1.3.9 Calculation results, Node-to-node anchor, 17: ALS: MHW [Phase_17] (17/1389), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	635.246	0.000	635.246
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	635.246	0.000	635.246
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	595.225	0.000	621.670
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	595.225	0.000	621.670

1.1.3.10 Calculation results, Node-to-node anchor, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	815.667	0.000	815.667
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	815.667	0.000	815.667
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	685.726	0.000	685.726
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	685.726	0.000	685.726

1.1.3.11 Calculation results, Node-to-node anchor, 18.2 ULS A2 [Phase_38] (38/1687), Table of node-to-node anchors

Structural element	Node [10 ^{3}]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	987.167	0.000	987.167
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	987.167	0.000	987.167
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	608.560	0.000	694.003
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	608.560	0.000	694.003

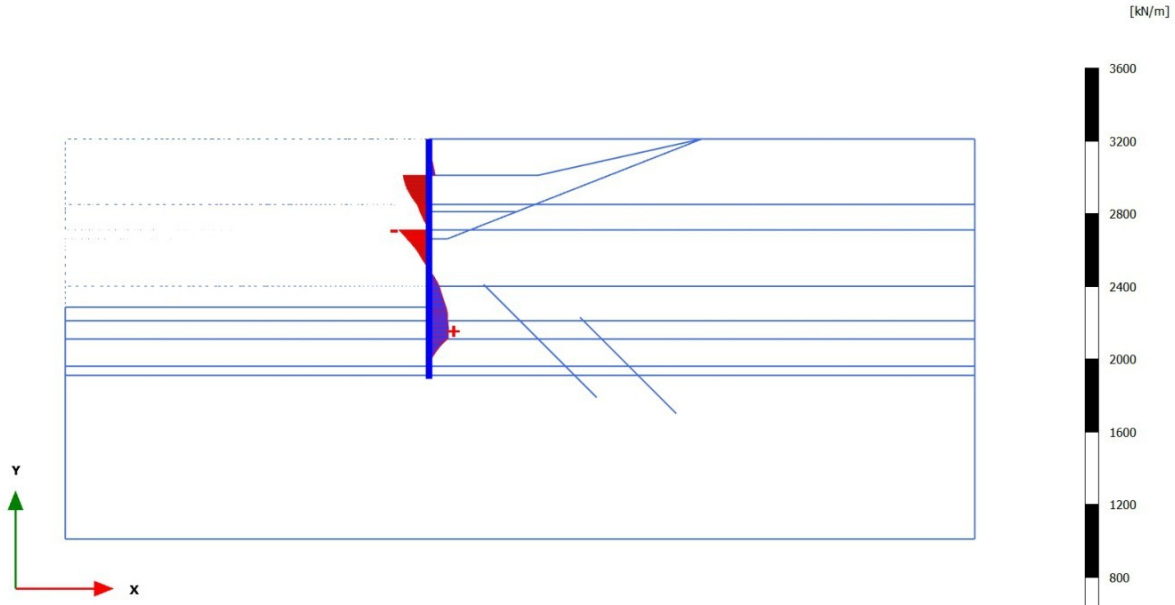
1.1.3.12 Calculation results, Node-to-node anchor, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	1846.464	0.000	1846.464
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	1846.464	0.000	1846.464
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	808.838	0.000	1018.041
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	808.838	0.000	1018.041

1.1.3.13 Calculation results, Node-to-node anchor, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Table of node-to-node anchors

Structural element	Node [10^3]	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	17528	1	28.300	12.200	1059.215	0.000	1059.215
Element 1-1 (Node-to-node anchor)	7740	2	20.000	20.000	1059.215	0.000	1059.215
NodeToNodeAnchor_2_1	7290	1	20.000	17.000	587.640	0.000	689.982
Element 2-2 (Node-to-node anchor)	17487	2	23.000	14.000	587.640	0.000	689.982

3.1.1.1.1 Calculation results, Plate, 10. Waterpeilverschil [Phase_10] (10/90), Shear forces Q

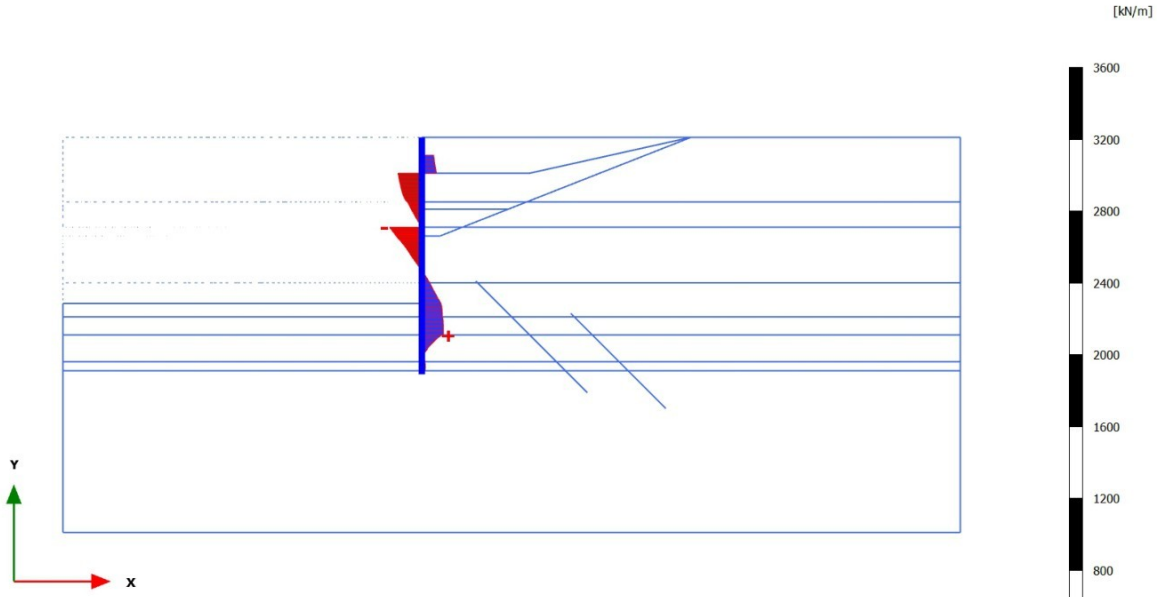


Shear forces Q (scaled up 0.0100 times)

Maximum value = 107.1 kN/m (Element 17 at Node 5985)

Minimum value = -165.4 kN/m (Element 8 at Node 7290)

3.1.1.1.2 Calculation results, Plate, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Shear forces Q

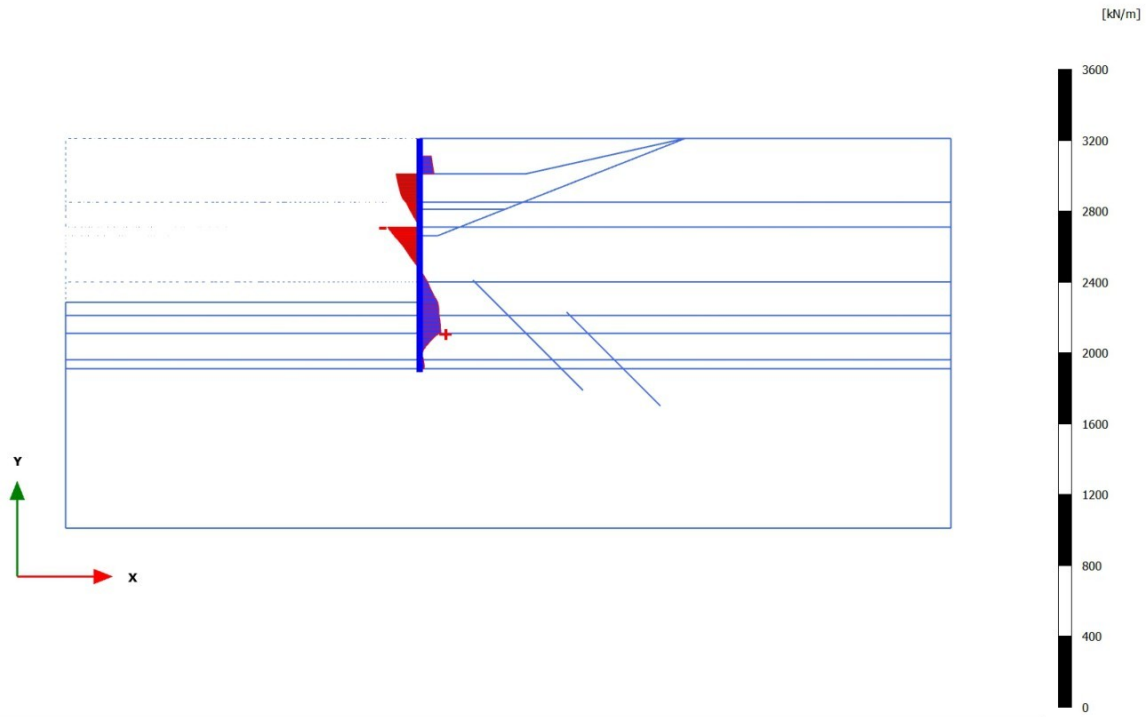


Shear forces Q (scaled up 0.0100 times)

Maximum value = 120.6 kN/m (Element 17 at Node 5983)

Minimum value = -180.2 kN/m (Element 8 at Node 7290)

3.1.1.1.3 Calculation results, Plate, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Shear forces Q

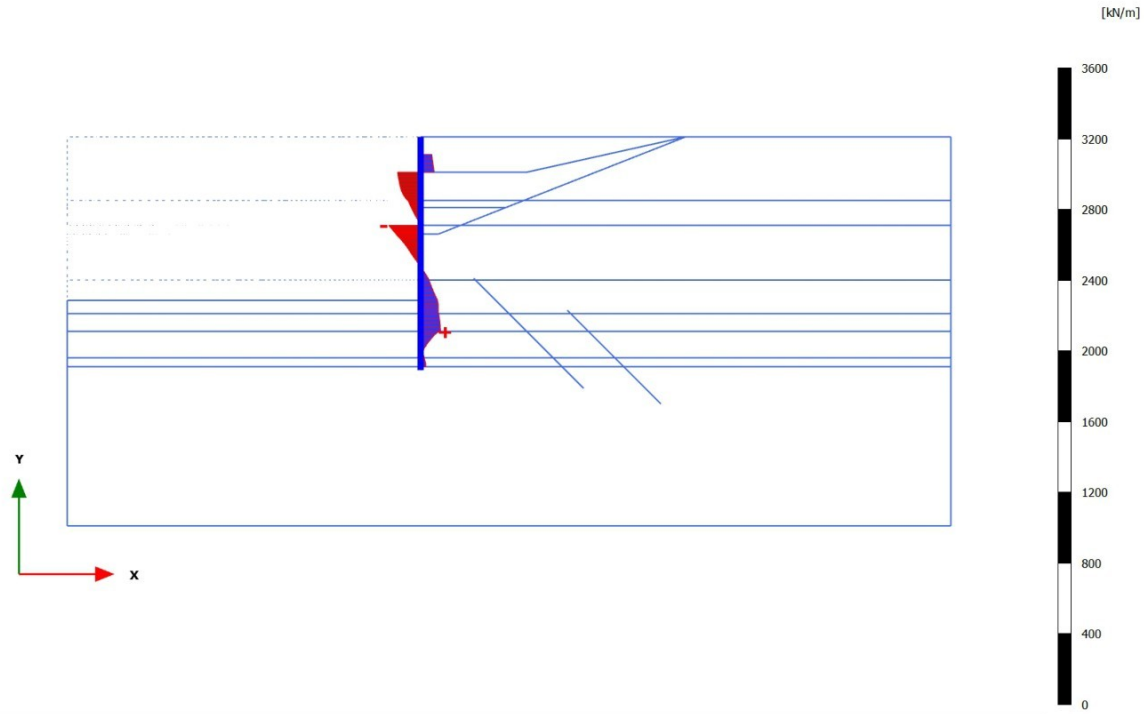


Shear forces Q (scaled up 0.0100 times)

Maximum value = 120.9 kN/m (Element 17 at Node 5983)

Minimum value = -182.7 kN/m (Element 8 at Node 7290)

3.1.1.1.4 Calculation results, Plate, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Shear forces Q

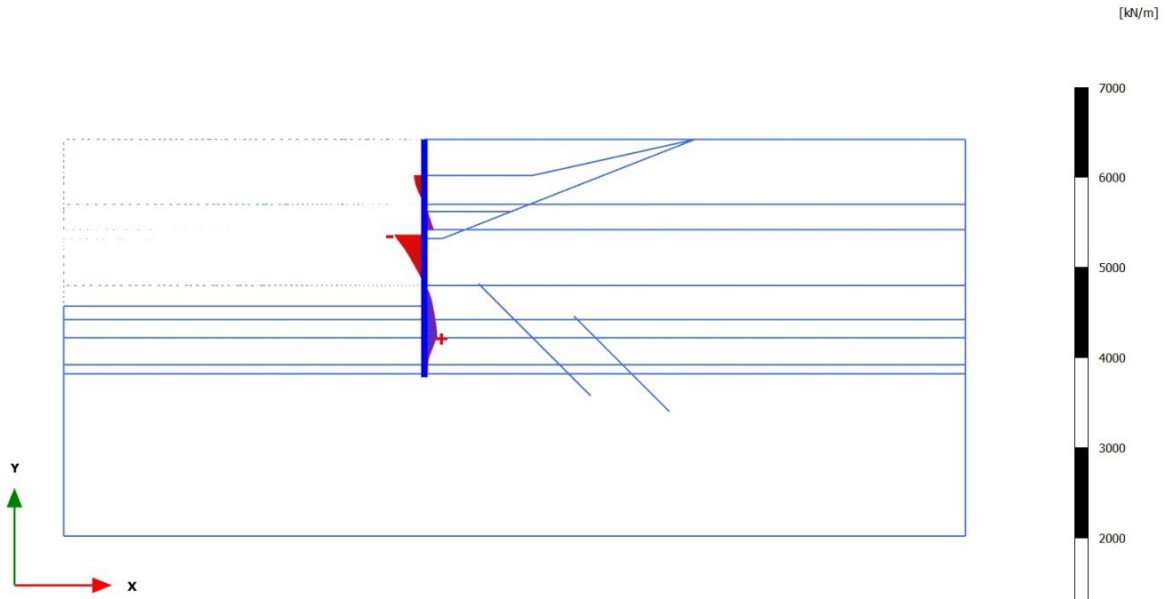


Shear forces Q (scaled up 0.0100 times)

Maximum value = 113.4 kN/m (Element 17 at Node 5983)

Minimum value = -181.0 kN/m (Element 8 at Node 7290)

3.1.1.1.5 Calculation results, Plate, 14. SLS KAR: H: Ijs + opslag + TB [Phase_14] (14/760), Shear forces Q

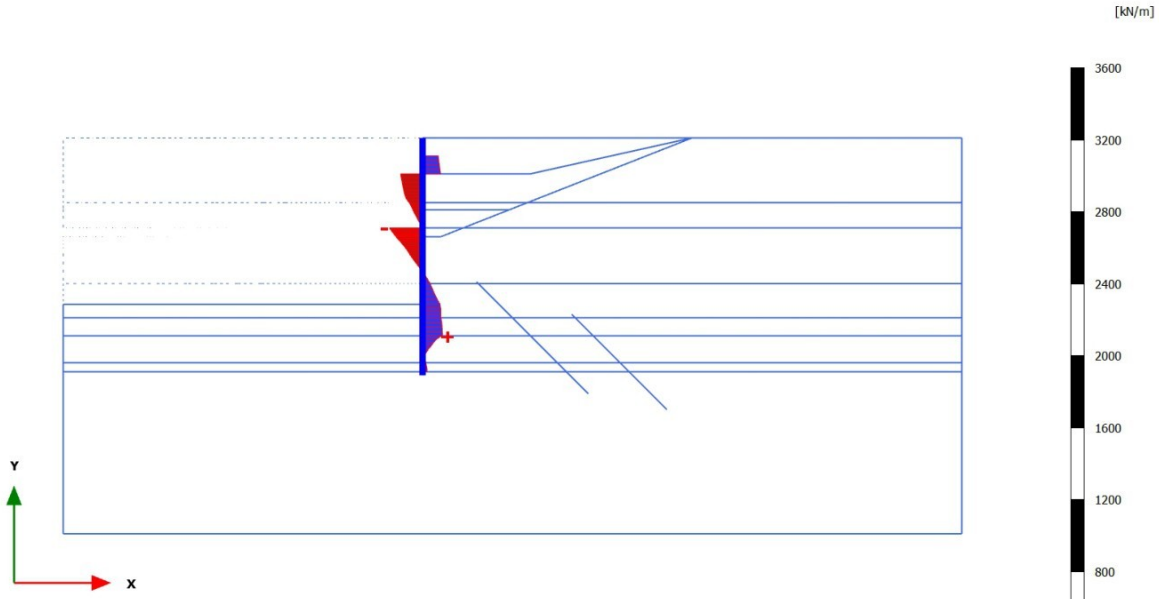


Shear forces Q (scaled up 5.00*10^{-3} times)

Maximum value = 138.4 kN/m (Element 17 at Node 5983)

Minimum value = -330.3 kN/m (Element 9 at Node 7289)

3.1.1.1.6 Calculation results, Plate, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Shear forces Q

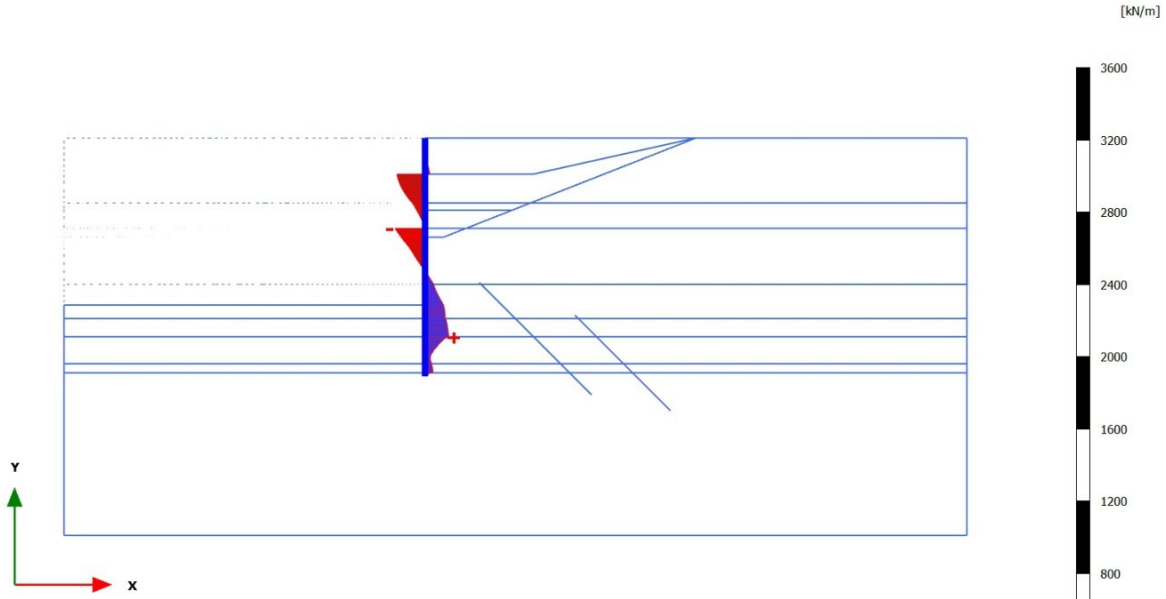


Shear forces Q (scaled up 0.0100 times)

Maximum value = 111.8 kN/m (Element 17 at Node 5983)

Minimum value = -185.0 kN/m (Element 8 at Node 7290)

3.1.1.1.7 Calculation results, Plate, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Shear forces Q

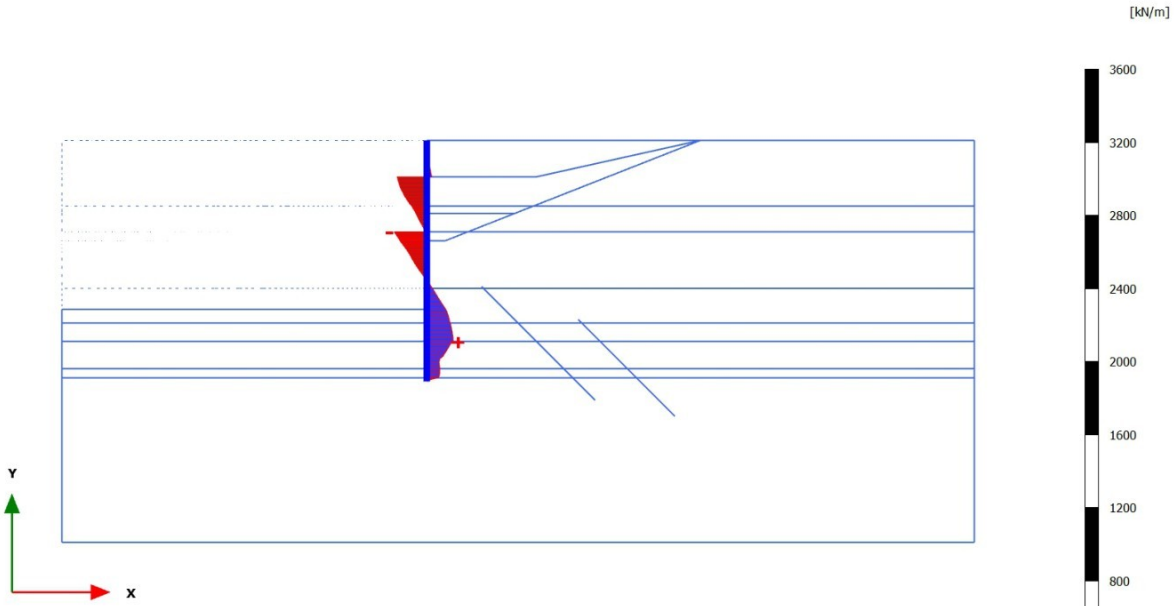


Shear forces Q (scaled up 0.0100 times)

Maximum value = 132.3 kN/m (Element 17 at Node 5983)

Minimum value = -167.1 kN/m (Element 8 at Node 7290)

3.1.1.1.8 Calculation results, Plate, 16.2 ULS A2 [Phase_36] (36/1382), Shear forces Q

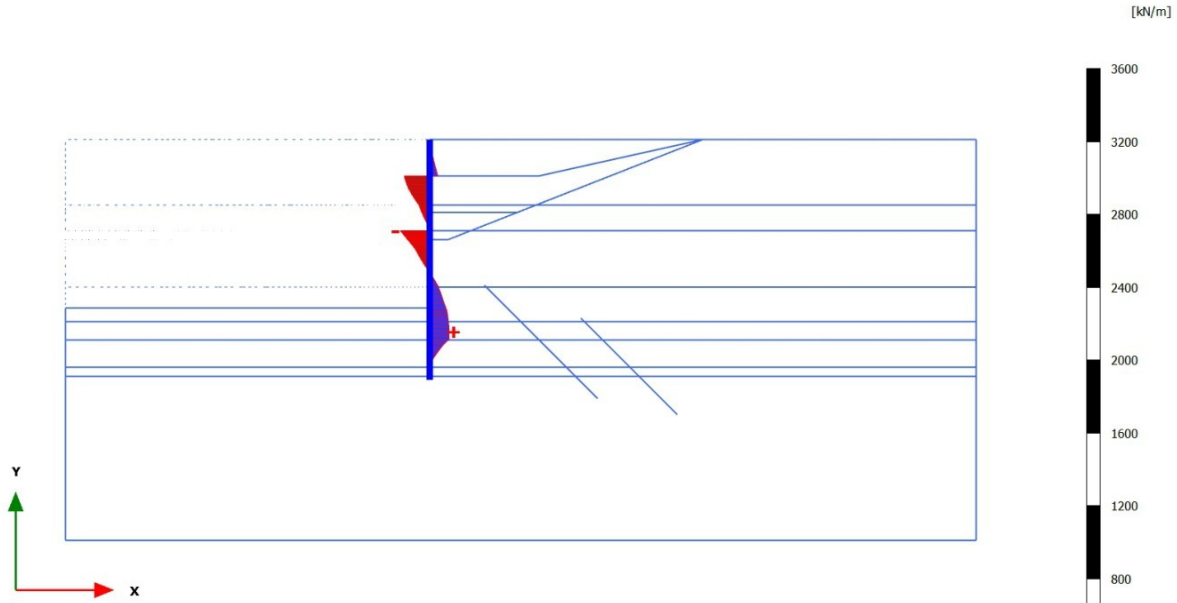


Shear forces Q (scaled up 0.0100 times)

Maximum value = 145.3 kN/m (Element 17 at Node 5983)

Minimum value = -178.0 kN/m (Element 8 at Node 7290)

3.1.1.1.9 Calculation results, Plate, 17: ALS: MHW [Phase_17] (17/1389), Shear forces Q

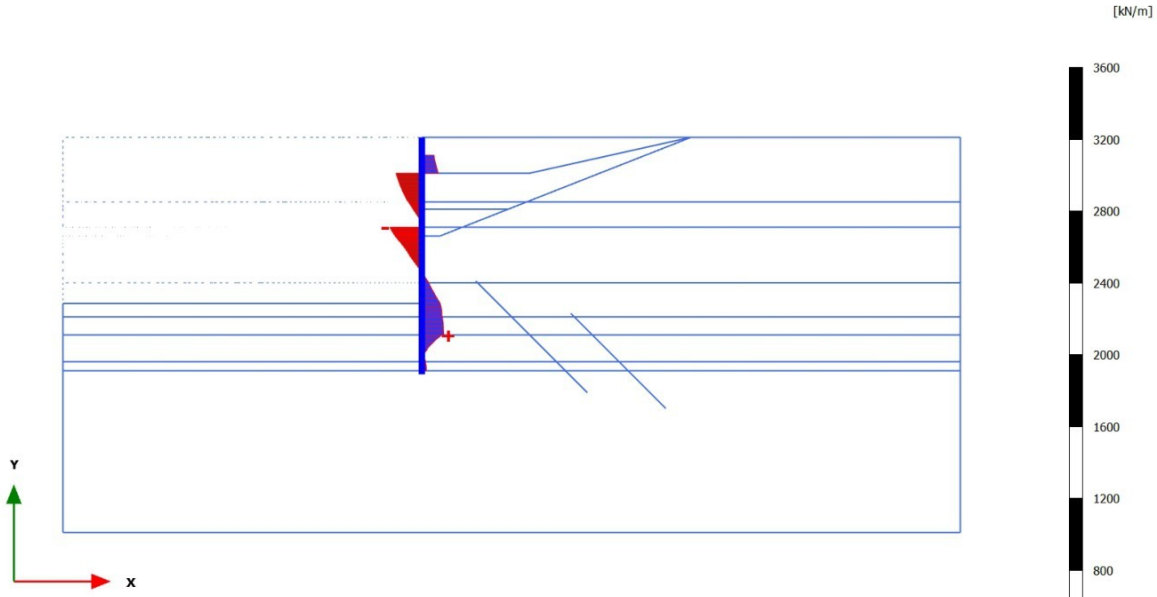


Shear forces Q (scaled up 0.0100 times)

Maximum value = 106.4 kN/m (Element 17 at Node 5985)

Minimum value = -162.6 kN/m (Element 8 at Node 7290)

3.1.1.1.10 Calculation results, Plate, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Shear forces Q

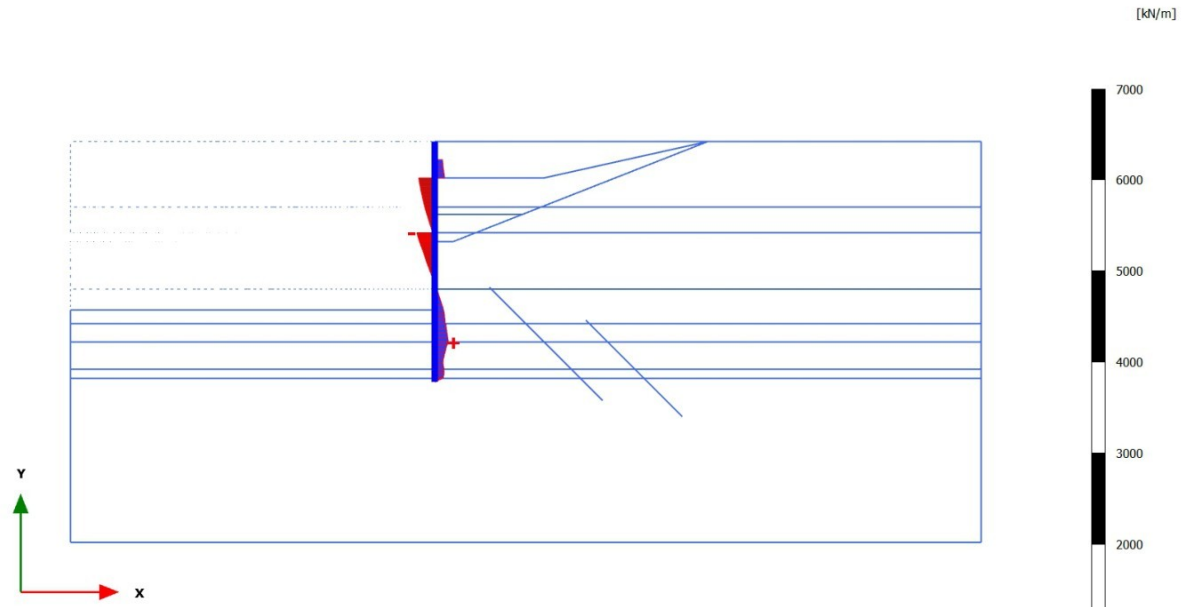


Shear forces Q (scaled up 0.0100 times)

Maximum value = 122.4 kN/m (Element 17 at Node 5983)

Minimum value = -178.9 kN/m (Element 8 at Node 7290)

3.1.1.1.11 Calculation results, Plate, 18.2 ULS A2 [Phase_38] (38/1687), Shear forces Q

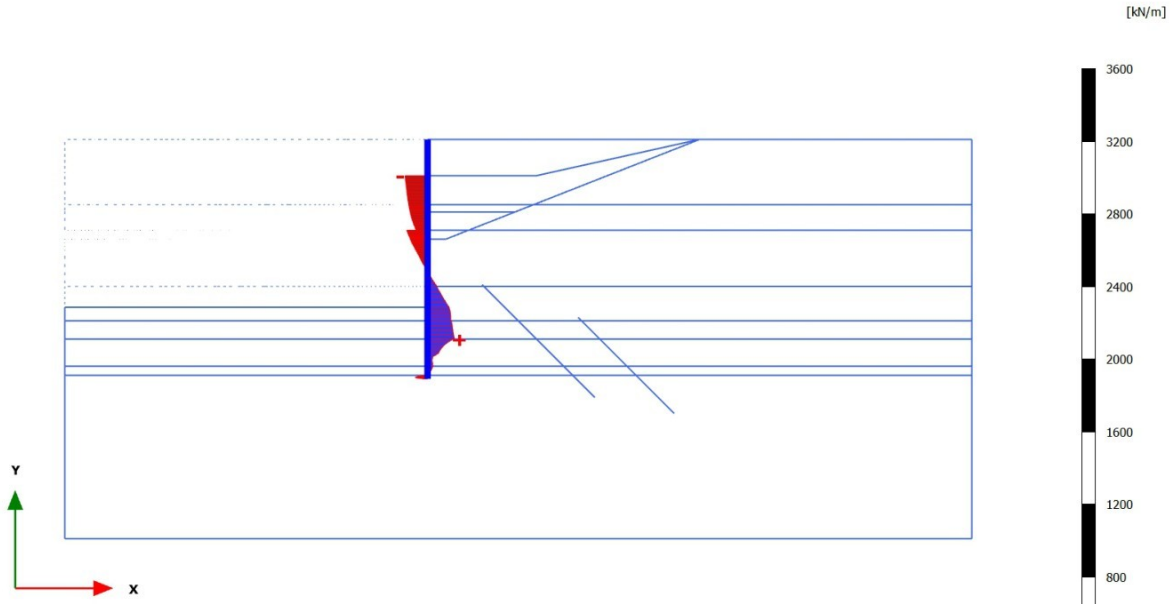


Shear forces Q (scaled up 5.00*10^{-3} times)

Maximum value = 151.1 kN/m (Element 17 at Node 5983)

Minimum value = -196.2 kN/m (Element 8 at Node 7290)

3.1.1.1.12 Calculation results, Plate, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Shear forces Q

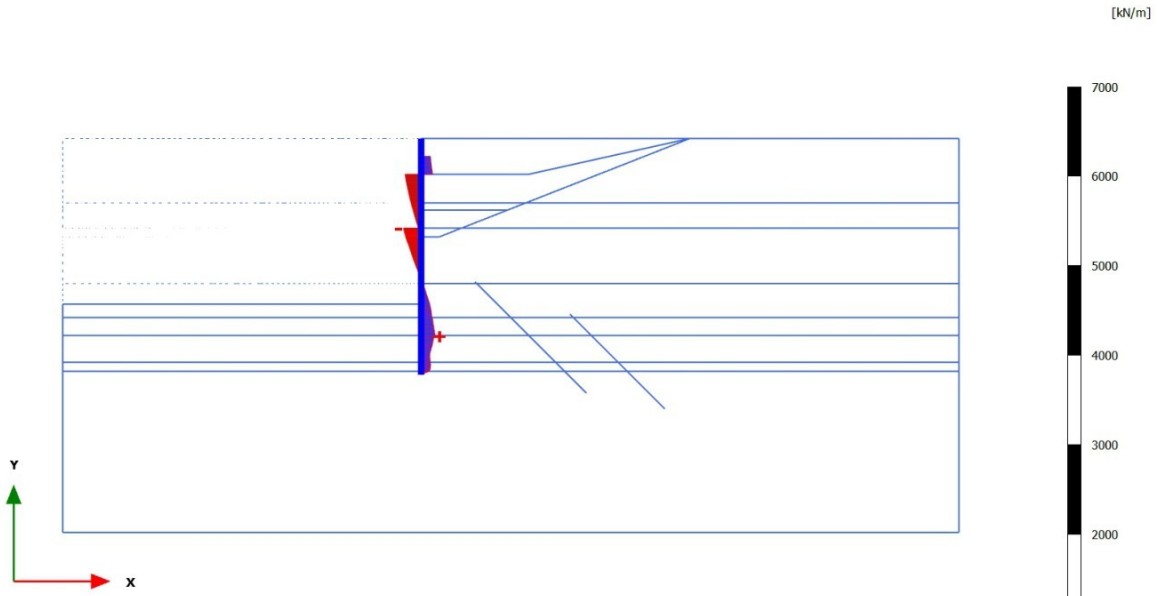


Shear forces Q (scaled up 0.0100 times)

Maximum value = 148.7 kN/m (Element 17 at Node 5983)

Minimum value = -124.8 kN/m (Element 3 at Node 7740)

3.1.1.1.13 Calculation results, Plate, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Shear forces Q

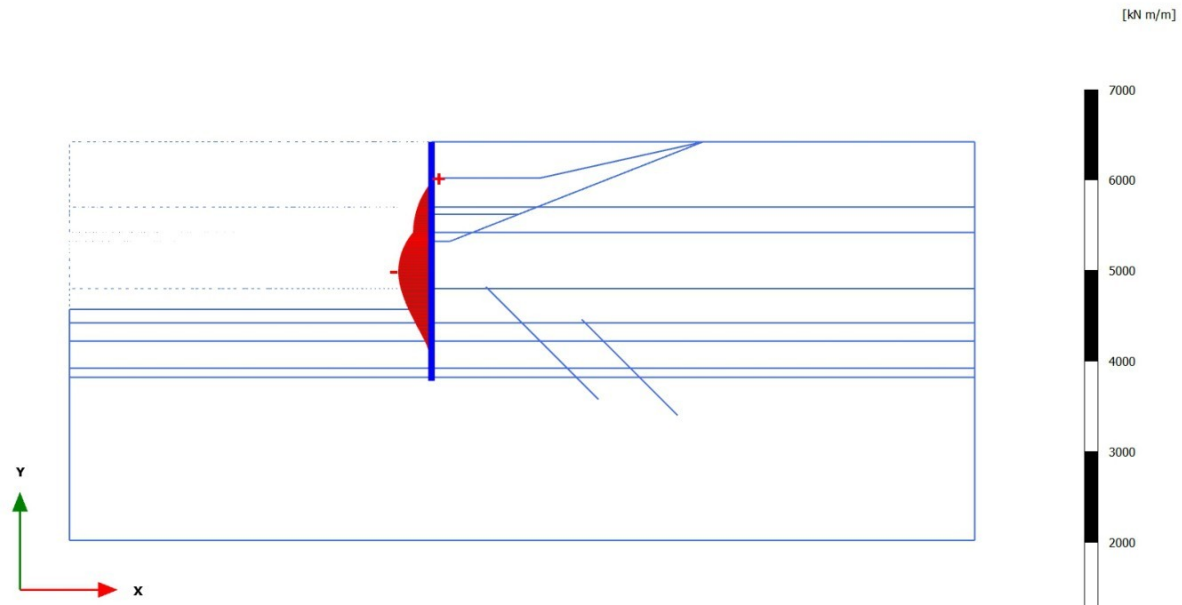


Shear forces Q (scaled up 5.00*10^{-3} times)

Maximum value = 154.3 kN/m (Element 17 at Node 5983)

Minimum value = -197.9 kN/m (Element 8 at Node 7290)

3.1.1.2.1 Calculation results, Plate, 10. Waterpeilverschil [Phase_10] (10/90), Bending moments M

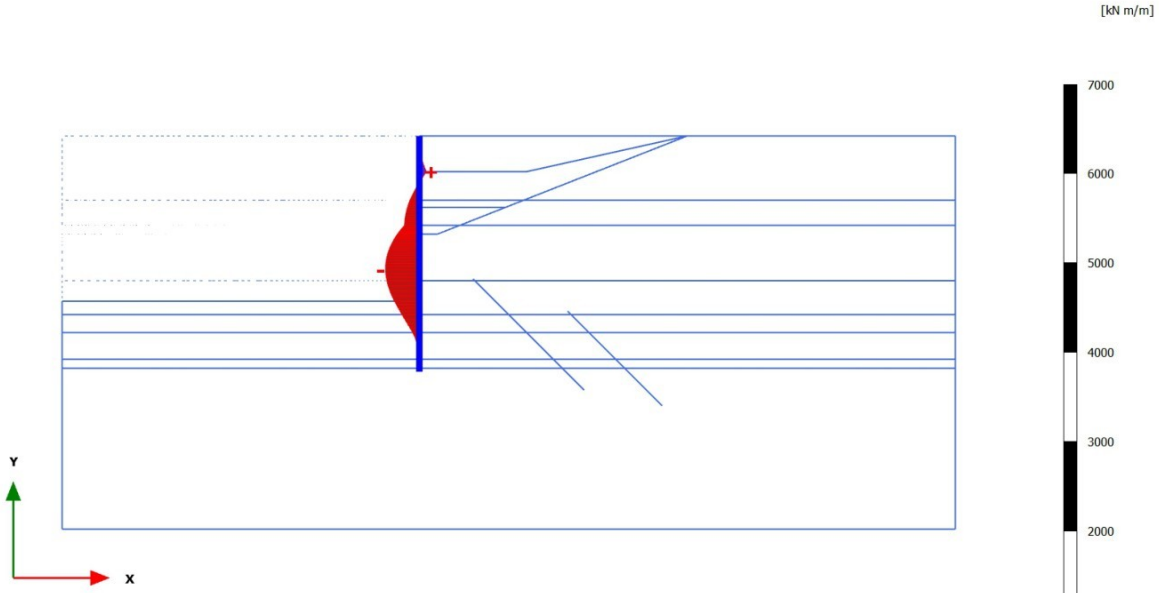


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 28.71 kN m/m (Element 2 at Node 7740)

Minimum value = -363.8 kN m/m (Element 13 at Node 6652)

3.1.1.2.2 Calculation results, Plate, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Bending moments M

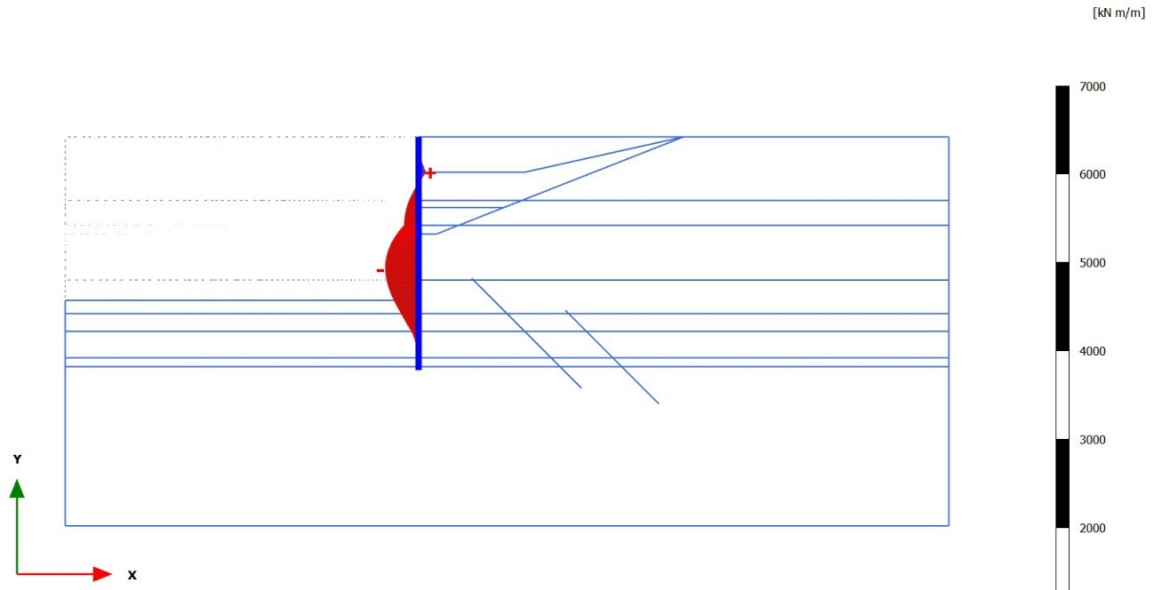


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 77.70 kN m/m (Element 3 at Node 7740)

Minimum value = -379.1 kN m/m (Element 14 at Node 6525)

3.1.1.2.3 Calculation results, Plate, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Bending moments M

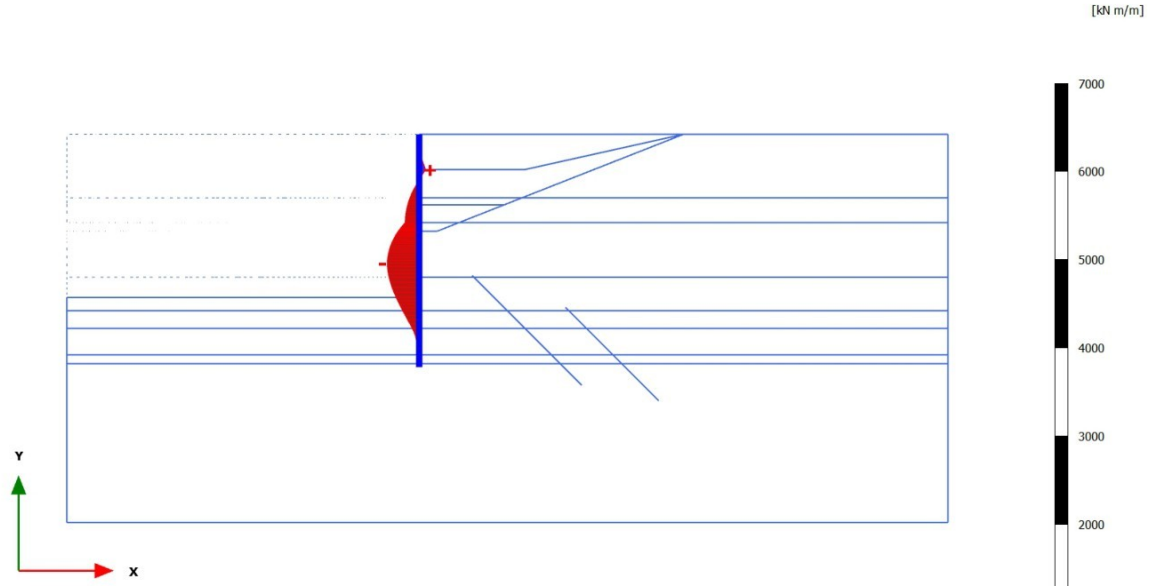


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 77.89 kN m/m (Element 2 at Node 7740)

Minimum value = -375.0 kN m/m (Element 14 at Node 6525)

3.1.1.2.4 Calculation results, Plate, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Bending moments M

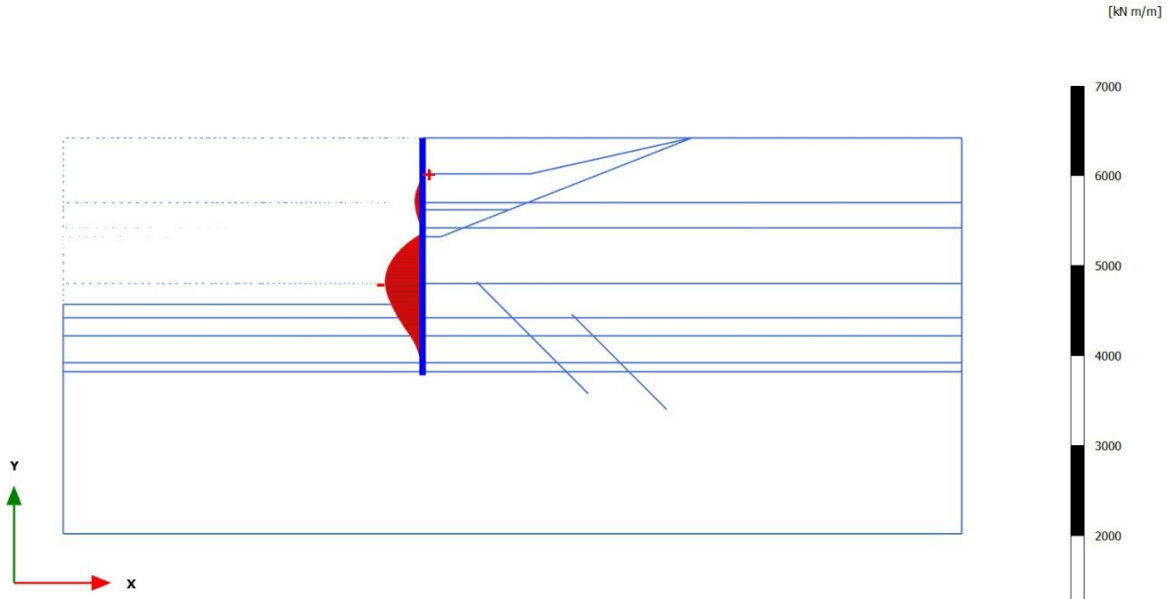


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 73.41 kN m/m (Element 3 at Node 7740)

Minimum value = -362.4 kN m/m (Element 13 at Node 6649)

3.1.1.2.5 Calculation results, Plate, 14. SLS KAR: H: Ijs + opslag + TB [Phase_14] (14/760), Bending moments M

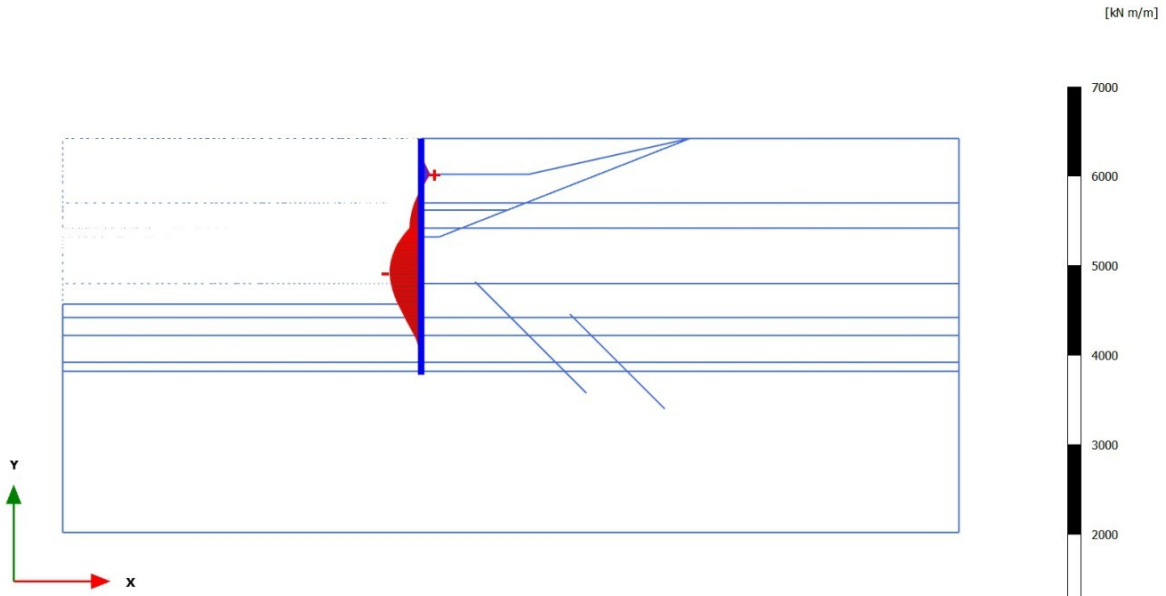


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 20.82 kN m/m (Element 2 at Node 7740)

Minimum value = -415.3 kN m/m (Element 14 at Node 6528)

3.1.1.2.6 Calculation results, Plate, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Bending moments M

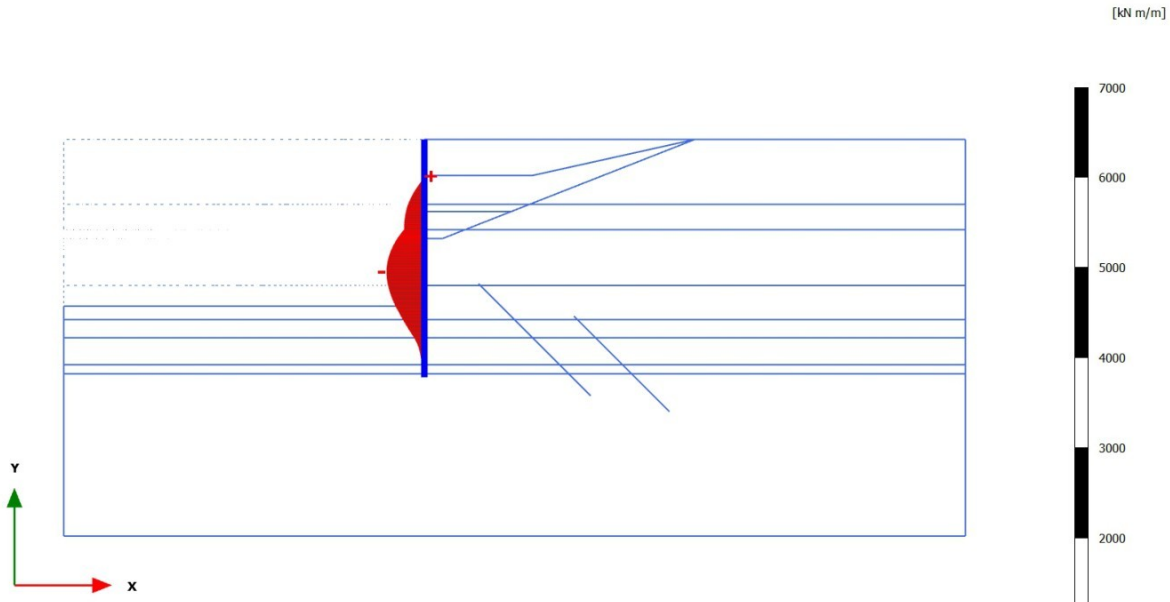


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 96.71 kN m/m (Element 2 at Node 7740)

Minimum value = -348.2 kN m/m (Element 14 at Node 6525)

3.1.1.2.7 Calculation results, Plate, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Bending moments M

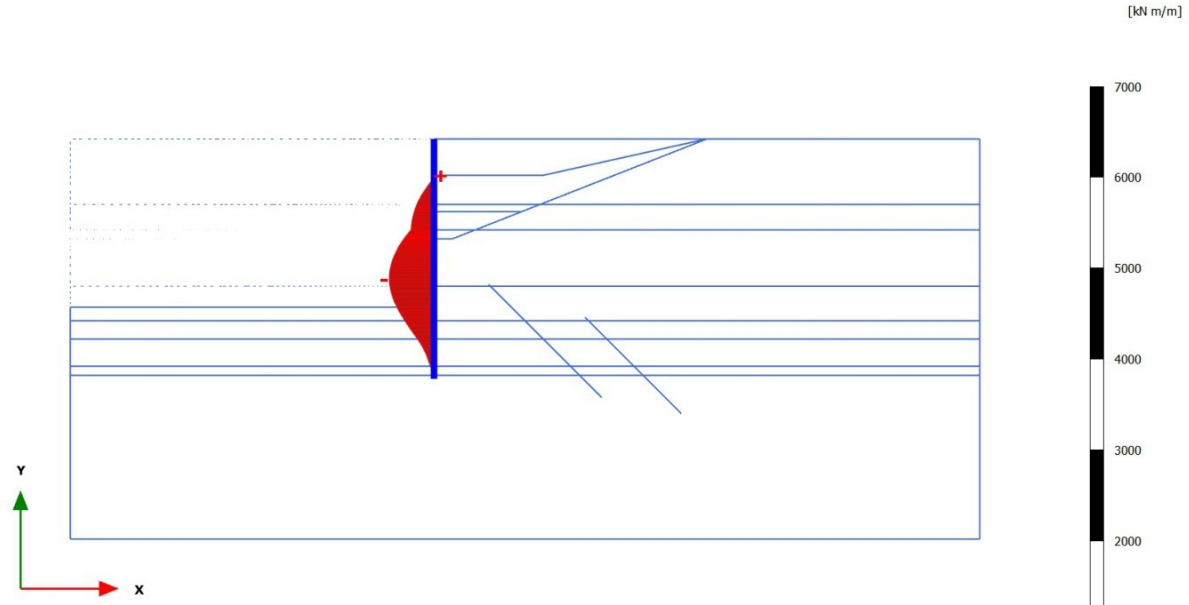


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 20.24 kN m/m (Element 3 at Node 7740)

Minimum value = -416.1 kN m/m (Element 13 at Node 6649)

3.1.1.2.8 Calculation results, Plate, 16.2 ULS A2 [Phase_36] (36/1382), Bending moments M

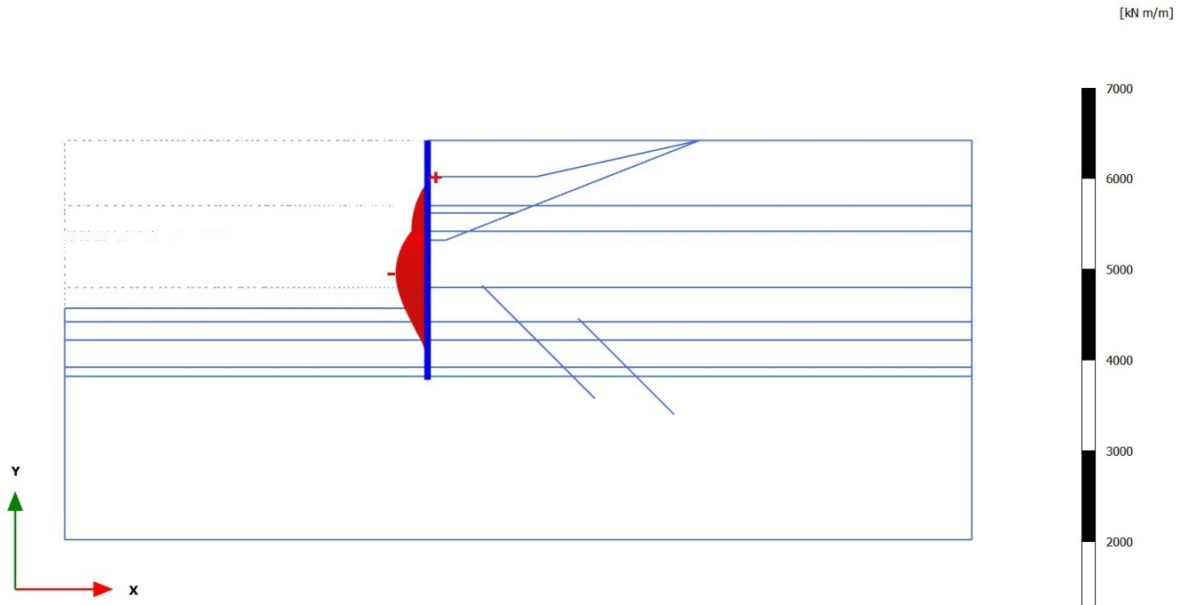


Bending moments M (scaled up $5.00*10^{-3}$ times)

Maximum value = 21.22 kN m/m (Element 2 at Node 7740)

Minimum value = -491.8 kN m/m (Element 14 at Node 6526)

3.1.1.2.9 Calculation results, Plate, 17: ALS: MHW [Phase_17] (17/1389), Bending moments M

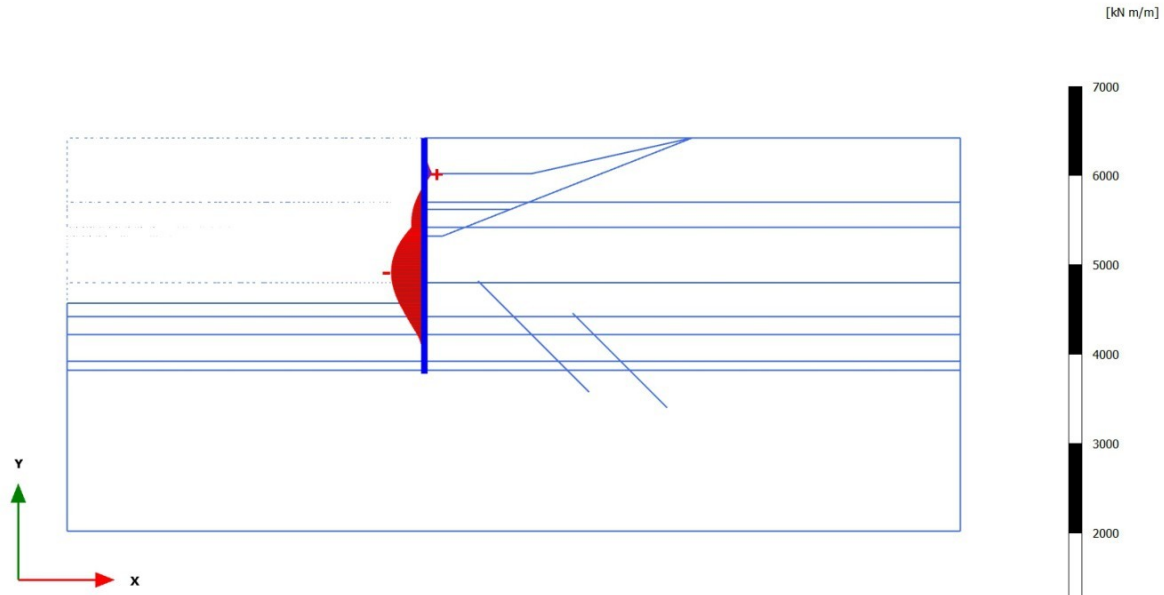


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 38.68 kN m/m (Element 3 at Node 7740)

Minimum value = -348.8 kN m/m (Element 13 at Node 6649)

3.1.1.2.10 Calculation results, Plate, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Bending moments M

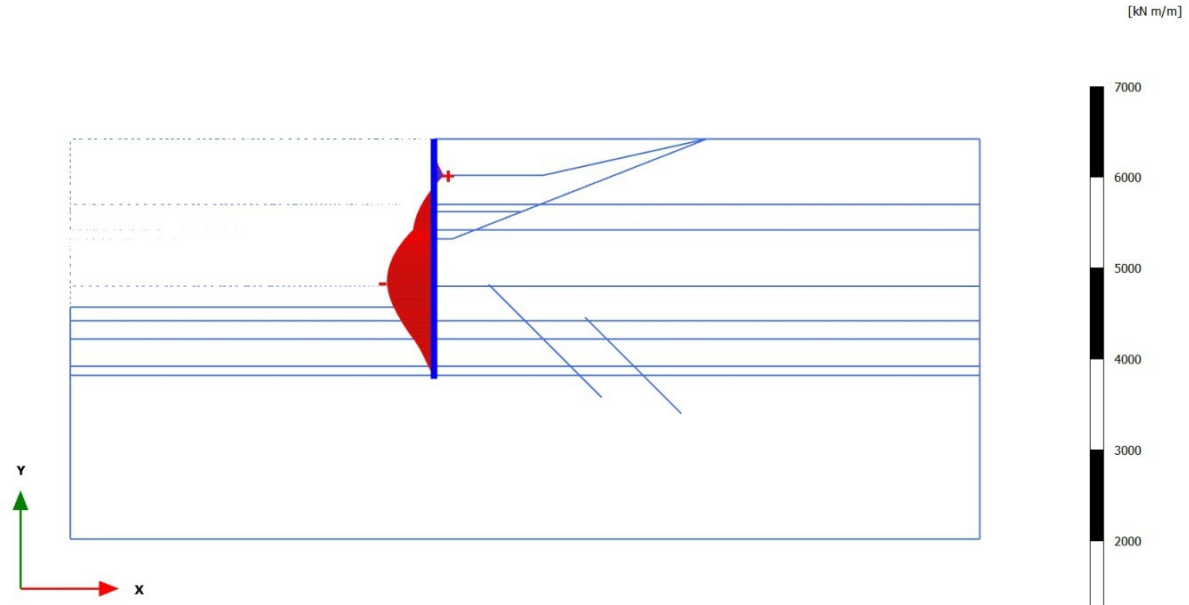


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 82.97 kN m/m (Element 3 at Node 7740)

Minimum value = -369.7 kN m/m (Element 14 at Node 6525)

3.1.1.2.11 Calculation results, Plate, 18.2 ULS A2 [Phase_38] (38/1687), Bending moments M

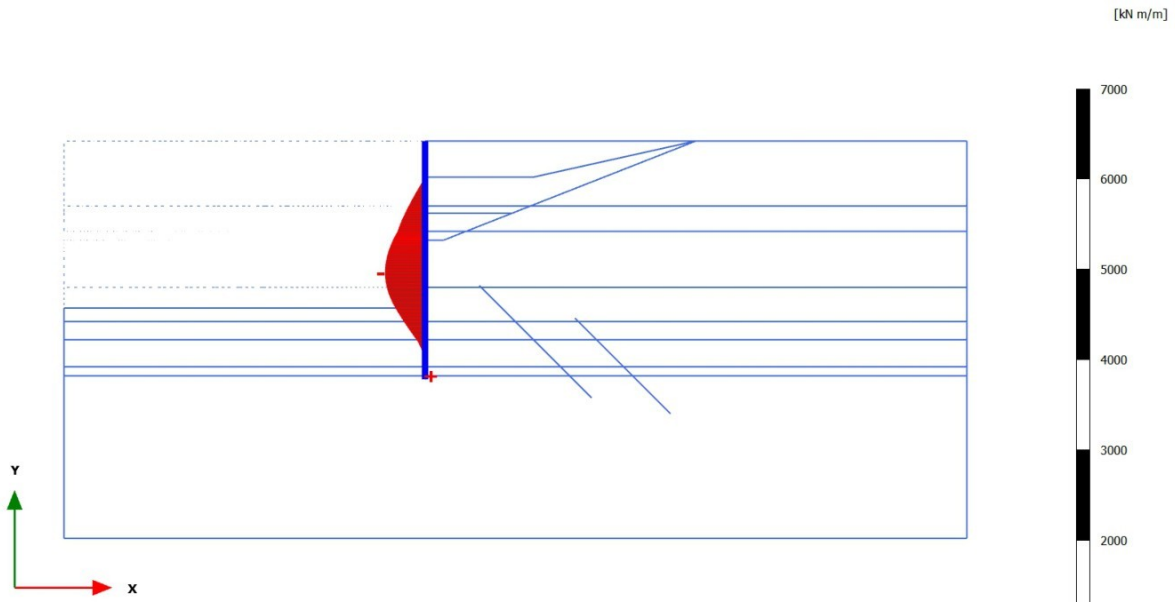


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 100.8 kN m/m (Element 3 at Node 7740)

Minimum value = -512.9 kN m/m (Element 14 at Node 6527)

3.1.1.2.12 Calculation results, Plate, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Bending moments M

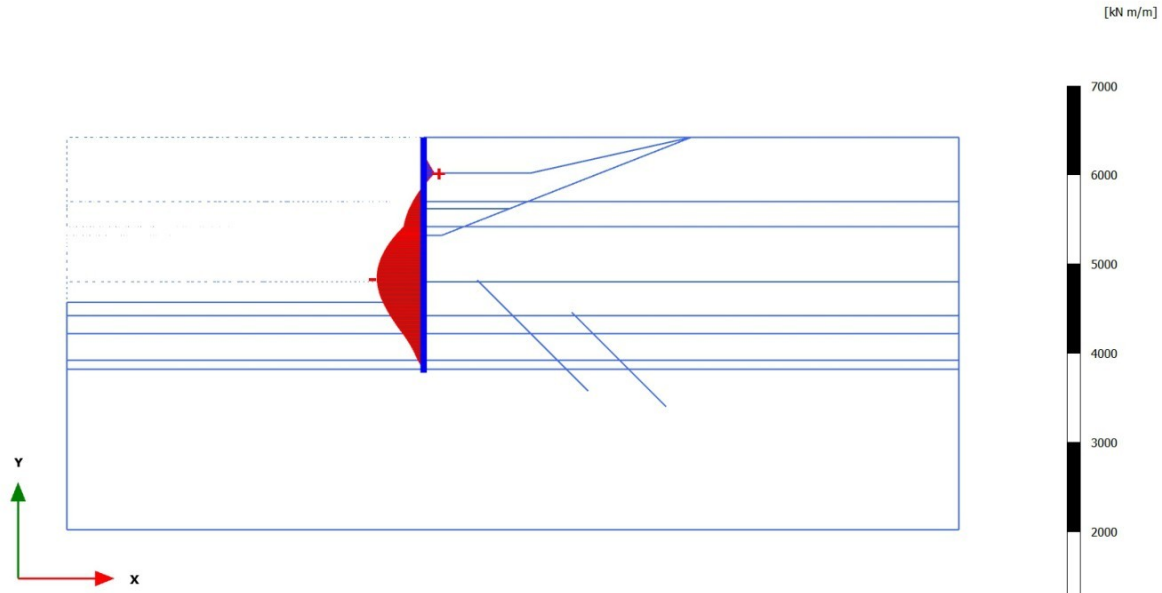


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 10.10 kN m/m (Element 20 at Node 6871)

Minimum value = -440.2 kN m/m (Element 14 at Node 6649)

3.1.1.2.13 Calculation results, Plate, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Bending moments M

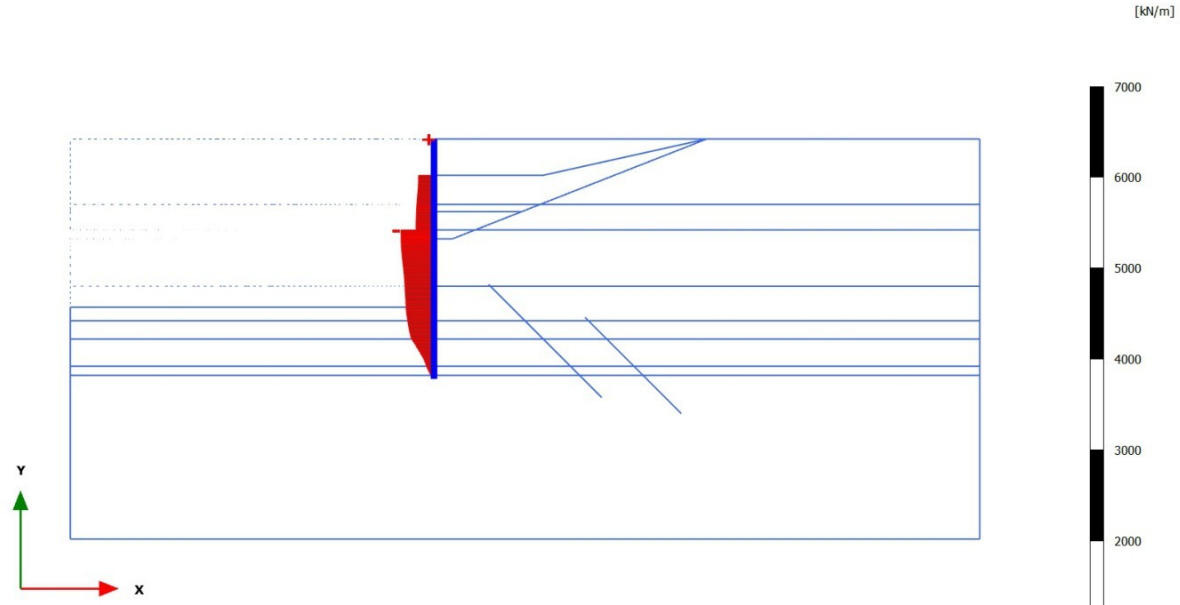


Bending moments M (scaled up 5.00*10^{-3} times)

Maximum value = 119.1 kN m/m (Element 2 at Node 7740)

Minimum value = -522.3 kN m/m (Element 14 at Node 6527)

3.1.1.3.1 Calculation results, Plate, 10. Waterpeilverschil [Phase_10] (10/90), Axial forces N

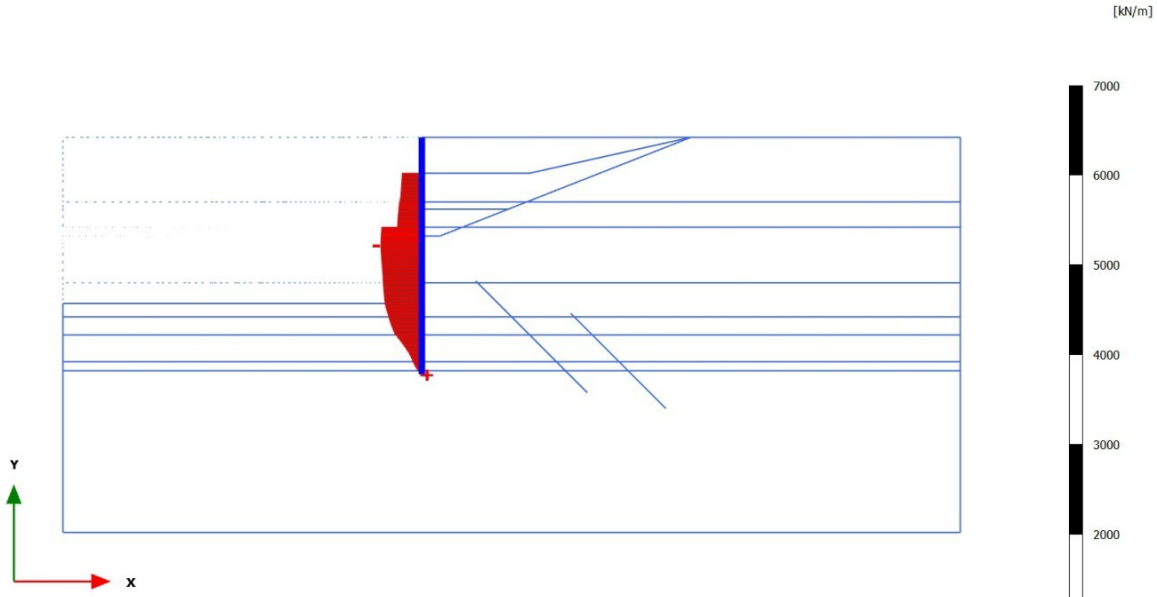


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = -0.05104 kN/m (Element 1 at Node 7594)

Minimum value = -364.6 kN/m (Element 8 at Node 7290)

3.1.1.3.2 Calculation results, Plate, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Axial forces N

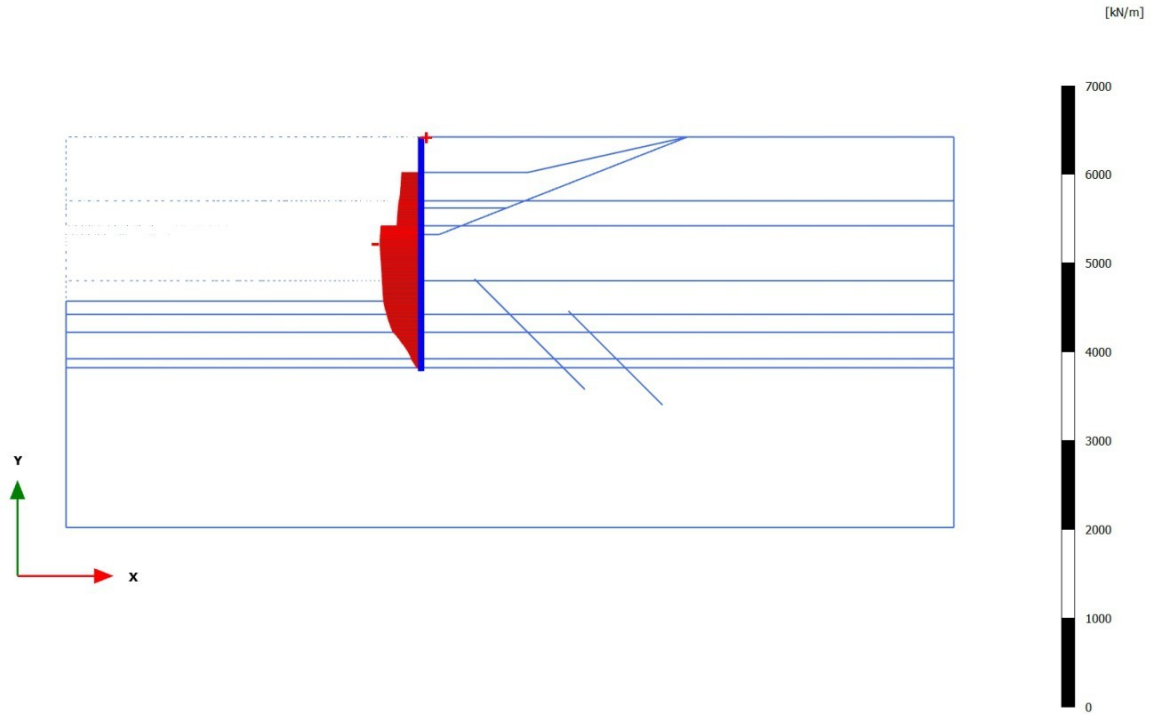


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = 0.1854 kN/m (Element 21 at Node 6875)

Minimum value = -456.2 kN/m (Element 11 at Node 6741)

3.1.1.3.3 Calculation results, Plate, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Axial forces N

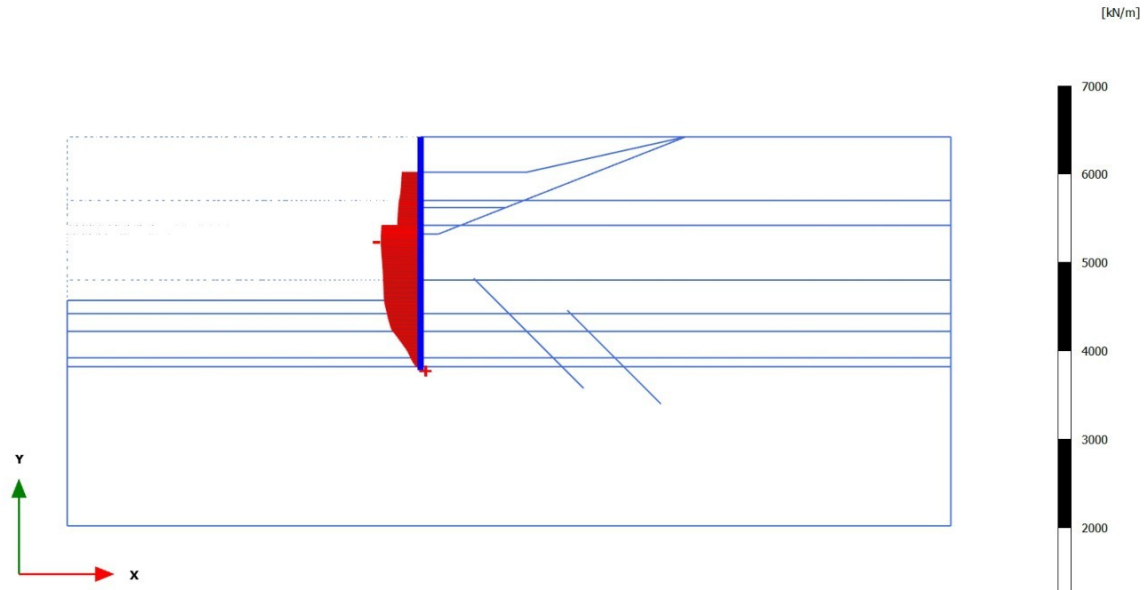


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = 8.956*10^{-3} kN/m (Element 1 at Node 7594)

Minimum value = -462.3 kN/m (Element 11 at Node 6741)

3.1.1.3.4 Calculation results, Plate, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Axial forces N

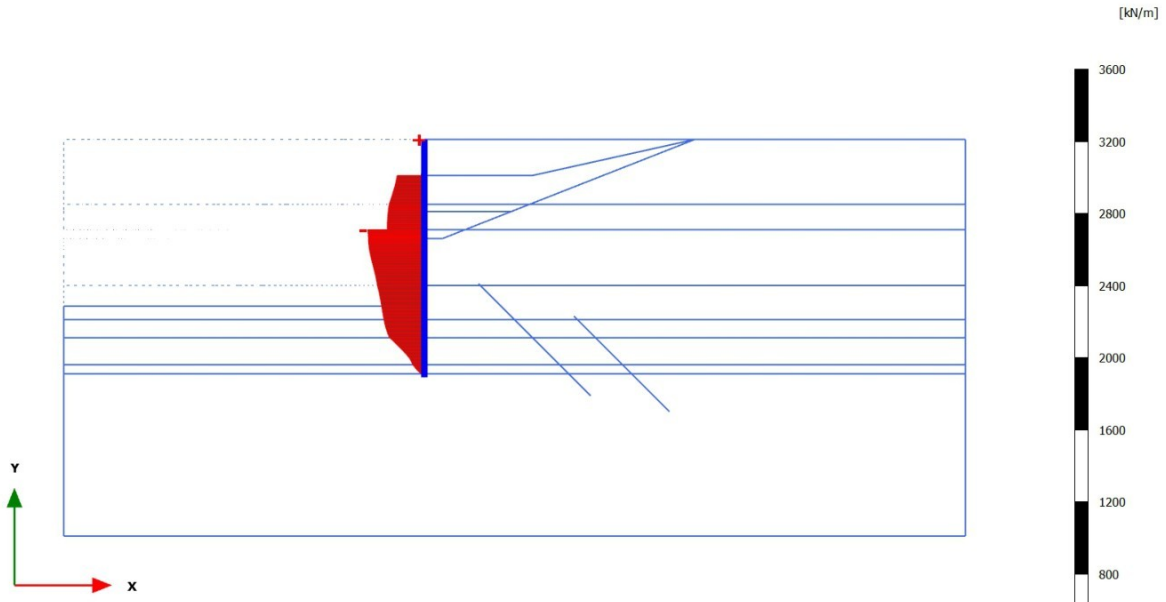


Axial forces N (scaled up $5.00*10^{-3}$ times)

Maximum value = 0.1083 kN/m (Element 21 at Node 6875)

Minimum value = -446.8 kN/m (Element 11 at Node 6740)

3.1.1.3.5 Calculation results, Plate, 14. SLS KAR: H: Ijs + opslag + TB [Phase_14] (14/760), Axial forces N

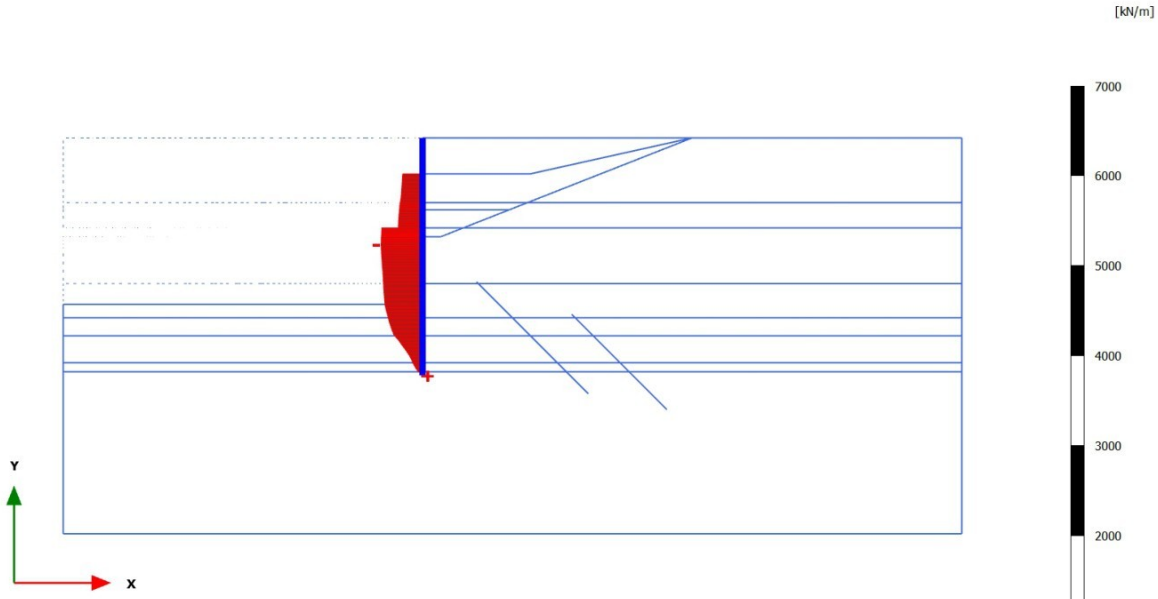


Axial forces N (scaled up 0.0100 times)

Maximum value = $-9.547*10^{-3}$ kN/m (Element 1 at Node 7594)

Minimum value = -314.3 kN/m (Element 8 at Node 7290)

3.1.1.3.6 Calculation results, Plate, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Axial forces N

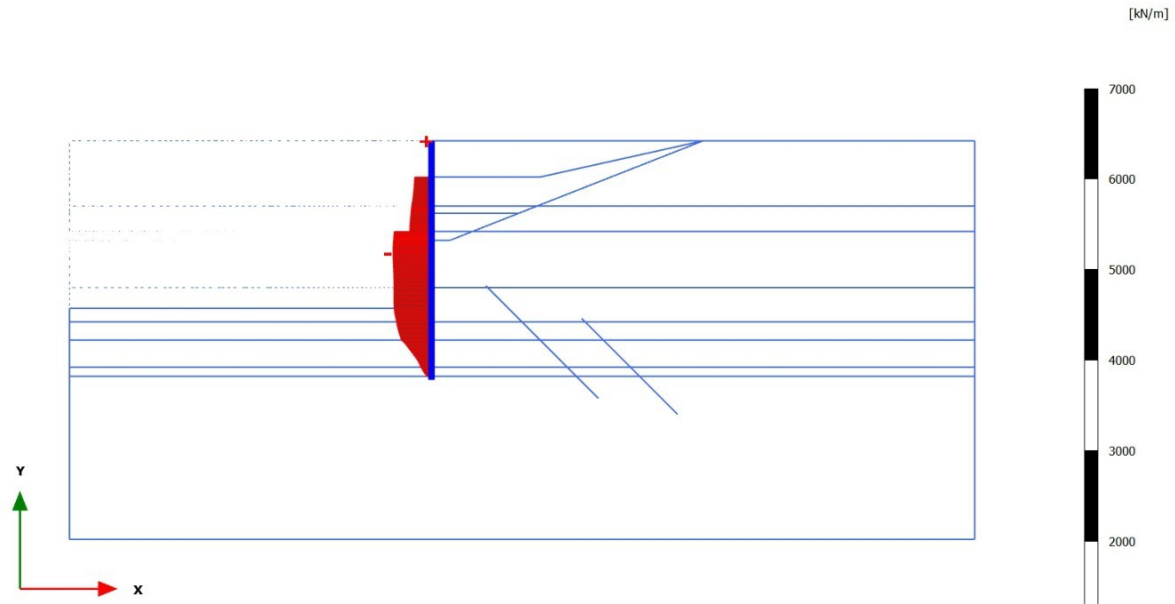


Axial forces N (scaled up $5.00*10^{-3}$ times)

Maximum value = 0.05856 kN/m (Element 21 at Node 6875)

Minimum value = -461.5 kN/m (Element 11 at Node 6740)

3.1.1.3.7 Calculation results, Plate, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Axial forces N

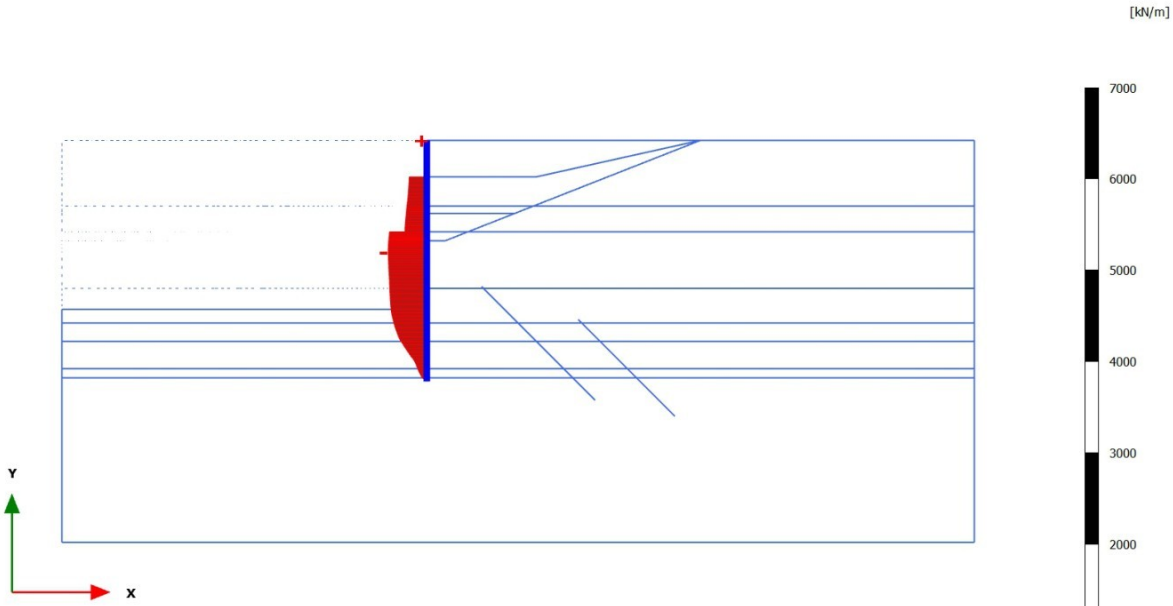


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = -4.539*10^{-3} kN/m (Element 1 at Node 7594)

Minimum value = -426.2 kN/m (Element 12 at Node 6739)

3.1.1.3.8 Calculation results, Plate, 16.2 ULS A2 [Phase_36] (36/1382), Axial forces N

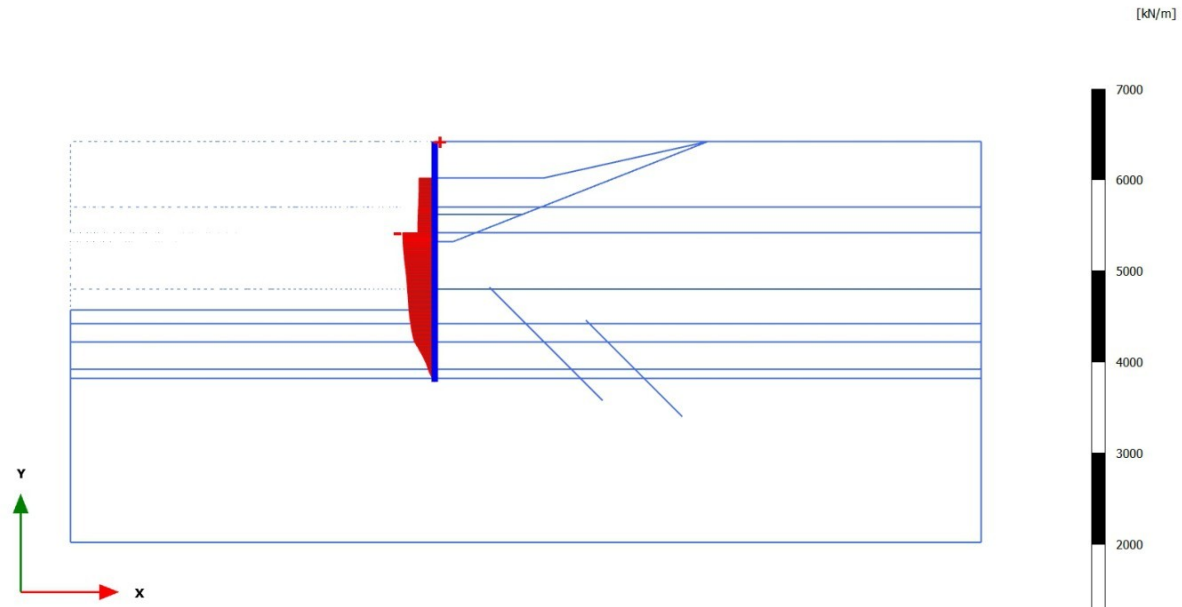


Axial forces N (scaled up $5.00*10^{-3}$ times)

Maximum value = $-5.147*10^{-3}$ kN/m (Element 1 at Node 7594)

Minimum value = -423.0 kN/m (Element 11 at Node 6742)

3.1.1.3.9 Calculation results, Plate, 17: ALS: MHW [Phase_17] (17/1389), Axial forces N

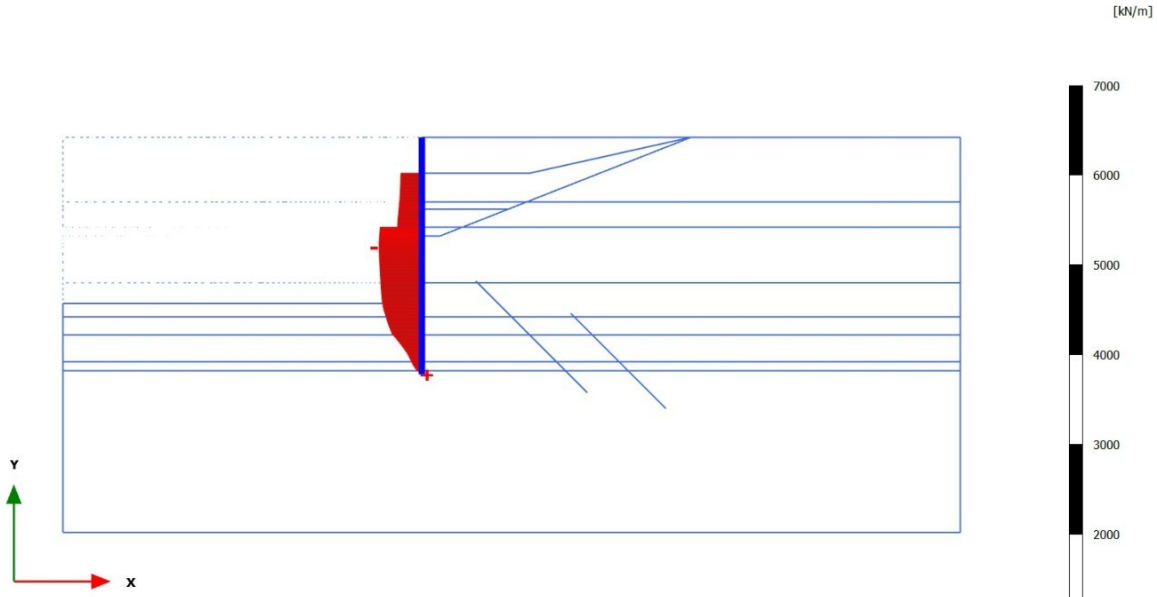


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = 0.04066 kN/m (Element 1 at Node 7594)

Minimum value = -352.7 kN/m (Element 8 at Node 7290)

3.1.1.3.10 Calculation results, Plate, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Axial forces N

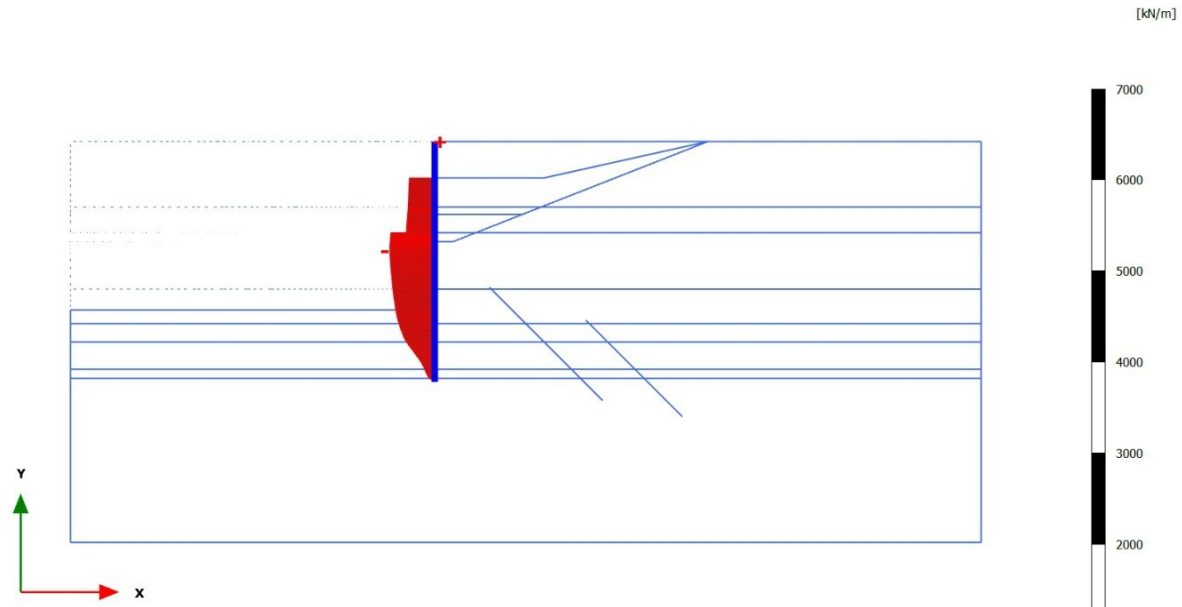


Axial forces N (scaled up $5.00*10^{-3}$ times)

Maximum value = 0.4657 kN/m (Element 21 at Node 6875)

Minimum value = -477.3 kN/m (Element 11 at Node 6742)

3.1.1.3.11 Calculation results, Plate, 18.2 ULS A2 [Phase_38] (38/1687), Axial forces N

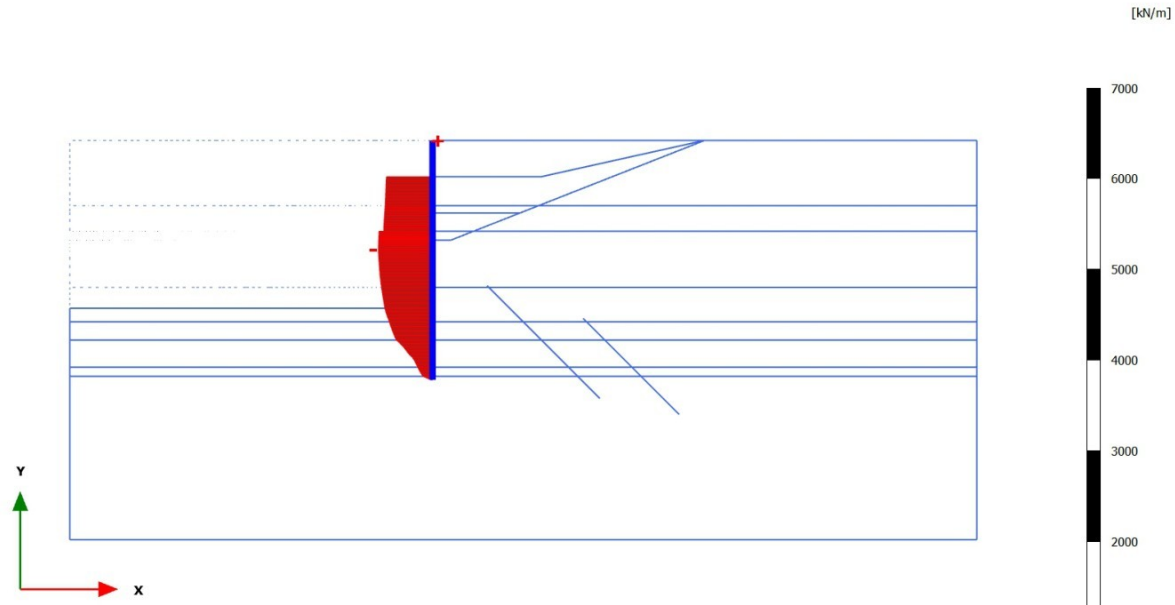


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = 2.525*10^{-3} kN/m (Element 1 at Node 7594)

Minimum value = -493.5 kN/m (Element 11 at Node 6741)

3.1.1.3.12 Calculation results, Plate, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Axial forces N

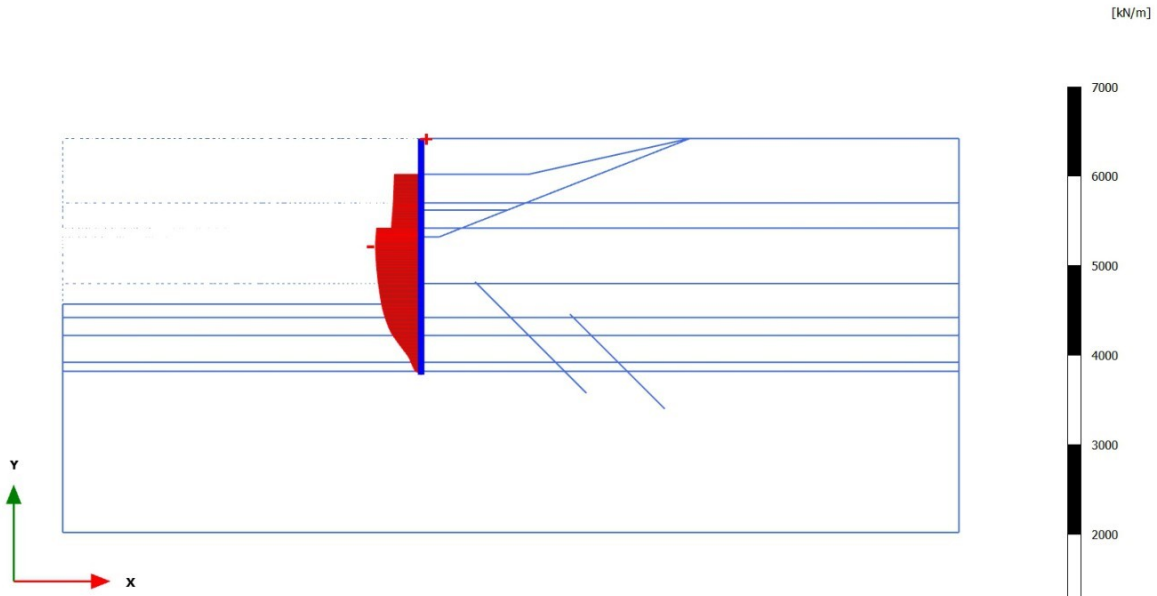


Axial forces N (scaled up 5.00*10^{-3} times)

Maximum value = 0.02073 kN/m (Element 1 at Node 7594)

Minimum value = -597.4 kN/m (Element 11 at Node 6741)

3.1.1.3.13 Calculation results, Plate, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Axial forces N

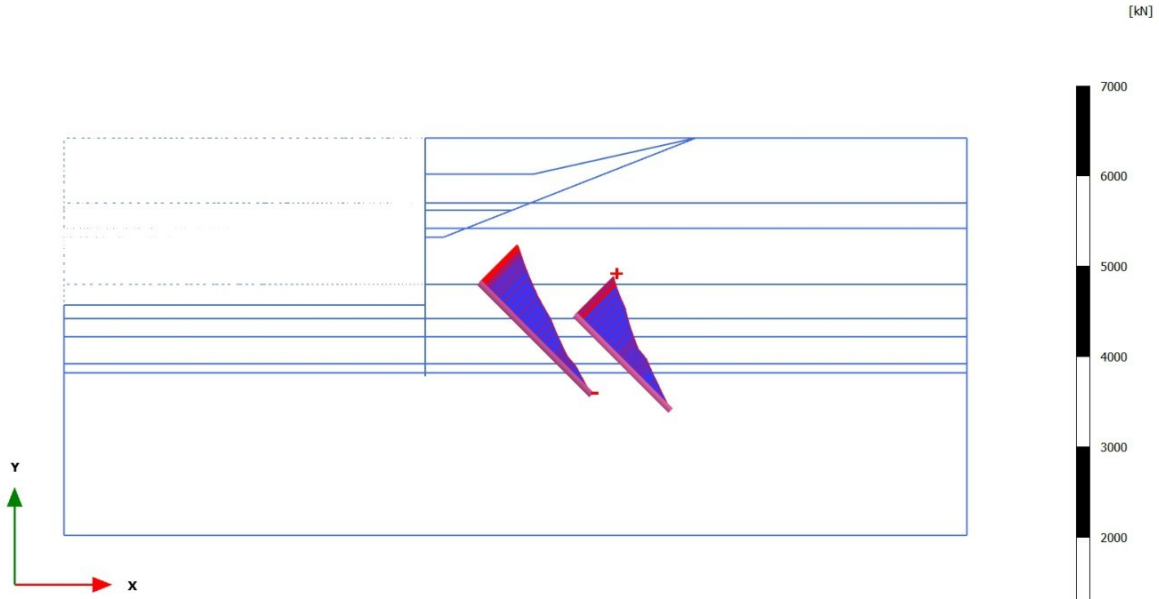


Axial forces N (scaled up $5.00*10^{-3}$ times)

Maximum value = 0.04088 kN/m (Element 1 at Node 7594)

Minimum value = -509.4 kN/m (Element 11 at Node 6741)

3.2.1.1.1 Calculation results, Embedded beam, 10. Waterpeilverschil [Phase_10] (10/90), Axial forces N

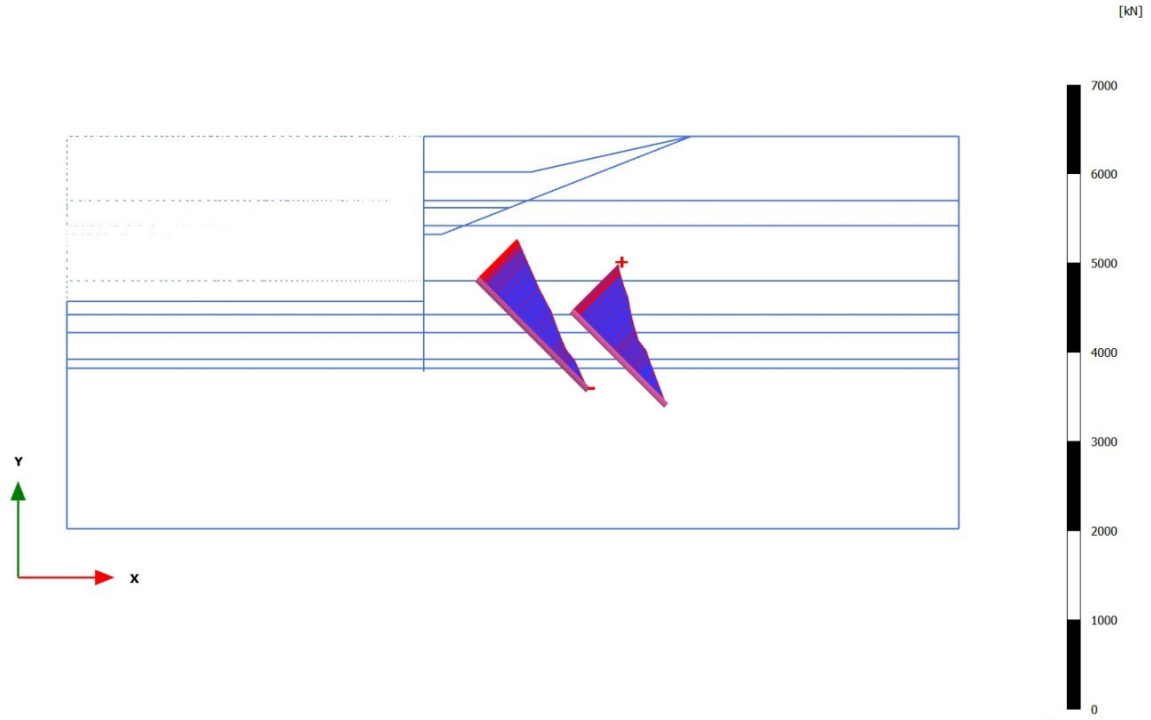


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 608.2 kN (Element 11 at Node 17528)

Minimum value = 0.3762 kN (Element 10 at Node 17527)

3.2.1.1.2 Calculation results, Embedded beam, 11. SLS KAR H: TB 27 kPa + haalpen x psi0 [Phase_11] (11/110), Axial forces N

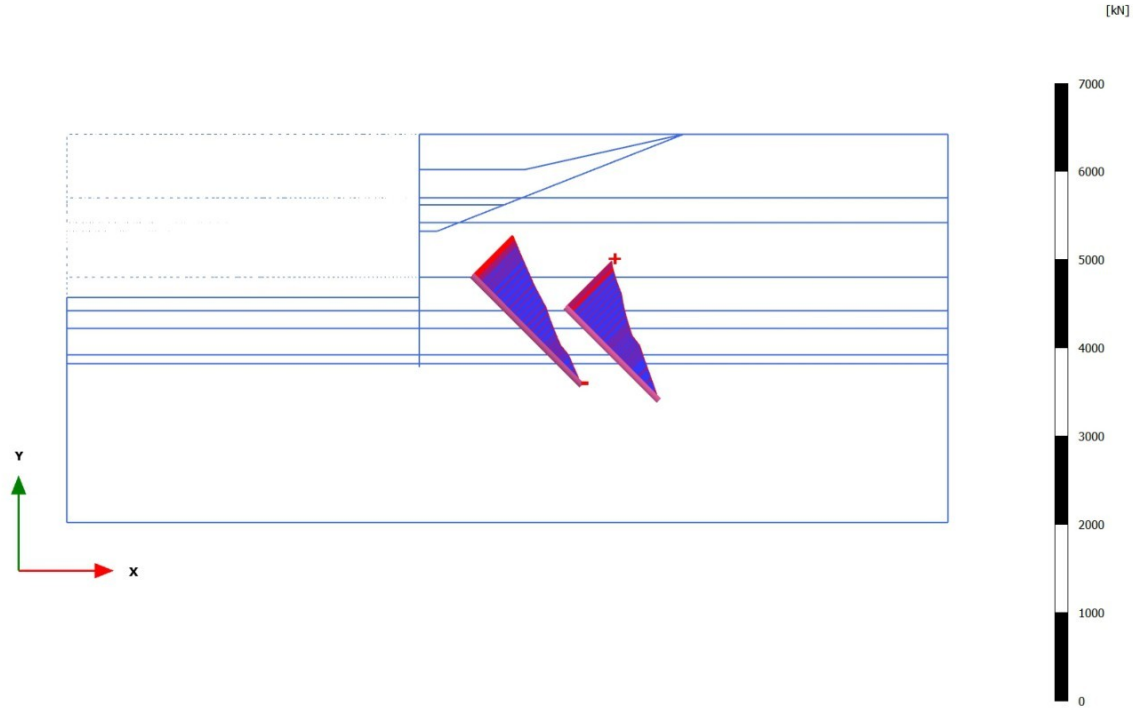


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 741.6 kN (Element 11 at Node 17528)

Minimum value = 0.5242 kN (Element 10 at Node 17527)

3.2.1.1.3 Calculation results, Embedded beam, 12. SLS KAR: TB 27 kPa + opslag 50 kPa x psi0+haalpenxpsi0 [Phase_12] (12/293), Axial forces N

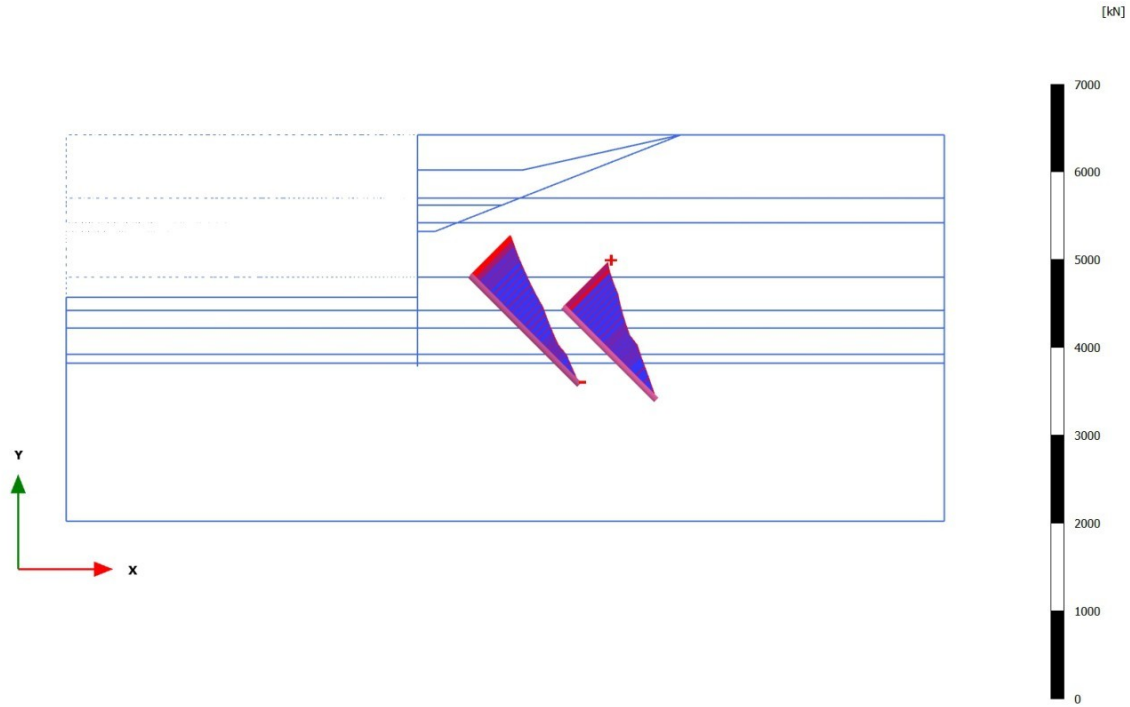


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 742.9 kN (Element 11 at Node 17528)

Minimum value = 0.6826 kN (Element 10 at Node 17527)

3.2.1.1.4 Calculation results, Embedded beam, 13. SLS KAR: H: opslag 50 kPa + TB 27 kPa x psi0 + haalpen x psi0 [Phase_13] (13/623), Axial forces N

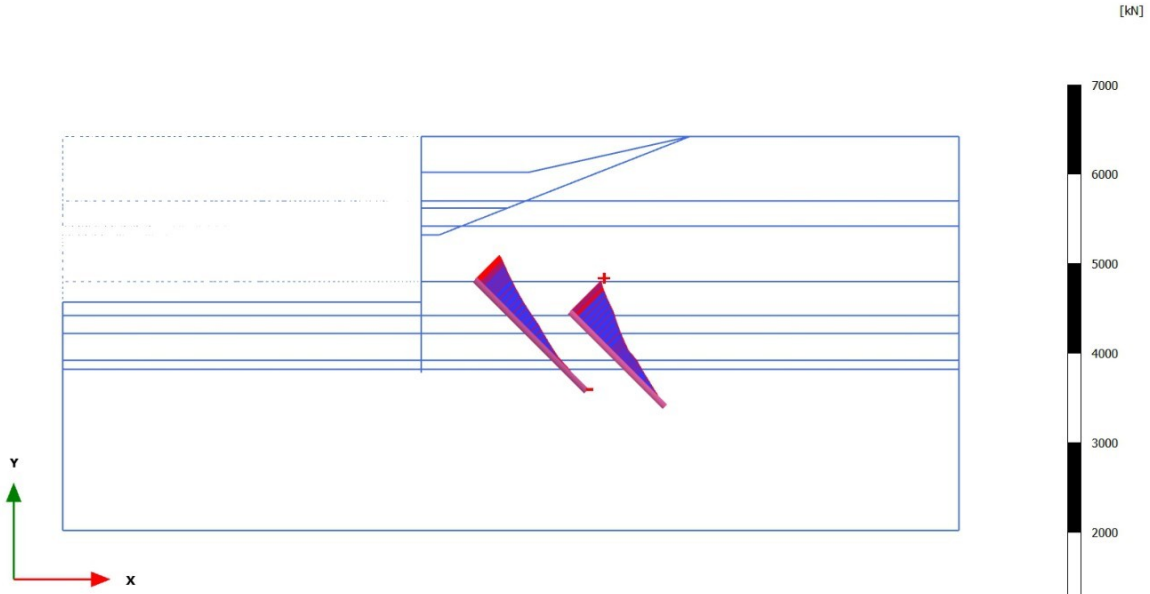


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 719.8 kN (Element 11 at Node 17528)

Minimum value = 0.7114 kN (Element 10 at Node 17527)

3.2.1.1.5 Calculation results, Embedded beam, 14. SLS KAR: H: Ijs + opslag + TB [Phase_14] (14/760), Axial forces N

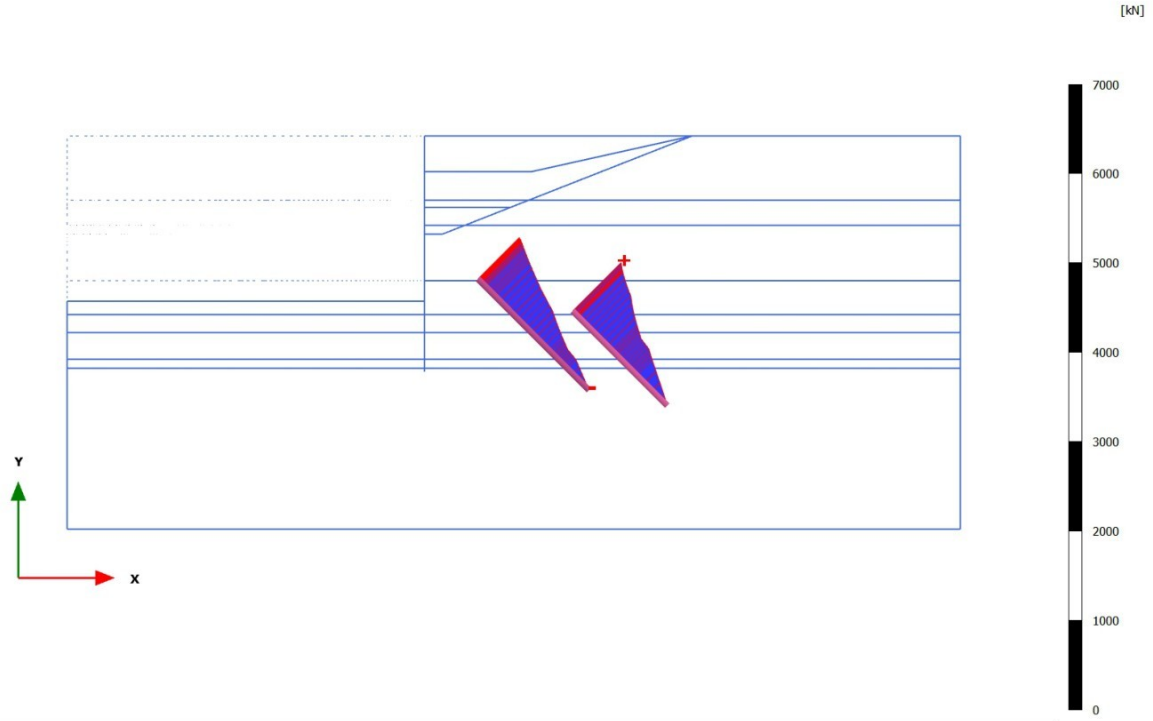


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 491.4 kN (Element 11 at Node 17528)

Minimum value = 0.3090 kN (Element 10 at Node 17527)

3.2.1.1.6 Calculation results, Embedded beam, 15. SLS KAR: H: Haalpen + opslag + TB [Phase_15] (15/878), Axial forces N

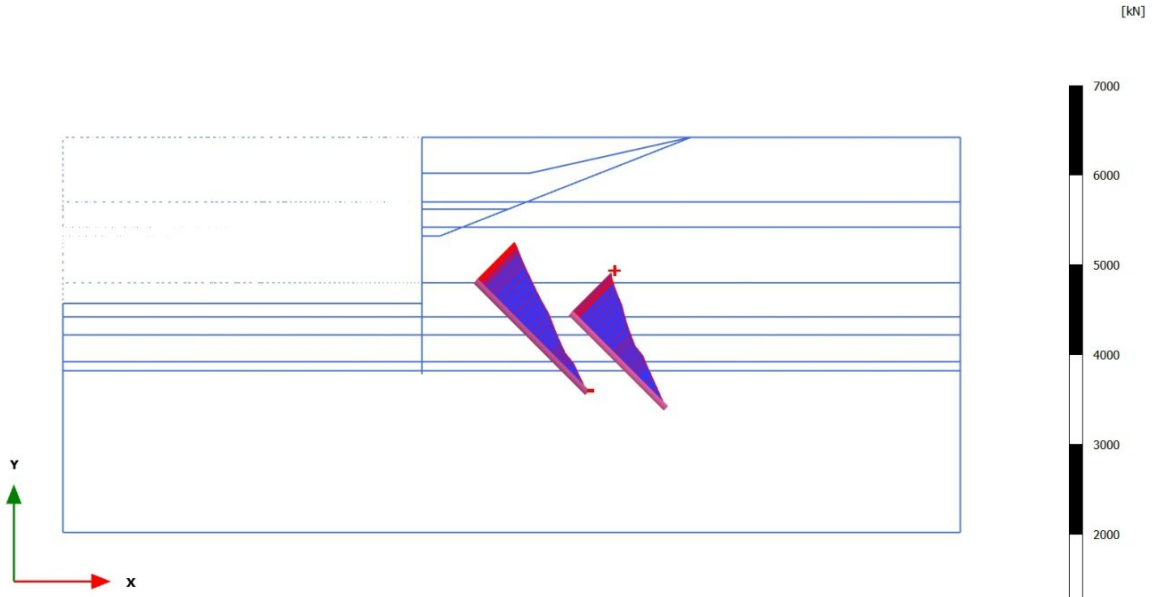


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 768.0 kN (Element 11 at Node 17528)

Minimum value = 0.6619 kN (Element 10 at Node 17527)

3.2.1.1.7 Calculation results, Embedded beam, 16. ALS: ELW + opslag + TB [Phase_16] (16/1047), Axial forces N

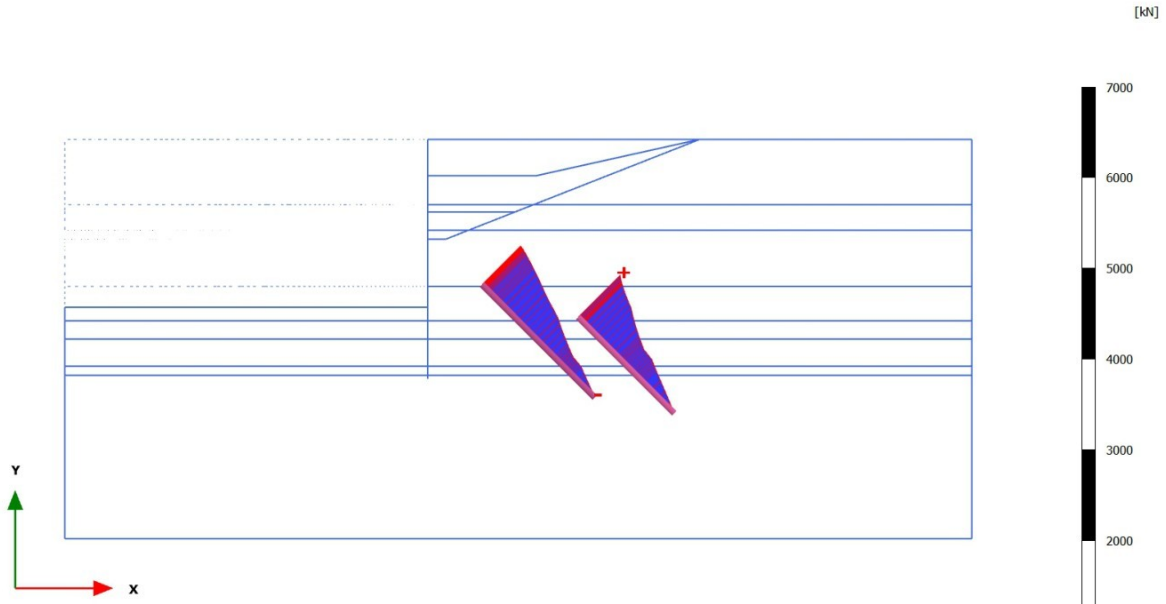


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 635.0 kN (Element 11 at Node 17528)

Minimum value = 0.6879 kN (Element 10 at Node 17527)

3.2.1.1.8 Calculation results, Embedded beam, 16.2 ULS A2 [Phase_36] (36/1382), Axial forces N

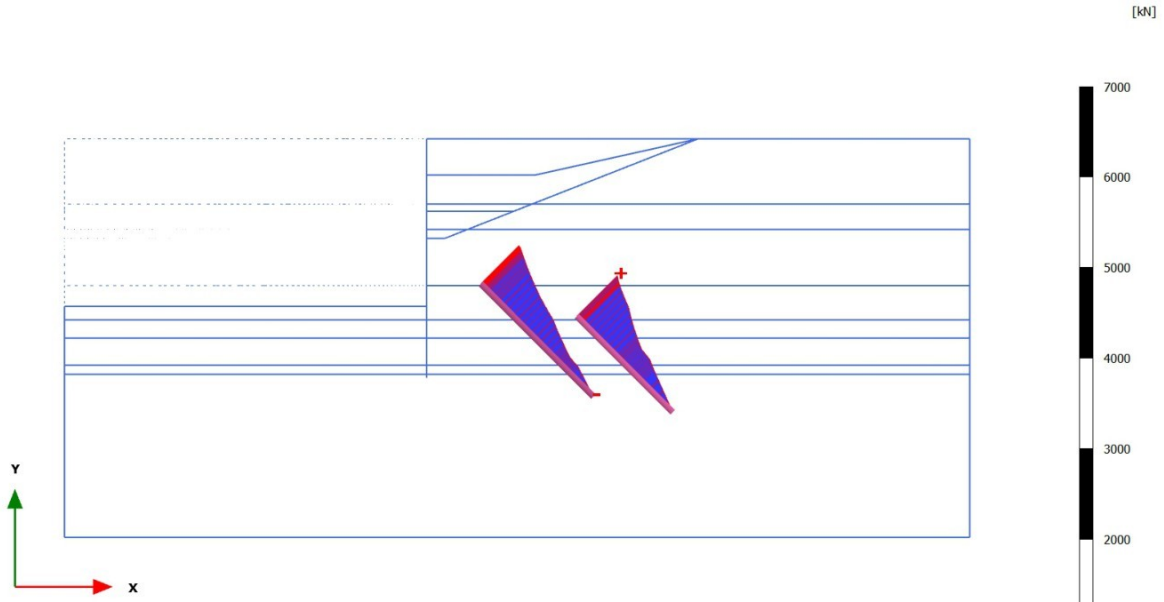


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 657.1 kN (Element 11 at Node 17528)

Minimum value = 0.7032 kN (Element 10 at Node 17527)

3.2.1.1.9 Calculation results, Embedded beam, 17: ALS: MHW [Phase_17] (17/1389), Axial forces N

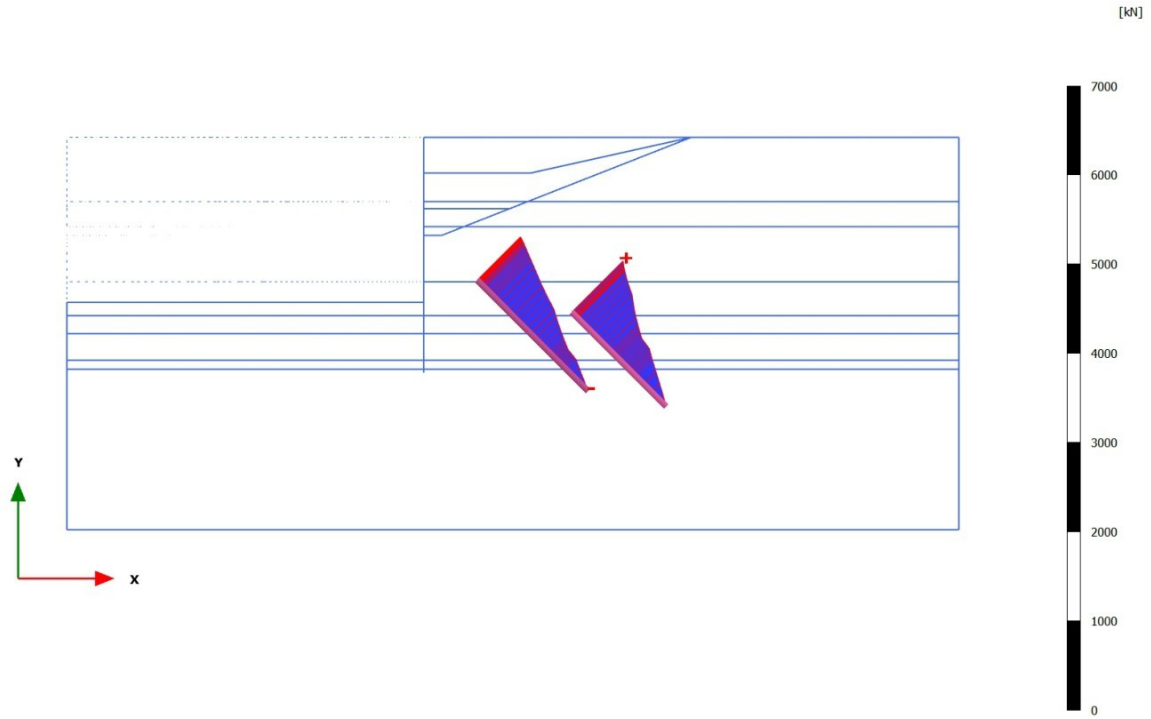


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 635.1 kN (Element 11 at Node 17528)

Minimum value = 0.3786 kN (Element 10 at Node 17527)

3.2.1.1.10 Calculation results, Embedded beam, 18: SLS KAR: Val na MHW + opslag + TB [Phase_18] (18/1515), Axial forces N

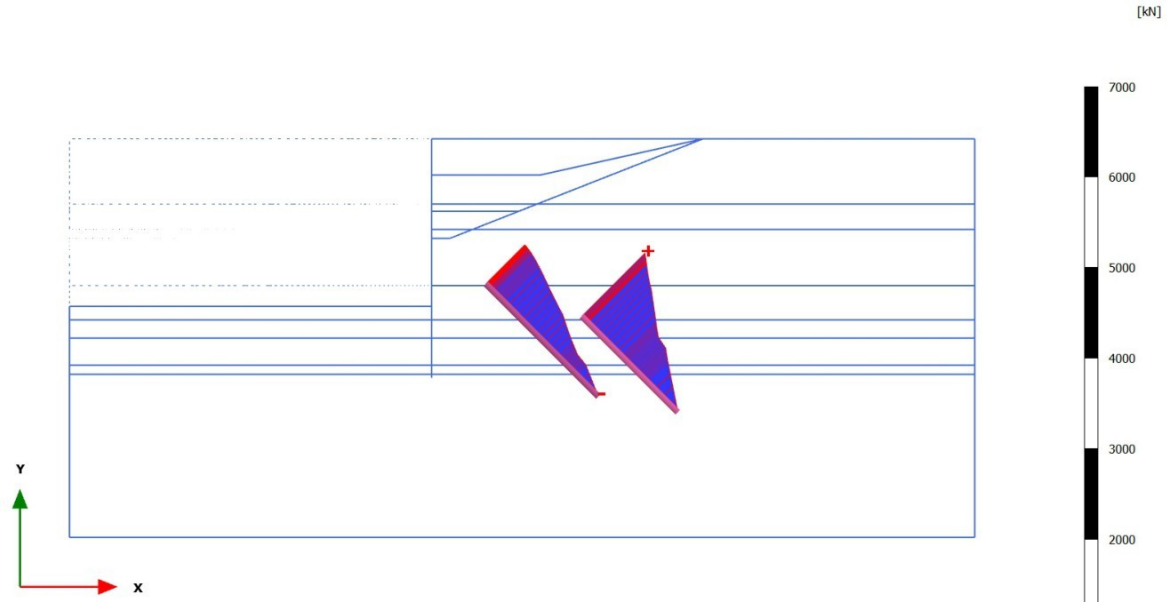


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 815.3 kN (Element 11 at Node 17528)

Minimum value = 0.7801 kN (Element 10 at Node 17527)

3.2.1.1.11 Calculation results, Embedded beam, 18.2 ULS A2 [Phase_38] (38/1687), Axial forces N

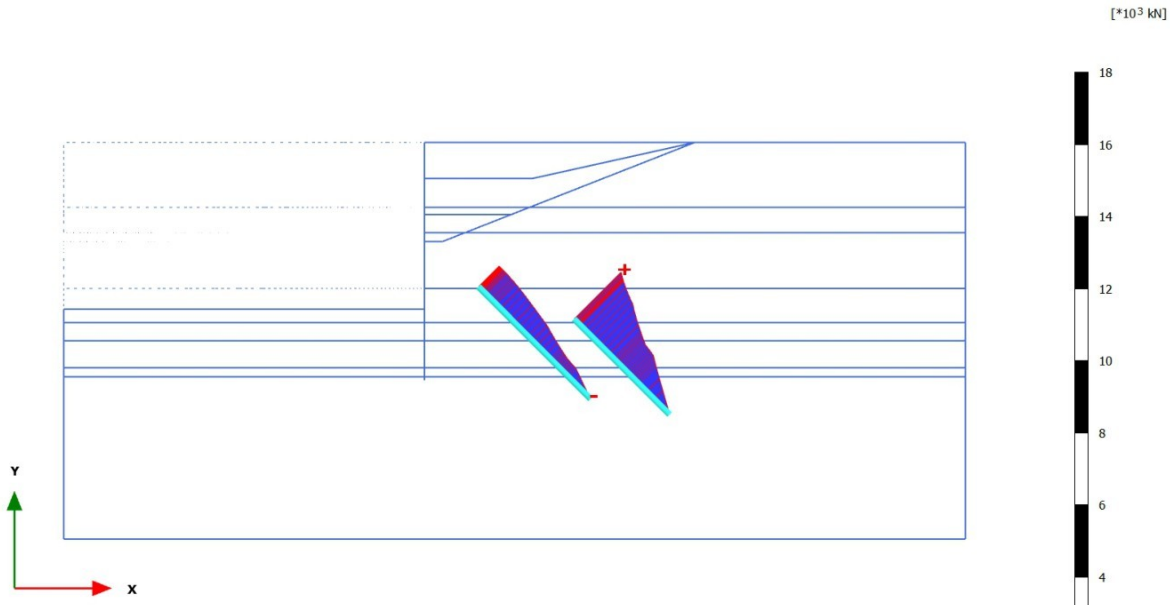


Axial forces N (scaled up 5.00*10^{-3} times) per structural element

Maximum value = 986.7 kN (Element 11 at Node 17528)

Minimum value = 0.8050 kN (Element 10 at Node 17527)

3.2.1.1.12 Calculation results, Embedded beam, 19.3 Kranz stabiliteit [Phase_19] (19/2070), Axial forces N

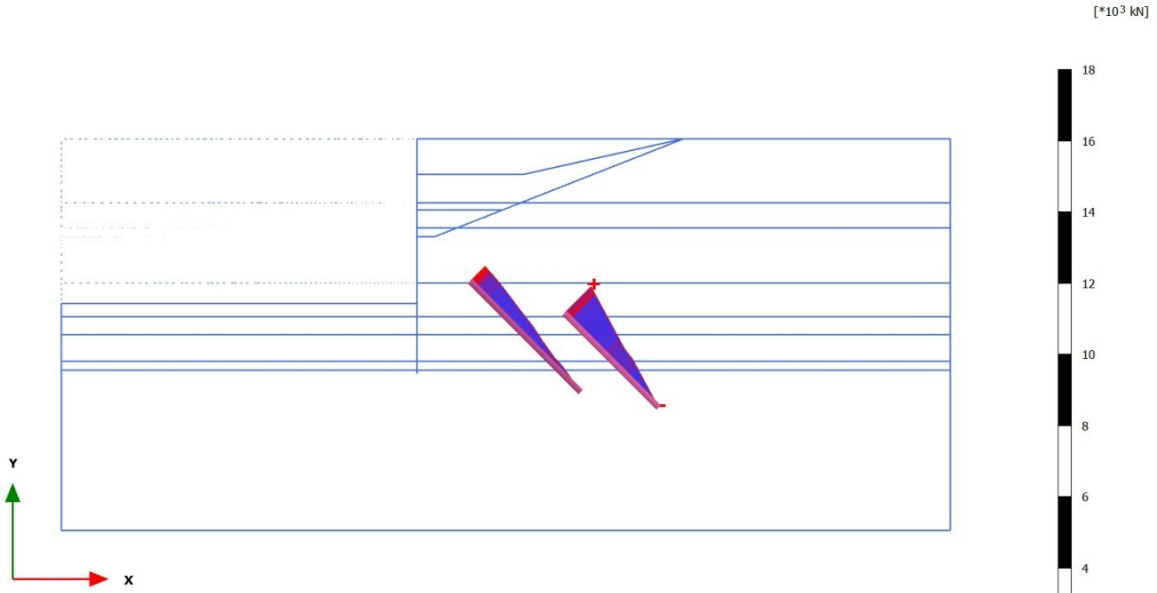


Axial forces N (scaled up 2.00*10^{-3} times) per structural element

Maximum value = 1846 kN (Element 11 at Node 17528)

Minimum value = 1.751 kN (Element 10 at Node 17527)

3.2.1.1.13 Calculation results, Embedded beam, 18.2 Haalpen 250kN - ULS A2: Val na MHW [Phase_29] (29/2892), Axial forces N



Axial forces N (scaled up 2.00*10^{-3} times) per structural element

Maximum value = 1059 kN (Element 11 at Node 17528)

Minimum value = 0.02255 kN (Element 18 at Node 17560)

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	21-3-2025
Time of report:	15:58:48
Report with version:	23.1.1.40517
Date of calculation:	21-3-2025
Time of calculation:	15:55:02
Calculated with version:	23.1.1.40517
File name:	3b1_Kerende_wand
Project identification:	Kaden Alexanderhaven Roermond Toetsingsberekening kade Willem-Alexander

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

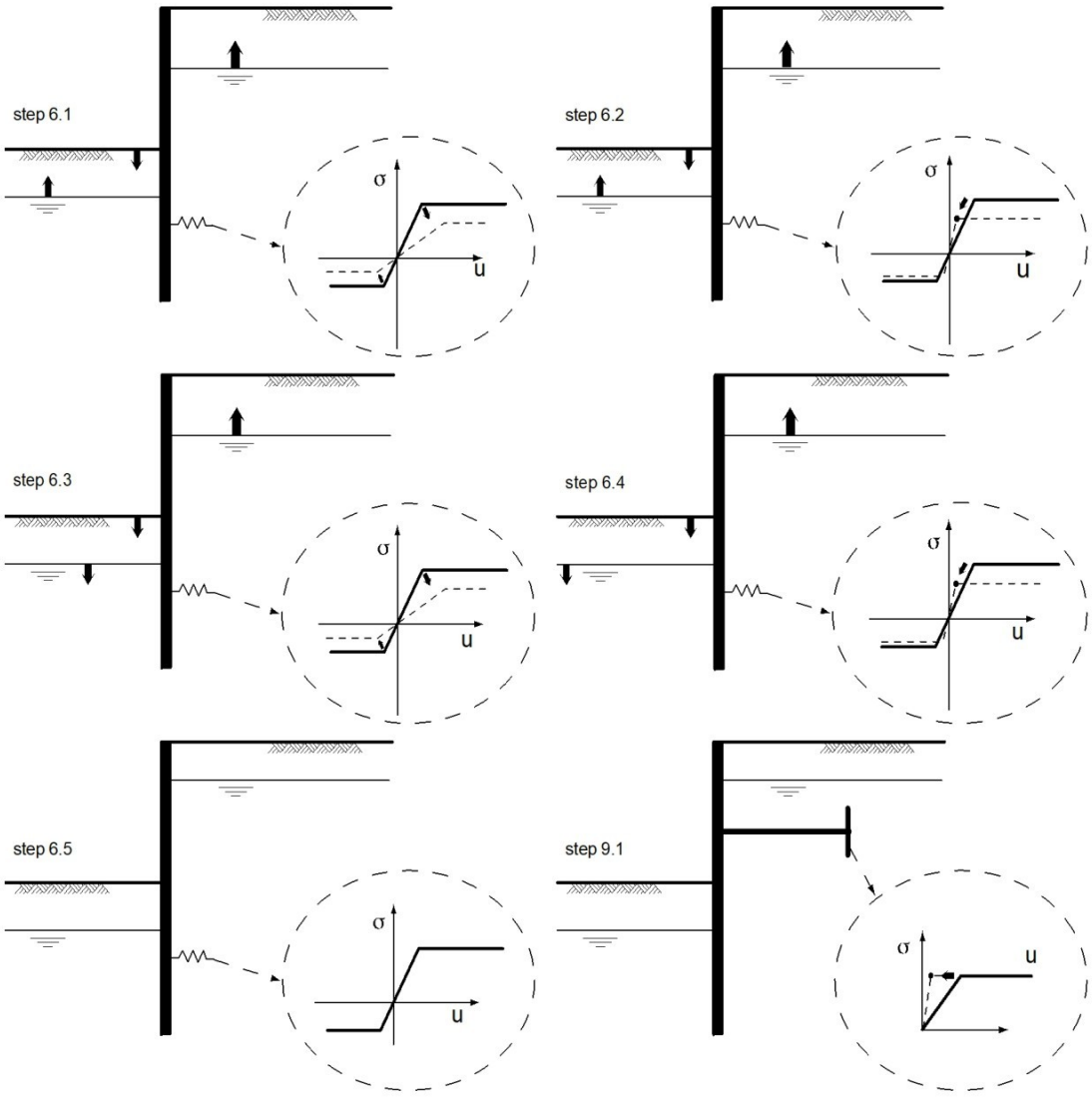
Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		0.00	0.00	0.0	11.8	
1	EC7(NL)-Step 6.2		0.00	0.00	0.0	11.8	
1	EC7(NL)-Step 6.3		0.00	0.00	0.0	11.8	
1	EC7(NL)-Step 6.4		0.00	0.00	0.0	11.8	
1	EC7(NL)-Step 6.5	0.0	0.00	0.00	0.0	11.8	
1	EC7(NL)-Step 6.5 x 1.000		0.00	0.00			
2	EC7(NL)-Step 6.1		-33.61	31.55	0.0	48.1	
2	EC7(NL)-Step 6.2		-32.86	31.13	0.0	48.0	
2	EC7(NL)-Step 6.3		-34.32	32.62	0.0	47.2	
2	EC7(NL)-Step 6.4		-33.52	32.16	0.0	47.1	
2	EC7(NL)-Step 6.5	6.2	-27.28	26.40	0.0	26.7	
2	EC7(NL)-Step 6.5 x 1.200		-32.74	31.68			
3	EC7(NL)-Step 6.1		-43.22	32.33	0.0	53.0	
3	EC7(NL)-Step 6.2		-43.12	32.22	0.0	53.0	
3	EC7(NL)-Step 6.3		-43.40	32.97	0.0	51.6	
3	EC7(NL)-Step 6.4		-43.30	32.85	0.0	51.6	
3	EC7(NL)-Step 6.5	7.9	-27.55	-18.44	0.0	31.7	
3	EC7(NL)-Step 6.5 x 1.200		-33.06	-22.13			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		**-54.65**	39.81	0.0	**68.5**	
4	EC7(NL)-Step 6.4		**-54.65**	**39.84**	0.0	68.4	
4	EC7(NL)-Step 6.5	**9.1**	-29.17	-19.78	0.0	40.5	
4	EC7(NL)-Step 6.5 x 1.200		-35.01	-23.73			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		-17.19	-13.89	0.0	49.0	
5	EC7(NL)-Step 6.4		-18.31	-14.79	0.0	48.9	
5	EC7(NL)-Step 6.5	5.6	-14.20	-13.60	0.0	34.6	
5	EC7(NL)-Step 6.5 x 1.200		-17.04	-16.32			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		-32.04	26.60	0.0	64.4	
6	EC7(NL)-Step 6.4		-32.03	26.63	0.0	64.4	
6	EC7(NL)-Step 6.5	6.0	-28.24	23.05	0.0	44.5	
6	EC7(NL)-Step 6.5 x 1.200		-33.89	27.66			
Max		**9.1**	**-54.65**	**39.84**	**0.0**	**68.5**	

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Overall Stability per Stage

Stage name	Stability factor [-]
B - Aanbrengen damwand	10000.00
Terreinbelasting actief	1.97
Hoog water	2.46
Hoog water (1)	2.17
Val na MHW	5.34
+ terreinbelasting	1.67

2.3 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	No
Number of construction stages	6
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	6.40 m
Level top side	22.40 m
Number of sections	1

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 18 -700 (S3...	16.00	22.40	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 18 -700 (S3...	7.9380E+04	1.00	7.9380E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 18 -700 (S3...	639.00	1.00	1.00	1.00	639.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: B - Aanbrengen damwand
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000

Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Verification of stage	2: Terreinbelasting actief
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	3: Hoog water
Used partial factor set	RC 2

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	4: Hoog water (1)
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined

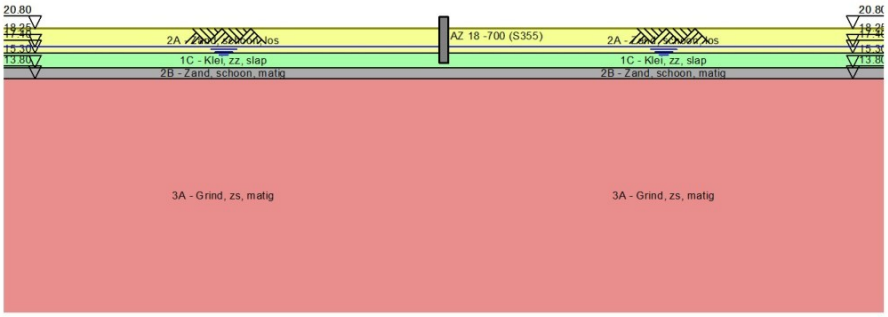
- Factor on unit weight soil	1.000
Verification of stage	5: Val na MHW
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	6: + terreinbelasting
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m

Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

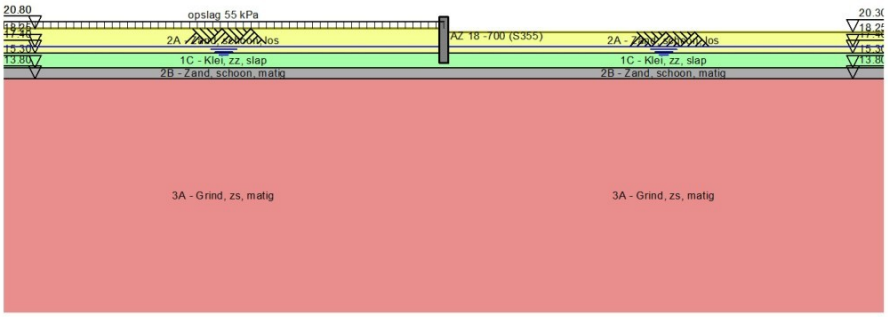
4 Outline Stage 1: B - Aanbrengen damwand

Outline - Stage 1: B - Aanbrengen damwand



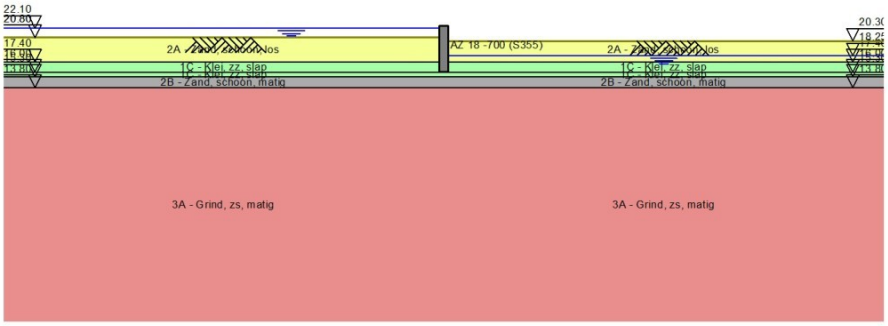
5 Outline Stage 2: Terreinbelasting actief

Outline - Stage 2: Terreinbelasting actief



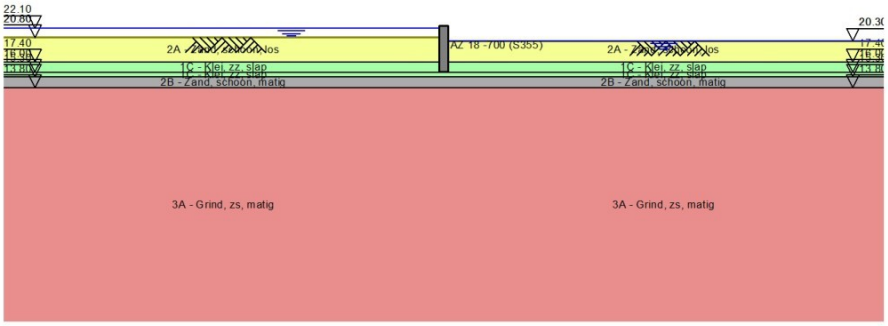
6 Outline Stage 3: Hoog water

Outline - Stage 3: Hoog water



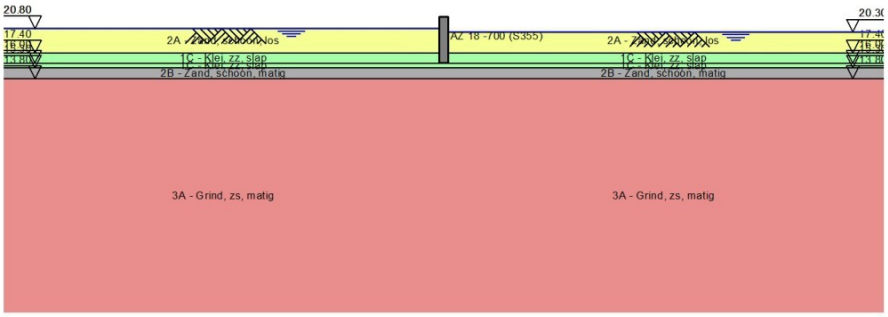
7 Outline Stage 4: Hoog water (1)

Outline - Stage 4: Hoog water (1)



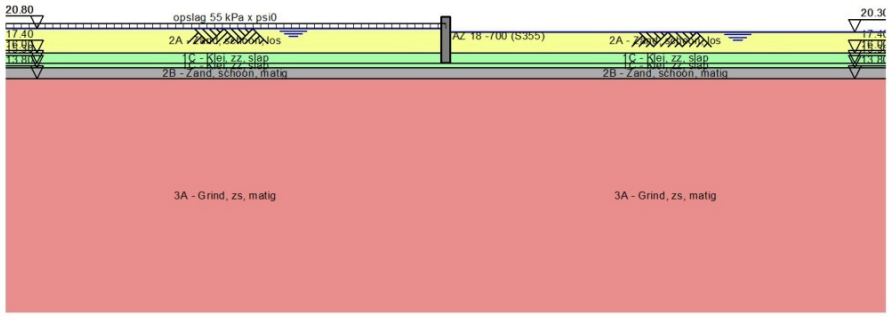
8 Outline Stage 5: Val na MHW

Outline - Stage 5: Val na MHW



9 Outline Stage 6: + terreinbelasting

Outline - Stage 6: + terreinbelasting



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	21-3-2025
Time of report:	16:02:20
Report with version:	23.1.1.40517
Date of calculation:	3-3-2025
Time of calculation:	14:05:20
Calculated with version:	23.1.1.40517
File name:	3c_Kerende_wand
Project identification:	Kaden Alexanderhaven Roermond Toetsingsberekening kade Willem-Alexander

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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2 Summary

2.1 Overview per Stage and Test

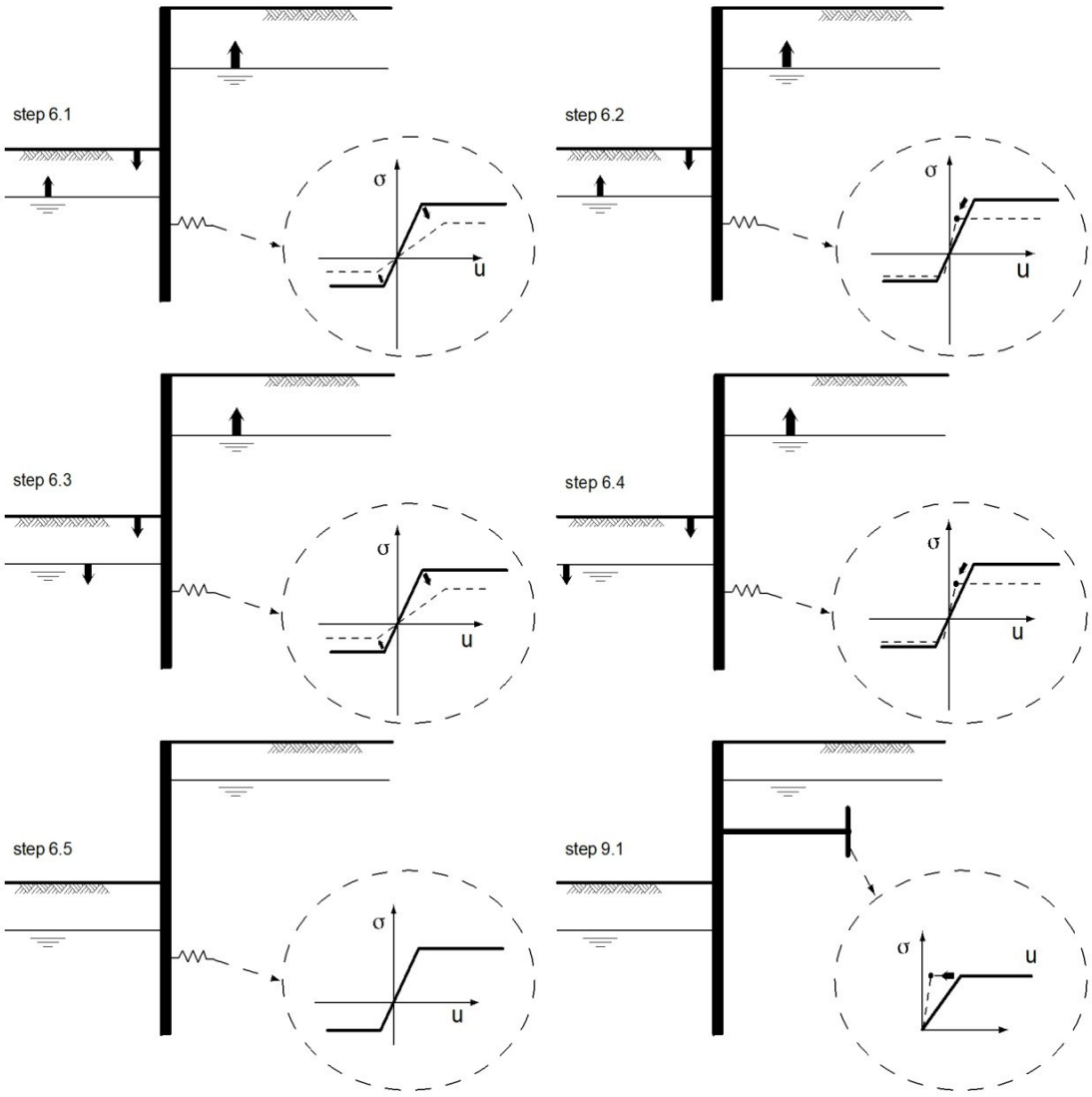
Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		0.00	0.00	0.0	11.4	
1	EC7(NL)-Step 6.2		0.00	0.00	0.0	11.4	
1	EC7(NL)-Step 6.3		0.00	0.00	0.0	11.4	
1	EC7(NL)-Step 6.4		0.00	0.00	0.0	11.4	
1	EC7(NL)-Step 6.5	0.0	0.00	0.00	0.0	11.4	
1	EC7(NL)-Step 6.5 x 1.000		0.00	0.00			
2	EC7(NL)-Step 6.1		86.93	-50.15	0.0	45.0	
2	EC7(NL)-Step 6.2		86.14	-51.96	0.0	45.0	
2	EC7(NL)-Step 6.3		86.86	-51.90	0.0	44.2	
2	EC7(NL)-Step 6.4		86.07	-53.59	0.0	44.3	
2	EC7(NL)-Step 6.5	-9.2	46.28	-49.50	0.0	26.1	
2	EC7(NL)-Step 6.5 x 1.200		55.54	-59.40			
3	EC7(NL)-Step 6.1						(D)*
3	EC7(NL)-Step 6.2						(D)*
3	EC7(NL)-Step 6.3		41.67	22.23	0.0	37.6	
3	EC7(NL)-Step 6.4		36.34	-20.12	0.0	37.5	
3	EC7(NL)-Step 6.5	-8.2	38.79	24.14	0.0	25.6	
3	EC7(NL)-Step 6.5 x 1.200		46.55	28.97			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		46.09	25.57	0.0	45.3	
4	EC7(NL)-Step 6.4		46.08	25.57	0.0	45.3	
4	EC7(NL)-Step 6.5	-9.0	36.34	23.40	0.0	31.4	
4	EC7(NL)-Step 6.5 x 1.200		43.61	28.08			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		**151.10**	**-138.95**	0.0	**89.2**	
5	EC7(NL)-Step 6.4		**151.10**	**-138.95**	0.0	**89.2**	
5	EC7(NL)-Step 6.5	**-24.6**	66.66	-40.97	0.0	40.3	
5	EC7(NL)-Step 6.5 x 1.200		79.99	-49.16			
Max		**-24.6**	**151.10**	**-138.95**	**0.0**	**89.2**	

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Overall Stability per Stage

Stage name	Stability factor [-]
Aanbrengen damwand	10000.00
Terreinbelasting actief	2.31
Hoog water - lang	6.93
Val na MHW	2.99
+ terreinbelasting	1.80

2.3 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	No
Number of construction stages	5
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	8.40 m
Level top side	22.40 m
Number of sections	1

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 18 -700 (S3...	14.00	22.40	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 18 -700 (S3...	7.9380E+04	1.00	7.9380E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 18 -700 (S3...	639.00	1.00	1.00	1.00	639.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: Aanbrengen damwand
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000

Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Verification of stage	2: Terreinbelasting actief
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	3: Hoog water - lang
Used partial factor set	RC 2

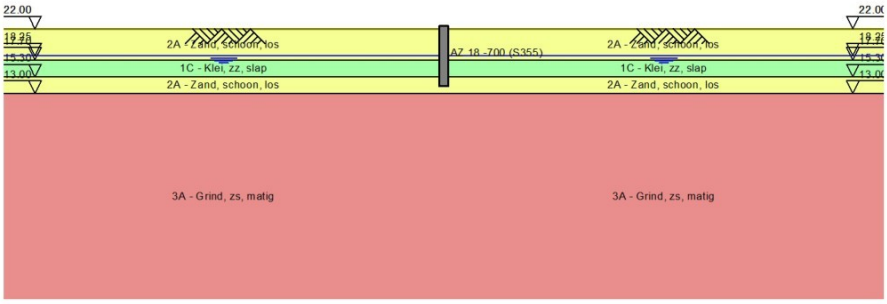
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	4: Val na MHW
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined

- Factor on unit weight soil	1.000
Verification of stage	5: + terreinbelasting
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

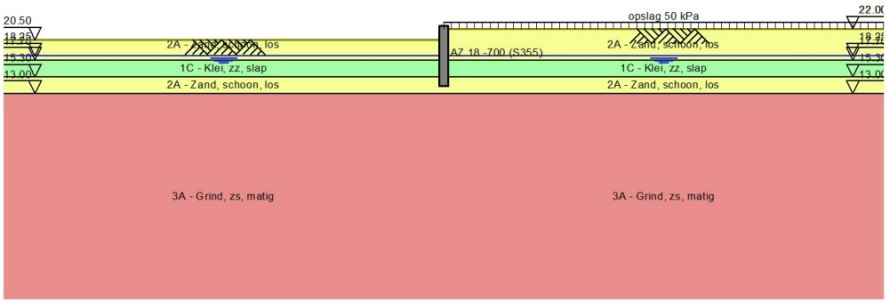
4 Outline Stage 1: Aanbrengen damwand

Outline - Stage 1: Aanbrengen damwand



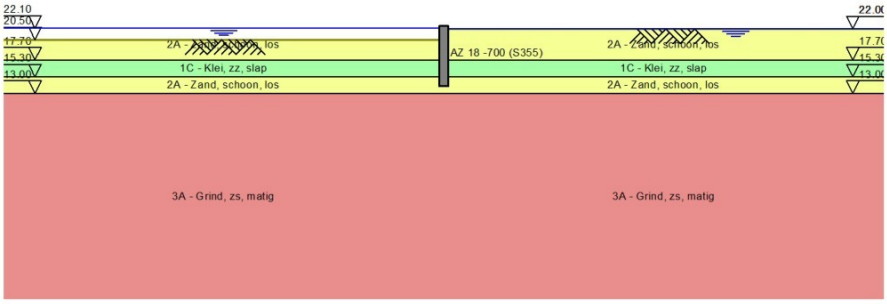
5 Outline Stage 2: Terreinbelasting actief

Outline - Stage 2: Terreinbelasting actief



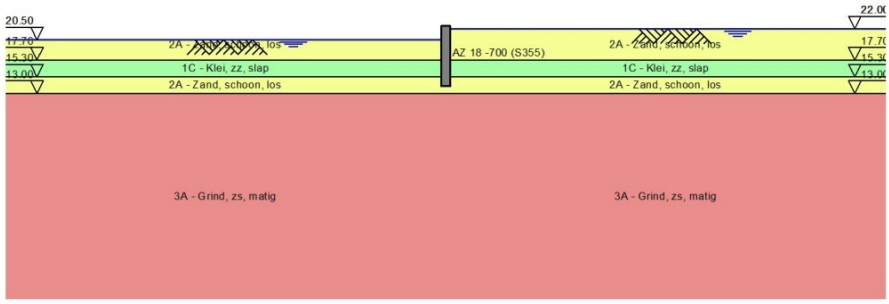
6 Outline Stage 3: Hoog water - lang

Outline - Stage 3: Hoog water - lang



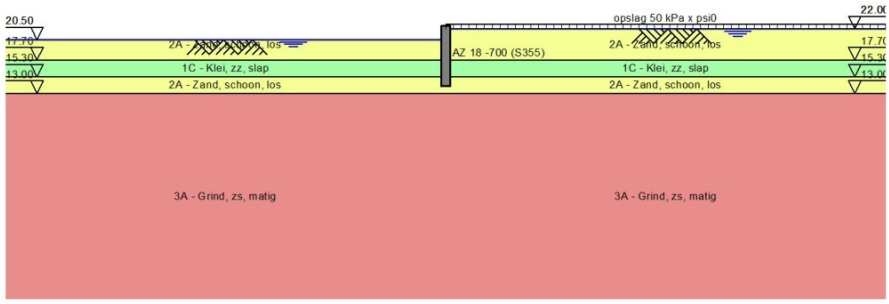
7 Outline Stage 4: Val na MHW

Outline - Stage 4: Val na MHW



8 Outline Stage 5: + terreinbelasting

Outline - Stage 5: + terreinbelasting



End of Report

Report for D-Sheet Piling 23.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares

Date of report:	21-3-2025
Time of report:	16:03:52
Report with version:	23.1.1.40517
Date of calculation:	3-3-2025
Time of calculation:	14:21:27
Calculated with version:	23.1.1.40517
File name:	3d_Kerende_wand
Project identification:	Kaden Alexanderhaven Roermond Toetsingsberekening kade Willem-Alexander

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

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8 Outline Stage 5: Val na MHW 14
9 Outline Stage 6: + terreinbelasting 15

2 Summary

2.1 Overview per Stage and Test

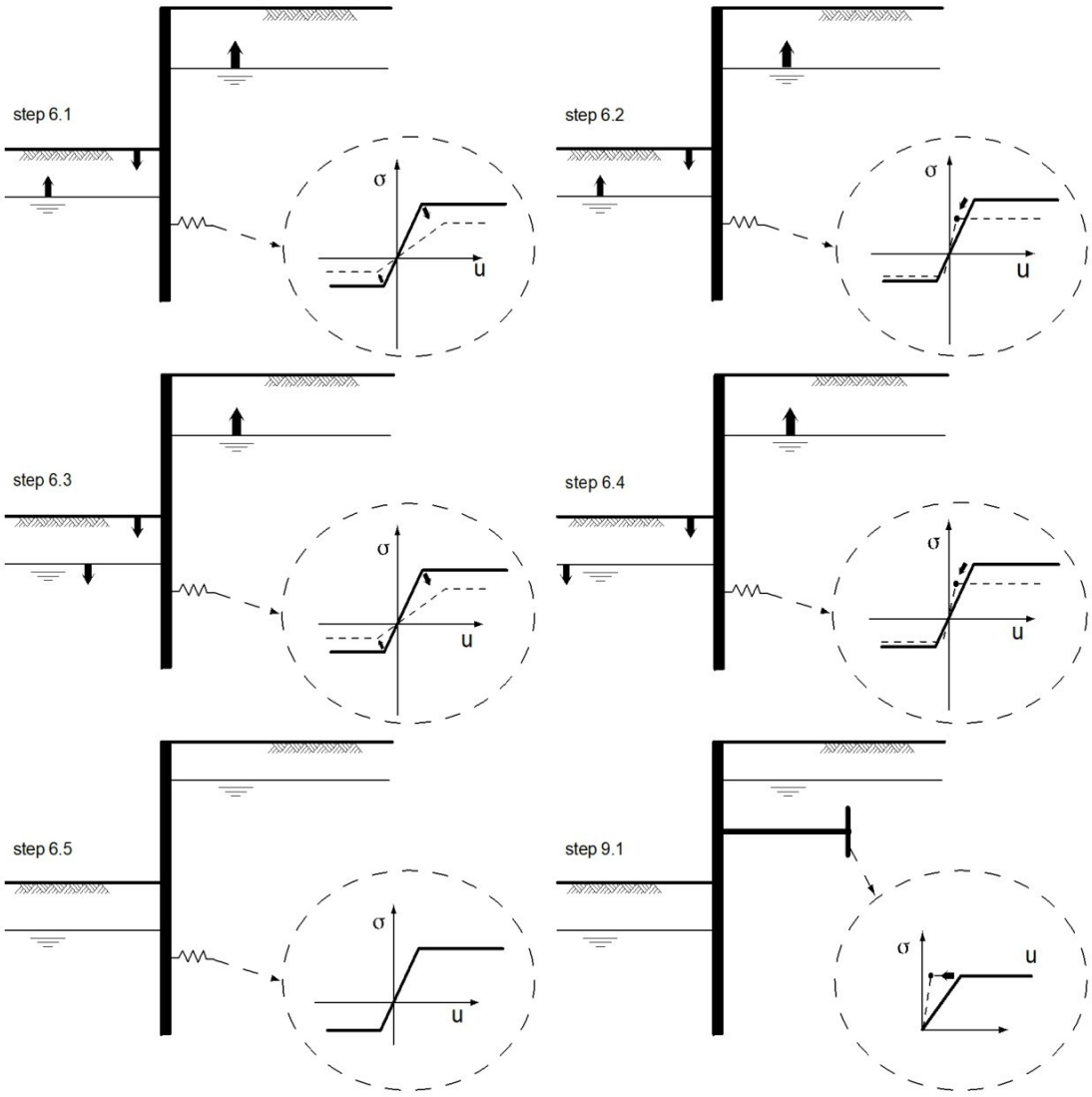
Stage nr.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Status
1	EC7(NL)-Step 6.1		0.00	0.00	0.0	10.1	
1	EC7(NL)-Step 6.2		0.00	0.00	0.0	10.1	
1	EC7(NL)-Step 6.3		0.00	0.00	0.0	10.1	
1	EC7(NL)-Step 6.4		0.00	0.00	0.0	10.1	
1	EC7(NL)-Step 6.5	0.0	0.00	0.00	0.0	10.1	
1	EC7(NL)-Step 6.5 x 1.000		0.00	0.00			
2	EC7(NL)-Step 6.1		-163.59	103.44	0.0	35.8	
2	EC7(NL)-Step 6.2		-125.78	78.64	0.0	34.4	
2	EC7(NL)-Step 6.3		-165.43	104.08	0.0	34.8	
2	EC7(NL)-Step 6.4		-125.65	78.22	0.0	33.6	
2	EC7(NL)-Step 6.5	18.9	-66.42	-57.41	0.0	22.3	
2	EC7(NL)-Step 6.5 x 1.200		-79.70	-68.90			
3	EC7(NL)-Step 6.1						(D)*
3	EC7(NL)-Step 6.2						(D)*
3	EC7(NL)-Step 6.3		-68.56	-33.12	0.0	21.5	
3	EC7(NL)-Step 6.4		-54.05	-26.30	0.0	21.5	
3	EC7(NL)-Step 6.5	17.1	-75.55	-40.04	0.0	16.0	
3	EC7(NL)-Step 6.5 x 1.200		-90.66	-48.05			
4	EC7(NL)-Step 6.1						(D)*
4	EC7(NL)-Step 6.2						(D)*
4	EC7(NL)-Step 6.3		-56.21	-31.59	0.0	26.2	
4	EC7(NL)-Step 6.4		-56.75	-31.87	0.0	26.2	
4	EC7(NL)-Step 6.5	18.3	-61.39	-33.85	0.0	20.1	
4	EC7(NL)-Step 6.5 x 1.200		-73.67	-40.61			
5	EC7(NL)-Step 6.1						(D)*
5	EC7(NL)-Step 6.2						(D)*
5	EC7(NL)-Step 6.3		-103.21	63.67	0.0	33.6	
5	EC7(NL)-Step 6.4		-91.47	55.81	0.0	33.1	
5	EC7(NL)-Step 6.5	20.2	-53.17	-30.82	0.0	24.7	
5	EC7(NL)-Step 6.5 x 1.200		-63.80	-36.98			
6	EC7(NL)-Step 6.1						(D)*
6	EC7(NL)-Step 6.2						(D)*
6	EC7(NL)-Step 6.3		**-313.66**	**216.68**	0.0	**68.4**	
6	EC7(NL)-Step 6.4		-311.94	213.73	0.0	67.9	
6	EC7(NL)-Step 6.5	**52.9**	-136.29	84.97	0.0	33.4	
6	EC7(NL)-Step 6.5 x 1.200		-163.55	101.97			
Max		**52.9**	**-313.66**	**216.68**	**0.0**	**68.4**	

*(A) Calculation numerically unstable, (B) Error found during calculation, (C) No convergence of probabilistic calculation, (D) In case of free water level on passive side, a low water level is the most unfavourable, so steps 6.1 and 6.2 are omitted.

2.2 Overall Stability per Stage

Stage name	Stability factor [-]
Bestaande toestand	10000.00
Terreinbelasting actief	2.93
Hoog water - kort	23.25
Hoog water - lang	9.34
Val na MHW	4.06
+ terreinbelasting	2.27

2.3 CUR Verification Steps



3 Input Data for all Stages

3.1 General Input Data

Verification according to National Annex of Eurocode 7 in the Netherlands (NEN 9997-1:2016)

Model	Sheet piling
Check vertical balance	No
Number of construction stages	6
Unit weight of water	9.81 kN/m³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	9.80 m
Level top side	22.30 m
Number of sections	1

3.2.1 General Properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 18 -700 (S3...	12.50	22.30	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm²/m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm²]	Note to reduction factor
AZ 18 -700 (S3...	7.9380E+04	1.00	7.9380E+04	

3.2.3 Maximum Allowable Moments

Section name	Mr;char;el [kNm/m']	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
AZ 18 -700 (S3...	639.00	1.00	1.00	1.00	639.00

3.3 Calculation Options

First stage represents initial situation	Yes
Calculation refinement	Fine
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verified stage only. Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	1: Bestaande toestand
Used partial factor set	RC 0 RC0 is added for simple constructions. To be compared with CUR class I
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000

Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.000
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.000
- Tangent phi	1.000 User defined
- Delta (wall friction angle)*	1.000 User defined
- Modulus of low representative subgrade reaction	1.000 User defined
Geometry modification	
- Increase retaining height	0.00 % User defined
- Maximum increase retaining height	0.00 m User defined
- Reduction in phreatic line on passive side**	0.00 m User defined
- Raise in phreatic line on active side	0.00 m User defined
Factors on representative values	
- Partial factor on M, D and Pmax	1.000 User defined
Overall stability factors	
- Cohesion	1.000 User defined
- Tangent phi	1.000 User defined
- Factor on unit weight soil	1.000
Verification of stage	2: Terreinbelasting actief
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	3: Hoog water - kort
Used partial factor set	RC 2

Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	4: Hoog water - lang
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined

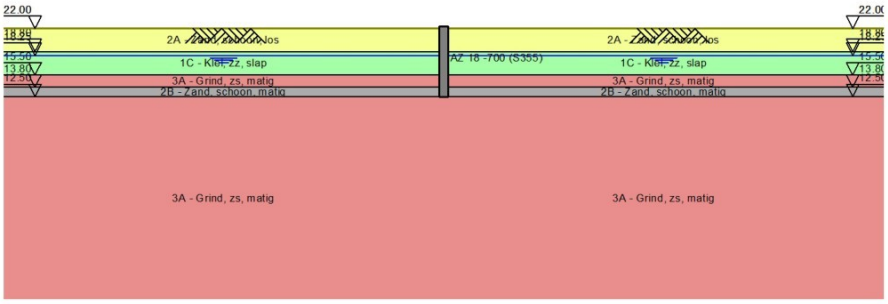
- Factor on unit weight soil	1.000
Verification of stage	5: Val na MHW
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m
Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000
Verification of stage	6: + terreinbelasting
Used partial factor set	RC 2
Factors on loads - Geotechnical loads	
- Permanent load, unfavourable	1.000
- Permanent load, favourable	1.000
- Variable load, unfavourable	1.100
- Variable load, favourable	0.000
Factors on loads - Constructive loads	
- Permanent load, unfavourable	1.350
- Permanent load, favourable	0.900
- Variable load, unfavourable	1.300 User defined
- Variable load, favourable	0.000
Material factors	
- Cohesion	1.288 User defined
- Tangent phi	1.199 User defined
- Delta (wall friction angle)*	1.199 User defined
- Modulus of low representative subgrade reaction	1.326 User defined
Geometry modification	
- Increase retaining height	10.00 %
- Maximum increase retaining height	0.50 m
- Reduction in phreatic line on passive side**	0.25 m
- Raise in phreatic line on passive side**	0.25 m
- Raise in phreatic line on active side	0.05 m

Factors on representative values	
- Partial factor on M, D and Pmax	1.200
Overall stability factors	
- Cohesion	1.494 User defined
- Tangent phi	1.275 User defined
- Factor on unit weight soil	1.000

* For delta (wall friction angle), the input value of tangent phi is used
** This modification of the phreatic level does not apply when the sheet piling is completely submerged.

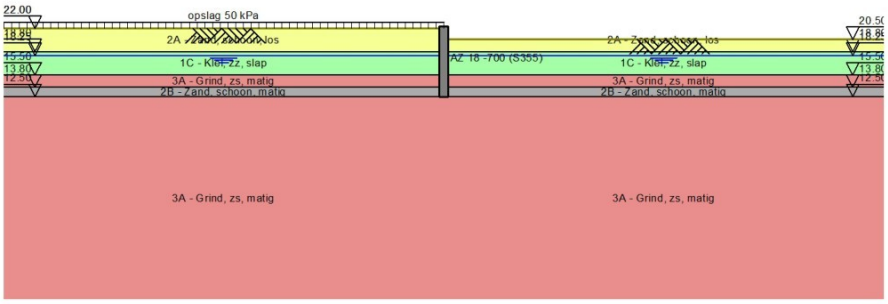
4 Outline Stage 1: Bestaande toestand

Outline - Stage 1: Bestaande toestand



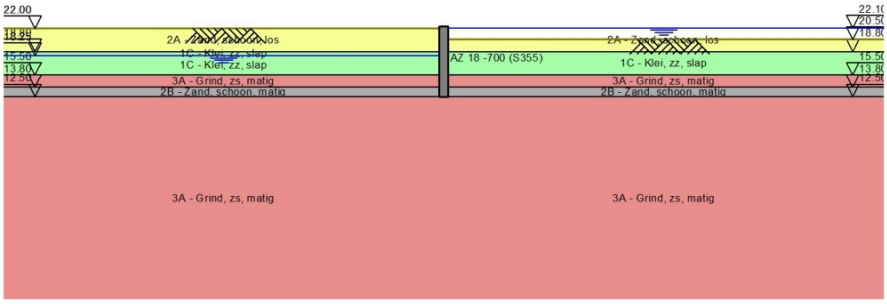
5 Outline Stage 2: Terreinbelasting actief

Outline - Stage 2: Terreinbelasting actief



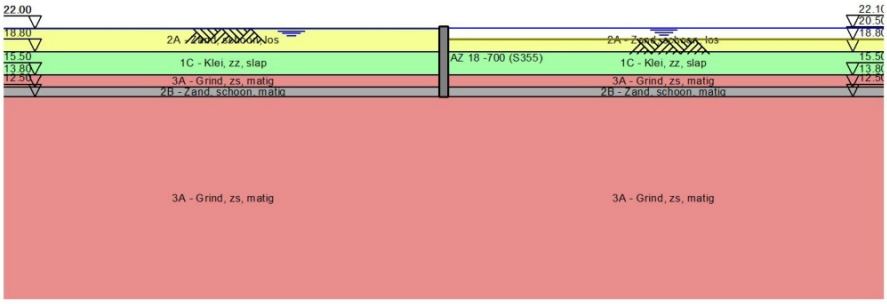
6 Outline Stage 3: Hoog water - kort

Outline - Stage 3: Hoog water - kort



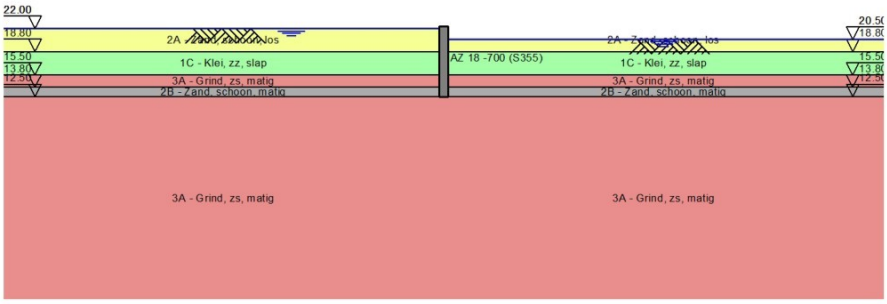
7 Outline Stage 4: Hoog water - lang

Outline - Stage 4: Hoog water - lang



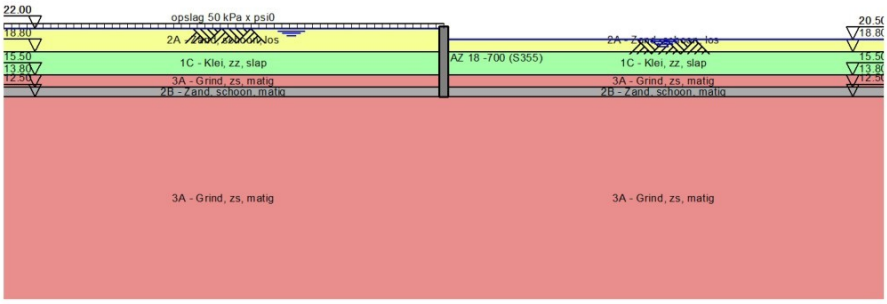
8 Outline Stage 5: Val na MHW

Outline - Stage 5: Val na MHW



9 Outline Stage 6: + terreinbelasting

Outline - Stage 6: + terreinbelasting



End of Report