

A1 Rijnkade gevoeligheidsanalyse incl. bijlagen

Notitie / Memo

HaskoningDHV Nederland B.V.

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Inleiding

Het VKA-rapport 'Geotechnische uitwerking van de bouwstenen' voorziet in een keerwand op buispalen (alternatief IV voor constructietype 1). Een belangrijk voordeel van dit systeem is dat het relatief minder gevoelig is voor (naar verwachting aanwezige) onbekende obstakels in de ondergrond in vergelijking met andere alternatieven.

Er is een verkennende berekening uitgevoerd in de VKA-fase. Hierbij is uitgegaan van een onverankerde wand op relatief grote diameter ($\varnothing 700$ mm) buispalen waarbij vanuit constructief en waterkerend oogpunt in eerste instantie een vrij ruim vervormingscriterium is gehanteerd van 100 mm. In deze fase was beperkt informatie beschikbaar met betrekking tot grondonderzoeksgegevens uit het archief.

Na de VKA-fase zijn meer grondgegevens uit het archief beschikbaar gekomen en zijn de vervormingscriteria nader beschouwd. In deze notitie zijn de aanvullende grondonderzoeksresultaten beschreven en wordt de invloed van de aanvullende informatie op de oorspronkelijke berekening toegelicht. Op basis hiervan zijn conclusies en aanbevelingen geformuleerd.

Ontwerp VKA-fase

De verkennende berekening in de VKA-fase gaat uit van een grondopbouw waarbij vanaf maaiveldniveau van de hoge kade (circa NAP +14 m) antropogene grond (los zand, klei- en puinhoudend) aanwezig is tot circa NAP +9 m. Tussen NAP +9 en NAP +7 m is zwak zandige, matig vaste klei geschematiseerd. Vanaf een niveau van NAP +7m en hieronder is matig vast zand aangehouden.

Het berekeningsresultaat leidt tot een berekende horizontale vervorming van 107 à 116 mm. Er is ingeschat dat de berekende vervormingen nog net acceptabel zijn (voldoen aan het gestelde criterium van 100 mm) aangezien de belastingen enigszins conservatief zijn aangehouden. Een deel van de berekende vervorming zal optreden tijdens de gebruiksfase van de hoge kade, naar verwachting met name tijdens de eerste hoogwater situaties na realisatie.

Grondonderzoeksgegevens uit archief

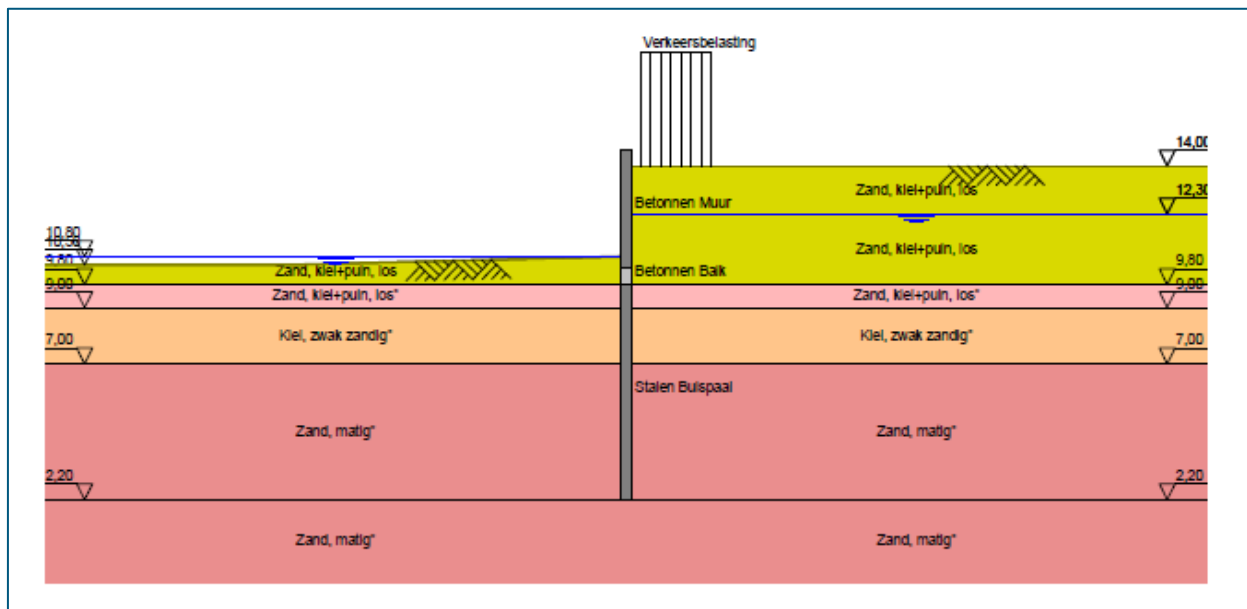
In de planuitwerkingsfase na het VKA zijn aanvullende grondonderzoeksgegevens ontvangen. Een overzicht van deze gegevens (eerste concept) is gegeven in bijlage A.

Het overzicht in bijlage A laat zien dat de grondopbouw grillig is, bestaande uit zandlagen met sterk wisselende dichtheid en (zandige) kleilagen. Enkele sonderingen die qua grondopbouw ongunstig zijn, zijn rood omcirkeld. De grondopbouw op deze locaties is ongunstiger dan wat is aangehouden in de VKA-fase.

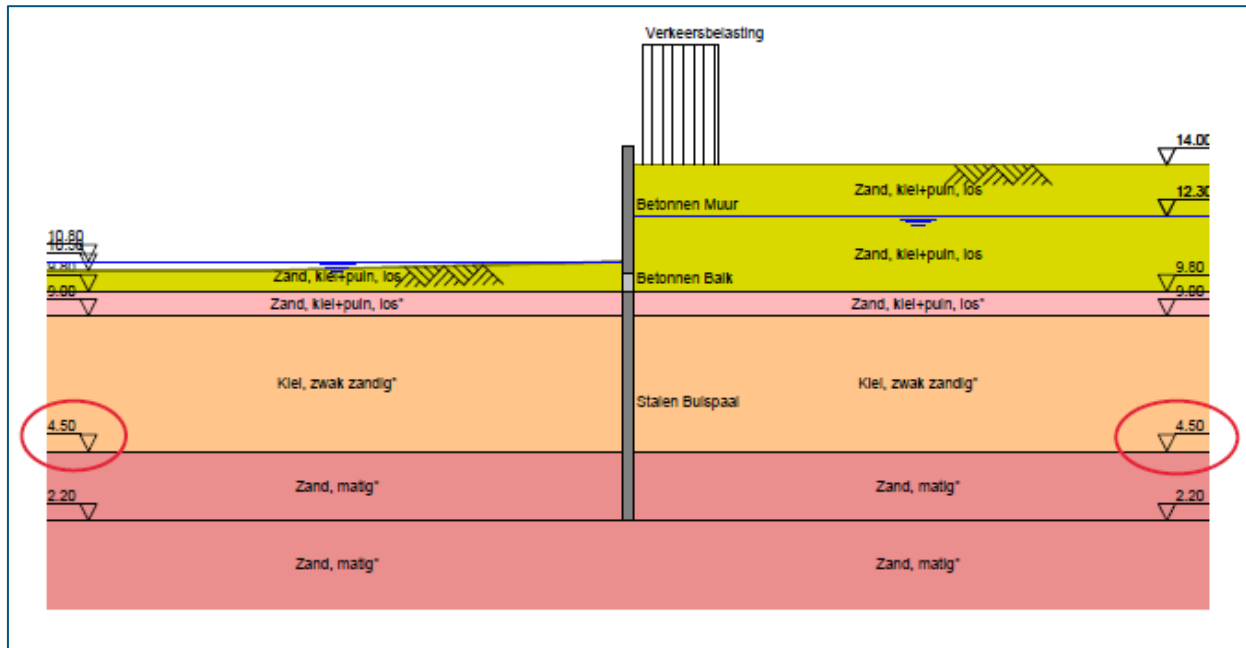
Om de invloed hiervan op het ontwerp in te schatten is een gevoeligheidsanalyse uitgevoerd.

Gevoeligheidsanalyse

Ten behoeve van een indicatie van de gevoeligheid is de VKA-berekening als uitgangspunt genomen en is hierin de grondopbouw aangepast conform de rood omcirkelde sonderingen in bijlage A. De bovenzijde van het matig vaste zand is hierbij verlaagd van NAP +7,0 m naar NAP +4,5 m zoals aangegeven in Figuur 1 en Figuur 2.



Figuur 1 VKA-berekeningsopzet



Figuur 2 Aangepaste berekeningsopzet, onderzijde zwak zandig klei aangepast van NAP +7,0 m naar NAP +4,5 m

De berekeningsresultaten zijn toegevoegd in bijlage B. De aangepaste berekening resulteert in een berekende vervorming van circa 165 mm à 174 mm. Dit is een toename van de vervorming van ruim 50%. Daarnaast voldoet de berekende veiligheid niet meer aan het niveau zoals aangehouden in het VKA.

In geval van eventuele toekomstige ontgravingen ter plaatse van de lage kade ten gevolge van bijvoorbeeld onderhoudswerkzaamheden of een calamiteit (leidingbreuk) neemt de rekentechnische vervorming verder toe. Alle vervormingen zijn grotendeels onomkeerbaar.

Een onverankerde constructie is tevens gevoelig voor eventuele toekomstige trillingen (bijvoorbeeld de vervanging van het resterende deel van de lage kade).

Conclusie en aanbeveling

De gevoeligheidsanalyse toont dat ter plaatse van een minder goede grondopbouw de hoge kade horizontaal kan vervormen tot meer dan 150 mm en dat de berekende veiligheid bij aangepaste grondopbouw niet meer voldoet aan het niveau zoals aangehouden in het VKA.

Een ontwerp dat in een dergelijk grote vervorming voorziet wordt afgeraden aangezien:

1. een aanzienlijk deel van de vervorming kan optreden na oplevering van de constructie en
2. over een aanzienlijke lengte interactie met de lage kade plaatsvindt welke hier niet op is ontworpen.

Ad 1) Vervorming na oplevering is reëel aangezien in de gebruiksfase herhaaldelijke bovenbelasting aanwezig is waardoor herhaaldelijk extra belasting op de wand optreedt en de constructie kan kruipen. Daarnaast treedt de maatgevende belastings- en draagkrachtcombinatie op bij (val na) hoge waterstanden waarbij de lage kade onder water loopt of extreem hoge waterstanden die WBN benaderen. Dit gebeurt na de oplevering herhaaldelijk tijdens de levensduur. Per hoogwaterperiode kan de kade verder uitbuigen. Andere omgevingseffecten zoals trillingen of

tijdelijke ontgravingen ter plaatse van de lage kade dragen ook bij aan een toename van de vervorming van de hoge kade tijdens de levensduur.

Vervorming tijdens de levensduur leidt rekentechnisch niet direct tot bezwijken van de hoge kade, maar vanuit onderhoudstechnisch (schade aan bestrating en inrichtingselementen), bestuurstechnisch en esthetisch oogpunt (ongelijkmatige vervorming) wordt dit niet wenselijk geacht en wordt dit afgeraden.

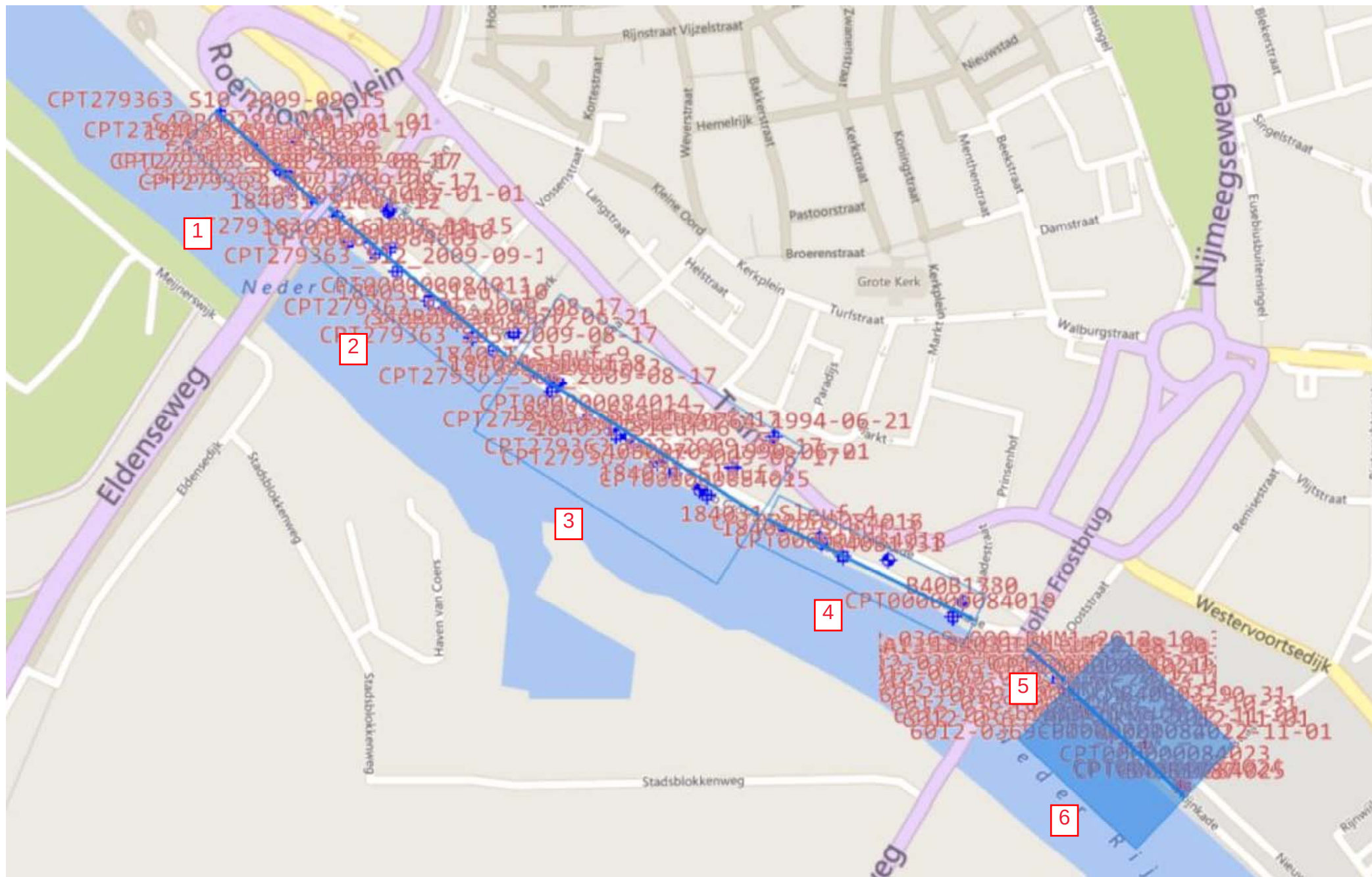
- Ad 2) Over een aanzienlijk deel van de hoge kade beïnvloeden de spanningen die worden geïntroduceerd door de nieuwe hoge kade het invloedsgebied van de lage kade. Krachtsafdracht van de hoge kade naar de lage kade dient te worden vermeden omdat de lage kade hier niet op is ontworpen. Relatief grote vervormingen van de hoge kade leiden tot relatief veel krachtsafdracht richting de lage kade, dit wordt niet wenselijk geacht en wordt afgeraden.

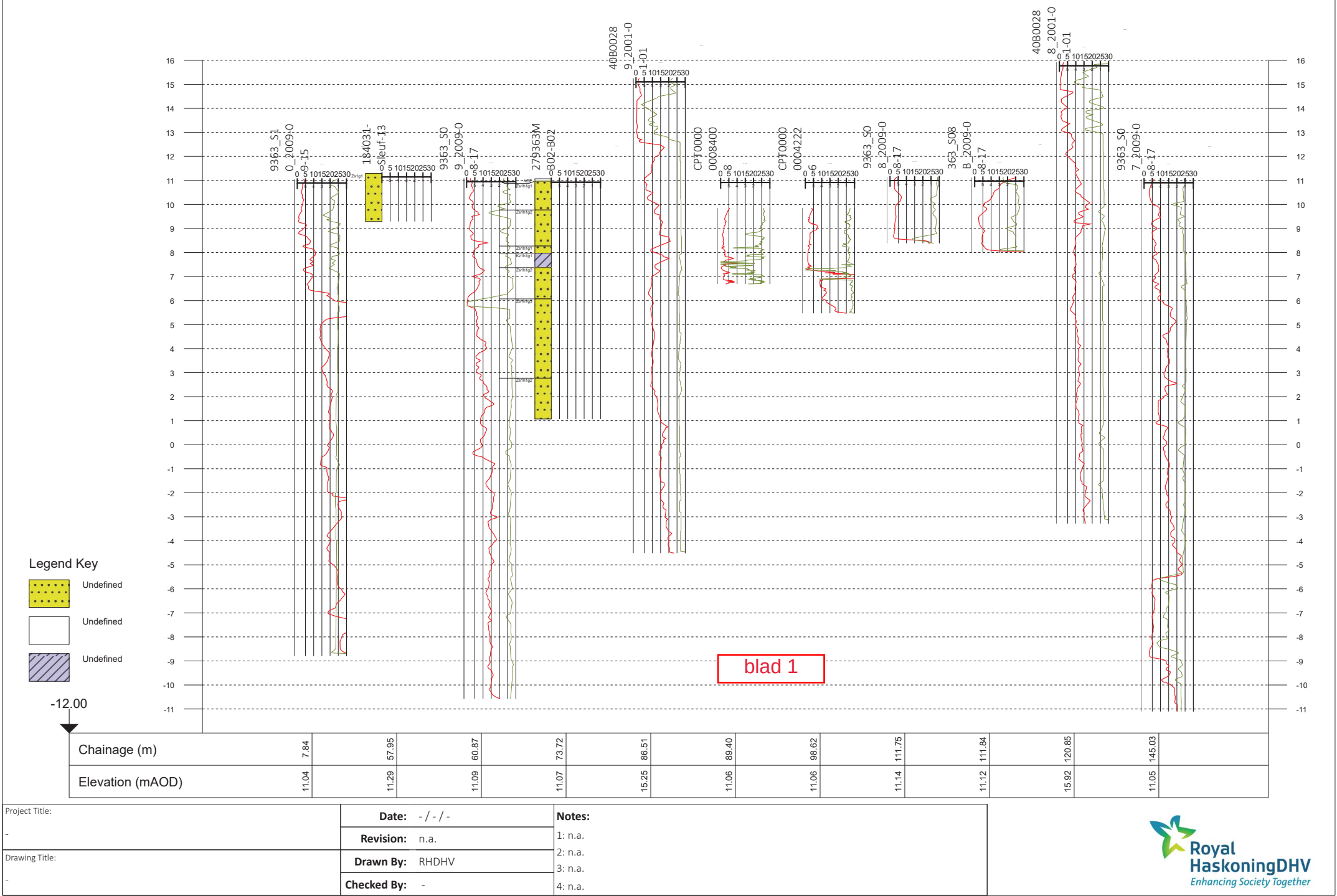
Een onverankerde constructie vervormt relatief veel ten opzichte van een verankerde constructie. Op basis van bovenstaande redenering wordt geadviseerd de constructievariant 'wand op palen' te verankeren. Bij dit concept kunnen slankere verticale (anker-)palen worden toegepast in combinatie met diagonale ankers in de richting van de bebouwing achter de hoge kade. Slankere (anker-) palen betekent ook een kleiner risico op obstakels in de ondergrond.

Het concept van de fundering (layout palen/ankers, type palen/ankers, bouwmethode...) dient nader te worden onderzocht. Hier zijn wel ideeën over, maar deze zijn nog niet uitgewerkt. Aandachtspunt is het risico op onbekende obstakels in de ondergrond. De verwachting is dat een paal- ankersysteem kan worden toegepast dat hier niet door wordt belemmerd. Een ander aandachtspunt is mogelijk de systeemgrens van de hoge kade. Afhankelijk van de helling en lengte van ankers kan mogelijk een raakvlak ontstaan met perceelsgrenzen.

BIJLAGE A

Grondonderzoeksgegevens archief





Project Title:

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Drawing Title:

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Date:

- / - / -

Revision:

n.a.

Drawn By:

RHDHV

Checked By:

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Notes:

1: n.a.

2: n.a.

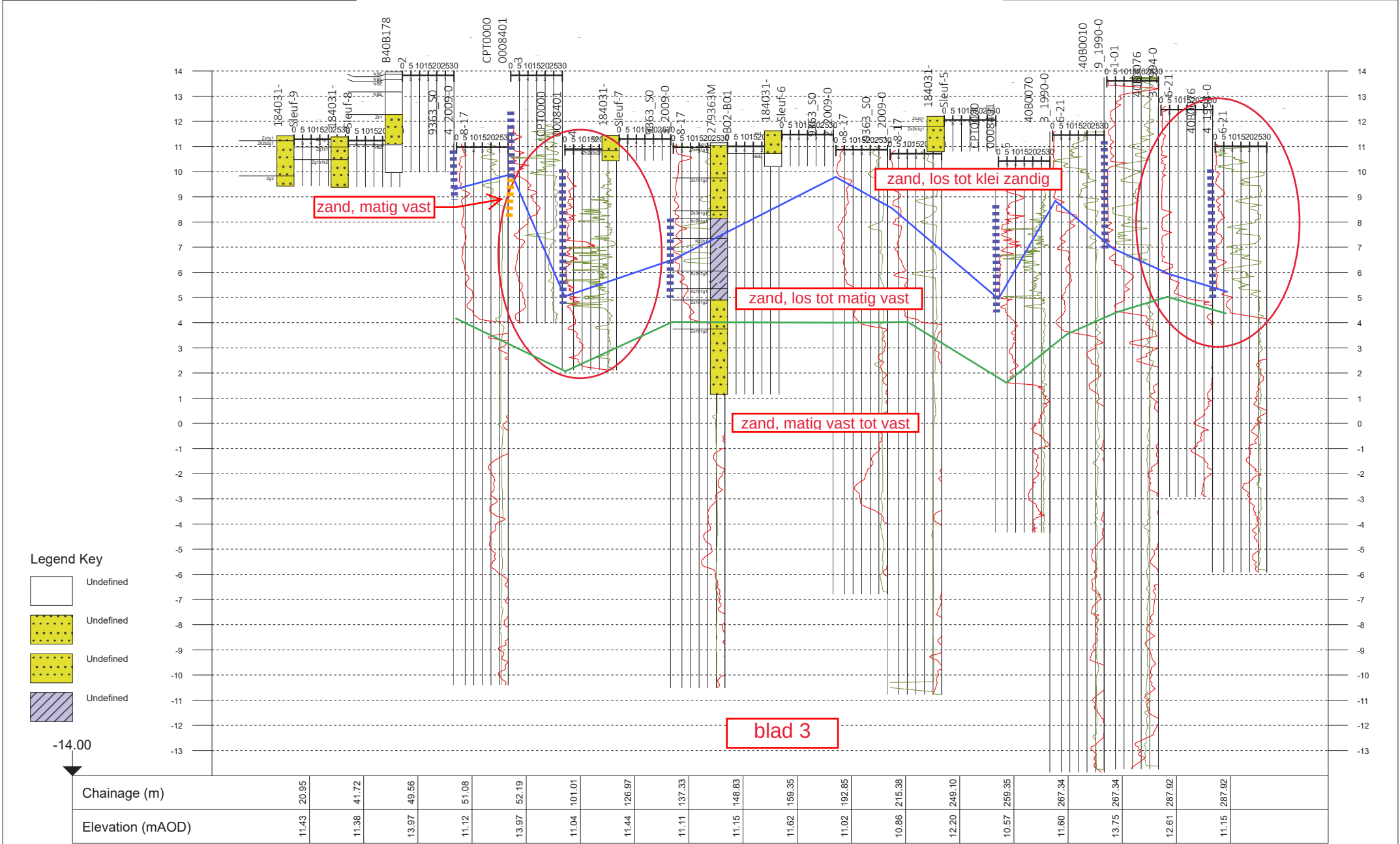
3: n.a.

4: n.a.

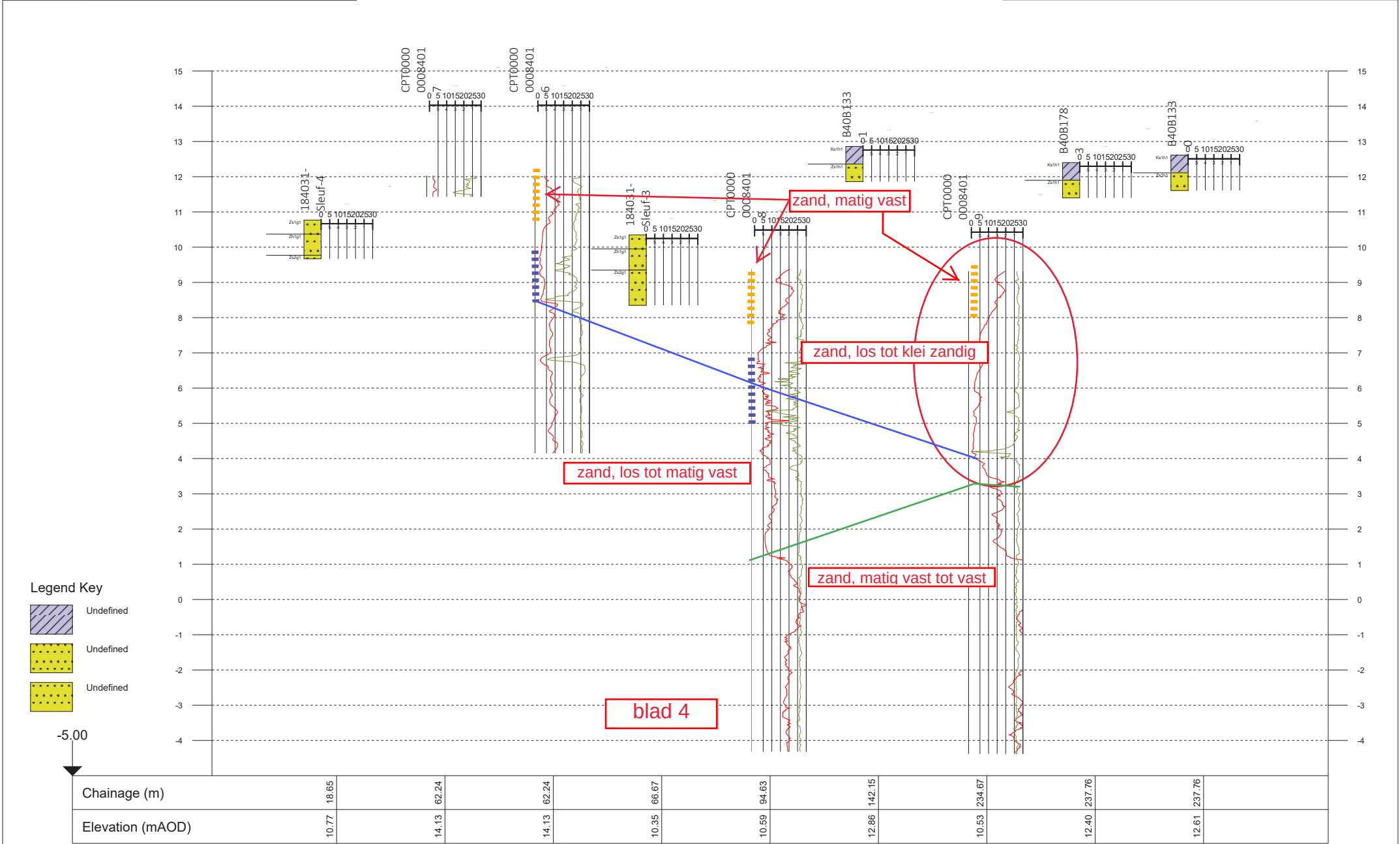
Royal HaskoningDHV

Enhancing Society Together

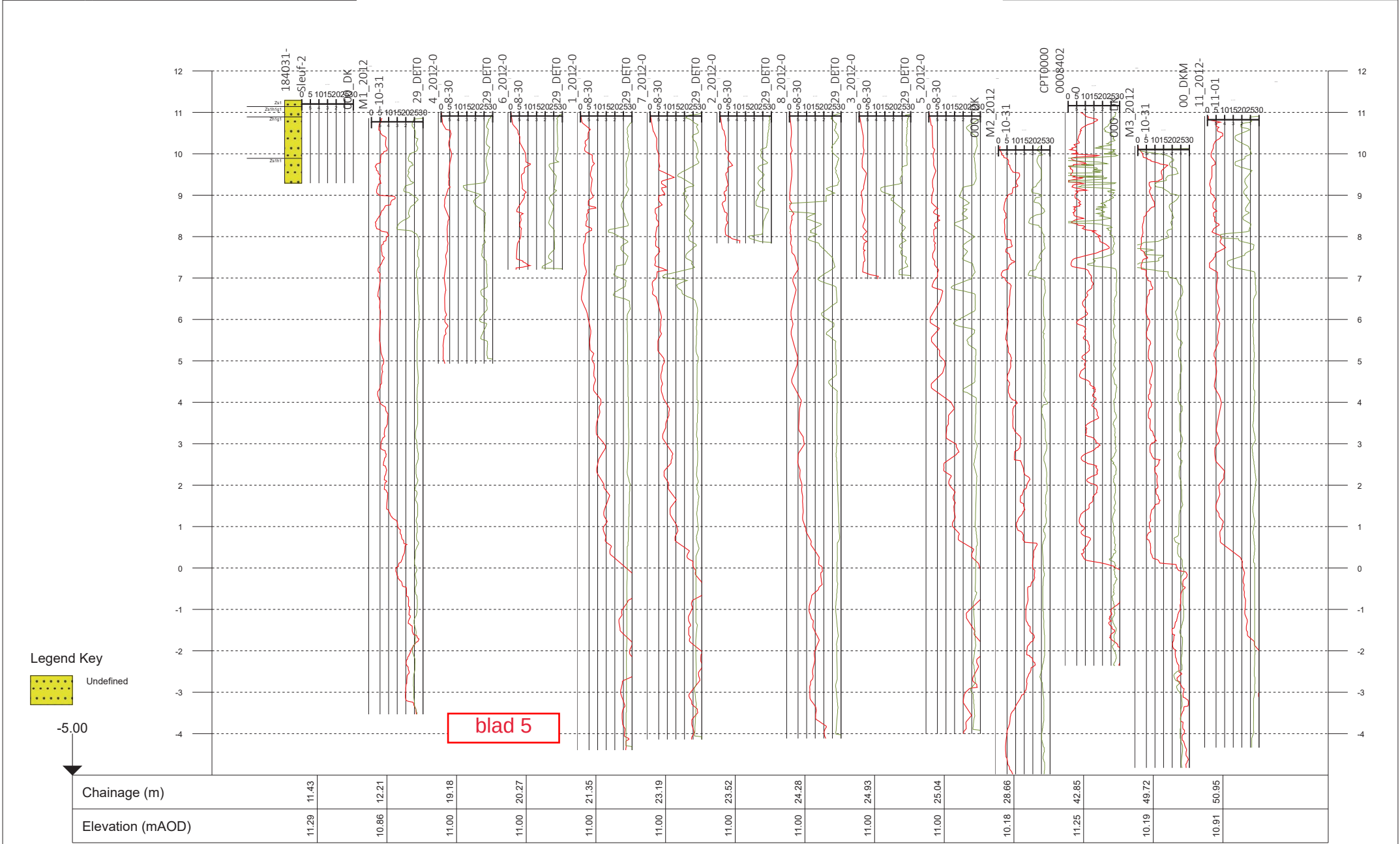




Project Title:	Date: - / - / -	Notes: 1: n.a. 2: n.a. 3: n.a. 4: n.a.
-	Revision: n.a.	
Drawing Title:	Drawn By: RHDHV	
-	Checked By: -	



Project Title:	Date: - / - / -	Notes:
-	Revision: n.a.	
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-	Revision: n.a.	
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-	Checked By: -	



BIJLAGE B
**Berekeningsresultaten VKA en gevoeligheidsanalyse met onderzijde
zandige klei op NAP +4,5 m**

Report for D-Sheet Piling 17.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 1/23/2018
Time of report: 12:21:58 PM

Date of calculation: 1/23/2018
Time of calculation: 12:19:27 PM

Filename: C:\.\Rijnkade_Vervanging Type 1_Buispaal

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	Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
1	Not verified						
2	EC7(NL)-Step 6.3		1163,97	-491,98	0,0	49,1	---
2	EC7(NL)-Step 6.4		1156,81	-483,23	0,0	48,6	---
2	EC7(NL)-Step 6.5	-106,5	665,09	-232,91	0,0	23,2	---
2	EC7(NL)-Step 6.5 * 1,20		798,11	-279,49			
Max		-106,5	1163,97	-491,98	0,0	49,1	---

2.2 Overall Stability per Stage

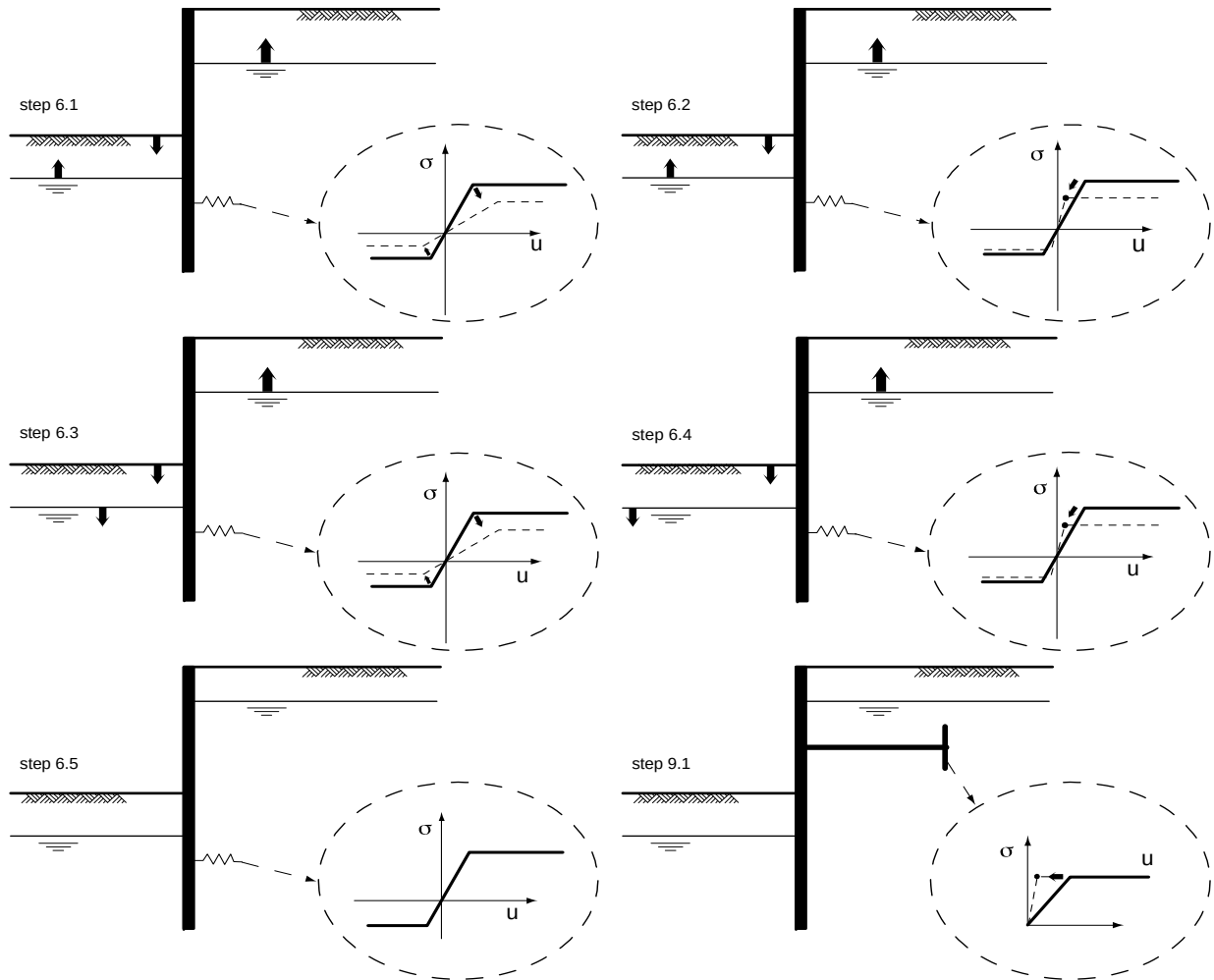
Stage name	Stability factor [-]
dH= 1.5 m	2,97

2.3 Warnings

* Vertical stability

The vertical balance cannot be calculated correctly under combined walls. It is not possible to indicate CPT resistances for both toe levels. The calculation only takes into account the lower toe resistance, the upper toe resistance is neglected.

2.4 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	2
Unit weight of water	9,81 kN/m ³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	12,40 m
Level top side	14,60 m
Number of sections	3
P _r ;max;point	0,00 MPa
Xi factor	1,39

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Acting width [m]
Betonnen Muur	10,40	14,60	Concrete	3,00
Betonnen Balk	9,80	10,40	Concrete	3,00
Stalen Buispaal	2,20	9,80	Steel	0,70

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm ² /m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
Betonnen Muur	1,1500E+05	1,00	3,4500E+05	
Betonnen Balk	9,1700E+05	1,00	2,7510E+06	
Stalen Buispaal	4,4100E+05	1,00	3,0870E+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]
Betonnen Muur	862,00	1,00	1,10	1,00	2350,92
Betonnen Balk	862,00	1,00	1,10	1,00	2350,92
Stalen Buispaal	2129,00	1,00	1,00	1,00	1490,30

3.2.4 Properties for vertical balance

Section name	From [m]	To [m]	Height [mm]	Coating area [m ² /m ² wall]	Section area [cm ² /m']
Betonnen Muur	10,40	14,60	500,00	1,47	648,00
Betonnen Balk	9,80	10,40	1000,00	2,00	600,00
Stalen Buispaal	2,20	9,80	700,00	2,00	140,00

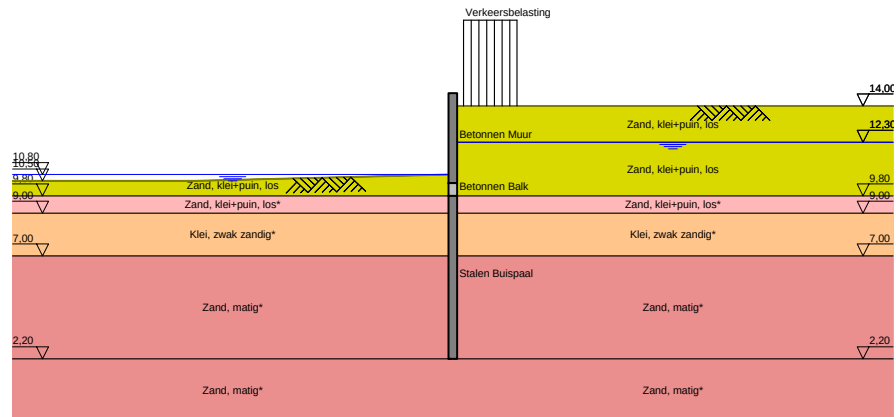
3.3 Calculation Options

First stage represents initial situation	No
Calculation refinement	Coarse
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verification

	Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.
Verification of stage	2: dH= 1.5 m
Used partial factor set	RC 3
Factors on loads	
- Permanent load, unfavourable	1,00
- Permanent load, favourable	1,00
- Variable load, unfavourable	1,25
- Variable load, favourable	0,00
Material factors	
- Cohesion	1,40
- Tangent phi	1,20
- Delta (wall friction angle)	1,20
- Modulus of low representative subgrade reaction	1,30
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
Overall stability factors	
- Cohesion	1,60
- Tangent phi	1,30
- Factor on unit weight soil	1,00
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1,20

4 Outline Stage 2: dH= 1.5 m

Outline - Stage 2: dH= 1.5 m

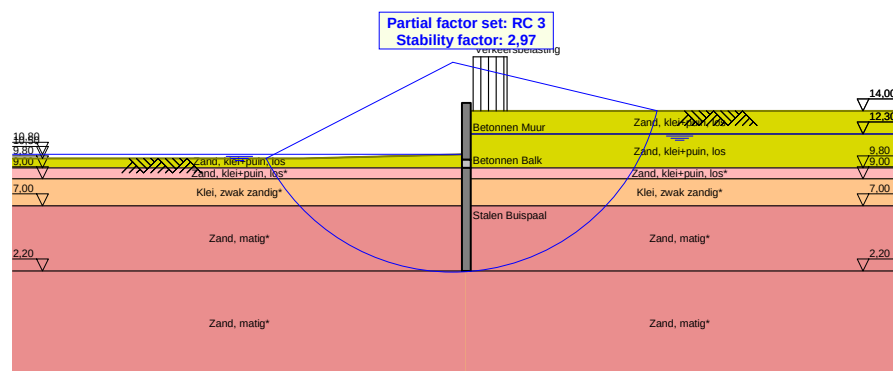


5 Overall Stability Stage 2: dH= 1.5 m

Stability factor : 2,97

5.1 Overall Stability

Overall Stability - Stage 2: dH= 1.5 m



6 Step 6.5 Stage 2: dH= 1.5 m

6.1 Input Data Left

6.1.1 Calculation Method

Calculation method: C, phi, delta

6.1.2 Water Level

Water level: 10,80 [m]

6.1.3 Surface

X [m]	Y [m]
0,00	10,80
12,00	10,50

6.1.4 Soil Material Properties in Profile: Profile Tip Level 2.2 (1)

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [degree]	Delta friction angle [degree]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	10,80	18,50	20,50	0,00	27,00	18,00
Zand, klei+puin...	9,80	18,50	20,50	0,00	27,00	18,00
Klei, zwak zand...	9,00	17,00	20,00	2,50	27,50	18,30
Zand, matig*	7,00	18,00	20,00	0,00	32,50	16,60
Zand, matig*	2,20	18,00	20,00	0,00	32,50	16,60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, klei+puin...	10,80	1,00	1,00	Fine
Zand, klei+puin...	9,80	1,50	1,00	Fine
Klei, zwak zand...	9,00	1,50	1,00	Fine
Zand, matig*	7,00	2,00	1,00	Fine
Zand, matig*	2,20	2,00	1,00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, klei+puin...	10,80	n.a.	n.a.	n.a.	0,00	0,00
Zand, klei+puin...	9,80	n.a.	n.a.	n.a.	0,00	0,00
Klei, zwak zand...	9,00	n.a.	n.a.	n.a.	0,00	7,50
Zand, matig*	7,00	n.a.	n.a.	n.a.	7,50	7,50
Zand, matig*	2,20	n.a.	n.a.	n.a.	7,50	7,50

6.1.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	10,80	12000,00	12000,00	6000,00	6000,00
Zand, klei+puin...	9,80	18000,00	18000,00	9000,00	9000,00
Klei, zwak zand...	9,00	4500,00	4500,00	2100,00	2100,00
Zand, matig*	7,00	32000,00	32000,00	16000,00	16000,00
Zand, matig*	2,20	32000,00	32000,00	16000,00	16000,00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	10,80	3000,00	3000,00
Zand, klei+puin...	9,80	4500,00	4500,00
Klei, zwak zand...	9,00	975,00	975,00
Zand, matig*	7,00	8000,00	8000,00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, matig*	2,20	8000,00	8000,00

6.2 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10,60	0,7	9,0	0,32	0,44	4,30
2	10,10	2,3	31,6	0,32	0,48	4,29
3	9,60	4,0	54,2	0,21	0,50	6,44
4	9,20	5,3	72,3	0,21	0,50	6,44
5	8,75	3,8	106,4	0,12	0,50	7,78
6	8,25	4,7	119,8	0,13	0,50	7,60
7	7,75	5,7	133,2	0,14	0,51	7,46
8	7,25	6,7	146,7	0,15	0,51	7,35
9	6,70	8,9	191,3	0,13	0,44	11,09
10	6,10	10,5	225,4	0,13	0,44	11,12
11	5,50	12,1	260,5	0,13	0,44	11,19
12	4,90	13,7	295,6	0,13	0,45	11,24
13	4,30	15,2	330,7	0,13	0,45	11,28
14	3,70	16,8	365,9	0,13	0,45	11,32
15	3,10	18,4	401,1	0,13	0,45	11,35
16	2,50	20,0	436,6	0,13	0,45	11,38

6.3 Calculated force from a layer Left

Name	Force
Zand, klei+puin, los	22,59
Zand, klei+puin, los*	75,89
Klei, zwak zandig*	191,20
Zand, matig*	460,92
Zand, matig*	0,00

6.4 Input Data Right

6.4.1 Calculation Method

Calculation method: C, phi, delta

6.4.2 Water Level

Water level: 12,30 [m]

6.4.3 Surface

X [m]	Y [m]
0,00	14,00
5,00	14,00

6.4.4 Soil Material Properties in Profile: Profile Tip Level 2.2 (2)

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [degree]	Delta friction angle [degree]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	14,00	18,50	20,50	0,00	27,00	18,00
Zand, klei+puin...	12,30	18,50	20,50	0,00	27,00	18,00
Zand, klei+puin...	9,80	18,50	20,50	0,00	27,00	18,00
Klei, zwak zand...	9,00	17,00	20,00	2,50	27,50	18,30
Zand, matig*	7,00	18,00	20,00	0,00	32,50	16,60
Zand, matig*	2,20	18,00	20,00	0,00	32,50	16,60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, klei+puin...	14,00	1,00	1,00	Fine
Zand, klei+puin...	12,30	1,00	1,00	Fine
Zand, klei+puin...	9,80	1,50	1,00	Fine
Klei, zwak zand...	9,00	1,50	1,00	Fine
Zand, matig*	7,00	2,00	1,00	Fine
Zand, matig*	2,20	2,00	1,00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m²]	Bottom [kN/m²]
Zand, klei+puin...	14,00	n.a.	n.a.	n.a.	0,00	0,00
Zand, klei+puin...	12,30	n.a.	n.a.	n.a.	0,00	0,00
Zand, klei+puin...	9,80	n.a.	n.a.	n.a.	0,00	0,00
Klei, zwak zand...	9,00	n.a.	n.a.	n.a.	0,00	-7,50
Zand, matig*	7,00	n.a.	n.a.	n.a.	-7,50	-7,50
Zand, matig*	2,20	n.a.	n.a.	n.a.	-7,50	-7,50

6.4.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m³]	Bottom [kN/m³]	Top [kN/m³]	Bottom [kN/m³]
Zand, klei+puin...	14,00	12000,00	12000,00	6000,00	6000,00
Zand, klei+puin...	12,30	12000,00	12000,00	6000,00	6000,00
Zand, klei+puin...	9,80	18000,00	18000,00	9000,00	9000,00
Klei, zwak zand...	9,00	4500,00	4500,00	2100,00	2100,00
Zand, matig*	7,00	32000,00	32000,00	16000,00	16000,00
Zand, matig*	2,20	32000,00	32000,00	16000,00	16000,00

Layer name	Level [m]	Branch 3	
		Top [kN/m³]	Bottom [kN/m³]
Zand, klei+puin...	14,00	3000,00	3000,00
Zand, klei+puin...	12,30	3000,00	3000,00
Zand, klei+puin...	9,80	4500,00	4500,00
Klei, zwak zand...	9,00	975,00	975,00
Zand, matig*	7,00	8000,00	8000,00
Zand, matig*	2,20	8000,00	8000,00

6.4.6 Surcharge Loads

Name	Distance [m]	Load [kN/m²]	Favourable / Unfavourable	Permanent / Variable
Verkeersbelasting	0,50	13,30	Unfavourable (D-Sheet Piling)	Variable
	3,00	13,30		

6.5 Calculated Earth Pressure Coefficients Right

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	13,72	2,2	61,3	0,37	1,50	10,26
2	13,15	8,4	111,1	0,41	0,78	5,37
3	12,58	12,3	126,1	0,37	0,60	3,76
4	12,05	14,9	158,4	0,35	0,54	3,75
5	11,55	16,7	180,9	0,35	0,52	3,79
6	11,05	18,4	204,3	0,35	0,50	3,86
7	10,60	20,0	225,5	0,35	0,50	3,92
8	10,10	21,5	249,4	0,34	0,50	3,99
9	9,60	21,7	273,3	0,22	0,50	6,08
10	9,20	21,6	292,6	0,20	0,51	6,15
11	8,75	19,0	346,1	0,17	0,50	6,77
12	8,25	21,0	379,6	0,17	0,51	6,84
13	7,75	23,2	410,3	0,17	0,51	6,85

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
14	7,25	25,4	442,7	0,18	0,51	6,88
15	6,70	25,4	581,6	0,12	0,44	11,32
16	6,10	26,6	617,7	0,12	0,44	11,38
17	5,50	28,0	641,9	0,12	0,45	11,22
18	4,90	29,6	677,5	0,12	0,45	11,26
19	4,30	31,2	713,2	0,12	0,45	11,30
20	3,70	32,8	748,9	0,12	0,45	11,34
21	3,10	34,4	784,6	0,12	0,45	11,37
22	2,50	36,0	820,3	0,13	0,45	11,40

6.6 Calculated force from a layer Right

Name	Force
Zand, klei+puin, los	12,98
Zand, klei+puin, los	45,88
Zand, klei+puin, los*	11,55
Klei, zwak zandig*	29,57
Zand, matig*	396,33
Zand, matig*	0,00

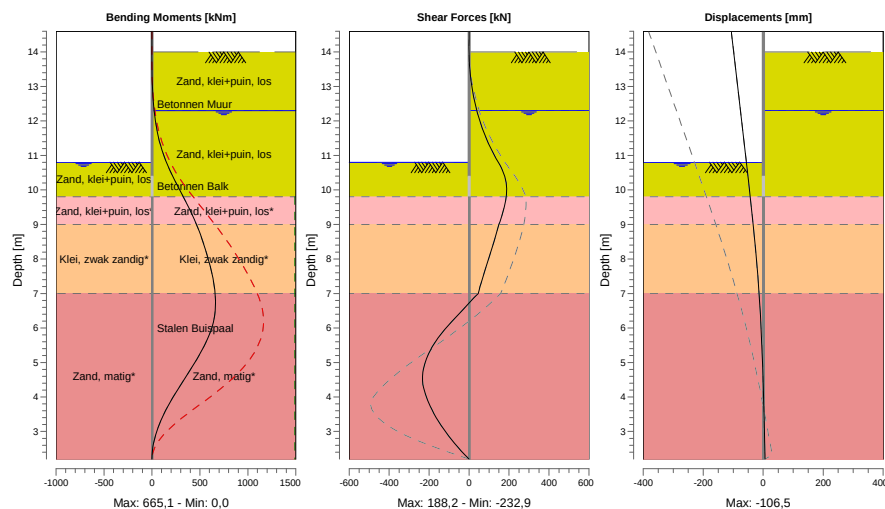
6.7 Calculation Results

Number of iterations: 4

6.7.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 2: dH= 1.5 m

Step 6.5 - Partial factor set: RC 3



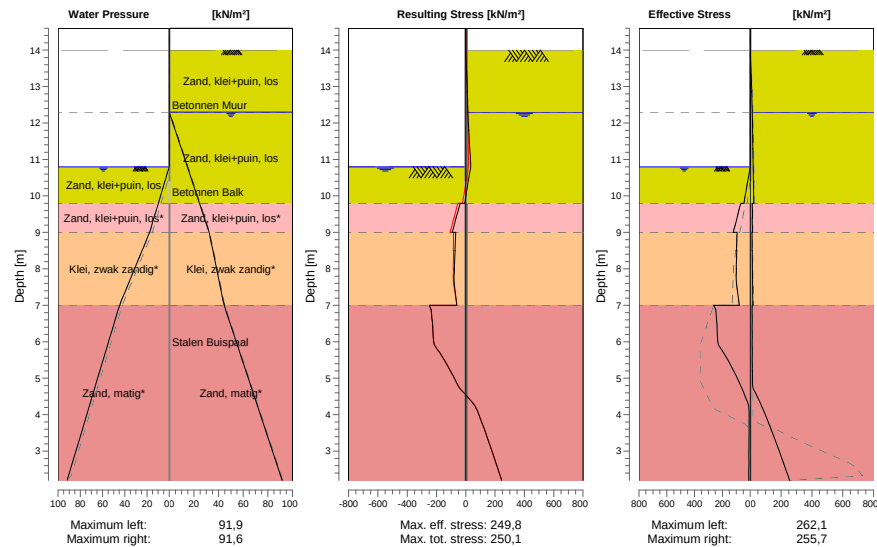
6.7.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14,60	0,00	0,00	-106,5
1	14,00	0,00	0,00	-98,5
2	14,00	0,00	0,00	-98,5
2	13,43	0,72	3,96	-91,0

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
3	13,43	0,72	3,96	-91,0
3	12,87	6,53	18,15	-83,4
4	12,87	6,53	18,15	-83,4
4	12,30	22,36	38,95	-75,9
5	12,30	22,36	38,95	-75,9
5	11,80	47,92	65,01	-69,3
6	11,80	47,92	65,01	-69,3
6	11,30	89,01	101,06	-62,7
7	11,30	89,01	101,06	-62,7
7	10,80	150,62	147,06	-56,2
8	10,80	150,62	147,06	-56,2
8	10,40	216,27	177,82	-51,0
9	10,40	216,27	177,82	-51,0
9	9,80	327,70	186,10	-43,4
10	9,80	327,70	186,10	-43,4
10	9,40	399,47	171,51	-38,4
11	9,40	399,47	171,51	-38,4
11	9,00	463,87	149,30	-33,6
12	9,00	463,88	149,27	-33,6
12	8,50	532,36	124,33	-28,0
13	8,50	532,36	124,33	-28,0
13	8,00	588,00	97,84	-22,8
14	8,00	588,00	97,84	-22,8
14	7,50	630,01	70,16	-18,1
15	7,50	630,01	70,13	-18,1
15	7,00	658,87	46,21	-13,9
16	7,00	658,87	46,22	-13,9
16	6,40	656,81	-51,76	-9,5
17	6,40	656,81	-51,76	-9,5
17	5,80	597,66	-143,77	-5,9
18	5,80	597,65	-143,85	-5,9
18	5,20	490,80	-205,98	-3,0
19	5,20	490,80	-206,06	-3,0
19	4,60	357,33	-232,87	-0,7
20	4,60	357,31	-232,91	-0,7
20	4,00	221,17	-213,51	1,2
21	4,00	221,18	-213,37	1,2
21	3,40	106,82	-164,01	2,9
22	3,40	106,82	-164,00	2,9
22	2,80	28,80	-92,52	4,4
23	2,80	28,80	-92,52	4,4
23	2,20	0,00	0,00	5,9
Max		658,87	-232,91	-106,5
Max, minor nodes incl.		665,09	-232,91	-106,5

6.7.3 Charts of Stresses

Stress States - Stage 2: dH= 1.5 m



6.7.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]
1	14,60	0,00	0,00	-		0,00	0,00	-	
1	14,00	0,00	0,00	-		0,00	0,00	-	
2	14,00	0,00	0,00	-		0,00	0,00	A	
2	13,43	0,00	0,00	-		5,00	0,00	A	
3	13,43	0,00	0,00	-		5,44	0,00	A	
3	12,87	0,00	0,00	-		11,09	0,00	A	
4	12,87	0,00	0,00	-		10,01	0,00	A	
4	12,30	0,00	0,00	-		14,38	0,00	A	
5	12,30	0,00	0,00	-		13,88	0,00	A	
5	11,80	0,00	0,00	-		15,92	4,91	A	
6	11,80	0,00	0,00	-		15,74	4,91	A	
6	11,30	0,00	0,00	-		17,60	9,81	A	
7	11,30	0,00	0,00	-		17,51	9,81	A	
7	10,80	0,00	0,00	-		19,29	14,71	A	
8	10,80	0,00	0,00	P		19,25	14,71	A	
8	10,40	18,08	3,92	P		20,64	18,64	A	
9	10,40	18,07	3,92	P		20,48	18,64	A	
9	9,80	45,17	9,81	P		22,53	24,52	A	
10	9,80	67,75	9,81	P		14,07	24,52	A	
10	9,40	94,86	13,73	P		14,92	28,45	A	
11	9,40	94,86	13,73	P		13,97	28,45	A	
11	9,00	121,97	17,66	P		14,77	32,37	A	
12	9,00	94,94	17,66	2	64	12,13	32,37	A	
12	8,50	98,51	24,44	2	57	13,22	35,40	A	
13	8,50	97,03	24,44	2	58	13,47	35,40	A	
13	8,00	100,62	31,22	2	53	14,58	38,43	A	
14	8,00	99,33	31,22	2	53	14,91	38,43	A	
14	7,50	95,69	38,00	1	45	16,05	41,46	A	
15	7,50	95,78	38,00	1	46	16,37	41,46	A	
15	7,00	78,42	44,78	1	34	17,54	44,49	A	

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
16	7,00	262,14	44,78	2	75	12,34	44,49	A	
16	6,40	238,68	50,66	2	57	13,06	50,38	A	
17	6,40	239,17	50,66	2	57	12,94	50,38	A	
17	5,80	208,20	56,55	1	43	13,65	56,27	A	
18	5,80	208,34	56,55	1	43	13,63	56,27	A	
18	5,20	118,17	62,44	1	21	14,34	62,15	A	
19	5,20	118,30	62,44	1	21	14,42	62,15	A	
19	4,60	46,38	68,32	1	7	33,65	68,04	1	
20	4,60	46,49	68,32	1	7	33,81	68,04	1	
20	4,00	8,02	74,21	A		97,75	73,92	1	7
21	4,00	8,02	74,21	A		97,91	73,92	1	7
21	3,40	8,80	80,09	A		153,54	79,81	1	10
22	3,40	8,80	80,09	A		153,68	79,81	1	10
22	2,80	9,59	85,98	A		205,23	85,69	1	13
23	2,80	9,59	85,98	A		205,36	85,69	1	13
23	2,20	10,38	91,87	A		255,70	91,58	1	15

*

Stat Status (A=active, P=passive, Number is branche, 0 is unloading)
 Mob Percentage passive mobilized

6.7.5 Percentage mobilized resistance

Horizontal soil pressure	Left [kN]	Right [kN]
Effective	577,4	482,8
Water	295,7	390,3
Total	873,0	873,1

Considered as passive side
 Maximum passive effective resistance 2492,60 kN
 Mobilized passive effective resistance 577,36 kN
 Percentage mobilized resistance 23,2 %

6.7.6 Vertical Force Balance

Xi factor 1,39
 Partial factor base resistance 1,20
 Maximum point resistance 0,00 [MPa]
 A maximum point resistance of zero results in a vertical toe capacity of zero

Vertical force balance unplugged	Force [kN]
Vertical force active	-177,26
Vertical force passive	211,93
Resulting vertical force (no dead weight)	34,67
Vertical toe capacity R _{b;d}	0,00
Resultant goes up	

Vertical force balance plugged	Force [kN]
Vertical force active	-177,26
Vertical force passive	211,93
Resulting vertical force (no dead weight)	34,67
Vertical toe capacity R _{b;d}	0,00
Resultant goes up	

6.7.7 Vertical Force Balance - Contribution per Layer

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
10,80	Zand, klei+puin...	22,01	14,00	Zand, klei+puin...	-12,66
9,80	Zand, klei+puin...	17,26	12,30	Zand, klei+puin...	-44,72

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
9,00	Klei, zwak zand...	44,26	9,80	Zand, klei+puin...	-2,63
7,00	Zand, matig*	128,40	9,00	Klei, zwak zand...	-6,84
			7,00	Zand, matig*	-110,40

End of Report

Report for D-Sheet Piling 18.2

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 5/6/2020
Time of report: 10:55:45 AM
Report with version: 18.2.1.20477

Date of calculation: 5/6/2020
Time of calculation: 10:55:22 AM
Calculated with version: 18.2.1.20477

File name: C:\...\Rijnkade_Vervanging Type 1_Buispaal

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	Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
2	Not verified						
2	EC7(NL)-Step 6.3 (A)		---	---	---	---	---
2	EC7(NL)-Step 6.4		1167.26	-748.88	0.0	74.9	Upwards
2	EC7(NL)-Step 6.5	-164.9	612.96	-228.52	0.0	26.6	Upwards
2	EC7(NL)-Step 6.5 * 1.35		827.50	-308.50			
Max		---	---	---	---	---	Sufficient

(A) Wall unstable

2.2 Overall Stability per Stage

Stage name	Stability factor [-]
dH= 1.5 m	2.89

2.3 Calculation Errors

Error

Sheet piling unstable in stage : 2

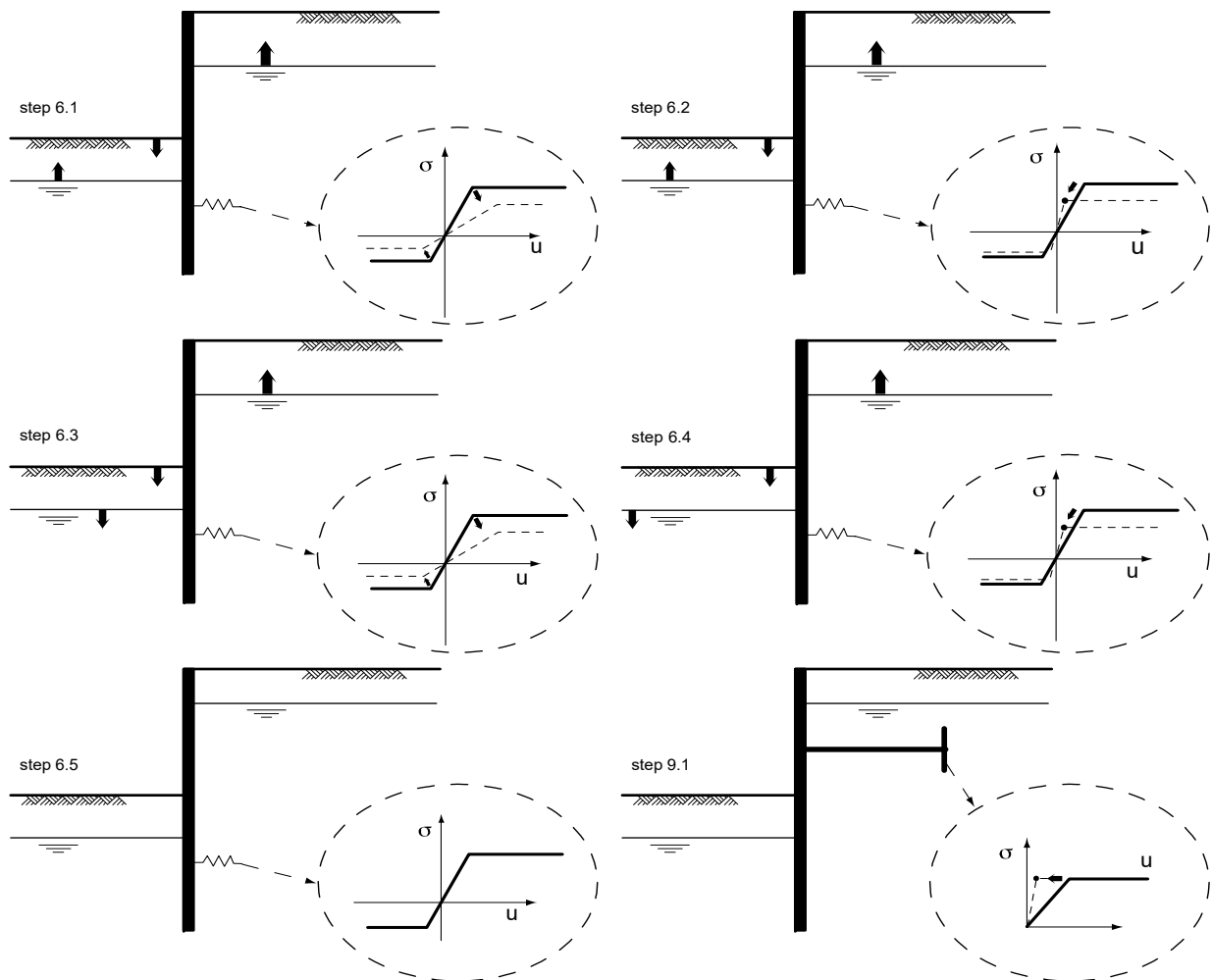
2.4 Warnings

* Vertical stability

The vertical balance cannot be calculated correctly under combined walls. It is not possible to indicate CPT resistances for both toe levels. The calculation only takes into account the lower toe resistance, the upper toe resistance is neglected.

* Vertical balance: The resultant vertical friction force is directed upward in stage 2 & 2 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	2
Unit weight of water	9.81 kN/m ³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	12.40 m
Level top side	14.60 m
Number of sections	3
q _b ;max	0.00 MPa
Xi factor	1.39

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Acting width [m]
Betonnen Muur	10.40	14.60	Concrete	3.00
Betonnen Balk	9.80	10.40	Concrete	3.00
Stalen Buispaal	2.20	9.80	Steel	0.70

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm ² /m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
Betonnen Muur	1.1500E+05	1.00	3.4500E+05	
Betonnen Balk	9.1700E+05	1.00	2.7510E+06	
Stalen Buispaal	4.4100E+05	1.00	3.0870E+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]
Betonnen Muur	862.00	1.00	1.10	1.00	2350.92
Betonnen Balk	862.00	1.00	1.10	1.00	2350.92
Stalen Buispaal	2129.00	1.00	1.00	1.00	1490.30

3.2.4 Properties for vertical balance

Section name	From [m]	To [m]	Height [mm]	Coating area [m ² /m ² wall]	Section area [cm ² /m']
Betonnen Muur	10.40	14.60	500.00	1.47	648.00
Betonnen Balk	9.80	10.40	1000.00	2.00	600.00
Stalen Buispaal	2.20	9.80	700.00	2.00	140.00

3.3 Calculation Options

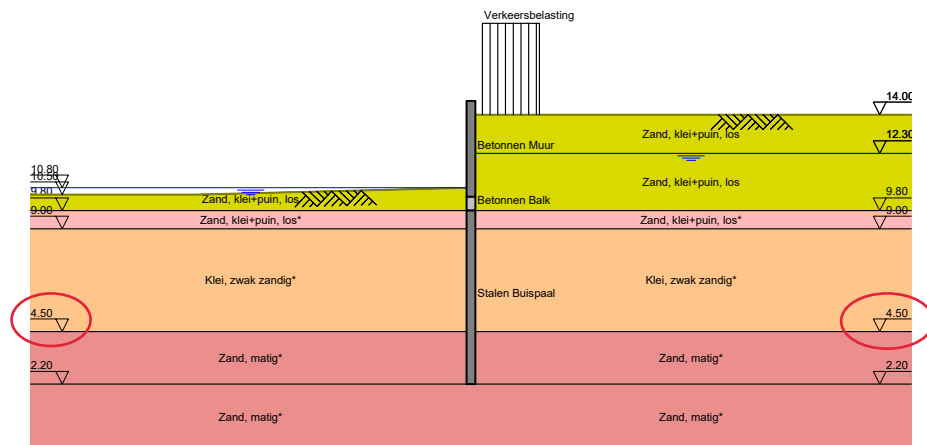
First stage represents initial situation	No
Calculation refinement	Coarse
Reduce delta(s) according to CUR	Yes
Verification	EC7 NA NL - method B: Partial factors (design values) in verification

Eurocode 7 using the factors as described in the National Annex of the Netherlands. It is basically design approach III.

Verification of stage	2: dH= 1.5 m
Used partial factor set	RC 3
Factors on loads	
- Permanent load, unfavourable	1.00
- Permanent load, favourable	1.00
- Variable load, unfavourable	1.25
- Variable load, favourable	0.00
Factors on representative values	
- Partial factor on M, D and Pmax	1.35
Material factors	
- Cohesion	1.40
- Tangent phi	1.20
- Delta (wall friction angle)	1.20
- Modulus of low representative subgrade reaction	1.30
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
Overall stability factors	
- Cohesion	1.60
- Tangent phi	1.30
- Factor on unit weight soil	1.00
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.20

4 Outline Stage 2: dH= 1.5 m

Outline - Stage 2: dH= 1.5 m

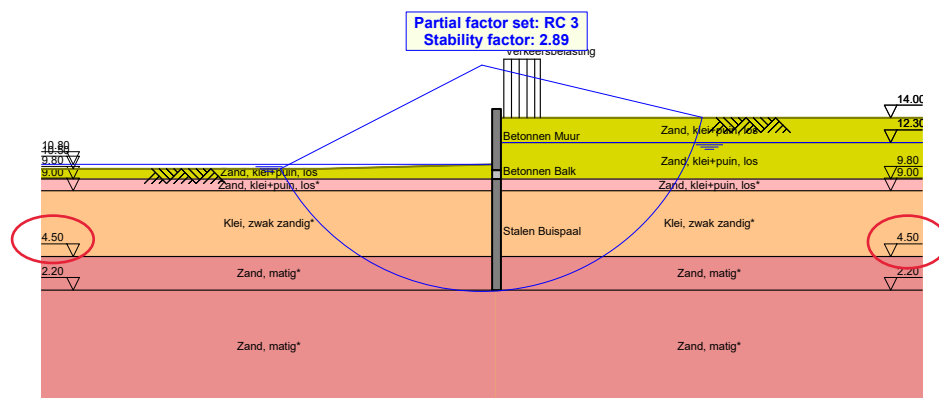


5 Overall Stability Stage 2: dH= 1.5 m

Stability factor : 2.89

5.1 Overall Stability

Overall Stability - Stage 2: dH= 1.5 m



6 Step 6.5 Stage 2: dH= 1.5 m

6.1 Input Data Left

6.1.1 Calculation Method

Calculation method: C, phi, delta

6.1.2 Water Level

Water level: 10.80 [m]

6.1.3 Surface

X [m]	Y [m]
0.00	10.80
12.00	10.50

6.1.4 Soil Material Properties in Profile: Profile Tip Level 2.2 (1)

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	10.80	18.50	20.50	0.00	27.00	18.00
Zand, klei+puin...	9.80	18.50	20.50	0.00	27.00	18.00
Klei, zwak zand...	9.00	17.00	20.00	2.50	27.50	18.30
Zand, matig*	4.50	18.00	20.00	0.00	32.50	16.60
Zand, matig*	2.20	18.00	20.00	0.00	32.50	16.60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, klei+puin...	10.80	1.00	1.00	Fine
Zand, klei+puin...	9.80	1.50	1.00	Fine
Klei, zwak zand...	9.00	1.50	1.00	Fine
Zand, matig*	4.50	2.00	1.00	Fine
Zand, matig*	2.20	2.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, klei+puin...	10.80	n.a.	n.a.	n.a.	0.00	0.00
Zand, klei+puin...	9.80	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	9.00	n.a.	n.a.	n.a.	0.00	7.50
Zand, matig*	4.50	n.a.	n.a.	n.a.	7.50	7.50
Zand, matig*	2.20	n.a.	n.a.	n.a.	7.50	7.50

6.1.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	10.80	12000.00	12000.00	6000.00	6000.00
Zand, klei+puin...	9.80	18000.00	18000.00	9000.00	9000.00
Klei, zwak zand...	9.00	4500.00	4500.00	2100.00	2100.00
Zand, matig*	4.50	32000.00	32000.00	16000.00	16000.00
Zand, matig*	2.20	32000.00	32000.00	16000.00	16000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	10.80	3000.00	3000.00
Zand, klei+puin...	9.80	4500.00	4500.00
Klei, zwak zand...	9.00	975.00	975.00
Zand, matig*	4.50	8000.00	8000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, matig*	2.20	8000.00	8000.00

6.2 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10.60	0.7	9.0	0.32	0.44	4.30
2	10.10	2.3	31.6	0.32	0.48	4.29
3	9.60	4.0	54.2	0.21	0.50	6.44
4	9.20	5.3	72.3	0.21	0.50	6.44
5	8.72	4.0	110.0	0.13	0.50	7.75
6	8.16	5.5	130.6	0.14	0.51	7.54
7	7.59	6.9	151.2	0.15	0.51	7.39
8	7.03	8.4	171.8	0.16	0.51	7.28
9	6.47	9.9	192.5	0.16	0.52	7.20
10	5.91	11.3	214.3	0.17	0.52	7.17
11	5.34	12.8	236.7	0.17	0.52	7.17
12	4.78	14.2	259.1	0.17	0.52	7.16
13	4.21	15.4	338.4	0.13	0.45	11.37
14	3.64	16.9	372.0	0.13	0.45	11.40
15	3.06	18.4	405.7	0.13	0.45	11.42
16	2.49	19.9	439.3	0.13	0.45	11.43

6.3 Calculated force from a layer Left

Name	Force
Zand, klei+puin, los	22.59
Zand, klei+puin, los*	75.89
Klei, zwak zandig*	541.67
Zand, matig*	137.87
Zand, matig*	0.00

6.4 Input Data Right

6.4.1 Calculation Method

Calculation method: C, phi, delta

6.4.2 Water Level

Water level: 12.30 [m]

6.4.3 Surface

X [m]	Y [m]
0.00	14.00
5.00	14.00

6.4.4 Soil Material Properties in Profile: Profile Tip Level 2.2 (2)

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	14.00	18.50	20.50	0.00	27.00	18.00
Zand, klei+puin...	12.30	18.50	20.50	0.00	27.00	18.00
Zand, klei+puin...	9.80	18.50	20.50	0.00	27.00	18.00
Klei, zwak zand...	9.00	17.00	20.00	2.50	27.50	18.30
Zand, matig*	4.50	18.00	20.00	0.00	32.50	16.60
Zand, matig*	2.20	18.00	20.00	0.00	32.50	16.60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, klei+puin...	14.00	1.00	1.00	Fine
Zand, klei+puin...	12.30	1.00	1.00	Fine
Zand, klei+puin...	9.80	1.50	1.00	Fine
Klei, zwak zand...	9.00	1.50	1.00	Fine
Zand, matig*	4.50	2.00	1.00	Fine
Zand, matig*	2.20	2.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m²]	Bottom [kN/m²]
Zand, klei+puin...	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, klei+puin...	12.30	n.a.	n.a.	n.a.	0.00	0.00
Zand, klei+puin...	9.80	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	9.00	n.a.	n.a.	n.a.	0.00	-7.50
Zand, matig*	4.50	n.a.	n.a.	n.a.	-7.50	-7.50
Zand, matig*	2.20	n.a.	n.a.	n.a.	-7.50	-7.50

6.4.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m³]	Bottom [kN/m³]	Top [kN/m³]	Bottom [kN/m³]
Zand, klei+puin...	14.00	12000.00	12000.00	6000.00	6000.00
Zand, klei+puin...	12.30	12000.00	12000.00	6000.00	6000.00
Zand, klei+puin...	9.80	18000.00	18000.00	9000.00	9000.00
Klei, zwak zand...	9.00	4500.00	4500.00	2100.00	2100.00
Zand, matig*	4.50	32000.00	32000.00	16000.00	16000.00
Zand, matig*	2.20	32000.00	32000.00	16000.00	16000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m³]	Bottom [kN/m³]
Zand, klei+puin...	14.00	3000.00	3000.00
Zand, klei+puin...	12.30	3000.00	3000.00
Zand, klei+puin...	9.80	4500.00	4500.00
Klei, zwak zand...	9.00	975.00	975.00
Zand, matig*	4.50	8000.00	8000.00
Zand, matig*	2.20	8000.00	8000.00

6.4.6 Surcharge Loads

Name	Distance [m]	Load [kN/m²]	Favourable / Unfavourable	Permanent / Variable
Verkeersbelasting	0.50	13.30	Unfavourable (D-Sheet Piling)	Variable
	3.00	13.30		

6.5 Calculated Earth Pressure Coefficients Right

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	13.72	2.2	61.3	0.37	1.50	10.26
2	13.15	8.4	111.1	0.41	0.78	5.37
3	12.58	12.3	126.1	0.37	0.60	3.76
4	12.05	14.9	158.4	0.35	0.54	3.75
5	11.55	16.7	180.9	0.35	0.52	3.79
6	11.05	18.4	204.3	0.35	0.50	3.86
7	10.60	20.0	225.5	0.35	0.50	3.92
8	10.10	21.5	249.4	0.34	0.50	3.99
9	9.60	21.7	273.3	0.22	0.50	6.08
10	9.20	21.6	292.6	0.20	0.51	6.15
11	8.72	18.9	345.5	0.17	0.50	6.78
12	8.16	20.9	377.2	0.17	0.51	6.84
13	7.59	23.0	406.5	0.17	0.51	6.85

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
14	7.03	25.1	437.7	0.18	0.51	6.88
15	6.47	27.2	469.0	0.18	0.51	6.91
16	5.91	29.3	500.2	0.18	0.52	6.94
17	5.34	31.4	531.5	0.18	0.52	6.96
18	4.78	33.5	562.8	0.18	0.52	6.98
19	4.21	32.0	729.9	0.13	0.45	11.49
20	3.64	33.1	766.2	0.12	0.45	11.55
21	3.06	34.5	787.2	0.12	0.45	11.38
22	2.49	36.0	821.3	0.12	0.45	11.40

6.6 Calculated force from a layer Right

Name	Force
Zand, klei+puin, los	12.98
Zand, klei+puin, los	45.88
Zand, klei+puin, los*	11.55
Klei, zwak zandig*	79.58
Zand, matig*	358.20
Zand, matig*	0.00

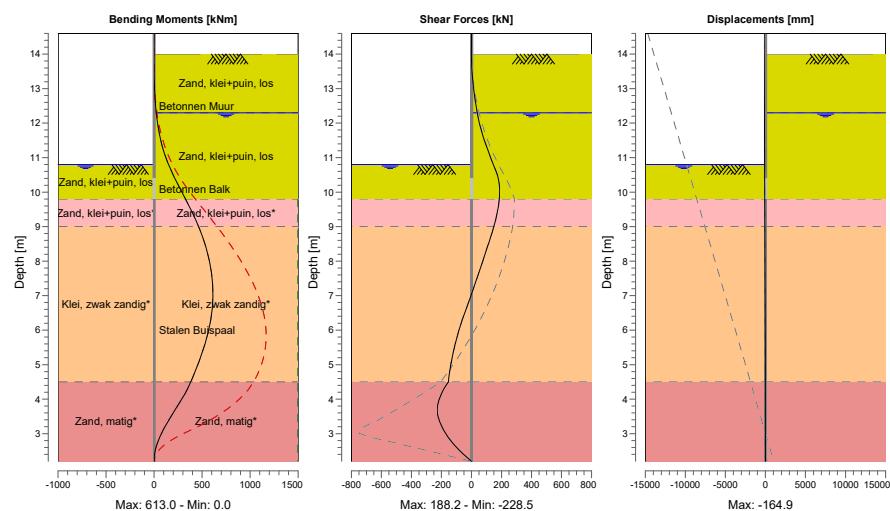
6.7 Calculation Results

Number of iterations: 5

6.7.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 2: dH= 1.5 m

Step 6.5 - Partial factor set: RC 3



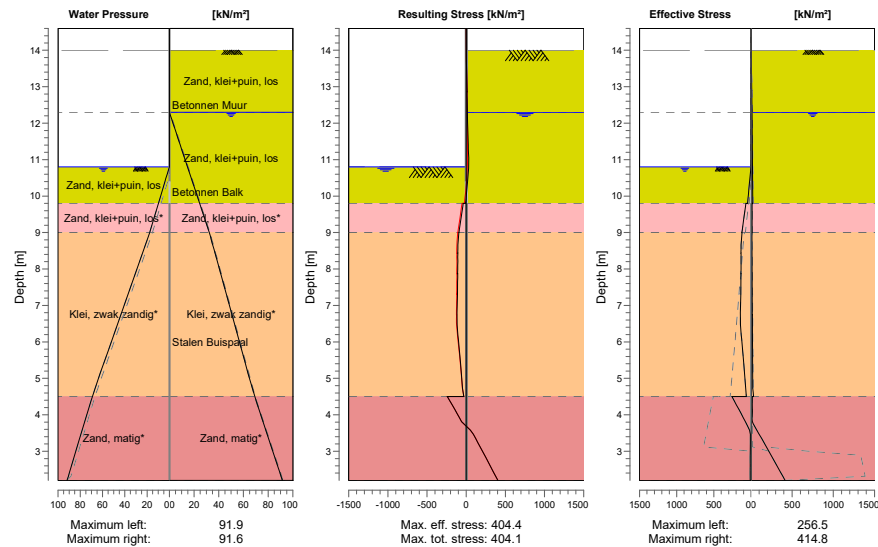
6.7.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14.60	0.00	0.00	-164.9
1	14.00	0.00	0.00	-153.9
2	14.00	0.00	0.00	-153.9
2	13.43	0.72	3.96	-143.5

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
3	13.43	0.72	3.96	-143.5
3	12.87	6.53	18.15	-133.1
4	12.87	6.53	18.15	-133.1
4	12.30	22.36	38.95	-122.7
5	12.30	22.36	38.95	-122.7
5	11.80	47.92	65.01	-113.6
6	11.80	47.92	65.01	-113.6
6	11.30	89.01	101.06	-104.5
7	11.30	89.01	101.06	-104.5
7	10.80	150.62	147.06	-95.5
8	10.80	150.62	147.06	-95.5
8	10.40	216.27	177.82	-88.3
9	10.40	216.27	177.82	-88.3
9	9.80	327.70	186.10	-77.7
10	9.80	327.70	186.10	-77.7
10	9.40	399.47	171.51	-70.7
11	9.40	399.47	171.51	-70.7
11	9.00	463.88	149.30	-63.9
12	9.00	463.88	149.14	-63.9
12	8.44	536.62	108.49	-54.7
13	8.44	536.62	108.15	-54.7
13	7.88	585.55	65.66	-46.2
14	7.88	585.55	65.34	-46.2
14	7.31	610.14	21.74	-38.2
15	7.31	610.14	21.42	-38.2
15	6.75	609.58	-23.83	-30.8
16	6.75	609.58	-24.18	-30.8
16	6.19	583.01	-69.61	-24.1
17	6.19	583.00	-69.96	-24.1
17	5.63	532.82	-106.86	-17.9
18	5.63	532.82	-107.09	-17.9
18	5.06	464.38	-134.80	-12.3
19	5.06	464.39	-134.98	-12.3
19	4.50	382.68	-153.70	-7.2
20	4.50	382.69	-153.85	-7.2
20	3.92	272.32	-219.79	-2.4
21	3.92	272.32	-219.99	-2.4
21	3.35	143.62	-212.12	2.2
22	3.35	143.63	-211.85	2.2
22	2.77	41.34	-134.38	6.5
23	2.77	41.34	-134.37	6.5
23	2.20	0.00	0.00	10.9
Max		610.14	-219.99	-164.9
Max, minor nodes incl.		612.96	-228.52	-164.9

6.7.3 Charts of Stresses

Stress States - Stage 2: dH= 1.5 m



6.7.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]
1	14.60	0.00	0.00	-		0.00	0.00	-	
1	14.00	0.00	0.00	-		0.00	0.00	-	
2	14.00	0.00	0.00	-		0.00	0.00	A	
2	13.43	0.00	0.00	-		5.00	0.00	A	
3	13.43	0.00	0.00	-		5.44	0.00	A	
3	12.87	0.00	0.00	-		11.09	0.00	A	
4	12.87	0.00	0.00	-		10.01	0.00	A	
4	12.30	0.00	0.00	-		14.38	0.00	A	
5	12.30	0.00	0.00	-		13.88	0.00	A	
5	11.80	0.00	0.00	-		15.92	4.91	A	
6	11.80	0.00	0.00	-		15.74	4.91	A	
6	11.30	0.00	0.00	-		17.60	9.81	A	
7	11.30	0.00	0.00	-		17.51	9.81	A	
7	10.80	0.00	0.00	-		19.29	14.71	A	
8	10.80	0.00	0.00	P		19.25	14.71	A	
8	10.40	18.08	3.92	P		20.64	18.64	A	
9	10.40	18.07	3.92	P		20.48	18.64	A	
9	9.80	45.17	9.81	P		22.53	24.52	A	
10	9.80	67.75	9.81	P		14.07	24.52	A	
10	9.40	94.86	13.73	P		14.92	28.45	A	
11	9.40	94.86	13.73	P		13.97	28.45	A	
11	9.00	121.97	17.66	P		14.77	32.37	A	
12	9.00	120.48	17.66	3	82	12.12	32.37	A	
12	8.44	134.98	24.11	2	74	13.15	36.95	A	
13	8.44	132.93	24.11	2	75	13.41	36.95	A	
13	7.88	135.28	30.57	2	63	14.47	41.53	A	
14	7.88	133.74	30.57	2	64	14.80	41.53	A	
14	7.31	138.54	37.02	2	57	15.88	46.11	A	
15	7.31	137.22	37.02	2	57	16.20	46.11	A	
15	6.75	142.53	43.48	2	52	17.31	50.70	A	

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
16	6.75	141.41	43.48	2	52	17.59	50.70	A	
16	6.19	130.37	49.94	1	43	18.73	55.28	A	
17	6.19	130.48	49.94	1	43	18.98	55.28	A	
17	5.63	105.29	56.39	1	31	20.14	59.86	A	
18	5.63	105.40	56.39	1	31	20.37	59.86	A	
18	5.06	82.67	62.85	1	22	21.54	64.44	A	
19	5.06	82.78	62.85	1	22	21.75	64.44	A	
19	4.50	62.20	69.30	1	15	32.18	69.02	1	
20	4.50	256.52	69.30	1	40	15.65	69.02	A	
20	3.92	104.41	74.94	1	15	16.36	74.66	A	
21	3.92	104.52	74.94	1	15	16.21	74.66	A	
21	3.35	8.82	80.58	A		130.09	80.30	1	8
22	3.35	8.83	80.58	A		130.23	80.30	1	8
22	2.77	9.58	86.23	A		273.22	85.94	1	17
23	2.77	9.59	86.23	A		273.35	85.94	1	17
23	2.20	10.34	91.87	A		414.77	91.58	1	25

*

Stat Status (A=active, P=passive, Number is branche, 0 is unloading)

Mob Percentage passive mobilized

6.7.5 Percentage mobilized resistance

Horizontal soil pressure	Left [kN]	Right [kN]
Effective	596.6	491.1
Water	289.1	396.9
Total	885.7	888.0

Considered as passive side

Maximum passive effective resistance

Mobilized passive effective resistance

Percentage mobilized resistance

Left

2238.96 kN

596.56 kN

26.6 %

6.7.6 Vertical Force Balance

Xi factor

1.39

Partial factor base resistance

1.20

Maximum point resistance

0.00 [MPa]

Vertical force balance unplugged	Force [kN]
Vertical force active	-178.21
Vertical force passive	203.08
Resulting vertical force (no dead weight)	24.87
Vertical toe capacity R _{b;d}	0.01
Resultant goes up	

Vertical force balance plugged	Force [kN]
Vertical force active	-178.21
Vertical force passive	203.08
Resulting vertical force (no dead weight)	24.87
Vertical toe capacity R _{b;d}	0.29
Resultant goes up	

6.7.7 Vertical Force Balance - Contribution per Layer

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
10.80	Zand, klei+puin...	22.01	14.00	Zand, klei+puin...	-12.66
9.80	Zand, klei+puin...	17.26	12.30	Zand, klei+puin...	-44.72
9.00	Klei, zwak zand...	125.40	9.80	Zand, klei+puin...	-2.63

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
4.50	Zand, matig*	38.41	9.00	Klei, zwak zand...	-18.42
			4.50	Zand, matig*	-99.78

End of Report

Report for D-Sheet Piling 17.1

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 1/23/2018

Time of report: 12:27:48 PM

Date of calculation: 1/23/2018

Time of calculation: 12:27:35 PM

Filename: C:\.\Rijnkade_Vervanging Type 1_Buispaal_qc =2500 en klei hoger

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2 Summary

2.1 Overview of Maxima

Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]
-116,1	824,09	-258,00	0,0	12,5

3 Input Data

3.1 General Input Data

Model Single pile; Pile loaded by forces
Unit weight of water 9,81 kN/m³

3.2 Pile Properties

Length 12,60 m
Level top side 14,60 m
Number of sections 1

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Diameter [m]
Stalen Buispaal	2,00	14,60	Steel	0,70

3.2.2 Stiffness EI (elastic behaviour)

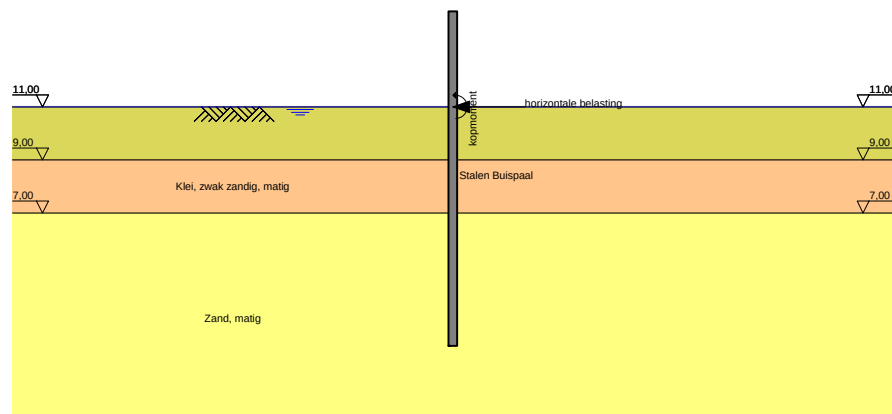
Section name	Elastic stiffness EI [kNm ²]	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
Stalen Buispaal	3,1300E+05	1,00	3,1300E+05	

3.2.3 Maximum allowable moments

Section name	Mr;char;el [kNm]	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
Stalen Buispaal	1490,00	1,00	1,00	1,00	1490,00

3.3 Outline

Outline



3.4 Horizontal Forces

Name	Level [m]	Load [kN]
horizontale bela...	11,00	-219,00

3.5 Moments

Name	Level [m]	Moment [kNm]
kopmoment	11,00	244,50

3.6 Water Level

Water level: 11,00 [m]

3.7 Surface

Surface level: 11,00 [m]

3.8 Soil Material Properties

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [degree]	Brinch Hansen used
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	14,00	18,50	20,50	0,00	27,00	Yes
Klei, zwak zand...	9,00	17,00	20,00	2,50	27,50	Yes
Zand, matig	7,00	18,00	20,00	0,00	32,50	Yes

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, klei+puin...	14,00	0,00	0,00	5,14	0,00	0,00
Klei, zwak zand...	9,00	0,00	0,00	7,14	0,00	0,00
Zand, matig	7,00	0,00	0,00	14,16	0,00	0,00

3.9 Soil Material Properties calculated using Brinch Hansen

Layer name	Level [m]	Fictive cohesion [kN/m ²]
Zand, klei+puin...	14,00	0,00
Klei, zwak zand...	9,00	12,97
Zand, matig	7,00	0,00

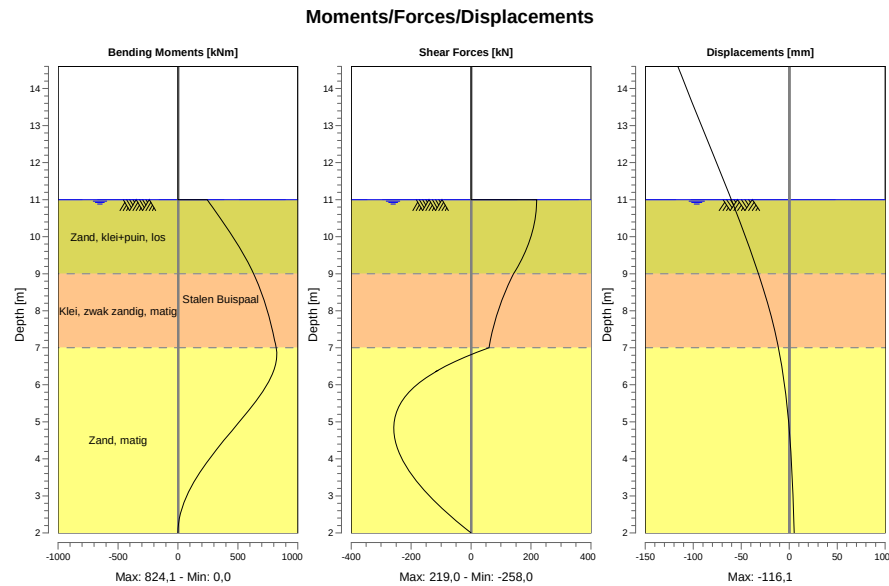
3.10 Modulus of Subgrade Reaction

Layer name	Level [m]	Ménard used	E-Mod Ménard [kN/m ²]	Soil type Ménard	Branch 1	
					Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	14,00	Yes	2500,00	Sand	10951,85	10951,85
Klei, zwak zand...	9,00	Yes	1000,00	Clay	2827,50	2827,50
Zand, matig	7,00	Yes	10000,00	Sand	43807,42	43807,42

4 Calculation Results

Number of iterations: 4

4.1 Charts of Moments, Forces and Displacements

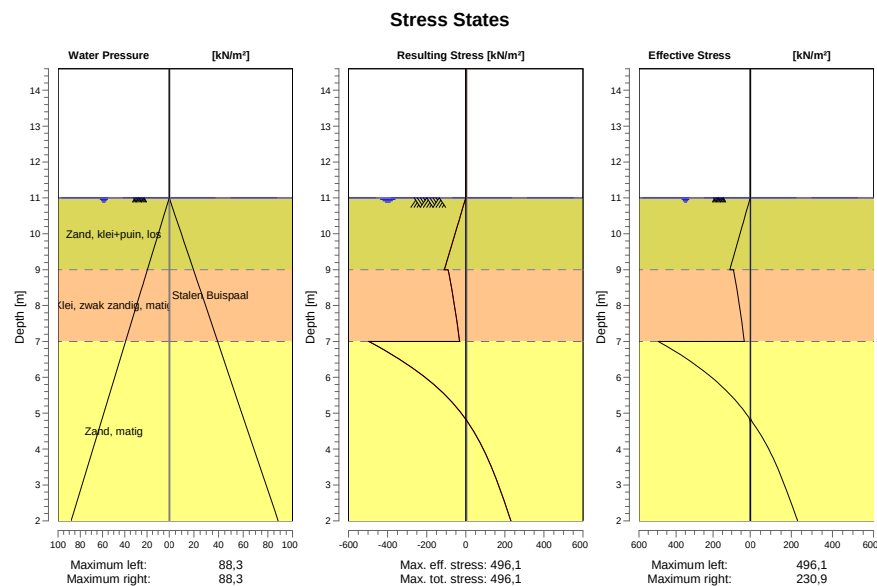


4.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14,60	0,00	0,00	-116,1
1	14,00	0,00	0,00	-106,8
2	14,00	0,00	0,00	-106,8
2	13,40	0,00	0,00	-97,5
3	13,40	0,00	0,00	-97,5
3	12,80	0,00	0,00	-88,2
4	12,80	0,00	0,00	-88,2
4	12,20	0,00	0,00	-79,0
5	12,20	0,00	0,00	-79,0
5	11,60	0,00	0,00	-69,7
6	11,60	0,00	0,00	-69,7
6	11,00	0,00	0,00	-60,4
7	11,00	244,50	219,00	-60,4
7	10,50	353,20	214,19	-52,8
8	10,50	353,20	214,19	-52,8
8	10,00	457,09	199,78	-45,5
9	10,00	457,09	199,78	-45,5
9	9,50	551,38	175,75	-38,5
10	9,50	551,38	175,75	-38,5
10	9,00	631,24	142,11	-32,0
11	9,00	631,24	142,12	-32,0
11	8,50	694,90	113,51	-25,9
12	8,50	694,90	113,51	-25,9
12	8,00	745,70	90,60	-20,5
13	8,00	745,70	90,61	-20,5
13	7,50	786,36	72,82	-15,6

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
14	7,50	786,36	72,83	-15,6
14	7,00	819,28	59,57	-11,3
15	7,00	819,28	59,60	-11,3
15	6,38	797,97	-113,72	-6,9
16	6,38	797,97	-113,66	-6,9
16	5,75	692,73	-212,24	-3,5
17	5,75	692,73	-212,19	-3,5
17	5,13	544,54	-253,87	-1,0
18	5,13	544,54	-253,82	-1,0
18	4,50	384,17	-253,39	0,9
19	4,50	384,17	-253,36	0,9
19	3,88	234,26	-221,91	2,3
20	3,88	234,26	-221,89	2,3
20	3,25	111,68	-166,84	3,4
21	3,25	111,69	-166,83	3,4
21	2,63	29,75	-92,30	4,4
22	2,63	29,75	-92,30	4,4
22	2,00	0,00	0,00	5,3
Max		819,28	-253,87	-116,1
Max, minor nodes incl.		824,09	-258,00	-116,1

4.3 Charts of Stresses



4.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]
1	14,60	0,00	0,00	-		0,00	0,00	-	
1	14,00	0,00	0,00	-		0,00	0,00	-	
2	14,00	0,00	0,00	-		0,00	0,00	-	
2	13,40	0,00	0,00	-		0,00	0,00	-	
3	13,40	0,00	0,00	-		0,00	0,00	-	
3	12,80	0,00	0,00	-		0,00	0,00	-	
4	12,80	0,00	0,00	-		0,00	0,00	-	

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
4	12,20	0,00	0,00	-		0,00	0,00	-	
5	12,20	0,00	0,00	-		0,00	0,00	-	
5	11,60	0,00	0,00	-		0,00	0,00	-	
6	11,60	0,00	0,00	-		0,00	0,00	-	
6	11,00	0,00	0,00	-		0,00	0,00	-	
7	11,00	0,00	0,00	P		0,00	0,00	A	
7	10,50	27,46	4,91	P		0,00	4,91	A	
8	10,50	27,46	4,91	P		0,00	4,91	A	
8	10,00	54,92	9,81	P		0,00	9,81	A	
9	10,00	54,92	9,81	P		0,00	9,81	A	
9	9,50	82,38	14,71	P		0,00	14,71	A	
10	9,50	82,38	14,71	P		0,00	14,71	A	
10	9,00	109,84	19,62	P		0,00	19,62	A	
11	9,00	90,37	19,62	-	41	0,00	19,62	A	
11	8,50	73,32	24,52	-	28	0,00	24,52	A	
12	8,50	73,32	24,52	-	28	0,00	24,52	A	
12	8,00	57,84	29,43	-	20	0,00	29,43	A	
13	8,00	57,84	29,43	-	20	0,00	29,43	A	
13	7,50	44,04	34,34	-	13	0,00	34,34	A	
14	7,50	44,04	34,34	-	13	0,00	34,34	A	
14	7,00	32,02	39,24	-	9	0,00	39,24	A	
15	7,00	496,10	39,24	-	84	0,00	39,24	A	
15	6,38	303,37	45,37	-	45	0,00	45,37	A	
16	6,38	303,37	45,37	-	45	0,00	45,37	A	
16	5,75	153,88	51,50	-	20	0,00	51,50	A	
17	5,75	153,88	51,50	-	20	0,00	51,50	A	
17	5,13	42,08	57,63	-	5	0,00	57,63	A	
18	5,13	42,08	57,63	-	5	0,00	57,63	A	
18	4,50	0,00	63,77	A		40,01	63,77	-	4
19	4,50	0,00	63,77	A		40,01	63,77	-	4
19	3,88	0,00	69,90	A		101,04	69,90	-	10
20	3,88	0,00	69,90	A		101,04	69,90	-	10
20	3,25	0,00	76,03	A		149,15	76,03	-	13
21	3,25	0,00	76,03	A		149,15	76,03	-	13
21	2,63	0,00	82,16	A		190,96	82,16	-	16
22	2,63	0,00	82,16	A		190,96	82,16	-	16
22	2,00	0,00	88,29	A		230,90	88,29	-	18

*

Stat
Mob

Status (A=active, P=passive, Number is branche, 0 is unloading)
Percentage passive mobilized

End of Report

Report for D-Sheet Piling 18.2

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 5/6/2020
Time of report: 11:00:36 AM
Report with version: 18.2.1.20477

Date of calculation: 5/6/2020
Time of calculation: 11:00:05 AM
Calculated with version: 18.2.1.20477

File name: C:\..\Rijnkade_Vervanging Type 1_Buispaal_qc =2500 en klei hoger

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2 Summary

2.1 Overview of Maxima

Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]
-174.0	722.52	-243.36	0.0	13.1

3 Input Data

3.1 General Input Data

Model Single pile; Pile loaded by forces
Unit weight of water 9.81 kN/m³

3.2 Pile Properties

Length 12.60 m
Level top side 14.60 m
Number of sections 1

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Diameter [m]
Stalen Buispaal	2.00	14.60	Steel	0.70

3.2.2 Stiffness EI (elastic behaviour)

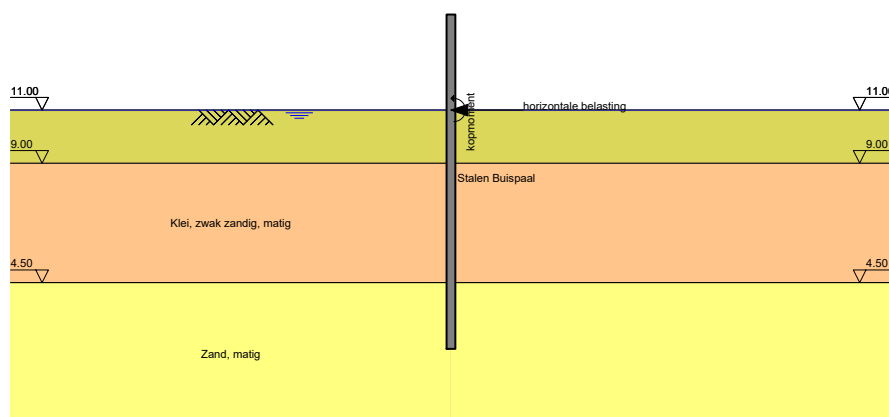
Section name	Elastic stiffness EI [kNm ²]	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
Stalen Buispaal	3.1300E+05	1.00	3.1300E+05	

3.2.3 Maximum allowable moments

Section name	Mr;char;el [kNm]	Modification factor [-]	Material factor [-]	Red. factor allow. moment [-]	Mr;d;el [kNm]
Stalen Buispaal	1490.00	1.00	1.00	1.00	1490.00

3.3 Outline

Outline



3.4 Horizontal Forces

Name	Level [m]	Load [kN]
horizontale bela...	11.00	-219.00

3.5 Moments

Name	Level [m]	Moment [kNm]
kopmoment	11.00	244.50

3.6 Water Level

Water level: 11.00 [m]

3.7 Surface

Surface level: 11.00 [m]

3.8 Soil Material Properties

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Brinch Hansen used
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, klei+puin...	14.00	18.50	20.50	0.00	27.00	Yes
Klei, zwak zand...	9.00	17.00	20.00	2.50	27.50	Yes
Zand, matig	4.50	18.00	20.00	0.00	32.50	Yes

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, klei+puin...	14.00	0.00	0.00	5.14	0.00	0.00
Klei, zwak zand...	9.00	0.00	0.00	7.90	0.00	0.00
Zand, matig	4.50	0.00	0.00	14.98	0.00	0.00

3.9 Soil Material Properties calculated using Brinch Hansen

Layer name	Level [m]	Fictive cohesion [kN/m ²]
Zand, klei+puin...	14.00	0.00
Klei, zwak zand...	9.00	13.86
Zand, matig	4.50	0.00

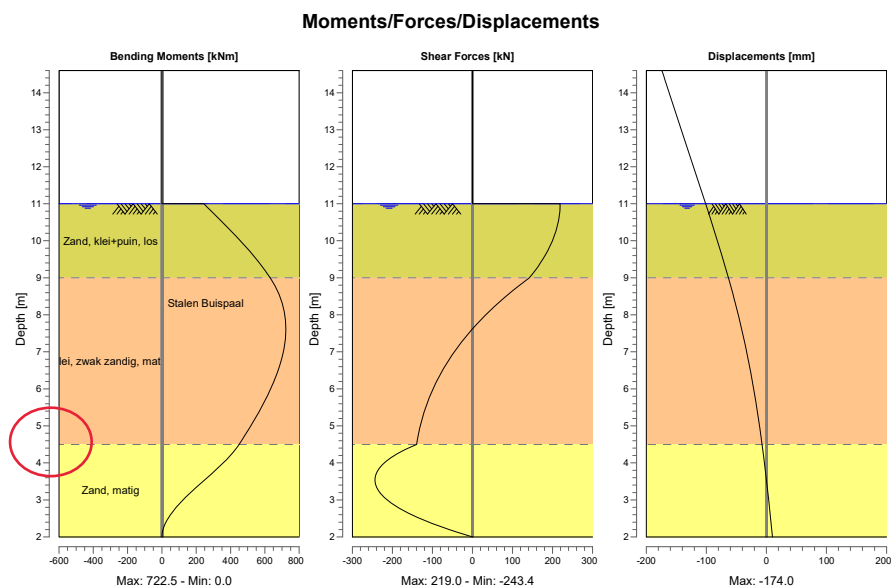
3.10 Modulus of Subgrade Reaction

Layer name	Level [m]	Ménard used	E-Mod Ménard [kN/m ²]	Soil type Ménard	Branch 1	
					Top [kN/m ³]	Bottom [kN/m ³]
Zand, klei+puin...	14.00	Yes	2500.00	Sand	10951.85	10951.85
Klei, zwak zand...	9.00	Yes	1000.00	Clay	2827.50	2827.50
Zand, matig	4.50	Yes	10000.00	Sand	43807.42	43807.42

4 Calculation Results

Number of iterations: 4

4.1 Charts of Moments, Forces and Displacements

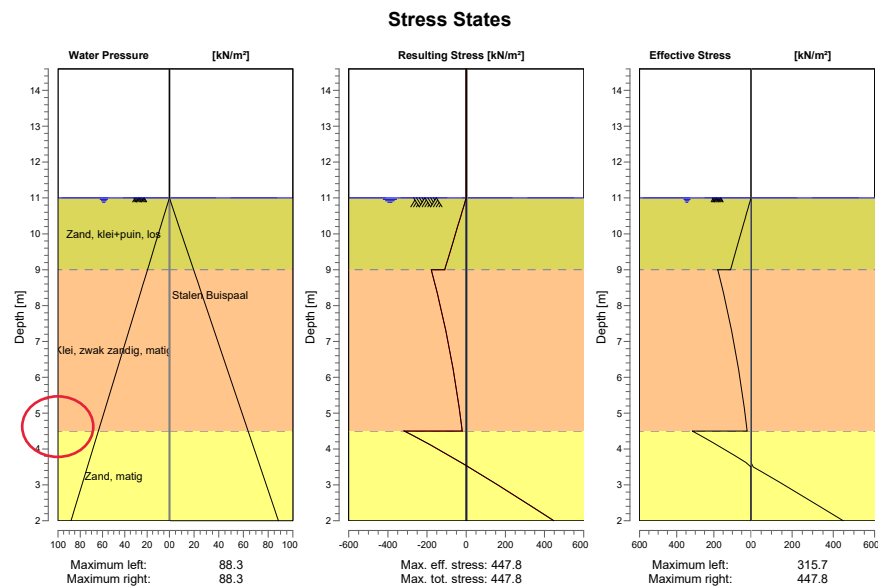


4.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14.60	0.00	0.00	-174.0
1	14.00	0.00	0.00	-161.9
2	14.00	0.00	0.00	-161.9
2	13.40	0.00	0.00	-149.8
3	13.40	0.00	0.00	-149.8
3	12.80	0.00	0.00	-137.6
4	12.80	0.00	0.00	-137.6
4	12.20	0.00	0.00	-125.5
5	12.20	0.00	0.00	-125.5
5	11.60	0.00	0.00	-113.4
6	11.60	0.00	0.00	-113.4
6	11.00	0.00	0.00	-101.2
7	11.00	244.50	219.00	-101.2
7	10.50	353.20	214.19	-91.2
8	10.50	353.20	214.19	-91.2
8	10.00	457.09	199.78	-81.5
9	10.00	457.09	199.78	-81.5
9	9.50	551.38	175.75	-72.2
10	9.50	551.38	175.75	-72.2
10	9.00	631.24	142.11	-63.3
11	9.00	631.24	142.12	-63.3
11	8.44	692.38	77.00	-53.8
12	8.44	692.38	77.01	-53.8
12	7.88	719.77	22.00	-45.1
13	7.88	719.77	22.01	-45.1
13	7.31	718.88	-23.68	-37.1

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
14	7.31	718.88	-23.68	-37.1
14	6.75	694.73	-60.86	-29.8
15	6.75	694.73	-60.85	-29.8
15	6.19	651.86	-90.32	-23.2
16	6.19	651.86	-90.32	-23.2
16	5.63	594.42	-112.84	-17.3
17	5.63	594.42	-112.84	-17.3
17	5.06	526.09	-129.10	-12.0
18	5.06	526.09	-129.10	-12.0
18	4.50	450.23	-139.74	-7.2
19	4.50	450.23	-139.73	-7.2
19	3.88	329.56	-231.12	-2.4
20	3.88	329.56	-231.10	-2.4
20	3.25	179.59	-234.78	2.0
21	3.25	179.59	-234.76	2.0
21	2.63	53.08	-156.81	6.1
22	2.63	53.08	-156.80	6.1
22	2.00	0.00	0.00	10.2
Max		719.77	-234.78	-174.0
Max, minor nodes incl.		722.52	-243.36	-174.0

4.3 Charts of Stresses



4.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]
1	14.60	0.00	0.00	-		0.00	0.00	-	
1	14.00	0.00	0.00	-		0.00	0.00	-	
2	14.00	0.00	0.00	-		0.00	0.00	-	
2	13.40	0.00	0.00	-		0.00	0.00	-	
3	13.40	0.00	0.00	-		0.00	0.00	-	
3	12.80	0.00	0.00	-		0.00	0.00	-	
4	12.80	0.00	0.00	-		0.00	0.00	-	

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
4	12.20	0.00	0.00	-		0.00	0.00	-	
5	12.20	0.00	0.00	-		0.00	0.00	-	
5	11.60	0.00	0.00	-		0.00	0.00	-	
6	11.60	0.00	0.00	-		0.00	0.00	-	
6	11.00	0.00	0.00	-		0.00	0.00	-	
7	11.00	0.00	0.00	P		0.00	0.00	A	
7	10.50	27.46	4.91	P		0.00	4.91	A	
8	10.50	27.46	4.91	P		0.00	4.91	A	
8	10.00	54.92	9.81	P		0.00	9.81	A	
9	10.00	54.92	9.81	P		0.00	9.81	A	
9	9.50	82.38	14.71	P		0.00	14.71	A	
10	9.50	82.38	14.71	P		0.00	14.71	A	
10	9.00	109.84	19.62	P		0.00	19.62	A	
11	9.00	178.84	19.62	-	72	0.00	19.62	A	
11	8.44	152.19	25.14	-	52	0.00	25.14	A	
12	8.44	152.19	25.14	-	52	0.00	25.14	A	
12	7.88	127.51	30.66	-	38	0.00	30.66	A	
13	7.88	127.51	30.66	-	38	0.00	30.66	A	
13	7.31	104.88	36.17	-	27	0.00	36.17	A	
14	7.31	104.88	36.17	-	27	0.00	36.17	A	
14	6.75	84.30	41.69	-	20	0.00	41.69	A	
15	6.75	84.30	41.69	-	20	0.00	41.69	A	
15	6.19	65.70	47.21	-	14	0.00	47.21	A	
16	6.19	65.70	47.21	-	14	0.00	47.21	A	
16	5.63	48.96	52.73	-	9	0.00	52.73	A	
17	5.63	48.96	52.73	-	9	0.00	52.73	A	
17	5.06	33.92	58.25	-	6	0.00	58.25	A	
18	5.06	33.92	58.25	-	6	0.00	58.25	A	
18	4.50	20.37	63.77	-	3	0.00	63.77	A	
19	4.50	315.67	63.77	-	31	0.00	63.77	A	
19	3.88	105.61	69.90	-	10	0.00	69.90	A	
20	3.88	105.61	69.90	-	10	0.00	69.90	A	
20	3.25	0.00	76.03	A		86.57	76.03	-	7
21	3.25	0.00	76.03	A		86.57	76.03	-	7
21	2.63	0.00	82.16	A		268.82	82.16	-	21
22	2.63	0.00	82.16	A		268.82	82.16	-	21
22	2.00	0.00	88.29	A		447.83	88.29	-	32

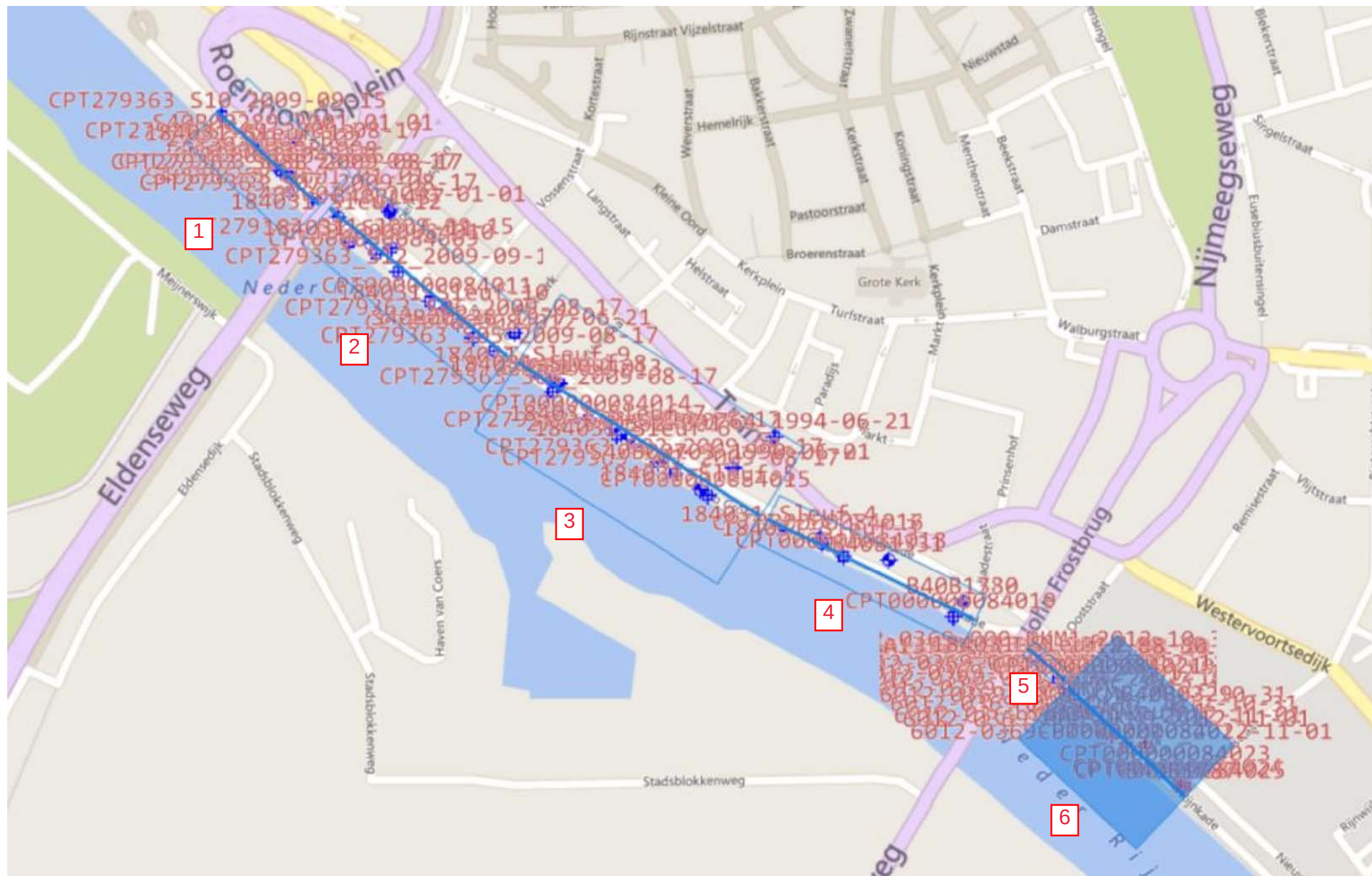
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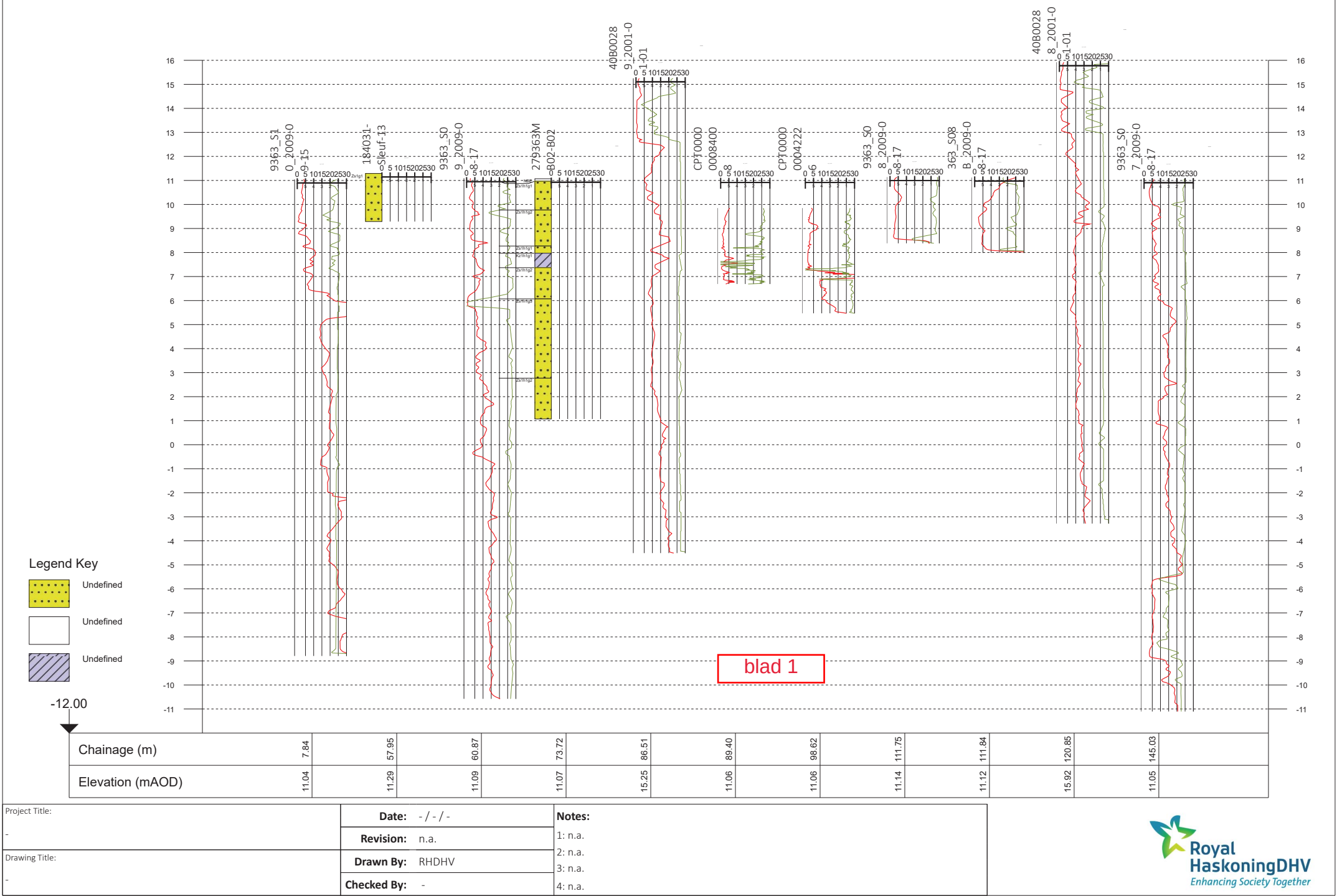
Stat
Mob

Status (A=active, P=passive, Number is branche, 0 is unloading)
Percentage passive mobilized

End of Report

B1 grondonderzoek Halebaze Grundlagen





Project Title:

-

Drawing Title:

-

Date:

- / - / -

Revision:

n.a.

Drawn By:

RHDHV

Checked By:

-

Notes:

1: n.a.

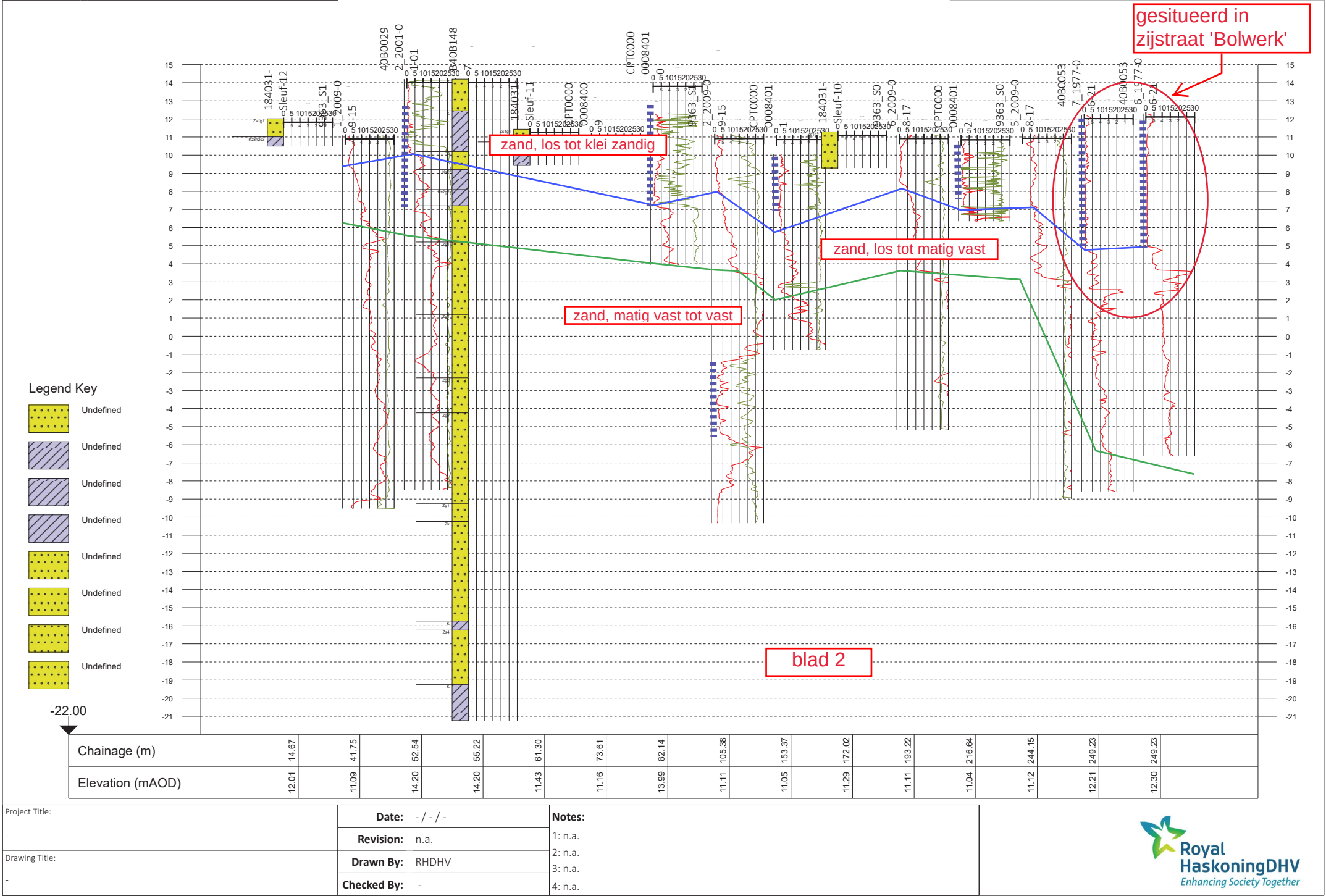
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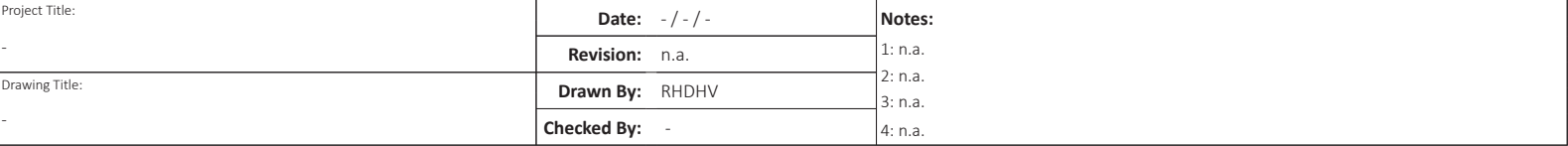
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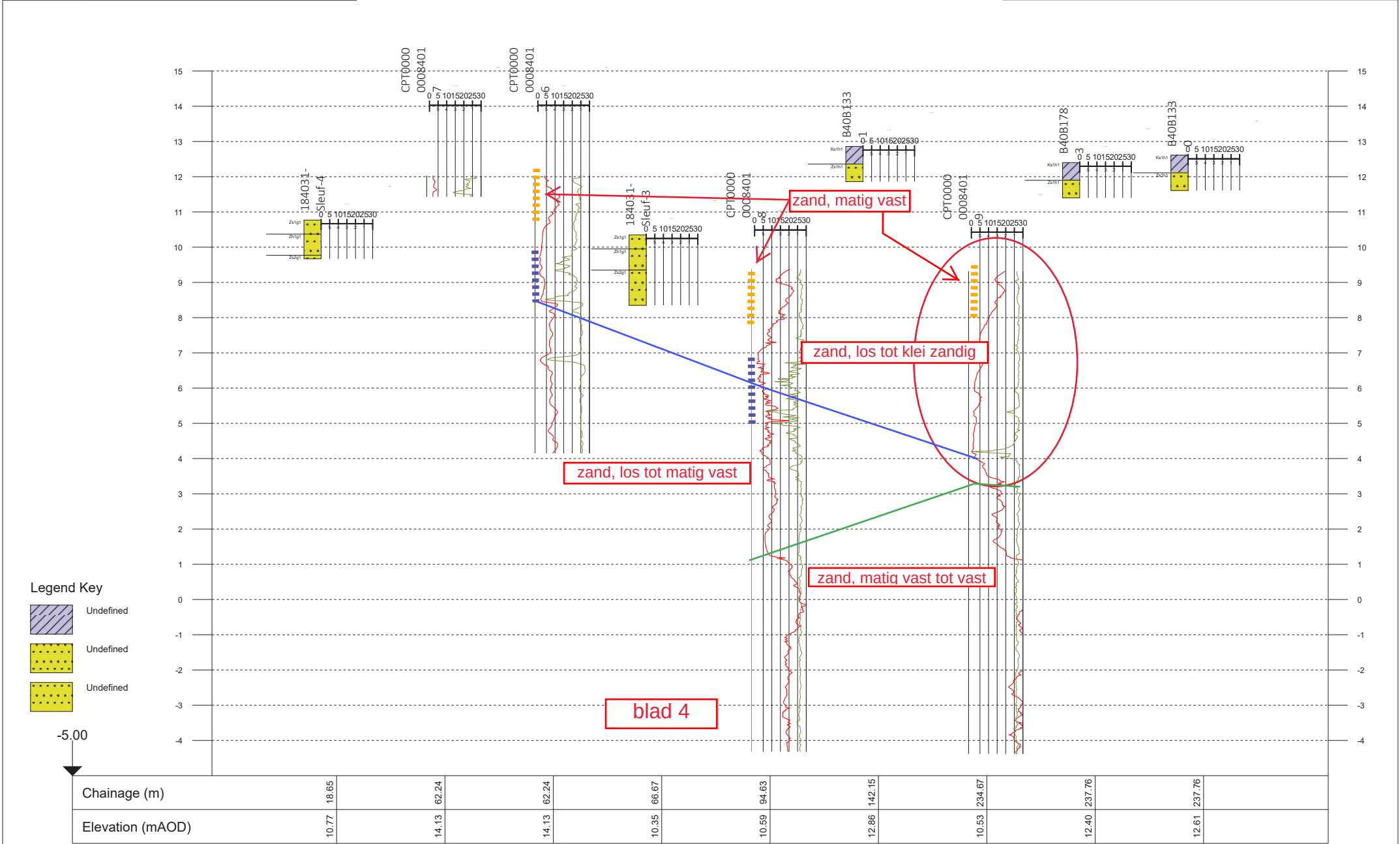
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Royal HaskoningDHV

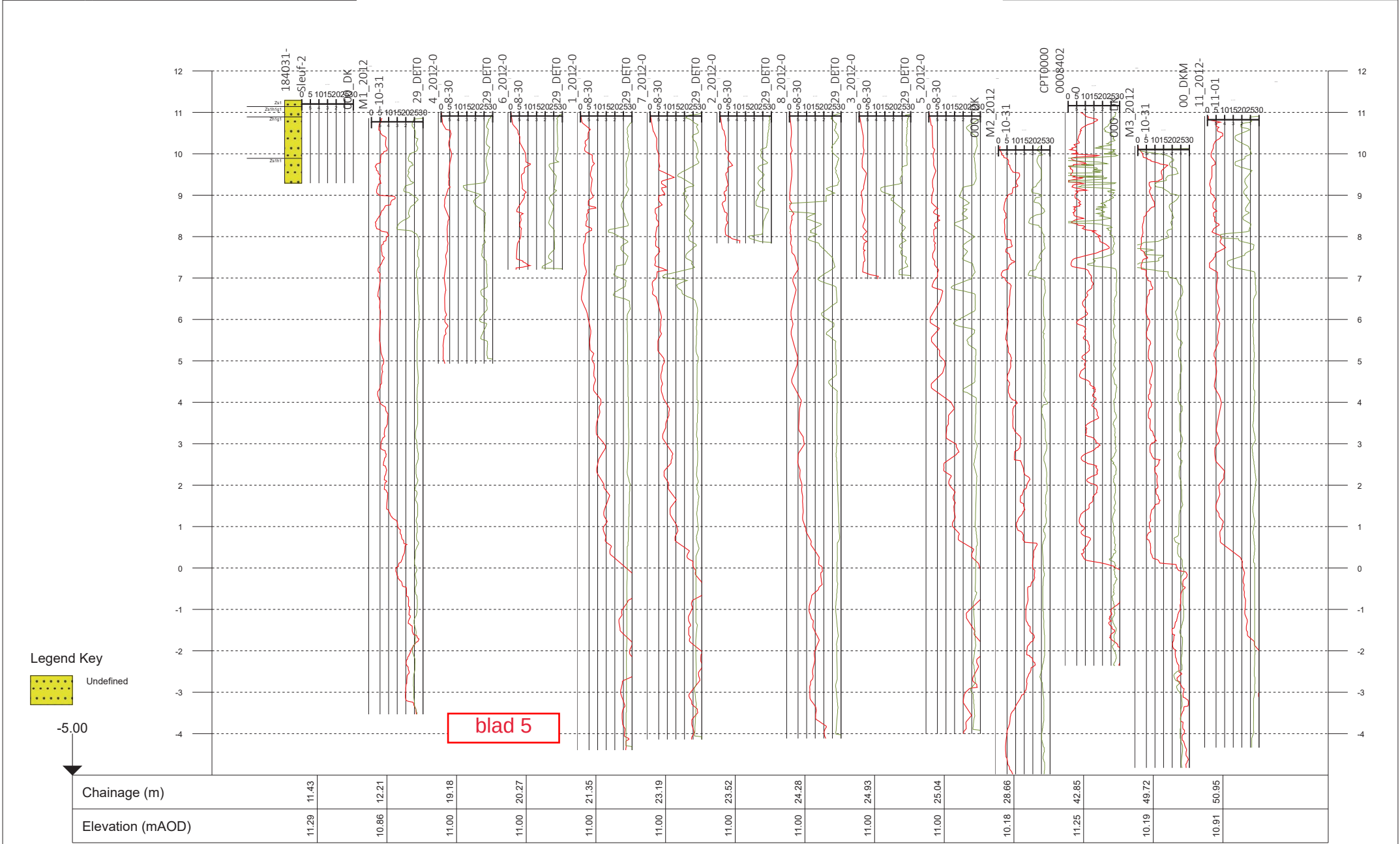
Enhancing Society Together



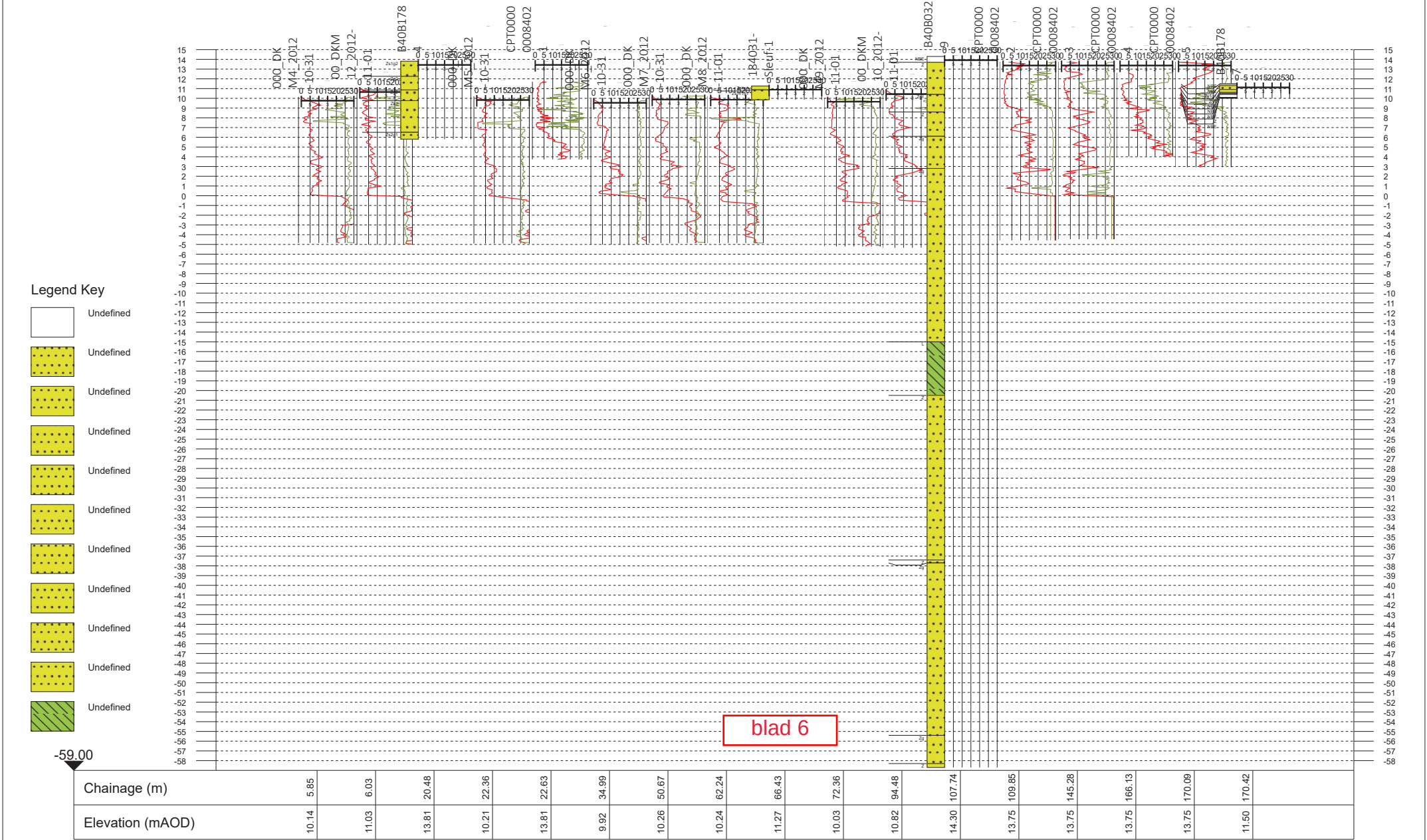




Project Title:	Date: - / - / -	Notes: 1: n.a. 2: n.a. 3: n.a. 4: n.a.
-	Revision: n.a.	
Drawing Title:	Drawn By: RHDHV	
-	Checked By: -	

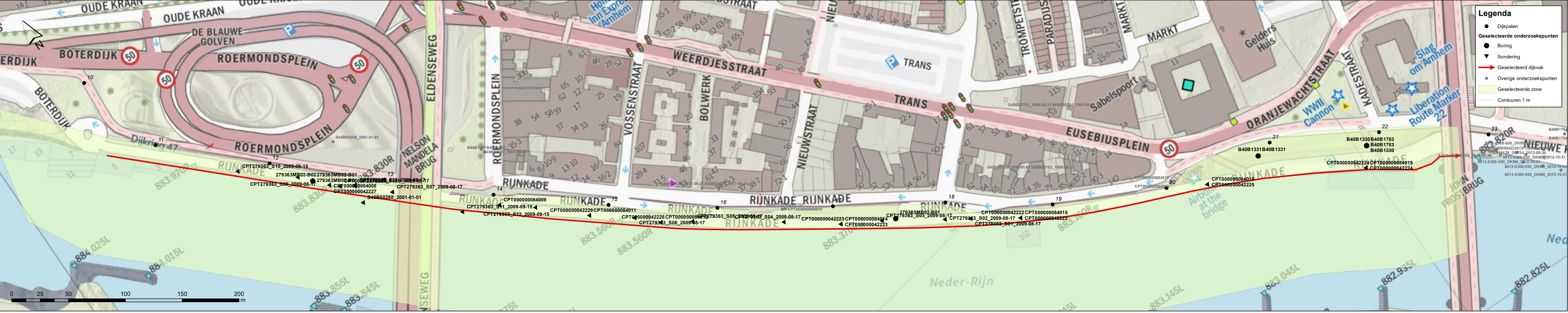
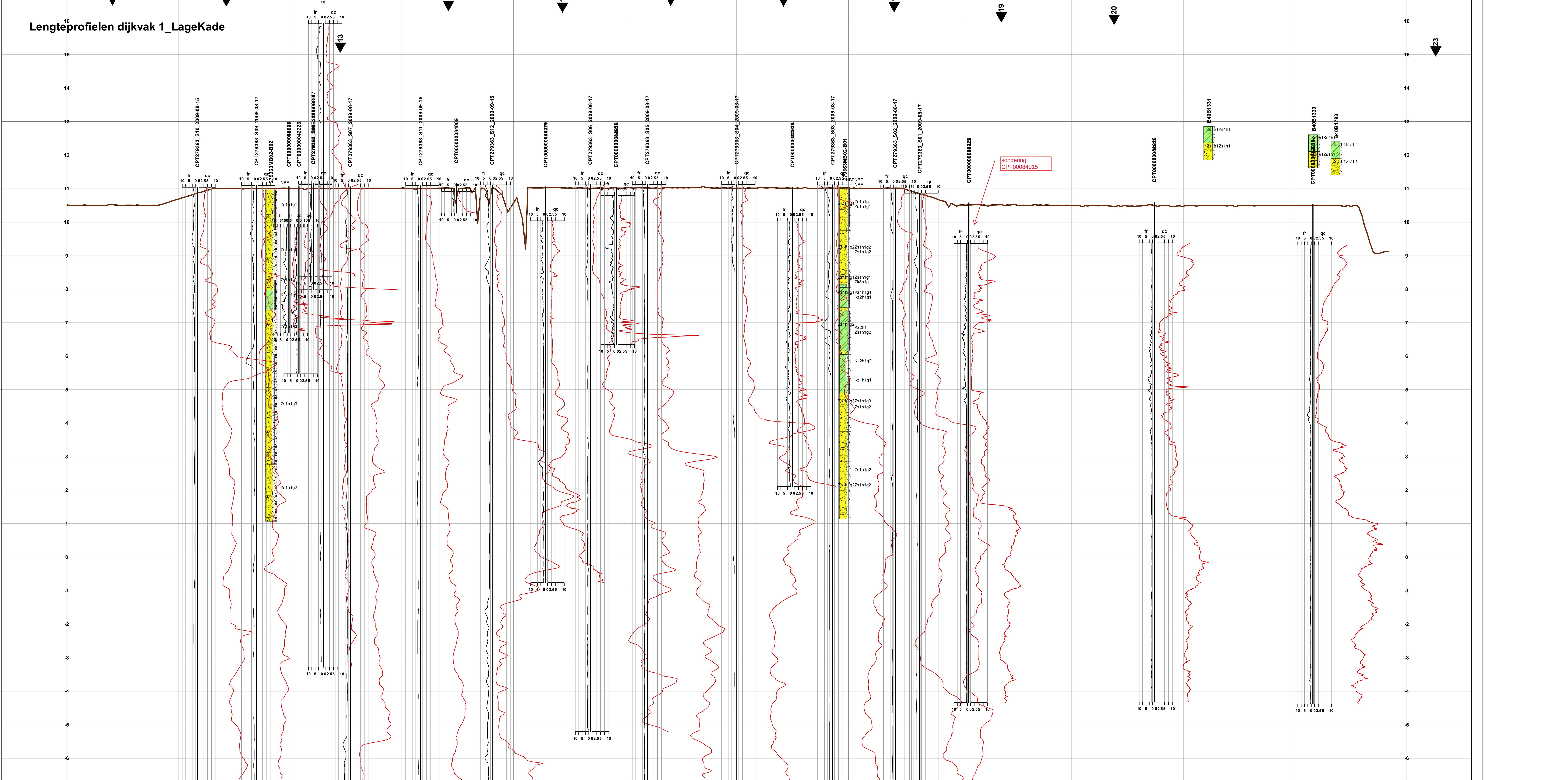


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-	Revision: n.a.	
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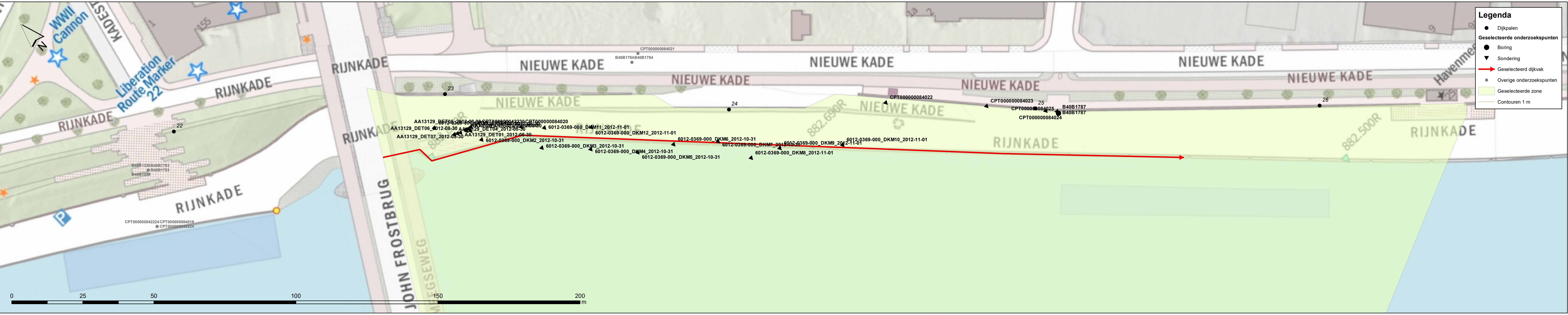
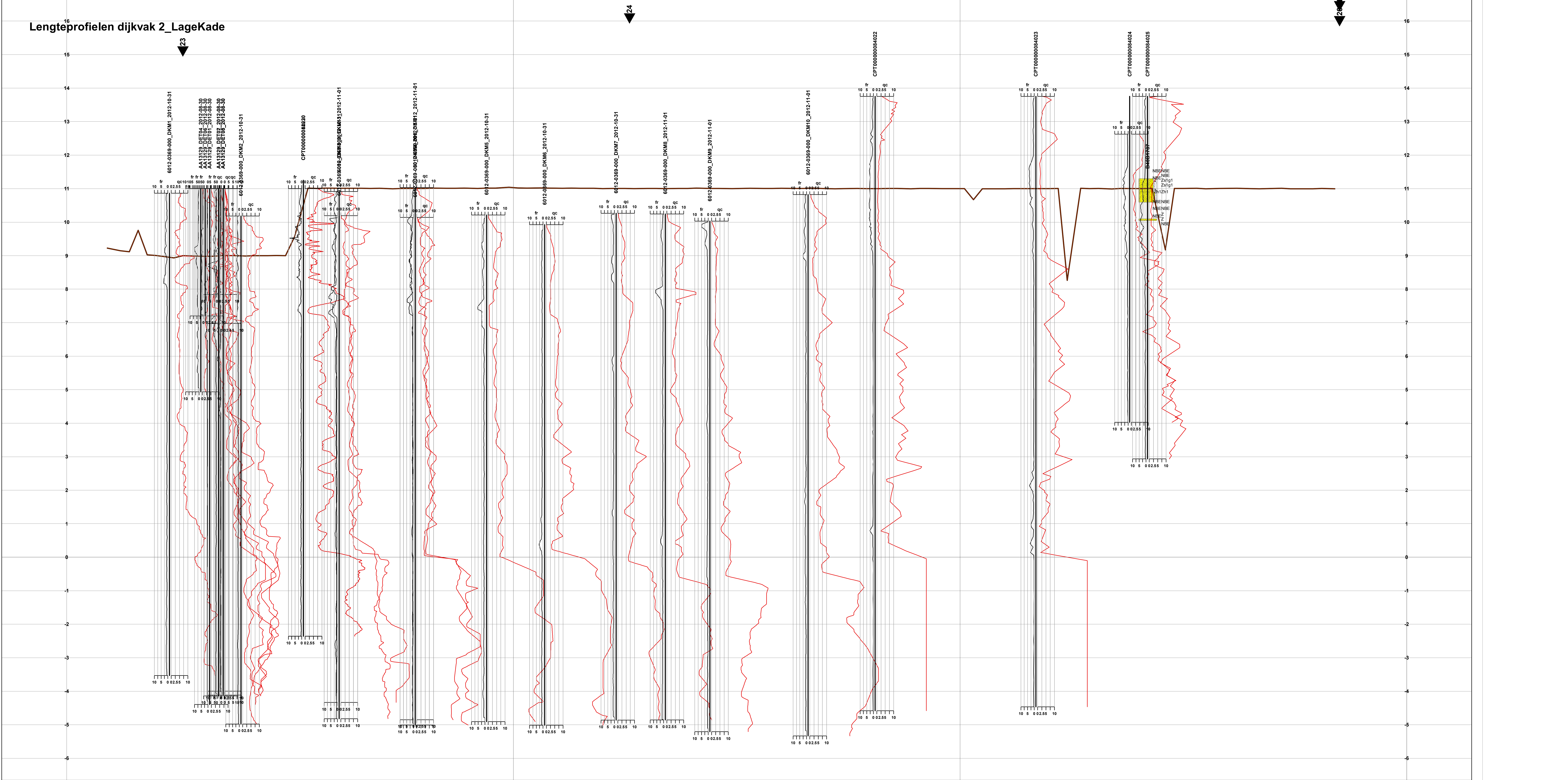


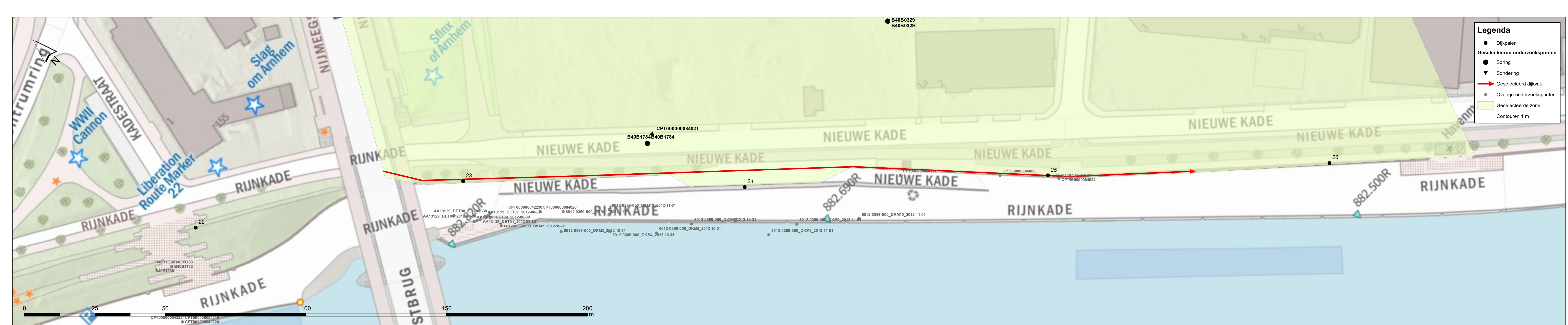
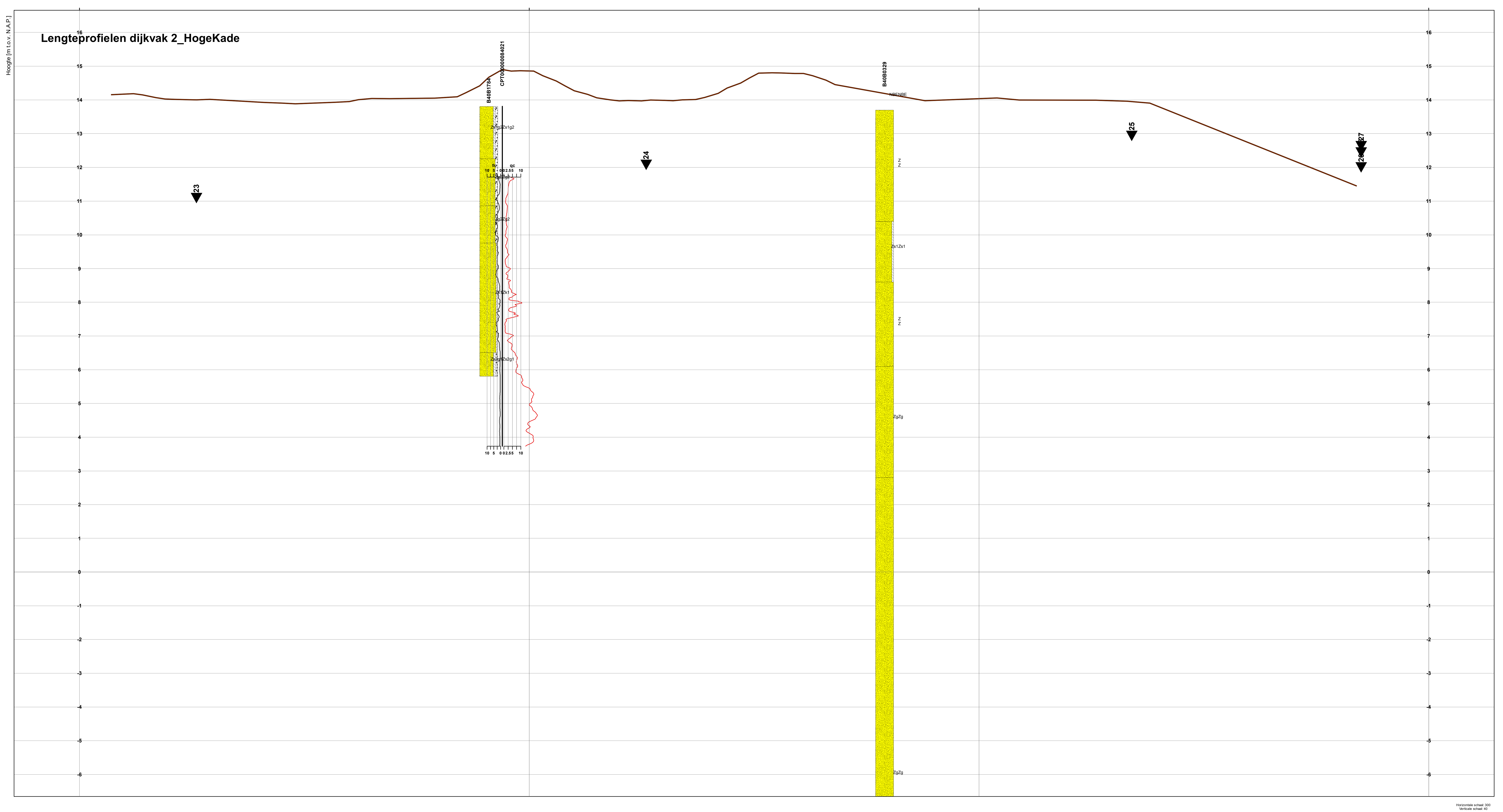
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-	Revision: n.a.	
Drawing Title:	Drawn By: RHDHV	
-	Checked By: -	

B2 geotechnisch profiel GIS









C2-1 Rapport vanuit D-Sheet som

Report for D-Sheet Piling 18.2

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 6/29/2020
Time of report: 12:36:57 PM
Report with version: 18.2.1.20477

Date of calculation: 6/29/2020
Time of calculation: 12:28:18 PM
Calculated with version: 18.2.1.20477

File name: C:\...\93 Werkmap Casper\D-Sheet\Final\Rijnkade_PPN-8_d0.3

Project identification: Testproject
Verticale wand op palen

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	Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
1	EC7(NL)-Step 6.1		-4.20	5.04	13.5	19.0	Not sufficient
1	EC7(NL)-Step 6.2		-3.68	5.00	13.5	19.1	Not sufficient
1	EC7(NL)-Step 6.3		-4.08	5.09	13.1	18.4	Not sufficient
1	EC7(NL)-Step 6.4		-3.63	5.03	13.2	18.5	Not sufficient
1	EC7(NL)-Step 6.5	-0.1	-1.16	2.06	9.6	13.5	Sufficient
1	EC7(NL)-Step 6.5 * 1.24		-1.44	2.55			
2	EC7(NL)-Step 6.1		49.74	-76.49	15.3	21.6	Not sufficient
2	EC7(NL)-Step 6.2		49.74	-73.59	15.5	22.4	Not sufficient
2	EC7(NL)-Step 6.3		49.74	-76.43	14.8	20.8	Not sufficient
2	EC7(NL)-Step 6.4		49.74	-73.57	15.0	21.6	Not sufficient
2	EC7(NL)-Step 6.5	-17.8	41.67	-55.88	10.3	15.3	Not sufficient
2	EC7(NL)-Step 6.5 * 1.24		51.67	-69.29			
3	EC7(NL)-Step 6.1		85.83	-108.01	15.2	21.1	Not sufficient
3	EC7(NL)-Step 6.2		86.38	-106.84	15.4	22.0	Not sufficient
3	EC7(NL)-Step 6.3		85.86	-107.98	14.7	20.4	Not sufficient
3	EC7(NL)-Step 6.4		86.39	-106.83	14.9	21.2	Not sufficient
3	EC7(NL)-Step 6.5	-17.2	96.08	-102.51	10.1	14.5	Not sufficient
3	EC7(NL)-Step 6.5 * 1.24		119.13	-127.11			
4	EC7(NL)-Step 6.1		85.78	-108.20	15.2	21.1	Not sufficient
4	EC7(NL)-Step 6.2		86.29	-107.09	15.4	22.0	Not sufficient
4	EC7(NL)-Step 6.3		85.80	-108.17	14.7	20.4	Not sufficient
4	EC7(NL)-Step 6.4		86.30	-107.07	14.9	21.2	Not sufficient
4	EC7(NL)-Step 6.5	-17.2	95.98	-102.74	10.1	14.5	Not sufficient
4	EC7(NL)-Step 6.5 * 1.24		119.02	-127.40			
5	EC7(NL)-Step 6.1		97.44	-115.27	17.5	24.7	Not sufficient
5	EC7(NL)-Step 6.2		101.92	-116.25	17.5	24.8	Not sufficient
5	EC7(NL)-Step 6.3		97.25	-114.71	17.5	25.2	Not sufficient
5	EC7(NL)-Step 6.4		100.38	-114.53	17.5	25.5	Not sufficient
5	EC7(NL)-Step 6.5	-17.0	100.03	-106.40	12.1	17.9	Not sufficient
5	EC7(NL)-Step 6.5 * 1.24		124.04	-131.93			
6	EC7(NL)-Step 6.1		101.43	-133.00	17.8	25.4	Not sufficient
6	EC7(NL)-Step 6.2		98.41	-131.12	18.0	25.9	Not sufficient
6	EC7(NL)-Step 6.3		100.08	-131.49	17.8	26.1	Not sufficient
6	EC7(NL)-Step 6.4		96.51	-129.18	18.0	26.6	Not sufficient
6	EC7(NL)-Step 6.5	-17.2	102.45	-112.23	12.2	18.4	Not sufficient
6	EC7(NL)-Step 6.5 * 1.24		127.04	-139.16			
7	EC7(NL)-Step 6.1		98.60	-124.17	15.1	20.4	Not sufficient
7	EC7(NL)-Step 6.2		99.22	-125.73	15.2	20.7	Not sufficient
7	EC7(NL)-Step 6.3		95.82	-122.36	14.9	20.7	Not sufficient
7	EC7(NL)-Step 6.4		96.20	-123.88	15.0	21.1	Not sufficient
7	EC7(NL)-Step 6.5	-16.9	100.42	-107.53	10.0	14.1	Not sufficient
7	EC7(NL)-Step 6.5 * 1.24		124.52	-133.34			
8	EC7(NL)-Step 6.1		99.28	-128.52	15.2	20.6	Not sufficient
8	EC7(NL)-Step 6.2		97.58	-128.00	15.3	21.0	Not sufficient
8	EC7(NL)-Step 6.3		96.53	-126.76	14.9	20.8	Not sufficient
8	EC7(NL)-Step 6.4		94.71	-126.18	15.1	21.2	Not sufficient
8	EC7(NL)-Step 6.5	-17.4	100.31	-108.57	10.1	14.2	Not sufficient
8	EC7(NL)-Step 6.5 * 1.24		124.38	-134.63			
9	EC7(NL)-Step 6.1		88.05	-114.69	14.5	20.7	Not sufficient
9	EC7(NL)-Step 6.2		93.13	-121.50	14.7	21.2	Not sufficient
9	EC7(NL)-Step 6.3		91.15	-116.94	14.7	21.4	Not sufficient
9	EC7(NL)-Step 6.4		95.02	-122.14	14.9	22.0	Not sufficient
9	EC7(NL)-Step 6.5	-16.8	93.66	-97.59	9.6	13.9	Not sufficient
9	EC7(NL)-Step 6.5 * 1.24		116.14	-121.01			
10	EC7(NL)-Step 6.1		89.73	-119.53	14.6	21.0	Not sufficient
10	EC7(NL)-Step 6.2		92.31	-123.89	14.8	21.6	Not sufficient
10	EC7(NL)-Step 6.3		92.77	-121.78	14.8	21.7	Not sufficient

Stage nr.	Verification	Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
10	EC7(NL)-Step 6.4		94.33	-124.58	15.0	22.2	Not sufficient
10	EC7(NL)-Step 6.5	-17.3	93.22	-100.68	9.7	14.2	Not sufficient
10	EC7(NL)-Step 6.5 * 1.24		115.59	-124.84			
11	EC7(NL)-Step 6.1		102.74	-132.33	17.1	24.3	Not sufficient
11	EC7(NL)-Step 6.2		102.80	-131.70	17.3	24.8	Not sufficient
11	EC7(NL)-Step 6.3		103.82	-140.91	17.5	25.3	Not sufficient
11	EC7(NL)-Step 6.4		103.90	-140.01	17.6	25.7	Not sufficient
11	EC7(NL)-Step 6.5	-18.9	93.82	-113.02	12.0	18.1	Not sufficient
11	EC7(NL)-Step 6.5 * 1.24		116.34	-140.15			
12	EC7(NL)-Step 6.1		141.08	-163.31	17.0	23.9	Not sufficient
12	EC7(NL)-Step 6.2		141.12	-162.43	17.2	24.5	Not sufficient
12	EC7(NL)-Step 6.3		142.15	-172.12	17.4	25.0	Not sufficient
12	EC7(NL)-Step 6.4		142.21	-171.03	17.5	25.3	Not sufficient
12	EC7(NL)-Step 6.5	-27.5	122.27	-136.97	11.9	17.9	Not sufficient
12	EC7(NL)-Step 6.5 * 1.24		151.61	-169.84			
13	EC7(NL)-Step 6.1		147.72	-155.42	13.2	17.2	Not sufficient
13	EC7(NL)-Step 6.2		153.35	-160.37	13.3	17.5	Not sufficient
13	EC7(NL)-Step 6.3		149.80	-162.68	13.0	17.1	Not sufficient
13	EC7(NL)-Step 6.4		156.07	-168.15	13.1	17.3	Not sufficient
13	EC7(NL)-Step 6.5	-26.3	134.29	-134.66	8.9	12.3	Not sufficient
13	EC7(NL)-Step 6.5 * 1.24		166.52	-166.98			
14	EC7(NL)-Step 6.1		148.22	-159.74	13.2	17.4	Not sufficient
14	EC7(NL)-Step 6.2		151.43	-162.56	13.3	17.8	Not sufficient
14	EC7(NL)-Step 6.3		150.30	-166.97	13.1	17.3	Not sufficient
14	EC7(NL)-Step 6.4		154.12	-170.32	13.1	17.6	Not sufficient
14	EC7(NL)-Step 6.5	-26.8	134.30	-135.72	8.9	12.4	Not sufficient
14	EC7(NL)-Step 6.5 * 1.24		166.53	-168.29			
15	EC7(NL)-Step 6.1		176.56	-160.76	13.5	15.6	Not sufficient
15	EC7(NL)-Step 6.2		178.99	-161.35	13.4	15.6	Not sufficient
15	EC7(NL)-Step 6.3		177.58	-164.52	13.3	15.7	Not sufficient
15	EC7(NL)-Step 6.4		178.82	-164.97	13.2	15.5	Not sufficient
15	EC7(NL)-Step 6.5	-25.6	159.01	-138.05	8.8	10.3	Not sufficient
15	EC7(NL)-Step 6.5 * 1.24		197.18	-171.19			
Max		-27.5	197.18	-172.12	18.0	26.6	Not sufficient

2.2 Anchors and Struts

Stage nr.	Verification type	Anchor/strut	
		Groutanker 50T	
		Force [kN]	State
1	EC7(NL)-Step 6.1	5.57	Elastic
1	EC7(NL)-Step 6.2	4.92	Elastic
1	EC7(NL)-Step 6.3	5.42	Elastic
1	EC7(NL)-Step 6.4	4.86	Elastic
1	EC7(NL)-Step 6.5 * 1.24	1.90	Elastic
2	EC7(NL)-Step 6.1	192.49	Elastic
2	EC7(NL)-Step 6.2	188.39	Elastic
2	EC7(NL)-Step 6.3	192.40	Elastic
2	EC7(NL)-Step 6.4	188.35	Elastic
2	EC7(NL)-Step 6.5 * 1.24	185.67	Elastic
3	EC7(NL)-Step 6.1	280.00	Elastic
3	EC7(NL)-Step 6.2	280.00	Elastic
3	EC7(NL)-Step 6.3	280.00	Elastic
3	EC7(NL)-Step 6.4	280.00	Elastic
3	EC7(NL)-Step 6.5 * 1.24	347.20	Elastic
4	EC7(NL)-Step 6.1	280.01	Elastic
4	EC7(NL)-Step 6.2	280.00	Elastic
4	EC7(NL)-Step 6.3	280.01	Elastic
4	EC7(NL)-Step 6.4	280.00	Elastic
4	EC7(NL)-Step 6.5 * 1.24	347.20	Elastic

Stage nr.	Verification type	Anchor/strut Groutanker 50T	
		Force [kN]	State
5	EC7(NL)-Step 6.1	290.92	Elastic
5	EC7(NL)-Step 6.2	289.62	Elastic
5	EC7(NL)-Step 6.3	290.41	Elastic
5	EC7(NL)-Step 6.4	287.32	Elastic
5	EC7(NL)-Step 6.5 * 1.24	352.07	Elastic
6	EC7(NL)-Step 6.1	329.10	Elastic
6	EC7(NL)-Step 6.2	324.21	Elastic
6	EC7(NL)-Step 6.3	326.06	Elastic
6	EC7(NL)-Step 6.4	320.30	Elastic
6	EC7(NL)-Step 6.5 * 1.24	362.93	Elastic
7	EC7(NL)-Step 6.1	315.23	Elastic
7	EC7(NL)-Step 6.2	319.23	Elastic
7	EC7(NL)-Step 6.3	311.24	Elastic
7	EC7(NL)-Step 6.4	315.00	Elastic
7	EC7(NL)-Step 6.5 * 1.24	353.16	Elastic
8	EC7(NL)-Step 6.1	324.73	Elastic
8	EC7(NL)-Step 6.2	322.68	Elastic
8	EC7(NL)-Step 6.3	320.88	Elastic
8	EC7(NL)-Step 6.4	318.54	Elastic
8	EC7(NL)-Step 6.5 * 1.24	359.11	Elastic
9	EC7(NL)-Step 6.1	294.29	Elastic
9	EC7(NL)-Step 6.2	311.61	Elastic
9	EC7(NL)-Step 6.3	297.17	Elastic
9	EC7(NL)-Step 6.4	309.96	Elastic
9	EC7(NL)-Step 6.5 * 1.24	333.55	Elastic
10	EC7(NL)-Step 6.1	304.68	Elastic
10	EC7(NL)-Step 6.2	315.37	Elastic
10	EC7(NL)-Step 6.3	307.64	Elastic
10	EC7(NL)-Step 6.4	313.78	Elastic
10	EC7(NL)-Step 6.5 * 1.24	340.84	Elastic
11	EC7(NL)-Step 6.1	351.65	Elastic
11	EC7(NL)-Step 6.2	350.72	Elastic
11	EC7(NL)-Step 6.3	369.35	Elastic
11	EC7(NL)-Step 6.4	368.08	Elastic
11	EC7(NL)-Step 6.5 * 1.24	386.55	Elastic
12	EC7(NL)-Step 6.1	443.55	Elastic
12	EC7(NL)-Step 6.2	442.27	Elastic
12	EC7(NL)-Step 6.3	461.60	Elastic
12	EC7(NL)-Step 6.4	460.05	Elastic
12	EC7(NL)-Step 6.5 * 1.24	473.42	Elastic
13	EC7(NL)-Step 6.1	417.96	Elastic
13	EC7(NL)-Step 6.2	432.91	Elastic
13	EC7(NL)-Step 6.3	432.95	Elastic
13	EC7(NL)-Step 6.4	449.57	Elastic
13	EC7(NL)-Step 6.5 * 1.24	452.74	Elastic
14	EC7(NL)-Step 6.1	427.31	Elastic
14	EC7(NL)-Step 6.2	436.29	Elastic
14	EC7(NL)-Step 6.3	442.27	Elastic
14	EC7(NL)-Step 6.4	452.93	Elastic
14	EC7(NL)-Step 6.5 * 1.24	458.67	Elastic
15	EC7(NL)-Step 6.1	441.61	Elastic
15	EC7(NL)-Step 6.2	442.58	Elastic
15	EC7(NL)-Step 6.3	453.52	Elastic
15	EC7(NL)-Step 6.4	456.96	Elastic
15	EC7(NL)-Step 6.5 * 1.24	472.82	Elastic
Max		473.42	

Due to multiplication of the representative value a force bigger than yield or buckling force may be present.

2.3 Overall Stability per Stage

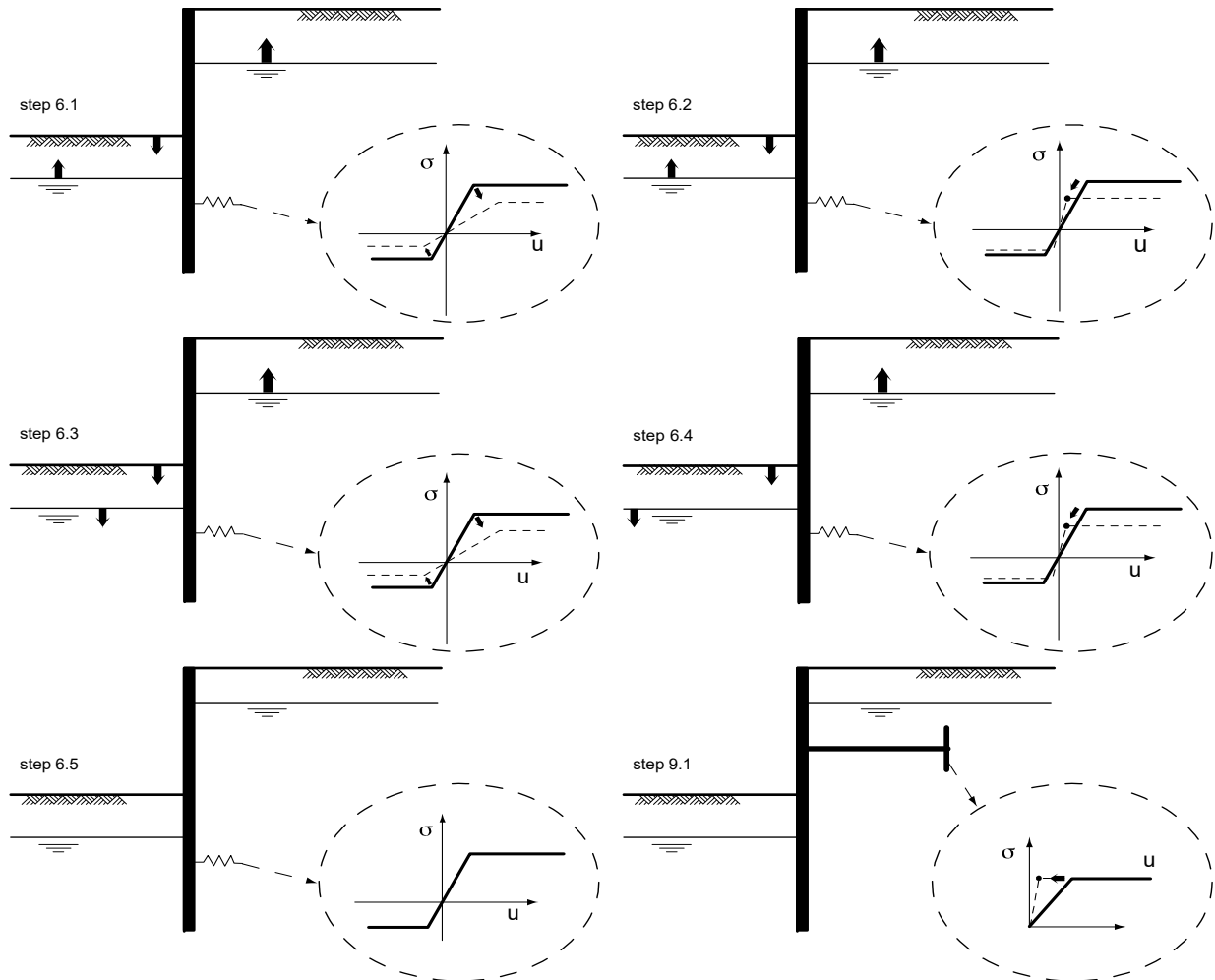
Stage name	Stability factor [-]
2a - Initial Stage	2.93
2b - Aanvullen tot maaiveld	2.93
2c - Ankers op spanning	2.93
2d - Bekleding betonwand	2.93
4a - geen verkeersbelasting 10.5/11.5m	2.25
4b - Aanbrengen verkeersbelasting 10.5/11.5m	2.25
4a - geen verkeersbelasting 8.5m	2.93
4b - Aanbrengen verkeersbelasting 8.5m	2.93
4a - geen verkeersbelasting 14.2/14m	3.95
4b - Aanbrengen verkeersbelasting 14.2/14m	3.93
4a - geen verkeersbelasting 12.2/14m	2.36
4b - Aanbrengen verkeersbelasting 12.2/14m	2.37
4a - geen verkeersbelasting 6.0m	3.48
4b - Aanbrengen verkeersbelasting 6.0m	3.48
7a - 8.5m erosiekrater, lage kade -1m	2.38

2.4 Warnings

* Vertical stability

The vertical balance cannot be calculated correctly under combined walls. It is not possible to indicate CPT resistances for both toe levels. The calculation only takes into account the lower toe resistance, the upper toe resistance is neglected.

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/m ³
Number of curves for spring characteristics	3
Unloading curve on spring characteristic	No
Elastic calculation	Yes

3.2 Sheet Piling Properties

Length	12.40 m
Level top side	14.90 m
Number of sections	2
q _b ;max	1.00 MPa
Xi factor	1.39

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Acting width [m]
Betonmuur	9.50	14.90	Concrete	2.80
Buispalen staal ...	2.50	9.50	Steel	0.20

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm ² /m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
Betonmuur	1.0000E+06	1.00	2.8000E+06	
Buispalen staal ...	4.5660E+03	1.00	9.1320E+02	

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]
Betonmuur	0.00	1.00	1.10	1.00	0.00
Buispalen staal ...	0.00	1.00	1.00	1.00	0.00

3.2.4 Properties for vertical balance

Section name	From [m]	To [m]	Height [mm]	Coating area [m ² /m ² wall]	Section area [cm ² /m']
Betonmuur	9.50	14.90	500.00	1.00	700.00
Buispalen staal ...	2.50	9.50	200.00	1.00	50.00

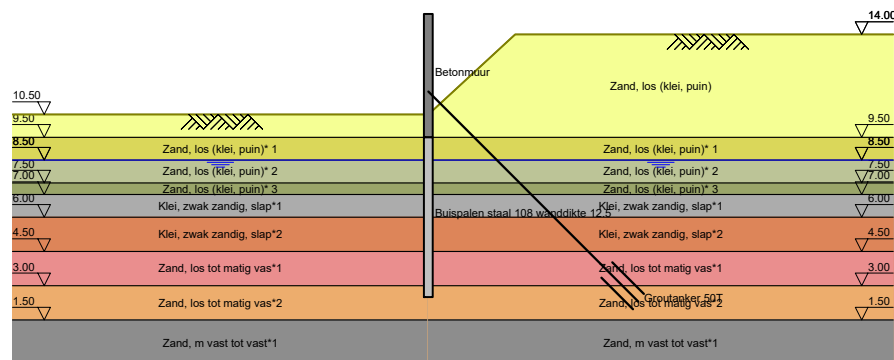
3.3 Calculation Options

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

Multiplication factor for anchor stiffness	1.000
Used partial factor set	RC 2
Factors on loads	
- Permanent load, unfavourable	1.00
- Permanent load, favourable	1.00
- Variable load, unfavourable	1.10
- Variable load, favourable	0.00
Factors on representative values	
- Partial factor on M, D and Pmax	1.24 User defined
Material factors	
- Cohesion	1.29 User defined
- Tangent phi	1.21 User defined
- Delta (wall friction angle)	1.21 User defined
- Modulus of low representative subgrade reaction	1.34 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
Overall stability factors	
- Cohesion	1.49 User defined
- Tangent phi	1.29 User defined
- Factor on unit weight soil	1.03 User defined
Vertical balance factors	
- Partial factor base resistance (gamma_b)	1.24 User defined

4 Outline Stage 1: 2a - Initial Stage

Outline - Stage 1: 2a - Initial Stage

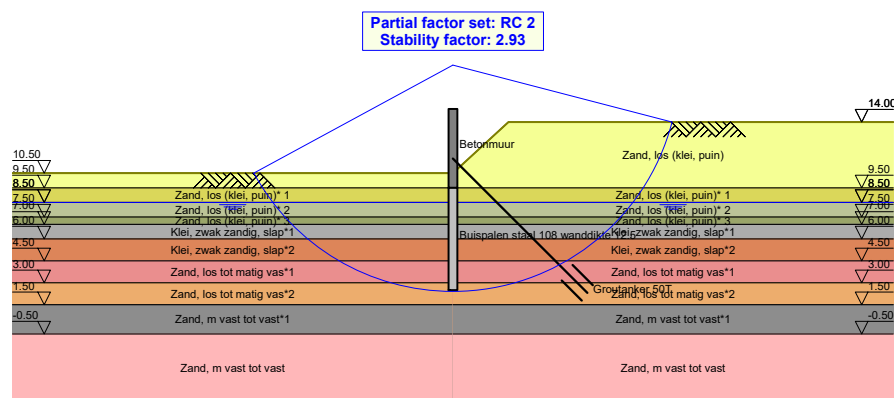


5 Overall Stability Stage 1: 2a - Initial Stage

Stability factor : 2.93

5.1 Overall Stability

Overall Stability - Stage 1: 2a - Initial Stage



6 Step 6.1 Stage 1: 2a - Initial Stage

6.1 Input Data Left

6.1.1 Calculation Method

Calculation method: C, phi, delta

6.1.2 Water Level

Water level: 8.75 [m]

6.1.3 Surface

X [m]	Y [m]
0.00	10.50

6.1.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, los (klei, ...)	14.00	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	9.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	8.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	7.50	18.00	20.00	0.00	22.84	15.22
Klei, zwak zand...	7.00	16.00	16.00	0.00	18.90	6.30
Klei, zwak zand...	6.00	16.00	16.00	0.00	18.90	6.30
Zand, los tot m...	4.50	17.00	19.00	0.00	25.51	17.00
Zand, los tot m...	3.00	17.00	19.00	0.00	25.51	17.00
Zand, m vast to...	1.50	18.00	20.00	0.00	27.77	18.51
Zand, m vast to...	-0.50	18.00	20.00	0.00	27.77	18.51

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...)	14.00	1.00	1.00	Fine
Zand, los (klei, ...)	9.50	1.77	1.00	Fine
Zand, los (klei, ...)	8.50	2.01	1.00	Fine
Zand, los (klei, ...)	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

6.1.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m³]	Bottom [kN/m³]	Top [kN/m³]	Bottom [kN/m³]
Zand, los (klei, ...	14.00	8955.22	8955.22	4477.61	4477.61
Zand, los (klei, ...	9.50	7667.80	7667.80	3833.24	3833.24
Zand, los (klei, ...	8.50	7683.00	7683.00	3841.50	3841.50
Zand, los (klei, ...	7.50	7673.13	7673.13	3836.57	3836.57
Klei, zwak zand...	7.00	8478.94	8478.94	2293.95	4239.47
Klei, zwak zand...	6.00	8474.44	8474.44	4238.13	4238.13
Zand, los tot m...	4.50	34992.06	34992.06	17496.03	17496.03
Zand, los tot m...	3.00	34951.21	34951.21	17474.61	17474.61
Zand, m vast to...	1.50	1005.66	1005.65	502.83	502.83
Zand, m vast to...	-0.50	70000.00	70000.00	35000.00	35000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m³]	Bottom [kN/m³]
Zand, los (klei, ...	14.00	2238.81	2238.81
Zand, los (klei, ...	9.50	1916.62	1916.62
Zand, los (klei, ...	8.50	1920.00	1920.00
Zand, los (klei, ...	7.50	1917.49	1917.49
Klei, zwak zand...	7.00	2118.85	2118.85
Klei, zwak zand...	6.00	2119.07	2119.07
Zand, los tot m...	4.50	8748.01	8748.01
Zand, los tot m...	3.00	8738.30	8738.30
Zand, m vast to...	1.50	251.41	251.41
Zand, m vast to...	-0.50	17500.00	17500.00

6.2 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	10.48	0.2	1.2	0.43	2.93	3.37
2	10.46	0.3	2.4	0.38	2.93	3.37
3	10.44	0.4	3.6	0.38	2.93	3.37
4	10.42	0.5	4.9	0.38	2.93	3.37
5	10.40	0.6	5.8	0.38	2.93	3.37
6	10.40	0.7	6.5	0.38	2.93	3.37
7	10.37	0.9	7.9	0.38	2.75	3.37
8	10.34	1.1	9.7	0.38	2.63	3.37
9	10.31	1.3	11.5	0.38	2.55	3.37
10	10.28	1.5	13.3	0.38	2.47	3.37
11	10.25	1.7	14.7	0.38	2.39	3.37
12	10.25	1.8	16.3	0.38	2.39	3.37
13	10.18	2.2	19.7	0.38	2.24	3.37
14	10.10	2.7	24.3	0.38	2.13	3.37
15	10.03	3.2	28.8	0.38	2.02	3.37
16	9.95	3.7	33.4	0.38	1.94	3.37
17	9.88	4.1	36.8	0.38	1.87	3.37
18	9.88	4.4	39.0	0.38	1.87	3.37
19	9.80	4.8	42.5	0.38	1.80	3.37
20	9.72	5.3	47.0	0.38	1.74	3.37
21	9.65	5.8	51.6	0.38	1.69	3.37
22	9.57	6.3	56.1	0.38	1.64	3.37
23	9.50	6.7	59.5	0.21	1.60	5.96
24	9.50	6.9	61.7	0.21	1.60	5.96
25	9.43	7.3	64.7	0.21	1.56	5.96
26	9.37	7.7	68.7	0.21	1.53	5.96
27	9.30	8.2	72.7	0.21	1.50	5.96
28	9.24	8.6	76.7	0.21	1.47	5.96
29	9.17	8.9	79.7	0.21	1.44	5.96
30	9.17	9.3	82.6	0.21	1.44	5.96
31	9.05	9.9	88.2	0.21	1.39	5.96

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
32	8.92	10.8	95.7	0.21	1.35	5.96
33	8.80	11.6	103.2	0.21	1.31	5.96
34	8.67	12.2	108.8	0.21	1.29	5.95
35	8.55	12.6	112.0	0.21	1.29	5.95
36	8.55	12.7	113.1	0.21	1.29	5.95
37	8.54	12.7	113.4	0.21	1.29	5.95
38	8.53	12.8	113.7	0.21	1.29	5.95
39	8.52	12.8	114.0	0.21	1.29	5.95
40	8.51	12.8	114.4	0.21	1.29	5.95
41	8.50	12.9	114.6	0.19	1.29	6.75
42	8.50	12.9	115.2	0.19	1.29	6.75
43	8.45	13.1	116.5	0.19	1.29	6.75
44	8.40	13.3	118.2	0.19	1.28	6.75
45	8.35	13.5	119.9	0.19	1.28	6.76
46	8.30	13.7	121.6	0.19	1.27	6.76
47	8.25	13.8	122.9	0.19	1.26	6.76
48	8.25	13.9	124.0	0.19	1.26	6.76
49	8.18	14.1	125.9	0.19	1.25	6.76
50	8.10	14.4	128.5	0.19	1.24	6.76
51	8.03	14.7	131.0	0.19	1.23	6.76
52	7.95	15.0	133.6	0.19	1.22	6.76
53	7.88	15.2	135.6	0.19	1.21	6.76
54	7.88	15.4	136.8	0.19	1.21	6.76
55	7.80	15.6	138.8	0.19	1.21	6.76
56	7.72	15.9	141.3	0.19	1.20	6.76
57	7.65	16.2	143.9	0.19	1.19	6.76
58	7.58	16.5	146.5	0.19	1.18	6.76
59	7.50	16.7	148.4	0.18	1.17	7.13
60	7.50	16.8	149.9	0.18	1.17	7.13
61	7.40	17.1	152.5	0.18	1.16	7.13
62	7.30	17.5	155.9	0.18	1.15	7.13
63	7.20	17.9	159.4	0.18	1.14	7.13
64	7.10	18.3	162.8	0.18	1.12	7.13
65	7.00	18.6	165.4	0.16	1.12	8.02
66	7.00	23.5	116.0	0.20	1.12	5.59
67	6.91	23.7	117.0	0.20	1.19	5.59
68	6.81	24.0	118.2	0.20	1.19	5.58
69	6.71	24.3	119.4	0.20	1.18	5.57
70	6.62	24.6	120.7	0.20	1.17	5.57
71	6.53	24.8	121.6	0.20	1.17	5.56
72	6.53	24.9	122.2	0.20	1.17	5.56
73	6.43	25.1	123.2	0.20	1.16	5.55
74	6.33	25.4	124.4	0.20	1.16	5.55
75	6.24	25.7	125.7	0.20	1.15	5.54
76	6.14	26.0	127.0	0.20	1.15	5.54
77	6.05	26.2	127.9	0.20	1.14	5.54
78	6.05	26.2	128.3	0.20	1.14	5.53
79	6.04	26.3	128.4	0.20	1.14	5.53
80	6.03	26.3	128.5	0.20	1.14	5.53
81	6.02	26.3	128.6	0.20	1.14	5.53
82	6.01	26.4	128.8	0.20	1.14	5.53
83	6.00	26.4	128.9	0.20	1.14	5.72
84	6.00	26.4	129.1	0.20	1.14	5.72
85	5.95	26.5	129.6	0.20	1.13	5.72
86	5.90	26.7	130.2	0.20	1.13	5.71
87	5.85	26.8	130.9	0.20	1.13	5.71
88	5.80	27.0	131.6	0.20	1.13	5.71
89	5.75	27.1	132.1	0.20	1.12	5.71
90	5.75	27.2	132.5	0.20	1.12	5.71
91	5.67	27.4	133.4	0.19	1.12	5.70
92	5.58	27.6	134.5	0.19	1.11	5.70
93	5.50	27.9	135.6	0.19	1.11	5.70
94	5.42	28.1	136.7	0.19	1.10	5.69
95	5.33	28.3	137.6	0.19	1.10	5.69

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
96	5.33	28.4	138.1	0.19	1.10	5.69
97	5.25	28.6	139.0	0.19	1.10	5.69
98	5.17	28.8	140.1	0.19	1.09	5.69
99	5.08	29.1	141.2	0.19	1.09	5.68
100	5.00	29.3	142.4	0.19	1.08	5.68
101	4.92	29.5	143.2	0.19	1.08	5.68
102	4.92	29.6	143.8	0.19	1.08	5.68
103	4.83	29.8	144.6	0.19	1.07	5.68
104	4.75	30.1	145.8	0.19	1.07	5.67
105	4.67	30.3	146.9	0.19	1.07	5.67
106	4.58	30.6	148.0	0.19	1.06	5.67
107	4.50	30.7	148.9	0.18	1.05	5.97
108	4.50	22.0	270.4	0.13	1.05	10.78
109	4.40	22.2	272.7	0.13	0.93	10.75
110	4.30	22.5	275.8	0.13	0.92	10.73
111	4.20	22.8	279.0	0.13	0.91	10.70
112	4.10	23.1	282.3	0.13	0.91	10.68
113	4.00	23.4	284.7	0.13	0.90	10.67
114	4.00	23.5	286.4	0.13	0.90	10.66
115	3.90	23.8	289.0	0.13	0.90	10.65
116	3.80	24.1	292.4	0.13	0.89	10.64
117	3.70	24.4	295.8	0.13	0.88	10.63
118	3.60	24.7	299.3	0.13	0.88	10.62
119	3.50	24.9	301.9	0.13	0.87	10.61
120	3.50	25.1	303.7	0.13	0.87	10.60
121	3.40	25.3	306.3	0.13	0.87	10.60
122	3.30	25.6	309.9	0.13	0.86	10.59
123	3.20	25.9	313.5	0.13	0.86	10.58
124	3.10	26.3	317.0	0.13	0.85	10.58
125	3.00	26.5	319.7	0.13	0.85	10.86
126	3.00	26.6	321.5	0.13	0.85	10.86
127	2.90	26.9	324.2	0.13	0.84	10.85
128	2.80	27.2	327.8	0.13	0.84	10.85
129	2.70	27.5	331.5	0.13	0.83	10.85
130	2.60	27.8	335.1	0.13	0.83	10.84
131	2.50	28.0	337.8	0.13	0.83	10.84

6.3 Calculated force from a layer Left

Name	Force
Zand, los (klei, puin)	17.90
Zand, los (klei, puin)* 1	39.63
Zand, los (klei, puin)* 2	48.23
Zand, los (klei, puin)* 3	26.23
Klei, zwak zandig, slap*1	59.61
Klei, zwak zandig, slap*2	97.09
Zand, los tot matig vas*1	93.70
Zand, los tot matig vas*2	33.33
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

6.4 Input Data Right

6.4.1 Calculation Method

Calculation method: C, phi, delta

6.4.2 Water Level

Water level: 8.55 [m]

6.4.3 Surface

X [m]	Y [m]
0.00	10.50
3.80	14.00

6.4.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, los (klei, ...)	14.00	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	9.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	8.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	7.50	18.00	20.00	0.00	22.84	15.22
Klei, zwak zand...	7.00	16.00	16.00	0.00	18.90	6.30
Klei, zwak zand...	6.00	16.00	16.00	0.00	18.90	6.30
Zand, los tot m...	4.50	17.00	19.00	0.00	25.51	17.00
Zand, los tot m...	3.00	17.00	19.00	0.00	25.51	17.00
Zand, m vast to...	1.50	18.00	20.00	0.00	27.77	18.51
Zand, m vast to...	-0.50	18.00	20.00	0.00	27.77	18.51

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...)	14.00	1.00	1.00	Fine
Zand, los (klei, ...)	9.50	1.77	1.00	Fine
Zand, los (klei, ...)	8.50	2.01	1.00	Fine
Zand, los (klei, ...)	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

6.4.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	8955.22	8955.22	4477.61	4477.61
Zand, los (klei, ...)	9.50	7667.80	7667.80	3833.24	3833.24
Zand, los (klei, ...)	8.50	7683.00	7683.00	3841.50	3841.50
Zand, los (klei, ...)	7.50	7673.13	7673.13	3836.57	3836.57
Klei, zwak zand...	7.00	8478.94	8478.94	2293.95	4239.47
Klei, zwak zand...	6.00	8474.44	8474.44	4238.13	4238.13
Zand, los tot m...	4.50	34992.06	34992.06	17496.03	17496.03
Zand, los tot m...	3.00	34951.21	34951.21	17474.61	17474.61

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, m vast to...	1.50	1005.66	1005.65	502.83	502.83
Zand, m vast to...	-0.50	70000.00	70000.00	35000.00	35000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...	14.00	2238.81	2238.81
Zand, los (klei, ...	9.50	1916.62	1916.62
Zand, los (klei, ...	8.50	1920.00	1920.00
Zand, los (klei, ...	7.50	1917.49	1917.49
Klei, zwak zand...	7.00	2118.85	2118.85
Klei, zwak zand...	6.00	2119.07	2119.07
Zand, los tot m...	4.50	8748.01	8748.01
Zand, los tot m...	3.00	8738.30	8738.30
Zand, m vast to...	1.50	251.41	251.41
Zand, m vast to...	-0.50	17500.00	17500.00

6.4.6 Anchors

Name	Level [m]	E-Modulus [kN/m ²]	Cross section [m ² /m']	Length [m]	Angle [°]	Yield force [kN/m']	Pre-tension. force [kN/m']
Groutanker 50T	11.50	2.100E+08	7.010E-04	13.00	-45.00	10000.00	n.a.

6.5 Calculated Earth Pressure Coefficients Right

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10.48	15.0	24.8	10.79	10.79	17.82
2	10.46	15.2	49.6	8.56	8.56	27.88
3	10.44	15.5	74.4	7.02	7.02	33.78
4	10.42	15.7	99.2	5.89	5.89	37.24
5	10.40	15.9	117.8	5.22	5.22	38.84
6	10.40	16.0	133.4	4.77	4.77	39.78
7	10.37	16.2	161.3	4.12	4.12	40.96
8	10.34	16.6	198.5	3.49	3.49	41.82
9	10.31	16.9	235.7	3.03	3.03	42.31
10	10.28	17.2	272.9	2.69	2.69	42.61
11	10.25	17.5	300.8	2.48	2.48	42.76
12	10.25	17.7	333.4	2.28	2.28	42.89
13	10.18	18.3	403.2	1.96	1.96	43.09
14	10.10	19.1	496.2	1.67	1.67	43.24
15	10.03	19.9	589.2	1.46	1.46	43.34
16	9.95	20.6	682.3	1.31	1.31	43.42
17	9.88	21.2	752.1	1.23	1.23	43.47
18	9.88	21.6	685.2	1.18	1.18	37.32
19	9.80	22.1	455.2	1.11	1.14	22.82
20	9.72	22.9	377.7	1.04	1.10	17.13
21	9.65	23.6	349.1	0.98	1.07	14.45
22	9.57	24.3	334.9	0.93	1.04	12.75
23	9.50	24.8	328.6	0.50	1.02	20.90
24	9.50	25.2	325.9	0.49	1.02	20.03
25	9.43	25.6	323.4	0.48	0.99	18.96
26	9.37	26.2	321.4	0.46	0.97	17.77
27	9.30	26.8	320.6	0.45	0.96	16.77
28	9.24	27.4	320.8	0.43	0.94	15.92
29	9.17	27.9	321.3	0.43	0.92	15.37
30	9.17	28.3	322.1	0.42	0.92	14.88
31	9.05	29.1	324.4	0.40	0.89	14.06
32	8.92	30.2	328.3	0.39	0.87	13.14
33	8.80	31.3	333.0	0.37	0.84	12.40
34	8.67	32.3	338.3	0.36	0.82	11.78
35	8.55	33.1	342.5	0.35	0.80	11.37

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
36	8.55	33.4	344.0	0.35	0.80	11.24
37	8.54	33.4	344.2	0.35	0.80	11.22
38	8.53	33.5	344.4	0.35	0.80	11.18
39	8.52	33.5	344.6	0.35	0.80	11.15
40	8.51	33.6	344.8	0.35	0.80	11.12
41	8.50	33.6	345.0	0.30	0.80	12.61
42	8.50	33.7	345.3	0.30	0.80	12.55
43	8.45	33.9	346.1	0.30	0.80	12.43
44	8.40	34.2	347.2	0.30	0.79	12.27
45	8.35	34.5	348.4	0.30	0.79	12.12
46	8.30	34.8	349.6	0.29	0.78	11.97
47	8.25	35.0	350.5	0.29	0.78	11.87
48	8.25	35.1	351.3	0.29	0.78	11.78
49	8.18	35.4	352.8	0.29	0.77	11.63
50	8.10	35.8	354.8	0.29	0.76	11.45
51	8.03	36.2	356.8	0.28	0.76	11.27
52	7.95	36.6	358.9	0.28	0.75	11.11
53	7.88	36.9	360.5	0.28	0.74	11.00
54	7.88	37.1	361.6	0.28	0.74	10.92
55	7.80	37.3	363.2	0.28	0.74	10.81
56	7.72	37.7	365.4	0.27	0.73	10.67
57	7.65	38.1	367.7	0.27	0.73	10.54
58	7.58	38.4	369.9	0.27	0.72	10.42
59	7.50	38.7	371.6	0.25	0.71	10.90
60	7.50	38.9	373.0	0.25	0.71	10.83
61	7.40	39.3	375.3	0.25	0.71	10.71
62	7.30	39.8	378.4	0.25	0.70	10.57
63	7.20	40.2	381.5	0.24	0.69	10.43
64	7.10	40.7	384.7	0.24	0.69	10.30
65	7.00	41.0	387.1	0.22	0.69	11.46
66	7.00	46.3	330.8	0.24	0.69	9.72
67	6.91	46.7	329.1	0.24	0.73	9.57
68	6.81	47.2	326.8	0.24	0.72	9.38
69	6.71	47.7	324.6	0.24	0.72	9.19
70	6.62	48.2	322.3	0.24	0.71	9.01
71	6.53	48.5	320.6	0.24	0.71	8.88
72	6.53	48.8	319.5	0.24	0.71	8.79
73	6.43	49.1	317.8	0.24	0.70	8.67
74	6.33	49.6	315.5	0.24	0.70	8.50
75	6.24	50.1	313.2	0.24	0.70	8.34
76	6.14	50.5	310.9	0.24	0.69	8.19
77	6.05	50.9	309.2	0.24	0.69	8.07
78	6.05	51.0	308.6	0.24	0.69	8.03
79	6.04	51.1	308.4	0.24	0.69	8.02
80	6.03	51.1	308.2	0.24	0.69	8.01
81	6.02	51.2	307.9	0.24	0.69	7.99
82	6.01	51.2	307.7	0.24	0.69	7.97
83	6.00	51.2	307.5	0.23	0.69	8.23
84	6.00	51.3	307.2	0.23	0.69	8.21
85	5.95	51.5	306.3	0.23	0.68	8.15
86	5.90	51.7	305.1	0.23	0.68	8.07
87	5.85	52.0	303.9	0.23	0.68	7.99
88	5.80	52.2	302.7	0.23	0.68	7.92
89	5.75	52.4	301.8	0.23	0.68	7.86
90	5.75	52.6	300.9	0.23	0.68	7.81
91	5.67	52.9	299.4	0.23	0.67	7.72
92	5.58	53.3	297.4	0.23	0.67	7.60
93	5.50	53.7	295.4	0.23	0.67	7.48
94	5.42	54.0	293.4	0.23	0.67	7.37
95	5.33	54.3	291.9	0.23	0.66	7.29
96	5.33	54.5	290.9	0.23	0.66	7.23
97	5.25	54.8	289.4	0.23	0.66	7.15
98	5.17	55.2	288.4	0.23	0.66	7.07
99	5.08	55.6	289.5	0.23	0.66	7.04

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
100	5.00	56.0	290.7	0.22	0.65	7.01
101	4.92	56.3	291.5	0.22	0.65	6.99
102	4.92	56.5	292.1	0.22	0.65	6.97
103	4.83	56.8	292.9	0.22	0.65	6.95
104	4.75	57.1	294.0	0.22	0.65	6.93
105	4.67	57.5	295.2	0.22	0.65	6.90
106	4.58	60.1	296.3	0.23	0.64	6.88
107	4.50	57.5	297.2	0.21	0.64	7.24
108	4.50	45.8	424.3	0.17	0.64	10.28
109	4.40	49.0	431.9	0.18	0.56	10.38
110	4.30	49.2	442.0	0.17	0.56	10.50
111	4.20	49.5	452.1	0.17	0.56	10.63
112	4.10	49.7	462.3	0.17	0.56	10.75
113	4.00	49.9	469.9	0.17	0.56	10.84
114	4.00	50.1	475.0	0.17	0.56	10.90
115	3.90	50.2	482.6	0.17	0.55	10.99
116	3.80	50.5	492.8	0.17	0.55	11.11
117	3.70	50.7	503.0	0.17	0.55	11.22
118	3.60	51.0	513.3	0.17	0.55	11.34
119	3.50	55.0	520.9	0.18	0.55	11.42
120	3.50	51.7	526.0	0.17	0.55	11.48
121	3.40	49.4	533.7	0.16	0.54	11.56
122	3.30	51.8	544.0	0.17	0.54	11.67
123	3.20	52.0	554.2	0.16	0.54	11.78
124	3.10	52.3	564.5	0.16	0.54	11.88
125	3.00	56.0	572.2	0.17	0.54	12.29
126	3.00	49.0	577.3	0.15	0.54	12.34
127	2.90	52.8	585.0	0.16	0.53	12.42
128	2.80	52.9	595.3	0.16	0.53	12.53
129	2.70	53.1	603.3	0.16	0.53	12.58
130	2.60	53.2	606.6	0.16	0.53	12.54
131	2.50	53.3	609.0	0.15	0.53	12.51

6.6 Calculated force from a layer Right

Name	Force
Zand, los (klei, puin)	19.89
Zand, los (klei, puin)* 1	34.18
Zand, los (klei, puin)* 2	47.55
Zand, los (klei, puin)* 3	26.99
Klei, zwak zandig, slap*1	61.82
Klei, zwak zandig, slap*2	99.79
Zand, los tot matig vas*1	97.28
Zand, los tot matig vas*2	34.19
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

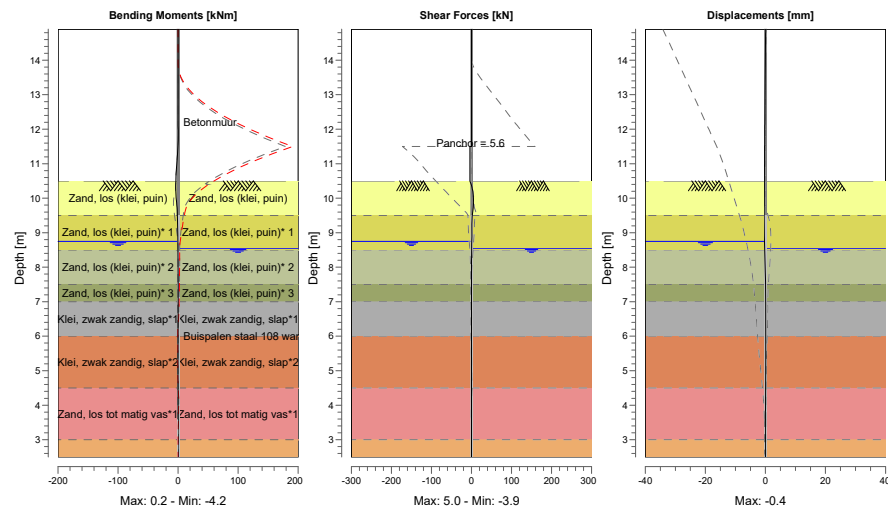
6.7 Calculation Results

Number of iterations: 3

6.7.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 1: 2a - Initial Stage

Step 6.1 - Partial factor set: RC 2



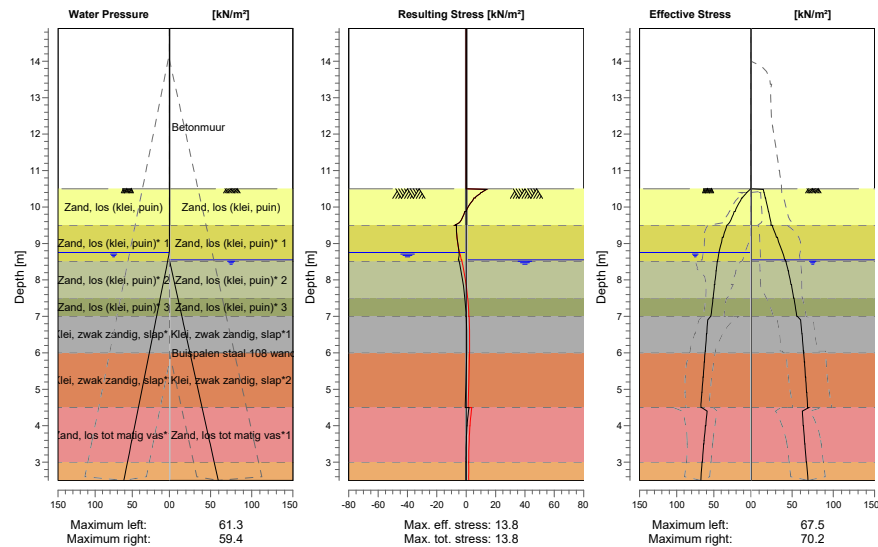
6.7.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14.90	0.00	0.00	0.1
1	14.55	0.00	0.00	0.0
2	14.55	0.00	0.00	0.0
2	14.20	0.00	0.00	0.0
3	14.20	0.00	0.00	0.0
3	14.05	0.00	0.00	0.0
4	14.05	0.00	0.00	0.0
4	14.00	0.00	0.00	0.0
5	14.00	0.00	0.00	0.0
5	13.95	0.00	0.00	0.0
6	13.95	0.00	0.00	0.0
6	13.37	0.00	0.00	-0.1
7	13.37	0.00	0.00	-0.1
7	12.78	0.00	0.00	-0.1
8	12.78	0.00	0.00	-0.1
8	12.20	0.00	0.00	-0.2
9	12.20	0.00	0.00	-0.2
9	11.95	0.00	0.00	-0.2
10	11.95	0.00	0.00	-0.2
10	11.55	0.00	0.00	-0.2
11	11.55	0.00	0.00	-0.2
11	11.50	0.00	0.00	-0.2
12	11.50	0.00	-3.94	-0.2
12	11.00	-1.97	-3.94	-0.3
13	11.00	-1.97	-3.94	-0.3
13	10.50	-3.94	-3.94	-0.3
14	10.50	-3.94	-3.94	-0.3
14	10.40	-4.18	-0.85	-0.3
15	10.40	-4.18	-0.85	-0.3
15	10.25	-4.03	2.54	-0.4
16	10.25	-4.03	2.54	-0.4

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
16	9.88	-2.42	5.04	-0.4
17	9.88	-2.42	5.04	-0.4
17	9.50	-0.98	1.62	-0.4
18	9.50	-0.98	1.62	-0.4
18	9.17	-0.51	1.19	-0.4
19	9.17	-0.51	1.19	-0.4
19	8.55	0.01	0.52	-0.2
20	8.55	0.01	0.52	-0.2
20	8.50	0.03	0.47	-0.2
21	8.50	0.03	0.47	-0.2
21	8.25	0.12	0.26	-0.1
22	8.25	0.12	0.26	-0.1
22	7.88	0.18	0.05	0.0
23	7.88	0.18	0.05	0.0
23	7.50	0.17	-0.06	0.0
24	7.50	0.17	-0.06	0.0
24	7.00	0.13	-0.10	0.1
25	7.00	0.13	-0.10	0.1
25	6.53	0.09	-0.09	0.1
26	6.53	0.09	-0.09	0.1
26	6.05	0.05	-0.05	0.1
27	6.05	0.05	-0.05	0.1
27	6.00	0.05	-0.05	0.1
28	6.00	0.05	-0.05	0.1
28	5.75	0.04	-0.04	0.1
29	5.75	0.04	-0.04	0.1
29	5.33	0.02	-0.03	0.1
30	5.33	0.02	-0.03	0.1
30	4.92	0.01	-0.05	0.1
31	4.92	0.01	-0.05	0.1
31	4.50	-0.02	-0.10	0.0
32	4.50	-0.02	-0.10	0.0
32	4.00	-0.04	0.02	0.0
33	4.00	-0.04	0.02	0.0
33	3.50	-0.02	0.04	0.0
34	3.50	-0.02	0.04	0.0
34	3.00	-0.01	0.02	0.0
35	3.00	-0.01	0.02	0.0
35	2.50	0.00	0.00	0.0
Max		-4.18	5.04	-0.4
Max, minor nodes incl.		-4.20	5.04	-0.4

6.7.3 Charts of Stresses

Stress States - Stage 1: 2a - Initial Stage



6.7.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]
1	14.90	0.00	0.00	-		0.00	0.00	-	
1	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.20	0.00	0.00	-		0.00	0.00	-	
3	14.20	0.00	0.00	-		0.00	0.00	-	
3	14.05	0.00	0.00	-		0.00	0.00	-	
4	14.05	0.00	0.00	-		0.00	0.00	-	
4	14.00	0.00	0.00	-		0.00	0.00	-	
5	14.00	0.00	0.00	-		0.00	0.00	-	
5	13.95	0.00	0.00	-		0.00	0.00	-	
6	13.95	0.00	0.00	-		0.00	0.00	-	
6	13.37	0.00	0.00	-		0.00	0.00	-	
7	13.37	0.00	0.00	-		0.00	0.00	-	
7	12.78	0.00	0.00	-		0.00	0.00	-	
8	12.78	0.00	0.00	-		0.00	0.00	-	
8	12.20	0.00	0.00	-		0.00	0.00	-	
9	12.20	0.00	0.00	-		0.00	0.00	-	
9	11.95	0.00	0.00	-		0.00	0.00	-	
10	11.95	0.00	0.00	-		0.00	0.00	-	
10	11.55	0.00	0.00	-		0.00	0.00	-	
11	11.55	0.00	0.00	-		0.00	0.00	-	
11	11.50	0.00	0.00	-		0.00	0.00	-	
12	11.50	0.00	0.00	-		0.00	0.00	-	
12	11.00	0.00	0.00	-		0.00	0.00	-	
13	11.00	0.00	0.00	-		0.00	0.00	-	
13	10.50	0.00	0.00	-		0.00	0.00	-	
14	10.50	0.00	0.00	P		0.00	0.00	A	
14	10.40	5.28	0.00	3	92	15.85	0.00	A	13
15	10.40	5.94	0.00	3	91	15.99	0.00	A	12
15	10.25	11.31	0.00	2	77	17.45	0.00	A	6

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
16	10.25	12.44	0.00	2	76	17.73	0.00	A	5
16	9.88	21.33	0.00	2	58	21.20	0.00	A	3
17	9.88	22.59	0.00	2	58	21.57	0.00	A	
17	9.50	32.11	0.00	1	30	24.39	0.00	1	
18	9.50	32.57	0.00	1	30	25.94	0.00	1	
18	9.17	37.25	0.00	1	26	30.92	0.00	1	
19	9.17	38.48	0.00	1	26	32.11	0.00	1	
19	8.55	44.43	1.96	1	23	41.04	0.00	1	
20	8.55	44.79	1.96	1	23	41.74	0.00	1	
20	8.50	45.26	2.45	1	20	42.45	0.49	1	
21	8.50	45.46	2.45	1	20	42.66	0.49	1	
21	8.25	46.67	4.91	1	19	45.02	2.94	1	
22	8.25	47.07	4.91	1	19	45.46	2.94	1	
22	7.88	48.73	8.58	1	18	48.62	6.62	1	
23	7.88	49.19	8.58	1	18	49.10	6.62	1	
23	7.50	50.81	12.26	1		51.84	10.30	1	7
24	7.50	51.33	12.26	1		52.36	10.30	1	7
24	7.00	53.98	17.17	1		55.73	15.21	1	6
25	7.00	54.36	17.17	1		56.27	15.21	1	7
25	6.53	59.51	21.83	1		61.76	19.87	1	8
26	6.53	59.85	21.83	1		62.13	19.87	1	8
26	6.05	61.38	26.49	1		63.65	24.52	1	9
27	6.05	61.57	26.49	1		63.85	24.52	1	9
27	6.00	61.73	26.98	1		63.99	25.02	1	8
28	6.00	61.84	26.98	1		64.10	25.02	1	8
28	5.75	62.66	29.43	1		64.82	27.47	1	9
29	5.75	62.89	29.43	1		65.05	27.47	1	9
29	5.33	64.26	33.52	1		66.16	31.56	1	9
30	5.33	64.55	33.52	1		66.44	31.56	1	9
30	4.92	65.92	37.60	1		67.48	35.64	1	9
31	4.92	66.20	37.60	1		67.74	35.64	1	9
31	4.50	67.29	41.69	1		68.60	39.73	1	9
32	4.50	66.36	41.69	1		70.23	39.73	1	6
32	4.00	60.89	46.60	1		63.47	44.64	1	5
33	4.00	61.30	46.60	1		63.80	44.64	1	5
33	3.50	63.28	51.50	1		65.24	49.54	1	5
34	3.50	63.68	51.50	1		65.56	49.54	1	5
34	3.00	65.43	56.41	1		67.22	54.45	1	4
35	3.00	65.82	56.41	1		67.52	54.45	1	4
35	2.50	67.51	61.31	1		69.25	59.35	1	4

*

Stat Status (A=active, P=passive, Number is branche, 0 is unloading)
 Mob Percentage passive mobilized

6.7.5 Percentage mobilized resistance

Horizontal soil pressure	Left [kN]	Right [kN]
Effective	129.7	136.1
Water	38.3	35.9
Total	168.0	172.0

Considered as passive side	Left
Left side is assigned as passive side by user	
Maximum passive effective resistance	682.78 kN
Mobilized passive effective resistance	129.70 kN
Percentage mobilized resistance	19.0 %
Position single support	11.50 m
Maximum passive moment	4025.24 kNm
Mobilized passive moment	543.09 kNm
Percentage mobilized moment	13.5 %

6.7.6 Vertical Force Balance

Xi factor	1.39
Partial factor base resistance	1.24
Maximum point resistance	1.00 [MPa]

Vertical force balance unplugged	Force [kN]
Vertical force active	-32.68
Vertical force passive	31.08
Vertical anchor force (*)	-4.33
Resulting vertical force (no dead weight)	-5.93
Vertical toe capacity $R_{b;d}$	2.90
Vertical toe capacity is not sufficient ($6 > 3$)	

Vertical force balance plugged	Force [kN]
Vertical force active	-32.68
Vertical force passive	31.08
Vertical anchor force (*)	-4.33
Resulting vertical force (no dead weight)	-5.93
Vertical toe capacity $R_{b;d}$	23.21
Vertical toe capacity is sufficient ($6 \leq 23$)	

(*) The vertical anchor force includes a factor of 1.1 as prescribed by art. 9.7.5(a) of Eurocode NEN 9997-1:2016.

6.7.7 Vertical Force Balance - Contribution per Layer

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
10.50	Zand, los (klei, ...	13.64	10.50	Zand, los (klei, ...	-15.15
9.50	Zand, los (klei, ...	2.16	9.50	Zand, los (klei, ...	-1.86
8.50	Zand, los (klei, ...	2.63	8.50	Zand, los (klei, ...	-2.59
7.50	Zand, los (klei, ...	1.43	7.50	Zand, los (klei, ...	-1.47
7.00	Klei, zwak zand...	1.32	7.00	Klei, zwak zand...	-1.36
6.00	Klei, zwak zand...	2.14	6.00	Klei, zwak zand...	-2.20
4.50	Zand, los tot m...	5.73	4.50	Zand, los tot m...	-5.95
3.00	Zand, los tot m...	2.04	3.00	Zand, los tot m...	-2.09

6.7.8 Anchors/Struts

Anchor/strut	Level [m]	E-Modulus [kN/m ²]	Force [kN]	State	Side	Type
Groutanker 50T	11.50	2.100E+08	5.57	Elastic	Right	Anchor

7 Step 6.3 Stage 1: 2a - Initial Stage

7.1 Input Data Left

7.1.1 Calculation Method

Calculation method: C, phi, delta

7.1.2 Water Level

Water level: 8.25 [m]

7.1.3 Surface

X [m]	Y [m]
0.00	10.50

7.1.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, los (klei, ...)	14.00	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	9.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	8.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	7.50	18.00	20.00	0.00	22.84	15.22
Klei, zwak zand...	7.00	16.00	16.00	0.00	18.90	6.30
Klei, zwak zand...	6.00	16.00	16.00	0.00	18.90	6.30
Zand, los tot m...	4.50	17.00	19.00	0.00	25.51	17.00
Zand, los tot m...	3.00	17.00	19.00	0.00	25.51	17.00
Zand, m vast to...	1.50	18.00	20.00	0.00	27.77	18.51
Zand, m vast to...	-0.50	18.00	20.00	0.00	27.77	18.51

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...)	14.00	1.00	1.00	Fine
Zand, los (klei, ...)	9.50	1.77	1.00	Fine
Zand, los (klei, ...)	8.50	2.01	1.00	Fine
Zand, los (klei, ...)	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

7.1.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m³]	Bottom [kN/m³]	Top [kN/m³]	Bottom [kN/m³]
Zand, los (klei, ...	14.00	8955.22	8955.22	4477.61	4477.61
Zand, los (klei, ...	9.50	7667.80	7667.80	3833.24	3833.24
Zand, los (klei, ...	8.50	7683.00	7683.00	3841.50	3841.50
Zand, los (klei, ...	7.50	7673.13	7673.13	3836.57	3836.57
Klei, zwak zand...	7.00	8478.94	8478.94	2293.95	4239.47
Klei, zwak zand...	6.00	8474.44	8474.44	4238.13	4238.13
Zand, los tot m...	4.50	34992.06	34992.06	17496.03	17496.03
Zand, los tot m...	3.00	34951.21	34951.21	17474.61	17474.61
Zand, m vast to...	1.50	1005.66	1005.65	502.83	502.83
Zand, m vast to...	-0.50	70000.00	70000.00	35000.00	35000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m³]	Bottom [kN/m³]
Zand, los (klei, ...	14.00	2238.81	2238.81
Zand, los (klei, ...	9.50	1916.62	1916.62
Zand, los (klei, ...	8.50	1920.00	1920.00
Zand, los (klei, ...	7.50	1917.49	1917.49
Klei, zwak zand...	7.00	2118.85	2118.85
Klei, zwak zand...	6.00	2119.07	2119.07
Zand, los tot m...	4.50	8748.01	8748.01
Zand, los tot m...	3.00	8738.30	8738.30
Zand, m vast to...	1.50	251.41	251.41
Zand, m vast to...	-0.50	17500.00	17500.00

7.2 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	10.48	0.2	1.2	0.43	2.93	3.37
2	10.46	0.3	2.4	0.38	2.93	3.37
3	10.44	0.4	3.6	0.38	2.93	3.37
4	10.42	0.5	4.9	0.38	2.93	3.37
5	10.40	0.6	5.8	0.38	2.93	3.37
6	10.40	0.7	6.5	0.38	2.93	3.37
7	10.37	0.9	7.9	0.38	2.75	3.37
8	10.34	1.1	9.7	0.38	2.63	3.37
9	10.31	1.3	11.5	0.38	2.55	3.37
10	10.28	1.5	13.3	0.38	2.47	3.37
11	10.25	1.7	14.7	0.38	2.39	3.37
12	10.25	1.8	16.3	0.38	2.39	3.37
13	10.18	2.2	19.7	0.38	2.24	3.37
14	10.10	2.7	24.3	0.38	2.13	3.37
15	10.03	3.2	28.8	0.38	2.02	3.37
16	9.95	3.7	33.4	0.38	1.94	3.37
17	9.88	4.1	36.8	0.38	1.87	3.37
18	9.88	4.4	39.0	0.38	1.87	3.37
19	9.80	4.8	42.5	0.38	1.80	3.37
20	9.72	5.3	47.0	0.38	1.74	3.37
21	9.65	5.8	51.6	0.38	1.69	3.37
22	9.57	6.3	56.1	0.38	1.64	3.37
23	9.50	6.7	59.5	0.21	1.60	5.96
24	9.50	6.9	61.7	0.21	1.60	5.96
25	9.43	7.3	64.7	0.21	1.56	5.96
26	9.37	7.7	68.7	0.21	1.53	5.96
27	9.30	8.2	72.7	0.21	1.50	5.96
28	9.24	8.6	76.7	0.21	1.47	5.96
29	9.17	8.9	79.7	0.21	1.44	5.96
30	9.17	9.3	82.6	0.21	1.44	5.96
31	9.05	9.9	88.2	0.21	1.39	5.96

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
32	8.92	10.8	95.7	0.21	1.35	5.96
33	8.80	11.6	103.2	0.21	1.31	5.96
34	8.67	12.4	110.8	0.21	1.27	5.96
35	8.55	13.1	116.4	0.21	1.24	5.96
36	8.55	13.3	118.4	0.21	1.24	5.96
37	8.54	13.4	118.9	0.21	1.24	5.96
38	8.53	13.4	119.5	0.21	1.24	5.96
39	8.52	13.5	120.1	0.21	1.23	5.96
40	8.51	13.6	120.7	0.21	1.23	5.96
41	8.50	13.6	121.2	0.19	1.23	6.77
42	8.50	13.7	122.1	0.19	1.23	6.77
43	8.45	14.0	124.3	0.19	1.21	6.77
44	8.40	14.3	127.4	0.19	1.19	6.77
45	8.35	14.6	130.4	0.19	1.18	6.77
46	8.30	15.0	133.4	0.19	1.16	6.77
47	8.25	15.2	135.7	0.19	1.14	6.77
48	8.25	15.4	137.1	0.19	1.14	6.77
49	8.18	15.6	139.1	0.19	1.14	6.77
50	8.10	15.9	141.6	0.19	1.13	6.77
51	8.03	16.2	144.2	0.19	1.12	6.77
52	7.95	16.5	146.8	0.19	1.12	6.77
53	7.88	16.7	148.7	0.19	1.11	6.77
54	7.88	16.8	150.0	0.19	1.11	6.77
55	7.80	17.1	151.9	0.19	1.10	6.77
56	7.72	17.4	154.5	0.19	1.10	6.77
57	7.65	17.6	157.1	0.19	1.09	6.77
58	7.58	17.9	159.7	0.19	1.08	6.77
59	7.50	18.2	161.6	0.18	1.08	7.14
60	7.50	18.3	163.1	0.18	1.08	7.14
61	7.40	18.6	165.7	0.18	1.07	7.14
62	7.30	19.0	169.1	0.18	1.06	7.14
63	7.20	19.4	172.5	0.18	1.05	7.14
64	7.10	19.8	176.0	0.18	1.04	7.14
65	7.00	20.1	178.5	0.16	1.04	8.03
66	7.00	25.4	125.2	0.20	1.04	5.60
67	6.91	25.6	126.1	0.20	1.11	5.59
68	6.81	25.9	127.3	0.20	1.10	5.59
69	6.71	26.1	128.6	0.20	1.10	5.58
70	6.62	26.4	129.8	0.20	1.09	5.57
71	6.53	26.6	130.7	0.20	1.09	5.57
72	6.53	26.8	131.3	0.20	1.09	5.57
73	6.43	27.0	132.3	0.20	1.08	5.56
74	6.33	27.3	133.5	0.20	1.08	5.56
75	6.24	27.5	134.8	0.20	1.08	5.55
76	6.14	27.8	136.0	0.20	1.07	5.55
77	6.05	28.0	137.0	0.20	1.07	5.54
78	6.05	28.1	137.3	0.20	1.07	5.54
79	6.04	28.1	137.4	0.20	1.07	5.54
80	6.03	28.2	137.6	0.20	1.07	5.54
81	6.02	28.2	137.7	0.20	1.06	5.54
82	6.01	28.2	137.8	0.20	1.06	5.54
83	6.00	28.2	137.9	0.20	1.06	5.73
84	6.00	28.3	138.1	0.20	1.06	5.73
85	5.95	28.4	138.6	0.20	1.06	5.72
86	5.90	28.5	139.3	0.20	1.06	5.72
87	5.85	28.7	139.9	0.20	1.06	5.72
88	5.80	28.8	140.6	0.20	1.05	5.72
89	5.75	28.9	141.1	0.20	1.05	5.71
90	5.75	29.0	141.6	0.20	1.05	5.71
91	5.67	29.2	142.4	0.20	1.05	5.71
92	5.58	29.5	143.5	0.20	1.04	5.71
93	5.50	29.7	144.6	0.20	1.04	5.70
94	5.42	30.0	145.7	0.20	1.04	5.70
95	5.33	30.1	146.6	0.20	1.03	5.70

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
96	5.33	30.3	147.1	0.20	1.03	5.70
97	5.25	30.4	148.0	0.20	1.03	5.69
98	5.17	30.7	149.1	0.20	1.03	5.69
99	5.08	30.9	150.2	0.20	1.02	5.69
100	5.00	31.2	151.4	0.20	1.02	5.69
101	4.92	31.4	152.2	0.20	1.02	5.68
102	4.92	31.5	152.8	0.20	1.02	5.68
103	4.83	31.7	153.6	0.20	1.01	5.68
104	4.75	31.9	154.8	0.20	1.01	5.68
105	4.67	32.2	155.9	0.20	1.01	5.68
106	4.58	32.4	157.0	0.20	1.00	5.67
107	4.50	32.6	157.9	0.18	0.99	5.98
108	4.50	23.3	286.7	0.13	0.99	10.80
109	4.40	23.5	288.9	0.13	0.88	10.77
110	4.30	23.8	292.0	0.13	0.87	10.74
111	4.20	24.1	295.2	0.13	0.86	10.72
112	4.10	24.5	298.4	0.13	0.86	10.70
113	4.00	24.7	300.9	0.13	0.85	10.68
114	4.00	24.8	302.5	0.13	0.85	10.68
115	3.90	25.1	305.0	0.13	0.85	10.67
116	3.80	25.4	308.4	0.13	0.84	10.65
117	3.70	25.7	311.9	0.13	0.84	10.64
118	3.60	26.0	315.3	0.13	0.83	10.63
119	3.50	26.2	318.0	0.13	0.83	10.62
120	3.50	26.4	319.7	0.13	0.83	10.62
121	3.40	26.6	322.3	0.13	0.83	10.61
122	3.30	26.9	325.9	0.13	0.82	10.60
123	3.20	27.3	329.4	0.13	0.82	10.60
124	3.10	27.6	333.0	0.13	0.81	10.59
125	3.00	27.8	335.7	0.13	0.81	10.87
126	3.00	28.0	337.5	0.13	0.81	10.87
127	2.90	28.2	340.2	0.13	0.80	10.87
128	2.80	28.5	343.8	0.13	0.80	10.86
129	2.70	28.8	347.4	0.13	0.80	10.86
130	2.60	29.1	351.0	0.13	0.79	10.85
131	2.50	29.4	353.7	0.13	0.79	10.85

7.3 Calculated force from a layer Left

Name	Force
Zand, los (klei, puin)	17.96
Zand, los (klei, puin)* 1	40.23
Zand, los (klei, puin)* 2	50.27
Zand, los (klei, puin)* 3	27.50
Klei, zwak zandig, slap*1	62.45
Klei, zwak zandig, slap*2	100.48
Zand, los tot matig vas*1	98.52
Zand, los tot matig vas*2	34.51
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

7.4 Input Data Right

7.4.1 Calculation Method

Calculation method: C, phi, delta

7.4.2 Water Level

Water level: 8.55 [m]

7.4.3 Surface

X [m]	Y [m]
0.00	10.50
3.80	14.00

7.4.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, los (klei, ...)	14.00	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	9.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	8.50	18.00	20.00	0.00	22.84	15.22
Zand, los (klei, ...)	7.50	18.00	20.00	0.00	22.84	15.22
Klei, zwak zand...	7.00	16.00	16.00	0.00	18.90	6.30
Klei, zwak zand...	6.00	16.00	16.00	0.00	18.90	6.30
Zand, los tot m...	4.50	17.00	19.00	0.00	25.51	17.00
Zand, los tot m...	3.00	17.00	19.00	0.00	25.51	17.00
Zand, m vast to...	1.50	18.00	20.00	0.00	27.77	18.51
Zand, m vast to...	-0.50	18.00	20.00	0.00	27.77	18.51

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...)	14.00	1.00	1.00	Fine
Zand, los (klei, ...)	9.50	1.77	1.00	Fine
Zand, los (klei, ...)	8.50	2.01	1.00	Fine
Zand, los (klei, ...)	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

7.4.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	8955.22	8955.22	4477.61	4477.61
Zand, los (klei, ...)	9.50	7667.80	7667.80	3833.24	3833.24
Zand, los (klei, ...)	8.50	7683.00	7683.00	3841.50	3841.50
Zand, los (klei, ...)	7.50	7673.13	7673.13	3836.57	3836.57
Klei, zwak zand...	7.00	8478.94	8478.94	2293.95	4239.47
Klei, zwak zand...	6.00	8474.44	8474.44	4238.13	4238.13
Zand, los tot m...	4.50	34992.06	34992.06	17496.03	17496.03
Zand, los tot m...	3.00	34951.21	34951.21	17474.61	17474.61

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, m vast to...	1.50	1005.66	1005.65	502.83	502.83
Zand, m vast to...	-0.50	70000.00	70000.00	35000.00	35000.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...	14.00	2238.81	2238.81
Zand, los (klei, ...	9.50	1916.62	1916.62
Zand, los (klei, ...	8.50	1920.00	1920.00
Zand, los (klei, ...	7.50	1917.49	1917.49
Klei, zwak zand...	7.00	2118.85	2118.85
Klei, zwak zand...	6.00	2119.07	2119.07
Zand, los tot m...	4.50	8748.01	8748.01
Zand, los tot m...	3.00	8738.30	8738.30
Zand, m vast to...	1.50	251.41	251.41
Zand, m vast to...	-0.50	17500.00	17500.00

7.4.6 Anchors

Name	Level [m]	E-Modulus [kN/m ²]	Cross section [m ² /m']	Length [m]	Angle [°]	Yield force [kN/m']	Pre-tension. force [kN/m']
Groutanker 50T	11.50	2.100E+08	7.010E-04	13.00	-45.00	10000.00	n.a.

7.5 Calculated Earth Pressure Coefficients Right

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10.48	15.0	24.8	10.79	10.79	17.82
2	10.46	15.2	49.6	8.56	8.56	27.88
3	10.44	15.5	74.4	7.02	7.02	33.78
4	10.42	15.7	99.2	5.89	5.89	37.24
5	10.40	15.9	117.8	5.22	5.22	38.84
6	10.40	16.0	133.4	4.77	4.77	39.78
7	10.37	16.2	161.3	4.12	4.12	40.96
8	10.34	16.6	198.5	3.49	3.49	41.82
9	10.31	16.9	235.7	3.03	3.03	42.31
10	10.28	17.2	272.9	2.69	2.69	42.61
11	10.25	17.5	300.8	2.48	2.48	42.76
12	10.25	17.7	333.4	2.28	2.28	42.89
13	10.18	18.3	403.2	1.96	1.96	43.09
14	10.10	19.1	496.2	1.67	1.67	43.24
15	10.03	19.9	589.2	1.46	1.46	43.34
16	9.95	20.6	682.3	1.31	1.31	43.42
17	9.88	21.2	752.1	1.23	1.23	43.47
18	9.88	21.6	685.2	1.18	1.18	37.32
19	9.80	22.1	455.2	1.11	1.14	22.82
20	9.72	22.9	377.7	1.04	1.10	17.13
21	9.65	23.6	349.1	0.98	1.07	14.45
22	9.57	24.3	334.9	0.93	1.04	12.75
23	9.50	24.8	328.6	0.50	1.02	20.90
24	9.50	25.2	325.9	0.49	1.02	20.03
25	9.43	25.6	323.4	0.48	0.99	18.96
26	9.37	26.2	321.4	0.46	0.97	17.77
27	9.30	26.8	320.6	0.45	0.96	16.77
28	9.24	27.4	320.8	0.43	0.94	15.92
29	9.17	27.9	321.3	0.43	0.92	15.37
30	9.17	28.3	322.1	0.42	0.92	14.88
31	9.05	29.1	324.4	0.40	0.89	14.06
32	8.92	30.2	328.3	0.39	0.87	13.14
33	8.80	31.3	333.0	0.37	0.84	12.40
34	8.67	32.3	338.3	0.36	0.82	11.78
35	8.55	33.1	342.5	0.35	0.80	11.37

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
36	8.55	33.4	344.0	0.35	0.80	11.24
37	8.54	33.4	344.2	0.35	0.80	11.22
38	8.53	33.5	344.4	0.35	0.80	11.18
39	8.52	33.5	344.6	0.35	0.80	11.15
40	8.51	33.6	344.8	0.35	0.80	11.12
41	8.50	33.6	345.0	0.30	0.80	12.61
42	8.50	33.7	345.3	0.30	0.80	12.55
43	8.45	33.9	346.1	0.30	0.80	12.43
44	8.40	34.2	347.2	0.30	0.79	12.27
45	8.35	34.5	348.4	0.30	0.79	12.12
46	8.30	34.8	349.6	0.29	0.78	11.97
47	8.25	35.0	350.5	0.29	0.78	11.87
48	8.25	35.1	351.3	0.29	0.78	11.78
49	8.18	35.4	352.8	0.29	0.77	11.63
50	8.10	35.8	354.8	0.29	0.76	11.45
51	8.03	36.2	356.8	0.28	0.76	11.27
52	7.95	36.6	358.9	0.28	0.75	11.11
53	7.88	36.9	360.5	0.28	0.74	11.00
54	7.88	37.1	361.6	0.28	0.74	10.92
55	7.80	37.3	363.2	0.28	0.74	10.81
56	7.72	37.7	365.4	0.27	0.73	10.67
57	7.65	38.1	367.7	0.27	0.73	10.54
58	7.58	38.4	369.9	0.27	0.72	10.42
59	7.50	38.7	371.6	0.25	0.71	10.90
60	7.50	38.9	373.0	0.25	0.71	10.83
61	7.40	39.3	375.3	0.25	0.71	10.71
62	7.30	39.8	378.4	0.25	0.70	10.57
63	7.20	40.2	381.5	0.24	0.69	10.43
64	7.10	40.7	384.7	0.24	0.69	10.30
65	7.00	41.0	387.1	0.22	0.69	11.46
66	7.00	46.3	330.8	0.24	0.69	9.72
67	6.91	46.7	329.1	0.24	0.73	9.57
68	6.81	47.2	326.8	0.24	0.72	9.38
69	6.71	47.7	324.6	0.24	0.72	9.19
70	6.62	48.2	322.3	0.24	0.71	9.01
71	6.53	48.5	320.6	0.24	0.71	8.88
72	6.53	48.8	319.5	0.24	0.71	8.79
73	6.43	49.1	317.8	0.24	0.70	8.67
74	6.33	49.6	315.5	0.24	0.70	8.50
75	6.24	50.1	313.2	0.24	0.70	8.34
76	6.14	50.5	310.9	0.24	0.69	8.19
77	6.05	50.9	309.2	0.24	0.69	8.07
78	6.05	51.0	308.6	0.24	0.69	8.03
79	6.04	51.1	308.4	0.24	0.69	8.02
80	6.03	51.1	308.2	0.24	0.69	8.01
81	6.02	51.2	307.9	0.24	0.69	7.99
82	6.01	51.2	307.7	0.24	0.69	7.97
83	6.00	51.2	307.5	0.23	0.69	8.23
84	6.00	51.3	307.2	0.23	0.69	8.21
85	5.95	51.5	306.3	0.23	0.68	8.15
86	5.90	51.7	305.1	0.23	0.68	8.07
87	5.85	52.0	303.9	0.23	0.68	7.99
88	5.80	52.2	302.7	0.23	0.68	7.92
89	5.75	52.4	301.8	0.23	0.68	7.86
90	5.75	52.6	300.9	0.23	0.68	7.81
91	5.67	52.9	299.4	0.23	0.67	7.72
92	5.58	53.3	297.4	0.23	0.67	7.60
93	5.50	53.7	295.4	0.23	0.67	7.48
94	5.42	54.0	293.4	0.23	0.67	7.37
95	5.33	54.3	291.9	0.23	0.66	7.29
96	5.33	54.5	290.9	0.23	0.66	7.23
97	5.25	54.8	289.4	0.23	0.66	7.15
98	5.17	55.2	288.4	0.23	0.66	7.07
99	5.08	55.6	289.5	0.23	0.66	7.04

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
100	5.00	56.0	290.7	0.22	0.65	7.01
101	4.92	56.3	291.5	0.22	0.65	6.99
102	4.92	56.5	292.1	0.22	0.65	6.97
103	4.83	56.8	292.9	0.22	0.65	6.95
104	4.75	57.1	294.0	0.22	0.65	6.93
105	4.67	57.5	295.2	0.22	0.65	6.90
106	4.58	60.1	296.3	0.23	0.64	6.88
107	4.50	57.5	297.2	0.21	0.64	7.24
108	4.50	45.8	424.3	0.17	0.64	10.28
109	4.40	49.0	431.9	0.18	0.56	10.38
110	4.30	49.2	442.0	0.17	0.56	10.50
111	4.20	49.5	452.1	0.17	0.56	10.63
112	4.10	49.7	462.3	0.17	0.56	10.75
113	4.00	49.9	469.9	0.17	0.56	10.84
114	4.00	50.1	475.0	0.17	0.56	10.90
115	3.90	50.2	482.6	0.17	0.55	10.99
116	3.80	50.5	492.8	0.17	0.55	11.11
117	3.70	50.7	503.0	0.17	0.55	11.22
118	3.60	51.0	513.3	0.17	0.55	11.34
119	3.50	55.0	520.9	0.18	0.55	11.42
120	3.50	51.7	526.0	0.17	0.55	11.48
121	3.40	49.4	533.7	0.16	0.54	11.56
122	3.30	51.8	544.0	0.17	0.54	11.67
123	3.20	52.0	554.2	0.16	0.54	11.78
124	3.10	52.3	564.5	0.16	0.54	11.88
125	3.00	56.0	572.2	0.17	0.54	12.29
126	3.00	49.0	577.3	0.15	0.54	12.34
127	2.90	52.8	585.0	0.16	0.53	12.42
128	2.80	52.9	595.3	0.16	0.53	12.53
129	2.70	53.1	603.3	0.16	0.53	12.58
130	2.60	53.2	606.6	0.16	0.53	12.54
131	2.50	53.3	609.0	0.15	0.53	12.51

7.6 Calculated force from a layer Right

Name	Force
Zand, los (klei, puin)	19.88
Zand, los (klei, puin)* 1	33.67
Zand, los (klei, puin)* 2	46.12
Zand, los (klei, puin)* 3	26.00
Klei, zwak zandig, slap*1	59.53
Klei, zwak zandig, slap*2	97.17
Zand, los tot matig vas*1	93.11
Zand, los tot matig vas*2	33.21
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

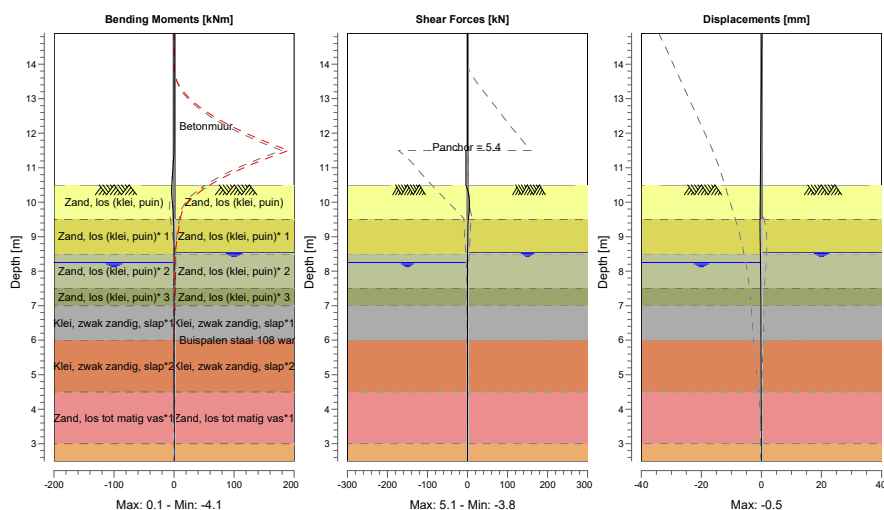
7.7 Calculation Results

Number of iterations: 4

7.7.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 1: 2a - Initial Stage

Step 6.3 - Partial factor set: RC 2



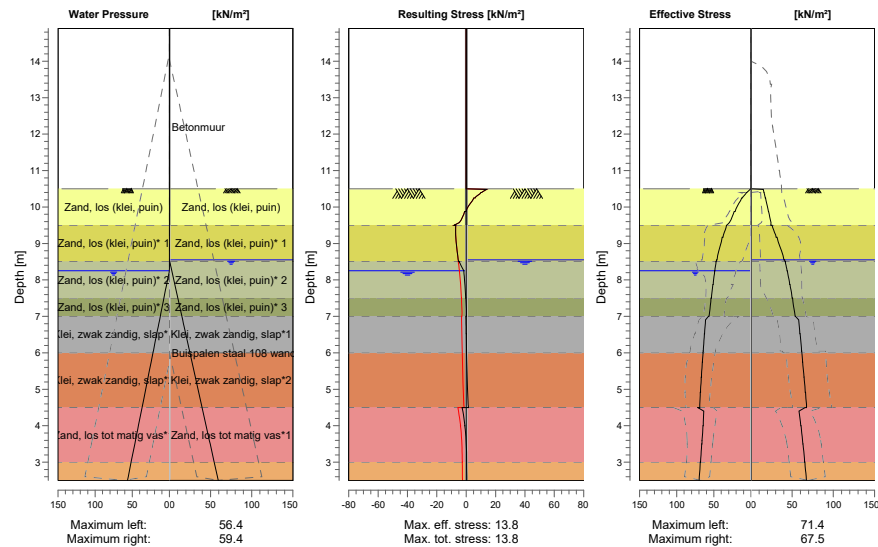
7.7.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14.90	0.00	0.00	0.1
1	14.55	0.00	0.00	0.1
2	14.55	0.00	0.00	0.1
2	14.20	0.00	0.00	0.1
3	14.20	0.00	0.00	0.1
3	14.05	0.00	0.00	0.0
4	14.05	0.00	0.00	0.0
4	14.00	0.00	0.00	0.0
5	14.00	0.00	0.00	0.0
5	13.95	0.00	0.00	0.0
6	13.95	0.00	0.00	0.0
6	13.37	0.00	0.00	0.0
7	13.37	0.00	0.00	0.0
7	12.78	0.00	0.00	-0.1
8	12.78	0.00	0.00	-0.1
8	12.20	0.00	0.00	-0.2
9	12.20	0.00	0.00	-0.2
9	11.95	0.00	0.00	-0.2
10	11.95	0.00	0.00	-0.2
10	11.55	0.00	0.00	-0.2
11	11.55	0.00	0.00	-0.2
11	11.50	0.00	0.00	-0.2
12	11.50	0.00	-3.83	-0.2
12	11.00	-1.91	-3.83	-0.3
13	11.00	-1.91	-3.83	-0.3
13	10.50	-3.83	-3.83	-0.4
14	10.50	-3.83	-3.83	-0.4
14	10.40	-4.07	-0.74	-0.4
15	10.40	-4.07	-0.74	-0.4
15	10.25	-3.90	2.64	-0.4
16	10.25	-3.90	2.64	-0.4

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
16	9.88	-2.26	5.09	-0.4
17	9.88	-2.26	5.09	-0.4
17	9.50	-0.81	1.55	-0.5
18	9.50	-0.81	1.55	-0.5
18	9.17	-0.38	1.08	-0.5
19	9.17	-0.38	1.08	-0.5
19	8.55	0.04	0.30	-0.4
20	8.55	0.04	0.30	-0.4
20	8.50	0.05	0.24	-0.3
21	8.50	0.05	0.24	-0.3
21	8.25	0.09	0.08	-0.3
22	8.25	0.09	0.08	-0.3
22	7.88	0.10	-0.02	-0.2
23	7.88	0.10	-0.02	-0.2
23	7.50	0.09	-0.06	-0.2
24	7.50	0.09	-0.06	-0.2
24	7.00	0.05	-0.06	-0.2
25	7.00	0.05	-0.06	-0.2
25	6.53	0.02	-0.07	-0.2
26	6.53	0.02	-0.07	-0.2
26	6.05	-0.01	-0.06	-0.2
27	6.05	-0.01	-0.06	-0.2
27	6.00	-0.01	-0.06	-0.2
28	6.00	-0.01	-0.06	-0.2
28	5.75	-0.03	-0.04	-0.1
29	5.75	-0.03	-0.04	-0.1
29	5.33	-0.04	0.00	-0.1
30	5.33	-0.04	0.00	-0.1
30	4.92	-0.03	0.06	-0.1
31	4.92	-0.03	0.06	-0.1
31	4.50	0.02	0.16	-0.1
32	4.50	0.02	0.16	-0.1
32	4.00	0.05	-0.01	-0.1
33	4.00	0.05	-0.01	-0.1
33	3.50	0.03	-0.05	0.0
34	3.50	0.03	-0.05	0.0
34	3.00	0.01	-0.03	0.0
35	3.00	0.01	-0.03	0.0
35	2.50	0.00	0.00	0.0
Max		-4.07	5.09	-0.5
Max, minor nodes incl.		-4.08	5.09	-0.5

7.7.3 Charts of Stresses

Stress States - Stage 1: 2a - Initial Stage



7.7.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]
1	14.90	0.00	0.00	-		0.00	0.00	-	
1	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.20	0.00	0.00	-		0.00	0.00	-	
3	14.20	0.00	0.00	-		0.00	0.00	-	
3	14.05	0.00	0.00	-		0.00	0.00	-	
4	14.05	0.00	0.00	-		0.00	0.00	-	
4	14.00	0.00	0.00	-		0.00	0.00	-	
5	14.00	0.00	0.00	-		0.00	0.00	-	
5	13.95	0.00	0.00	-		0.00	0.00	-	
6	13.95	0.00	0.00	-		0.00	0.00	-	
6	13.37	0.00	0.00	-		0.00	0.00	-	
7	13.37	0.00	0.00	-		0.00	0.00	-	
7	12.78	0.00	0.00	-		0.00	0.00	-	
8	12.78	0.00	0.00	-		0.00	0.00	-	
8	12.20	0.00	0.00	-		0.00	0.00	-	
9	12.20	0.00	0.00	-		0.00	0.00	-	
9	11.95	0.00	0.00	-		0.00	0.00	-	
10	11.95	0.00	0.00	-		0.00	0.00	-	
10	11.55	0.00	0.00	-		0.00	0.00	-	
11	11.55	0.00	0.00	-		0.00	0.00	-	
11	11.50	0.00	0.00	-		0.00	0.00	-	
12	11.50	0.00	0.00	-		0.00	0.00	-	
12	11.00	0.00	0.00	-		0.00	0.00	-	
13	11.00	0.00	0.00	-		0.00	0.00	-	
13	10.50	0.00	0.00	-		0.00	0.00	-	
14	10.50	0.00	0.00	P		0.00	0.00	A	
14	10.40	5.29	0.00	3	92	15.85	0.00	A	13
15	10.40	5.95	0.00	3	91	15.99	0.00	A	12
15	10.25	11.35	0.00	2	77	17.45	0.00	A	6

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob*
16	10.25	12.48	0.00	2	77	17.73	0.00	A	5
16	9.88	21.39	0.00	2	58	21.20	0.00	A	3
17	9.88	22.65	0.00	2	58	21.57	0.00	A	
17	9.50	32.39	0.00	1	31	24.11	0.00	1	
18	9.50	32.81	0.00	1	30	25.70	0.00	1	
18	9.17	37.60	0.00	1	27	30.56	0.00	1	
19	9.17	38.83	0.00	1	27	31.76	0.00	1	
19	8.55	45.59	0.00	1	22	40.16	0.00	1	
20	8.55	46.34	0.00	1	22	40.85	0.00	1	
20	8.50	46.81	0.00	1	19	41.51	0.49	1	
21	8.50	47.15	0.00	1	19	41.73	0.49	1	
21	8.25	48.40	0.00	1	18	43.82	2.94	1	
22	8.25	48.88	0.00	1	18	44.26	2.94	1	
22	7.88	50.92	3.68	1	17	47.05	6.62	1	
23	7.88	51.34	3.68	1	17	47.54	6.62	1	
23	7.50	53.25	7.36	1	16	49.99	10.30	1	
24	7.50	53.73	7.36	1	16	50.52	10.30	1	
24	7.00	56.58	12.26	1	13	53.68	15.21	1	
25	7.00	57.14	12.26	1	19	54.00	15.21	1	
25	6.53	62.38	16.92	1	20	59.44	19.87	1	
26	6.53	62.70	16.92	1	20	59.82	19.87	1	
26	6.05	64.16	21.58	1	20	61.42	24.52	1	
27	6.05	64.34	21.58	1	20	61.61	24.52	1	
27	6.00	64.49	22.07	1	19	61.78	25.02	1	
28	6.00	64.58	22.07	1	19	61.89	25.02	1	
28	5.75	65.30	24.52	1	19	62.71	27.47	1	
29	5.75	65.52	24.52	1	19	62.94	27.47	1	
29	5.33	66.64	28.61	1	18	64.31	31.56	1	
30	5.33	66.91	28.61	1	18	64.58	31.56	1	
30	4.92	67.94	32.70	1	18	65.99	35.64	1	
31	4.92	68.20	32.70	1	18	66.24	35.64	1	
31	4.50	68.91	36.79	1	17	67.50	39.73	1	
32	4.50	71.41	36.79	1	10	65.69	39.73	1	
32	4.00	64.32	41.69	1	8	60.49	44.64	1	
33	4.00	64.71	41.69	1	8	60.82	44.64	1	
33	3.50	65.94	46.60	1	8	63.02	49.54	1	
34	3.50	66.32	46.60	1	8	63.33	49.54	1	
34	3.00	67.85	51.50	1	8	65.23	54.45	1	
35	3.00	68.22	51.50	1	8	65.53	54.45	1	
35	2.50	69.84	56.41	1	7	67.32	59.35	1	

*

Stat Status (A=active, P=passive, Number is branche, 0 is unloading)
Mob Percentage passive mobilized

7.7.5 Percentage mobilized resistance

Horizontal soil pressure	Left [kN]	Right [kN]
Effective	133.1	133.4
Water	32.4	35.9
Total	165.5	169.3

Considered as passive side
Left side is assigned as passive side by user
Maximum passive effective resistance 723.20 kN
Mobilized passive effective resistance 133.07 kN
Percentage mobilized resistance 18.4 %
Position single support 11.50 m
Maximum passive moment 4281.85 kNm
Mobilized passive moment 562.65 kNm
Percentage mobilized moment 13.1 %

7.7.6 Vertical Force Balance

Xi factor	1.39
Partial factor base resistance	1.24
Maximum point resistance	1.00 [MPa]

Vertical force balance unplugged	Force [kN]
Vertical force active	-32.09
Vertical force passive	31.84
Vertical anchor force (*)	-4.21
Resulting vertical force (no dead weight)	-4.46
Vertical toe capacity $R_{b;d}$	2.90
Vertical toe capacity is not sufficient ($4 > 3$)	

Vertical force balance plugged	Force [kN]
Vertical force active	-32.09
Vertical force passive	31.84
Vertical anchor force (*)	-4.21
Resulting vertical force (no dead weight)	-4.46
Vertical toe capacity $R_{b;d}$	23.21
Vertical toe capacity is sufficient ($4 \leq 23$)	

(*) The vertical anchor force includes a factor of 1.1 as prescribed by art. 9.7.5(a) of Eurocode NEN 9997-1:2016.

7.7.7 Vertical Force Balance - Contribution per Layer

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
10.50	Zand, los (klei, ...	13.68	10.50	Zand, los (klei, ...	-15.15
9.50	Zand, los (klei, ...	2.19	9.50	Zand, los (klei, ...	-1.83
8.50	Zand, los (klei, ...	2.74	8.50	Zand, los (klei, ...	-2.51
7.50	Zand, los (klei, ...	1.50	7.50	Zand, los (klei, ...	-1.42
7.00	Klei, zwak zand...	1.38	7.00	Klei, zwak zand...	-1.31
6.00	Klei, zwak zand...	2.22	6.00	Klei, zwak zand...	-2.15
4.50	Zand, los tot m...	6.03	4.50	Zand, los tot m...	-5.70
3.00	Zand, los tot m...	2.11	3.00	Zand, los tot m...	-2.03

7.7.8 Anchors/Struts

Anchor/strut	Level [m]	E-Modulus [kN/m ²]	Force [kN]	State	Side	Type
Groutanker 50T	11.50	2.100E+08	5.42	Elastic	Right	Anchor

8 Step 6.5 Stage 1: 2a - Initial Stage

8.1 Input Data Left

8.1.1 Calculation Method

Calculation method: C, phi, delta

8.1.2 Water Level

Water level: 8.50 [m]

8.1.3 Surface

X [m]	Y [m]
0.00	10.50

8.1.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m ²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m ³]	Sat. [kN/m ³]			
Zand, los (klei, ...)	14.00	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...)	9.50	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...)	8.50	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...)	7.50	18.00	20.00	0.00	27.00	18.00
Klei, zwak zand...	7.00	16.00	16.00	0.00	22.50	7.50
Klei, zwak zand...	6.00	16.00	16.00	0.00	22.50	7.50
Zand, los tot m...	4.50	17.00	19.00	0.00	30.00	20.00
Zand, los tot m...	3.00	17.00	19.00	0.00	30.00	20.00
Zand, m vast to...	1.50	18.00	20.00	0.00	32.50	16.60
Zand, m vast to...	-0.50	18.00	20.00	0.00	32.50	16.60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...)	14.00	1.00	1.00	Fine
Zand, los (klei, ...)	9.50	1.77	1.00	Fine
Zand, los (klei, ...)	8.50	2.01	1.00	Fine
Zand, los (klei, ...)	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

8.1.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	12000.00	12000.00	6000.00	6000.00
Zand, los (klei, ...)	9.50	10274.85	10274.85	5136.54	5136.54
Zand, los (klei, ...)	8.50	10295.22	10295.22	5147.61	5147.61
Zand, los (klei, ...)	7.50	10282.00	10282.00	5141.00	5141.00
Klei, zwak zand...	7.00	11361.78	11361.78	3073.89	5680.89
Klei, zwak zand...	6.00	11355.75	11355.75	5679.10	5679.10
Zand, los tot m...	4.50	46889.36	46889.36	23444.68	23444.68
Zand, los tot m...	3.00	46834.62	46834.62	23415.98	23415.98
Zand, m vast to...	1.50	1347.59	1347.58	673.79	673.79
Zand, m vast to...	-0.50	93800.00	93800.00	46900.00	46900.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	3000.00	3000.00
Zand, los (klei, ...)	9.50	2568.27	2568.27
Zand, los (klei, ...)	8.50	2572.80	2572.80
Zand, los (klei, ...)	7.50	2569.44	2569.44
Klei, zwak zand...	7.00	2839.26	2839.26
Klei, zwak zand...	6.00	2839.55	2839.55
Zand, los tot m...	4.50	11722.34	11722.34
Zand, los tot m...	3.00	11709.32	11709.32
Zand, m vast to...	1.50	336.89	336.89
Zand, m vast to...	-0.50	23450.00	23450.00

8.2 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10.40	0.6	8.1	0.32	2.93	4.52
2	10.30	1.1	16.3	0.32	2.53	4.52
3	10.20	1.7	24.4	0.32	2.29	4.52
4	10.10	2.3	32.6	0.32	2.13	4.52
5	10.00	2.7	38.7	0.32	2.00	4.52
6	10.00	3.0	42.7	0.32	2.00	4.52
7	9.90	3.4	48.8	0.32	1.89	4.52
8	9.80	4.0	57.0	0.32	1.80	4.52
9	9.70	4.6	65.1	0.32	1.73	4.52
10	9.60	5.1	73.3	0.32	1.66	4.52
11	9.50	5.6	79.4	0.18	1.60	8.00
12	9.50	5.9	83.4	0.18	1.60	8.00
13	9.40	6.3	89.5	0.18	1.55	8.00
14	9.30	6.9	97.7	0.18	1.50	8.00
15	9.20	7.4	105.8	0.18	1.45	8.00
16	9.10	8.0	113.9	0.18	1.41	8.00
17	9.00	8.4	120.0	0.18	1.38	8.00
18	9.00	8.7	124.1	0.18	1.38	8.00
19	8.90	9.1	130.2	0.18	1.34	8.00
20	8.80	9.7	138.4	0.18	1.31	8.00
21	8.70	10.3	146.5	0.18	1.28	8.00
22	8.60	10.9	154.6	0.18	1.25	8.00
23	8.50	11.3	160.7	0.16	1.23	9.09
24	8.50	11.5	163.9	0.16	1.23	9.09
25	8.40	11.8	167.4	0.16	1.22	9.09
26	8.30	12.1	172.0	0.16	1.21	9.09
27	8.20	12.4	176.6	0.16	1.20	9.09
28	8.10	12.7	181.2	0.16	1.19	9.09
29	8.00	13.0	184.7	0.16	1.17	9.09
30	8.00	13.1	187.0	0.16	1.17	9.09
31	7.90	13.4	190.4	0.16	1.16	9.09

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
32	7.80	13.7	195.0	0.16	1.15	9.09
33	7.70	14.0	199.6	0.16	1.14	9.09
34	7.60	14.3	204.2	0.16	1.13	9.09
35	7.50	14.6	207.7	0.15	1.12	9.59
36	7.50	14.8	210.0	0.15	1.12	9.59
37	7.40	15.0	213.5	0.15	1.11	9.59
38	7.30	15.3	218.1	0.15	1.10	9.59
39	7.20	15.6	222.7	0.15	1.09	9.59
40	7.10	16.0	227.3	0.15	1.08	9.59
41	7.00	16.2	230.7	0.13	1.08	10.78
42	7.00	21.2	146.8	0.18	1.08	6.82
43	6.90	21.4	148.0	0.18	1.15	6.81
44	6.80	21.6	149.5	0.18	1.14	6.80
45	6.70	21.9	151.0	0.18	1.14	6.78
46	6.60	22.1	152.5	0.18	1.13	6.77
47	6.50	22.3	153.6	0.18	1.13	6.76
48	6.50	22.5	154.4	0.18	1.13	6.76
49	6.40	22.7	155.6	0.18	1.12	6.75
50	6.30	22.9	157.1	0.18	1.12	6.74
51	6.20	23.2	158.6	0.18	1.11	6.73
52	6.10	23.4	160.2	0.18	1.11	6.72
53	6.00	23.6	161.4	0.17	1.10	6.94
54	6.00	23.7	162.1	0.17	1.10	6.94
55	5.90	23.9	163.3	0.17	1.10	6.93
56	5.80	24.2	164.9	0.17	1.09	6.93
57	5.70	24.4	166.4	0.17	1.08	6.92
58	5.60	24.7	168.0	0.17	1.08	6.91
59	5.50	24.9	169.2	0.17	1.07	6.91
60	5.50	25.0	170.0	0.17	1.07	6.90
61	5.40	25.2	171.1	0.17	1.07	6.90
62	5.30	25.5	172.7	0.17	1.06	6.89
63	5.20	25.7	174.3	0.17	1.06	6.88
64	5.10	26.0	175.9	0.17	1.06	6.88
65	5.00	26.2	177.1	0.17	1.05	6.87
66	5.00	26.3	177.9	0.17	1.05	6.87
67	4.90	26.5	179.1	0.17	1.05	6.87
68	4.80	26.7	180.7	0.17	1.04	6.86
69	4.70	27.0	182.3	0.17	1.04	6.86
70	4.60	27.3	183.9	0.17	1.03	6.85
71	4.50	27.4	185.1	0.16	1.02	7.22
72	4.50	18.6	401.0	0.11	1.02	15.53
73	4.40	18.8	403.4	0.11	0.90	15.46
74	4.30	19.1	406.9	0.11	0.89	15.39
75	4.20	19.4	410.8	0.11	0.89	15.33
76	4.10	19.6	414.8	0.11	0.88	15.28
77	4.00	19.8	418.0	0.11	0.88	15.24
78	4.00	19.9	420.2	0.11	0.88	15.22
79	3.90	20.1	423.5	0.11	0.87	15.20
80	3.80	20.4	428.0	0.11	0.87	15.17
81	3.70	20.6	432.6	0.11	0.86	15.14
82	3.60	20.9	437.3	0.11	0.86	15.12
83	3.50	21.1	440.9	0.11	0.85	15.10
84	3.50	21.2	443.3	0.11	0.85	15.09
85	3.40	21.4	446.9	0.11	0.85	15.08
86	3.30	21.7	451.8	0.11	0.84	15.06
87	3.20	21.9	456.7	0.11	0.84	15.05
88	3.10	22.2	461.6	0.11	0.83	15.03
89	3.00	22.4	465.3	0.10	0.83	15.43
90	3.00	22.5	467.8	0.10	0.83	15.42
91	2.90	22.7	471.6	0.10	0.82	15.42
92	2.80	23.0	476.6	0.10	0.82	15.41
93	2.70	23.2	481.6	0.10	0.82	15.40
94	2.60	23.5	486.7	0.10	0.81	15.39
95	2.50	23.7	490.5	0.10	0.81	15.38

8.3 Calculated force from a layer Left

Name	Force
Zand, los (klei, puin)	17.32
Zand, los (klei, puin)* 1	37.29
Zand, los (klei, puin)* 2	48.27
Zand, los (klei, puin)* 3	26.74
Klei, zwak zandig, slap*1	60.99
Klei, zwak zandig, slap*2	98.85
Zand, los tot matig vas*1	95.73
Zand, los tot matig vas*2	33.85
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

8.4 Input Data Right

8.4.1 Calculation Method

Calculation method: C, phi, delta

8.4.2 Water Level

Water level: 8.50 [m]

8.4.3 Surface

X [m]	Y [m]
0.00	10.50
3.80	14.00

8.4.4 Soil Material Properties in Profile: Maatgevend profiel korter

Layer name	Level [m]	Unit weight		Cohesion [kN/m²]	Friction angle phi [°]	Delta friction angle [°]
		Unsat [kN/m³]	Sat. [kN/m³]			
Zand, los (klei, ...	14.00	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...	9.50	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...	8.50	18.00	20.00	0.00	27.00	18.00
Zand, los (klei, ...	7.50	18.00	20.00	0.00	27.00	18.00
Klei, zwak zand...	7.00	16.00	16.00	0.00	22.50	7.50
Klei, zwak zand...	6.00	16.00	16.00	0.00	22.50	7.50
Zand, los tot m...	4.50	17.00	19.00	0.00	30.00	20.00
Zand, los tot m...	3.00	17.00	19.00	0.00	30.00	20.00
Zand, m vast to...	1.50	18.00	20.00	0.00	32.50	16.60
Zand, m vast to...	-0.50	18.00	20.00	0.00	32.50	16.60

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Zand, los (klei, ...	14.00	1.00	1.00	Fine
Zand, los (klei, ...	9.50	1.77	1.00	Fine
Zand, los (klei, ...	8.50	2.01	1.00	Fine
Zand, los (klei, ...	7.50	2.12	1.00	Fine
Klei, zwak zand...	7.00	2.37	1.00	Fine
Klei, zwak zand...	6.00	2.45	1.00	Fine
Zand, los tot m...	4.50	2.59	1.00	Fine
Zand, los tot m...	3.00	2.66	1.00	Fine
Zand, m vast to...	1.50	2.95	1.00	Fine
Zand, m vast to...	-0.50	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m ²]	Bottom [kN/m ²]
Zand, los (klei, ...)	14.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	9.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	8.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los (klei, ...)	7.50	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	7.00	n.a.	n.a.	n.a.	0.00	0.00
Klei, zwak zand...	6.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	4.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, los tot m...	3.00	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	1.50	n.a.	n.a.	n.a.	0.00	0.00
Zand, m vast to...	-0.50	n.a.	n.a.	n.a.	0.00	0.00

8.4.5 Modulus of Subgrade Reaction (Secant)

Layer name	Level [m]	Branch 1		Branch 2	
		Top [kN/m ³]	Bottom [kN/m ³]	Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	12000.00	12000.00	6000.00	6000.00
Zand, los (klei, ...)	9.50	10274.85	10274.85	5136.54	5136.54
Zand, los (klei, ...)	8.50	10295.22	10295.22	5147.61	5147.61
Zand, los (klei, ...)	7.50	10282.00	10282.00	5141.00	5141.00
Klei, zwak zand...	7.00	11361.78	11361.78	3073.89	5680.89
Klei, zwak zand...	6.00	11355.75	11355.75	5679.10	5679.10
Zand, los tot m...	4.50	46889.36	46889.36	23444.68	23444.68
Zand, los tot m...	3.00	46834.62	46834.62	23415.98	23415.98
Zand, m vast to...	1.50	1347.59	1347.58	673.79	673.79
Zand, m vast to...	-0.50	93800.00	93800.00	46900.00	46900.00

Layer name	Level [m]	Branch 3	
		Top [kN/m ³]	Bottom [kN/m ³]
Zand, los (klei, ...)	14.00	3000.00	3000.00
Zand, los (klei, ...)	9.50	2568.27	2568.27
Zand, los (klei, ...)	8.50	2572.80	2572.80
Zand, los (klei, ...)	7.50	2569.44	2569.44
Klei, zwak zand...	7.00	2839.26	2839.26
Klei, zwak zand...	6.00	2839.55	2839.55
Zand, los tot m...	4.50	11722.34	11722.34
Zand, los tot m...	3.00	11709.32	11709.32
Zand, m vast to...	1.50	336.89	336.89
Zand, m vast to...	-0.50	23450.00	23450.00

8.4.6 Anchors

Name	Level [m]	E-Modulus [kN/m ²]	Cross section [m ² /m']	Length [m]	Angle [°]	Yield force [kN/m']	Pre-tension. force [kN/m']
Groutanker 50T	11.50	2.100E+08	7.010E-04	13.00	-45.00	10000.00	n.a.

8.5 Calculated Earth Pressure Coefficients Right

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
1	10.40	12.0	2019.5	3.80	3.80	639.62
2	10.30	13.0	677.1	2.22	2.22	115.76
3	10.20	14.0	444.7	1.62	1.62	51.41
4	10.10	15.0	405.1	1.30	1.33	35.30
5	10.00	15.7	392.2	1.15	1.26	28.85
6	10.00	16.1	387.6	1.07	1.26	25.82
7	9.90	16.8	383.9	0.98	1.19	22.42
8	9.80	17.7	382.6	0.89	1.14	19.18
9	9.70	18.6	384.0	0.82	1.09	16.87
10	9.60	19.4	387.0	0.76	1.05	15.14

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
11	9.50	20.1	390.1	0.41	1.02	24.97
12	9.50	20.5	392.4	0.40	1.02	23.91
13	9.40	21.1	396.2	0.38	0.98	22.53
14	9.30	21.9	401.8	0.37	0.95	20.98
15	9.20	22.7	407.8	0.35	0.93	19.70
16	9.10	23.5	414.1	0.34	0.90	18.62
17	9.00	24.1	419.1	0.33	0.88	17.91
18	9.00	24.5	422.4	0.32	0.88	17.48
19	8.90	25.0	427.6	0.32	0.86	16.89
20	8.80	25.8	434.6	0.31	0.84	16.20
21	8.70	26.5	441.8	0.30	0.83	15.59
22	8.60	27.3	449.1	0.29	0.81	15.05
23	8.50	27.8	454.6	0.25	0.80	16.68
24	8.50	28.1	457.4	0.25	0.80	16.45
25	8.40	28.5	460.3	0.25	0.79	16.15
26	8.30	29.0	464.3	0.24	0.78	15.79
27	8.20	29.4	468.3	0.24	0.77	15.46
28	8.10	29.9	472.4	0.24	0.76	15.15
29	8.00	30.2	475.5	0.23	0.75	14.93
30	8.00	30.5	477.6	0.23	0.75	14.80
31	7.90	30.8	480.8	0.23	0.74	14.60
32	7.80	31.2	485.0	0.23	0.73	14.35
33	7.70	31.6	489.3	0.23	0.72	14.12
34	7.60	32.1	493.6	0.22	0.72	13.91
35	7.50	32.4	496.8	0.21	0.71	14.51
36	7.50	32.6	499.0	0.21	0.71	14.41
37	7.40	32.9	502.3	0.21	0.70	14.26
38	7.30	33.3	506.7	0.21	0.70	14.08
39	7.20	33.7	511.1	0.20	0.69	13.90
40	7.10	34.1	515.5	0.20	0.68	13.74
41	7.00	34.4	518.8	0.18	0.68	15.29
42	7.00	39.6	428.4	0.21	0.68	12.53
43	6.90	40.0	424.3	0.21	0.72	12.27
44	6.80	40.4	418.8	0.21	0.72	11.95
45	6.70	40.9	413.4	0.20	0.71	11.63
46	6.60	41.4	407.9	0.20	0.71	11.32
47	6.50	41.7	403.8	0.20	0.70	11.10
48	6.50	41.9	401.1	0.20	0.70	10.95
49	6.40	42.2	397.0	0.20	0.70	10.74
50	6.30	42.7	391.5	0.20	0.69	10.46
51	6.20	43.1	386.0	0.20	0.69	10.19
52	6.10	43.6	380.5	0.20	0.69	9.92
53	6.00	43.9	376.4	0.20	0.68	10.06
54	6.00	44.1	373.6	0.20	0.68	9.93
55	5.90	44.4	369.5	0.19	0.68	9.73
56	5.80	44.8	364.0	0.19	0.68	9.48
57	5.70	45.3	358.5	0.19	0.67	9.24
58	5.60	45.7	353.0	0.19	0.67	9.00
59	5.50	46.0	348.8	0.19	0.67	8.82
60	5.50	46.2	346.6	0.19	0.67	8.72
61	5.40	46.5	347.4	0.19	0.66	8.68
62	5.30	46.9	349.0	0.19	0.66	8.63
63	5.20	47.3	350.6	0.19	0.66	8.58
64	5.10	47.7	352.1	0.19	0.65	8.54
65	5.00	48.0	353.3	0.19	0.65	8.51
66	5.00	48.2	354.1	0.19	0.65	8.48
67	4.90	48.5	355.3	0.19	0.65	8.45
68	4.80	49.0	356.8	0.19	0.65	8.41
69	4.70	49.4	358.4	0.19	0.64	8.38
70	4.60	49.8	360.0	0.19	0.64	8.34
71	4.50	50.1	361.1	0.18	0.64	8.77
72	4.50	40.8	577.9	0.15	0.64	13.95
73	4.40	41.0	591.4	0.15	0.56	14.15
74	4.30	41.2	609.3	0.15	0.56	14.42

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m ²]	Passive [kN/m ²]	Ka [-]	Ko [-]	Kp [-]
75	4.20	41.4	627.3	0.14	0.56	14.69
76	4.10	41.6	645.4	0.14	0.56	14.95
77	4.00	41.7	658.9	0.14	0.55	15.14
78	4.00	41.8	668.0	0.14	0.55	15.27
79	3.90	42.0	681.5	0.14	0.55	15.46
80	3.80	42.2	699.6	0.14	0.55	15.71
81	3.70	42.4	717.8	0.14	0.55	15.95
82	3.60	42.6	735.9	0.14	0.54	16.19
83	3.50	42.7	749.6	0.14	0.54	16.37
84	3.50	42.8	758.7	0.14	0.54	16.49
85	3.40	43.0	772.3	0.14	0.54	16.67
86	3.30	43.2	790.6	0.14	0.54	16.90
87	3.20	43.4	808.8	0.14	0.54	17.13
88	3.10	43.6	827.0	0.14	0.54	17.35
89	3.00	47.7	835.6	0.14	0.53	17.88
90	3.00	40.0	852.2	0.12	0.53	18.15
91	2.90	44.0	850.1	0.13	0.53	17.99
92	2.80	44.3	854.3	0.13	0.53	17.91
93	2.70	44.5	858.5	0.13	0.53	17.85
94	2.60	44.7	862.8	0.13	0.53	17.78
95	2.50	44.8	866.1	0.13	0.53	17.73

8.6 Calculated force from a layer Right

Name	Force
Zand, los (klei, puin)	17.76
Zand, los (klei, puin)* 1	36.62
Zand, los (klei, puin)* 2	48.13
Zand, los (klei, puin)* 3	26.77
Klei, zwak zandig, slap*1	60.99
Klei, zwak zandig, slap*2	98.81
Zand, los tot matig vas*1	95.80
Zand, los tot matig vas*2	33.84
Zand, m vast tot vast*1	0.00
Zand, m vast tot vast	0.00

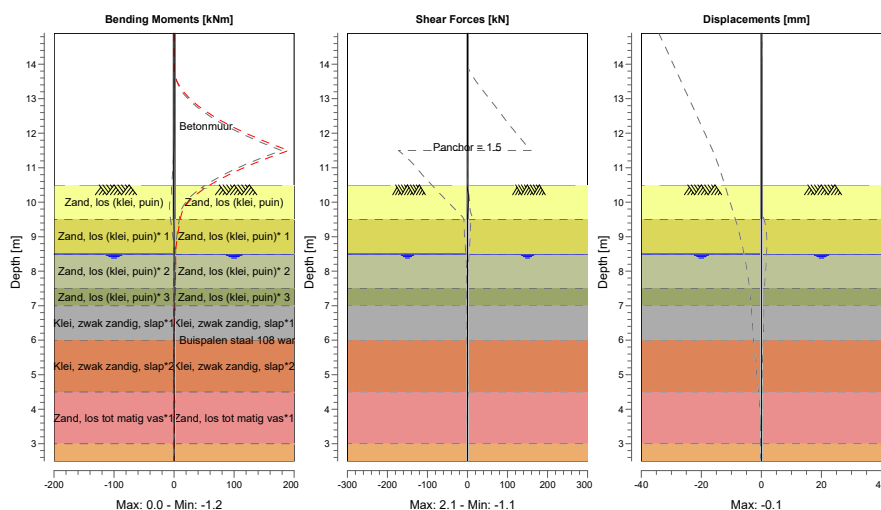
8.7 Calculation Results

Number of iterations: 2

8.7.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 1: 2a - Initial Stage

Step 6.5 - Partial factor set: RC 2



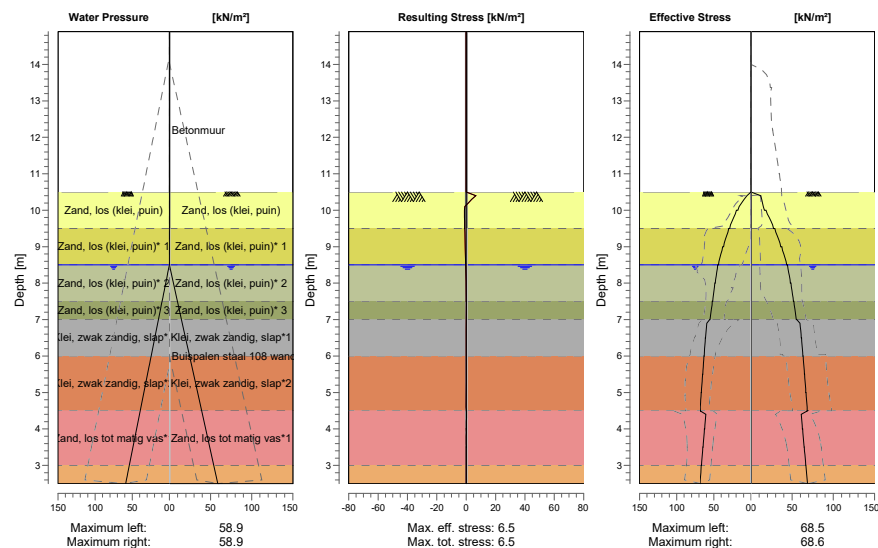
8.7.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	14.90	0.00	0.00	-0.1
1	14.55	0.00	0.00	-0.1
2	14.55	0.00	0.00	-0.1
2	14.20	0.00	0.00	-0.1
3	14.20	0.00	0.00	-0.1
3	14.00	0.00	0.00	-0.1
4	14.00	0.00	0.00	-0.1
4	13.40	0.00	0.00	-0.1
5	13.40	0.00	0.00	-0.1
5	12.80	0.00	0.00	-0.1
6	12.80	0.00	0.00	-0.1
6	12.20	0.00	0.00	-0.1
7	12.20	0.00	0.00	-0.1
7	11.85	0.00	0.00	-0.1
8	11.85	0.00	0.00	-0.1
8	11.50	0.00	0.00	-0.1
9	11.50	0.00	-1.08	-0.1
9	11.00	-0.54	-1.08	-0.1
10	11.00	-0.54	-1.08	-0.1
10	10.50	-1.08	-1.08	-0.1
11	10.50	-1.08	-1.08	-0.1
11	10.00	-0.53	1.75	-0.1
12	10.00	-0.53	1.75	-0.1
12	9.50	-0.06	0.15	0.0
13	9.50	-0.06	0.15	0.0
13	9.00	-0.01	0.07	0.0
14	9.00	-0.01	0.07	0.0
14	8.50	0.01	0.02	0.0
15	8.50	0.01	0.02	0.0
15	8.00	0.02	0.00	0.0
16	8.00	0.02	0.00	0.0

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
16	7.50	0.01	-0.01	0.0
17	7.50	0.01	-0.01	0.0
17	7.00	0.01	0.00	0.0
18	7.00	0.01	0.00	0.0
18	6.50	0.01	0.00	0.0
19	6.50	0.01	0.00	0.0
19	6.00	0.00	0.00	0.0
20	6.00	0.00	0.00	0.0
20	5.50	0.00	0.00	0.0
21	5.50	0.00	0.00	0.0
21	5.00	0.00	0.00	0.0
22	5.00	0.00	0.00	0.0
22	4.50	0.00	-0.01	0.0
23	4.50	0.00	-0.01	0.0
23	4.00	0.00	0.00	0.0
24	4.00	0.00	0.00	0.0
24	3.50	0.00	0.00	0.0
25	3.50	0.00	0.00	0.0
25	3.00	0.00	0.00	0.0
26	3.00	0.00	0.00	0.0
26	2.50	0.00	0.00	0.0
Max		-1.08	1.75	-0.1
Max, minor nodes incl.		-1.16	2.06	-0.1

8.7.3 Charts of Stresses

Stress States - Stage 1: 2a - Initial Stage



8.7.4 Stresses

Node number	Level [m]	Left				Right			
		Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat* [%]	Mob* [%]
1	14.90	0.00	0.00	-		0.00	0.00	-	
1	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.55	0.00	0.00	-		0.00	0.00	-	
2	14.20	0.00	0.00	-		0.00	0.00	-	
3	14.20	0.00	0.00	-		0.00	0.00	-	

Node number	Level [m]	Left				Right			
		Effective stress [kN/m ²]	Water stress [kN/m ²]	Stat*	Mob*	Effective stress [kN/m ²]	Water stress [kN/m ²]	Stat*	Mob*
3	14.00	0.00	0.00	-		0.00	0.00	-	
4	14.00	0.00	0.00	-		0.00	0.00	-	
4	13.40	0.00	0.00	-		0.00	0.00	-	
5	13.40	0.00	0.00	-		0.00	0.00	-	
5	12.80	0.00	0.00	-		0.00	0.00	-	
6	12.80	0.00	0.00	-		0.00	0.00	-	
6	12.20	0.00	0.00	-		0.00	0.00	-	
7	12.20	0.00	0.00	-		0.00	0.00	-	
7	11.85	0.00	0.00	-		0.00	0.00	-	
8	11.85	0.00	0.00	-		0.00	0.00	-	
8	11.50	0.00	0.00	-		0.00	0.00	-	
9	11.50	0.00	0.00	-		0.00	0.00	-	
9	11.00	0.00	0.00	-		0.00	0.00	-	
10	11.00	0.00	0.00	-		0.00	0.00	-	
10	10.50	0.00	0.00	-		0.00	0.00	-	
11	10.50	0.00	0.00	P		0.00	0.00	A	
11	10.00	17.67	0.00	1	46	16.47	0.00	1	
12	10.00	19.47	0.00	1	46	18.24	0.00	1	
12	9.50	28.60	0.00	1	20	27.54	0.00	1	
13	9.50	29.96	0.00	1	20	29.03	0.00	1	
13	9.00	36.89	0.00	1	17	36.23	0.00	1	
14	9.00	38.13	0.00	1	17	37.43	0.00	1	
14	8.50	43.84	0.00	1	14	43.50	0.00	1	
15	8.50	44.71	0.00	1	14	44.39	0.00	1	
15	8.00	48.05	4.91	1	13	47.89	4.91	1	
16	8.00	48.65	4.91	1	13	48.55	4.91	1	
16	7.50	51.54	9.81	1		51.55	9.81	1	5
17	7.50	52.11	9.81	1		52.14	9.81	1	5
17	7.00	55.15	14.71	1		55.11	14.71	1	4
18	7.00	55.59	14.71	1		55.59	14.71	1	5
18	6.50	61.02	19.62	1		61.00	19.62	1	6
19	6.50	61.37	19.62	1		61.39	19.62	1	6
19	6.00	62.98	24.52	1		62.98	24.52	1	7
20	6.00	63.32	24.52	1		63.34	24.52	1	7
20	5.50	64.85	29.43	1		64.84	29.43	1	8
21	5.50	65.18	29.43	1		65.18	29.43	1	8
21	5.00	66.66	34.34	1		66.63	34.34	1	8
22	5.00	66.99	34.34	1		66.94	34.34	1	8
22	4.50	68.12	39.24	1		68.16	39.24	1	7
23	4.50	68.42	39.24	1		68.60	39.24	1	5
23	4.00	62.32	44.15	1		62.42	44.15	1	4
24	4.00	62.72	44.15	1		62.74	44.15	1	4
24	3.50	64.43	49.05	1		64.46	49.05	1	3
25	3.50	64.82	49.05	1		64.77	49.05	1	3
25	3.00	66.50	53.95	1		66.51	53.95	1	3
26	3.00	66.88	53.95	1		66.81	53.95	1	3
26	2.50	68.54	58.86	1		68.56	58.86	1	3

*

Stat Status (A=active, P=passive, Number is branche, 0 is unloading)
Mob Percentage passive mobilized

8.7.5 Percentage mobilized resistance

Horizontal soil pressure	Left [kN]	Right [kN]
Effective	128.8	129.9
Water	35.3	35.3
Total	164.2	165.3

Considered as passive side	Left
Left side is assigned as passive side by user	
Maximum passive effective resistance	953.85 kN
Mobilized passive effective resistance	128.84 kN
Percentage mobilized resistance	13.5 %
Position single support	11.50 m
Maximum passive moment	5684.44 kNm
Mobilized passive moment	547.30 kNm
Percentage mobilized moment	9.6 %

8.7.6 Vertical Force Balance

Xi factor	1.39
Partial factor base resistance	1.20
Maximum point resistance	1.00 [MPa]

Vertical force balance unplugged	Force [kN]
Vertical force active	-37.05
Vertical force passive	36.70
Vertical anchor force (*)	-1.19
Resulting vertical force (no dead weight)	-1.54
Vertical toe capacity R _{b;d}	3.00
Vertical toe capacity is sufficient (2 ≤ 3)	

Vertical force balance plugged	Force [kN]
Vertical force active	-37.05
Vertical force passive	36.70
Vertical anchor force (*)	-1.19
Resulting vertical force (no dead weight)	-1.54
Vertical toe capacity R _{b;d}	23.98
Vertical toe capacity is sufficient (2 ≤ 24)	

(*) The vertical anchor force includes a factor of 1.1 as prescribed by art. 9.7.5(a) of Eurocode NEN 9997-1:2016.

8.7.7 Vertical Force Balance - Contribution per Layer

Left			Right		
Level [m]	Layer name	Contribution [kN]	Level [m]	Layer name	Contribution [kN]
10.50	Zand, los (klei, ...	15.76	10.50	Zand, los (klei, ...	-16.16
9.50	Zand, los (klei, ...	2.42	9.50	Zand, los (klei, ...	-2.38
8.50	Zand, los (klei, ...	3.14	8.50	Zand, los (klei, ...	-3.13
7.50	Zand, los (klei, ...	1.74	7.50	Zand, los (klei, ...	-1.74
7.00	Klei, zwak zand...	1.61	7.00	Klei, zwak zand...	-1.61
6.00	Klei, zwak zand...	2.60	6.00	Klei, zwak zand...	-2.60
4.50	Zand, los tot m...	6.97	4.50	Zand, los tot m...	-6.97
3.00	Zand, los tot m...	2.46	3.00	Zand, los tot m...	-2.46

8.7.8 Anchors/Struts

Anchor/strut	Level [m]	E-Modulus [kN/m ²]	Force [kN]	State	Side	Type
Groutanker 50T	11.50	2.100E+08	1.53	Elastic	Right	Anchor

End of Report

C2-2 Rapport vanuit D-Sheet som_Kranz

Verification anchor force

D-Sheet Piling version 18.2

Date : 7/3/2020

Time: 4:44:00 PM

Problem identification

Testproject

Verticale wand op palen

Stage 15: 7a - 8.5m erosiekrater, lage kade -1m

Height of anchor wall	:	0.00	[m]
Anchor wall bottom	:	2.31	[m]
Anchor wall top	:	2.31	[m]
Length of anchor	:	13.00	[m]
Cross section of anchor	:	701.00	[mm ²]

Anchorage is: short anchorage

Results Kranz calculation:

WARNING: Kranz calculation is only significant if bottom anchor wall is above bottom sheet piling

Sheet piling active	(Ea) :	825.603	[kN]
Horizontal force	(Er) :	-3267.064	[kN]
Anchor wall active	(Eo) :	1120.293	[kN]
Cohesion x length	(Ec) :	0.000	[kN]
Factor due to angle	(Es) :	1.325	[-]

Characteristic Kranz anchor strength			
$R_{kr;k} = (Ea - (Er + Eo) + Ec) / Es$	:	2242.814	[kN]

WARNING: The characteristic Kranz anchor strength is calculated WITH loads.

Control of anchor (art. 9.7.2(a) NEN 9997-1:2016):

Characteristic Kranz anchor strength ($R_{kr;k}$)	:	2242.814	[kN]
Actual anchor force CUR ($1.5 * P_{max}$)	:	686.345	[kN]

MET according to CUR/EC7-NL

End of anchor force verification

C2-3 Rapport vanuit D-Sheet som_Kranz2

Verification anchor force

D-Sheet Piling version 18.2

Date : 7/3/2020

Time: 4:53:41 PM

Problem identification

Testproject

Verticale wand op palen

Stage 12: 4b - Aanbrengen verkeersbelasting 12.2/14m

Height of anchor wall	:	0.00	[m]
Anchor wall bottom	:	2.31	[m]
Anchor wall top	:	2.31	[m]
Length of anchor	:	13.00	[m]
Cross section of anchor	:	701.00	[mm ²]

Anchorage is: short anchorage

Results Kranz calculation:

WARNING: Kranz calculation is only significant if bottom anchor wall is above bottom sheet piling

Sheet piling active	(Ea) :	137.617	[kN]
Horizontal force	(Er) :	-4727.532	[kN]
Anchor wall active	(Eo) :	706.742	[kN]
Cohesion x length	(Ec) :	0.000	[kN]
Factor due to angle	(Es) :	2.269	[-]

Characteristic Kranz anchor strength
 $R_{kr;k} = (Ea - (Er + Eo) + Ec) / Es$: 1832.688 [kN]

WARNING: The characteristic Kranz anchor strength is calculated WITH loads.

Control of anchor (art. 9.7.2(a) NEN 9997-1:2016):

Characteristic Kranz anchor strength ($R_{kr;k}$)	:	1832.688	[kN]
Actual anchor force CUR ($1.5 * P_{max}$)	:	703.231	[kN]

MET according to CUR/EC7-NL

End of anchor force verification

D2 Verticale draagkracht Arnhem Rijnkade Update TL

Report for D-Foundations 17.1

Design and Verification according to Eurocode 7 of Bearing/Tension Piles and Shallow Foundations
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 7/3/2020
Time of report: 5:28:52 PM

Date of calculation: 7/3/2020
Time of calculation: 5:26:33 PM

Filename: C:\..\D-Foundations\Verticale draagkracht Arnhem Rijnkade Update TL

Project identification: Rijnkade Arnhem
Verticale draagkracht palen
D-Foundations Verticale draagkracht Arnhem Rijnkade Update TL

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2 Input Data

2.1 General Input Data

Model Bearing Piles (EC7-NL)

2.2 General Report Data

Geotechnical consultant : Casper Gies
Design engineer superstructure :
Principal :
Title 1 : Rijnkade Arnhem
Title 2 : Verticale draagkracht palen
Title 3 : D-Foundations Verticale draagkracht Arnhem Rijnkade Update TL
Number of project : BG8703
Location of project : Nijmegen

2.3 Application Area Model Bearing Piles

The verifications performed by the model BEARING PILES of D-FOUNDATIONS concern pile foundations on which axial static or quasi-static loads cause pressures in the piles. The calculations of pile forces and pile displacements are based on Cone Penetration Tests. Possible rise of (tension-)piles and horizontal displacements of piles and/or pile groups are not taken into account.

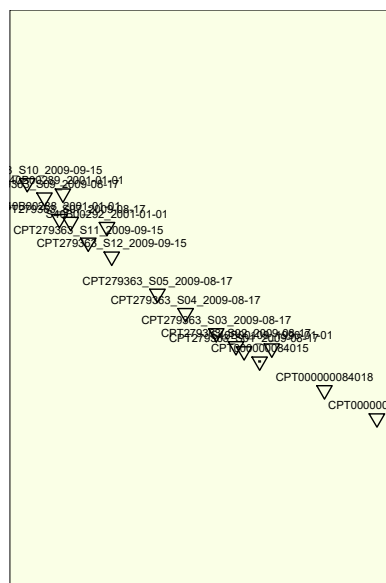
2.4 Superstructure

Rigidity of the superstructure : Non-Rigid

2.5 General CPT Data

Number of CPT's : 4
Timing of CPT's : CPT - Excavation - Install

2.5.1 View of CPT's in Foundation Plan



Legend
• Round 200 dp ex
▽ CPT

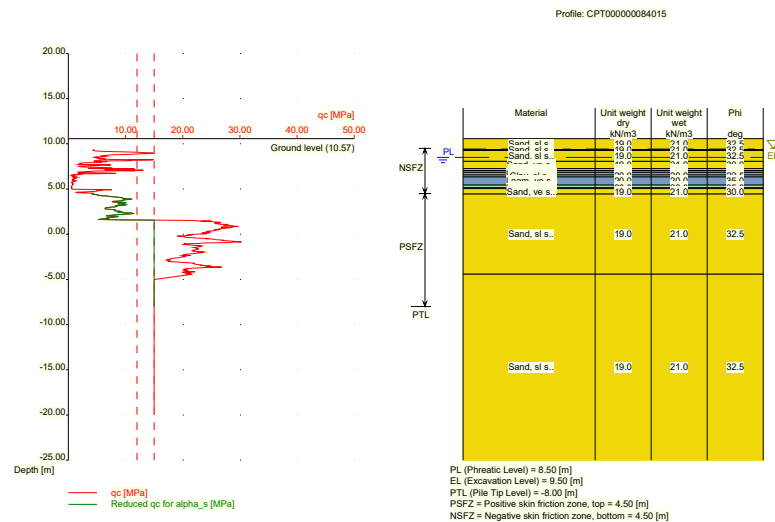
Number/Name CPT	Pile tip level [m R.L.]	Top of pos. friction zone [m R.L.]	Bottom of neg. friction zone [m R.L.]	X-coor- dinate [m]	Y-coor- dinate [m]
1: CPT0000000..	-8.00	4.50	4.50	190721.50	443296.30
2: CPT279363 ..	-8.00	3.50	3.50	190619.12	443362.72
3: CPT0000000..	-8.00	6.00	6.00	190874.10	443228.60
4: CPT0000000..	-8.00	4.00	4.00	190997.70	443162.40

2.6 Soil Data

Number of soil profiles (= number of CPT's) : 4

2.6.1 Soil Profile CPT000000084015

Belonging to CPT	CPT000000084015
Surface level in [m. reference level] :	10.57
Phreatic level in [m. reference level] :	8.50
Pile tip level in [m. reference level] :	-8.00
Top of positive skin friction zone in [m. reference level] :	4.50
Bottom of negative skin friction zone in [m. reference level] :	4.50
OCR-value foundation layer :	1.00
Expected groundlevel settlement in [m] :	0.11
Number of layers in profile :	14



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	10.570	19.00	21.00	32.50	Sand	0.200
2	9.361	19.00	21.00	32.50	Sand	0.200
3	9.261	19.00	21.00	32.50	Sand	0.200
4	8.061	19.00	21.00	30.00	Sand	0.200
5	7.261	19.00	21.00	32.50	Sand	0.200
6	7.061	19.00	21.00	30.00	Sand	0.200
7	6.861	20.00	20.00	35.00	Loam	--
8	6.561	20.00	20.00	22.50	Clay	--
9	6.342	20.00	20.00	35.00	Loam	--
10	5.442	20.00	20.00	22.50	Clay	--

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
11	5.142	20.00	20.00	35.00	Loam	--
12	5.042	19.00	21.00	30.00	Sand	0.200
13	4.442	19.00	21.00	32.50	Sand	0.200
14	-4.424	19.00	21.00	32.50	Sand	0.200

2.6.2 Soil Profile CPT279363_S03_2009-08-17

Belonging to CPT

CPT279363_S03_2009-08-17

Surface level in [m. reference level] :

11.11

Phreatic level in [m. reference level] :

8.50

Pile tip level in [m. reference level] :

-8.00

Top of positive skin friction zone in [m. reference level] :

3.50

Bottom of negative skin friction zone in [m. reference level] :

3.50

OCR-value foundation layer :

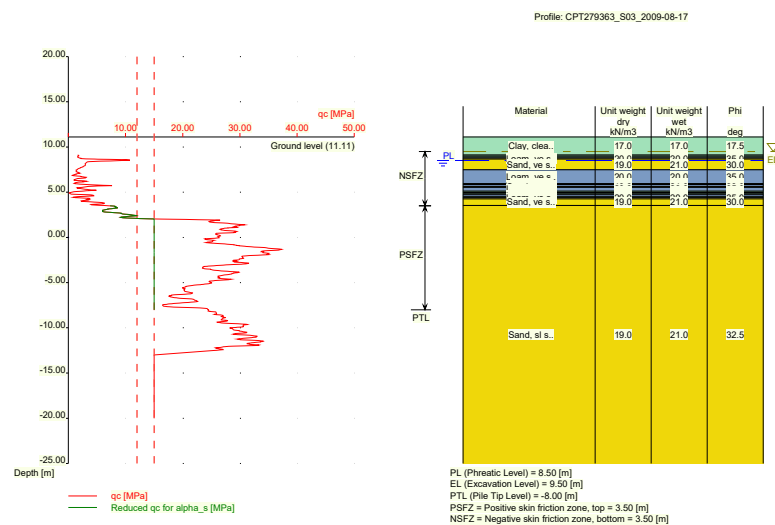
1.00

Expected groundlevel settlement in [m] :

0.11

Number of layers in profile :

19



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	11.110	17.00	17.00	17.50	Clay	--
2	9.112	17.00	17.00	17.50	Clay	--
3	8.985	17.00	17.00	17.50	Clay	--
4	8.879	20.00	20.00	22.50	Clay	--
5	8.774	20.00	20.00	35.00	Loam	--
6	8.668	19.00	21.00	30.00	Sand	0.200
7	7.484	20.00	20.00	35.00	Loam	--
8	5.962	20.00	20.00	22.50	Clay	--
9	5.856	20.00	20.00	35.00	Loam	--
10	5.645	19.00	21.00	30.00	Sand	0.200
11	5.539	20.00	20.00	35.00	Loam	--
12	5.116	20.00	20.00	22.50	Clay	--
13	4.968	17.00	17.00	17.50	Clay	--
14	4.820	20.00	20.00	22.50	Clay	--
15	4.715	20.00	20.00	35.00	Loam	--

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
16	4.503	20.00	20.00	22.50	Clay	--
17	4.397	20.00	20.00	35.00	Loam	--
18	4.271	19.00	21.00	30.00	Sand	0.200
19	3.531	19.00	21.00	32.50	Sand	0.200

2.6.3 Soil Profile CPT000000084018

Belonging to CPT

CPT000000084018

Surface level in [m. reference level] :

10.59

Phreatic level in [m. reference level] :

8.50

Pile tip level in [m. reference level] :

-8.00

Top of positive skin friction zone in [m. reference level] :

6.00

Bottom of negative skin friction zone in [m. reference level] :

6.00

OCR-value foundation layer :

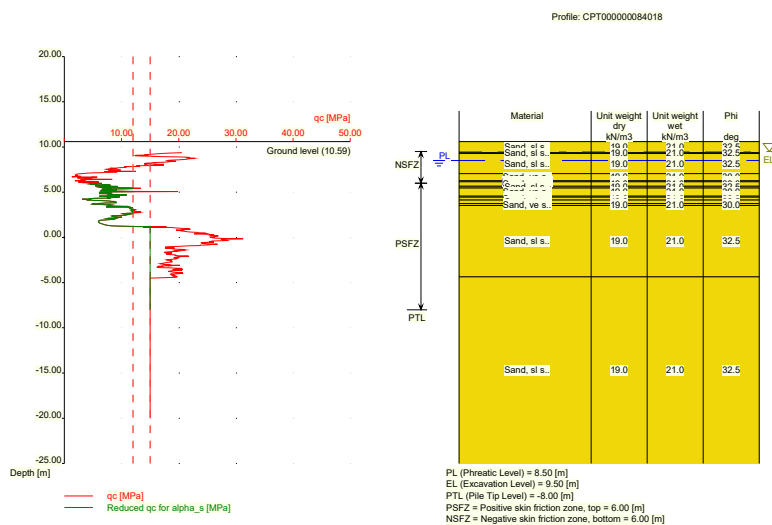
1.00

Expected groundlevel settlement in [m] :

0.11

Number of layers in profile :

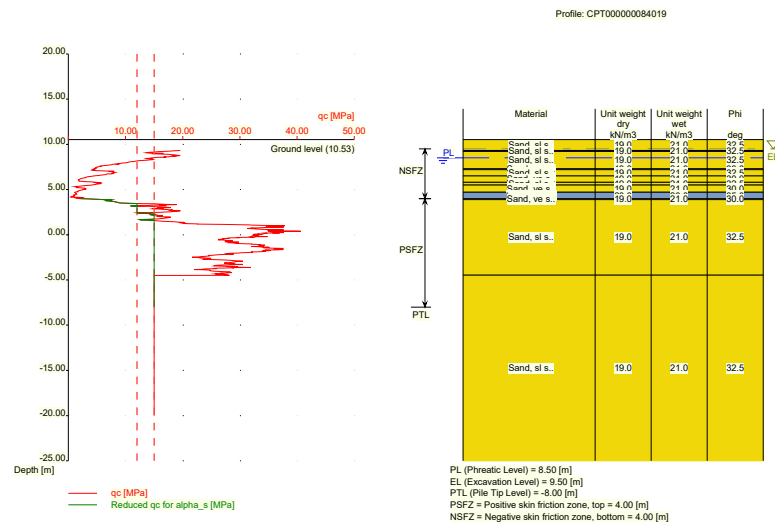
14



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	10.590	19.00	21.00	32.50	Sand	0.200
2	9.380	19.00	21.00	32.50	Sand	0.200
3	9.280	19.00	21.00	32.50	Sand	0.200
4	7.061	19.00	21.00	30.00	Sand	0.200
5	6.261	20.00	20.00	35.00	Loam	--
6	6.161	19.00	21.00	30.00	Sand	0.200
7	5.661	19.00	21.00	32.50	Sand	0.200
8	5.461	19.00	21.00	30.00	Sand	0.200
9	4.561	19.00	21.00	32.50	Sand	0.200
10	4.461	19.00	21.00	30.00	Sand	0.200
11	4.142	19.00	21.00	32.50	Sand	0.200
12	3.742	19.00	21.00	30.00	Sand	0.200
13	3.542	19.00	21.00	32.50	Sand	0.200
14	-4.353	19.00	21.00	32.50	Sand	0.200

2.6.4 Soil Profile CPT000000084019

Belonging to CPT	CPT000000084019
Surface level in [m. reference level] :	10.53
Phreatic level in [m. reference level] :	8.50
Pile tip level in [m. reference level] :	-8.00
Top of positive skin friction zone in [m. reference level] :	4.00
Bottom of negative skin friction zone in [m. reference level] :	4.00
OCR-value foundation layer :	1.00
Expected groundlevel settlement in [m] :	0.11
Number of layers in profile :	12



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	10.530	19.00	21.00	32.50	Sand	0.200
2	9.320	19.00	21.00	32.50	Sand	0.200
3	9.220	19.00	21.00	32.50	Sand	0.200
4	7.301	19.00	21.00	30.00	Sand	0.200
5	7.201	19.00	21.00	32.50	Sand	0.200
6	6.501	19.00	21.00	30.00	Sand	0.200
7	5.801	19.00	21.00	32.50	Sand	0.200
8	5.501	19.00	21.00	30.00	Sand	0.200
9	4.701	20.00	20.00	35.00	Loam	--
10	4.001	19.00	21.00	30.00	Sand	0.200
11	3.901	19.00	21.00	32.50	Sand	0.200
12	-4.456	19.00	21.00	32.50	Sand	0.200

2.7 Pile Types

2.7.1 Pile type : Round 300 anchor bored

Pile type :	Micro pile, anchor, bored
Materialtype for pile :	Concrete
Slip layer :	None

Pile shape : Round pile
 beta (Shape factor) according to figure 7.i, NEN 9997-1:2016.
 s (factor for the influence of the shape of the crosssection of the pile base) according to NEN 9997-1:2016.

Pile dimensions :
 Diameter [m] : 0.300

2.7.2 Pile type : Round 200 dp not extorted

Pile type : Micro pile, double pipe, not extorted

Materialtype for pile : Concrete
 Slip layer : None
 Pile shape : Round pile
 beta (Shape factor) according to figure 7.i, NEN 9997-1:2016.
 s (factor for the influence of the shape of the crosssection of the pile base) according to NEN 9997-1:2016.

Pile dimensions :
 Diameter [m] : 0.200

2.7.3 Pile type : Round 200 dp extorted

Pile type : Micro pile, double pipe, extorted

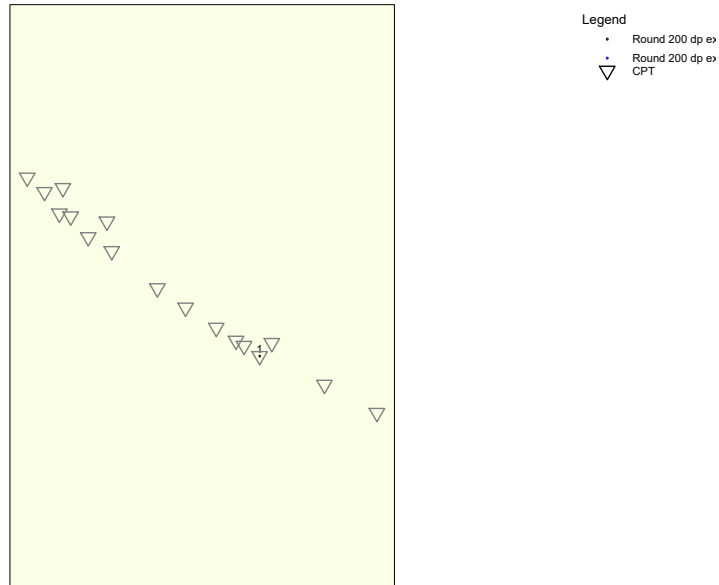
Materialtype for pile : Concrete
 Slip layer : None
 Pile shape : Round pile
 beta (Shape factor) according to figure 7.i, NEN 9997-1:2016.
 s (factor for the influence of the shape of the crosssection of the pile base) according to NEN 9997-1:2016.

Pile dimensions :
 Diameter [m] : 0.200

2.8 Foundation Plan

Number of piles : 1
 Number of collaborating piles* : 1
 * : 0 = not defined, 1 = non rigid superstructure, >1 = rigid superstructure

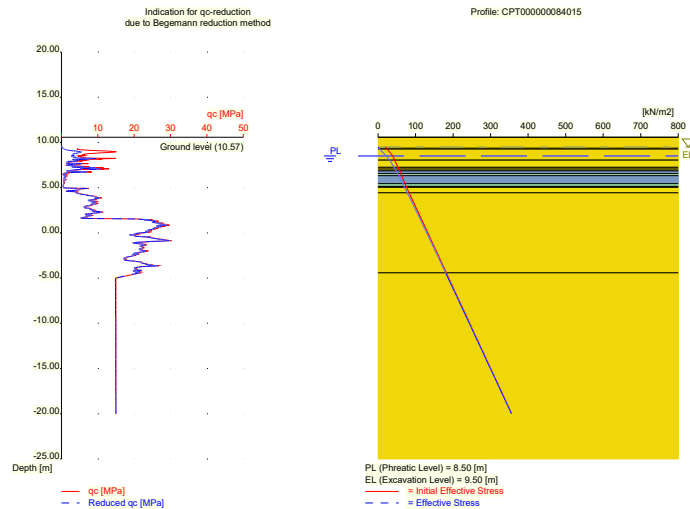
2.8.1 View of Foundation Plan



Pile nr/name	X-coordinate [m]	Y-coordinate [m]	Fc;d (STR/GEO) [kN]	Fc;d (SLS) [kN]	P0 [kN/m2]	Pile head level [m R.L.]
1: 1	190721.50	443296.30	750.00	600.00	0.00	9.50

2.9 Excavation Data

Excavation level in [m. reference level] : 9.50
Reduction model : Begemann
Distance edge pile to excavation boundary [m] : 1.00



2.10 Totalized Loads (design values)

Total load on all piles	
For limit state STR/GEO in [kN] :	750.00
For Serviceability limit state in [kN] :	600.00

2.11 Requirements

Limit state GEO	
Maximum allowed settlement in [m] :	0.150
Maximum allowed (relative) rotation :	1 / 100
Serviceability Limit State	
Maximum allowed settlement in [m] :	0.150
Maximum allowed (relative) rotation :	1 / 300

2.12 Overruled Parameters

User defined Factor xi3 [-] :	1.39
User defined Factor xi4 [-] :	1.39

2.13 Model Options

Suppress pile group (for negative skin friction)

Do not create intermediate results file

Use reduction for continuous flight auger piles (standard)

Use the influence of excavations (standard).

2.14 Model Options

Selected pile types :

- Round 200 dp extorted

Selected profiles :

- CPT000000084015
- CPT279363_S03_2009-08-17
- CPT000000084018

-CPT000000084019

3 Bearing Piles (EC7-NL): Results of the Option Complete Verification

3.1 Errors and Warnings

Warning : The factor ξ_3 (NEN 9997-1:2016) is user defined. Evidence to support this from the NEN deviating value has to be provided.

Warning : The factor ξ_4 (NEN 9997-1:2016) is user defined. Evidence to support this from the NEN deviating value has to be provided.

Warning : The depth of the CPT's does not meet the requirements as set by NEN 9997-1:2016 art. 3.2.3.

The CPT's do not meet the requirements set by NEN 9997-1:2016 art. 3.2.3 because :

- The bearing capacity per CPT differs too much for this to be a valid calculation ($\Delta R_{c;cal;max} > 0.5 \cdot R_{c;cal;max;gem}$).
- $\Delta R_{c;cal;max} = 741.34$ $R_{c;cal;max;gem} = 1391.16$

ALL THE RESULTS OF THIS CALCULATION ARE INVALID.

3.2 Remarks

When checking the survey and testing of soil according to NEN 9997-1:2016 art. 3.2.3 lid (e), the program uses the provided CPT test level. It does NOT take into account possible different pile tip levels. When different pile tip levels are used in this calculation, the user itself must check for possibly required additional survey and testing of soil.

The requirements set by NEN 9997-1:2016 art. 3.3.3 are not met. The variation (13.42%) is too large (> 12%). In fact, the CPT's should not be combined in one calculation as they differ too much to be able to obtain valid values for ξ_3 and ξ_4 .

3.3 Calculation Parameters

3.3.1 Pile Factors

$\gamma_{b;STR/GEO}$ (NEN 9997-1:2016, table A.6 A.7 A.8, Limit State STR/GEO) :	1.20
$\gamma_{b;S}$ (NEN 9997-1:2016, table A.6 A.7 A.8, the Serviceability Limit State) :	1.00
$\gamma_{s;STR/GEO}$ (NEN 9997-1:2016, table A.6 A.7 A.8, Limit State STR/GEO) :	1.20
$\gamma_{s;S}$ (NEN 9997-1:2016, table A.6 A.7 A.8, the Serviceability Limit State) :	1.00
ξ_3 (user defined) :	1.39
ξ_4 (user defined) :	1.39
Xi 4 has been used.	

Even though it is possible, the pilegroup model has not been used to calculate the negative skin friction.

3.3.2 Pile type : Round 200 dp extorted

Pile type :	Micro pile, double pipe, extorted
Materialtype for pile :	Concrete
Slip layer :	None
Pile shape :	Round pile
β (Shape factor: figuur 7.i, NEN 9997-1:2016 art. 7.6.2.3(g) : Pile tip) :	1.00
s (NEN 9997-1:2016 art. 7.6.2.3(h) : factor for the influence of the shape of the crosssection of the pile base) :	1.00
Pile dimensions :	
Diameter [m] :	0.200

CPT	Alpha_s Sand/ Gravel	Alpha_s Clay/Loam Peat	Alpha_p
CPT000000...	0.0110	--	0.3500
CPT279363...	0.0110	--	0.3500
CPT000000...	0.0110	--	0.3500
CPT000000...	0.0110	--	0.3500

3.4 Verification of Limit State STR

Required by NEN 9997-1:2016 art. 2.4.8: $E_d \leq C_d$.

Non rigid superstructure, verify load per pile with bearing capacity per pile.

$F_{c;d} = 750.000$ [kN]

$R_{c;d} = 567.871$ [kN]

The requirements of limit state STR are NOT met, limit state STR is NOT ok.

Note: Negative skin friction plays NO part in Limit State STR. Its influence is incorporated in the tests for Limit State GEO and the Serviceability limit state. The intermediate results provide a full overview of all values that are calculated for the negative skin friction.

Purely indicative, the values for the negative skin friction vary from 4 [kN] to 43 [kN] per pile.

3.5 Verification of Limit State GEO

Required by NEN 9997-1:2016 art. 2.4.9: $S_d \leq S_{req}$.

$S_d = 99.015$ [m]

$S_{req} = 0.150$ [m]

The settlement requirements of limit state GEO are NOT met, this is NOT ok.

With only 1 pile rotation as defined in the NEN is not an issue.

3.6 Verification of Serviceability limit state

Required by NEN 9997-1:2016 art. 2.4.9: $S_d \leq S_{req}$.

For houses, the requirement is : $S_{req} = 0.05$ m. For other types of superstructures a different (well considered) requirement can be specified.

$S_d = 0.022$ [m]

$S_{req} = 0.150$ [m]

The settlement requirements of the Serviceability Limit State are met, this is ok.

With only 1 pile rotation as defined in the NEN is not an issue.

3.7 Additional Information

The design values of the maximum shaft tensions (calculated at the transition of positive to negative skin friction) are

At Limit state STR, GEO : $\sigma = 25.25$ [N/mm²]

At Serviceability Limit States $\sigma = 20.48$ [N/mm²]

The maximum settlement was found at :

Limit state GEO

CPT name CPT279363_S09_2009-08-17

Pile name: 1

Components of the maximum settlement are :

$s_{neg} = 0.000$ [m]

$s_b = 99.000$ [m]

$s_{el;d} = 0.015$ [m]

$s_2 = 0.000$ [m]

Serviceability Limit State

CPT name CPT279363_S09_2009-08-17
Pile name: 1

Components of the maximum settlement are :

sneg = 0.000 [m]
sb = 0.009 [m]
sel;d = 0.013 [m]
s2 = 0.000 [m]

sneg stands for the settlement due to negative skin friction when the expected ground level settlement (egls) is within the next boundaries : $0.02 < \text{egls} \leq 0.10$ meter.

For expected ground level settlement beyond the boundaries, sneg = 0.

3.7.1 The bearing capacity of shaft and point at Limit state GEO

The next table shows the values of the bearing capacities per CPT and these are purely informative. The presented design values are determined using the maximum value of ksi3 and ksi4.

name CPT	Bearing Cap. Shaft [kN] Rs;d	Bearing Cap. Point [kN] Rb;d	Bearing Cap. Total [kN]
CPT000000...	690.795	98.536	789.331
CPT279363...	675.833	138.573	814.406
CPT000000...	732.339	98.533	830.872
CPT000000...	704.728	98.549	803.277
CPT279363...	743.358	200.517	943.875
CPT279363...	744.075	187.184	931.259
CPT279363...	733.593	148.989	882.582
CPT279363...	817.768	194.555	1012.323
CPT279363...	766.350	32.724	799.074
CPT279363...	490.095	77.777	567.872
CPT279363...	753.737	137.932	891.669
CPT279363...	740.788	132.792	873.580
CPT279363...	603.606	76.503	680.109
S40B00109...	828.923	149.118	978.041
S40B00288...	623.503	92.778	716.281
S40B00289...	668.234	107.602	775.836
S40B00292...	793.414	94.656	888.070

3.7.2 The bearing capacity of shaft and point at the Serviceability Limit State

The next table shows the values of the bearing capacities per CPT and these are purely informative. The presented design values are determined using the maximum value of ksi3 and ksi4.

name CPT	Bearing Cap. Shaft [kN] Rs;d	Bearing Cap. Point [kN] Rb;d	Bearing Cap. Total [kN]
CPT000000...	828.953	118.243	947.196
CPT279363...	810.999	166.288	977.287
CPT000000...	878.807	118.239	997.046
CPT000000...	845.674	118.259	963.933
CPT279363...	892.030	240.620	1132.650
CPT279363...	892.890	224.621	1117.511
CPT279363...	880.311	178.787	1059.098
CPT279363...	981.321	233.466	1214.787
CPT279363...	919.620	39.269	958.889
CPT279363...	588.114	93.332	681.446
CPT279363...	904.485	165.518	1070.003
CPT279363...	888.945	159.351	1048.296
CPT279363...	724.327	91.803	816.130
S40B00109...	994.708	178.941	1173.649
S40B00288...	748.203	111.334	859.537

name CPT	Bearing Cap. Shaft [kN] Rs;d	Bearing Cap. Point [kN] Rb;d	Bearing Cap. Total [kN]
S40B00289...	801.881	129.122	931.003
S40B00292...	952.097	113.587	1065.684

End of Report

E1 Material parameters Plaxis

Material set			
Identification number		1	2
Identification		Zand, los (klei- en puinhoudend)	Zand, los tot matig vast
Material model		Hardening soil	Hardening soil
Drainage type		Drained	Drained
Colour		RGB 240, 139, 15	RGB 240, 236, 10
Comments			
General properties			
Y _{unsat}	kN/m ³	18.00	17.00
Y _{sat}	kN/m ³	20.00	19.00
Advanced			
Void ratio			
Dilatancy cut-off		No	No
e _{init}		0.5000	0.5000
e _{min}		0.000	0.000
e _{max}		999.0	999.0
Damping			
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Stiffness			
E ₅₀ ^{ref}	kN/m ²	5400	17.00E3
E _{oed} ^{ref}	kN/m ²	5400	17.00E3
E _{ur} ^{ref}	kN/m ²	16.00E3	50.00E3
power (m)		0.5000	0.5000
Alternatives			
Use alternatives		No	No
C _c		0.06389	0.02029
C _s		0.01941	6.210E-3
e _{init}		0.5000	0.5000
Strength			
c _{ref}	kN/m ²	0.2000	0.2000
φ (phi)	°	29.90	29.90
ψ (psi)	°	0.000	0.000

Project description	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade	Output Version 20.0.0.119	
Company	: Royal Haskoning DHV		
Project filename	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade		Date : 7/7/2020
Output	: Materials		Page : 2

Identification		Zand, los (klei- en puinhoudend)	Zand, los tot matig vast
Advanced			
Set to default values		No	No
Stiffness			
v_{ur}		0.2000	0.2000
p_{ref}	kN/m ²	100.0	100.0
K_0^{nc}		0.5020	0.5020
Strength			
c_{inc}	kN/m ² /m	0.000	0.000
γ_{ref}	m	0.000	0.000
R_f		0.9000	0.9000
Tension cut-off		Yes	Yes
Tensile strength	kN/m ²	0.000	0.000
Undrained behaviour			
Undrained behaviour		Standard	Standard
Skempton-B		0.9866	0.9866
v_u		0.4950	0.4950
$K_{w,ref} / n$	kN/m ²	655.6E3	2.049E6
Stiffness			
Stiffness		Standard	Standard
Strength			
Strength		Manual	Manual
R_{inter}		0.5000	0.6700
Consider gap closure		Yes	Yes
Real interface thickness			
δ_{inter}		0.000	0.000
Groundwater			
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m ³ /day/m	0.000	0.000

Project description	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade	Output Version 20.0.0.119	
Company	: Royal Haskoning DHV		
Project filename	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade		Date : 7/7/2020
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Identification		Zand, matig vast tot vast	Klei, zwak zandig, slap
Advanced			
Set to default values		No	No
Stiffness			
v_{ur}		0.2000	0.2000
p_{ref}	kN/m ²	100.0	100.0
K_0^{nc}		0.4640	0.5020
Strength			
c_{inc}	kN/m ² /m	0.000	0.000
γ_{ref}	m	0.000	0.000
R_f		0.9000	0.9000
Tension cut-off		Yes	Yes
Tensile strength	kN/m ²	0.000	0.000
Undrained behaviour			
Undrained behaviour		Standard	Standard
Skempton-B		0.9866	0.9866
v_u		0.4950	0.4950
$K_{w,ref} / n$	kN/m ²	4.015E6	315.5E3
Stiffness			
Stiffness		Standard	Standard
Strength			
Strength		Manual	Manual
R_{inter}		0.6700	0.3300
Consider gap closure		Yes	No
Real interface thickness			
δ_{inter}		0.000	0.000
Groundwater			
Cross permeability		Impermeable	Impermeable
Drainage conductivity, dk	m ³ /day/m	0.000	0.000

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Material set		
Identification number		5
Identification		Type 1 kering
Material model		Hardening soil
Drainage type		Drained
Colour		RGB 161, 226, 232
Comments		
General properties		
V_{unsat}	kN/m ³	18.00
V_{sat}	kN/m ³	20.00
Advanced		
Void ratio		
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Damping		
Rayleigh α		0.000
Rayleigh β		0.000
Stiffness		
E_{50}^{ref}	kN/m ²	5400
E_{oed}^{ref}	kN/m ²	5400
E_{ur}^{ref}	kN/m ²	16.00E3
power (m)		0.5000
Alternatives		
Use alternatives		No
C_c		0.06389
C_s		0.01941
e_{init}		0.5000
Strength		
C_{ref}	kN/m ²	10.00
ϕ (phi)	°	29.90
ψ (psi)	°	0.000

Identification		Type 1 kering
K0 settings		
K ₀ determination		Automatic
K _{0,x} = K _{0,z}		Yes
K _{0,x}		0.5020
K _{0,z}		0.5020
Overconsolidation		
OCR		1.000
POP	kN/m²	0.000
Model		
Data set		Standard
Soil		
Type		Coarse
< 2 µm	%	10.00
2 µm - 50 µm	%	13.00
50 µm - 2 mm	%	77.00
Flow parameters		
Use defaults		None
k _x	m/day	1.000E-3
k _y	m/day	1.000E-3
-ψ _{unsat}	m	10.00E3
e _{init}		0.5000
S _s	1/m	0.000
Change of permeability		
c _k		1000E12

Project description	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade	Output Version 20.0.0.119	
Company	: Royal Haskoning DHV		
Project filename	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade		Date : 7/7/2020
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Project description	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade	Output Version 20.0.0.119	
Company	: Royal Haskoning DHV		
Project filename	: Rijnkade_Arnhem_v10.0_palen_smalle_lage_kade		Date : 7/7/2020
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Identification		Klei, ongedraineerd
Parameters		
G/s_u^A		100.0
γ_f^C	%	5.000
γ_f^E	%	10.00
γ_f^{DSS}	%	15.00
$s_{u\text{ ref}}^A$		31.00
$vert_{ref}$		7.000
$s_{u\text{ inc}}^A$		1.900
s_u^P/s_u^A		1.010
τ_0/s_u^A		0.000
s_u^{DSS}/s_u^A		1.010
v		0.2000
v_u		0.4950
alpha		0.2200
power		0.8000
$s_{u,min}$		2.000
Advanced		
Undrained behaviour		
Undrained behaviour		Standard
Stiffness		
Stiffness		Standard
Strength		
Strength		Manual
R_{inter}		0.3300
Consider gap closure		Yes
Real interface thickness		
δ_{inter}		0.000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m ³ /day/m	0.000

Material set		
Identification number		7
Identification		Zand, aanvulling
Material model		Mohr-Coulomb
Drainage type		Drained
Colour		RGB 236, 232, 156
Comments		
General properties		
Y _{unsat}	kN/m ³	18.00
Y _{sat}	kN/m ³	20.00
Advanced		
Void ratio		
Dilatancy cut-off		No
e _{init}		0.5000
e _{min}		0.000
e _{max}		999.0
Damping		
Rayleigh α		0.000
Rayleigh β		0.000
Stiffness		
E	kN/m ²	30.00E3
ν (nu)		0.2000
Alternatives		
G	kN/m ²	12.50E3
E _{oed}	kN/m ²	33.33E3
Strength		
c _{ref}	kN/m ²	0.2000
φ (phi)	°	29.90
ψ (psi)	°	0.000
Velocities		
V _s	m/s	82.54
V _p	m/s	134.8

Identification		Zand, aanvulling
Advanced		
Set to default values		Yes
Stiffness		
E _{inc}	kN/m ² /m	0.000
Y _{ref}	m	0.000
Strength		
C _{inc}	kN/m ² /m	0.000
Y _{ref}	m	0.000
Tension cut-off		Yes
Tensile strength	kN/m ²	0.000
Undrained behaviour		
Undrained behaviour		Standard
Skempton-B		0.9866
v _u		0.4950
K _{w,ref} / n	kN/m ²	1.229E6
Stiffness		
Stiffness		Standard
Strength		
Strength		Manual
R _{inter}		0.6670
Consider gap closure		Yes
Real interface thickness		
δ _{inter}		0.000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m ³ /day/m	0.000
K0 settings		
K ₀ determination		Automatic
Model		
Data set		Standard

Identification		Zand, aanvulling
Soil		
Type		Coarse
< 2 µm	%	10.00
2 µm - 50 µm	%	13.00
50 µm - 2 mm	%	77.00
Flow parameters		
Use defaults		None
k _x	m/day	1.000
k _y	m/day	1.000
-ψ _{unsat}	m	10.00E3
e _{init}		0.5000
S _s	1/m	0.000
Change of permeability		
c _k		1000E12

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Material set			
Identification number		1	2
Identification		Beton-7.5	AZ 37-700-430
Comments		Yield strength of steel is 430 [N/mm2]	
Colour		RGB 0, 0, 255	RGB 28, 0, 255
Material type		Elastic	Elastoplastic
Properties			
Isotropic		Yes	No
EA ₁	kN/m	9.000E6	4.746E6
EA ₂	kN/m	9.000E6	237.3E3
EI	kN m ² /m	67.50E3	194.0E3
d	m	0.3000	0.7004
w	kN/m/m	7.500	1.776
v (nu)		0.000	0.000
M _p	kN m/m	1000E12	1832
N _{p,1}	kN/m	10.00E9	9718
N _{p,2}	kN/m	10.00E9	485.9
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Prevent punching		No	No
Parameters			
Identification number		1	2

Material set			
Identification number		3	4
Identification		Hoge kade maaiveld plate	Beton-12.5
Comments			
Colour		RGB 242, 54, 211	RGB 55, 121, 242
Material type		Elastic	Elastic
Properties			
Isotropic		Yes	Yes
EA ₁	kN/m	4.000E6	9.000E6
EA ₂	kN/m	4.000E6	9.000E6
EI	kN m ² /m	194.0E3	67.50E3
d	m	0.7629	0.3000
w	kN/m/m	0.000	12.50
v (nu)		0.000	0.000
M _p	kN m/m	1000E12	1000E12
N _{p,1}	kN/m	10.00E9	10.00E9
N _{p,2}	kN/m	10.00E9	10.00E9
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Prevent punching		No	No
Parameters			
Identification number		3	4

Material set			
Identification number		1	2
Identification		Nieuw Anker Hoge kade GEWI 50T	Anker Lage kade Titan 6Strengs
Comments			
Colour		RGB 212, 8, 184	RGB 27, 20, 240
Material type		Elastic	Elastic
Properties			
EA	kN	412.3E3	189.0E3
L _{spacing}	m	2.800	2.800
Parameters			
Identification number		1	2
Parameters			
Identification number		1	2
Parameters			
Identification number		1	2

Material set		
Identification number		3
Identification		Anker in plaats van embedded beam row
Comments		
Colour		RGB 0, 0, 0
Material type		Elastic
Properties		
EA	kN	1.000E6
L _{spacing}	m	2.800
Parameters		
Identification number		3
Parameters		
Identification number		3
Parameters		
Identification number		3

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Material set		
Identification number		1
Identification		Ankerpalen 108-12.5
Comments		
Colour		RGB 199, 82, 143
Material type		Elastic
Properties		
E	kN/m ²	33.90E6
Y	kN/m ³	0.000
Beam type		User-defined
A	m ²	0.03142
I ₂	m ⁴	0.02700E-3
I ₃	m ⁴	0.02700E-3
Rayleigh α		0.000
Rayleigh β		0.000
Axial skin resistance		
Axial skin resistance		Multi-linear
Multi-linear axial resistance		Axial skin resistance table
Base resistance		
F _{max}	kN	200.0
Material set		
Identification number		1
Identification		Ankerpalen 108-12.5
Comments		
Colour		RGB 199, 82, 143
Material type		Elastic

Identification		Ankerpalen 108-12.5
Properties		
E	kN/m ²	33.90E6
γ	kN/m ³	0.000
Beam type		User-defined
A	m ²	0.03142
I	m ⁴	0.02700E-3
L _{spacing}	m	2.800
Rayleigh α		0.000
Rayleigh β		0.000
Axial skin resistance		
Axial skin resistance		Multi-linear
Multi-linear axial resistance		Axial skin resistance table
Lateral resistance		
Lateral resistance		Multi-linear
Multi-linear lateral resistance		Lateral resistance table
Base resistance		
F _{max}	kN	200.0
Interface stiffness factor		
Default values		Yes
Axial stiffness factor		0.2078
Lateral stiffness factor		0.2078
Base stiffness factor		2.078
Parameters		
Identification number		1

Identification		Ankerpalen 108-12.5 zonder puntweerstand	
Properties			
E	kN/m ²	33.90E6	
γ	kN/m ³	0.000	
Beam type		User-defined	
A	m ²	0.03142	
I	m ⁴	0.02700E-3	
L _{spacing}	m	2.800	
Rayleigh α		0.000	
Rayleigh β		0.000	
Axial skin resistance			
Axial skin resistance		Multi-linear	
Multi-linear axial resistance		Axial skin resistance table	
Lateral resistance			
Lateral resistance		Multi-linear	
Multi-linear lateral resistance		Lateral resistance table	
Base resistance			
F _{max}	kN	0.000	
Interface stiffness factor			
Default values		Yes	
Axial stiffness factor		0.2078	
Lateral stiffness factor		0.2078	
Base stiffness factor		2.078	
Parameters			
Identification number		2	

E2 verticale paal eigenschappen

Paal Input Dsheet en Plaxis zonder corrosie

E staal	2.10E+08	kN/m2
uitwendige diameter staalbuis	0.1080	m
wanddikte staalbuis	0.0125	m
inwendige diameter staalbuis	0.0830	m
E beton	10.000	N/mm2
E beton	1.00E+07	kN/m2
diameter beton	0.200	m

ongecorrodeerde eigenschappen

straal buitenkant staal	0.0540	m	
straal binnenzijde staal	0.0415	m	
I buis	4.35E-06	m4	klopt met profielenboek
I buis	435	cm4	
A buis uitwendig	9.16E-03	m2	
A buis inwendig	5.41E-03	m2	
A buis inwendig	3.75E-03	m2	
A staal	3.750	mm2	klopt met profielenboek
EI van staal staaf	913.22	kNm2	
EA van staal staaf	787.558	kN	
straal beton	0.1	m	
A beton (excl. staal)	2.77E-02	m2	
A beton (excl. staal)	27.666	mm2	
EA van beton	2.77E+05	kN	

Invoer in D-Sheetpiling

I van staal buis	4.35E-06	m4
diameter paal	0.200	m
I per m'	2.17E-05	m4/m'
EI per m'	4.57E+03	kNm2/m'

Invoer in Plaxis

I van staal buis	4.35E-06	m4	
A van totale paal	0.03142	m2	check
E samengesteld	3.39E+07	kN/m2	

EA gecombineerd is dan	1.06E+06	kN	is van betonpaal + staal -> verticale stijfheid
EI is dan	147.31	kNm2	16.1% is laag -> hogere I invoeren om staaf te simuleren
			I wordt dan 913.22 m4
			EI 2.70E+05 kNm2
			hart op hart afstand 2.800 m

weerstandsmoment buis	80531	mm3	elastisch, buizentabel Van Leeuwen
weerstandsmoment berekend	8.05311E-05	m3	
weerstandsmoment buis	0.000080531	m3	
staalkwaliteit	235	N/mm2	aanname, lage staalkwaliteit
staalspanning	235.000	kN/m2	
opneembaar moment	18.9	kNm	

Paal Input Dsheet en Plaxis met corrosie

E staal	2.10E+08	kN/m2
uitwendige diameter staalbuis	0.1080	m
wanddikte staalbuis	0.0125	m
inwendige diameter staalbuis	0.0830	m
corrosie buitenzijde	0.0022	m/100 jaar
E beton	10.000	N/mm2
E beton	1.00E+07	kN/m2
diameter beton	0.200	m

gecorrodeerde eigenschappen

uitwendige diameter staalbuis corr	0.1036	m	
wanddikte staalbuis corr	0.0103	m	
inwendige diameter staalbuis corr	0.0830	m	
straal buitenkant staal	0.0518	m	
straal binnenzijde staal	0.0415	m	
I buis	3.33E-06	m4	
I buis	333	cm4	klopt met profielenboek bij 0 corrosie
A buis uitwendig	8.43E-03	m2	
A buis inwendig	5.41E-03	m2	
A staal	3.02E-03	m2	
A staal	3.019	mm2	klopt met profielenboek bij 0 corrosie
EI van staal staaf	698.27	kNm2	
EA van staal staaf	633.998	kN	
straal beton	0.1	m	
A beton (excl. staal)	2.84E-02	m2	
A beton (excl. staal)	28.397	mm2	
EA van beton	2.84E+05	kN	

Invoer in D-Sheetpiling

I van staal buis	3.33E-06	m4
diameter paal	0.200	m
I per m'	1.66E-05	m4/m'
EI per m'	3.49E+03	kNm2/m'

Invoer in Plaxis

I van staal buis	3.33E-06	m4	
A van totale paal	0.03142	m2	check
E samengesteld	2.92E+07	kN/m2	

EA gecombineerd is dan	9.18E+05	kN	is van betonpaal + staal -> verticale stijfheid
EI is dan	97.16	kNm2	13.9% is laag -> hogere I invoeren om staaf te simuleren?
			I wordt dan 2.39E-05 m4
			EI 698.27 kNm2
			hart of hart afstand 2.800 m

weerstandsmoment buis	80531	mm3	elastisch, buizentabel Van Leeuwen
weerstandsmoment berekend	6.42E-05	m3	gecorrodeerd
weerstandsmoment buis	0.000064191	m3	
staalkwaliteit	235	N/mm2	aanname, lage staalkwaliteit
staalspanning	235.000	kN/m2	
opneembaar moment	15.1	kNm	

knik gecorrodeerd verkenning

CUR 236 paragraaf 7.4

Voor een veilige ondergrensbepaling met betrekking tot de rekenwaarde van de kritieke drukkracht kan gebruik gemaakt worden van de volgende formule:

$$R_{buc,s} = \beta_1 \cdot \sqrt{(C_{br} \cdot E_{lmax}) / \gamma_{m,buc}}$$

B	11	[-]	bron CUR 236
Cu	25	[kN/m2]	ontwerpproject Rijnkade
EI buis	698.27	kNm2	
gamma,m	1.5		bron CUR 236
Rbuc,d	969	kN	

belasting circa 750 kN voorlopige schatting gewicht muur, ankercomponent en Fnk

UC 0.77 - voldoet

I Check invloed nieuwe L-wand

Report for D-Sheet Piling 18.2

Design of Diaphragm and Sheet Pile Walls
Developed by Deltares



Company: Royal HaskoningDHV

Date of report: 9/30/2020
Time of report: 8:25:06 AM
Report with version: 18.2.1.20477

Date of calculation: 8/14/2020
Time of calculation: 5:58:32 PM
Calculated with version: 18.2.1.20477

File name: C:\.\Check invloed L-wand

Project identification: Rijnkade Arnhem
Analyse invloed L-wand op lage kade

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2 Summary

2.1 Maxima per Stage

Stage nr.	Stage	Displacement [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
1	bestaand	-9.8	-179.30	74.63	26.7	29.2	Not sufficient
2	bestaand met P0	-45.1	-258.52	123.30	38.3	42.5	Not sufficient
3	bestaand met L-...	-46.2	-261.93	124.88	38.8	43.0	Not sufficient

Max		-46.2	-261.93	124.88	38.8	43.0	Not sufficient
-----	--	--------------	----------------	---------------	-------------	-------------	----------------

2.2 Anchors and Struts

Stage name	Anchor/strut Titan anker	
	Force [kN]	State
bestaand	100.00	Elastic
bestaand met P0	143.63	Elastic
bestaand met L-wand en P0	144.81	Elastic

Max	144.81	
-----	---------------	--

3 Input Data for all Stages

3.1 General Input Data

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

3.2 Sheet Piling Properties

Length	14.00 m
Level top side	11.00 m
Number of sections	1
q _b ;max	1.00 MPa
Xi factor	1.39

3.2.1 General properties

Section name	From [m]	To [m]	Material type	Acting width [m]
AZ 37 -700 (S32...	-3.00	11.00	Steel	1.00

3.2.2 Stiffness EI (elastic behaviour)

Section name	Elastic stiffness EI [kNm ² /m']	Red. factor on EI [-]	Corrected elas. stiffness EI [kNm ²]	Note to reduction factor
AZ 37 -700 (S32...	1.9404E+05	1.00	1.9404E+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 37 -700 (S32...	1186.00	1.00	1.00	1.00	1186.00

3.2.4 Properties for vertical balance

Section name	From [m]	To [m]	Height [mm]	Coating area [m ² /m ² wall]	Section area [cm ² /m']
AZ 37 -700 (S32...	-3.00	11.00	499.00	1.46	226.00

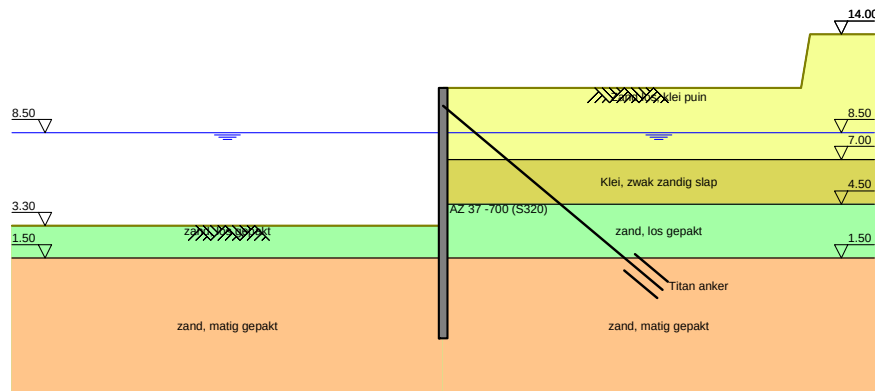
3.3 Calculation Options

First stage represents initial situation	No
Calculation refinement	Fine
Lambda recalculation	Automatic
Reduce delta(s) according to CUR	Yes

4 Construction Stage 1: bestaand

4.1 Outline

Outline - Stage 1: bestaand

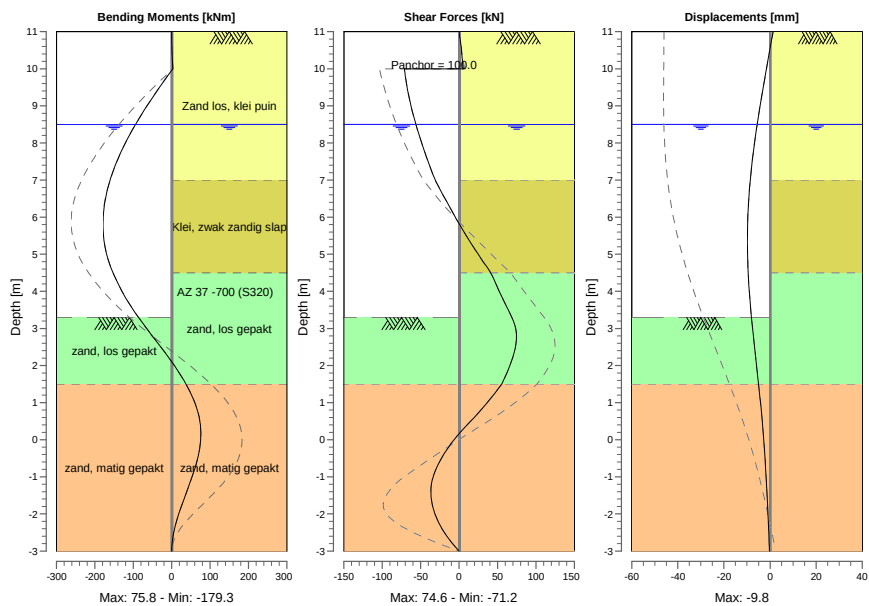


4.2 Calculation Results

Number of iterations: 6

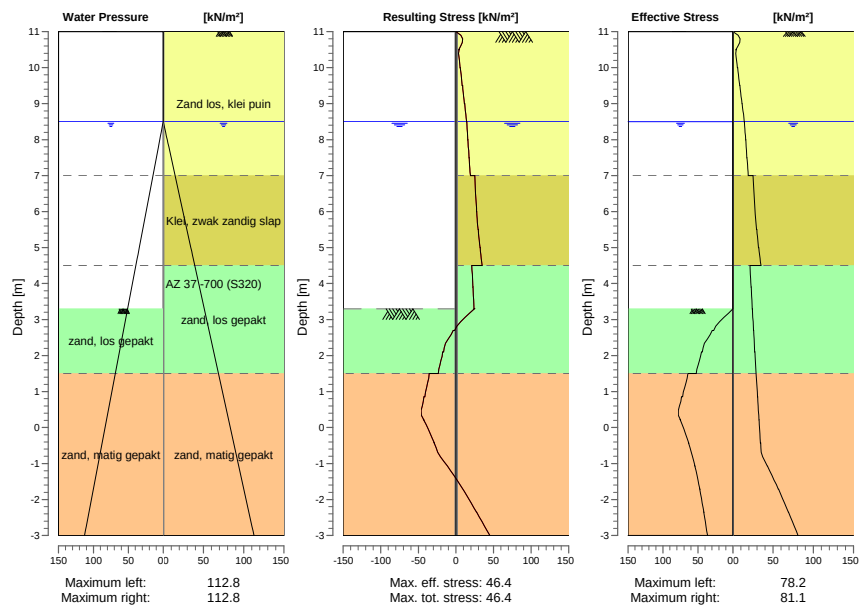
4.2.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 1: bestand



4.2.2 Charts of Stresses

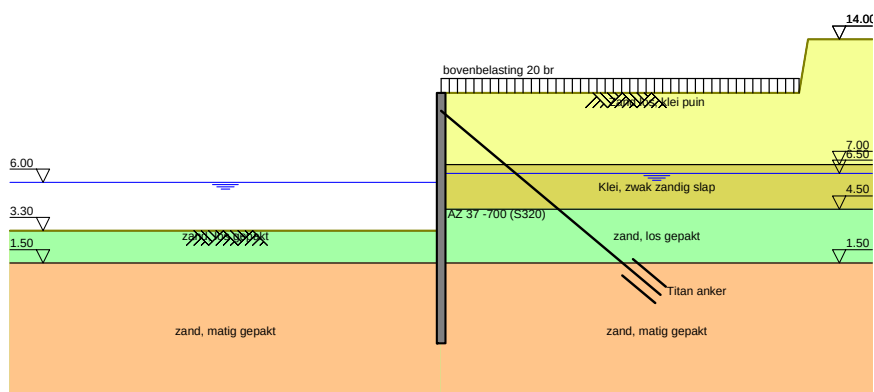
Stress States - Stage 1: bestand



5 Construction Stage 2: bestaand met P0

5.1 Outline

Outline - Stage 2: bestaand met P0

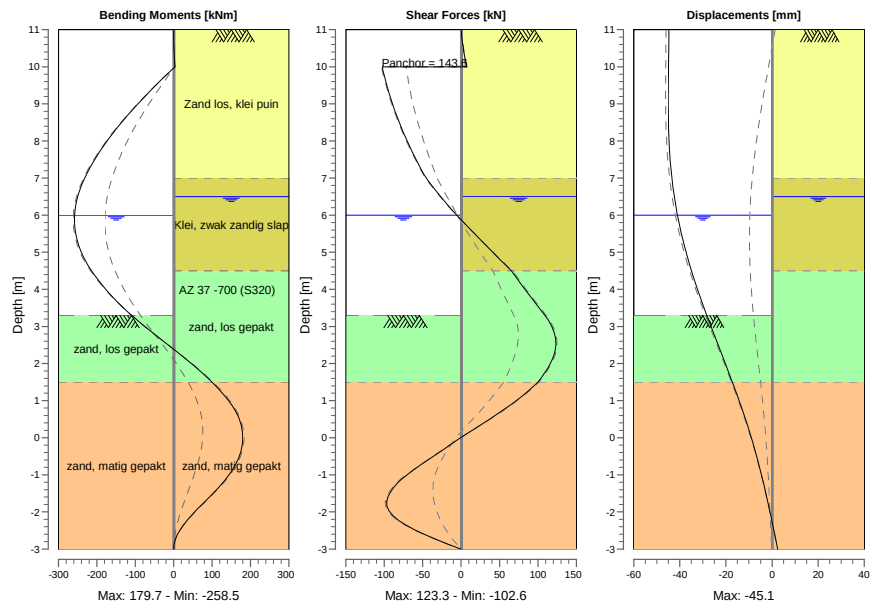


5.2 Calculation Results

Number of iterations: 5

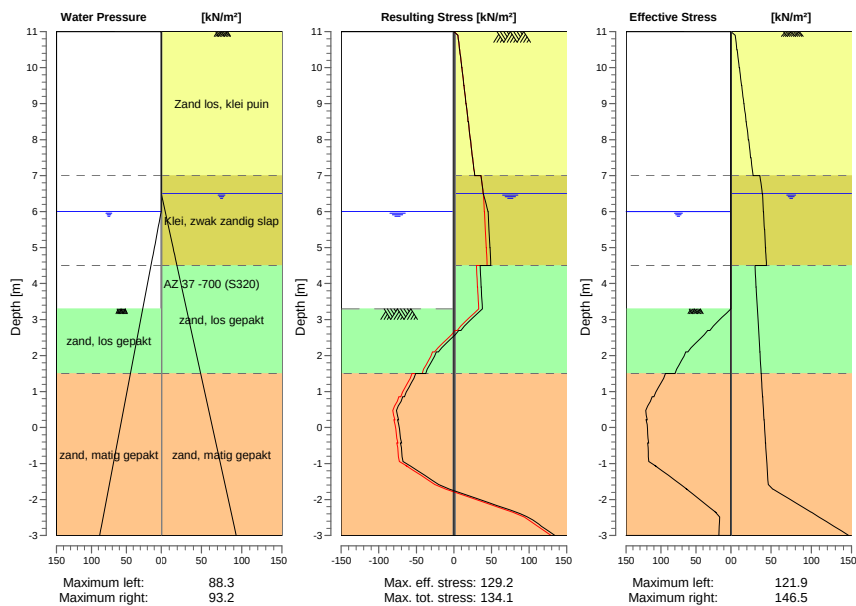
5.2.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 2: bestand met P0



5.2.2 Charts of Stresses

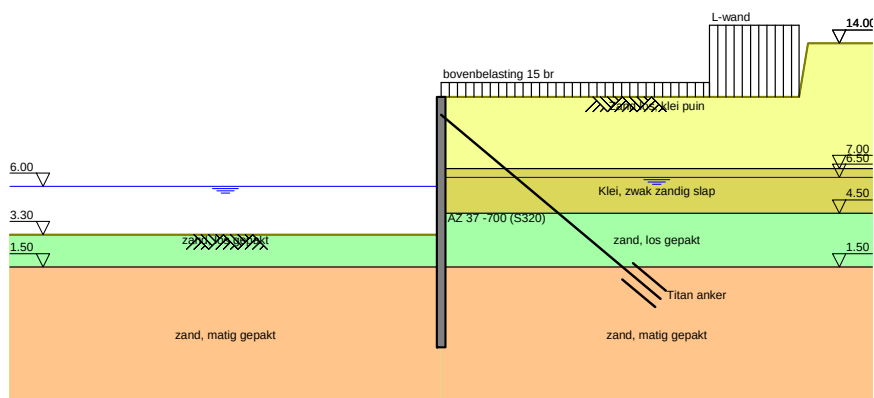
Stress States - Stage 2: bestaand met P0



6 Construction Stage 3: bestaand met L-wand en P0

6.1 Outline

Outline - Stage 3: bestaand met L-wand en P0

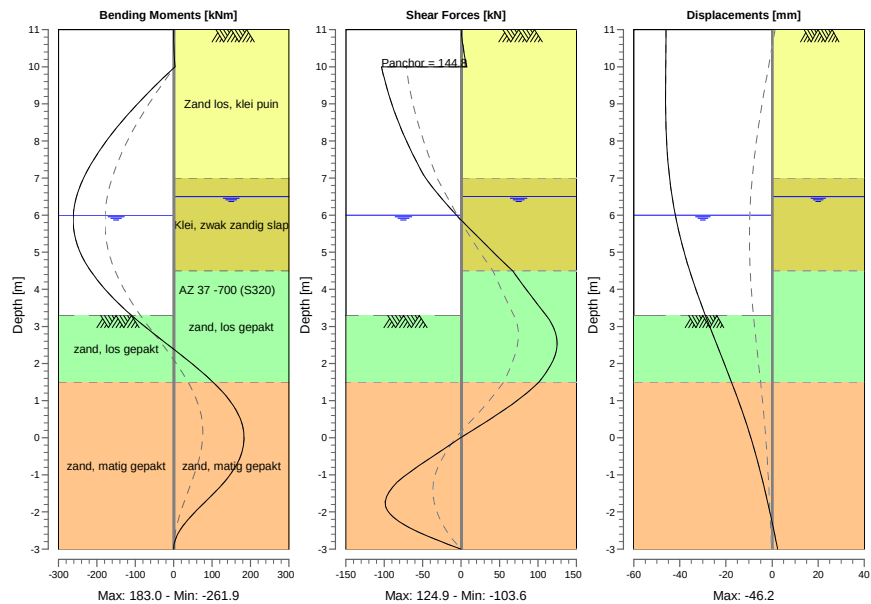


6.2 Calculation Results

Number of iterations: 5

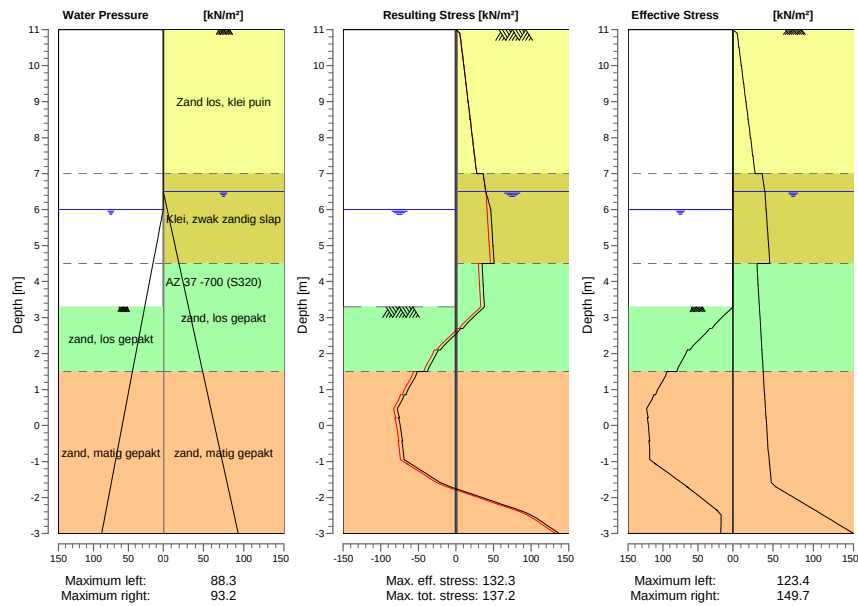
6.2.1 Charts of Moments, Forces and Displacements

Moments/Forces/Displacements - Stage 3: bestaand met L-wand en P0



6.2.2 Charts of Stresses

Stress States - Stage 3: bestand met L-wand en P0



End of Report