Document:	**Rapportage WSI-palen**
Projectomschrijving:	Woning Herman Gorterstraat 20
Projectlocatie:	Amsterdam
	Berekening en tekening
Documentnummer:	PB H221363-1
Datum:	23 juni 2023

Op al onze werkzaamheden is de DNR2011 van toepassing.

Document: **Rapportage WSI-palen**

Projectomschrijving: Woning Herman Gorterstraat 20
Projectlocatie: Amsterdam

Berekening en tekening

Documentnummer: PB H221363-1
Datum: 23 juni 2023

Opdrachtgever: 5.1, 2, e

Opgesteld door: **Hektec B.V.**
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Documentbeheer					
Versie	**Datum**	**Auteur**	**Paraaf**	**Verificatie**	**Paraaf**
-1	23-06-2023	Ing. 5.1, 2, e	5.1, 2, e	Ing. 5.1, 2, e	5.1, 2, e

Op al onze werkzaamheden is de DNR2011 van toepassing.

RAPPORTAGE

Rapportnummer:	PB H221363-1
Project:	Woning Herman Gorterstraat 20
Locatie:	Amsterdam

Inhoudsopgave

Bijlage(n)

A Gegevens
B Berekening grondmechanisch draagvermogen (uitvoer CloudPiling)
C Controle kopplaat en schachtspanning
D Specificaties grout
E Paaltekening

1 Inleiding

Dit rapport omvat de berekening en tekening van de WSI-palen ten behoeve van het project “Woning Herman Gorterstraat 20” te Amsterdam.

Voor het project is reeds een funderingsadvies opgesteld door 5.1, 2, e , gebaseerd op HEKpalen.

Hektec BV, heeft van De Waalpaal B.V./ Gebr. van ’t Hek de opdracht ontvangen om het funderingsadvies aan te passen op basis van WSI-paal (schroefinjectiepalen) en op basis van de nieuw gemaakte sonderingen.

De in het rapport gehanteerde uitgangspunten dienen door de opdrachtgever gecontroleerd te worden.

2 Algemene gegevens

Aangeleverde gegevens:

[1] Funderingsadvies opgesteld door 5.1, 2, e , kenmerk S21.597-F1/JHo, d.d. 14-01-2022.
[2] Sonderingen uitgevoerd door 5.1, 2, e , kenmerk S21.597, d.d. 14-06-2023.
[3] Palenplan opgesteld door BREED Integrated Design, proj.nr. 21038, tek.nr. TO.2000V, versie 1, d.d. 07-10-2022.

Normen, richtlijnen en software:

De volgende normen, richtlijnen en software zijn gebruikt:

- NEN-EN 9997-1+C2 (nl), november 2017, Geotechnisch ontwerp van constructies - Deel 1: Algemene regels.
- NEN-EN 1993-1-1+C2 (nl), december 2011, Eurocode 3: Ontwerp en berekening van staalconstructies – Deel 1-1: Algemene regels en regels voor gebouwen
- NEN-EN 1993-1-1+C2/NB (nl), december 2011, Nationale bijlage bij NEN-EN 1993-1-1+C2
- NEN-EN 1993-1-8+C2 (nl), december 2011, Eurocode 3: Ontwerp en berekening van staalconstructies – Deel 1-8: Ontwerp en berekening van verbindingen
- NEN-EN 1993-1-8+C2/NB (nl), december 2011, Nationale bijlage bij NEN-EN 1993-1-8+C2
- NEN-EN 12699 (en), mei 2015, Uitvoering van bijzonder geotechnisch werk - Verdringingspalen
- 'Theory of plates and shells' (5.1, 2, e e.a.)
- Deep Foundation Software, Cloud Piling

3 Berekeningsuitgangspunten

Type paal:

WSI-palen:	Geschroefde stalen buispaal met groutinjectie, trillingsvrij–geluidsarm

Afmetingen WSI-palen:

Buisdiameter:	∅168,3 mm[1]
Wanddikte bovenin:	10 mm[1]
Diameter groutlichaam:	∅500 mm[1]

Belastingen:

$F_{c;d;max}$:	1025 kN [3]
$F_{t;d;max}$:	295 kN [3]

Materialen:

Kwaliteit, casing/ring/kopplaat:	S355
Kwaliteit, grout:	WP2 (≈ C30/37)

4 Grondmechanisch draagvermogen – druk –

Het draagvermogen wordt bepaald op basis van resultaten van grondonderzoek. Het palenplan en de sonderingen zijn te vinden in bijlage A.

I.v.m. het grondprofiel en de werkzaamheden wordt er voor alle palen ervan uitgegaan dat er **geen** negatieve kleef zal optreden maar wel een ontgravingsreductie.

Het paaldraagvermogen is berekend op grond van de schacht-/puntdiameter met de paalfactoren behorende bij een Waal-Schroefinjectie-Paal:
Paalpuntfactor α_p = 0,63
Paalvoet vormfactor β = 1,000
Paalschachtfactor α_s = 0,008

De rekenwaarde van het paaldraagvermogen wordt berekend met de volgende factoren;
Correlatiefactor $\xi_3 = \xi_4$ = 1,30 (niet stijfbouwwerk)
Partiële weerstandsfactor $\gamma_{b=}\gamma_s$ = 1,20 (R3, op basis van grondonderzoek)

De berekeningen van het grondmechanisch draagvermogen zijn weergegeven in bijlage B.
De resultaten zijn weergegeven in tabel 4.1.

Tabel 4.1 Maatgevende berekeningsresultaten, Waal-Schroefinjectie-Paal Ø500 mm¹

Sondering nr.	Paalpuntniveau [m¹ t.o.v. NAP]	$R_{c;d}$ [kN]	$R_{t;d}$ [kN]
1 t/m 3	-17,0	1063	340

4.1 Conclusie

Voldaan wordt aan de eis $F_{c;d} < R_{c;d}$

1025 kN < 1063 kN

Voldaan wordt aan de eis $F_{t;d} < R_{t;d}$

295 kN < 340 kN

De WSI-paal Ø500 mm¹ heeft voldoende draagvermogen op een paalpuntniveau van NAP – 17,00 m¹.

5 Constructief draagvermogen

De paalkopafwerking van de palen wordt uitgevoerd met een vierkante kopplaat welke rust op een aan de casing gelaste ring (zie bijlage E).

5.1 Controle schachtspanning standaard:

De stalen casing Ø168,3/10 mm[1] met staalkwaliteit S355 dient op sterkte gecontroleerd te worden, waarbij voor dit project de drukkracht maatgevend is.

Bij de controle van de maatgevende schachtspanning wordt uitgegaan van een initiële excentriciteit van 0,1 maal de paaldiameter met een minimum van 50 mm[1].

De casing wordt belast op een (druk)kracht 1025 kN en een moment van 51,25 kNm t.g.v. excentriciteit. In de berekening wordt rekening gehouden met een corrosie toeslag.
De controle van de schachtspanning is uitgevoerd in bijlage C.

Uit de controle volgt u.c. = 0,96 ≤ 1,00. De casing Ø168,3/10 voldoet op sterkte.

N.B. De Waalpaal B.V. als paalleverancier beperkt zich tot het aanbrengen van de palen / casings. Vanwege de beperkte capaciteit van de funderingsmachines is stand zekerheid van de palen niet te garanderen. De uitvoering van de stutconstructie en de verzekering van sterkte, stijfheid een stabiliteit, behoren niet tot de paalleverantie.

5.2 Controle kopplaat

Voor de berekening van de maatgevende spanning in de kopplaat wordt gebruik gemaakt van de 'Theory of plates and shells' ([5.1, 2, e] e.a.), de berekening is weergegeven in bijlage C. De vierkante kopplaat is geschematiseerd tot een ronde plaat met een equivalente diameter.

De aangehouden afmeting van de vierkante kopplaat bedraagt #280×280×50 mm[1]. De staalkwaliteit bedraagt S355.

Uit de controle volgt u.c. = 0,80 ≤ 1,00. De kopplaat voldoet op sterkte.

Controle las:
De vierkante kopplaat rust op een stalen ring welke aan de onder- en bovenzijde rondom aan de casing is gelast middels elektrisch lassen. De aangehouden lasdikte bedraagt a_{las} = 4 mm[1] en zal uitgevoerd worden in a_{las} = 6 mm[1]. (las met spleet, NEN-EN 1993-1-8+C2:2011/NB:2011, art. 4.7.3(3)).
De controle is uitgevoerd in bijlage C.

Uit de controle volgt u.c. = 0,82 ≤ 1,00. De las voldoet op sterkte.

5.3 Controle betonspanning onder trekring:

Als trekring wordt een Ø240 mm[1] t= 25 mm[1] toegepast welke vanaf de bovenzijde gelast wordt aan de casing (zie bijlage C). De aangehouden lasdikte bedraagt a_{las} = 4 mm[1] en zal uitgevoerd worden in a_{las} = 6 mm[1]. (las met spleet, NEN-EN 1993-1-8+C2:2011/NB:2011, art. 4.7.3(3)).

Uit de controle volgt u.c. = 0,86 ≤ 1,0 => controle ring
Uit de controle volgt u.c. = 0,45 ≤ 1,0 => controle las

6 Conclusie

WSI-palen:

Aantal:	33 stuks
Buis:	Ø168,3/10 mm¹, S355
Diameter groutlichaam:	Ø500 mm¹
Paalpuntniveau:	NAP – 17,00 m¹
Kopplaat:	#280 mm¹×280 mm¹×50 mm¹, S355
Ring (trek):	Ø240×25 mm¹, S355
Paaltekening:	zie bijlage E

Specificaties grout zie bijlage D.

Op de uitvoering van de Waal-Compact-Palen is de norm NEN-EN 12699 - Uitvoering van bijzonder geotechnisch werk – Verdringingspalen - van toepassing.
Aanvullende voorwaarde conform NEN 9997-1 betreft: de paal wordt over de laatste gang van 8× de paaldiameter tot het beoogde paalpuntniveau niet op en neer gehaald.

Deze rapportage is gebaseerd op een, door De Waalpaal B.V., maximaal te leveren draagvermogen van $F_{c;d}$ = 1025 kN en $F_{t;d}$ = 295 kN. Indien door wijzigingen deze waarde wordt overschreden, dient dit ter controle en goedkeuring aan De Waalpaal B.V. te worden voorgelegd. Tevens, de verantwoordelijkheid voor omvang en correctheid van het grondonderzoek ligt bij de verstrekker.

BIJLAGE

A Gegevens

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Postbus 60 1850 AB Heiloo
Telefoon 072 5064817
Website tjadenadvies.nl
E-mail info@tjadenadvies.nl

Funderingsadvies betreffende:

Herman Gorterstraat 20
te Amsterdam

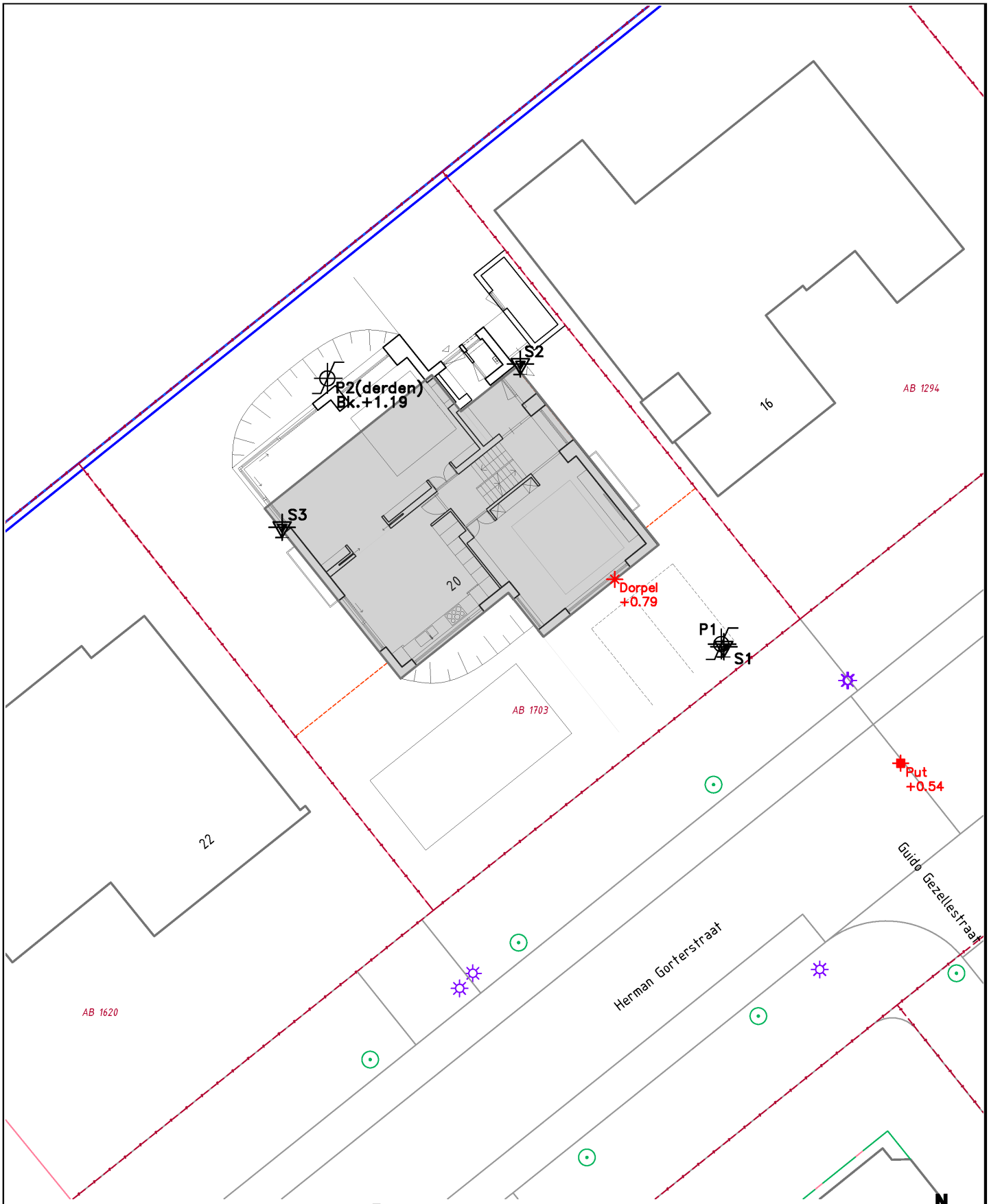
ons kenmerk S 21.597-F1/JHo
datum 14 januari 2022

Opdrachtgever 5.1, 2, e

Constructeur 5.1, 2, e

Naam	Functie	Paraaf
5.1, 2, e	Geotechnisch Adviseur (auteur)	5.1, 2, e
	Geotechnisch Adviseur (controle)	

5.1, 2, e Adviesbureau voor Grondmechanica B.V. maakt deel uit van de Theo van Velzen Holding BV K.v.K. 54294959. Opdrachten worden aanvaard volgens de algemene voorwaarden welke zijn gedeponeerd ter griffie van de arrondissementsrechtbank te 's-Gravenhage.



Sondering met Kleefmeting Boring Peilbuis Sondering nog uitvoeren

Tekening overgenomen van derden
De genoemde inmeet– en waterpasresultaten zijn alleen van toepassing op het bodemonderzoek en kunnen niet dienen als basis voor de realisatie van het bouwproject en/of andere doeleinden.

Tjaden ADVIESBUREAU VOOR Grondmechanica

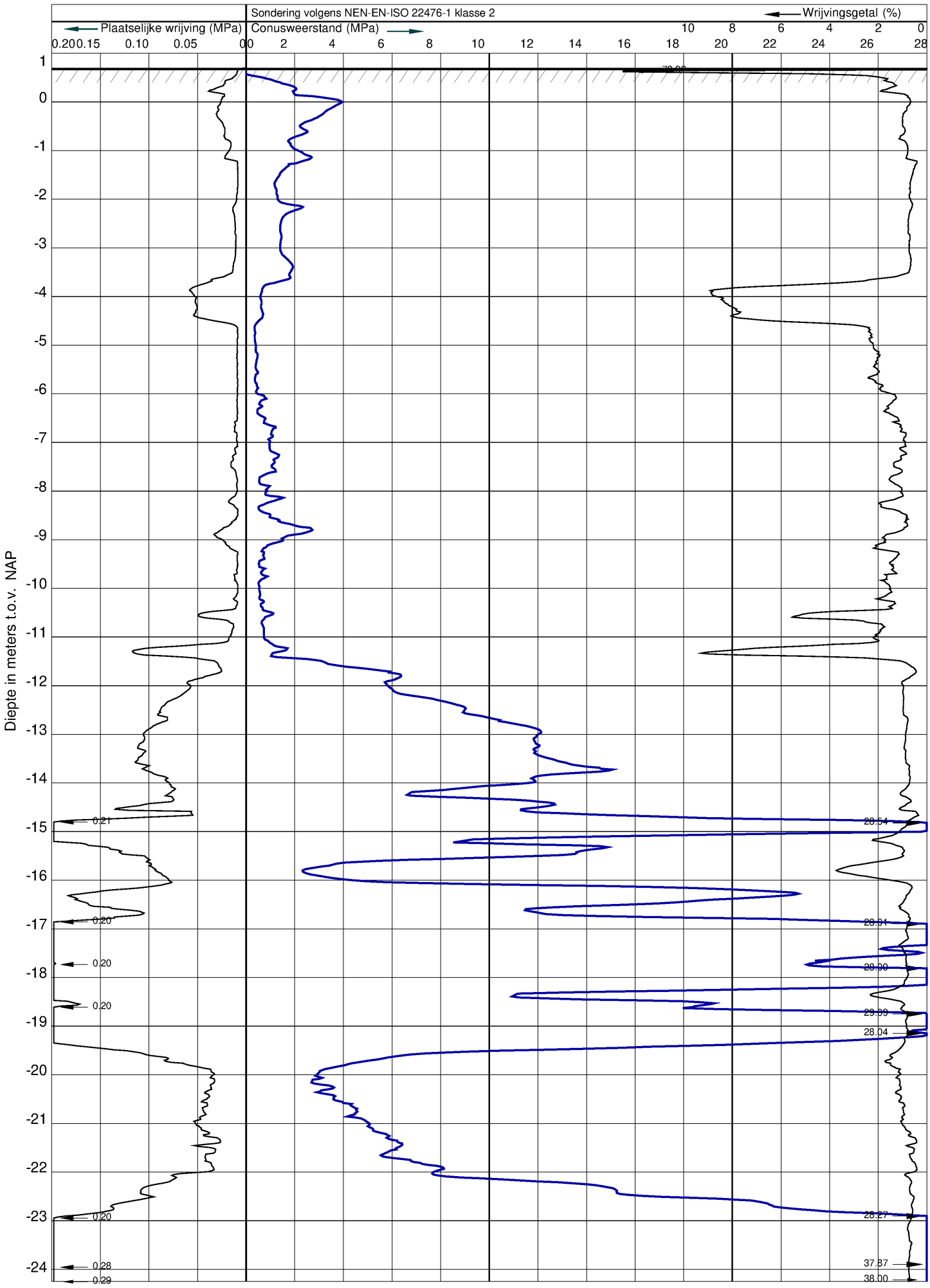
Herman Gorterstraat 20
Amsterdam

SITUATIE

kaartblad: (A4)	schaal: 1:250
get.: 23.12.2021	opdr. nr.: S 21.597
gew.: 14.06.2023	nr.:
gew.:	

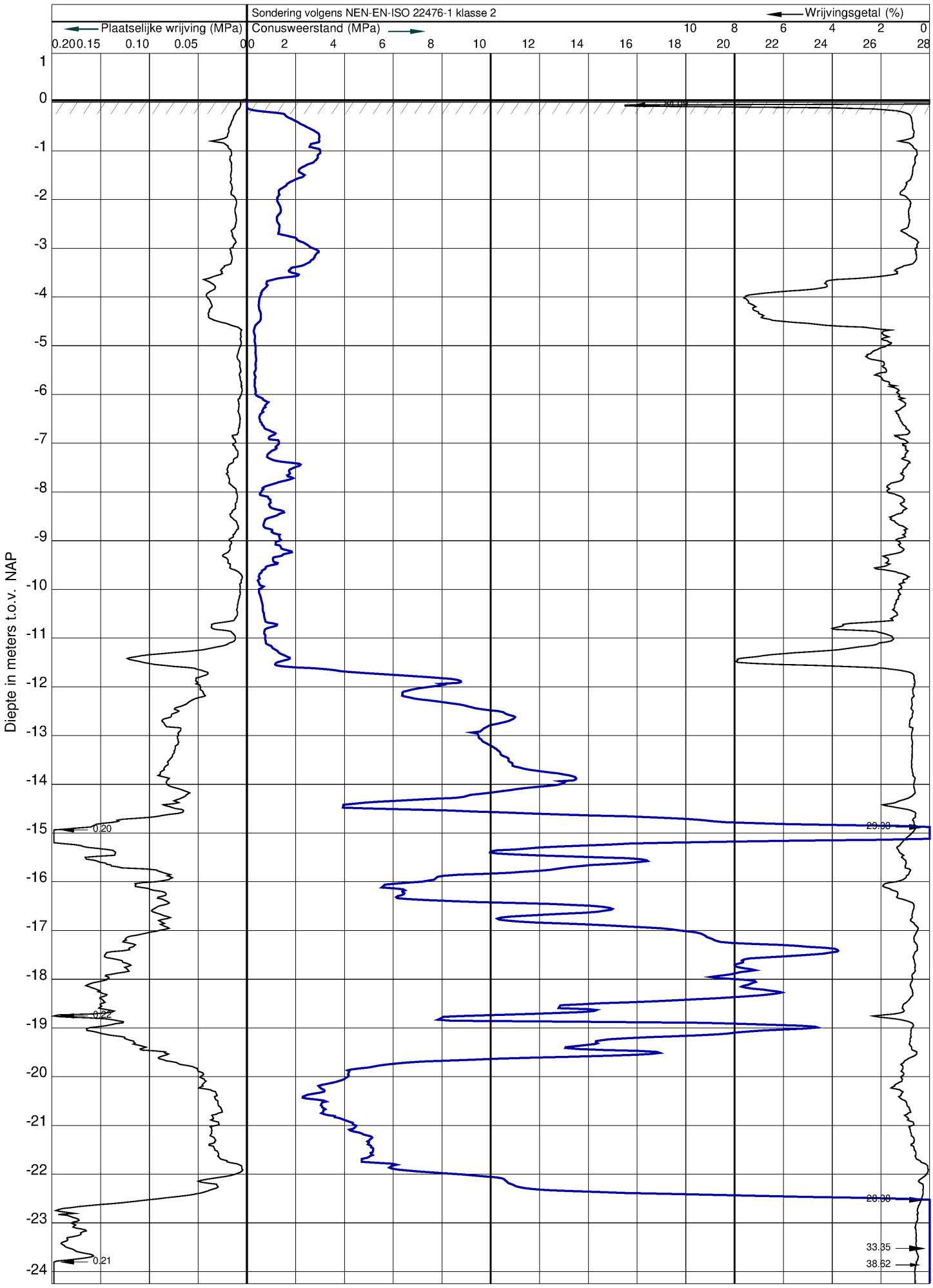
Tjaden
ADVIESBUREAU VOOR GRONDMECHANICA
Pyrietstraat 1, 1812 S[redacted]aar
Tel:072-5064817 E-mail:info@tjadenadvies.nl

Werknummer	: S21597	Plaats	: Amsterdam
Sonderingnr.	: 1	Locatie	: Herman Gorterstraat 20
Datum	: 21-12-2021	Conustype	: I-CFXY-15
Maaiveld	: 0.7 m. t.o.v. NAP	Opdrachtgever	: Kwinfra BV
RD-coördinaten	: X:1206257 Y:4844074	Opmerking	:



Tjaden
ADVIESBUREAU VOOR GRONDMECHANICA
Pyrietstraat 1, 1812 S[illegible]aar
Tel:072-5064817 E-mail:info@tjadenadvies.nl

Werknummer	: S21597	Plaats	: Amsterdam
Sonderingnr.	: 2	Locatie	: Herman Gorterstraat 20
Datum	: 13-6-2023	Conustype	: I-CFXY-15
Maaiveld	: 0.06 m. t.o.v. NAP	Opdrachtgever	: Kwinfra BV
RD-coördinaten	: X:120647 Y:484421	Opmerking	:



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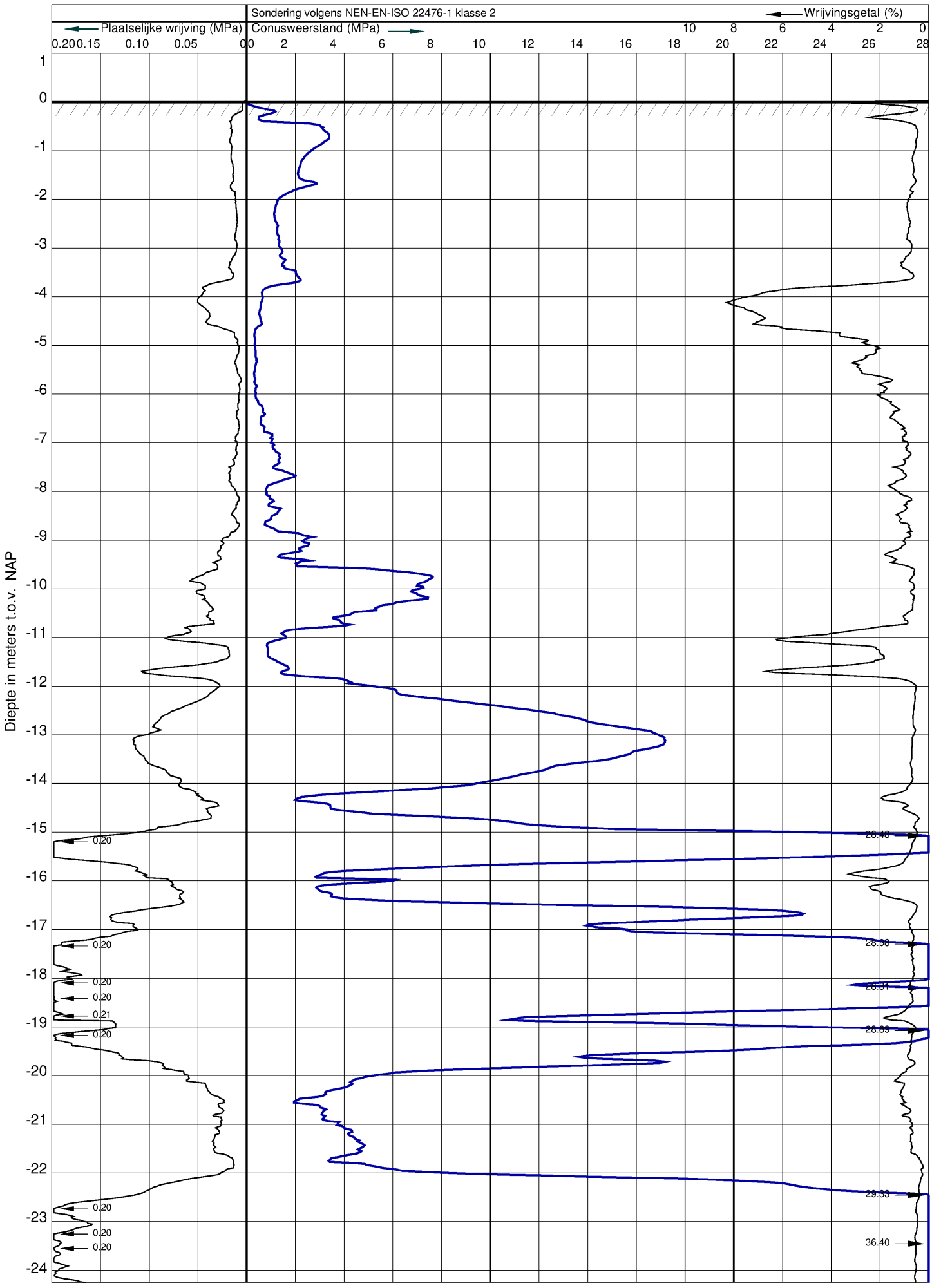
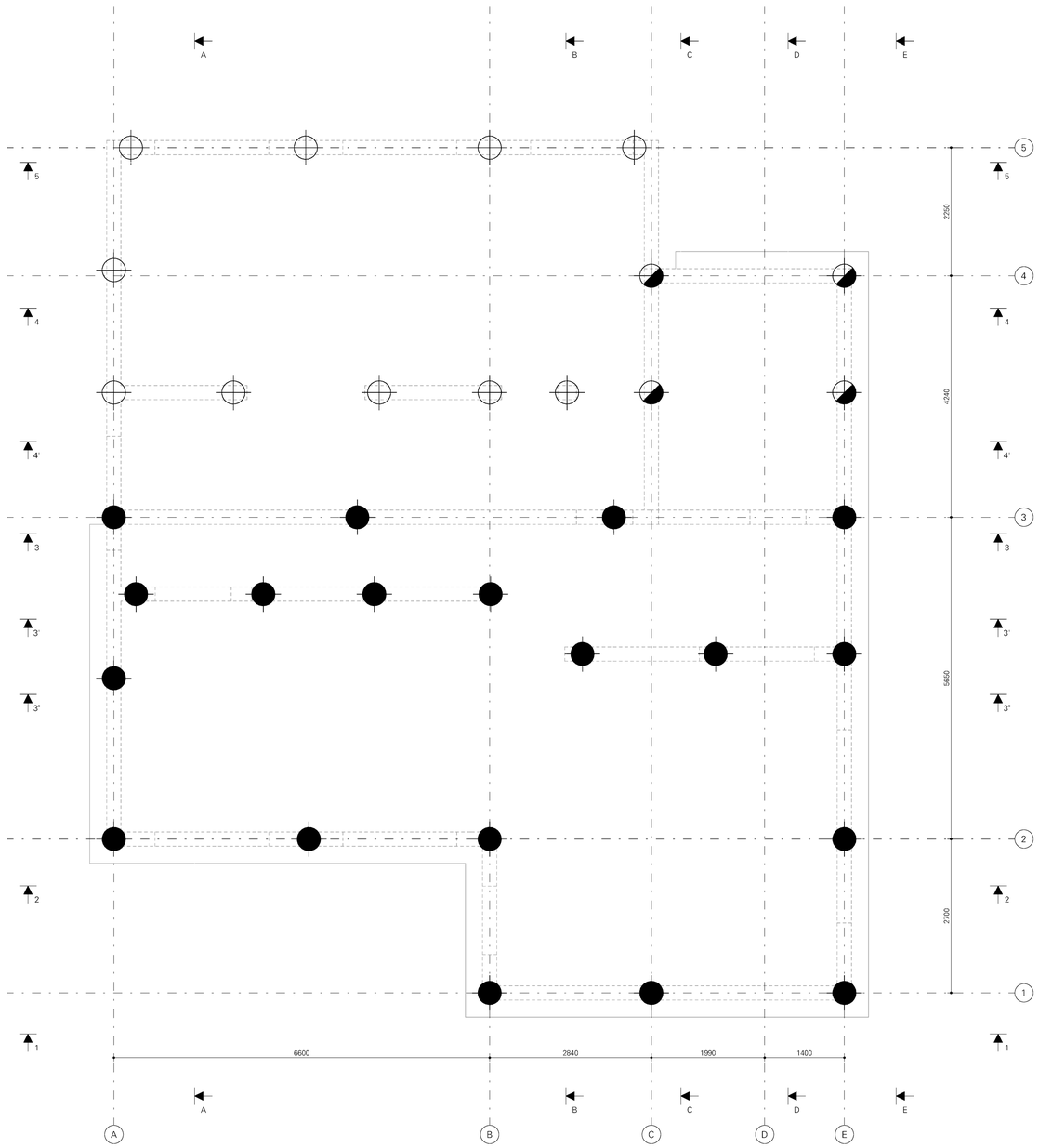
ADVIESBUREAU VOOR GRONDMECHANICA
Pyrietstraat 1, 1812 SC Alkmaar
Tel:072-5064817 E-mail:info@tjadenadvies.nl

Werknummer	: S21597	Plaats	: Amsterdam
Sonderingnr.	: 3	Locatie	: Herman Gorterstraat 20
Datum	: 13-6-2023	Conustype	: I-CFXY-15
Maaiveld	: 0.02 m. t.o.v. NAP	Opdrachtgever	: Kwinfra BV
RD-coördinaten	: X:120635 Y:484413	Opmerking	:





Palenplan

1 : 50

S1

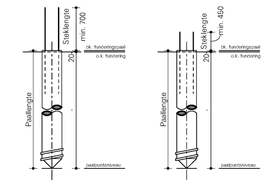
Opmerkingen

- Peil = 0 = NAP +0.6 m

Algemeen

- Palen Ø410/500 berekenen op een excentriciteit van 50mm
- werkniveau heistelling = maaiveld
- Milieuklasse palen: XC2, XS2

Fundex



Paal belast door trek

Paal belast op druk

Renvooi funderingspalen

Symbol	Paal nummer	Paal Type	Afhakhoogte (m) t.o.v. Peil	Afhakhoogte (m) t.o.v. NAP	Inheidiepte (m) t.o.v. NAP	Aantal
●	01.X	Fundex of Hek-paal 410/500	-0.26	0.34	-17.00	19
⊕	02.X	Fundex of Hek-paal 410/500	-2.08	-1.48	-17.00	10
◕	03.X	Fundex of Hek-paal 410/500	-3.44	-2.84	-17.00	4
						33

XX

Behorende bij rapport van
5.1, 2, e
rapportnummer: S 21.597-F1/JIHO
datum: 14 JANUARI 2022

Maaiveldniveau = NAP +0.7m
Grondwaterstand = NAP -0,4m, overeenkomstig open waterpeil

Paaldraagvermogen = 1025 kN
Paaltrekvermogen = 295 kN to.b.v. 6Ø12 stekwapening)
Paaldraag- en trekvermogen gebaseerd op 1 sondering. Na sloop dient nog aanvullend gesondeerd te worden. De uitkomst hiervan kan invloed hebben op het paaldraagvermogen en palenplan.

Deze tekening is eigendom van BREED Integrated Design.
Zonder schriftelijke toestemming mag niets worden gekopieerd, gebruikt of de inhoud ervan ter kennis van derden worden gebracht.

Versie:	Omschrijving:	Get:	Datum:
1	TO	mll	07-10-2022

BREED INTEGRATEDDESIGN
Korte Koedijkstraat 6/8
2511 CE The Hague, Netherlands
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www.breedid.nl
T 5.1, 2, e

Opdrachtgever Familie 5.1, 2, e

Architect HofmanDujardin

Project

Herman Gorterstraat

Onderwerp

Palenplan

Fase	TO	Schaal	As indicated
Status	Definitief	Bladformaat	A1

Laatste Versie?

Projectnummer 21038

Tekeningnr. TO.2000V

Versie 1

BIJLAGE

B Berekening grondmechanisch draagvermogen (uitvoer CloudPiling)

draft

CALCULATION NOTE

Client:

Gebroeders Van 't Hek NV
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Project:

H221363
Amsterdam - Woning Herman Gorterstraat 20
Herman Gorterstraat 20
1077 WH Amsterdam
The Netherlands

Ø500

DRUK EN TREK

Screw injection pile

Created by:

5.1, 2, e
5.1, 2, e
5.1, 2, e

Created on:

23-06-2023 08:53:48

Report:

PB H221363-1

Representing:

Hektec BV
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1. Table Of Content

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2. References

NEN 9997-1+C1 (2012) Goetechnisch ontwerp van constructies - Deel 1: Algemene regels

NEN 9997-1+C1 (2012) paragraaf 7 Paalfunderingen

NEN 9997-1+C1 (2012) 7.6.2.3 Uiterste draagkracht op druk gebaseerd op resultaten van grondonderzoek

NEN 9997-1+C1 (2012) 7.6.3.3 Uiterste trekkracht gebaseerd op grondonderzoeksresultaten

NEN 9997-1+C1 (2012) A.3.3.2 Partiële weerstandsfactoren voor paalfunderingen

NEN 9997-1+C1 (2012) A.3.3.3 Correlatiefactoren voor paalfunderingen

EN 1993-1-8 'Design of steel structures: Design of joints

NEN EN 1993-5-NL (2011) Ontwerp en berekenening van staalconstructies: Palen en damwanden

NEN EN 1993-1-1 NL (2005) Ontwerp en berekening van staalconstructies: Algemene regels en regels voor gebouwen

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3. Load Combinations

In this paragraph, the various load combinations are presented that where considered in the calculations. Based on the below load combinations, the **required bearing capacity in compression and tension is respectively 1025.0kN and -295.0kN**.

Load Combination - DRUK | RC1

Partial Factors according to a RC1 limit state

$\gamma_{P,unfav}$ [-]	$\gamma_{P,fav}$ [-]	$\gamma_{Q,unfav}$ [-]	$\gamma_{Q,fav}$ [-]	γ_{γ} [-]	γ_{φ} [-]	γ_{c} [-]	γ_{cu} [-]
1.00	1.00	1.00	0.00	1.00	1.15	1.15	1.50

Point Loads

level [mNAP]	F_z [kN]	e_x [mm]	F_x [kN]	$M_{y/z}$ [kNm]	P/Q [-]	fav/unfav [-]
-3.44	1025.00	50.0	0.00	0.00	P	unfav

Load Combination - TREK | RC1

Partial Factors according to a RC1 limit state

$\gamma_{P,unfav}$ [-]	$\gamma_{P,fav}$ [-]	$\gamma_{Q,unfav}$ [-]	$\gamma_{Q,fav}$ [-]	γ_{γ} [-]	γ_{φ} [-]	γ_{c} [-]	γ_{cu} [-]
1.00	1.00	1.00	0.00	1.00	1.15	1.15	1.50

Point Loads

level [mNAP]	F_z [kN]	e_x [mm]	F_x [kN]	$M_{y/z}$ [kNm]	P/Q [-]	fav/unfav [-]
-3.44	-295.00	0.0	0.00	0.00	P	unfav

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4. Cone Penetration Tests

Cone Penetration Tests 5.1, 2, e *2023*

no.	coordinate system	X	Y	surface level	depth	h_{crit}	D_c	type
[-]	[-]	[-]	[-]	[mNAP]	[mNAP]	[m]	[m]	[m]
1	31000 - RD1918	1206257.0000	4844074.0000	0.70	-27.06	0.02	0.0357	E
2	31000 - RD1918	120647.0000	484421.0000	0.06	-29.94	0.02	0.0357	E
3	31000 - RD1918	120635.0000	484413.0000	0.02	-27.52	0.02	0.0357	E

Cone Penetration Tests

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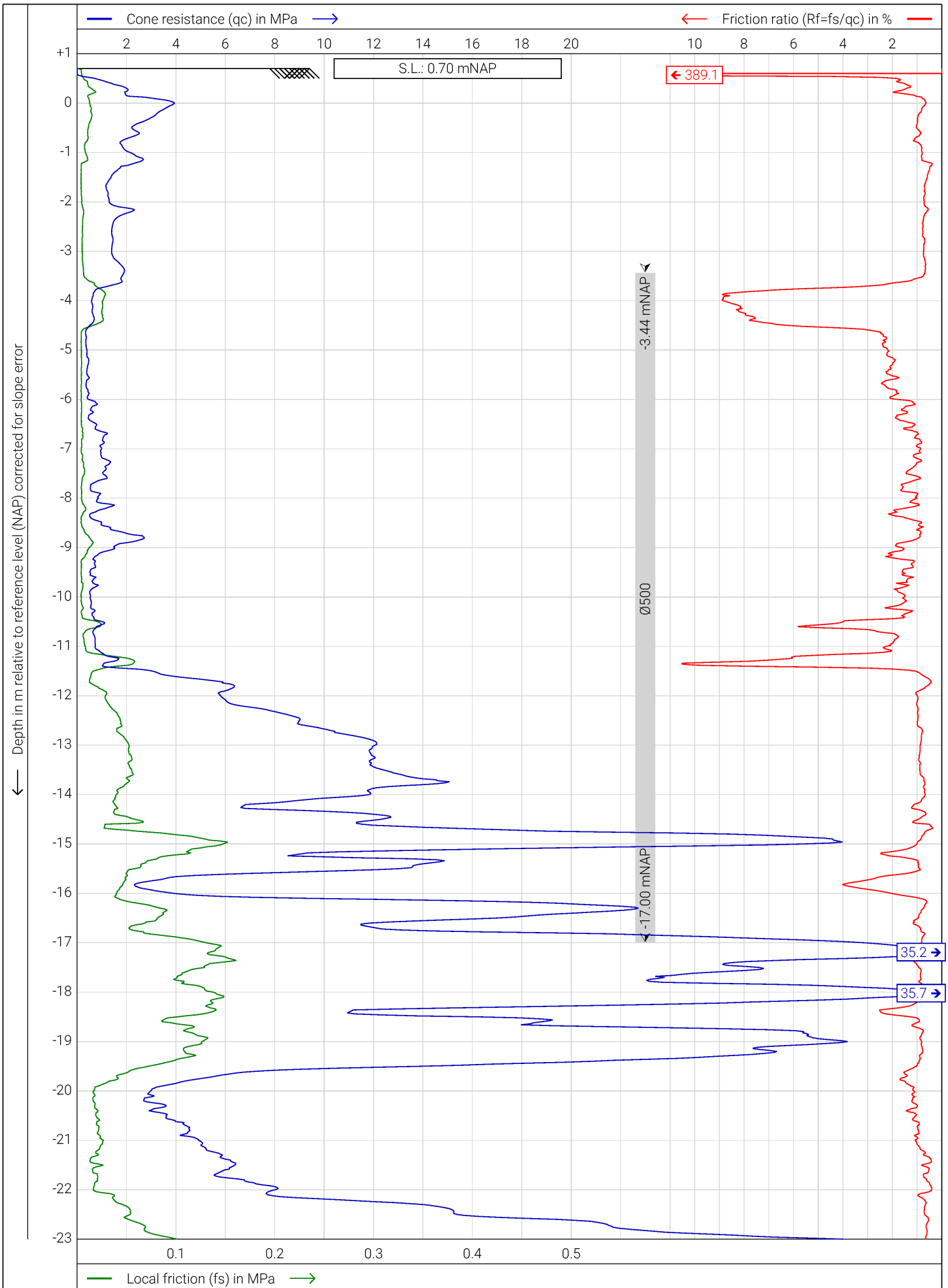
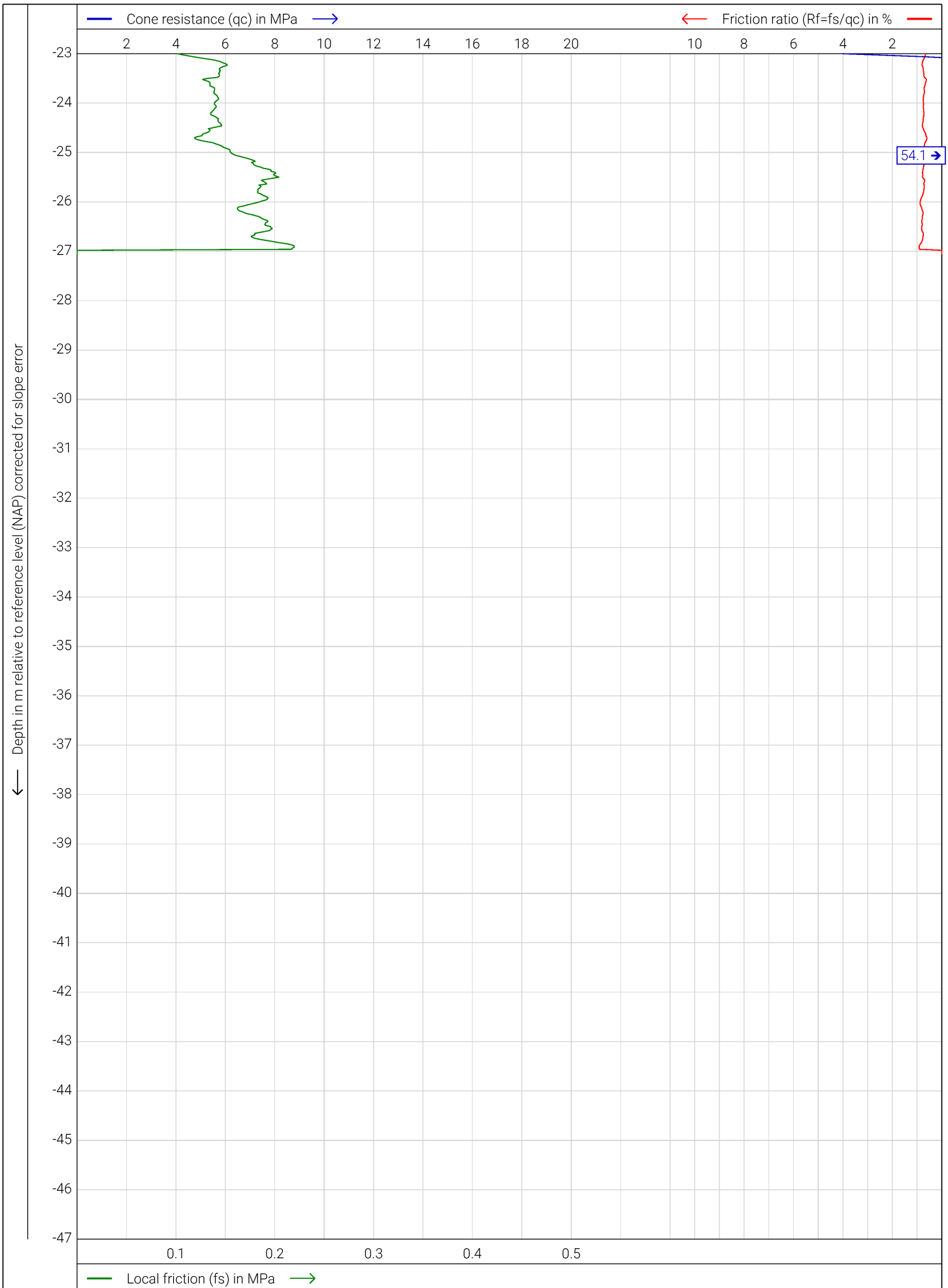


HEKTEC	Hektec | info@hektec.nl | +31 299 420 808	Date: 2023-06-23
		Conus no.: E
	Project: Amsterdam - Woning Herman Gorterstraat 20	Project no.: 5.1, 2, e 2023
	Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands	CPT no.: 1



HEKTEC

Hektec | info@hektec.nl | +31 299 420 808

Project: Amsterdam - Woning Herman Gorterstraat 20

Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands

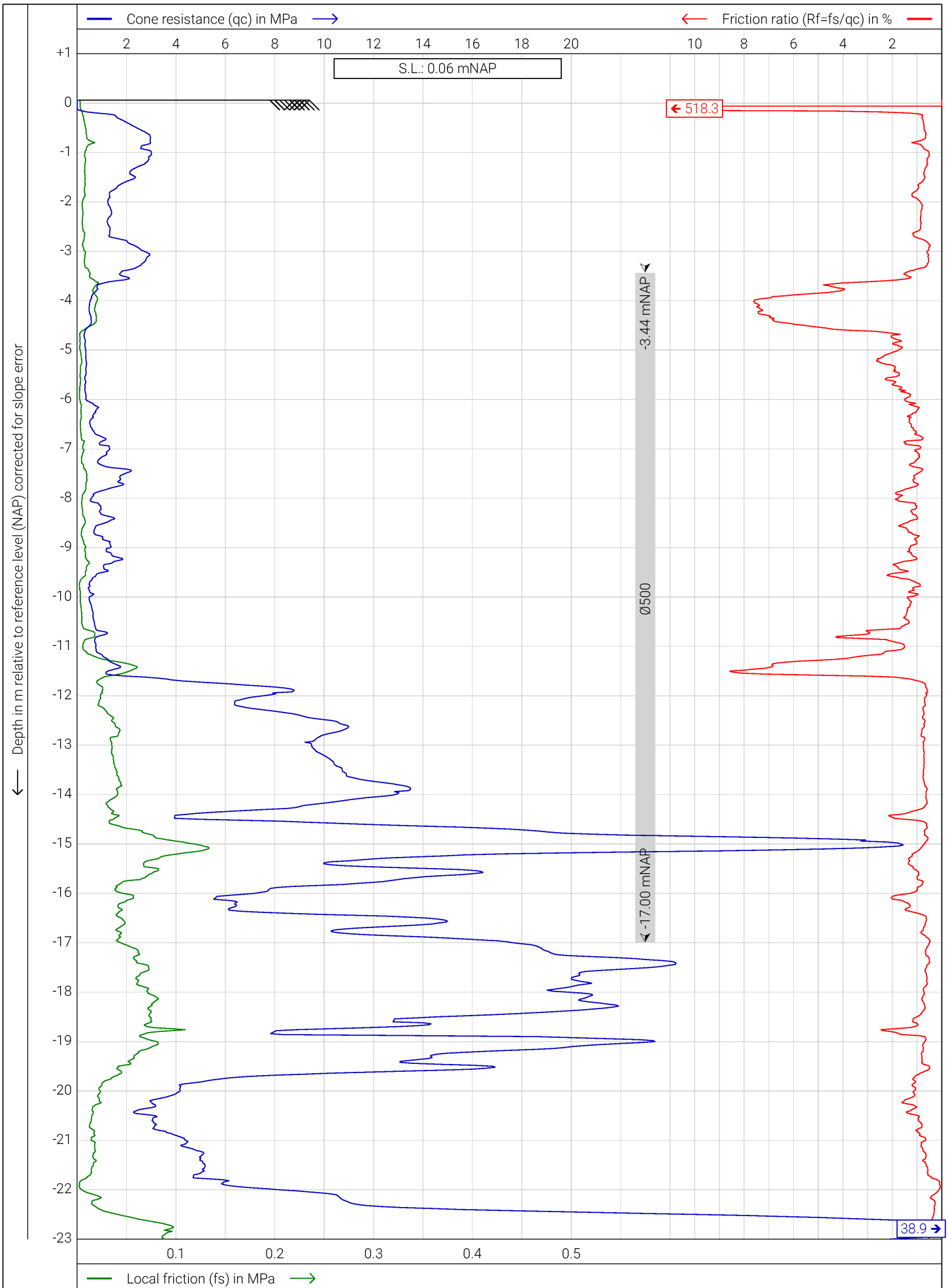
Date: 2023-06-23

Conus no.: E

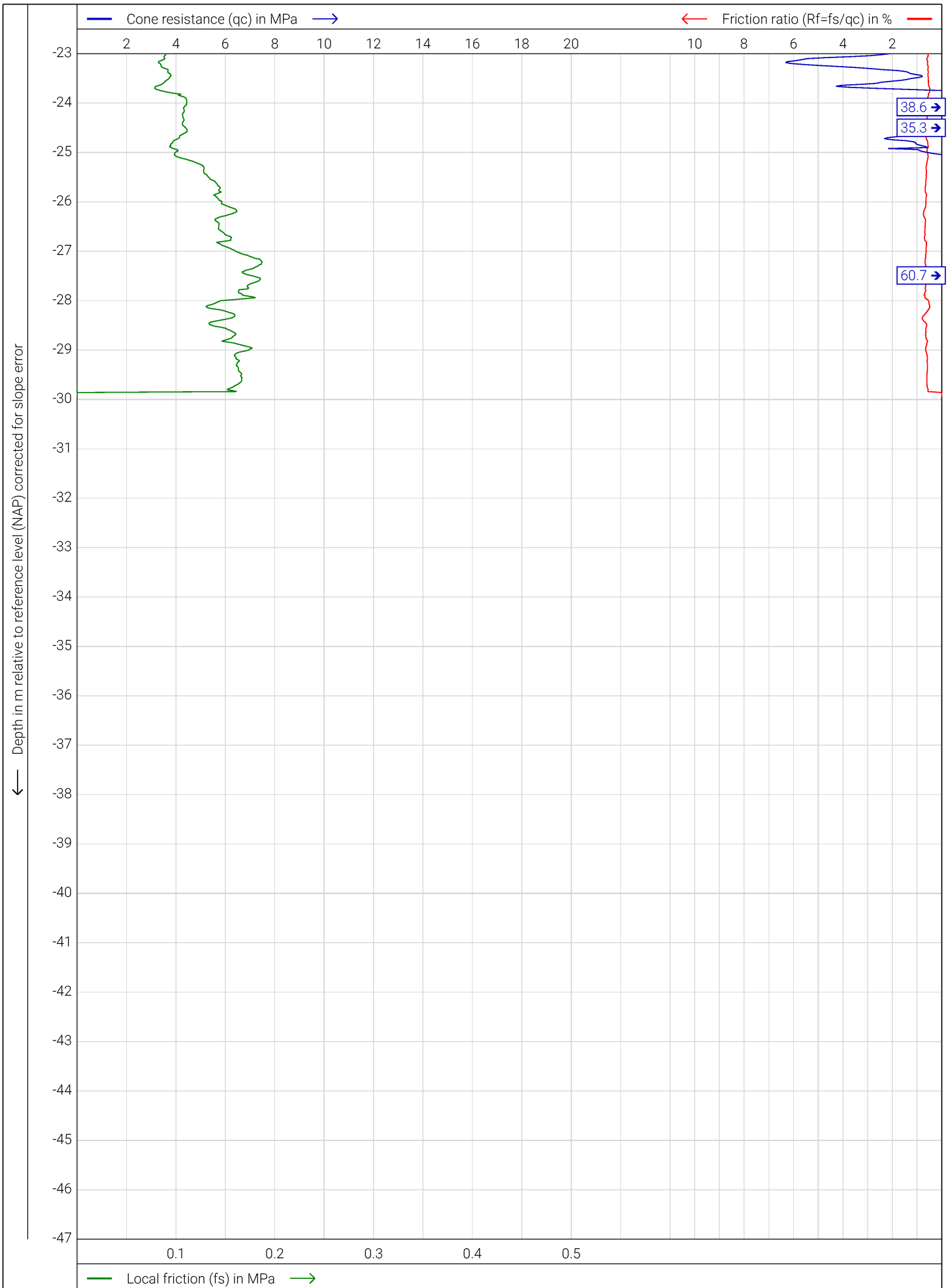
Project no.: 5.1, 2, e 2023

CPT no.: 1

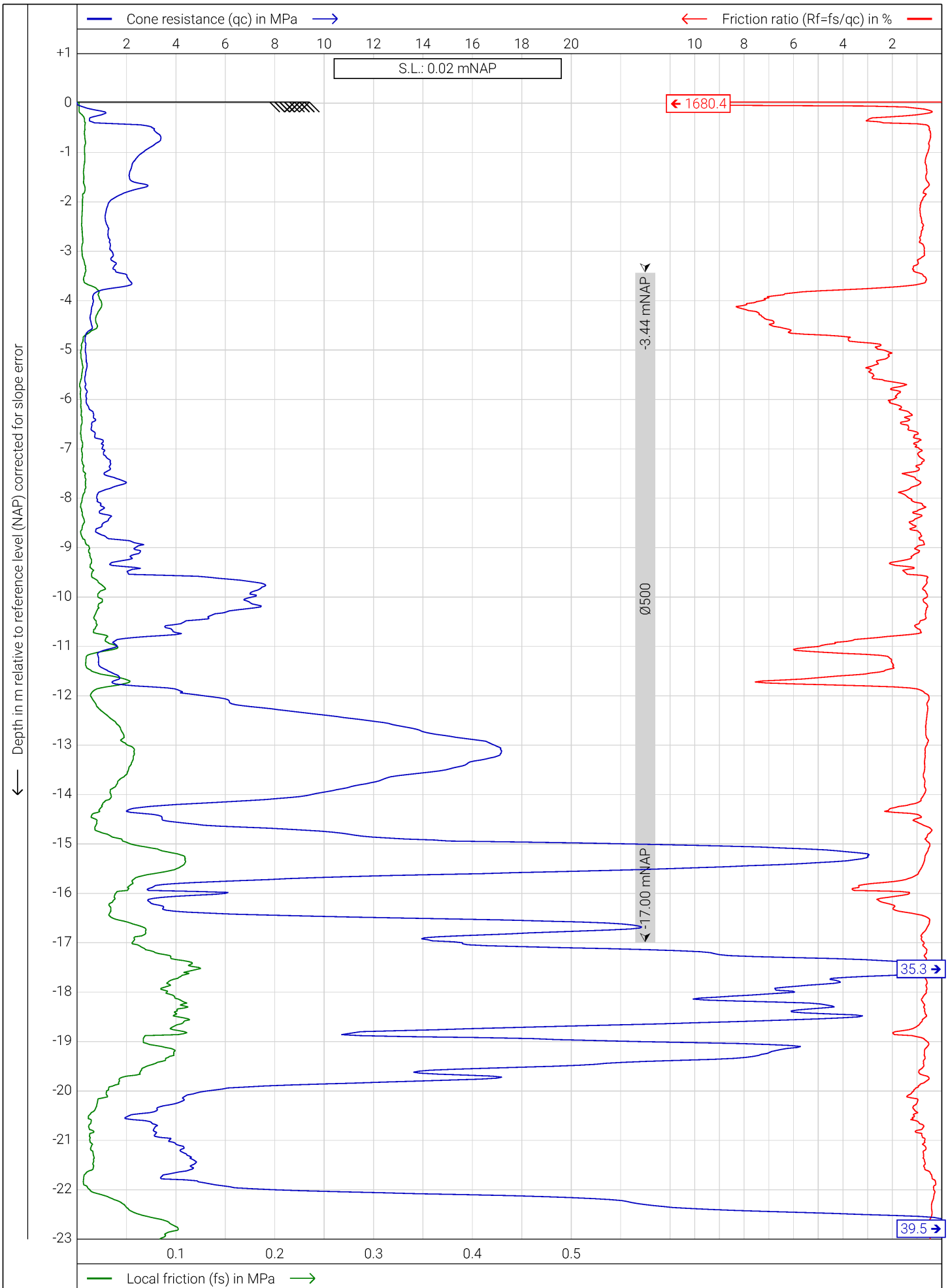
2 / 2



HEKTEC	Hektec | info@hektec.nl | +31 299 420 808	Date: 2023-06-23
		Conus no.: E
	Project: Amsterdam - Woning Herman Gorterstraat 20	Project no.: 5.1, 2, e 2023
	Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands	CPT no.: 2



HEKTEC	Hektec | info@hektec.nl | +31 299 420 808	Date: 2023-06-23
		Conus no.: E
	Project: Amsterdam - Woning Herman Gorterstraat 20	Project no.: 5.1, 2, e 2023
	Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands	CPT no.: 2 2 / 2



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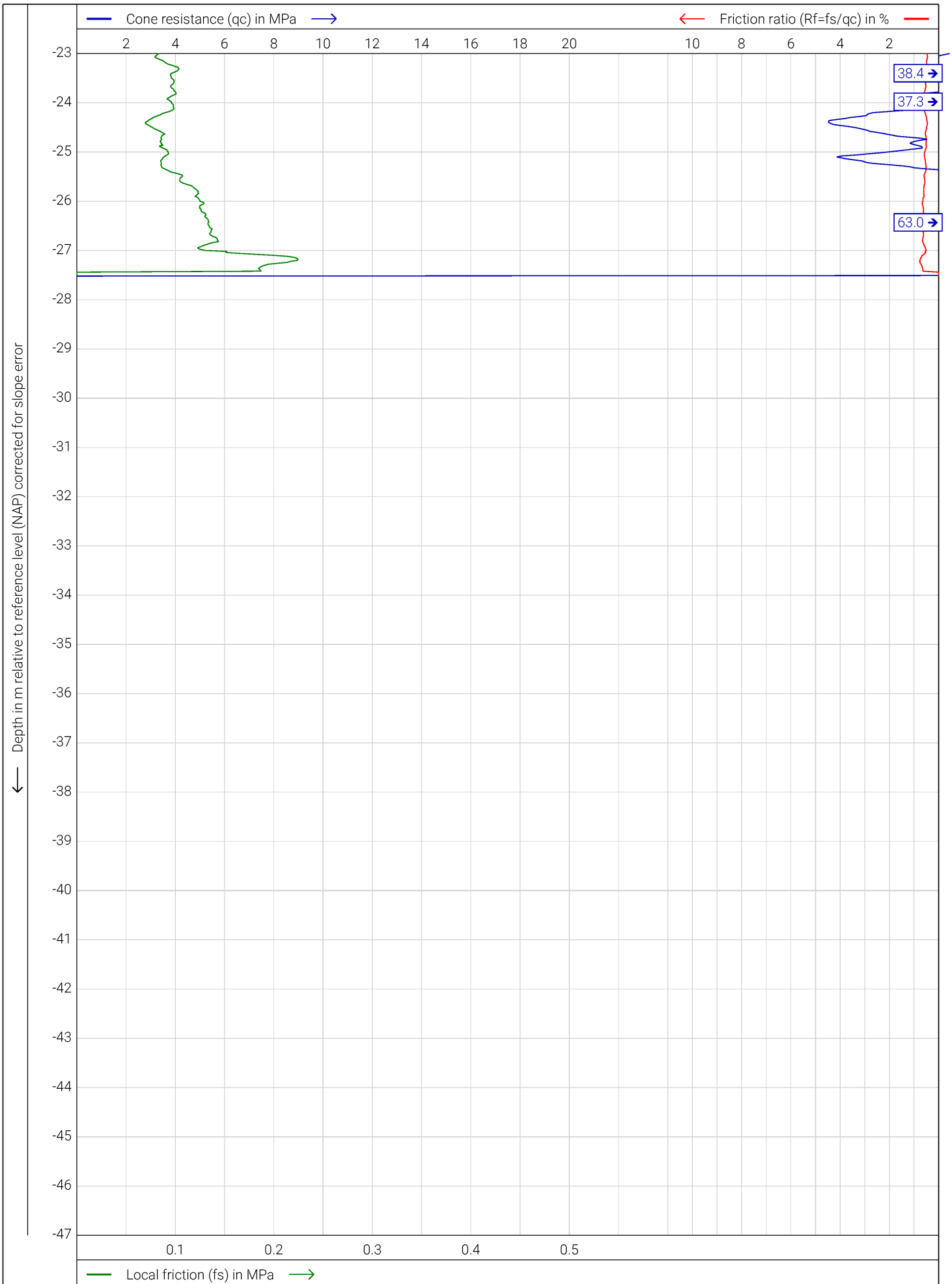
		Conus no.: E
	Project: Amsterdam - Woning Herman Gorterstraat 20	Project no.: 5.1, 2, e 2023
	Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands	CPT no.: 3



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Project: Amsterdam - Woning Herman Gorterstraat 20

Location: Herman Gorterstraat 20 1077 WH Amsterdam The Netherlands

Date: 2023-06-23

Conus no.: E

Project no.: 5.1, 2, e 2023

CPT no.: 3

2 / 2

Excavation of the existing soil layer profile in the Cone Penetration Tests

Preperation of the working terrain: Excavation:-3.44

5. Bearing Capacity

Theory

The bearing capacity is determined in accordance with the NEN 9997-1:2016. This standard includes NEN-EN 1997-1+C1+A1:2016+NB:2016 to ensure that the calculations comply with the requirements of the Building Decree 2012. At the start of the bearing capacity calculation, the measured cone resistances are reduced according to the following rules:

Due to **excavation works after the execution of the cone penetration tests**, the measured cone resistances in sand and gravel layers are reduced according to the following formula: The cone penetration tests were excavation up to **-3.44mNAP**:.

$$q_{c;z;ontg} = q_{c;z} (\sigma'_{v;z;ontg} / \sigma'_{v;z;0})^{0.5}$$

Where:

- $q_{c;z;ontg}$: the reduced cone resistance at depth z (below the bottom of the excavation)
- $q_{c;z}$: the cone resistance measured prior to excavation at depth z
- $\sigma'_{v;z;ontg}$: the effective vertical stress at depth z (below the bottom of the excavation)
- $\sigma'_{v;z;0}$: the initial effective vertical stress at depth z at moment of the cone penetration test

The measured cone resistances **in gravel layers** with a value greater than 20MPa are **limited up to 20MPa**. This reduction occurs after considering the effects of overconsolidation and excavation. We refer to the paragraphs **cone penetration tests** and **soil layer profiles** for more insides in the applied soil types for each cone penetration test.

The structure is considered as a rigid construction. The number of cone penetration tests considered in the calculation of the bearing capacity is 3. The **correlating factors ξ_3 = 1.30 and ξ_4 = 1.30** have been established based on the aforementioned conditions. The maximum bearing capacity of the pile tip has been calculated using the 4D/8D method by Koppejan. For the calculation of the point bearing capacity of a screw injection pile, a **pile class factor α_p of 0.630** is applied, and β and s are respectively equal to 1.00 and 1.00. The maximum shaft friction is determined based on a percentage of the average cone resistance. The used **pile class factor α_s is 0.008**. The partial factors γ_b and γ_s are respectively equal to 1.20 and 1.20. The pile characteristics D_{eq}, A_b and $O_{s;\Delta L;gem}$ are respectively equal to 0.500m, 0.196m² and 0.691m. The required bearing capacity results from the defined load combinations (see paragraph **load combinations**) and values **1025.0kN**.

$$R_{cd,net} = R_{c;d} - F_{nk;d}$$

$$R_{c;d} = R_{b;k} / \gamma_b + R_{s;k} / \gamma_s$$

$$R_{c;k} = \min((R_{c;cal;i})_{avg} / \xi_3 ; (R_{c;cal;i})_{min} / \xi_4)$$

$$R_{b;k} = \min((R_{b;cal;i})_{avg} / \xi_3 ; (\text{5.1, 2, e}_{min} / \xi_4)$$

$$R_{s;k} = \min((R_{s;cal;i})_{avg} / \xi_3 ; (R_{s;cal;i})_{min} / \xi_4)$$

$$R_{c;cal;i} = R_{b;cal;i} + R_{s;cal;i}$$

$$R_{b;cal;i} = A_b \, q_{b;max;i}$$

$$R_{s;cal;i} = \alpha_s \, O_{s;\Delta L;gem} \, \Delta L \, q_{c;z;a;i}$$

$$q_{b;max;i} = 1 / 2 \, \alpha_p \, \beta \, s \, ((q_{c;I;gem} + q_{c;II;gem}) / 2 + q_{c;III;gem})$$

Where:

- $R_{cd,net}$: the design value of the netto bearing capacity in compression
- $F_{nk;d}$: the design value of the negative skin friction force
- $R_{c;d}$: the design value of the bearing capacity of the pile in compression
- γ_b : the partial factor applied on the bearing capacity at the pile base of compression piles
- γ_s : the partial factor applied on the bearing capacity over the pile shaft of compression piles
- $R_{c;k}$: the characteristic value of the bearing capacity of the pile in compression
- 5.1, 2, e: the characteristic value of the bearing capacity over the pile shaft
- $R_{s;k}$: the characteristic value of the bearing capacity over the pile shaft
- ξ_3 : the correlation factor on the average value of the calibrated bearing capacities over the group of cone penetration tests
- ξ_4 : the correlation factor on the minimum value of the calibrated bearing capacities over the group of cone penetration tests
- $R_{c;cal;i}$: the calibrated value of the bearing capacity of the pile in compression
- $R_{s;cal;i}$: the calibrated value of the bearing capacity at the pile base
- α_s : the pile class factor for the shaft friction in compression
- $O_{s;\Delta L;gem}$: the circumference of the pile

- $q_{c;z;a;i}$: the cone resistance whereby peaks in the qc diagram exceeding 12 MPa are truncated at 12 MPa. If the layer is thicker than 1 m, it may be truncated at the lowest qc value measured in that layer, with a maximum of 15 MPa
- $R_{b;cal;i}$: the calibrated value of the bearing capacity at the pile base
- A_b : the pile surface at base level
- $q_{b;max;i}$: the maximum point resistance in cone penetration test i, this value cannot exceed 15 MPa
- α_p : the pile class factor for calculating the bearing capacity of the pile base
- β : the factor that takes into account the influence of the pile base shape
- s : the factor that takes into account the influence of the shape of the cross-section of the pile base
- $q_{c;I;gem}$: the average value of the cone resistances over the interval I, which runs from the pile base level to a level that is at least 0.7 × Deq and at most 4 × Deq deeper. The endpoint of interval I should be chosen within the given limits so that qb;max is minimized.
- $q_{c;II;gem}$: the average value of cone resistances over the interval II, which runs from the endpoint of interval I to the pile base level, where the value for cone resistance to be considered should never exceed the underlying value.
- $q_{c;III;gem}$: the average value of cone resistances over interval III, which is traversed from bottom to top from the pile base level to a level that is (8 × Deq), where the value for cone resistance to be considered should never exceed the directly underlying value, starting with the lowest considered value of cone resistance over interval II.

The pile class factor for shaft friction under compression (as well as under tension) is further refined as follows

- In clay layers with $q_{c,avg}$ greater than 2.5MPa, the pile class factor is limited to 0.03.
- In clay layers with $q_{c,avg}$ between 2MPa and 2.5MPa, the pile class factor is equal to $0.02(q_{c,avg} - 1)$.
- In clay layers with $q_{c,avg}$ less than 2MPa, the pile class factor is limited to 0.02.
- In strongly sandy loam layers, the pile class factor is equal to the coefficient of friction with a maximum of 0.025.
- In weakly sandy loam layers, the pile class factor is equal to 0.025.
- In peat layers, the pile class factor is zero.

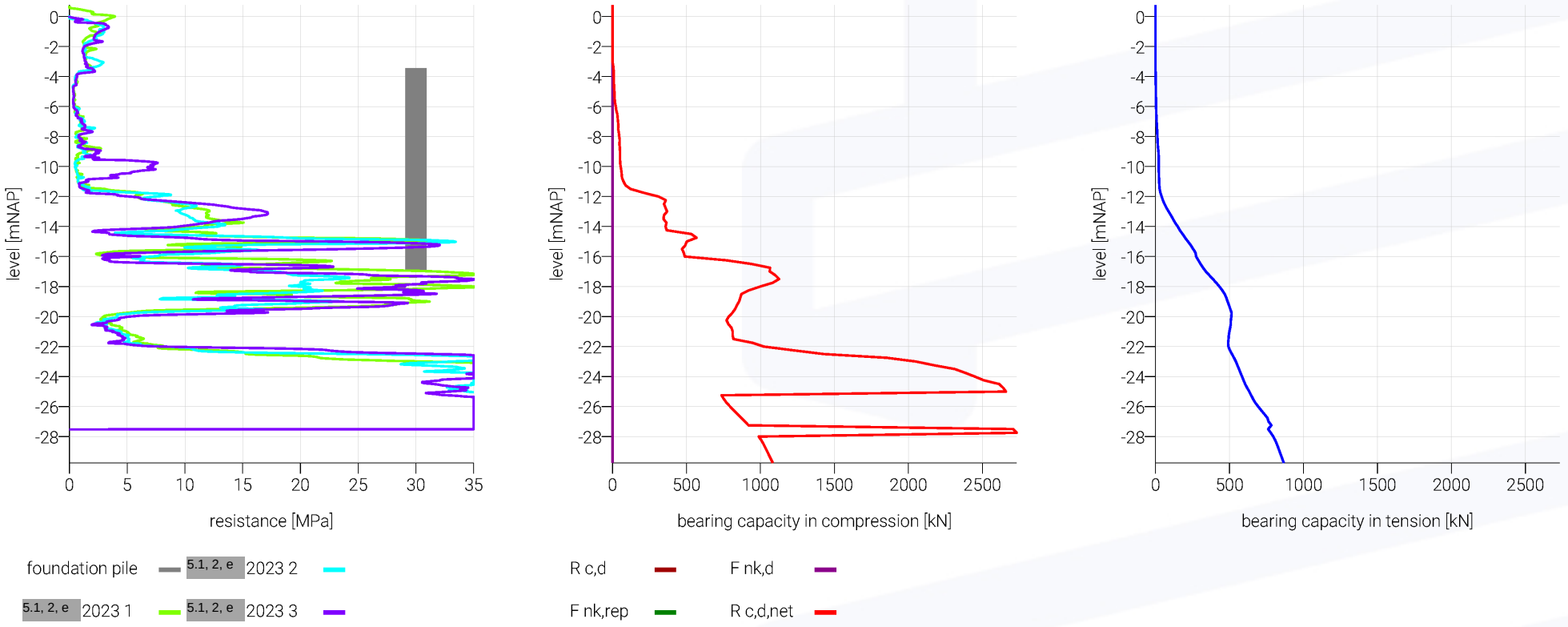
In the paragraphs **soil layer profile**, the applied soil types for each cone penetration test are presented. The aforementioned design guidelines depending on the soil type are applied based on the soil layer profile(s), see paragraph **soil layer profile** for more details.

cone penetration test [-]	$q_{c;I;gem}$ [MPa]	$q_{c;II;gem}$ [MPa]	$q_{c;III;gem}$ [MPa]	$q_{b;max;i}$ [MPa]	$R_{b;cal;i}$ [kN]	$R_{s;cal;i}$ [kN]	$R_{c;cal;i}$ [kN]	$F_{nk;rep}$ [kN]
5.1, 2, e 2023 2	16.74	7.07	4.74	5.24	1029.3	636.2	1665.4	0.0
5.1, 2, e 2023 1	23.18	10.38	3.86	6.50	1276.7	645.8	1922.5	0.0
5.1, 2, e 2023 3	23.92	9.83	3.35	6.37	1250.6	628.9	1879.6	0.0

working level	-0.26	mNAP
top level	-3.44	mNAP
base level	-17.00	mNAP
α_v	0.0	°
D_{eq}	0.500	m
A_b	0.196	m²
$O_{s;\Delta L;gem}$	0.691	m
α_p	0.630	-
α_s	0.008	-

ξ_3	1.30	-
ξ_4	1.30	-
γ_b	1.20	-
γ_s	1.20	-
R_{cd}	1062.9	kN
$F_{nk;d}$	0.0	kN
$R_{cd,net}$	1062.9	kN
R_{td}	340.3	kN

Bearing Capacity Graphs



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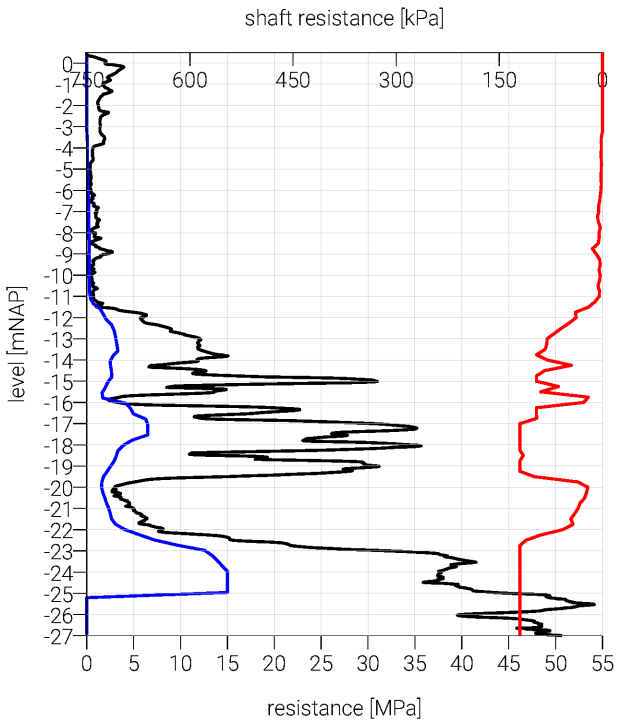

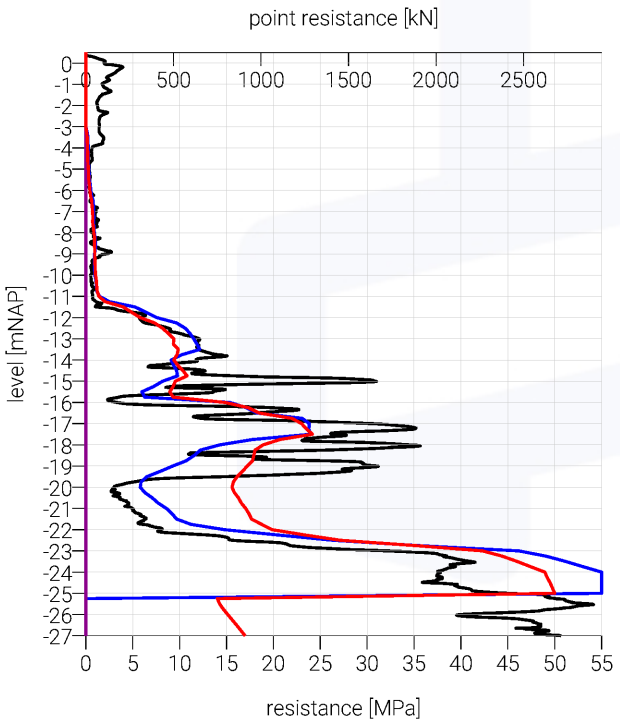

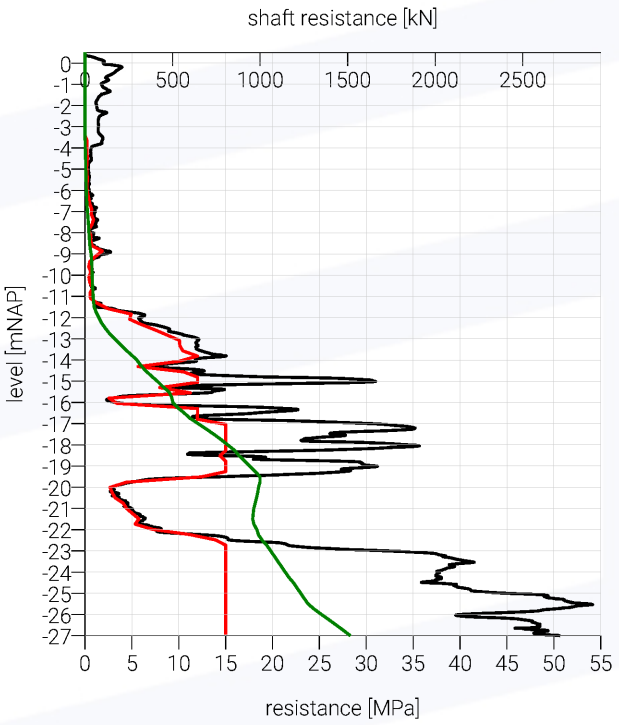

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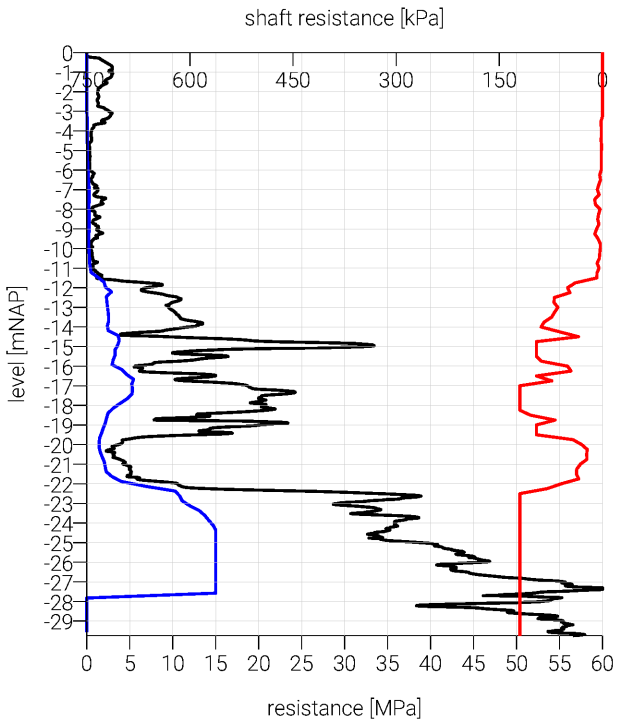

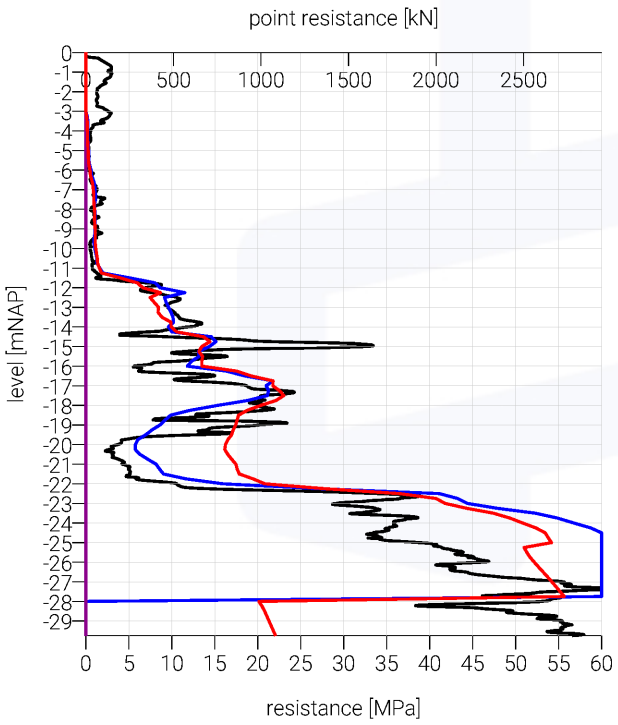

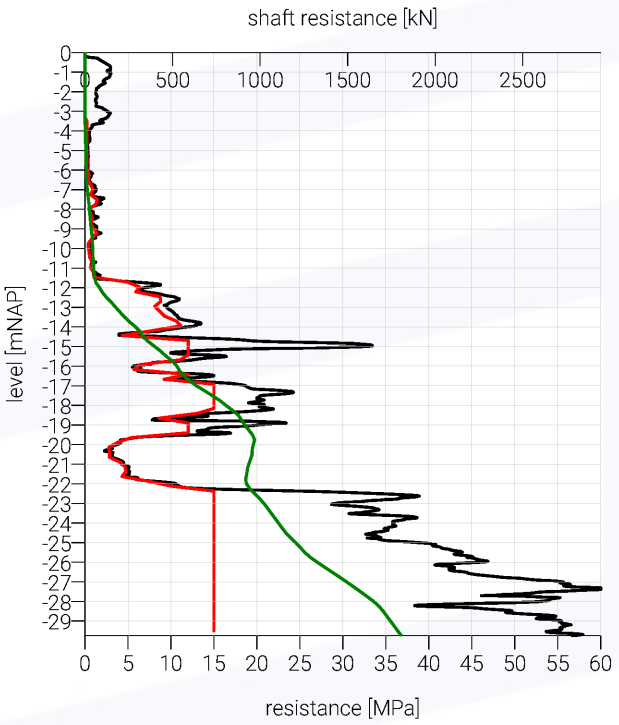

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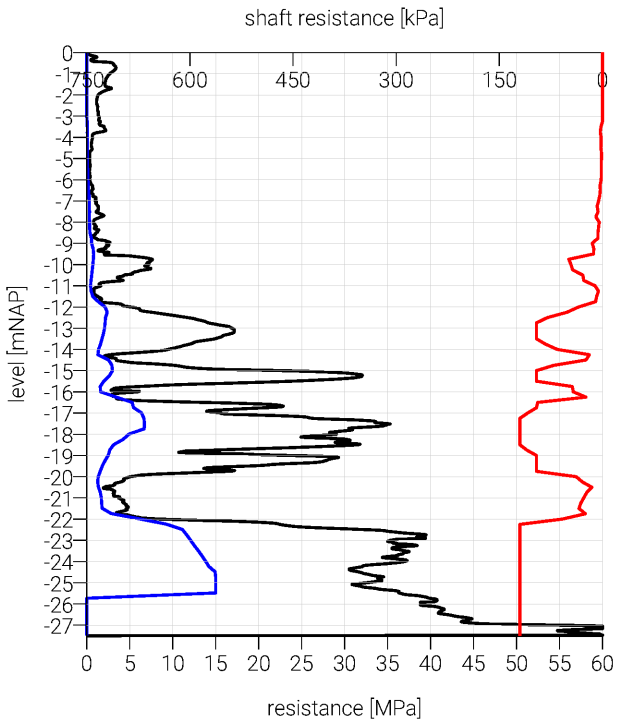

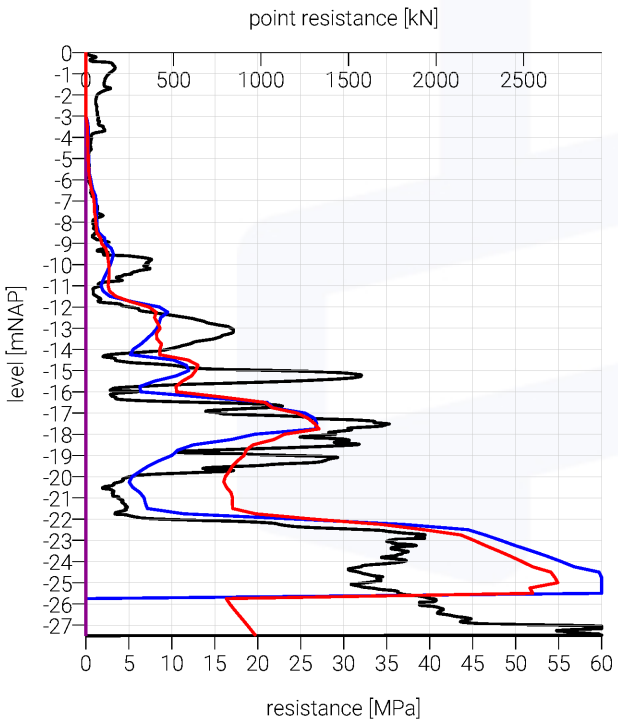

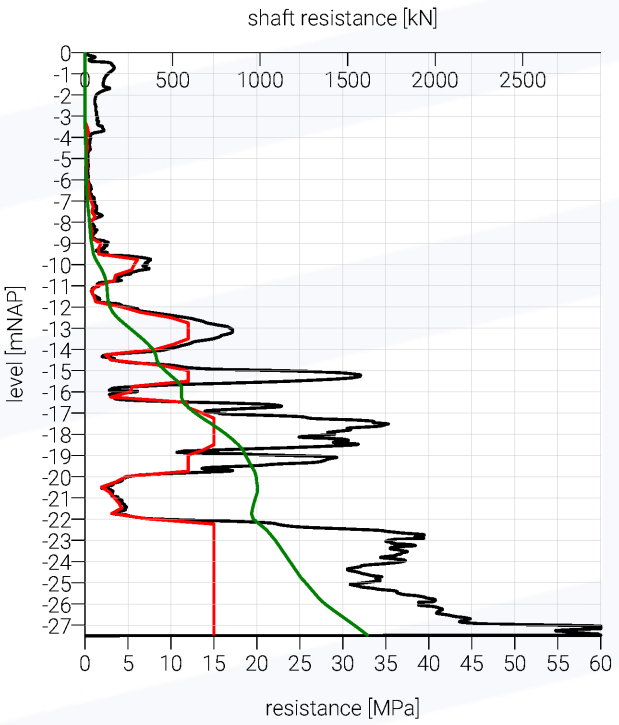

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Appendix - Bearing Capacity

level [mNAP]	R_{sk} [kN]	R_{bk} [kN]	R_{ck} [kN]	5.1, 2, e [kN]	R_{cd} [kN]	$F_{nk;rep}$ [kN]	$F_{nk;d}$ [kN]	$R_{cd,net}$ [kN]	R_{td} [kN]
0.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.25	0.0	5.2	5.2	0.0	4.3	0.0	0.0	4.3	0.0
-3.50	0.1	8.8	8.9	0.1	7.4	0.0	0.0	7.4	0.1
-3.75	0.8	9.0	9.8	0.7	8.1	0.0	0.0	8.1	0.5
-4.00	1.3	9.3	10.6	1.2	8.9	0.0	0.0	8.9	0.9
-4.25	1.8	9.8	11.6	1.7	9.7	0.0	0.0	9.7	1.2
-4.50	2.4	9.6	12.0	2.4	10.0	0.0	0.0	10.0	1.8
-4.75	2.8	10.9	13.7	2.6	11.4	0.0	0.0	11.4	1.9
-5.00	3.2	12.2	15.4	3.2	12.9	0.0	0.0	12.9	2.4
-5.25	3.7	12.9	16.6	3.7	13.8	0.0	0.0	13.8	2.7
-5.50	4.3	13.4	17.6	4.2	14.7	0.0	0.0	14.7	3.1
-5.75	4.7	16.1	21.5	4.7	17.4	0.0	0.0	17.4	3.5
-6.00	5.3	21.6	27.4	5.2	22.4	0.0	0.0	22.4	3.9
-6.25	6.4	24.3	30.6	6.3	25.5	0.0	0.0	25.5	4.7
-6.50	7.3	31.5	39.4	7.3	32.4	0.0	0.0	32.4	5.4

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-6.75	8.5	33.5	42.6	8.4	35.0	0.0	0.0	35.0	6.2
-7.00	10.4	34.5	45.3	10.3	37.4	0.0	0.0	37.4	7.6
-7.25	12.2	35.4	48.0	12.2	39.7	0.0	0.0	39.7	9.0
-7.50	13.6	32.5	46.0	14.4	38.4	0.0	0.0	38.4	10.7
-7.75	16.1	35.5	51.6	16.0	43.0	0.0	0.0	43.0	11.8
-8.00	17.3	37.3	54.7	17.2	45.5	0.0	0.0	45.5	12.8
-8.25	19.2	39.8	60.0	19.1	49.1	0.0	0.0	49.1	14.1
-8.50	19.1	37.2	58.3	20.3	46.9	0.0	0.0	46.9	15.0
-8.75	21.7	38.2	60.6	23.0	49.9	0.0	0.0	49.9	17.1
-9.00	25.3	35.7	61.0	26.9	50.8	0.0	0.0	50.8	19.9
-9.25	26.9	34.9	61.8	28.6	51.5	0.0	0.0	51.5	21.2
-9.50	28.0	33.8	63.2	29.7	51.5	0.0	0.0	51.5	22.0
-9.75	28.8	33.5	64.3	28.5	51.9	0.0	0.0	51.9	21.1
-10.00	29.6	36.8	66.5	29.3	55.3	0.0	0.0	55.3	21.7
-10.25	30.3	40.8	71.7	30.0	59.3	0.0	0.0	59.3	22.2
-10.50	31.2	43.3	74.5	30.9	62.0	0.0	0.0	62.0	22.9
-10.75	32.4	44.7	77.1	32.1	64.3	0.0	0.0	64.3	23.8
-11.00	33.5	56.0	89.5	33.2	74.6	0.0	0.0	74.6	24.6
-11.25	35.1	70.3	107.5	34.9	87.9	0.0	0.0	87.9	25.8
-11.50	40.5	106.4	205.6	37.6	122.4	0.0	0.0	122.4	27.8
-11.75	48.4	204.4	306.5	44.8	210.6	0.0	0.0	210.6	33.2
-12.00	60.7	311.6	372.4	56.2	310.3	0.0	0.0	310.3	41.6
-12.25	72.7	360.0	470.6	67.2	360.6	0.0	0.0	360.6	49.8
-12.50	89.1	328.9	440.2	82.3	348.3	0.0	0.0	348.3	60.9
-12.75	107.6	322.2	469.1	99.2	358.2	0.0	0.0	358.2	73.5
-13.00	130.3	312.6	498.4	119.7	369.0	0.0	0.0	369.0	88.7
-13.25	143.5	274.0	483.8	140.6	347.9	0.0	0.0	347.9	104.2
-13.50	163.2	250.8	486.6	159.6	345.0	0.0	0.0	345.0	118.2
-13.75	196.2	241.4	518.9	179.0	364.6	0.0	0.0	364.6	132.6
-14.00	222.7	207.8	506.5	202.7	358.7	0.0	0.0	358.7	150.2
-14.25	244.2	195.5	506.4	221.8	366.4	0.0	0.0	366.4	164.3
-14.50	254.5	384.9	664.9	247.0	532.9	0.0	0.0	532.9	183.0
-14.75	278.8	402.6	693.7	270.0	567.8	0.0	0.0	567.8	200.0
-15.00	286.7	315.3	612.7	296.1	501.7	0.0	0.0	501.7	219.3

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-15.25	312.4	278.4	597.8	321.8	492.3	0.0	0.0	492.3	238.4
-15.50	334.0	230.2	575.0	343.5	470.2	0.0	0.0	470.2	254.4
-15.75	356.1	221.8	598.2	365.4	481.6	0.0	0.0	481.6	270.7
-16.00	361.1	225.5	622.4	370.4	488.8	0.0	0.0	488.8	274.4
-16.25	407.8	513.6	937.6	390.6	767.9	0.0	0.0	767.9	289.4
-16.50	431.4	699.0	1133.3	411.2	942.0	0.0	0.0	942.0	304.6
-16.75	456.0	822.1	1278.1	433.9	1065.1	0.0	0.0	1065.1	321.4
-17.00	483.8	791.7	1281.1	459.4	1062.9	0.0	0.0	1062.9	340.3
-17.25	518.5	802.5	1327.1	491.1	1100.9	0.0	0.0	1100.9	363.7
-17.50	553.7	797.3	1356.4	523.0	1125.8	0.0	0.0	1125.8	387.4
-17.75	588.1	711.3	1303.3	554.2	1082.9	0.0	0.0	1082.9	410.5
-18.00	619.1	579.6	1198.8	583.1	999.0	0.0	0.0	999.0	431.9
-18.25	647.8	459.6	1107.4	609.1	922.8	0.0	0.0	922.8	451.2
-18.50	673.4	372.6	1046.0	631.3	871.7	0.0	0.0	871.7	467.7
-18.75	688.5	347.9	1036.4	646.5	863.6	0.0	0.0	863.6	478.9
-19.00	701.3	325.6	1026.9	658.0	855.7	0.0	0.0	855.7	487.4
-19.25	718.3	290.7	1009.7	670.8	840.9	0.0	0.0	840.9	496.9
-19.50	731.1	263.0	998.7	682.1	828.4	0.0	0.0	828.4	505.3
-19.75	745.0	227.9	973.0	694.4	810.7	0.0	0.0	810.7	514.3
-20.00	739.6	203.4	955.6	692.1	785.8	0.0	0.0	785.8	512.7
-20.25	734.8	190.3	944.9	687.9	770.9	0.0	0.0	770.9	509.5
-20.50	734.4	205.5	963.6	687.5	783.2	0.0	0.0	783.2	509.2
-20.75	727.2	237.5	994.2	681.1	803.9	0.0	0.0	803.9	504.5
-21.00	719.5	255.8	1005.0	674.2	812.7	0.0	0.0	812.7	499.4
-21.25	713.4	261.3	1003.4	668.8	812.2	0.0	0.0	812.2	495.4
-21.50	710.9	270.1	1006.2	666.5	817.5	0.0	0.0	817.5	493.7
-21.75	705.9	429.1	1146.4	662.1	945.9	0.0	0.0	945.9	490.4
-22.00	663.3	562.8	1226.1	665.0	1021.7	0.0	0.0	1021.7	492.6
-22.25	677.8	788.4	1501.5	678.9	1221.8	0.0	0.0	1221.8	502.9
-22.50	697.3	1016.4	1744.5	697.4	1428.1	0.0	0.0	1428.1	516.6
-22.75	766.6	1459.1	2258.9	716.1	1854.8	0.0	0.0	1854.8	530.5
-23.00	786.2	1675.6	2461.8	733.5	2051.5	0.0	0.0	2051.5	543.3
-23.25	802.1	1807.1	2609.3	747.6	2174.4	0.0	0.0	2174.4	553.7
-23.50	818.1	1958.0	2792.9	761.6	2313.4	0.0	0.0	2313.4	564.1

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-23.75	834.0	2025.8	2906.3	775.6	2383.2	0.0	0.0	2383.2	574.5
-24.00	850.0	2088.1	2988.1	789.6	2448.4	0.0	0.0	2448.4	584.9
-24.25	865.9	2145.7	3061.7	803.5	2509.7	0.0	0.0	2509.7	595.2
-24.50	882.2	2254.5	3147.8	817.7	2613.9	0.0	0.0	2613.9	605.7
-24.75	903.1	2265.6	3168.6	835.9	2640.5	0.0	0.0	2640.5	619.2
-25.00	925.9	2265.6	3191.4	855.7	2659.5	0.0	0.0	2659.5	633.8
-25.25	884.6	0.0	901.3	873.0	737.2	0.0	0.0	737.2	646.7
-25.50	903.4	0.0	916.6	890.3	752.8	0.0	0.0	752.8	659.5
-25.75	925.5	0.0	942.3	910.7	771.3	0.0	0.0	771.3	674.6
-26.00	954.2	0.0	972.0	937.2	795.2	0.0	0.0	795.2	694.2
-26.25	984.1	0.0	1002.7	964.6	820.1	0.0	0.0	820.1	714.5
-26.50	1014.8	0.0	1032.7	992.7	845.7	0.0	0.0	845.7	735.4
-26.75	1045.1	0.0	1062.0	1020.5	870.9	0.0	0.0	870.9	755.9
-27.00	1074.6	0.0	1106.0	1031.5	895.5	0.0	0.0	895.5	764.1
-27.25	1103.2	0.0	1135.1	1057.1	919.3	0.0	0.0	919.3	783.1
-27.50	1131.2	2118.9	3250.1	1027.8	2708.4	0.0	0.0	2708.4	761.3
-27.75	1159.3	2118.9	3278.2	1051.7	2731.9	0.0	0.0	2731.9	779.0
-28.00	1185.9	0.0	1185.9	1074.2	988.3	0.0	0.0	988.3	795.7
-28.25	1207.8	0.0	1207.8	1092.7	1006.5	0.0	0.0	1006.5	809.4
-28.50	1225.3	0.0	1225.3	1107.5	1021.1	0.0	0.0	1021.1	820.3
-28.75	1240.2	0.0	1240.2	1120.0	1033.5	0.0	0.0	1033.5	829.7
-29.00	1255.1	0.0	1255.1	1132.6	1045.9	0.0	0.0	1045.9	839.0
-29.25	1270.0	0.0	1270.0	1145.2	1058.4	0.0	0.0	1058.4	848.3
-29.50	1284.9	0.0	1284.9	1157.7	1070.8	0.0	0.0	1070.8	857.5
-29.75	1299.9	0.0	1299.9	1170.2	1083.2	0.0	0.0	1083.2	866.8

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Appendix - Method Koppejan - 5.1, 2, e 2023 1

level [mNAP]	$q_{b;max;i}$ [MPa]	$q_{s;max;z;i}$ [kPa]	$R_{s;cal;i}$ [kN]	$R_{b;cal;i}$ [kN]	$R_{c;cal;i}$ [kN]	$R_{t;cal;i}$ [kN]	$F_{nk;rep}$ [kN]	$F_{nk;d}$ [kN]	R_{cd} [kN]	$R_{cd,net}$ [kN]
0.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.25	0.04	0.0	0.0	7.2	7.2	0.0	0.0	0.0	4.3	4.3
-3.50	0.06	1.7	0.1	12.5	12.6	0.1	0.0	0.0	8.1	8.1
-3.75	0.06	1.9	1.1	12.6	13.7	1.1	0.0	0.0	8.8	8.8
-4.00	0.07	1.6	1.8	13.3	15.1	1.7	0.0	0.0	9.7	9.7
-4.25	0.07	2.0	2.5	13.9	16.4	2.5	0.0	0.0	10.5	10.5
-4.50	0.07	1.9	3.4	13.5	16.8	3.3	0.0	0.0	10.8	10.8
-4.75	0.08	1.5	3.9	15.1	19.1	3.9	0.0	0.0	12.2	12.2
-5.00	0.09	1.7	4.5	17.8	22.3	4.5	0.0	0.0	14.3	14.3
-5.25	0.10	2.0	5.2	18.7	23.9	5.2	0.0	0.0	15.3	15.3
-5.50	0.10	1.9	5.9	20.2	26.1	5.9	0.0	0.0	16.7	16.7
-5.75	0.13	1.8	6.7	25.2	31.9	6.7	0.0	0.0	20.5	20.5
-6.00	0.14	2.3	7.5	28.0	35.6	7.5	0.0	0.0	22.8	22.8
-6.25	0.17	3.3	8.8	32.8	41.6	8.8	0.0	0.0	26.6	26.6
-6.50	0.21	4.1	10.0	41.8	51.8	9.9	0.0	0.0	33.2	33.2
-6.75	0.22	5.7	11.9	43.5	55.4	11.8	0.0	0.0	35.5	35.5

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-7.00	0.23	5.4	14.1	44.8	58.9	14.0	0.0	0.0	37.7	37.7
-7.25	0.23	7.3	16.3	46.1	62.4	16.2	0.0	0.0	40.0	40.0
-7.50	0.23	5.8	18.9	45.1	64.0	18.8	0.0	0.0	38.4	38.4
-7.75	0.24	3.1	20.9	46.2	67.1	20.7	0.0	0.0	43.0	43.0
-8.00	0.25	5.0	22.5	48.5	71.1	22.4	0.0	0.0	45.5	45.5
-8.25	0.27	5.0	25.0	53.0	78.0	24.8	0.0	0.0	50.0	50.0
-8.50	0.28	5.9	26.5	54.5	81.1	26.4	0.0	0.0	48.6	48.6
-8.75	0.28	14.7	30.2	54.0	84.2	30.0	0.0	0.0	50.5	50.5
-9.00	0.25	9.2	35.2	49.6	84.7	34.9	0.0	0.0	50.8	50.8
-9.25	0.25	4.2	37.5	48.5	85.9	37.2	0.0	0.0	51.5	51.5
-9.50	0.25	3.2	39.0	48.9	87.9	38.7	0.0	0.0	52.7	52.7
-9.75	0.25	4.9	40.0	49.5	89.5	39.7	0.0	0.0	53.6	53.6
-10.00	0.26	3.3	41.1	51.3	92.4	40.8	0.0	0.0	55.4	55.4
-10.25	0.29	4.1	42.1	57.6	99.7	41.7	0.0	0.0	59.8	59.8
-10.50	0.31	6.6	43.3	60.2	103.5	43.0	0.0	0.0	62.0	62.0
-10.75	0.32	4.2	45.0	62.2	107.2	44.7	0.0	0.0	64.3	64.3
-11.00	0.40	4.7	46.5	77.8	124.4	46.1	0.0	0.0	74.6	74.6
-11.25	0.69	10.9	48.8	134.8	183.6	48.4	0.0	0.0	110.1	110.1
-11.50	1.43	19.9	52.7	281.1	333.8	52.2	0.0	0.0	213.9	213.9
-11.75	1.75	39.4	63.9	343.9	407.7	63.3	0.0	0.0	261.4	261.4
-12.00	2.06	38.2	79.0	405.1	484.1	78.1	0.0	0.0	310.3	310.3
-12.25	2.63	48.2	94.5	517.2	611.8	93.5	0.0	0.0	392.2	392.2
-12.50	2.89	59.6	115.9	567.2	683.1	114.3	0.0	0.0	437.9	437.9
-12.75	3.03	70.0	139.9	595.0	734.9	137.8	0.0	0.0	471.1	471.1
-13.00	3.14	80.6	169.4	615.6	785.0	166.4	0.0	0.0	503.2	503.2
-13.25	3.23	80.9	199.4	634.1	833.6	195.5	0.0	0.0	499.8	499.8
-13.50	3.32	83.4	229.7	651.1	880.8	224.6	0.0	0.0	528.0	528.0
-13.75	2.79	96.0	264.2	547.9	812.1	257.7	0.0	0.0	520.6	520.6
-14.00	2.48	80.1	296.5	487.0	783.4	288.4	0.0	0.0	502.2	502.2
-14.25	2.55	45.3	318.3	501.4	819.7	309.2	0.0	0.0	525.5	525.5
-14.50	2.64	84.0	346.2	518.1	864.3	335.6	0.0	0.0	554.0	554.0
-14.75	2.67	96.0	378.5	523.3	901.8	366.1	0.0	0.0	578.1	578.1
-15.00	2.23	96.0	413.4	438.3	851.7	398.9	0.0	0.0	510.6	510.6
-15.25	1.97	63.8	444.0	387.0	830.9	427.5	0.0	0.0	498.2	498.2

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-15.50	1.63	89.9	479.2	320.0	799.3	460.4	0.0	0.0	479.2	479.2
-15.75	1.71	20.5	495.0	336.5	831.5	475.1	0.0	0.0	498.5	498.5
-16.00	4.19	27.1	501.9	822.2	1324.1	481.5	0.0	0.0	793.8	793.8
-16.25	4.67	96.0	530.2	917.9	1448.1	507.8	0.0	0.0	928.3	928.3
-16.50	4.97	96.0	566.9	976.5	1543.4	541.8	0.0	0.0	989.4	989.4
-16.75	6.29	95.6	600.2	1235.0	1835.1	572.6	0.0	0.0	1176.4	1176.4
-17.00	6.50	120.0	645.8	1276.7	1922.5	614.6	0.0	0.0	1232.4	1232.4
-17.25	6.49	120.0	691.4	1273.5	1964.9	656.3	0.0	0.0	1259.6	1259.6
-17.50	6.53	120.0	736.1	1282.3	2018.4	697.1	0.0	0.0	1293.9	1293.9
-17.75	4.84	120.0	776.8	951.2	1728.0	734.0	0.0	0.0	1107.7	1107.7
-18.00	3.90	120.0	815.2	764.8	1580.0	768.8	0.0	0.0	1012.8	1012.8
-18.25	3.33	120.0	853.2	653.3	1506.5	803.0	0.0	0.0	965.7	965.7
-18.50	3.15	115.2	878.3	618.7	1497.0	825.5	0.0	0.0	959.6	959.6
-18.75	2.92	120.0	911.3	573.3	1484.6	855.1	0.0	0.0	951.7	951.7
-19.00	2.53	120.0	941.3	495.9	1437.2	881.8	0.0	0.0	921.3	921.3
-19.25	2.16	120.0	970.8	424.8	1395.7	908.1	0.0	0.0	894.7	894.7
-19.50	1.77	99.2	999.2	347.8	1347.0	933.3	0.0	0.0	863.5	863.5
-19.75	1.61	35.6	999.6	315.2	1314.8	933.5	0.0	0.0	842.8	842.8
-20.00	1.58	21.3	991.3	310.4	1301.7	926.2	0.0	0.0	834.4	834.4
-20.25	1.72	23.2	986.5	336.9	1323.4	922.0	0.0	0.0	848.3	848.3
-20.50	1.93	25.8	979.8	379.3	1359.1	916.1	0.0	0.0	871.2	871.2
-20.75	2.11	32.6	972.2	413.6	1385.8	909.3	0.0	0.0	888.3	888.3
-21.00	2.34	35.4	964.0	460.2	1424.2	902.0	0.0	0.0	912.9	912.9
-21.25	2.51	40.7	960.8	492.4	1453.2	899.2	0.0	0.0	931.5	931.5
-21.50	2.64	46.0	957.8	518.3	1476.0	896.5	0.0	0.0	946.2	946.2
-21.75	3.06	42.8	965.2	601.1	1566.3	903.1	0.0	0.0	1004.0	1004.0
-22.00	4.04	57.9	981.8	792.5	1774.3	917.8	0.0	0.0	1063.7	1063.7
-22.25	5.58	89.8	991.3	1095.9	2087.1	926.2	0.0	0.0	1251.3	1251.3
-22.50	7.20	111.5	1012.1	1412.8	2424.9	944.7	0.0	0.0	1453.8	1453.8
-22.75	9.66	120.0	1039.7	1896.8	2936.5	969.1	0.0	0.0	1882.4	1882.4
-23.00	12.59	120.0	1060.7	2472.5	3533.2	987.6	0.0	0.0	2264.9	2264.9
-23.25	13.39	120.0	1081.4	2628.9	3710.4	1005.9	0.0	0.0	2378.4	2378.4
-23.50	13.96	120.0	1102.2	2741.0	3843.1	1024.1	0.0	0.0	2463.6	2463.6
-23.75	14.47	120.0	1122.9	2841.7	3964.6	1042.2	0.0	0.0	2541.4	2541.4

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-24.00	15.00	120.0	1143.6	2945.2	4088.9	1060.3	0.0	0.0	2621.1	2621.1
-24.25	15.00	120.0	1164.4	2945.2	4109.6	1078.4	0.0	0.0	2634.4	2634.4
-24.50	15.00	120.0	1190.5	2945.2	4135.8	1101.1	0.0	0.0	2651.1	2651.1
-24.75	15.00	120.0	1211.3	2945.2	4156.5	1119.1	0.0	0.0	2664.4	2664.4
-25.00	15.00	120.0	1232.0	2945.2	4177.3	1137.0	0.0	0.0	2677.7	2677.7
-25.25	0.00	120.0	1252.7	0.0	1252.7	1154.9	0.0	0.0	751.0	751.0
-25.50	0.00	120.0	1274.1	0.0	1274.1	1173.3	0.0	0.0	763.8	763.8
-25.75	0.00	120.0	1309.8	0.0	1309.8	1204.0	0.0	0.0	785.3	785.3
-26.00	0.00	120.0	1351.1	0.0	1351.1	1239.5	0.0	0.0	810.0	810.0
-26.25	0.00	120.0	1393.7	0.0	1393.7	1275.9	0.0	0.0	835.6	835.6
-26.50	0.00	120.0	1435.5	0.0	1435.5	1311.6	0.0	0.0	860.6	860.6
-26.75	0.00	120.0	1476.2	0.0	1476.2	1346.3	0.0	0.0	885.0	885.0
-27.00	0.00	120.0	1516.1	0.0	1516.1	1380.2	0.0	0.0	908.9	908.9

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Appendix - Method Koppejan - 5.1, 2, e 2023 2

level [mNAP]	$q_{b;max;i}$ [MPa]	$q_{s;max;z;i}$ [kPa]	$R_{s;cal;i}$ [kN]	$R_{b;cal;i}$ [kN]	$R_{c;cal;i}$ [kN]	$R_{t;cal;i}$ [kN]	$F_{nk;rep}$ [kN]	$F_{nk;d}$ [kN]	R_{cd} [kN]	$R_{cd,net}$ [kN]
0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.25	0.04	0.0	0.0	7.5	7.5	0.0	0.0	0.0	4.5	4.5
-3.50	0.06	1.9	0.1	11.5	11.6	0.1	0.0	0.0	7.5	7.5
-3.75	0.06	1.9	1.0	11.7	12.7	1.0	0.0	0.0	8.1	8.1
-4.00	0.06	1.6	1.7	12.1	13.8	1.7	0.0	0.0	8.9	8.9
-4.25	0.06	1.8	2.3	12.7	15.1	2.3	0.0	0.0	9.7	9.7
-4.50	0.06	2.0	3.1	12.5	15.6	3.1	0.0	0.0	10.0	10.0
-4.75	0.07	1.2	3.7	14.1	17.8	3.6	0.0	0.0	11.4	11.4
-5.00	0.08	1.5	4.2	15.9	20.1	4.2	0.0	0.0	12.9	12.9
-5.25	0.09	1.8	4.8	16.7	21.6	4.8	0.0	0.0	13.8	13.8
-5.50	0.09	1.7	5.5	17.4	22.9	5.5	0.0	0.0	14.7	14.7
-5.75	0.11	1.6	6.2	21.8	27.9	6.1	0.0	0.0	17.9	17.9
-6.00	0.15	1.8	6.9	30.0	36.8	6.8	0.0	0.0	23.6	23.6
-6.25	0.16	4.0	8.3	31.6	39.8	8.2	0.0	0.0	25.5	25.5
-6.50	0.22	2.9	9.5	42.3	51.9	9.5	0.0	0.0	33.3	33.3
-6.75	0.26	5.4	11.0	50.5	61.6	11.0	0.0	0.0	39.5	39.5
-7.00	0.27	7.5	13.5	52.6	66.1	13.4	0.0	0.0	42.4	42.4
-7.25	0.28	4.8	15.9	54.7	70.6	15.8	0.0	0.0	45.2	45.2

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-7.50	0.28	11.4	19.4	55.4	74.8	19.3	0.0	0.0	44.9	44.9
-7.75	0.25	10.2	23.4	49.5	72.9	23.3	0.0	0.0	46.8	46.8
-8.00	0.26	3.5	25.6	51.2	76.7	25.4	0.0	0.0	49.2	49.2
-8.25	0.26	5.6	27.5	51.7	79.2	27.3	0.0	0.0	50.8	50.8
-8.50	0.26	6.9	30.4	51.7	82.1	30.2	0.0	0.0	49.2	49.2
-8.75	0.27	5.2	32.2	53.1	85.3	32.0	0.0	0.0	51.1	51.1
-9.00	0.27	8.4	35.2	52.9	88.1	35.0	0.0	0.0	52.8	52.8
-9.25	0.26	11.1	38.8	50.8	89.5	38.5	0.0	0.0	53.7	53.7
-9.50	0.24	6.5	41.7	47.0	88.7	41.4	0.0	0.0	53.2	53.2
-9.75	0.24	3.2	42.8	46.5	89.3	42.5	0.0	0.0	53.6	53.6
-10.00	0.26	3.2	43.8	51.1	94.9	43.4	0.0	0.0	56.9	56.9
-10.25	0.29	3.9	44.8	56.8	101.6	44.4	0.0	0.0	60.9	60.9
-10.50	0.32	4.6	46.0	62.7	108.7	45.7	0.0	0.0	65.2	65.2
-10.75	0.32	7.7	48.0	63.7	111.7	47.6	0.0	0.0	67.0	67.0
-11.00	0.40	5.0	49.7	79.1	128.8	49.2	0.0	0.0	77.2	77.2
-11.25	0.50	8.0	51.7	97.7	149.4	51.2	0.0	0.0	89.6	89.6
-11.50	1.28	8.2	55.2	252.1	307.3	54.7	0.0	0.0	197.0	197.0
-11.75	2.01	39.6	62.9	394.5	457.4	62.3	0.0	0.0	293.2	293.2
-12.00	2.16	50.7	83.6	423.9	507.5	82.7	0.0	0.0	325.3	325.3
-12.25	2.88	47.4	100.4	564.9	665.2	99.2	0.0	0.0	426.4	426.4
-12.50	2.29	70.0	123.2	449.0	572.2	121.5	0.0	0.0	366.8	366.8
-12.75	2.34	70.5	151.0	458.9	609.9	148.6	0.0	0.0	391.0	391.0
-13.00	2.41	64.9	175.6	472.3	647.9	172.4	0.0	0.0	415.4	415.4
-13.25	2.48	69.6	200.6	486.5	687.0	196.6	0.0	0.0	411.9	411.9
-13.50	2.53	73.9	226.9	497.1	724.0	221.9	0.0	0.0	434.1	434.1
-13.75	2.55	84.9	255.0	501.0	756.1	248.9	0.0	0.0	484.7	484.7
-14.00	2.40	89.3	289.5	471.6	761.1	281.8	0.0	0.0	487.9	487.9
-14.25	2.50	62.2	317.4	491.3	808.7	308.3	0.0	0.0	518.4	518.4
-14.50	3.65	34.8	330.9	716.6	1047.5	321.1	0.0	0.0	671.5	671.5
-14.75	3.78	96.0	362.4	742.8	1105.3	350.9	0.0	0.0	708.5	708.5
-15.00	3.59	96.0	398.5	705.3	1103.8	384.9	0.0	0.0	661.7	661.7
-15.25	3.27	96.0	434.2	642.8	1077.0	418.4	0.0	0.0	645.7	645.7
-15.50	3.30	96.0	464.3	647.2	1111.5	446.5	0.0	0.0	666.4	666.4
-15.75	3.07	88.6	500.6	603.8	1104.3	480.3	0.0	0.0	662.1	662.1

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-16.00	2.95	50.8	524.8	579.5	1104.2	502.8	0.0	0.0	662.0	662.0
-16.25	4.08	45.7	541.0	800.9	1342.0	517.8	0.0	0.0	860.2	860.2
-16.50	4.63	96.0	564.6	908.7	1473.3	539.7	0.0	0.0	944.5	944.5
-16.75	5.45	73.7	598.6	1069.2	1667.7	571.1	0.0	0.0	1069.1	1069.1
-17.00	5.24	120.0	636.2	1029.3	1665.4	605.7	0.0	0.0	1067.6	1067.6
-17.25	5.31	120.0	682.0	1043.3	1725.3	647.7	0.0	0.0	1106.0	1106.0
-17.50	5.28	120.0	726.9	1036.5	1763.4	688.7	0.0	0.0	1130.4	1130.4
-17.75	4.71	120.0	769.5	924.7	1694.2	727.5	0.0	0.0	1086.1	1086.1
-18.00	3.84	120.0	804.9	753.5	1558.4	759.4	0.0	0.0	999.0	999.0
-18.25	3.04	120.0	842.1	597.4	1439.6	793.1	0.0	0.0	922.8	922.8
-18.50	2.47	104.8	875.4	484.4	1359.8	822.9	0.0	0.0	871.7	871.7
-18.75	2.30	69.0	895.0	452.3	1347.3	840.5	0.0	0.0	863.6	863.6
-19.00	2.16	96.0	911.7	423.2	1334.9	855.4	0.0	0.0	855.7	855.7
-19.25	1.92	96.0	934.6	377.9	1312.6	875.9	0.0	0.0	841.4	841.4
-19.50	1.74	96.0	956.4	341.9	1298.3	895.3	0.0	0.0	832.3	832.3
-19.75	1.51	42.9	968.6	296.3	1264.9	906.1	0.0	0.0	810.8	810.8
-20.00	1.44	30.3	961.5	282.4	1243.9	899.8	0.0	0.0	797.4	797.4
-20.25	1.44	22.1	955.2	282.1	1237.3	894.2	0.0	0.0	793.1	793.1
-20.50	1.58	23.0	954.7	309.4	1264.1	893.7	0.0	0.0	810.3	810.3
-20.75	1.80	22.5	945.4	354.1	1299.4	885.4	0.0	0.0	833.0	833.0
-21.00	2.04	32.1	935.4	401.0	1336.3	876.5	0.0	0.0	856.6	856.6
-21.25	2.14	37.4	927.4	420.7	1348.1	869.4	0.0	0.0	864.2	864.2
-21.50	2.26	37.9	924.1	443.2	1367.3	866.5	0.0	0.0	876.5	876.5
-21.75	2.92	34.5	917.6	572.6	1490.3	860.7	0.0	0.0	955.3	955.3
-22.00	3.98	59.8	921.9	782.3	1704.3	864.5	0.0	0.0	1021.7	1021.7
-22.25	6.79	80.7	942.1	1333.5	2275.7	882.5	0.0	0.0	1364.3	1364.3
-22.50	10.28	120.0	969.2	2018.4	2987.6	906.6	0.0	0.0	1791.1	1791.1
-22.75	10.81	120.0	996.6	2123.0	3119.6	931.0	0.0	0.0	1999.7	1999.7
-23.00	11.09	120.0	1022.0	2178.3	3200.3	953.5	0.0	0.0	2051.5	2051.5
-23.25	11.96	120.0	1042.8	2349.3	3392.1	971.8	0.0	0.0	2174.4	2174.4
-23.50	13.07	120.0	1063.5	2567.2	3630.7	990.1	0.0	0.0	2327.4	2327.4
-23.75	13.72	120.0	1084.2	2694.0	3778.2	1008.3	0.0	0.0	2421.9	2421.9
-24.00	14.19	120.0	1105.0	2786.2	3891.2	1026.5	0.0	0.0	2494.3	2494.3
-24.25	14.68	120.0	1125.7	2882.9	4008.6	1044.6	0.0	0.0	2569.6	2569.6

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-24.50	15.00	120.0	1146.8	2945.2	4092.1	1063.0	0.0	0.0	2623.1	2623.1
-24.75	15.00	120.0	1174.0	2945.2	4119.2	1086.6	0.0	0.0	2640.5	2640.5
-25.00	15.00	120.0	1203.6	2945.2	4148.9	1112.4	0.0	0.0	2659.5	2659.5
-25.25	15.00	120.0	1229.6	2945.2	4174.9	1134.9	0.0	0.0	2502.9	2502.9
-25.50	15.00	120.0	1255.7	2945.2	4200.9	1157.4	0.0	0.0	2518.6	2518.6
-25.75	15.00	120.0	1286.5	2945.2	4231.7	1184.0	0.0	0.0	2537.0	2537.0
-26.00	15.00	120.0	1326.4	2945.2	4271.6	1218.3	0.0	0.0	2560.9	2560.9
-26.25	15.00	120.0	1367.9	2945.2	4313.2	1254.0	0.0	0.0	2585.8	2585.8
-26.50	15.00	120.0	1410.6	2945.2	4355.9	1290.6	0.0	0.0	2611.4	2611.4
-26.75	15.00	120.0	1452.7	2945.2	4398.0	1326.6	0.0	0.0	2636.7	2636.7
-27.00	15.00	120.0	1493.7	2945.2	4438.9	1361.5	0.0	0.0	2661.2	2661.2
-27.25	15.00	120.0	1533.4	2945.2	4478.7	1395.4	0.0	0.0	2685.0	2685.0
-27.50	15.00	120.0	1572.4	2945.2	4517.6	1428.6	0.0	0.0	2708.4	2708.4
-27.75	15.00	120.0	1611.5	2945.2	4556.7	1461.8	0.0	0.0	2731.9	2731.9
-28.00	0.00	120.0	1648.4	0.0	1648.4	1493.1	0.0	0.0	988.3	988.3
-28.25	0.00	120.0	1678.9	0.0	1678.9	1518.9	0.0	0.0	1006.5	1006.5
-28.50	0.00	120.0	1703.1	0.0	1703.1	1539.4	0.0	0.0	1021.1	1021.1
-28.75	0.00	120.0	1723.9	0.0	1723.9	1556.9	0.0	0.0	1033.5	1033.5
-29.00	0.00	120.0	1744.6	0.0	1744.6	1574.3	0.0	0.0	1045.9	1045.9
-29.25	0.00	120.0	1765.3	0.0	1765.3	1591.8	0.0	0.0	1058.4	1058.4
-29.50	0.00	120.0	1786.1	0.0	1786.1	1609.2	0.0	0.0	1070.8	1070.8
-29.75	0.00	120.0	1806.8	0.0	1806.8	1626.5	0.0	0.0	1083.2	1083.2

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Appendix - Method Koppejan - 5.1, 2, e 2023 3

level [mNAP]	$q_{b;max;i}$ [MPa]	$q_{s;max;z;i}$ [kPa]	$R_{s;cal;i}$ [kN]	$R_{b;cal;i}$ [kN]	$R_{c;cal;i}$ [kN]	$R_{t;cal;i}$ [kN]	$F_{nk;rep}$ [kN]	$F_{nk;d}$ [kN]	R_{cd} [kN]	$R_{cd,net}$ [kN]
0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.25	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.50	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.75	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.25	0.05	0.0	0.0	9.0	9.0	0.0	0.0	0.0	5.4	5.4
-3.50	0.07	2.1	0.2	13.6	13.8	0.2	0.0	0.0	8.8	8.8
-3.75	0.07	3.2	1.6	13.3	14.9	1.6	0.0	0.0	9.5	9.5
-4.00	0.07	2.0	2.3	13.7	16.1	2.3	0.0	0.0	10.3	10.3
-4.25	0.07	2.0	3.1	14.2	17.3	3.1	0.0	0.0	11.1	11.1
-4.50	0.07	2.3	3.9	14.5	18.4	3.9	0.0	0.0	11.8	11.8
-4.75	0.08	1.4	4.6	14.8	19.4	4.6	0.0	0.0	12.4	12.4
-5.00	0.08	1.5	5.2	16.4	21.6	5.2	0.0	0.0	13.9	13.9
-5.25	0.09	1.8	5.9	17.3	23.2	5.8	0.0	0.0	14.8	14.8
-5.50	0.09	1.7	6.6	18.5	25.1	6.5	0.0	0.0	16.1	16.1
-5.75	0.11	1.6	7.2	20.9	28.1	7.1	0.0	0.0	18.0	18.0
-6.00	0.14	1.9	7.9	28.2	36.1	7.9	0.0	0.0	23.2	23.2
-6.25	0.17	3.4	8.9	33.8	42.7	8.8	0.0	0.0	27.4	27.4
-6.50	0.21	3.2	10.3	41.0	51.3	10.2	0.0	0.0	32.9	32.9
-6.75	0.28	4.0	11.7	54.8	66.5	11.6	0.0	0.0	42.7	42.7
-7.00	0.30	5.7	13.9	58.3	72.2	13.8	0.0	0.0	46.3	46.3
-7.25	0.31	7.8	16.5	60.7	77.2	16.4	0.0	0.0	49.5	49.5

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-7.50	0.32	6.4	19.5	62.4	81.8	19.3	0.0	0.0	49.1	49.1
-7.75	0.31	9.6	23.3	61.4	84.7	23.1	0.0	0.0	54.3	54.3
-8.00	0.32	4.8	25.6	62.7	88.3	25.4	0.0	0.0	56.6	56.6
-8.25	0.33	5.7	27.9	65.2	93.1	27.7	0.0	0.0	59.7	59.7
-8.50	0.37	6.6	30.7	73.6	104.3	30.5	0.0	0.0	62.5	62.5
-8.75	0.54	6.5	32.9	106.5	139.4	32.6	0.0	0.0	83.6	83.6
-9.00	0.57	14.8	37.8	112.2	150.0	37.5	0.0	0.0	89.9	89.9
-9.25	0.74	12.6	43.5	145.9	189.4	43.1	0.0	0.0	113.5	113.5
-9.50	0.80	13.1	48.1	157.1	205.1	47.6	0.0	0.0	123.0	123.0
-9.75	0.76	48.9	61.2	150.2	211.4	60.6	0.0	0.0	126.7	126.7
-10.00	0.71	45.9	79.2	139.4	218.7	78.3	0.0	0.0	131.1	131.1
-10.25	0.64	43.4	96.7	125.7	222.4	95.4	0.0	0.0	133.3	133.3
-10.50	0.57	28.5	110.1	111.6	221.8	108.4	0.0	0.0	133.0	133.0
-10.75	0.49	27.1	119.8	97.1	216.9	117.8	0.0	0.0	130.0	130.0
-11.00	0.44	10.8	124.6	86.9	211.5	122.5	0.0	0.0	126.8	126.8
-11.25	0.50	5.8	126.9	98.6	225.5	124.7	0.0	0.0	135.2	135.2
-11.50	0.70	8.4	129.0	138.3	267.3	126.8	0.0	0.0	171.4	171.4
-11.75	1.35	10.0	132.8	265.7	398.5	130.5	0.0	0.0	255.4	255.4
-12.00	2.14	34.7	142.3	419.8	562.1	139.7	0.0	0.0	360.3	360.3
-12.25	2.38	51.8	158.7	468.0	626.6	155.6	0.0	0.0	401.7	401.7
-12.50	2.18	80.1	184.3	427.5	611.8	180.4	0.0	0.0	392.2	392.2
-12.75	2.13	96.0	218.9	418.9	637.8	213.7	0.0	0.0	408.9	408.9
-13.00	2.07	96.0	255.4	406.3	661.7	248.6	0.0	0.0	424.2	424.2
-13.25	1.94	96.0	291.6	380.8	672.5	283.1	0.0	0.0	403.2	403.2
-13.50	1.78	96.0	327.7	348.6	676.3	317.2	0.0	0.0	405.5	405.5
-13.75	1.60	83.0	360.7	313.8	674.5	348.3	0.0	0.0	432.4	432.4
-14.00	1.38	65.8	388.4	270.1	658.5	374.3	0.0	0.0	422.1	422.1
-14.25	1.29	19.2	404.2	254.1	658.3	389.1	0.0	0.0	422.0	422.0
-14.50	2.55	24.0	410.2	500.4	910.6	394.7	0.0	0.0	583.7	583.7
-14.75	2.92	70.7	426.2	573.8	1000.0	409.7	0.0	0.0	641.1	641.1
-15.00	2.99	96.0	457.8	587.5	1045.3	439.2	0.0	0.0	626.7	626.7
-15.25	2.62	96.0	492.3	514.8	1007.1	471.3	0.0	0.0	603.7	603.7
-15.50	1.99	96.0	527.4	391.0	918.3	503.8	0.0	0.0	550.6	550.6
-15.75	1.57	43.9	550.8	308.3	859.1	525.4	0.0	0.0	515.0	515.0

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-16.00	1.60	42.4	551.6	313.5	865.1	526.1	0.0	0.0	518.6	518.6
-16.25	3.40	24.2	551.3	667.7	1218.9	525.8	0.0	0.0	781.4	781.4
-16.50	5.27	94.1	560.8	1035.7	1596.5	534.6	0.0	0.0	1023.4	1023.4
-16.75	5.44	96.0	592.8	1068.7	1661.5	564.1	0.0	0.0	1065.1	1065.1
-17.00	6.37	108.8	628.9	1250.6	1879.6	597.2	0.0	0.0	1204.9	1204.9
-17.25	6.65	120.0	674.1	1305.6	1979.6	638.4	0.0	0.0	1269.0	1269.0
-17.50	6.72	120.0	719.8	1318.6	2038.3	679.9	0.0	0.0	1306.6	1306.6
-17.75	6.68	120.0	764.6	1311.6	2076.2	720.5	0.0	0.0	1330.9	1330.9
-18.00	4.91	120.0	806.2	964.3	1770.5	758.0	0.0	0.0	1134.9	1134.9
-18.25	4.23	120.0	843.8	829.8	1673.6	791.8	0.0	0.0	1072.8	1072.8
-18.50	3.12	120.0	876.2	613.4	1489.5	820.7	0.0	0.0	954.8	954.8
-18.75	2.67	109.9	903.0	525.1	1428.1	844.7	0.0	0.0	915.5	915.5
-19.00	2.50	96.0	917.3	491.5	1408.8	857.4	0.0	0.0	903.1	903.1
-19.25	2.13	96.0	933.9	417.9	1351.7	872.1	0.0	0.0	866.5	866.5
-19.50	1.81	96.0	950.4	356.1	1306.5	886.8	0.0	0.0	837.5	837.5
-19.75	1.57	96.0	968.5	308.9	1277.3	902.7	0.0	0.0	818.8	818.8
-20.00	1.35	38.3	977.9	264.4	1242.3	911.0	0.0	0.0	796.4	796.4
-20.25	1.26	29.2	981.0	247.4	1228.4	913.7	0.0	0.0	787.4	787.4
-20.50	1.36	15.4	985.5	267.2	1252.7	917.7	0.0	0.0	803.0	803.0
-20.75	1.57	22.9	983.7	308.8	1292.5	916.1	0.0	0.0	828.5	828.5
-21.00	1.69	27.3	974.0	332.5	1306.5	907.5	0.0	0.0	837.5	837.5
-21.25	1.73	31.5	964.7	339.7	1304.4	899.3	0.0	0.0	836.2	836.2
-21.50	1.79	34.1	957.0	351.1	1308.1	892.4	0.0	0.0	838.5	838.5
-21.75	2.84	24.9	951.3	557.9	1509.2	887.4	0.0	0.0	967.4	967.4
-22.00	6.11	58.4	961.0	1199.2	2160.1	896.0	0.0	0.0	1295.0	1295.0
-22.25	9.23	120.0	998.0	1812.0	2810.1	928.8	0.0	0.0	1684.7	1684.7
-22.50	11.11	120.0	1035.5	2181.7	3217.2	961.9	0.0	0.0	1928.8	1928.8
-22.75	11.61	120.0	1061.5	2280.0	3341.5	984.8	0.0	0.0	2142.0	2142.0
-23.00	12.06	120.0	1086.8	2368.4	3455.1	1007.0	0.0	0.0	2214.8	2214.8
-23.25	12.49	120.0	1107.8	2452.6	3560.4	1025.5	0.0	0.0	2282.3	2282.3
-23.50	12.96	120.0	1128.5	2545.4	3673.9	1043.6	0.0	0.0	2355.1	2355.1
-23.75	13.41	120.0	1149.3	2633.6	3782.9	1061.7	0.0	0.0	2424.9	2424.9
-24.00	13.82	120.0	1170.0	2714.5	3884.5	1079.7	0.0	0.0	2490.1	2490.1
-24.25	14.21	120.0	1190.7	2789.4	3980.2	1097.7	0.0	0.0	2551.4	2551.4

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-24.50	14.93	120.0	1211.5	2930.8	4142.3	1115.7	0.0	0.0	2655.3	2655.3
-24.75	15.00	120.0	1232.4	2945.2	4177.7	1133.8	0.0	0.0	2678.0	2678.0
-25.00	15.00	120.0	1259.7	2945.2	4205.0	1157.4	0.0	0.0	2695.5	2695.5
-25.25	15.00	120.0	1285.8	2945.2	4231.0	1179.7	0.0	0.0	2536.6	2536.6
-25.50	15.00	120.0	1311.8	2945.2	4257.0	1202.1	0.0	0.0	2552.2	2552.2
-25.75	0.00	120.0	1337.8	0.0	1337.8	1224.3	0.0	0.0	802.0	802.0
-26.00	0.00	120.0	1370.5	0.0	1370.5	1252.3	0.0	0.0	821.7	821.7
-26.25	0.00	120.0	1410.6	0.0	1410.6	1286.5	0.0	0.0	845.7	845.7
-26.50	0.00	120.0	1452.8	0.0	1452.8	1322.5	0.0	0.0	871.0	871.0
-26.75	0.00	120.0	1495.5	0.0	1495.5	1358.8	0.0	0.0	896.6	896.6
-27.00	0.00	120.0	1537.3	0.0	1537.3	1394.3	0.0	0.0	921.7	921.7
-27.25	0.00	120.0	1577.8	0.0	1577.8	1428.5	0.0	0.0	945.9	945.9
-27.50	0.00	120.0	1617.4	0.0	1617.4	1462.1	0.0	0.0	969.7	969.7

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BIJLAGE

C Controle kopplaat en schachtspanning

Controleberekening schachtspanning

Werk:	Herman Gorterstraat 20
Plaats:	Amsterdam
Werknr.:	H221363
Datum:	23-06-223

buisprofiel klasse 1

γ_{M0} =	1,0				
Staal S	355				
f_y =	355	N/mm²			
E_s =	210.000	N/mm²			
			N_{ed} =	1.025	kN
ϕ_{casing} =	168,3	mm	V_{ed} =	0	kN
t =	10	mm	exc. =	50	mm
t_{corr} =	1,75	mm	M_{ed} =	51,25	kNm

$V_{pl,Rd} = A_v \times (f_y/\sqrt{3})/\gamma_{M0}$

$A_v = 2 \times A/\pi$

$q = 1{,}03 \times \sqrt{[1-(V_{ed}/V_{pl,Rd})^2]}$

$M_{V,Rd} = q \times M_{pl,Rd}/\gamma_{M0}$

$N_{V,Rd} = q \times N_{pl,Rd}/\gamma_{M0}$

toets: $M_{ed}/[1{,}04 \times M_{V,Rd}] + (N_{Ed}/N_{V,Rd})^{1,7}$

uit

$N_{Ed} = N_{ed;s} + N_{ed;b}$ $\quad \delta_s = \delta_b$

$V_{Ed} = V_{ed;s} + V_{ed;b}$ $\quad \delta_s = \delta_b$

$M_{Ed} = M_{ed;s} + M_{ed;b}$ $\quad \kappa_s = \kappa_b$

volgt

$N'_b = N'_{ed}/[1+(E_sA_s/E_bA_b)]$

$V'_b = V'_{ed}/[1+(E_sA_s/E_bA_b)]$

$M'_b = M'_{ed}/[1+(E_sI_s/E_bI_b)]$

$\phi_{casing,corr}$ =	164,8	mm	N'_b =	295,7	kN
ϕ_{inw} =	148,3	mm	N'_s =	729,3	kN
A_s =	4.057,5	mm²	A_b =	17.273,2	mm²
I_s =	12.464.575,3	mm^4	I_b =	23.742.940,4	mm^4
W_s =	151.269,1	mm^3	W_b =	320.201,5	mm^3
W_{pl} =	202.377,4	mm^3			
E_s =	210.000	N/mm²	$E_{b;\infty}$ =	20.000	N/mm²
$E_s \times I_s$ =	2,618E+12	Nmm²	$E_b \times I_b$ =	4,749E+11	Nmm²
$E_s \times A_s$ =	8,521E+08	N	$E_b \times A_b$ =	3,455E+08	N

$N_{pl,Rd}$ =	1.440,4	kN	$N_{pl,Rd} = A_s \times f_y$
$V_{pl,Rd}$ =	529,4	kN	$V_{pl,Rd} = A_v \times (f_y/\sqrt{3})/\gamma_{M0}$ met $A_v = 2 \times A_s/\pi$
$M_{pl,Rd}$ =	71,8	kNm	$M_{pl,Rd} = W_{pl} \times f_y$
q =	1,03	-	

$M_{ed}/[1{,}04 \times M_{V,Rd}]$ =	0,67	-	$M_{ed}/M_{V,Rd}$ =	0,71	<1 voldoet
$(N_s/N_{V,Rd})^{1,7}$ =	0,30	-			
	0,96	<1 voldoet	σ_b =	17,12	N/mm²

Op al onze werkzaamheden is de DNR 2011 van toepassing.

HEKTEC

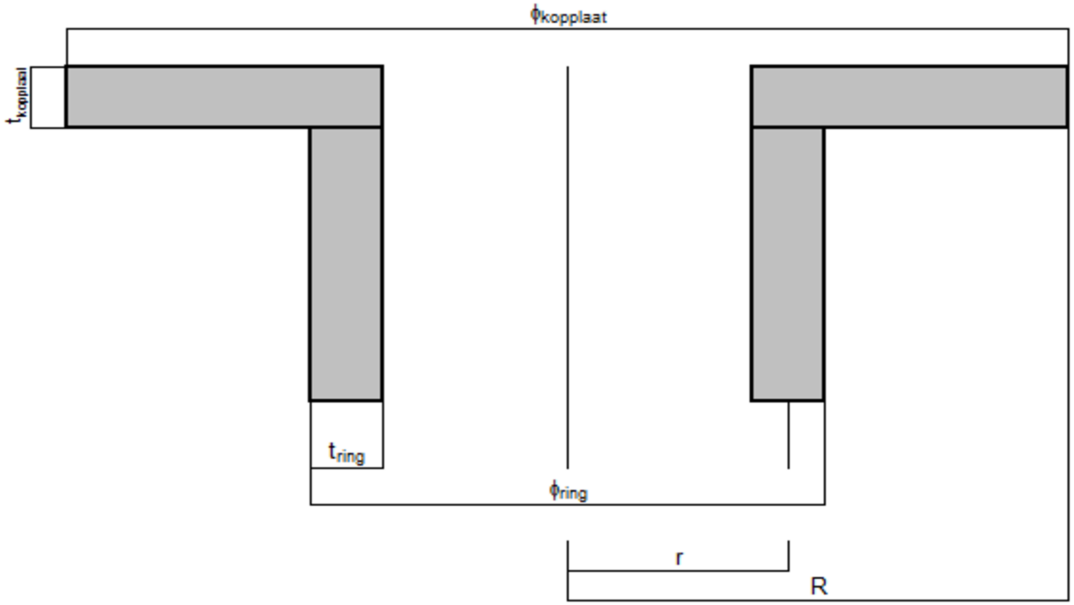
Berekening spanning in kopplaat

Werk:	Herman Gorterstraat 20
Plaats:	Amsterdam
Werknr.:	H221363
Datum:	23-06-223

Berekening gebaseerd op 5.1, 2, e e.a. - Theory of plates and shells.

$\sigma = k \times q \times R^2/t^2_{kopplaat}$

k= f(a/b)=f(R/r) tabel 3 pag. 62



kopplaat vierkant #

	$l_a = l_b$ =	280	mm
	$t_{kopplaat}$ =	50	mm
	ϕ_{casing} =	168,3	mm
	ϕ_{ring} =	210	mm
Paalbelasting	$F_{c;d}$ =	1.025,0	kN
Staalkwaliteit		S355	-

Afgeleide grootheden:

Kopplaat	ϕ_{equi} =	$\sqrt{(4 \times l_a^2/\pi)}$ =	315,9	mm
	R =	$\frac{1}{2} \times \phi_{equi}$ =	158,0	mm
	r=	$\frac{1}{4} \times (\phi_{casing} + \phi_{ring})$ =	94,6	mm
	$A_{kopplaat\#}$ =	$l_a \times l_b - \frac{1}{4} \times \pi \times \phi^2_{casing}$ =	56.153,7	mm²
	q =	$F_{c;d}/A_{kopplaat\#}$ =	18,25	N/mm²

Buigend moment.

Tabel 3, case: 2

a/b = R/r = 1,67

k = 1,48

					≤ f_y							
σ =	$k \times q \times R^2/t^2_{kopplaat}$ =	269,6	N/mm²	≤	335	N/mm²	voldoet	u.c. =	0,80	≤	1,00	**voldoet**

Lasberekening

f_u =	470	N/mm²		γ_{M2} =	1,25	-					
$a_{las;min}$ =	4,0	mm		β_w =	0,9	-					
$\sigma_1 = \tau_1$ =	$F_{s;d} \times \sqrt{2} / (4 \times a_{las} \times l_{eff})$										
$\sigma_1 = \tau_1$ =	171,4	N/mm²	≤ $0,9 \times f_u/\gamma_{M2}$ =		338,4	N/mm²	voldoet	u.c. =	0,51	≤	1,00	**voldoet**
$\sigma_{w;s;d}$ =	$\sqrt{[\sigma^2_1 + 3 \times \tau^2_1]}$ =										
$\sigma_{w;s;d}$ =	342,7	N/mm²	≤ $f_u/(\beta.\gamma_M)$ =		417,8	N/mm²	voldoet	u.c. =	0,82	≤	1,00	**voldoet**

Berekening sterkte trekring

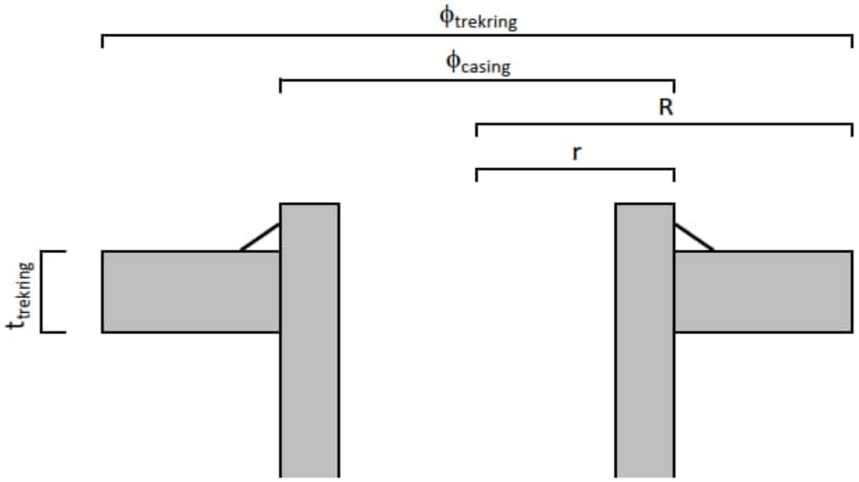
Werk:	Herman Gorterstraat 20
Plaats:	Amsterdam
Werknr.:	H221363
Datum:	23-06-223

Berekening gebaseerd op 5.1, 2, e e.a. - Theory of plates and shells.

σ = $k \times q \times R^2/t^2_{kopplaat}$

k = f(a/b)=f(R/r) tabel 3 pag. 62

$\phi_{trekring}$ =	240	mm	
$t_{trekring}$ =	25	mm	
ϕ_{casing} =	168,3	mm	
Paalbelasting $F_{t;d}$ =	295,0	kN	
Betonkwaliteit	C30/37	-	
Staalkwaliteit:	S355	-	



Afgeleide grootheden:

Kopplaat R =	$\frac{1}{2} \times \phi_{trekring}$ =	120,0	mm	
r =	$\frac{1}{2} \times \phi_{casing}$ =	84,2	mm	
$A_{trekring}$ =	$\frac{1}{4} \times \pi \times (\phi^2_{trekring} - \phi^2_{ring})$ =	22.992,6	mm²	
$\sigma_c = q$ =	$F_{t;d}/A_{trekring}$ =	12,83	N/mm²	

Buigend moment.

Tabel 3, case:	2						
a/b = R/r =	1,43						
k =	1,03				$\leq f_y$		
σ =	$k \times q \times R^2/t^2_{kopplaat}$ =	305,4	N/mm²	≤	355	N/mm²	**voldoet**
				uc	**0,86**		**voldoet**

Lasberekening

f_u =	490	N/mm²		γ_{M2} =	1,25	-	
$a_{las;min}$ =	4,0	mm		β_w =	0,9	-	
$\sigma_1 = \tau_1$ =	$F_{t;d} \times \sqrt{2} / (\frac{1}{2} \times 4 \times a_{las} \times l_{eff})$						
$\sigma_1 = \tau_1$ =	98,6	N/mm²	≤	$0,9 \times f_u/\gamma_{M2}$ =	352,8	N/mm²	**voldoet**
$\sigma_{w;s;d}$ =	$\sqrt{[\sigma^2_1 + 3 \times \tau^2_1]}$ =			**uc**	**0,45**		**voldoet**
$\sigma_{w;s;d}$ =	197,3	N/mm²	≤	$f_u/(\beta_w \cdot \gamma_M)$ =	435,6	N/mm²	**voldoet**

Controle betonspanning onder ring

Spanning onder ring	σ_c =	12,83	N/mm²

Toetsing conform NEN-EN-1-1+C2:23011/NB:2011

art. 10.9.4.3 (7): oplegdruk ≤ $0,7.f_{cd}$

f_{cd} =		20,00	N/mm²
$0,7.f_{cd}$ =		14,00	N/mm²
UC = $\sigma_c/0,7.f_{cd}$ =		0,9	≤ 1,0
		voldoet	

BIJLAGE

D Specificaties grout

Bruil Groutmortel
WP2

Bruil Groutmortel WP 2 is een fabrieksmatig vervaardigde cementgebonden droge mortel, geleverd op samenstelling.

Toepassing
Bruil Groutmortel WP 2 is geschikt voor het vullen van groutankers en funderingspalen

Producteigenschappen

Bindmiddel	Cement	(NEN-EN 197-1)
Vulstof	Kalksteenmeel	(NEN-EN 13139)
Toevoegingen	Hulpstoffen	(NEN-EN 934-3)
Maximale korrel	< 200 µm	
Waterbehoefte	49 %	
Volumieke massa (bij wb: 49%)	1790 ± 15 kg/m^3	
Verwerkingstijd	2 uur	
Buig-treksterkte (bij wb: 49%)	≥ 5,0 N/mm^2	
Druksterkte (bij wb: 49%)	≥ 35 N/mm^2	

Gebruiksaanwijzing
Zakgoed:
Doseer ca. 12 liter schoon leidingwater per zak van 25kg in een schone kuip of speciemolen. Voeg hier de benodigde hoeveelheid Bruil Groutmortel WP 2 aan toe. Meng machinaal tot een homogene plastische groutspecie ontstaat.
Silo:
Maak gebruik van schoon leidingwater en stel de waterbehoefte op de doorstroommenger zodanig in tot de gewenste verwerkbaarheid is verkregen.
Verwerk de groutspecie binnen 2 uur bij een omgevingstemperatuur van 5 tot 30 °C. Machines en gereedschap direct na gebruik reinigen met water.

Nabehandeling
Bescherm de aangebrachte groutspecie indien nodig tegen ongunstige weersinvloeden (regen, tocht, vorst en zon) en in het bijzonder bevriezing. Bijvoorbeeld door bovenkant te isoleren.

Verbruik
Het verbruik is sterk afhankelijk van de toepassing van het product.
Eén zak Bruil Groutmortel WP 2 mortel van 25kg levert ca. 20 liter groutspecie op.

De uitlevering in bulk per ton is afhankelijk van de waterdosering (zie tabel 1)

indicatief mengselvolume en volumieke massa specie bij verschillende waterbehoeftes

1 ton drogemortel (liter)	toevoeging water per ton mortel (liter)	lucht 1 % (liter)	totaal mengsel (liters)	wcf	Volumieke massa (kg/m^3)
345	300	6	651	0,38	1996
345	350	7	702	0,44	1923
345	400	7	752	0,50	1861
345	450	8	803	0,56	1806
345	500	8	853	0,63	1758
345	550	9	904	0,69	1715
345	600	9	954	0,75	1676

Ecologie/ toxicologie
Bij normaal gebruik levert het product geen gevaar op voor mens en milieu. De verpakking helemaal leegmaken, productresten laten drogen en/of verharden en als normaal bouwafval afvoeren.

Veiligheidsvoorschriften
Van alle Bruil beton & mix producten is een separaat veiligheidsinformatieblad beschikbaar. Neem deze informatie altijd van tevoren door. Niet in combinatie met andere middelen gebruiken tenzij nadrukkelijk vermeld in deze documentatie.

Leveringsvorm
Bruil Groutmortel WP 2 wordt geleverd in de volgende verpakkingseenheden:

Verpakking	Gewicht	Equipment
Zakgoed	25 kg	Nvt
Big bag	1000 kg	Nvt
Silo	Ca. 22.000 kg	D100b, SMP, D150 (nat) Schuine worm (droog)

Opslag en houdbaarheid
Bruil Groutmortel WP 2 droog en vorstvrij opslaan. In ongeopende verpakking minimaal 1 jaar na productiedatum houdbaar. (zie zijkant verpakking of afleverbon)

Overige informatie
De informatie berust op onze huidige kennis en ervaring en is van toepassing op het product zoals door ons geleverd. Bruil beton & mix verstrekt deze informatie zonder waarborg en aanvaardt geen enkele aansprakelijkheid voor schade welke zou kunnen ontstaan uit het gebruik van deze informatie. Dit product is speciaal bedoeld voor de professionele verwerker

Keurmerken
Bruil Groutmortel WP 2 wordt geleverd onder het KOMO certificaat conform BRL 1904 en is gecertificeerd conform Besluit Bodem Kwaliteit.

734-jj-f

734-jj-BBK
vormgegeven bouwstof

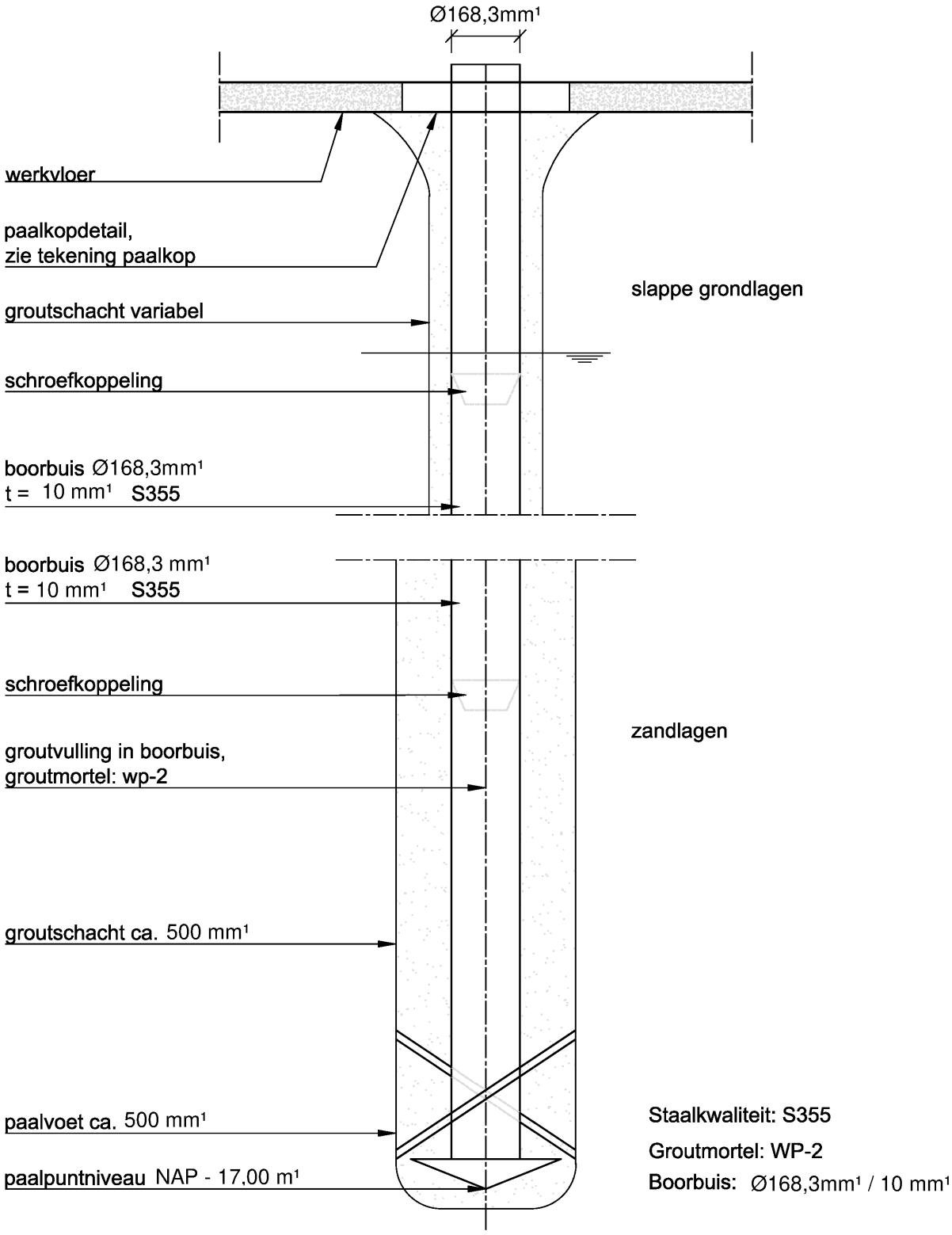
Vragen en advies
Voor vragen of deskundig advies met betrekking tot de verwerking van Bruil Groutmortel WP 2 kunt u contact opnemen met onze technisch adviseurs. Voor overige informatie verwijzen wij u graag naar onze website.

Bruil beton & mix
Galvanistraat 8
Postbus 19
NL-6710 BA Ede
www.bruil.nl

Waalpaal

BIJLAGE

E Paaltekening



Datum: 23-06-2023 Opdrachtgever: RSW Bouw

Hektec BV
Postbus 88
1462 ZH Middenbeemster

tel 0299 420808
fax 0299 313025
e-mail: info@hektec.nl

Project: Amsterdam - Woning Herman Gorterstraat 20

PAALTEKENING

Waal-Compact-Paal Ø168,3mm¹ / 10 mm¹

Schaal: -
Formaat: A4
Projectnr.: H22.1263

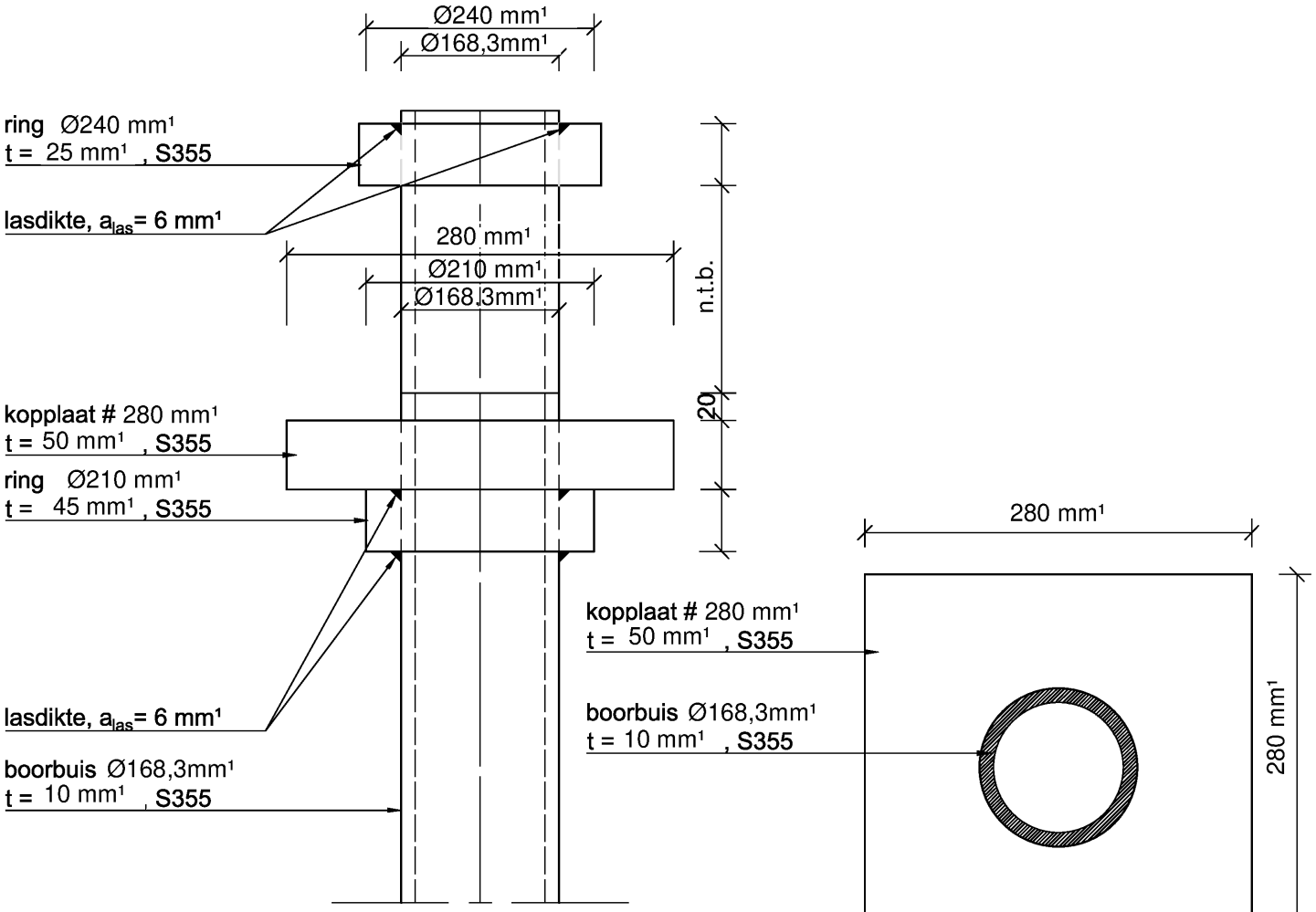
5.1, 2, e

Verificatie:

5.1, 2, e

Volgnr.: 1.1

ENGINEERING EN MONITORING VOOR
GWW EN GEOTECHNIEK



Datum: 23-06-2023 Opdrachtgever: RSW Bouw

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Project: Amsterdam - Woning Herman Gorterstraat 20

KOPDETAIL

Waal-Compact-Paal Ø168,3mm¹ / 10 mm¹

Schaal: -

Formaat: A4

Projectnr.: H22.1263

Volgnr.: 1.2

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