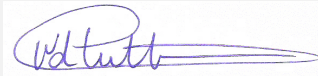


DO Funderingsadvies Veldschanstunnel

RIJNLANDROUTE N206 EUROPAWEG



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Projectomschrijving	Rijnlandroute N206 Europaweg		
Opdrachtgever	Provincie Zuid-Holland		
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Opsteller	Roel van der Putten		2025-09-11
Gecontroleerd	Ruud Steenbrink		2025-09-11
Vrijgegeven	Roy Gerritzen		2025-09-11

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Aan	Van
Giulio van den Brink, Rik Cederhout, Roy Gerritzen	Roel van der Putten
Kopie	
Ruud Steenbrink	
MEMO	
DO Funderingsadvies Veldschanstunnel	

INLEIDING

In dit schrijven wordt het funderingsadvies verstrekt voor de Veldschanstunnel. In dit funderingsadvies worden, aan de hand van de in de DO-fase berekende paalbelastingen in combinatie met het gekozen paaltype, het onderstaande bepaald:

- Paalpuntniveau en bijbehorend paal draagvermogen
- Paalpuntveerstijfheid
- Bedding tegen paalschacht en maximale passieve gronddruk, inclusief groepseffect

De bedding tegen de paalschacht en de maximale passieve gronddruk is bepaald met de theorie van respectievelijk Ménard en Brinch-Hansen.

Bij het opstellen van deze memo is gebruik gemaakt van de volgende documenten en tekeningen:

- 39055-BER-00597 DO Berekening Veldschanstunnel
- 39055-TEK-00594 DO Tekening Veldschanstunnel
- 39055-RAP-00781 DO Grondinterpretatierapport
- 39055-RAP-00626 DO Ontwerpbasis Geotechniek

Het funderingsadvies is opgesteld conform NEN9997-1: 2017. Middels VTW-0070 is de in juni 2025 verschenen NEN9997-1:2025 van toepassing verklaard voor de definitieve constructies. De gewijzigde norm heeft met name impact op het paal draagvermogen van geboorde paalsystemen zoals schroefinjectiepalen (bijvoorbeeld Fundex-GI en Tubex-GI) en mortelschroefpalen.

De belangrijkste consequentie van de gewijzigde norm is dat langere palen moeten worden toegepast. Dit zal worden verwerkt in de DO-fase v2.0.

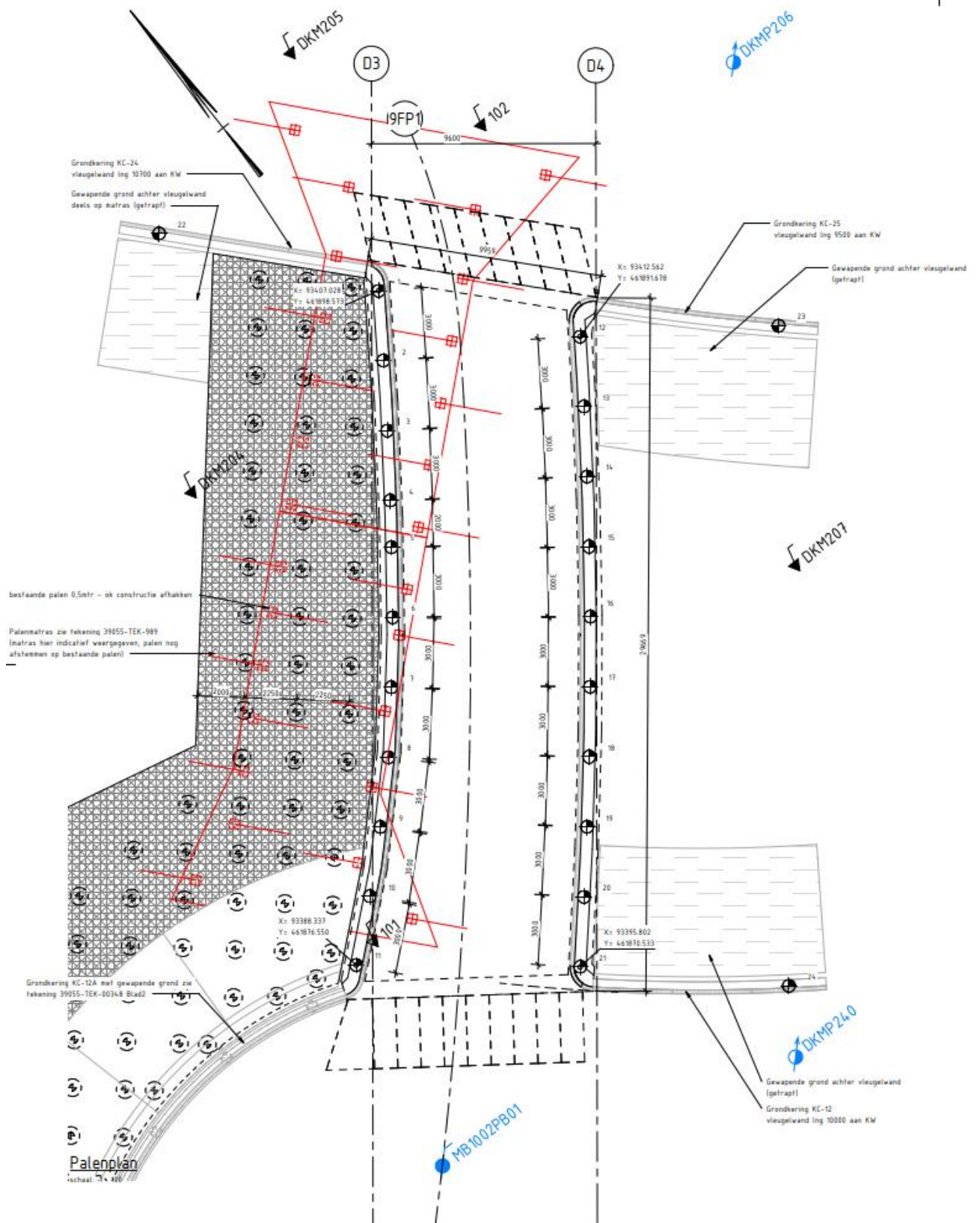
UITGANGSPUNTEN

Palenplan en uitgevoerd grondonderzoek

De Veldschanstunnel wordt als gesloten doorsnede, dus met vloer ontworpen. De Veldschanstunnel wordt iets ten oosten van de bestaande tunnel gebouwd in een open bouwkuip. Na sloop van de bestaande tunnel, waarbij de palen in de grond achterblijven, wordt direct de nieuwe tunnel gebouwd.

De Gemeente heeft aangegeven dat de bestaande tunnel zolang mogelijk beschikbaar moet blijven voor langzaam verkeer. Hierdoor is geen tijd beschikbaar om het “gat” van de oude tunnel voor te belasten zodanig dat aan de restzettingseisen wordt voldaan. Een zettingsvrije oplossing in de vorm van een paalmatras zal worden toegepast. Het paalmatras wordt in het DO v2.0 in een separate nota uitgewerkt (39055-MEM-00978).

In onderstaande figuur is het palenplan alsmede de beschikbare sonderingen weergegeven (zie ook bijlage 1 voor een situatietekening met de sondeerlocaties). De paalposities voor het paalmatras zijn indicatief weergegeven. Het uitgevoerde grondonderzoek voldoet qua diepte en intensiteit aan de NEN9997-1.



Figuur 1: Palenplan Veldschanstunnel (paaltipe Fundex-GI 540/660); paalposities paalmatras indicatief

Ter plaatse van de Veldschanstunnel zijn de volgende sonderingen beschikbaar:

- 101
- 102
- DKM204
- DKM205
- DKMP206
- DKM207
- DKMP240

Tevens is boring MB1002 aan de zuidzijde van de tunnel uitgevoerd. De sondeergrafieken en boorstaat zijn opgenomen in bijlage 1. Het maaiveldniveau ter plaatse van de sonderingen varieert van NAP +0,35 m (uitgevoerd in de “berenkuil”) tot NAP +3,29 m (uitgevoerd vanaf de N206). De sondeerdiepte reikt tot NAP -24,9 à -29,5 m.

Paalsysteem en optredende paalbelastingen

Voor de fundering van de Veldschanstunnel moet uit worden gegaan van een trillingsarm paalsysteem. Omdat de ondergrond nauwelijks slappe lagen bevat is er geen risico op insnoering van de paalschacht. Derhalve kan uit worden gegaan van een paalsysteem, waarbij de casing weer wordt getrokken.

Als paalsysteem wordt uitgegaan van Fundex-GI palen 540/660 mm. Deze palen worden door diverse partijen onder eigen merknamen gemaakt, met kleine verschillen in diameter van de casing en of de schroefpunt.

De volgende paalbelastingen treden op ter plaatse van de tunnel:

- UGT: maximum 2041 kN
- BGT: maximum 1545 kN
- Permanent: maximum 1060 kN

Onder de vleugelwanden wordt één paal toegepast met de volgende belastingen:

- UGT: maximum 691 kN
- BGT: maximum 592 kN

Voor het bepalen van het draagvermogen geldt voor Fundex-GI palen (of gelijkwaardig):

- schachtdiameter = schroefpunt diameter
- $\alpha_s = 0,009$ (paalklasse factoren schacht: druk in zandlagen) #
- $\alpha_p = 0,63$ (paalklassefactor punt) #
- $\beta = s = 1,0$ (paalvoetvormfactoren)
- $\gamma_t = 1,2$ (partiële weerstandsfactor op druk belaste palen)
- $\xi_3 = 1,17$ en $\xi_4 = 0,93$ (stijf bouwwerk, 6 sonderingen)
- Last-zakkingslijn: 1

Op basis van NEN9997-1:2017. In het DO v2.0 wordt dit herzien op basis van de recent verschenen NEN9997-1:2025

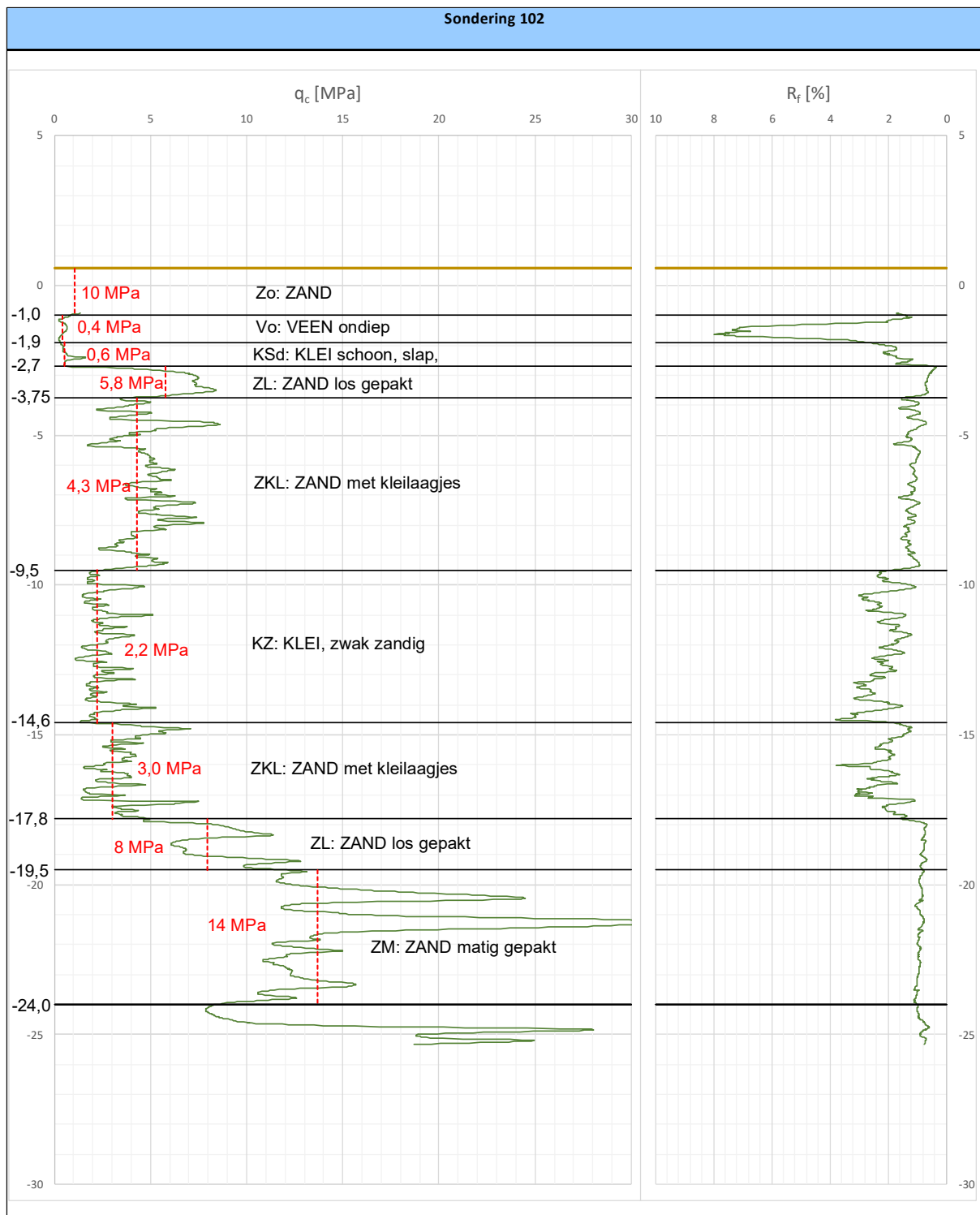
Bodemopbouw

Sondering DKM102 geeft een representatief beeld van de ondergrond ter plaatse van de Veldschanstunnel. In figuur 2 is deze sondering inclusief interpretatie van de bodemopbouw opgenomen. De laagbeschrijving (inclusief afkorting) is conform het “DO Grondinterpretatierapport”.

Uit de sonderingen uitgevoerd vanaf de N206 blijkt dat het ophoogzand een vaste tot zeer vaste pakking heeft. In het ontwerp wordt uitgegaan van een conservatieve waarde van 10 MPa. De conusweerstand in de “Berenkuil” laten lagere conusweerstand zien, maar dit betreft dus niet de N206.

De grondlaag tussen NAP -1,0 en -1,9 m laat een hoog wrijvingsgetal zien en is in de sondering geclassificeerd als veen. In het verleden was echter sprake van een polder met een maaiveldniveau van circa NAP -1,0 m en een polderpeil van NAP -2,0 m. Het is dus zeer goed mogelijk dat het hier een uitgedroogde kleilaag betreft.

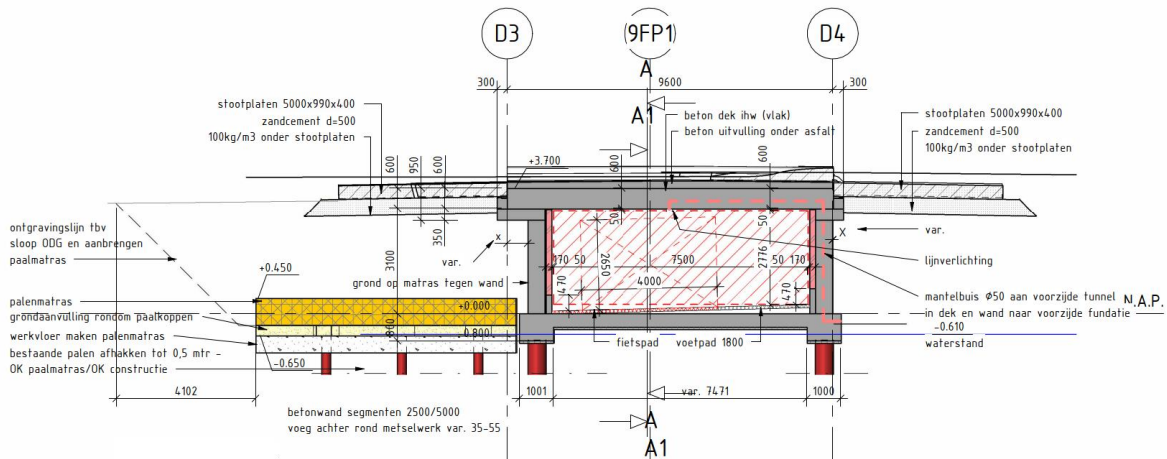
Ten behoeve van ontgravingseffect en berekening negatieve kleef is uitgegaan van een GLG (Gemiddeld Lage Grondwaterstand) van NAP -0,61m (zomerpeil) ter plaatse van de tunnel. Ter plaatse van de tunnel wordt een drainage voorzien om opbolling van het grondwater te voorkomen en bovengenoemd peil te garanderen zodat aan de droogleggingseis kan worden voldaan.



Figuur 2: Beschrijving bodemopbouw ter plaatse van Veldschanstunnel

FUNDERINGSADVIES

Uitgangspunten



Figuur 3: Dwarsdoorsnede Veldschanstunnel

Uitgangspunten funderingsontwerp:

- Maaiveldniveau aan binnenzijde tunnel (ontgravingsniveau): circa NAP -0,50m.
- Gemiddeld maaiveldniveau aan buitenzijde tunnel: circa NAP +4,0 m (incl. verharding en uitvullaag). Dit maaiveldniveau ligt circa 0,7 m hoger dan het bestaande maaiveld.
- Een ontgraving tot NAP -0,50 m is in rekening gebracht met de methode Begeman, waarbij rekening wordt gehouden met de beperkte breedte van de ontgraving.
- Negatieve kleef: Ter plaatse van de bestaande tunnel wordt een palenmatras toegepast. Door het doorhangen van het geotextiel zullen enige zettingen optreden in de bovenste slappe lagen. Aan de oostzijde komt het maaiveld circa 0,70 m hoger te liggen en is eveneens sprake van enige zettingen in de bovenste slappe lagen (tot circa NAP -3,0 m). Hieronder is sprake van een zandige en stijve ondergrond en in combinatie met de ontgraving voor de nieuwe tunnel zal hier geen zetting optreden.
- Landhoofden: Voor permanente belastingen is positieve kleef is in rekening gebracht vanaf de Pleistocene zandlaag die aanvangt op een niveau variërend van NAP -12,8 m tot NAP -18,4 m. Bij kortdurende belastingen zal ook positieve kleef worden ontleend aan de relatief stijve wadzandlagen* vanaf NAP -2,6 à -3,2 m.
- Vleugelwanden: De paalbelasting is relatief beperkt. Voorkomen moet worden dat de paal zich zeer stijf bedraagt (lage U.C. draagvermogen) en daardoor veel belasting naar zich toetrekt. Dit kan leiden tot hoge trekspanningen onderin de vleugelwand ter hoogte van de betonvloer. Derhalve wordt geadviseerd om korte palen in de zandlaag omstreeks NAP -6 à -8 m toe te passen.
- Enkele rij palen h.o.h. circa 3,00 m onder tunnelwanden

* Hierbij is ook in de klei- en leemlagen gerekend met een $\alpha_s = 0,009$, in plaats van 0,020 tot 0,030 (tabel 7.d van NEN9997-1) omdat een grotere verplaatsing benodigd is om deze wrijving volledig te mobiliseren.

Paalpuntniveau, paal draagvermogen en paalpuntveerstijfheid

Voor de Veldschanstunnel zijn in totaal 7 sonderingen beschouwd. Er is relatief veel variatie in paal draagvermogen aanwezig, mede doordat er een behoorlijk verschil aanwezig is in het niveau bovenkant Pleistocene zandlaag plus verschillen in vastheid van het Pleistocene zandpakket.

Landhoofden

In onderstaande tabel is de rekenwaarde van het paal draagvermogen voor verschillende paalpuntniveau's opgenomen, waarbij onderscheid is gemaakt tussen het draagvermogen bij permanente belastingen (draagvermogen volledig ontleend aan Pleistocene zandlaag) en kortdurende belastingen (draagvermogen ontleend aan Wadzand plus Pleistocene zandlaag).

Bij kortdurende belastingen is de variatie in het paal draagvermogen beduidend kleiner, maar de variatiecoëfficiënt is nog steeds groter dan 12%.

Tabel 1: Paalpuntniveau en bijbehorende rekenwaarde van de netto paal draagkracht ($R_{c,net,d}$) voor de landhoofden

Paalpuntniveau [NAP ... m]	BIJ PERMANENTE BELASTING	BIJ KORTDURENDE BELASTING
	$R_{c,net,perm,d}$ [kN]	$R_{c,net,kort,d}$ [kN]
	$\varnothing_{schacht} / \varnothing_{punt}$ Fundex-GI 540/660 mm	$\varnothing_{schacht} / \varnothing_{punt}$ Fundex-GI 540/660 mm
-18,5	601	1486
-19,0	646	1531
-19,5	1065	1998
-20,0	1131	2028
-20,5	1326	2137
-21,0	1439	2249
-21,5	1440	2251
-22,0	1329	2139

Geadviseerd wordt om voor beide landhoofden van hetzelfde paalpuntniveau uit te gaan. Op basis van de paalbelastingen, zoals opgegeven in **Fout! Verwijzingsbron niet gevonden.**, wordt een paalpuntniveau van NAP -21,0 m geadviseerd.

Permanente belasting (karakteristiek): $F_{perm,k} = 1060$ kN

Rekenwaarde permanente belasting: $F_{perm,d} = 1060 \times 1,25 = 1325$ kN

Toetsing: $F_{perm,d} \leq R_{c,net,perm,d} \rightarrow 1325 \text{ kN} \leq 1439 \text{ kN} \rightarrow \text{Voldoet: U.C.} = 0,92$.

Paalbelasting UGT: $F_{s,d} = 2041$ kN

Toetsing: $F_{s,d} \leq R_{c,net,perm,d} \rightarrow 2041 \text{ kN} \leq 2249 \text{ kN} \rightarrow \text{Voldoet: U.C.} = 0,91$.

De draagkrachtberekeningen zijn uitgevoerd met D-Foundations. Voor de berekeningsrapporten wordt verwezen naar bijlage 2. In deze bijlage zijn ook de statistische analyses opgenomen.

Voor het paalpuntniveau van NAP -21,0 m is de karakteristieke waarde voor de paalpuntveerstijfheid ($k_{v,b,k}$) voor een op druk belaste paal onder het landhoofd bepaald. Hierbij zijn de volgende uitgangspunten gehanteerd:

- Zakking paalpunt (s_b) berekend uitgaande van de BGT belasting ($F_{s,k}$), inclusief negatieve kleeft (kortdurende belasting; eindsituatie)
- Paalpuntveerstijfheid ($k_{v,b,k}$) = $F_{s,k} / s_b$
- $F_{s,k} = 1.545$ kN
- $E_{beton} = 20.000$ N/mm²

Tabel 2: Paalpuntveerstijfheid landhoofden

VELDSCHANSTUNNEL LANDHOOFDEN; PAALPUNTNIVEAU NAP -21,0 M							
$\varnothing_{\text{paalpunt}}$ [mm]	$R_{b;\text{cal}}$ [kN]	$R_{s;\text{cal}}$ [kN]	$R_{c;\text{net;d}}$ [kN]	$F_{s;k}$ [kN]	$F_{nk;k}$ [kN]	S_b [mm]	$k_{v;b;k}$ [MN/m]
660 mm	1258	1919	2249	1545	53	3,6	425

Voor de paalpuntveerstijfheid van de funderingspalen onder de landhoofden worden de volgende rekenwaarden geadviseerd:

- Ondergrens: $425 / \sqrt{2} = 300 \text{ MN/m}^1$
- Bovengrens: $425 \times \sqrt{2} = 600 \text{ MN/m}^1$

Vleugelwanden

In onderstaande tabel is de rekenwaarde van het paal draagvermogen voor verschillende paalpuntniveau's opgenomen voor de palen onder de vleugelwanden.

Bij kortdurende belastingen is de variatie in het paal draagvermogen beduidend kleiner, maar de variatiecoëfficiënt is nog steeds groter dan 12%, met uitzondering van het paalpuntniveau van NAP -7,0 m.

Tabel 3: Paalpuntniveau en bijbehorende rekenwaarde van de netto paal draagkracht ($R_{c;\text{net;d}}$) voor de vleugelwanden

VLEUGELWANDEN	
Paalpuntniveau [NAP ... m]	$R_{c;\text{net;d}}$ [kN] $\varnothing_{\text{schacht}} / \varnothing_{\text{punt}}$ Fundex-GI 540/660 mm
-5,0	413
-5,5	505
-6,0	489
-6,5	534
-7,0	693

Voor de relatief licht belaste vleugelwanden wordt een paalpuntniveau van NAP -7,0 m geadviseerd:

Paalbelasting UGT: $F_{s;d} = 691 \text{ kN}$

Toetsing: $F_{s;d} \leq R_{c;\text{net;perm;d}} \rightarrow 691 \text{ kN} \leq 693 \text{ kN} \rightarrow \text{Voldoet: U.C.} = 1,00.$

De draagkrachtberekening is uitgevoerd met D-Foundations. Voor het berekeningsrapport wordt verwezen naar bijlage 3. In deze bijlage is ook de statistische analyse opgenomen.

Voor de bepaling van paalpuntveerstijfheid ($k_{v;b;k}$) voor de palen onder de vleugelwanden zijn volgende uitgangspunten gehanteerd:

- Zakking paalpunt (s_b) berekend uitgaande van de BGT belasting ($F_{s;k}$), inclusief negatieve kleeft (kortdurende belasting; eindsituatie)
- Paalpuntveerstijfheid ($k_{v;b;k}$) = $F_{s;k} / s_b$
- $F_{s;k} = 592 \text{ kN}$
- $E_{\text{beton}} = 20.000 \text{ N/mm}^2$

Tabel 4: Paalpunteerstijfheid vleugelwanden

VELDSCHANSTUNNEL VLEUGELWANDEN; PAALPUNTNIVEAU NAP -7,0 M							
Ø paalpunt [mm]	R _{b;cal} [kN]	R _{s;cal} [kN]	R _{c;net;d} [kN]	F _{s;k} [kN]	F _{nk;k} [kN]	S _b [mm]	k _{v;b;k} [MN/m]
660 mm	569	454	693	592	57	6,2	95

Voor de paalpunteerstijfheid voor de volgende rekenwaarden geadviseerd:

- Ondergrens: $95 / \sqrt{2} = 70 \text{ MN/m}^1$
- Bovengrens: $95 \times \sqrt{2} = 135 \text{ MN/m}^1$

Bedding en maximale passieve gronddruk tegen paalschacht

Sondering 102 geeft een representatief beeld van de ondergrond ter plaatse van de Veldschanstunnel.

Voor een paal met een uitwendige diameter van 660 mm is de bedding en de maximale passieve gronddruk tegen de paalschacht bepaald. De palen staan h.o.h. 3,00 m. Volgens de theorie van Reese en Van Impe dient een reductiefactor (e) te worden toegepast van:

$$\varnothing 660 \text{ mm: } e = 0,64(s/b)^{0,34} = 0,64(3,00/0,66)^{0,34} = 1,07 \text{ (geen reductie).}$$

Uit bovenstaande resultaten blijkt dat bij een h.o.h.-afstand van 3,00 m geen reductie in rekening hoeft te worden gebracht. De resultaten zijn in tabel 5 samengevat weergegeven. Het maaiveldniveau heeft invloed op de maximaal te mobiliseren gronddruk. Gerekend is met een maaiveldniveau gelijk aan het niveau onderkant stootplaat (NAP +3,20 m). Onderkant funderingsbalk bevindt zich hierbij op NAP -0,80 m.

Voor de berekening zie bijlage 4. Ter bepaling van de rekenwaarde zijn de volgende materiaalfactoren gehanteerd:

- Bedding, k_h : 1,30 (conform tabel A.4c NEN9997-1)
- Passieve gronddruk, $\tan\phi$: 1,15 (conform tabel A.4a NEN9997-1)
- Passieve gronddruk, c: 1,60 (conform tabel A.4a NEN9997-1)

Tabel 5: Bedding (k_h) en maximale passieve gronddruk (σ_p) tegen paalschacht voor Fundex-GI 540/660 mm

Fundex-GI 540/660		karakteristiek		rekenwaarde ondergrens		rekenwaarde bovengrens	
bk. laag [mNAP]	ok. laag [mNAP]	$k_{h;k}$ [kN/m ³]	$\sigma_{p;k}$ [kN/m ²]	$k_{h;laag;d}$ [kN/m ³]	$\sigma_{p;laag;d}$ [kN/m ²]	$k_{h;hoog;d}$ [kN/m ³]	$\sigma_{p;hoog;d}$ [kN/m ²]
-0,80	-1,00	29.000	216	22.250	144	37.750	362
-1,00	-1,90	2.300	120	1.800	85	3.000	183
-1,90	-2,70	3.300	115	2.500	86	4.300	159
-2,70	-3,75	16.750	257	13.000	184	22.000	379
-3,75	-9,50	14.250	739	11.000	496	18.750	1191
-9,50	-14,60	12.000	1268	9.300	830	15.750	2169
-14,60	-17,80	10.000	2312	7.700	1473	13.000	4056
-17,80	-19,50	23.250	2139	18.000	1417	30.250	3581
-19,50	-21,00	40.750	3110	31.250	1941	53.000	5634

Deze beddingen mogen voor zowel de palen onder de landhoofden als voor de vleugelwanden worden toegepast.

De tunnel wordt omgeven door goed verdicht zand. In principe kan in het constructief model ook een bedding tegen de tunnelwand worden toegepast voor de opname van onder andere de remkrachten. In het constructief ontwerp is er echter voor gekozen om geen bedding tegen de tunnelwanden toe te passen en de horizontale weerstand aan enkel de funderingspalen te ontleen.

UITVOERING

Op basis van het beschikbare grondonderzoek wordt het risico op insnoeren van de paalschacht zeer klein geacht en daarmee worden Fundex-GI palen geschikt geacht.

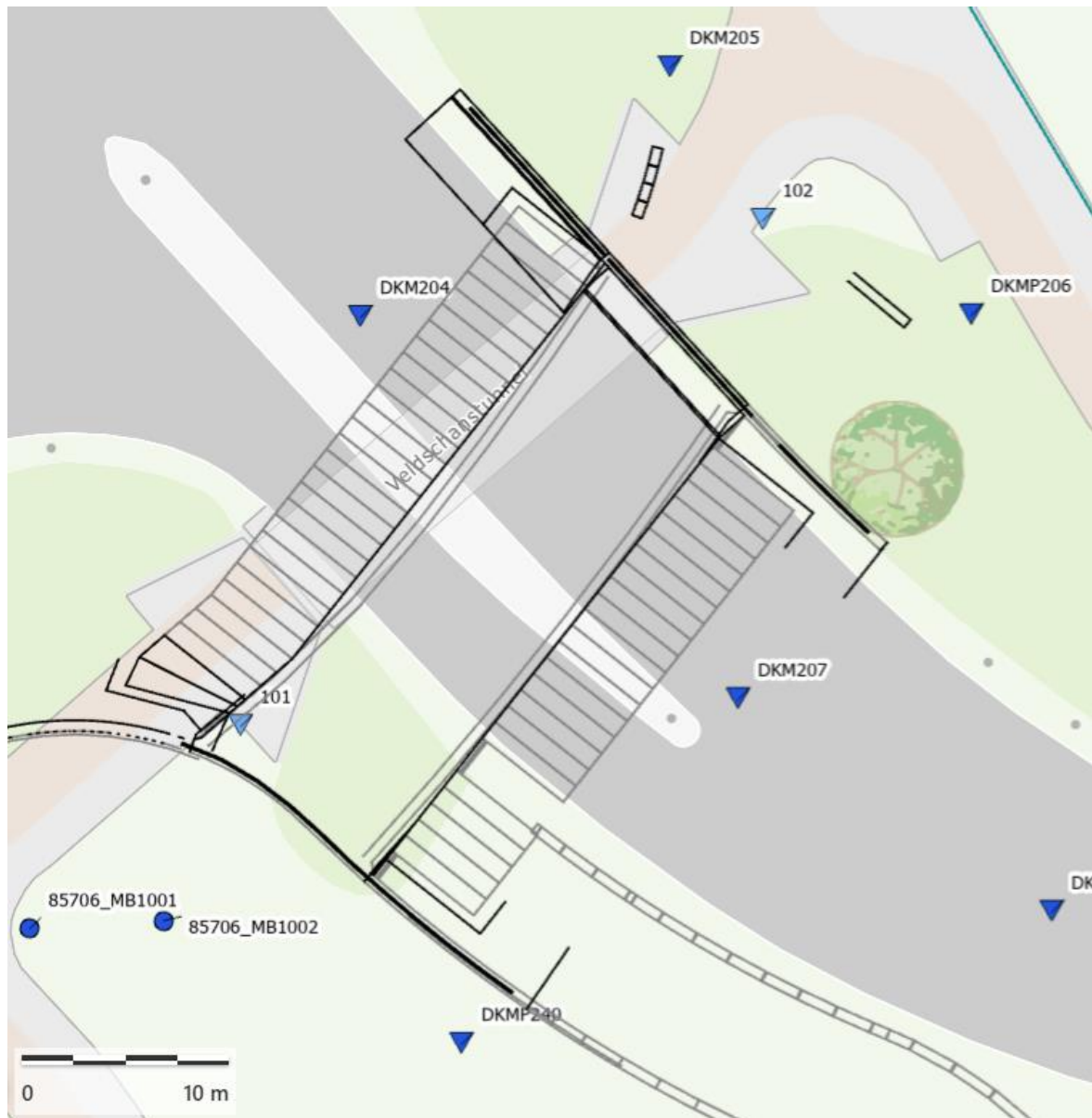
Om de palen direct na elkaar te kunnen maken moet de afstand ten minste $3x D_{eq}$, ofwel $3 \times 0,66 = 1,98$ m. Aan deze randvoorwaarde wordt voldaan.

RESTPUNTEN VERVOLGFASE

In het DO v2.0 dient het paal draagvermogen te worden bepaald conform de NEN9997-1:2025. Dit heeft tot gevolg dat langere palen moeten worden toegepast. Sonderingen 101 en DKM204 zijn vervolgens te kort om het paal draagvermogen te kunnen bepalen. Deze sonderingen moeten dan ook opnieuw, maar tot grotere diepte (tot 35 m minus maaiveld) worden uitgevoerd.

Daarnaast dient in het v2.0 het paalmatras aan de westzijde van de Veldschanstunnel te worden uitgewerkt, waarbij tevens moet worden gecontroleerd of dit nog impact heeft op de (funderingspalen) van de Veldschanstunnel. Naar verwachting is een eventuele impact gering en zal dit niet leiden tot een grotere paaldiameter, meer palen of een ander paaltype.

BIJLAGE 1: GRONDONDERZOEK

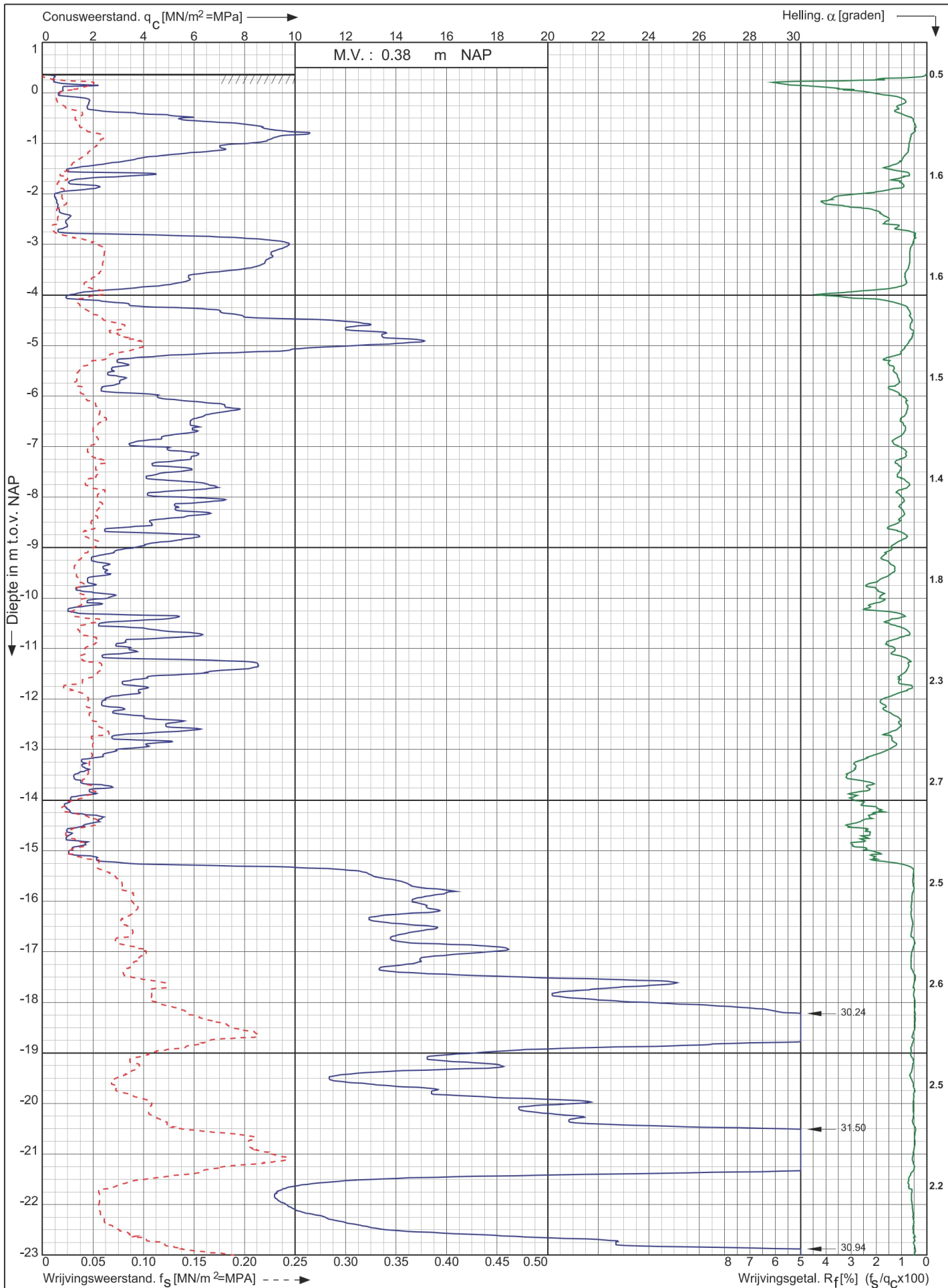


Figuur 4: Uitgevoerd grondonderzoek

Conusserienummer: S20310

Conustype: cilindrisch elektrisch S15CFII

Sondering volgens norm NEN-EN-ISO 22476-1 klasse 3



Aanvullend onderzoek N206 Rijnlandroute te
Leiden

RD-coördinaten : X = 93371.30 Y = 461874.88

Opdr. nr. : 2021-1555

Datum uity. : 11-10-2021

Sond. nr. : 103

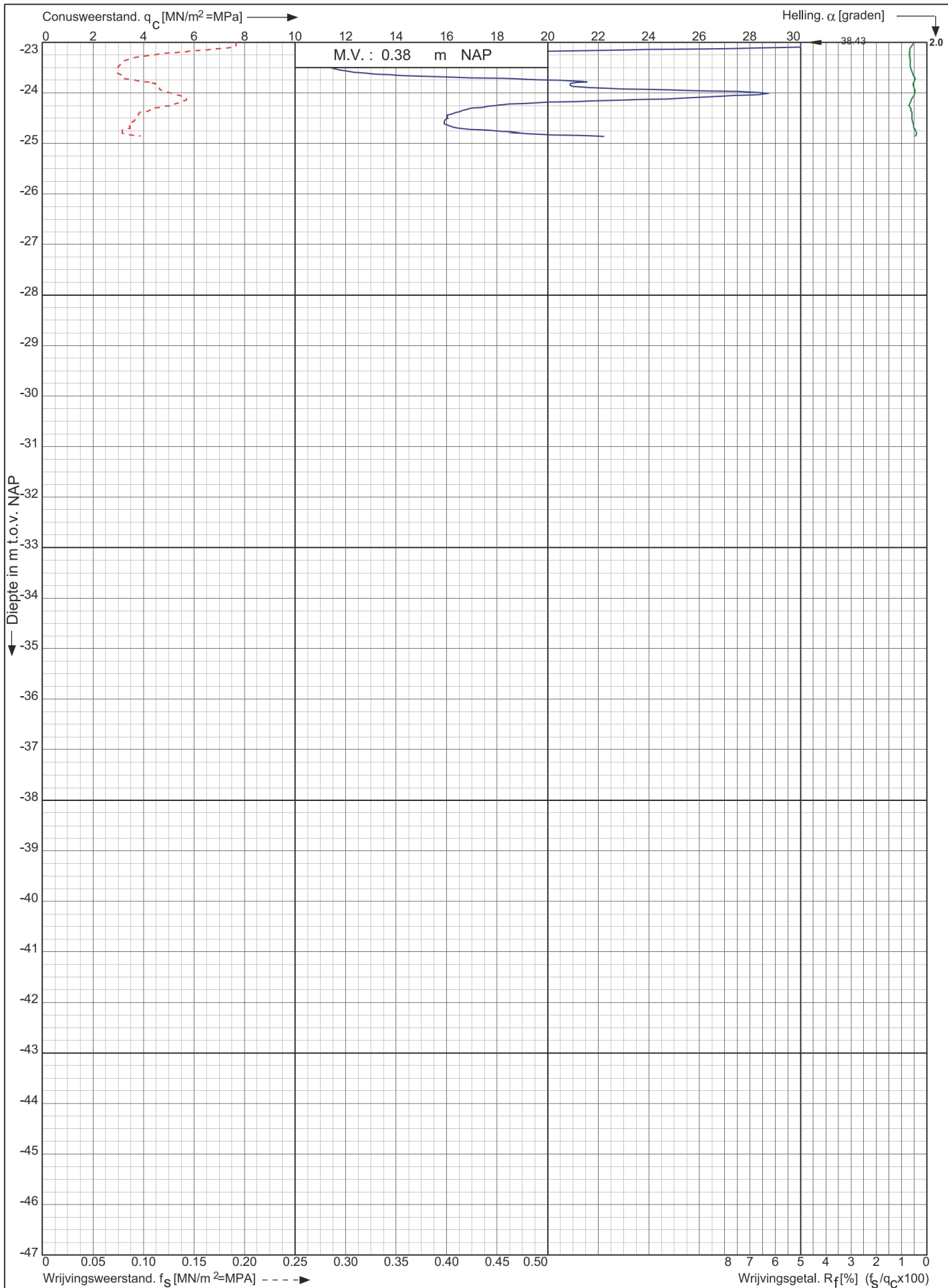


0522 - 260 084

Conusserienummer: S20310

Conustype: cilindrisch elektrisch S15CFII

Sondering volgens norm NEN-EN-ISO 22476-1 klasse 3



Aanvullend onderzoek N206 Rijnlandroute te
Leiden

RD-coördinaten : X = 93371.30 Y = 461874.88

Opdr. nr. : 2021-1555

Datum uitv. : 11-10-2021

Sond. nr. : 103

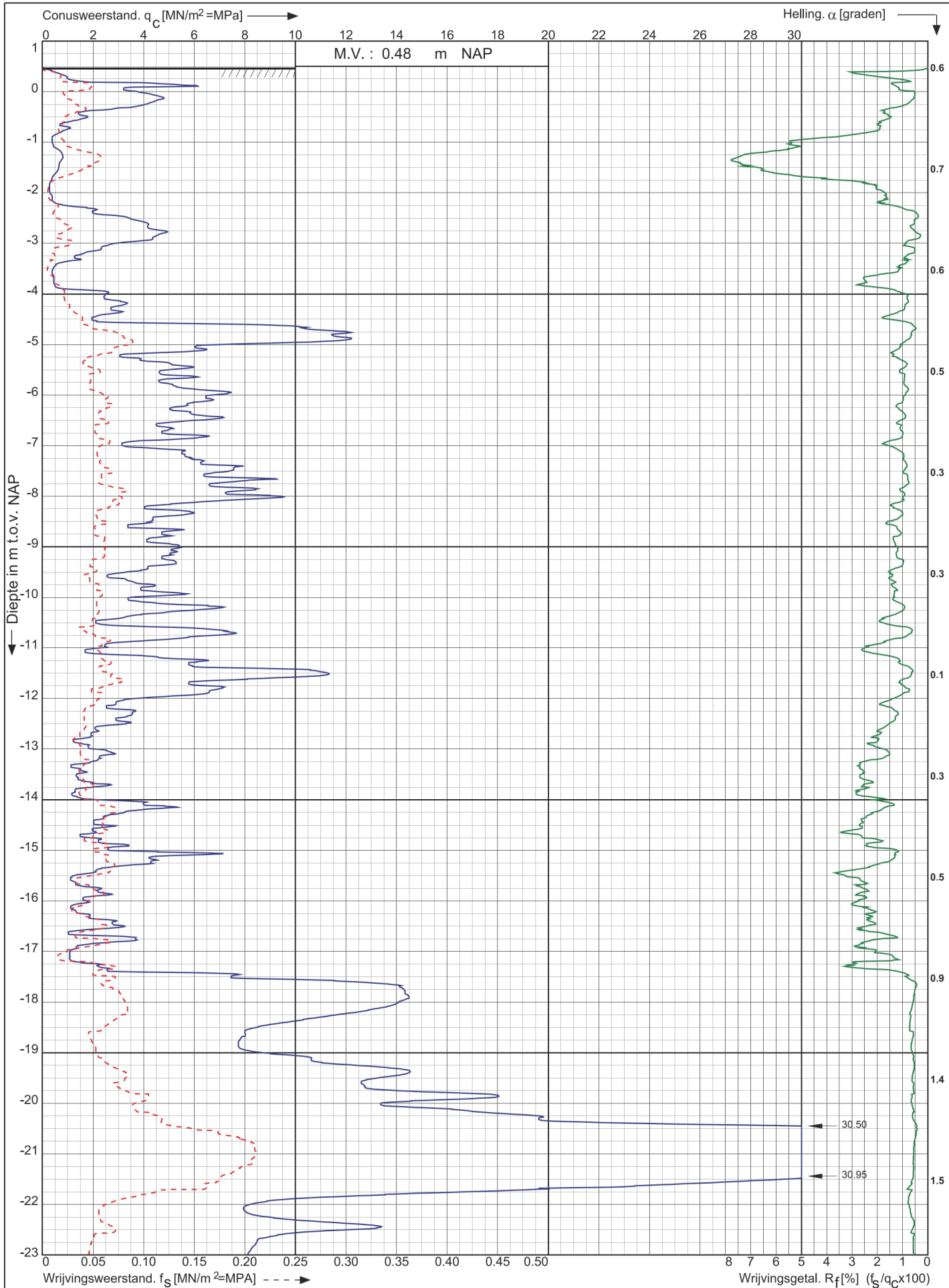


0522 - 260 084

Conusserienummer: S20310

Conustype: cilindrisch elektrisch S15CFII

Sondering volgens norm NEN-EN-ISO 22476-1 klasse 3



Aanvullend onderzoek N206 Rijnlandroute te
Leiden

RD-coördinaten : X = 93332.97 Y = 461899.72

Opdr. nr. : 2021-1555

Datum uity. : 11-10-2021

Sond. nr. : 104

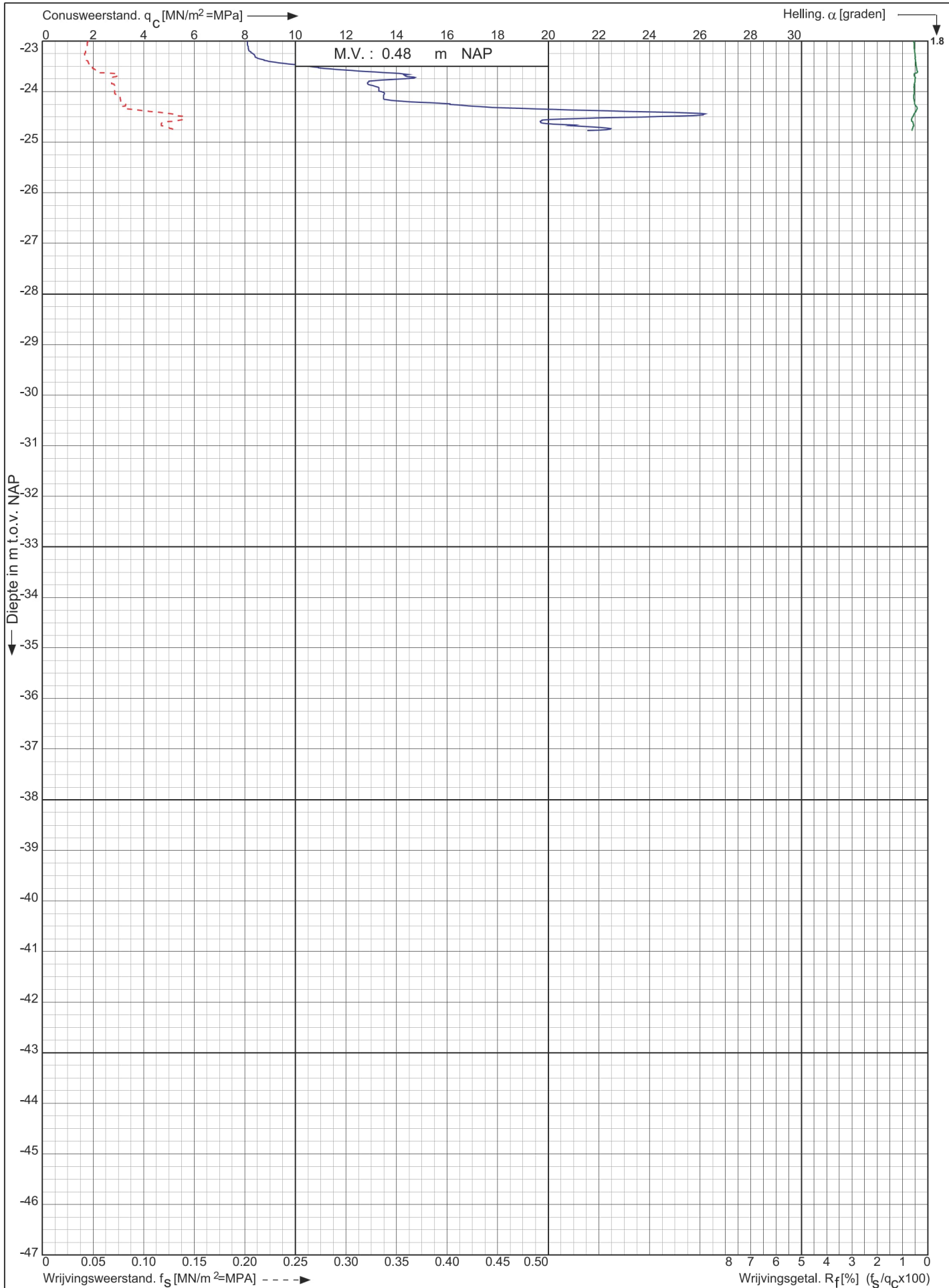


0522 - 260 084

Conusserienummer: S20310

Conustype: cilindrisch elektrisch S15CFII

Sondering volgens norm NEN-EN-ISO 22476-1 klasse 3



Aanvullend onderzoek N206 Rijnlandroute te
Leiden

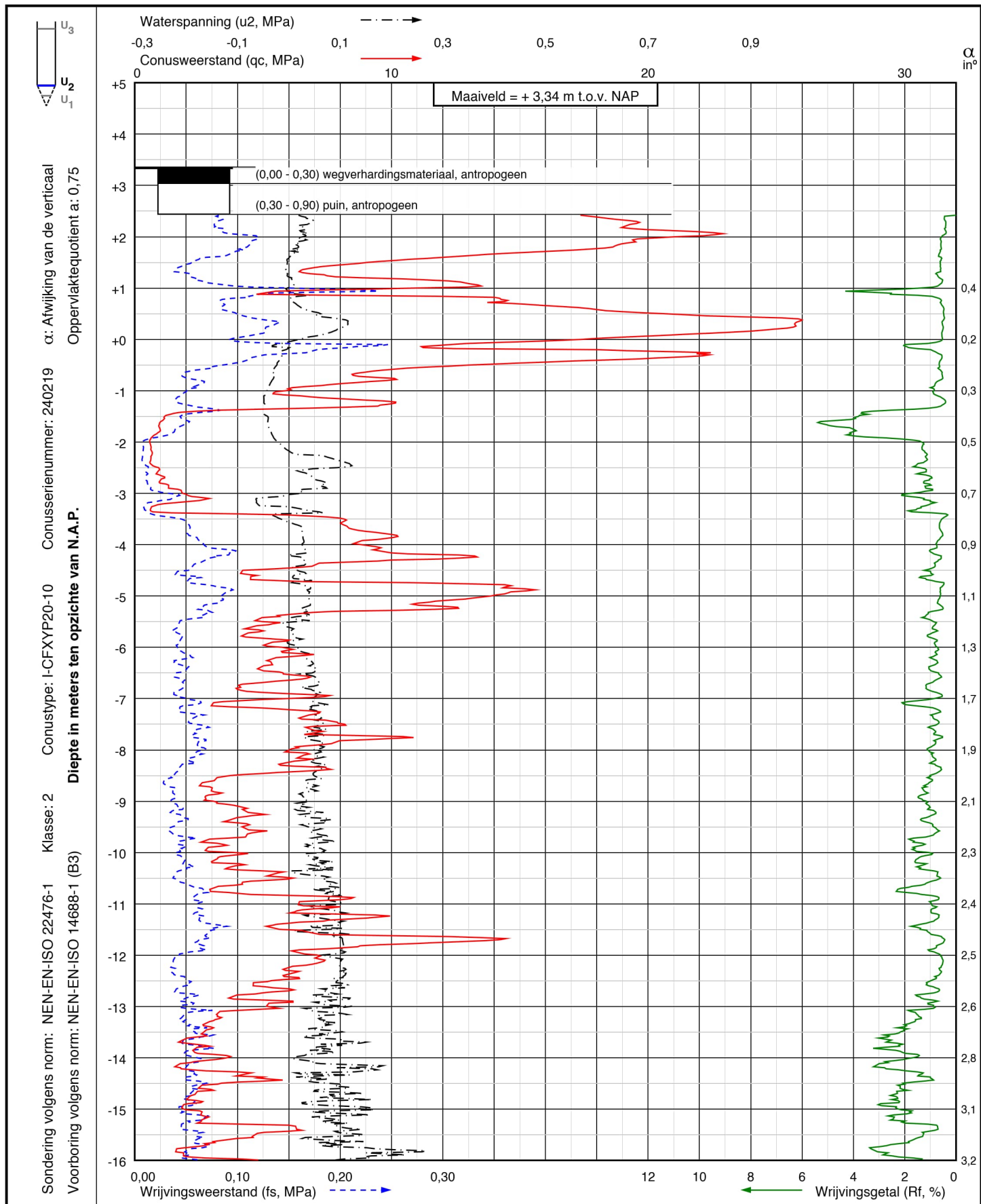
RD-coördinaten : X = 93332.97 Y = 461899.72

Opdr. nr. : 2021-1555

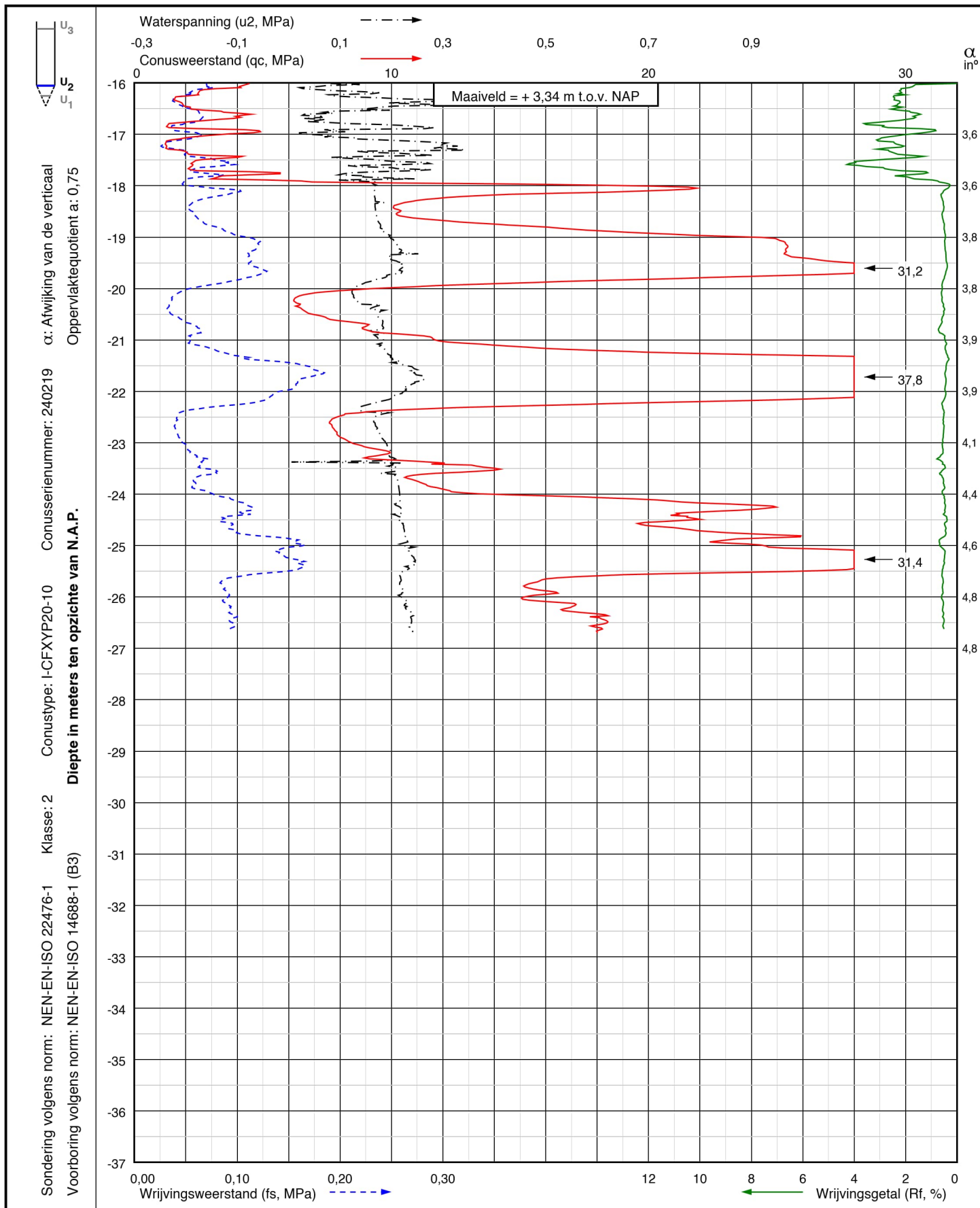
Datum uitv. : 11-10-2021

Sond. nr. : 104





Project: Project N206 Europaweg te Leiden		Sondering: DKMP208	
	RD coördinaten X = 93360,2 Y = 461899,1	Opdr.nr.: VN-85706-1	
	Blad: 1 van 2	Datum: 24-09-2024	



Project: Project N206 Europaweg
te Leiden

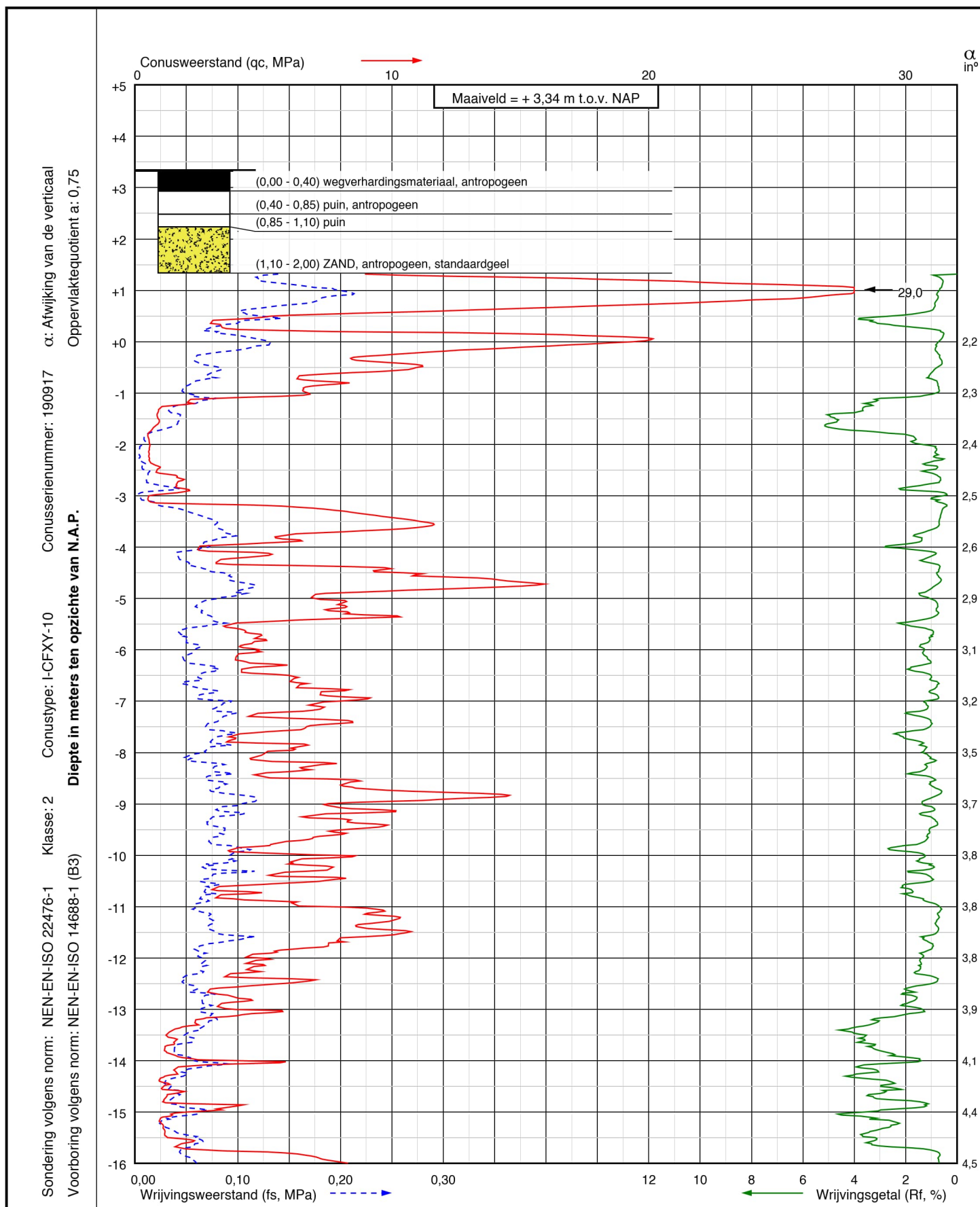
Sondering:
DKMP208

RD coördinaten
X = 93360,2
Y = 461899,1

Opdr.nr.: VN-85706-1

Blad: 2 van 2

Datum: 24-09-2024



Project: Project N206 Europaweg
te Leiden

Sondering:
DKM209



Wiertsema & Partners
RAADGEVEND INGENIEURS

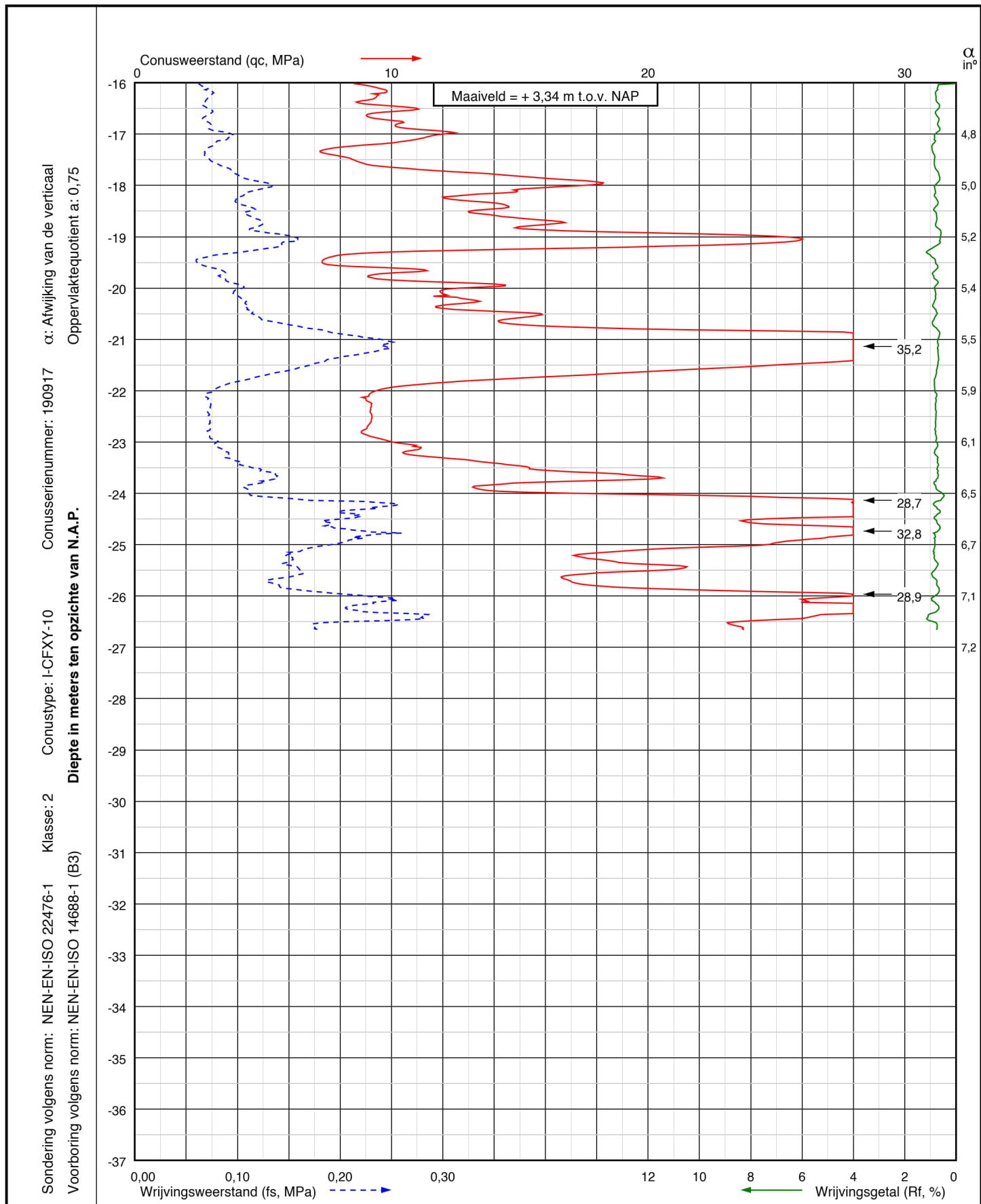
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X = 93337,4
Y = 461888,0

Blad: 1 van 2

Opdr.nr.: VN-85706-1

Datum: 12-07-2024

AKKOORD
UITV



Project: Project N206 Europaweg
te Leiden

Sondering:
DKM209



Wiertsema & Partners
RAADGEVEND INGENIEURS

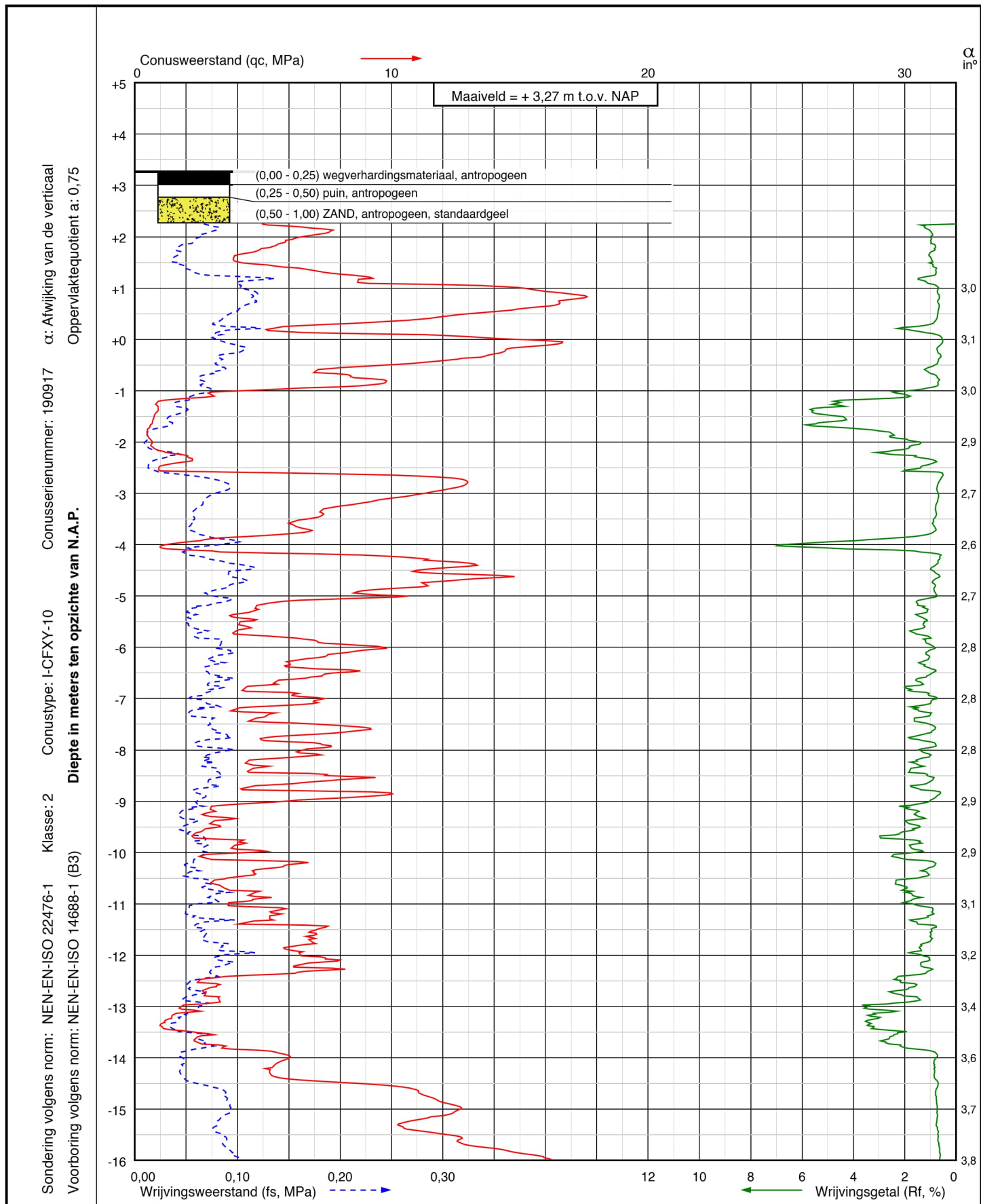
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X = 93337,4
Y = 461888,0

Blad: 2 van 2

Opdr.nr.: VN-85706-1

Datum: 12-07-2024

AKKOORD
UITV



Project: Project N206 Europaweg
te Leiden

Sondering:
DKM210



Wiertsema & Partners
RAADGEVEND INGENIEURS

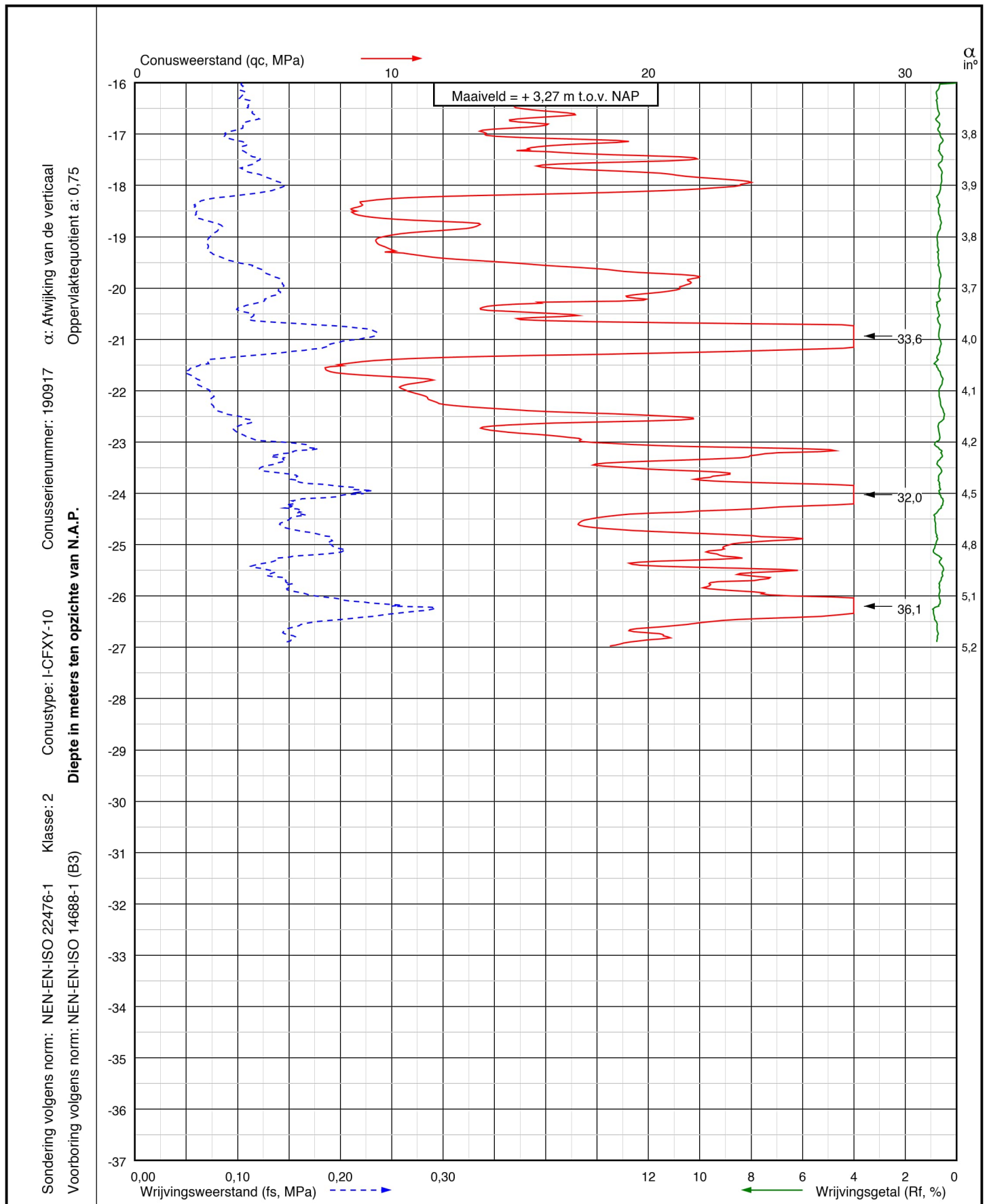
RD coördinaten
X = 93355,6
Y = 461873,0

Blad: 1 van 2

Opdr.nr.: VN-85706-1

Datum: 18-07-2024

AKKOORD
UITV



Project: Project N206 Europaweg
te Leiden

Sondering:
DKM210



Wiertsema & Partners
RAADGEVEND INGENIEURS

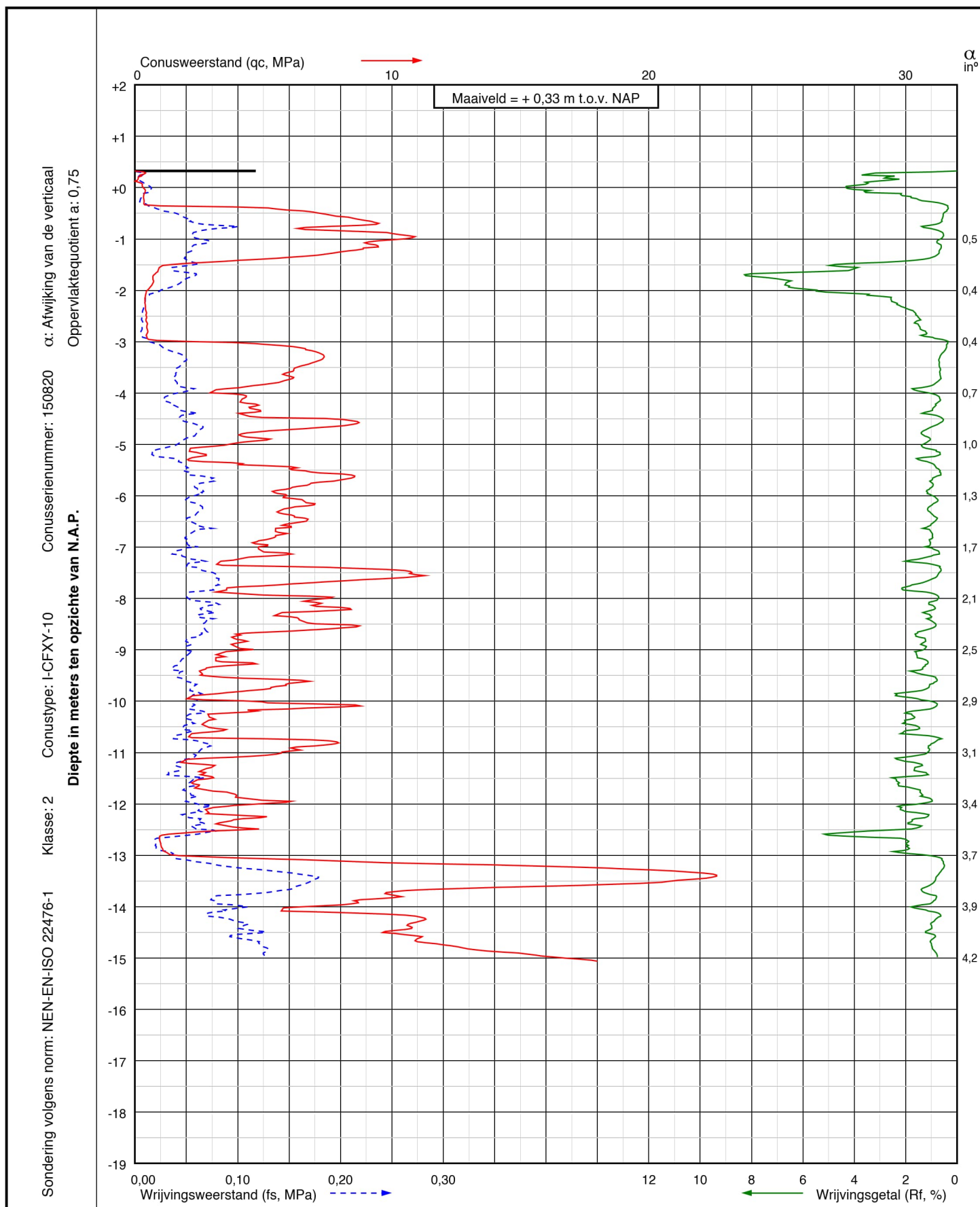
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Y = 461873,0

Blad: 2 van 2

Opdr.nr.: VN-85706-1

Datum: 18-07-2024

AKKOORD
UITV



Project: Project N206 Europaweg
te Leiden

Sondering:
DKM241



Wiertsema & Partners
RAADGEVEND INGENIEURS

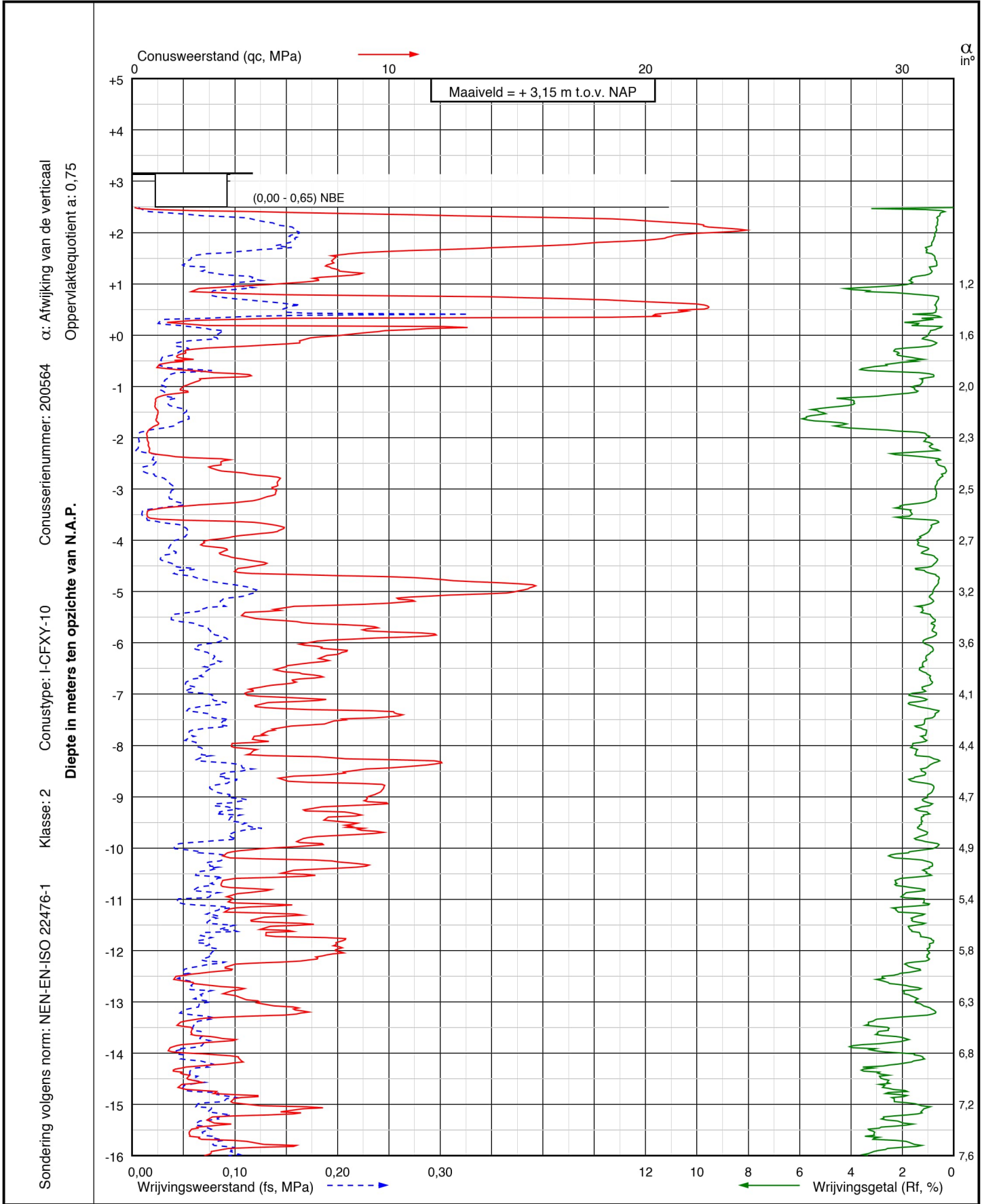
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Y = 461854,5

Blad: 1 van 1

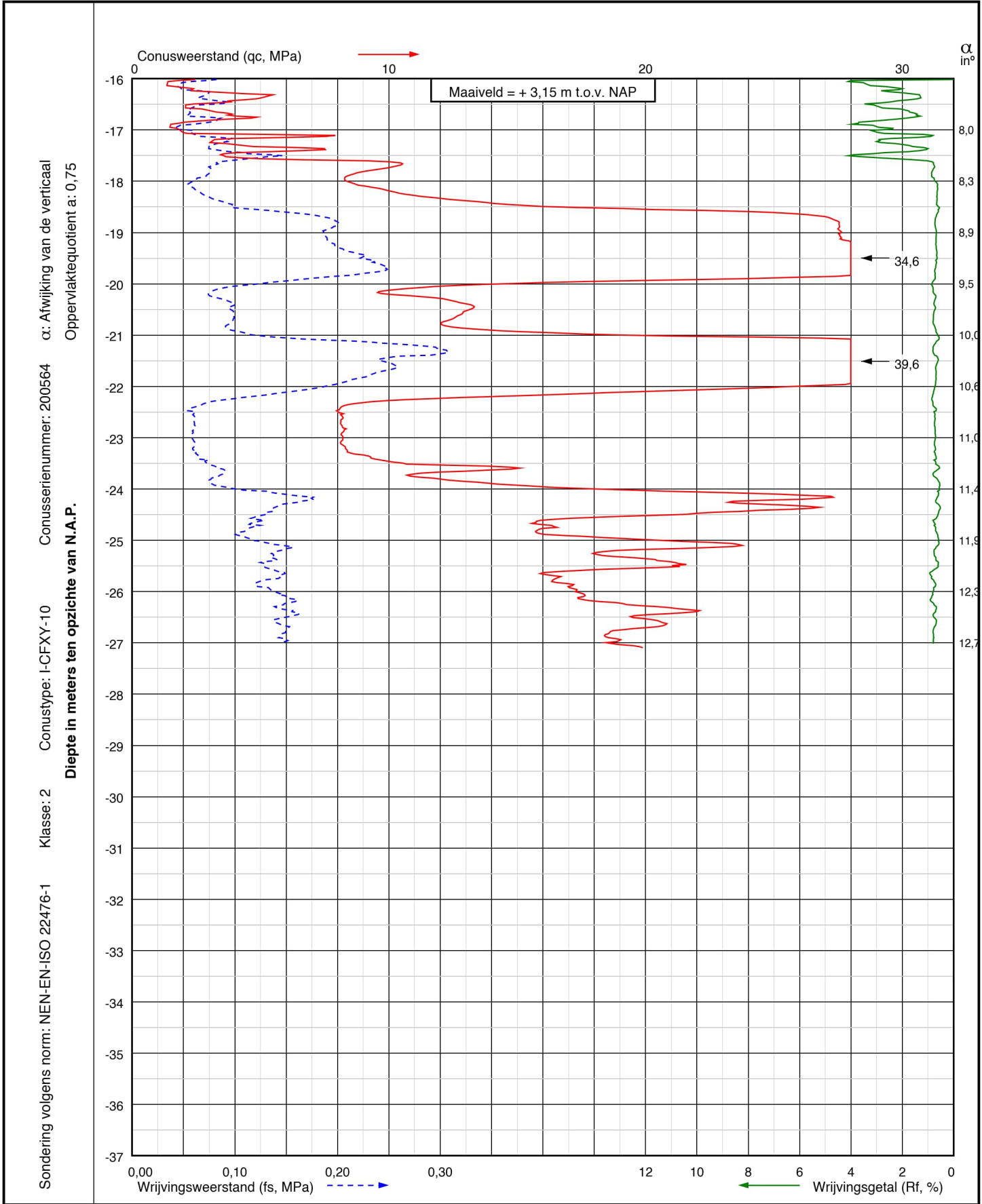
Opdr.nr.: VN-85706-1

Datum: 04-04-2024

AKKOORD
UITV



Project: Project N206 Europaweg te Leiden		Sondering: DKM304	
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	Blad: 1 van 2	Datum: 25-09-2024	

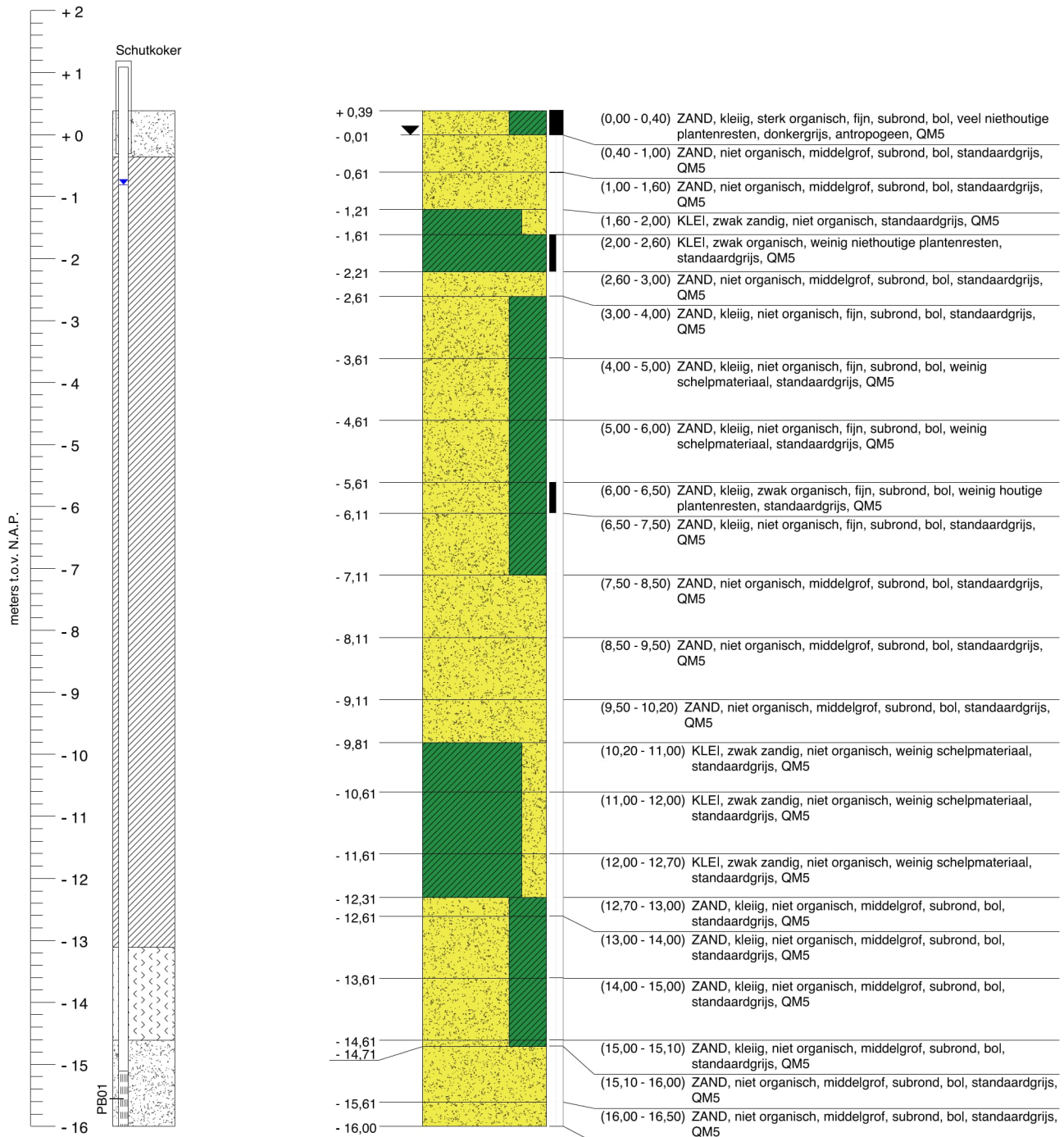


Project: Project N206 Europaweg te Leiden		Sondering: DKM304	
	RD coördinaten X = 93352,4 Y = 461905,2	Opdr.nr.: VN-85706-1	
	Blad: 2 van 2	Datum: 25-09-2024	

Veldboorbeschrijving (klasse 2)

Maatvoering in meters t.o.v. N.A.P.

Maatvoering in meters t.o.v. maaiveld



Geotechnisch onderzoek (Boorbeschrijving conform NEN-EN-ISO-14688)

RD coördinaten

Project N206 Europaweg te Leiden

X = 93385,9

Y = 461867,5

Uitgevoerd:
03-04-2024

Opdrachtnr.: VN-85706-1

PB102
Boornr (W&P): MB1002

Blad 1 van 2

AKKOORD
UITV

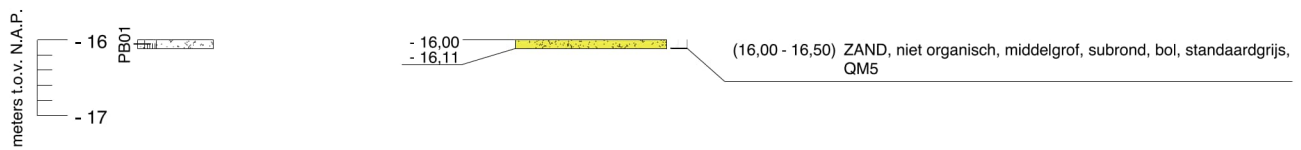


Wiertsema & Partners
RAADGEVEND INGENIEURS

Veldboorbeschrijving (klasse 2)

Maatvoering in meters t.o.v. N.A.P.

Maatvoering in meters t.o.v. maaiveld



	t.o.v. N.A.P.	t.o.v. maaiveld	Ec
BK PB01 (Øint = 31,6mm) :	+ 1,09 m	+ 0,70 m	
GWS PB01 d.d. (03-04-2024) :	- 0,81 m	- 1,20 m	1.570 µS/cm
BK filter PB01 :	- 15,11 m	- 15,50 m	
OK filter PB01 :	- 16,11 m	- 16,50 m	
Materiaal PB01 :	pvc		
GWS MB1002 d.d. (03-04-2024) :	- 0,01 m	- 0,40 m	
G.H.G. MB1002 d.d. (03-04-2024) :	niet waargenomen		
G.L.G. MB1002 d.d. (03-04-2024) :	niet waargenomen		
Nieuwerderder			

Geotechnisch onderzoek (Boorbeschrijving conform NEN-EN-ISO-14688)	RD coördinaten	Project N206 Europaweg te Leiden	
	X = 93385,9		
 Wiertsema & Partners RAADGEVEND INGENIEURS	Y = 461867,5		
	Uitgevoerd: 03-04-2024	Opdrachtnr.: VN-85706-1	
	Blad 2 van 2	PB102 Boornr (W&P): MB1002	

BIJLAGE 2: BEREKENINGSRAPPORTEN D-FOUNDATIONS VOOR DE LANDHOOFDEN

N206 Veldschanstunnel

Fundex-GI palen 540/660 mm ξ_3 1,15 ξ_4 0,92

Schachtwrijving vanaf Pleistocene zandlaag (permanente belasting)

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-18,0	1780	462	2242	1625	45	45	1580
102	-18,0	957	95	1052	762	42	42	720
DKM204	-18,0	778	0	778	564	41	41	523
DKM205	-18,0	662	0	662	480	57	57	423
DKMP206	-18,0	753	107	860	623	40	40	583
DKM207	-18,0	1617	73	1690	1225	53	53	1172
DKMP240	-18,0	2706	1176	3882	2813	49	49	2764
gemiddelde / ξ_3				1387	1156			1109
var.coeff.				72,53%	72,52%			75,48%
minimum / ξ_4				720	600	57	57	543

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-18,5	1962	572	2534	1836	45	45	1791
102	-18,5	933	183	1116	809	42	42	767
DKM204	-18,5	1476	46	1522	1103	41	41	1062
DKM205	-18,5	1209	13	1222	886	57	57	829
DKMP206	-18,5	682	202	884	641	40	40	601
DKM207	-18,5	1684	196	1880	1362	53	53	1309
DKMP240	-18,5	2710	1299	4009	2905	49	49	2856
gemiddelde / ξ_3				1636	1363			1316
var.coeff.				57,82%	57,80%			59,75%
minimum / ξ_4				961	801	40	40	761

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-19,0	2427	688	3115	2257	45	45	2212
102	-19,0	1361	244	1605	1163	42	42	1121
DKM204	-19,0	1366	185	1551	1124	41	41	1083
DKM205	-19,0	1419	97	1516	1099	57	57	1042
DKMP206	-19,0	695	251	946	686	40	40	646
DKM207	-19,0	1680	336	2016	1461	53	53	1408
DKMP240	-19,0	2612	1422	4034	2923	49	49	2874
gemiddelde / ξ_3				1836	1530			1484
var.coeff.				51,13%	51,11%			52,63%
minimum / ξ_4				1028	857	40	40	817

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-19,5	2569	820	3389	2456	45	45	2411
102	-19,5	1643	341	1984	1438	42	42	1396
DKM204	-19,5	1201	325	1526	1106	41	41	1065
DKM205	-19,5	1698	195	1893	1372	57	57	1315
DKMP206	-19,5	1299	293	1592	1154	40	40	1114
DKM207	-19,5	1236	476	1712	1241	53	53	1188
DKMP240	-19,5	2154	1544	3698	2680	49	49	2631
		gemiddelde / ξ_3		1962	1635			1589
		var.coeff.		39,80%	39,79%			40,92%
		minimum / ξ_4		1659	1382	41	41	1341

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-20,0	2579	957	3536	2562	45	45	2517
102	-20,0	1960	451	2411	1747	42	42	1705
DKM204	-20,0	1200	417	1617	1172	41	41	1131
DKM205	-20,0	2145	307	2452	1777	57	57	1720
DKMP206	-20,0	1573	386	1959	1420	40	40	1380
DKM207	-20,0	1156	598	1754	1271	53	53	1218
DKMP240	-20,0	2790	1642	4432	3212	49	49	3163
		gemiddelde / ξ_3		2256	1880			1833
		var.coeff.		39,75%	39,75%			40,71%
		minimum / ξ_4		1758	1465	41	41	1424

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-20,5	2440	1097	3537	2563	45	45	2518
102	-20,5	2007	563	2570	1862	42	42	1820
DKM204	-20,5	1720	493	2213	1604	41	41	1563
DKM205	-20,5	2299	439	2738	1984	57	57	1927
DKMP206	-20,5	1825	495	2320	1681	40	40	1641
DKM207	-20,5	1210	693	1903	1379	53	53	1326
DKMP240	-20,5	2763	1777	4540	3290	49	49	3241
		gemiddelde / ξ_3		2462	2052			2005
		var.coeff.		32,24%	32,24%			32,96%
		minimum / ξ_4		2068	1724	53	53	1671

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-21,0	2197	1237	3434	2488	45	45	2443
102	-21,0	2055	677	2732	1980	42	42	1938
DKM204	-21,0	1714	603	2317	1679	41	41	1638
DKM205	-21,0	2304	579	2883	2089	57	57	2032
DKMP206	-21,0	1828	635	2463	1785	40	40	1745
DKM207	-21,0	1258	801	2059	1492	53	53	1439
DKMP240	-21,0	2525	1917	4442	3219	49	49	3170
		gemiddelde / ξ_3		2525	2105			2058
		var.coeff.		27,86%	27,86%			28,46%
		minimum / ξ_4		2238	1865	53	53	1812

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-21,5	1813	1375	3188	2310	45	45	2265
102	-21,5	1713	798	2511	1820	42	42	1778
DKM204	-21,5	1882	709	2591	1878	41	41	1837
DKM205	-21,5	2002	719	2721	1972	57	57	1915
DKMP206	-21,5	1563	775	2338	1694	40	40	1654
DKM207	-21,5	1147	913	2060	1493	53	53	1440
DKMP240	-21,5	2068	2057	4125	2989	49	49	2940
		gemiddelde / ξ_3		2427	2022			1976
		var.coeff.		24,48%	24,47%			25,02%
		minimum / ξ_4		2239	1866	53	53	1813

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-22,0	1890	1458	3348	2426	45	45	2381
102	-22,0	1729	916	2645	1917	42	42	1875
DKM204	-22,0	2009	823	2832	2052	41	41	2011
DKM205	-22,0	1757	859	2616	1896	57	57	1839
DKMP206	-22,0	1648	872	2520	1826	40	40	1786
DKM207	-22,0	896	1011	1907	1382	53	53	1329
DKMP240	-22,0	1897	2176	4073	2951	49	49	2902
		gemiddelde / ξ_3		2477	2064			2018
		var.coeff.		24,15%	24,14%			24,74%
		minimum / ξ_4		2073	1727	53	53	1674

Report for D-Foundations 23.1

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



NOBLEO
bouw & infra

Company: Nobleo Bouw & Infra

Date of report: 17-6-2025

Time of report: 14:11:06

Report with version: 23.1.1.40340

Date of calculation: 17-6-2025

Time of calculation: 14:08:53

Calculated with version: 23.1.1.40340

File name: Veldschanstunnel fase DO v0.2

Project identification: N206 Europaweg Leiden
Veldschanstunnel, fase DO. PERMANENTE BELASTING
D-Foundations Veldschanstunnel fase DO v0.2

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2 Input Data

2.1 General Input Data

Model Bearing Piles (EC7-NL)

2.2 General Report Data

Geotechnical consultant : ir. Roel van der Putten
 Design engineer superstructure :
 Principal :
 Title 1 : N206 Europaweg Leiden
 Title 2 : Veldschanstunnel, fase DO. PERMANENTE BELASTING
 Title 3 : D-Foundations Veldschanstunnel fase DO v0.2
 Number of project :
 Location of project :

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.

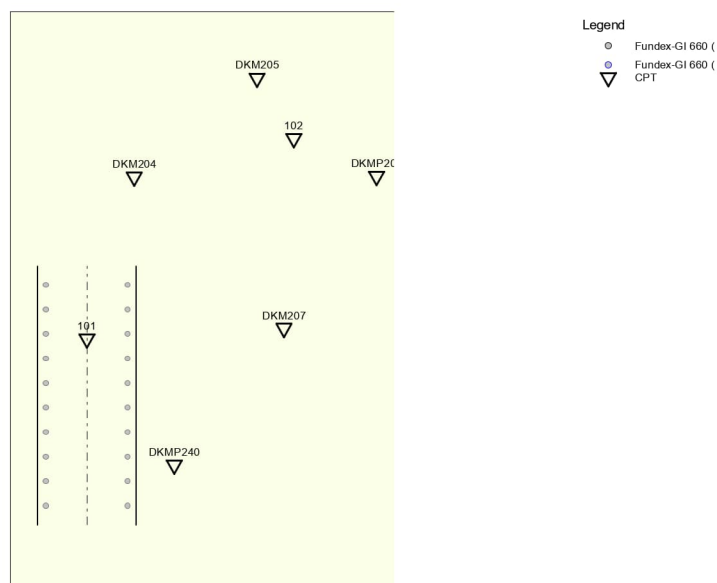
2.4 Superstructure

Rigidity of the superstructure : Rigid

2.5 General CPT Data

Number of CPT's : 7
 Timing of CPT's : CPT - Excavation - Install

2.5.1 View of CPT's in Foundation Plan



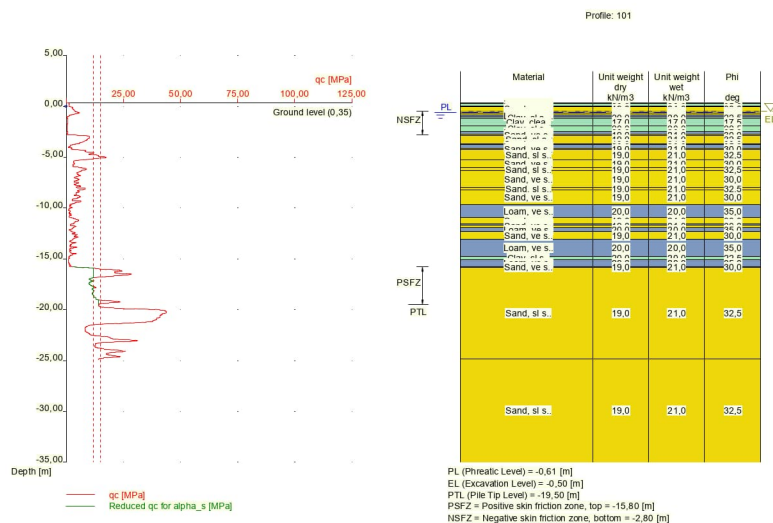
Name CPT	Pile tip level [m R.L.]	Top of pos. friction zone [m R.L.]	Bottom of neg. friction zone [m R.L.]	X-coor- dinate [m]	Y-coor- dinate [m]
101	-19,50	-15,80	-2,80	93389,60	461876,90
102	-19,50	-17,20	-2,70	93414,90	461901,40
DKM204	-19,50	-18,20	-2,70	93395,40	461896,70
DKM205	-19,50	-18,40	-3,20	93410,40	461908,80
DKMP206	-19,50	-17,30	-2,60	93425,00	461896,80
DKM207	-19,50	-17,50	-3,10	93413,70	461878,20
DKMP240	-19,50	-12,80	-2,90	93400,30	461861,50

2.6 Soil Data

Number of soil profiles (= number of CPT's) : 7

2.6.1 Soil Profile 101

Belonging to CPT	101
Surface level in [m. reference level] :	0,35
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-15,80
Bottom of negative skin friction zone in [m. reference level] :	-2,80
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	35

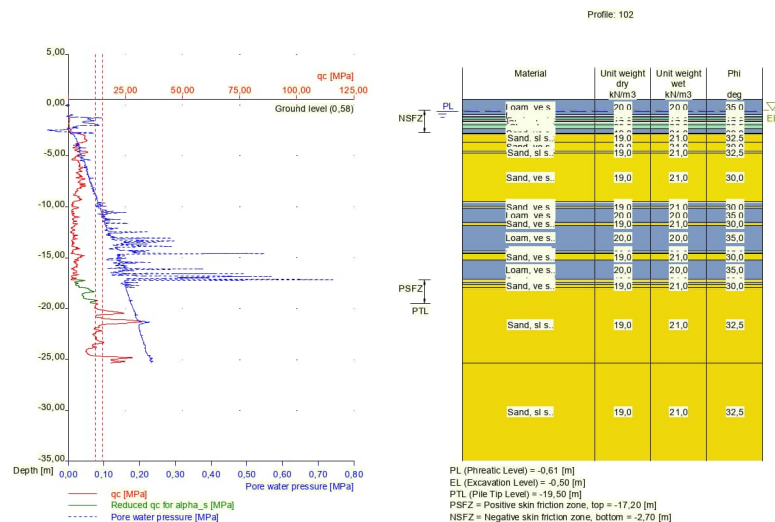


Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,350	20,00	20,00	35,00	Loam	--
2	0,340	20,00	20,00	35,00	Loam	--
3	0,240	20,00	20,00	22,50	Clay	--
4	0,040	20,00	20,00	35,00	Loam	--
5	-0.060	19.00	21.00	30.00	Sand	0.200

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
6	-0,460	19,00	21,00	32,50	Sand	0,200
7	-0,660	19,00	21,00	30,00	Sand	0,200
8	-0,860	20,00	20,00	35,00	Loam	--
9	-1,060	20,00	20,00	22,50	Clay	--
10	-1,160	17,00	17,00	17,50	Clay	--
11	-1,960	20,00	20,00	22,50	Clay	--
12	-2,460	20,00	20,00	35,00	Loam	--
13	-2,760	19,00	21,00	30,00	Sand	0,200
14	-2,860	19,00	21,00	32,50	Sand	0,200
15	-3,660	19,00	21,00	30,00	Sand	0,200
16	-3,760	20,00	20,00	35,00	Loam	--
17	-4,160	19,00	21,00	30,00	Sand	0,200
18	-4,260	19,00	21,00	32,50	Sand	0,200
19	-5,260	19,00	21,00	30,00	Sand	0,200
20	-6,060	19,00	21,00	32,50	Sand	0,200
21	-6,360	19,00	21,00	30,00	Sand	0,200
22	-7,960	19,00	21,00	32,50	Sand	0,200
23	-8,260	19,00	21,00	30,00	Sand	0,200
24	-9,660	20,00	20,00	35,00	Loam	--
25	-10,960	19,00	21,00	30,00	Sand	0,200
26	-11,560	20,00	20,00	35,00	Loam	--
27	-11,660	19,00	21,00	30,00	Sand	0,200
28	-11,960	20,00	20,00	35,00	Loam	--
29	-12,360	19,00	21,00	30,00	Sand	0,200
30	-13,060	20,00	20,00	35,00	Loam	--
31	-14,760	20,00	20,00	22,50	Clay	--
32	-15,060	20,00	20,00	35,00	Loam	--
33	-15,760	19,00	21,00	30,00	Sand	0,200
34	-15,860	19,00	21,00	32,50	Sand	0,200
35	-24,860	19,00	21,00	32,50	Sand	0,200

2.6.2 Soil Profile 102

Belonging to CPT	102
Surface level in [m. reference level] :	0,58
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-17,20
Bottom of negative skin friction zone in [m. reference level] :	-2,70
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	27



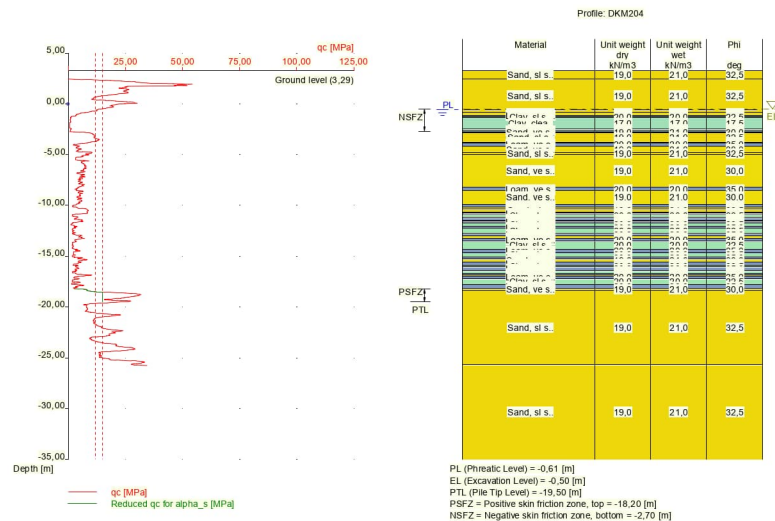
Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,580	20,00	20,00	35,00	Loam	--
2	-0,920	20,00	20,00	35,00	Loam	--
3	-1,120	20,00	20,00	22,50	Clay	--
4	-1,220	17,00	17,00	17,50	Clay	--
5	-1,420	13,00	13,00	15,00	Peat	--
6	-1,620	17,00	17,00	17,50	Clay	--
7	-1,920	20,00	20,00	22,50	Clay	--
8	-2,320	20,00	20,00	35,00	Loam	--
9	-2,720	19,00	21,00	30,00	Sand	0,200
10	-2,820	19,00	21,00	32,50	Sand	0,200
11	-3,620	19,00	21,00	30,00	Sand	0,200
12	-4,520	19,00	21,00	32,50	Sand	0,200
13	-4,720	19,00	21,00	30,00	Sand	0,200
14	-9,520	20,00	20,00	35,00	Loam	--
15	-9,920	19,00	21,00	30,00	Sand	0,200
16	-10,120	20,00	20,00	35,00	Loam	--
17	-11,520	19,00	21,00	30,00	Sand	0,200
18	-11,820	20,00	20,00	35,00	Loam	--
19	-14,320	20,00	20,00	22,50	Clay	--
20	-14,520	20,00	20,00	35,00	Loam	--
21	-14,620	19,00	21,00	30,00	Sand	0,200
22	-15,220	20,00	20,00	35,00	Loam	--
23	-17,120	19,00	21,00	30,00	Sand	0,200
24	-17,420	20,00	20,00	35,00	Loam	--
25	-17,620	19,00	21,00	30,00	Sand	0,200
26	-17,920	19,00	21,00	32,50	Sand	0,200
27	-25,320	19,00	21,00	32,50	Sand	0,200

2.6.3 Soil Profile DKM204

Belonging to CPT
Surface level in [m. reference level] :

DKM204
3,29

Phreatic level in [m. reference level] : -0,61
 Pile tip level in [m. reference level] : -19,50
 Top of positive skin friction zone in [m. reference level] : -18,20
 Bottom of negative skin friction zone in [m. reference level] : -2,70
 OCR-value foundation layer : 1,00
 Expected groundlevel settlement in [m] : 0,11
 Number of layers in profile : 49

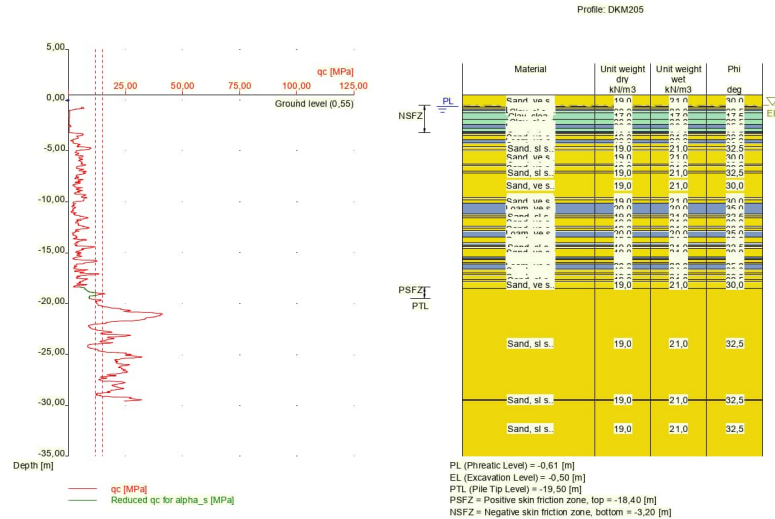


Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	3,290	19,00	21,00	32,50	Sand	0,200
2	2,470	19,00	21,00	32,50	Sand	0,200
3	-0,830	19,00	21,00	30,00	Sand	0,200
4	-1,130	20,00	20,00	35,00	Loam	--
5	-1,230	20,00	20,00	22,50	Clay	--
6	-1,330	17,00	17,00	17,50	Clay	--
7	-2,450	20,00	20,00	22,50	Clay	--
8	-2,650	20,00	20,00	35,00	Loam	--
9	-2,750	19,00	21,00	30,00	Sand	0,200
10	-2,850	19,00	21,00	32,50	Sand	0,200
11	-3,750	19,00	21,00	30,00	Sand	0,200
12	-3,850	20,00	20,00	35,00	Loam	--
13	-4,150	19,00	21,00	30,00	Sand	0,200
14	-4,770	19,00	21,00	32,50	Sand	0,200
15	-4,970	19,00	21,00	30,00	Sand	0,200
16	-8,230	20,00	20,00	35,00	Loam	--
17	-8,530	19,00	21,00	30,00	Sand	0,200
18	-9,850	20,00	20,00	35,00	Loam	--
19	-10,150	19,00	21,00	30,00	Sand	0,200
20	-10,350	19,00	21,00	32,50	Sand	0,200
21	-10,650	19,00	21,00	30,00	Sand	0,200
22	-10,750	20,00	20,00	35,00	Loam	--
23	-10,850	20,00	20,00	22,50	Clay	--
24	-11,150	20,00	20,00	35,00	Loam	--
25	-11,450	19,00	21,00	30,00	Sand	0,200

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
26	-11,550	20,00	20,00	35,00	Loam	--
27	-11,750	20,00	20,00	22,50	Clay	--
28	-12,050	20,00	20,00	35,00	Loam	--
29	-12,250	20,00	20,00	22,50	Clay	--
30	-12,750	20,00	20,00	35,00	Loam	--
31	-12,970	19,00	21,00	30,00	Sand	0,200
32	-13,270	20,00	20,00	35,00	Loam	--
33	-13,488	20,00	20,00	22,50	Clay	--
34	-14,310	20,00	20,00	35,00	Loam	--
35	-14,630	20,00	20,00	22,50	Clay	--
36	-15,048	20,00	20,00	35,00	Loam	--
37	-15,250	19,00	21,00	30,00	Sand	0,200
38	-15,570	20,00	20,00	35,00	Loam	--
39	-15,870	20,00	20,00	22,50	Clay	--
40	-15,988	20,00	20,00	35,00	Loam	--
41	-16,390	20,00	20,00	22,50	Clay	--
42	-16,710	20,00	20,00	35,00	Loam	--
43	-16,810	19,00	21,00	30,00	Sand	0,200
44	-16,927	20,00	20,00	35,00	Loam	--
45	-17,230	20,00	20,00	22,50	Clay	--
46	-17,750	20,00	20,00	35,00	Loam	--
47	-18,168	19,00	21,00	30,00	Sand	0,200
48	-18,370	19,00	21,00	32,50	Sand	0,200
49	-25,668	19,00	21,00	32,50	Sand	0,200

2.6.4 Soil Profile DKM205

Belonging to CPT	DKM205
Surface level in [m. reference level] :	0,55
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-18,40
Bottom of negative skin friction zone in [m. reference level] :	-3,20
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	47



Number layer	Top layer [m R.L.]	Gamma [kN/m ³]	Gamma;sat [kN/m ³]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,550	19,00	21,00	30,00	Sand	0,200
2	-0,670	19,00	21,00	30,00	Sand	0,200
3	-0,870	20,00	20,00	35,00	Loam	--
4	-0,970	20,00	20,00	22,50	Clay	--
5	-1,270	17,00	17,00	17,50	Clay	--
6	-1,870	20,00	20,00	22,50	Clay	--
7	-2,370	20,00	20,00	35,00	Loam	--
8	-2,770	20,00	20,00	22,50	Clay	--
9	-3,070	20,00	20,00	35,00	Loam	--
10	-3,170	19,00	21,00	30,00	Sand	0,200
11	-3,270	19,00	21,00	32,50	Sand	0,200
12	-3,470	19,00	21,00	30,00	Sand	0,200
13	-3,870	20,00	20,00	35,00	Loam	--
14	-4,189	19,00	21,00	30,00	Sand	0,200
15	-4,589	19,00	21,00	32,50	Sand	0,200
16	-4,889	19,00	21,00	30,00	Sand	0,200
17	-6,289	19,00	21,00	32,50	Sand	0,200
18	-6,389	19,00	21,00	30,00	Sand	0,200
19	-6,989	19,00	21,00	32,50	Sand	0,200
20	-7,189	19,00	21,00	30,00	Sand	0,200
21	-9,589	19,00	21,00	32,50	Sand	0,200
22	-9,789	19,00	21,00	30,00	Sand	0,200
23	-10,089	20,00	20,00	35,00	Loam	--
24	-11,189	19,00	21,00	30,00	Sand	0,200
25	-11,390	19,00	21,00	32,50	Sand	0,200
26	-11,590	19,00	21,00	30,00	Sand	0,200
27	-12,390	19,00	21,00	32,50	Sand	0,200
28	-12,590	19,00	21,00	30,00	Sand	0,200
29	-12,790	20,00	20,00	35,00	Loam	--
30	-13,490	19,00	21,00	30,00	Sand	0,200
31	-13,990	20,00	20,00	35,00	Loam	--
32	-14,290	19,00	21,00	30,00	Sand	0,200

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel [mm]
33	-14,390	19,00	21,00	32,50	Sand	0,200
34	-14,590	19,00	21,00	30,00	Sand	0,200
35	-15,390	20,00	20,00	35,00	Loam	--
36	-15,590	19,00	21,00	30,00	Sand	0,200
37	-15,690	19,00	21,00	32,50	Sand	0,200
38	-15,990	19,00	21,00	30,00	Sand	0,200
39	-16,090	20,00	20,00	35,00	Loam	--
40	-16,590	19,00	21,00	30,00	Sand	0,200
41	-16,990	19,00	21,00	32,50	Sand	0,200
42	-17,190	19,00	21,00	30,00	Sand	0,200
43	-17,590	19,00	21,00	32,50	Sand	0,200
44	-17,790	19,00	21,00	30,00	Sand	0,200
45	-18,490	19,00	21,00	32,50	Sand	0,200
46	-29,430	19,00	21,00	32,50	Sand	0,200
47	-29,530	19,00	21,00	32,50	Sand	0,200

2.6.5 Soil Profile DKMP206

Belonging to CPT

Surface level in [m. reference level] :

Phreatic level in [m. reference level] :

Pile tip level in [m. reference level] :

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

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

OCR-value foundation layer :

Expected groundlevel settlement in [m] :

Number of layers in profile :

DKMP206

0.83

-0.61

-19.50

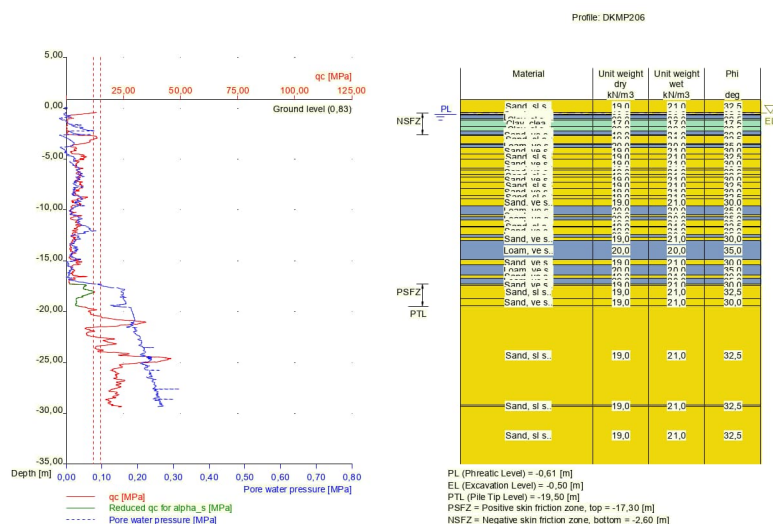
-17,30

-2,60

1,00

0,11

42

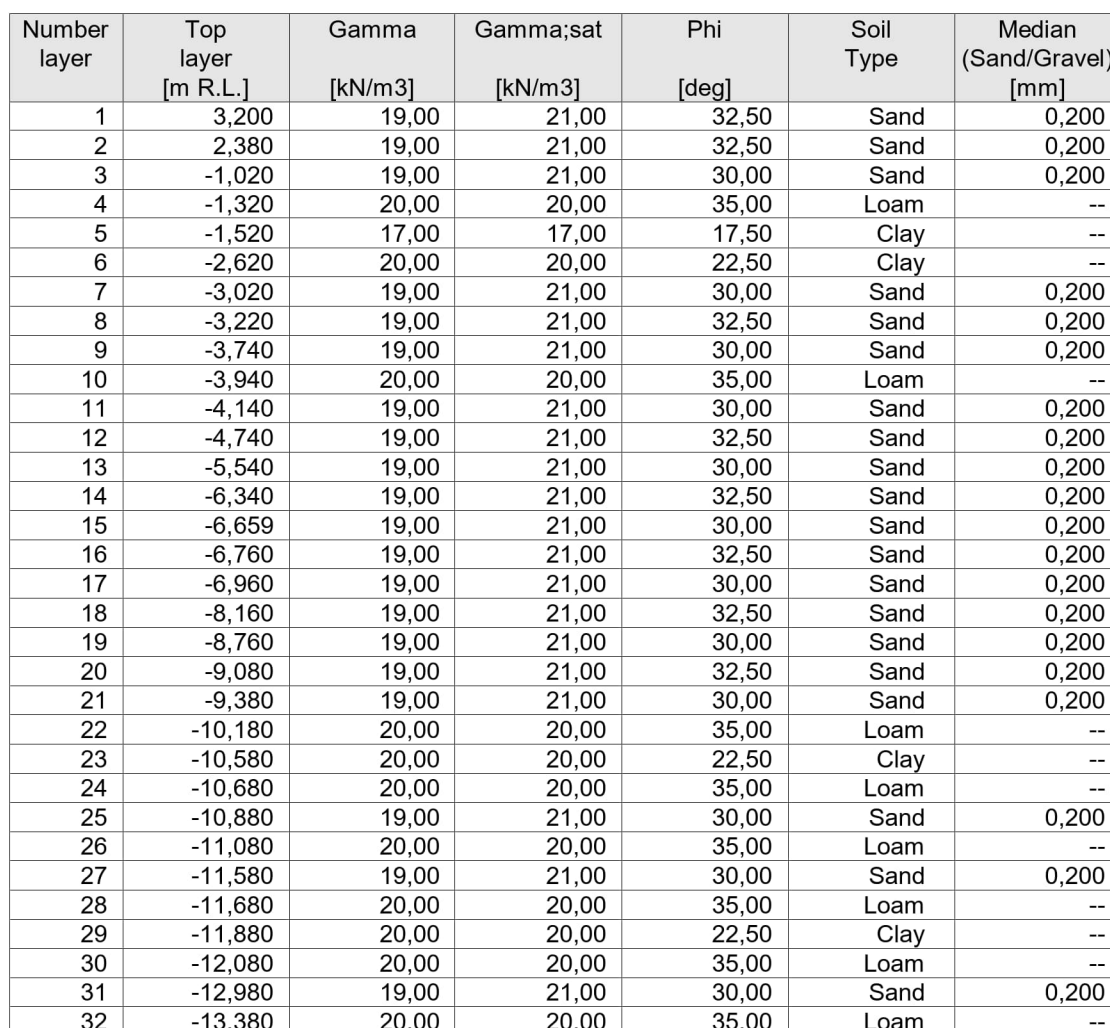


Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,830	19,00	21,00	32,50	Sand	0,200
2	-0.390	19.00	21.00	32.50	Sand	0.200

Number layer	Top layer [m R.L.]	Gamma [kN/m ³]	Gamma;sat [kN/m ³]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
3	-0,590	19,00	21,00	30,00	Sand	0,200
4	-0,690	20,00	20,00	35,00	Loam	--
5	-1,090	20,00	20,00	22,50	Clay	--
6	-1,190	17,00	17,00	17,50	Clay	--
7	-1,790	20,00	20,00	22,50	Clay	--
8	-2,290	20,00	20,00	35,00	Loam	--
9	-2,590	19,00	21,00	30,00	Sand	0,200
10	-2,690	19,00	21,00	32,50	Sand	0,200
11	-3,490	19,00	21,00	30,00	Sand	0,200
12	-3,590	20,00	20,00	35,00	Loam	--
13	-3,890	19,00	21,00	30,00	Sand	0,200
14	-4,510	19,00	21,00	32,50	Sand	0,200
15	-5,010	19,00	21,00	30,00	Sand	0,200
16	-5,910	19,00	21,00	32,50	Sand	0,200
17	-6,110	19,00	21,00	30,00	Sand	0,200
18	-6,510	19,00	21,00	32,50	Sand	0,200
19	-6,810	19,00	21,00	30,00	Sand	0,200
20	-7,310	19,00	21,00	32,50	Sand	0,200
21	-7,910	19,00	21,00	30,00	Sand	0,200
22	-8,610	19,00	21,00	32,50	Sand	0,200
23	-8,910	19,00	21,00	30,00	Sand	0,200
24	-9,610	20,00	20,00	35,00	Loam	--
25	-10,510	19,00	21,00	30,00	Sand	0,200
26	-10,710	20,00	20,00	35,00	Loam	--
27	-11,010	19,00	21,00	30,00	Sand	0,200
28	-11,610	19,00	21,00	32,50	Sand	0,200
29	-11,710	19,00	21,00	30,00	Sand	0,200
30	-12,410	20,00	20,00	35,00	Loam	--
31	-12,710	19,00	21,00	30,00	Sand	0,200
32	-13,010	20,00	20,00	35,00	Loam	--
33	-14,910	19,00	21,00	30,00	Sand	0,200
34	-15,410	20,00	20,00	35,00	Loam	--
35	-16,410	19,00	21,00	30,00	Sand	0,200
36	-16,710	20,00	20,00	35,00	Loam	--
37	-17,310	19,00	21,00	30,00	Sand	0,200
38	-17,410	19,00	21,00	32,50	Sand	0,200
39	-18,710	19,00	21,00	30,00	Sand	0,200
40	-19,410	19,00	21,00	32,50	Sand	0,200
41	-29,210	19,00	21,00	32,50	Sand	0,200
42	-29,310	19,00	21,00	32,50	Sand	0,200

2.6.6 Soil Profile DKM207

Belonging to CPT	DKM207
Surface level in [m. reference level] :	3,20
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-17,50
Bottom of negative skin friction zone in [m. reference level] :	-3,10
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	50



Number layer	Top layer [m R.L.]	Gamma [kN/m ³]	Gamma;sat [kN/m ³]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
33	-13,580	20,00	20,00	22,50	Clay	--
34	-13,680	20,00	20,00	35,00	Loam	--
35	-14,100	20,00	20,00	22,50	Clay	--
36	-14,800	20,00	20,00	35,00	Loam	--
37	-15,000	20,00	20,00	22,50	Clay	--
38	-15,720	20,00	20,00	35,00	Loam	--
39	-15,820	19,00	21,00	30,00	Sand	0,200
40	-16,020	20,00	20,00	35,00	Loam	--
41	-16,220	20,00	20,00	22,50	Clay	--
42	-16,720	17,00	17,00	17,50	Clay	--
43	-17,020	20,00	20,00	22,50	Clay	--
44	-17,420	20,00	20,00	35,00	Loam	--
45	-17,520	19,00	21,00	30,00	Sand	0,200
46	-17,620	19,00	21,00	32,50	Sand	0,200
47	-22,160	19,00	21,00	30,00	Sand	0,200
48	-22,360	19,00	21,00	32,50	Sand	0,200
49	-26,780	19,00	21,00	32,50	Sand	0,200
50	-26,880	19,00	21,00	32,50	Sand	0,200

2.6.7 Soil Profile DKMP240

Belonging to CPT

Surface level in [m. reference level] :

Phreatic level in [m. reference level] :

Pile tip level in [m. reference level] :

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

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

OCR-value foundation layer :

Expected groundlevel settlement in [m] :

Number of layers in profile :

DKMP240

1.51

-0.61

-19,50

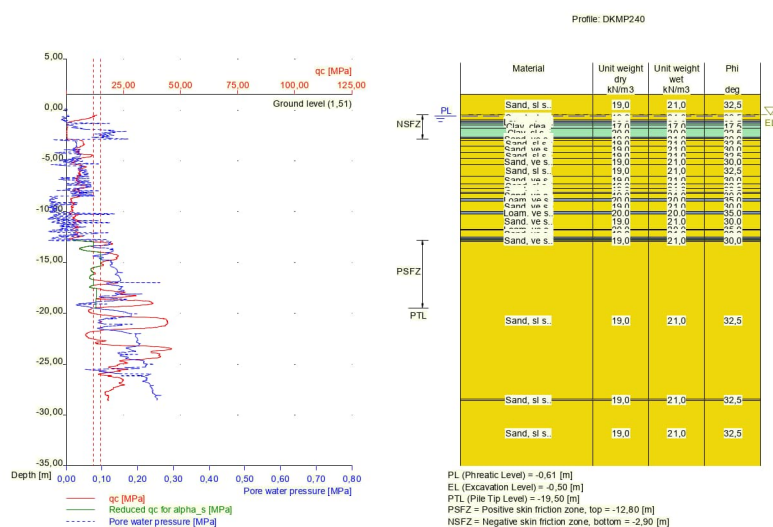
-12,80

-2,90

1,00

0,11

32



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	1,510	19,00	21,00	32,50	Sand	0,200
2	-0,507	19,00	21,00	32,50	Sand	0,200
3	-1,007	19,00	21,00	30,00	Sand	0,200
4	-1,107	20,00	20,00	35,00	Loam	--
5	-1,307	20,00	20,00	22,50	Clay	--
6	-1,507	17,00	17,00	17,50	Clay	--
7	-1,807	20,00	20,00	22,50	Clay	--
8	-2,707	20,00	20,00	35,00	Loam	--
9	-2,807	19,00	21,00	30,00	Sand	0,200
10	-3,007	19,00	21,00	32,50	Sand	0,200
11	-3,607	19,00	21,00	30,00	Sand	0,200
12	-4,207	19,00	21,00	32,50	Sand	0,200
13	-4,807	19,00	21,00	30,00	Sand	0,200
14	-5,407	19,00	21,00	32,50	Sand	0,200
15	-6,507	19,00	21,00	30,00	Sand	0,200
16	-7,307	19,00	21,00	32,50	Sand	0,200
17	-7,707	19,00	21,00	30,00	Sand	0,200
18	-8,107	19,00	21,00	32,50	Sand	0,200
19	-8,207	19,00	21,00	30,00	Sand	0,200
20	-8,707	20,00	20,00	35,00	Loam	--
21	-9,007	19,00	21,00	30,00	Sand	0,200
22	-10,007	20,00	20,00	35,00	Loam	--
23	-10,207	19,00	21,00	30,00	Sand	0,200
24	-11,726	20,00	20,00	35,00	Loam	--
25	-11,826	19,00	21,00	30,00	Sand	0,200
26	-12,527	20,00	20,00	35,00	Loam	--
27	-12,627	20,00	20,00	22,50	Clay	--
28	-12,727	20,00	20,00	35,00	Loam	--
29	-12,827	19,00	21,00	30,00	Sand	0,200
30	-12,927	19,00	21,00	32,50	Sand	0,200
31	-28,467	19,00	21,00	32,50	Sand	0,200
32	-28,567	19,00	21,00	32,50	Sand	0,200

2.7 Pile Types

2.7.1 Pile type : Fundex-GI 660

Pile type : Screw pile, cast in place, with grout

Materialtype for pile :

Concrete

Slip layer :

None

Pile shape :

Round pile

beta (Shape factor) according to figure 7.i, NEN 9997-1+C2:2017.

s (factor for influence of the shape of the crossection of the pile base) according to NEN 9997-1+C2:2017.

Pile dimensions :

Diameter [m] :

0,660

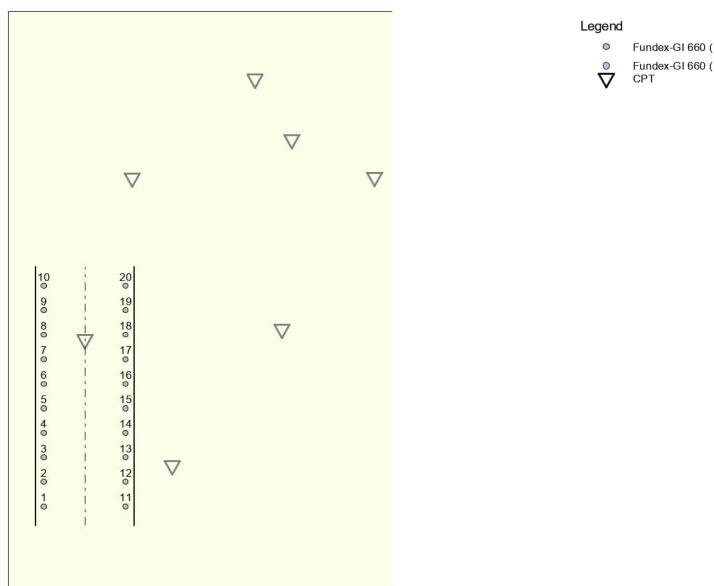
2.8 Foundation Plan

Number of piles : 20

Number of collaborating piles* : 20

* : 0 = not defined, 1 = non rigid superstructure, >1 = rigid superstructure

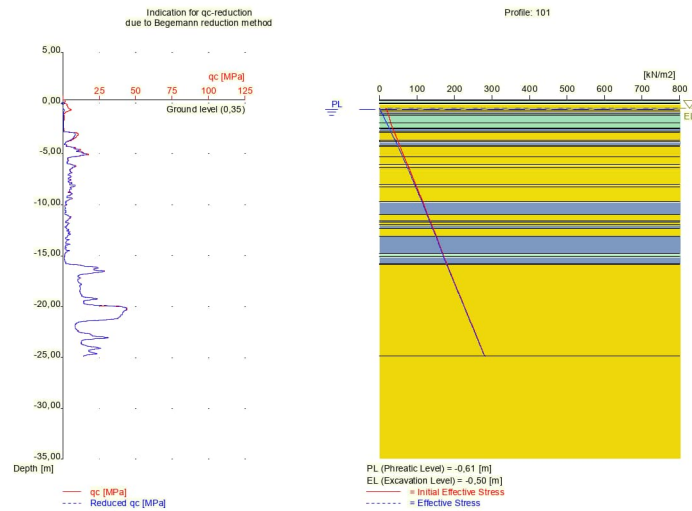
2.8.1 View of Foundation Plan



Pile nr/name	X-coordinate [m]	Y-coordinate [m]	Fc;d (EQU/STR/GEO) [kN]	Fc;d (SLS) [kN]	P0 [kN/m2]	Pile head level [m R.L.]
1: 1	93384,60	461856,50	0,00	0,00	27,70	-0,80
2: 2	93384,60	461859,50	0,00	0,00	27,70	-0,80
3: 3	93384,60	461862,50	0,00	0,00	27,70	-0,80
4: 4	93384,60	461865,50	0,00	0,00	27,70	-0,80
5: 5	93384,60	461868,50	0,00	0,00	27,70	-0,80
6: 6	93384,60	461871,50	0,00	0,00	27,70	-0,80
7: 7	93384,60	461874,50	0,00	0,00	27,70	-0,80
8: 8	93384,60	461877,50	0,00	0,00	27,70	-0,80
9: 9	93384,60	461880,50	0,00	0,00	27,70	-0,80
10: 10	93384,60	461883,50	0,00	0,00	27,70	-0,80
11: 11	93394,60	461856,50	0,00	0,00	27,70	-0,80
12: 12	93394,60	461859,50	0,00	0,00	27,70	-0,80
13: 13	93394,60	461862,50	0,00	0,00	27,70	-0,80
14: 14	93394,60	461865,50	0,00	0,00	27,70	-0,80
15: 15	93394,60	461868,50	0,00	0,00	27,70	-0,80
16: 16	93394,60	461871,50	0,00	0,00	27,70	-0,80
17: 17	93394,60	461874,50	0,00	0,00	27,70	-0,80
18: 18	93394,60	461877,50	0,00	0,00	27,70	-0,80
19: 19	93394,60	461880,50	0,00	0,00	27,70	-0,80
20: 20	93394,60	461883,50	0,00	0,00	27,70	-0,80

2.9 Excavation Data

Excavation level in [m. reference level] : -0,50
Reduction model : Begemann
Distance edge pile to excavation boundary [m] : 1,00



2.10 Overruled Parameters

User defined Factor xi3 [-] : 1,15
User defined Factor xi4 [-] : 0,92

2.11 Model Options

Use pilegroup for negative skin friction (standard)
Do not create intermediate results file
Use reduction for continuous flight auger piles (standard)
Use the influence of excavations (standard).

2.12 Model Options

Selected pile types :
-Fundex-GI 660

Selected profiles :
-101
-102
-DKM204
-DKM205
-DKMP206
-DKM207
-DKMP240

Trajectory
-begin [m] : -18,00
-end [m] : -22,00
-interval [m] : 0,50

3 Bearing Piles (EC7-NL): Results Preliminary Design, Indication Bearing Capacity

3.1 Errors and Warnings

Warning : The factor ξ_3 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

Warning : The factor ξ_4 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

The warning just below concerns at least one of the used soil profiles.

Warning : The positive skin friction zone contains compressible layers. The demands set by article 7.6.1.1 b are not met. A calculation of interaction is required to show that given schematization is valid.

The calculated pile settlement as mentioned in the report should be adapted based on that calculation.

Soil profile 101

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile 102

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM204

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM205

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP206

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM207

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP240

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

3.2 Remarks

When checking the survey and testing of soil according to NEN 9997-1+C2:2017 art. 3.2.3 section (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.

Note : The calculations performed are based on a single pile for limit state EQU/STR/GEO (= ultimate limit state). Due to the nature of preliminary design, a single pile is always assumed. A possible pileplan is disregarded when using the preliminary design option. Hence a non rigid superstructure is assumed and pile group effects are not considered.

3.3 Calculation Parameters

3.3.1 Pile Factors

γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8, Limit State EQU/STR/GEO) :	1,20
γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	

the Serviceability Limit State) :	1,00
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
Limit State EQU/STR/GEO) :	1,20
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
the Serviceability Limit State) :	1,00
xi3 (user defined) :	1,15
xi4 (user defined) :	0,92

3.3.2 Pile type : Fundex-GI 660

Pile type :	Screw pile, cast in place, with grout
Materialtype for pile :	Concrete
Slip layer :	None
Pile shape :	Round pile
beta (Shape factor: figure 7.i, NEN 9997-1+C2:2017	
art. 7.6.2.3(g) : Pile tip) :	1,00
s (NEN 9997-1+C2:2017 art. 7.6.2.3(h) : factor for	
the influence of the shape of the crossection of the pile base) :	1,00
Pile dimensions :	
Diameter [m] :	0,660

Number/Name CPT	Alpha_s Sand/ Gravel	Alpha_s Clay/Loam Peat	Alpha_p
1:101	0,0090	--	0,6300
7:102	0,0090	0,0250	0,6300
2:DKM204	0,0090	--	0,6300
3:DKM205	0,0090	--	0,6300
5:DKMP206	0,0090	0,0250	0,6300
4:DKM207	0,0090	0,0250	0,6300
6:DKMP240	0,0090	0,0230	0,6300

3.4 Results Bearing Forces for Pile type : Fundex-GI 660

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
1:101	-18.00	1780	462	2242	1625	45	45	1580
1:101	-18.50	1962	572	2534	1836	45	45	1791
1:101	-19.00	2427	688	3115	2257	45	45	2212
1:101	-19.50	2569	820	3389	2456	45	45	2411
1:101	-20.00	2579	957	3536	2562	45	45	2517
1:101	-20.50	2440	1097	3537	2563	45	45	2518
1:101	-21.00	2197	1237	3434	2488	45	45	2443
1:101	-21.50	1813	1375	3188	2310	45	45	2265
1:101	-22.00	1890	1458	3348	2426	45	45	2381
7:102	-18.00	957	95	1052	762	42	42	720
7:102	-18.50	933	183	1116	809	42	42	767
7:102	-19.00	1361	244	1605	1163	42	42	1121
7:102	-19.50	1643	341	1984	1438	42	42	1396
7:102	-20.00	1960	451	2411	1747	42	42	1705
7:102	-20.50	2007	563	2570	1862	42	42	1820
7:102	-21.00	2055	677	2732	1980	42	42	1938
7:102	-21.50	1713	798	2511	1820	42	42	1778
7:102	-22.00	1729	916	2645	1917	42	42	1875
2:DKM204	-18.00	778	0	778	564	41	41	523
2:DKM204	-18.50	1476	46	1522	1103	41	41	1062
2:DKM204	-19.00	1366	185	1551	1124	41	41	1083
2:DKM204	-19.50	1201	325	1526	1106	41	41	1065
2:DKM204	-20.00	1200	417	1617	1172	41	41	1131
2:DKM204	-20.50	1720	493	2213	1604	41	41	1563
2:DKM204	-21.00	1714	603	2317	1679	41	41	1638

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
2:DKM204	-21.50	1882	709	2591	1878	41	41	1837
2:DKM204	-22.00	2009	823	2832	2052	41	41	2011
3:DKM205	-18.00	662	0	662	480	57	57	423
3:DKM205	-18.50	1209	13	1222	886	57	57	829
3:DKM205	-19.00	1419	97	1516	1099	57	57	1042
3:DKM205	-19.50	1698	195	1893	1372	57	57	1315
3:DKM205	-20.00	2145	307	2452	1777	57	57	1720
3:DKM205	-20.50	2299	439	2738	1984	57	57	1927
3:DKM205	-21.00	2304	579	2883	2089	57	57	2032
3:DKM205	-21.50	2002	719	2721	1972	57	57	1915
3:DKM205	-22.00	1757	859	2616	1896	57	57	1839
5:DKMP206	-18.00	753	107	860	623	40	40	583
5:DKMP206	-18.50	682	202	884	641	40	40	601
5:DKMP206	-19.00	695	251	946	686	40	40	646
5:DKMP206	-19.50	1299	293	1592	1154	40	40	1114
5:DKMP206	-20.00	1573	386	1959	1420	40	40	1380
5:DKMP206	-20.50	1825	495	2320	1681	40	40	1641
5:DKMP206	-21.00	1828	635	2463	1785	40	40	1745
5:DKMP206	-21.50	1563	775	2338	1694	40	40	1654
5:DKMP206	-22.00	1648	872	2520	1826	40	40	1786
4:DKM207	-18.00	1617	73	1690	1225	53	53	1172
4:DKM207	-18.50	1684	196	1880	1362	53	53	1309
4:DKM207	-19.00	1680	336	2016	1461	53	53	1408
4:DKM207	-19.50	1236	476	1712	1241	53	53	1188
4:DKM207	-20.00	1156	598	1754	1271	53	53	1218
4:DKM207	-20.50	1210	693	1903	1379	53	53	1326
4:DKM207	-21.00	1258	801	2059	1492	53	53	1439
4:DKM207	-21.50	1147	913	2060	1493	53	53	1440
4:DKM207	-22.00	896	1011	1907	1382	53	53	1329
6:DKMP240	-18.00	2706	1176	3882	2813	49	49	2764
6:DKMP240	-18.50	2710	1299	4009	2905	49	49	2856
6:DKMP240	-19.00	2612	1422	4034	2923	49	49	2874
6:DKMP240	-19.50	2154	1544	3698	2680	49	49	2631
6:DKMP240	-20.00	2790	1642	4432	3212	49	49	3163
6:DKMP240	-20.50	2763	1777	4540	3290	49	49	3241
6:DKMP240	-21.00	2525	1917	4442	3219	49	49	3170
6:DKMP240	-21.50	2068	2057	4125	2989	49	49	2940
6:DKMP240	-22.00	1897	2176	4073	2951	49	49	2902

* Rc;net;d = Rc;d - Fnsf;d

3.5 Summary Net Bearing Capacity in kN

Number/Name CPT	Groundlevel [m R.L.]	Level [m R.L.]	Fundex-GI 660 Rc;net;d [kN]
1:101	0,35	-18,00	1580,00
1:101	0,35	-18,50	1791,00
1:101	0,35	-19,00	2212,00
1:101	0,35	-19,50	2411,00
1:101	0,35	-20,00	2517,00
1:101	0,35	-20,50	2518,00
1:101	0,35	-21,00	2443,00
1:101	0,35	-21,50	2265,00
1:101	0,35	-22,00	2381,00
7:102	0,58	-18,00	720,00
7:102	0,58	-18,50	767,00
7:102	0,58	-19,00	1121,00
7:102	0,58	-19,50	1396,00
7:102	0,58	-20,00	1705,00
7:102	0,58	-20,50	1820,00
7:102	0,58	-21,00	1938,00
7:102	0,58	-21,50	1778,00

Number/Name CPT	Groundlevel [m R.L.]	Level [m R.L.]	Fundex-GI 660 Rc;net;d [kN]
7:102	0,58	-22,00	1875,00
2:DKM204	3,29	-18,00	523,00
2:DKM204	3,29	-18,50	1062,00
2:DKM204	3,29	-19,00	1083,00
2:DKM204	3,29	-19,50	1065,00
2:DKM204	3,29	-20,00	1131,00
2:DKM204	3,29	-20,50	1563,00
2:DKM204	3,29	-21,00	1638,00
2:DKM204	3,29	-21,50	1837,00
2:DKM204	3,29	-22,00	2011,00
3:DKM205	0,55	-18,00	423,00
3:DKM205	0,55	-18,50	829,00
3:DKM205	0,55	-19,00	1042,00
3:DKM205	0,55	-19,50	1315,00
3:DKM205	0,55	-20,00	1720,00
3:DKM205	0,55	-20,50	1927,00
3:DKM205	0,55	-21,00	2032,00
3:DKM205	0,55	-21,50	1915,00
3:DKM205	0,55	-22,00	1839,00
5:DKMP206	0,83	-18,00	583,00
5:DKMP206	0,83	-18,50	601,00
5:DKMP206	0,83	-19,00	646,00
5:DKMP206	0,83	-19,50	1114,00
5:DKMP206	0,83	-20,00	1380,00
5:DKMP206	0,83	-20,50	1641,00
5:DKMP206	0,83	-21,00	1745,00
5:DKMP206	0,83	-21,50	1654,00
5:DKMP206	0,83	-22,00	1786,00
4:DKM207	3,20	-18,00	1172,00
4:DKM207	3,20	-18,50	1309,00
4:DKM207	3,20	-19,00	1408,00
4:DKM207	3,20	-19,50	1188,00
4:DKM207	3,20	-20,00	1218,00
4:DKM207	3,20	-20,50	1326,00
4:DKM207	3,20	-21,00	1439,00
4:DKM207	3,20	-21,50	1440,00
4:DKM207	3,20	-22,00	1329,00
6:DKMP240	1,51	-18,00	2764,00
6:DKMP240	1,51	-18,50	2856,00
6:DKMP240	1,51	-19,00	2874,00
6:DKMP240	1,51	-19,50	2631,00
6:DKMP240	1,51	-20,00	3163,00
6:DKMP240	1,51	-20,50	3241,00
6:DKMP240	1,51	-21,00	3170,00
6:DKMP240	1,51	-21,50	2940,00
6:DKMP240	1,51	-22,00	2902,00

End of Report

N206 Veldschanstunnel

Fundex-GI palen 540/660 mm

ξ_3 1,15 ξ_4 0,92

Met volledige schachtwrijving vanaf NAP -3 m (alle lagen gemarkeerd als zand; $\alpha_s = 0,009$; kortdurende belasting)

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-18,0	1780	1507	3287	2382	45	45	2337
102	-18,0	957	1102	2059	1492	42	42	1450
DKM204	-18,0	773	1343	2116	1533	41	41	1492
DKM205	-18,0	662	1358	2020	1464	57	57	1407
DKMP206	-18,0	753	1329	2082	1509	40	40	1469
DKM207	-18,0	1617	1190	2807	2034	53	53	1981
DKMP240	-18,0	2706	2082	4788	3470	49	49	3421
gemiddelde / ξ_3				2380	1983			1937
var.coeff.				37,45%	37,45%			38,29%
minimum / ξ_4				2196	1830	57	57	1773

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-18,5	1962	1617	3579	2593	45	45	2548
102	-18,5	933	1190	2123	1538	42	42	1496
DKM204	-18,5	1473	1400	2873	2082	41	41	2041
DKM205	-18,5	1209	1404	2613	1893	57	57	1836
DKMP206	-18,5	682	1424	2106	1526	40	40	1486
DKM207	-18,5	1684	1314	2998	2172	53	53	2119
DKMP240	-18,5	2710	2205	4915	3562	49	49	3513
gemiddelde / ξ_3				2634	2195			2148
var.coeff.				32,26%	32,27%			32,89%
minimum / ξ_4				2289	1908	40	40	1868

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-19,0	2427	1732	4159	3014	45	45	2969
102	-19,0	1361	1251	2612	1893	42	42	1851
DKM204	-19,0	1363	1538	2901	2102	41	41	2061
DKM205	-19,0	1419	1488	2907	2107	57	57	2050
DKMP206	-19,0	695	1473	2168	1571	40	40	1531
DKM207	-19,0	1680	1454	3134	2271	53	53	2218
DKMP240	-19,0	2612	2328	4940	3580	49	49	3531
gemiddelde / ξ_3				2835	2363			2316
var.coeff.				29,40%	29,40%			29,92%
minimum / ξ_4				2357	1964	40	40	1924

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-19,5	2569	1864	4433	3212	45	45	3167
102	-19,5	1643	1348	2991	2167	42	42	2125
DKM204	-19,5	1198	1678	2876	2084	41	41	2043
DKM205	-19,5	1698	1587	3285	2380	57	57	2323
DKMP206	-19,5	1299	1516	2815	2040	40	40	2000
DKM207	-19,5	1236	1594	2830	2051	53	53	1998
DKMP240	-19,5	2154	2450	4604	3336	49	49	3287
gemiddelde / ξ_3				2961	2467			2420
var.coeff.				22,87%	22,87%			23,27%
minimum / ξ_4				3060	2550	40	40	2510

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-20,0	2579	2002	4581	3320	45	45	3275
102	-20,0	1960	1458	3418	2477	42	42	2435
DKM204	-20,0	1198	1771	2969	2151	41	41	2110
DKM205	-20,0	2145	1698	3843	2785	57	57	2728
DKMP206	-20,0	1573	1608	3181	2305	40	40	2265
DKM207	-20,0	1156	1716	2872	2081	53	53	2028
DKMP240	-20,0	2790	2548	5338	3868	49	49	3819
gemiddelde / ξ_3				3255	2712			2666
var.coeff.				24,47%	24,48%			24,86%
minimum / ξ_4				3122	2601	53	53	2548

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-20,5	2440	2142	4582	3320	45	45	3275
102	-20,5	2007	1570	3577	2592	42	42	2550
DKM204	-20,5	1719	1847	3566	2584	41	41	2543
DKM205	-20,5	2299	1831	4130	2993	57	57	2936
DKMP206	-20,5	1825	1717	3542	2567	40	40	2527
DKM207	-20,5	1211	1811	3022	2190	53	53	2137
DKMP240	-20,5	2763	2683	5446	3946	49	49	3897
gemiddelde / ξ_3				3461	2885			2838
var.coeff.				20,45%	20,45%			20,75%
minimum / ξ_4				3285	2737	53	53	2684

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-21,0	2197	2282	4479	3246	45	45	3201
102	-21,0	2055	1685	3740	2710	42	42	2668
DKM204	-21,0	1712	1957	3669	2659	41	41	2618
DKM205	-21,0	2304	1971	4275	3098	57	57	3041
DKMP206	-21,0	1828	1857	3685	2670	40	40	2630
DKM207	-21,0	1258	1919	3177	2302	53	53	2249
DKMP240	-21,0	2525	2823	5348	3875	49	49	3826
gemiddelde / ξ_3				3525	2937			2890
var.coeff.				17,61%	17,61%			17,85%
minimum / ξ_4				3453	2878	53	53	2825

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-21,5	1813	2419	4232	3067	45	45	3022
102	-21,5	1713	1805	3518	2549	42	42	2507
DKM204	-21,5	1881	2063	3944	2858	41	41	2817
DKM205	-21,5	2002	2111	4113	2980	57	57	2923
DKMP206	-21,5	1563	1997	3560	2580	40	40	2540
DKM207	-21,5	1148	2031	3179	2304	53	53	2251
DKMP240	-21,5	2068	2963	5031	3646	49	49	3597
gemiddelde / ξ_3				3426	2855			2808
var.coeff.				15,40%	15,40%			15,62%
minimum / ξ_4				3455	2880	53	53	2827

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-22,0	1890	2503	4393	3183	45	45	3138
102	-22,0	1729	1924	3653	2647	42	42	2605
DKM204	-22,0	2009	2177	4186	3033	41	41	2992
DKM205	-22,0	1757	2251	4008	2904	57	57	2847
DKMP206	-22,0	1648	2095	3743	2712	40	40	2672
DKM207	-22,0	896	2129	3025	2192	53	53	2139
DKMP240	-22,0	1897	3082	4979	3608	49	49	3559
gemiddelde / ξ_3				3477	2897			2850
var.coeff.				15,43%	15,43%			15,71%
minimum / ξ_4				3288	2740	53	53	2687

Report for D-Foundations 23.1

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



NOBLEO
bouw & infra

Company: Nobleo Bouw & Infra

Date of report: 17-6-2025

Time of report: 14:14:29

Report with version: 23.1.1.40340

Date of calculation: 17-6-2025

Time of calculation: 14:13:15

Calculated with version: 23.1.1.40340

File name: Veldschanstunnel fase DO

Project identification: N206 Europaweg Leiden
Veldschanstunnel, fase DO KORTDURENDE BELASTING
D-Foundations Veldschanstunnel fase DO

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2 Input Data

2.1 General Input Data

Model Bearing Piles (EC7-NL)

2.2 General Report Data

Geotechnical consultant : ir. Roel van der Putten
 Design engineer superstructure :
 Principal :
 Title 1 : N206 Europaweg Leiden
 Title 2 : Veldschanstunnel, fase DO KORTDURENDE BELASTING
 Title 3 : D-Foundations Veldschanstunnel fase DO
 Number of project :
 Location of project :

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.

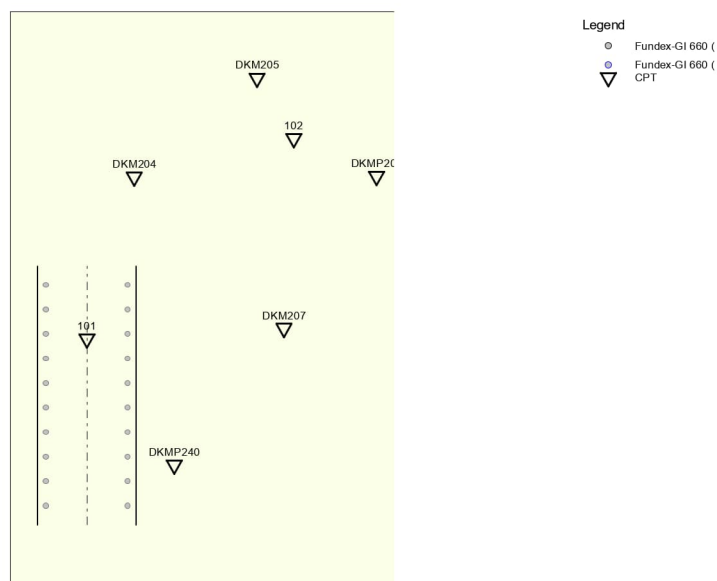
2.4 Superstructure

Rigidity of the superstructure : Rigid

2.5 General CPT Data

Number of CPT's : 7
 Timing of CPT's : CPT - Excavation - Install

2.5.1 View of CPT's in Foundation Plan



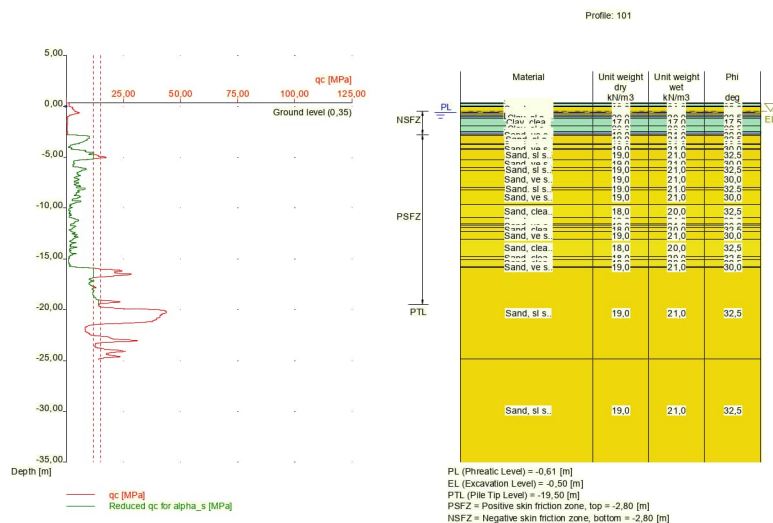
Name CPT	Pile tip level [m R.L.]	Top of pos. friction zone [m R.L.]	Bottom of neg. friction zone [m R.L.]	X-coor- dinate [m]	Y-coor- dinate [m]
101	-19,50	-2,80	-2,80	93389,60	461876,90
102	-19,50	-2,70	-2,70	93414,90	461901,40
DKM204	-19,50	-2,70	-2,70	93395,40	461896,70
DKM205	-19,50	-3,20	-3,20	93410,40	461908,80
DKMP206	-19,50	-2,60	-2,60	93425,00	461896,80
DKM207	-19,50	-3,10	-3,10	93413,70	461878,20
DKMP240	-19,50	-2,90	-2,90	93400,30	461861,50

2.6 Soil Data

Number of soil profiles (= number of CPT's) : 7

2.6.1 Soil Profile 101

Belonging to CPT	101
Surface level in [m. reference level] :	0,35
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,80
Bottom of negative skin friction zone in [m. reference level] :	-2,80
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	35

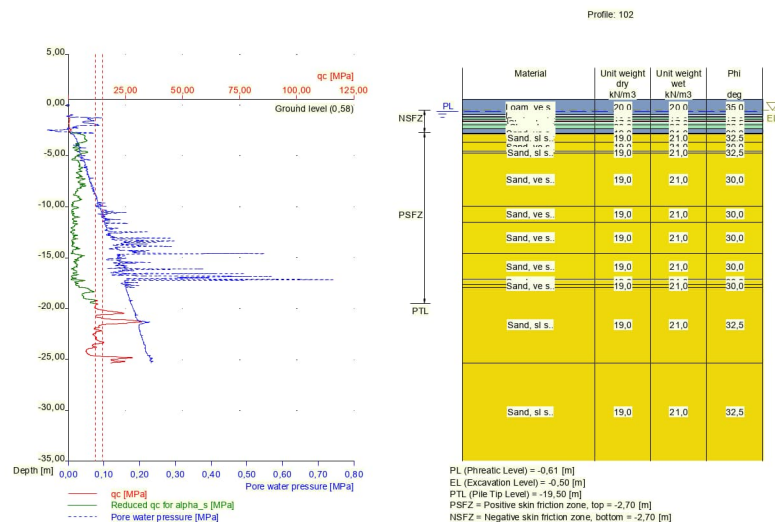


Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,350	20,00	20,00	35,00	Loam	--
2	0,340	20,00	20,00	35,00	Loam	--
3	0,240	20,00	20,00	22,50	Clay	--
4	0,040	20,00	20,00	35,00	Loam	--
5	-0,060	19,00	21,00	30,00	Sand	0,200

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
6	-0,460	19,00	21,00	32,50	Sand	0,200
7	-0,660	19,00	21,00	30,00	Sand	0,200
8	-0,860	20,00	20,00	35,00	Loam	--
9	-1,060	20,00	20,00	22,50	Clay	--
10	-1,160	17,00	17,00	17,50	Clay	--
11	-1,960	20,00	20,00	22,50	Clay	--
12	-2,460	20,00	20,00	35,00	Loam	--
13	-2,760	19,00	21,00	30,00	Sand	0,200
14	-2,860	19,00	21,00	32,50	Sand	0,200
15	-3,660	19,00	21,00	30,00	Sand	0,200
16	-3,760	18,00	20,00	32,50	Sand	0,200
17	-4,160	19,00	21,00	30,00	Sand	0,200
18	-4,260	19,00	21,00	32,50	Sand	0,200
19	-5,260	19,00	21,00	30,00	Sand	0,200
20	-6,060	19,00	21,00	32,50	Sand	0,200
21	-6,360	19,00	21,00	30,00	Sand	0,200
22	-7,960	19,00	21,00	32,50	Sand	0,200
23	-8,260	19,00	21,00	30,00	Sand	0,200
24	-9,660	18,00	20,00	32,50	Sand	0,200
25	-10,960	19,00	21,00	30,00	Sand	0,200
26	-11,560	18,00	20,00	32,50	Sand	0,200
27	-11,660	19,00	21,00	30,00	Sand	0,200
28	-11,960	18,00	20,00	32,50	Sand	0,200
29	-12,360	19,00	21,00	30,00	Sand	0,200
30	-13,060	18,00	20,00	32,50	Sand	0,200
31	-14,760	18,00	20,00	32,50	Sand	0,200
32	-15,060	18,00	20,00	32,50	Sand	0,200
33	-15,760	19,00	21,00	30,00	Sand	0,200
34	-15,860	19,00	21,00	32,50	Sand	0,200
35	-24,860	19,00	21,00	32,50	Sand	0,200

2.6.2 Soil Profile 102

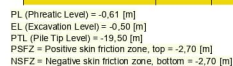
Belonging to CPT	102
Surface level in [m. reference level] :	0,58
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,70
Bottom of negative skin friction zone in [m. reference level] :	-2,70
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	20



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,580	20,00	20,00	35,00	Loam	--
2	-0,920	20,00	20,00	35,00	Loam	--
3	-1,120	20,00	20,00	22,50	Clay	--
4	-1,220	17,00	17,00	17,50	Clay	--
5	-1,420	13,00	13,00	15,00	Peat	--
6	-1,620	17,00	17,00	17,50	Clay	--
7	-1,920	20,00	20,00	22,50	Clay	--
8	-2,320	20,00	20,00	35,00	Loam	--
9	-2,720	19,00	21,00	30,00	Sand	0,200
10	-2,820	19,00	21,00	32,50	Sand	0,200
11	-3,620	19,00	21,00	30,00	Sand	0,200
12	-4,520	19,00	21,00	32,50	Sand	0,200
13	-4,720	19,00	21,00	30,00	Sand	0,200
14	-9,920	19,00	21,00	30,00	Sand	0,200
15	-11,520	19,00	21,00	30,00	Sand	0,200
16	-14,620	19,00	21,00	30,00	Sand	0,200
17	-17,120	19,00	21,00	30,00	Sand	0,200
18	-17,620	19,00	21,00	30,00	Sand	0,200
19	-17,920	19,00	21,00	32,50	Sand	0,200
20	-25,320	19,00	21,00	32,50	Sand	0,200

2.6.3 Soil Profile DKM204

Belonging to CPT	DKM204
Surface level in [m. reference level] :	3,29
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,70
Bottom of negative skin friction zone in [m. reference level] :	-2,70
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	28

Page 7

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
21	-9,789	19,00	21,00	30,00	Sand	0,200
22	-11,189	19,00	21,00	30,00	Sand	0,200
23	-11,390	19,00	21,00	32,50	Sand	0,200
24	-11,590	19,00	21,00	30,00	Sand	0,200
25	-12,390	19,00	21,00	32,50	Sand	0,200
26	-12,590	19,00	21,00	30,00	Sand	0,200
27	-13,490	19,00	21,00	30,00	Sand	0,200
28	-14,290	19,00	21,00	30,00	Sand	0,200
29	-14,390	19,00	21,00	32,50	Sand	0,200
30	-14,590	19,00	21,00	30,00	Sand	0,200
31	-15,590	19,00	21,00	30,00	Sand	0,200
32	-15,690	19,00	21,00	32,50	Sand	0,200
33	-15,990	19,00	21,00	30,00	Sand	0,200
34	-16,590	19,00	21,00	30,00	Sand	0,200
35	-16,990	19,00	21,00	32,50	Sand	0,200
36	-17,190	19,00	21,00	30,00	Sand	0,200
37	-17,590	19,00	21,00	32,50	Sand	0,200
38	-17,790	19,00	21,00	30,00	Sand	0,200
39	-18,490	19,00	21,00	32,50	Sand	0,200
40	-29,430	19,00	21,00	32,50	Sand	0,200
41	-29,530	19,00	21,00	32,50	Sand	0,200

2.6.5 Soil Profile DKMP206

Belonging to CPT

Surface level in [m. reference level] :

Phreatic level in [m. reference level] :

Pile tip level in [m. reference level] :

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

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

OCR-value foundation layer :

Expected groundlevel settlement in [m] :

Number of layers in profile :

DKMP206

0,83

-0,61

-19,50

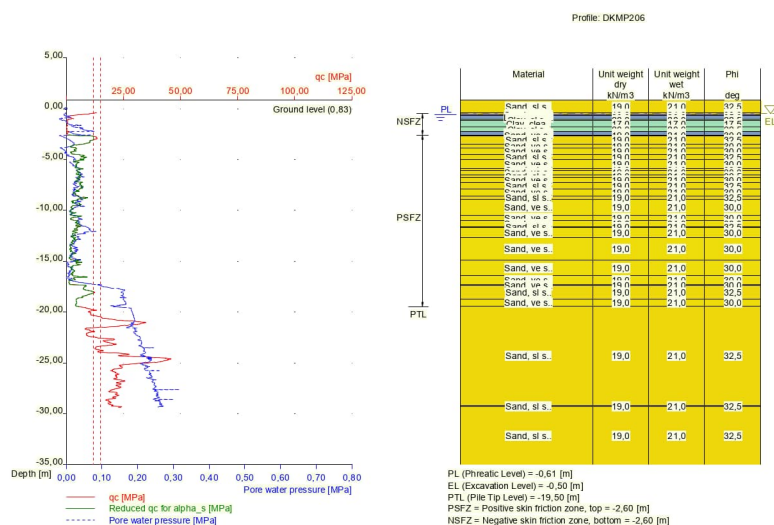
-2,60

-2,60

1,00

0,11

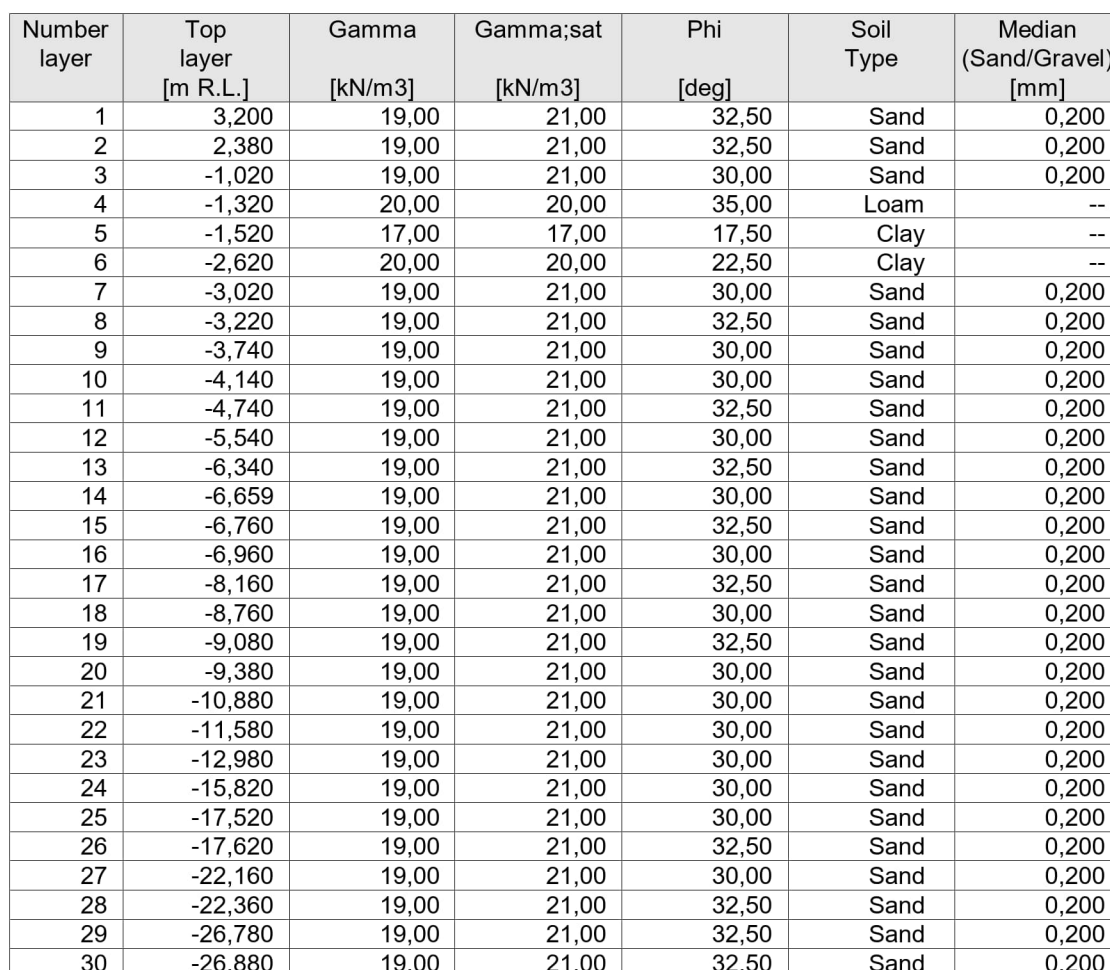
35



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,830	19,00	21,00	32,50	Sand	0,200
2	-0,390	19,00	21,00	32,50	Sand	0,200
3	-0,590	19,00	21,00	30,00	Sand	0,200
4	-0,690	20,00	20,00	35,00	Loam	--
5	-1,090	20,00	20,00	22,50	Clay	--
6	-1,190	17,00	17,00	17,50	Clay	--
7	-1,790	20,00	20,00	22,50	Clay	--
8	-2,290	20,00	20,00	35,00	Loam	--
9	-2,590	19,00	21,00	30,00	Sand	0,200
10	-2,690	19,00	21,00	32,50	Sand	0,200
11	-3,490	19,00	21,00	30,00	Sand	0,200
12	-3,890	19,00	21,00	30,00	Sand	0,200
13	-4,510	19,00	21,00	32,50	Sand	0,200
14	-5,010	19,00	21,00	30,00	Sand	0,200
15	-5,910	19,00	21,00	32,50	Sand	0,200
16	-6,110	19,00	21,00	30,00	Sand	0,200
17	-6,510	19,00	21,00	32,50	Sand	0,200
18	-6,810	19,00	21,00	30,00	Sand	0,200
19	-7,310	19,00	21,00	32,50	Sand	0,200
20	-7,910	19,00	21,00	30,00	Sand	0,200
21	-8,610	19,00	21,00	32,50	Sand	0,200
22	-8,910	19,00	21,00	30,00	Sand	0,200
23	-10,510	19,00	21,00	30,00	Sand	0,200
24	-11,010	19,00	21,00	30,00	Sand	0,200
25	-11,610	19,00	21,00	32,50	Sand	0,200
26	-11,710	19,00	21,00	30,00	Sand	0,200
27	-12,710	19,00	21,00	30,00	Sand	0,200
28	-14,910	19,00	21,00	30,00	Sand	0,200
29	-16,410	19,00	21,00	30,00	Sand	0,200
30	-17,310	19,00	21,00	30,00	Sand	0,200
31	-17,410	19,00	21,00	32,50	Sand	0,200
32	-18,710	19,00	21,00	30,00	Sand	0,200
33	-19,410	19,00	21,00	32,50	Sand	0,200
34	-29,210	19,00	21,00	32,50	Sand	0,200
35	-29,310	19,00	21,00	32,50	Sand	0,200

2.6.6 Soil Profile DKM207

Belonging to CPT	DKM207
Surface level in [m. reference level] :	3,20
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-3,10
Bottom of negative skin friction zone in [m. reference level] :	-3,10
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	30



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
21	-10,207	19,00	21,00	30,00	Sand	0,200
22	-11,826	19,00	21,00	30,00	Sand	0,200
23	-12,827	19,00	21,00	30,00	Sand	0,200
24	-12,927	19,00	21,00	32,50	Sand	0,200
25	-28,467	19,00	21,00	32,50	Sand	0,200
26	-28,567	19,00	21,00	32,50	Sand	0,200

2.7 Pile Types

2.7.1 Pile type : Fundex-GI 660

Pile type : Screw pile, cast in place, with grout

Materialtype for pile : Concrete

Slip layer : None

Pile shape : Round pile

beta (Shape factor) according to figure 7.i, NEN 9997-1+C2:2017.

s (factor for influence of the shape of the crosssection of the pile base) according to NEN 9997-1+C2:2017.

Pile dimensions :

Diameter [m] : 0,660

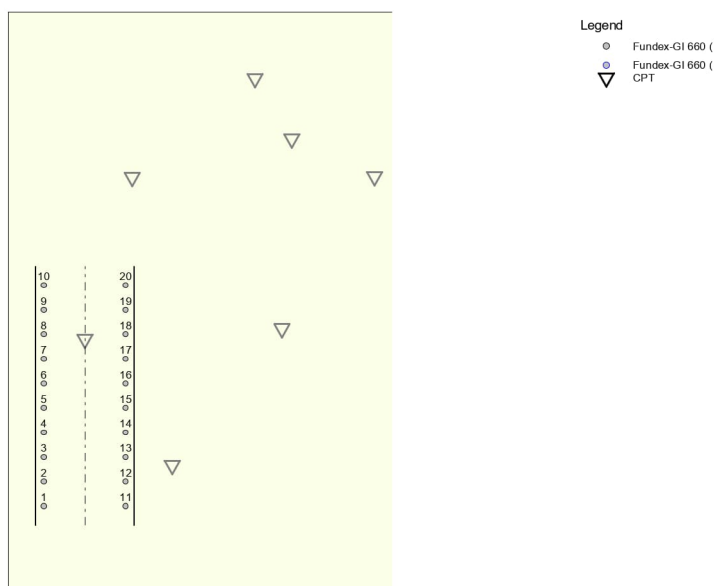
2.8 Foundation Plan

Number of piles : 20

Number of collaborating piles* : 20

* : 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 (EQU/STR/GEO) [kN]	Fc;d (SLS) [kN]	P0 [kN/m2]	Pile head level [m R.L.]
1: 1	93384,60	461856,50	0,00	0,00	27,70	-0,80
2: 2	93384,60	461859,50	0,00	0,00	27,70	-0,80
3: 3	93384,60	461862,50	0,00	0,00	27,70	-0,80
4: 4	93384,60	461865,50	0,00	0,00	27,70	-0,80
5: 5	93384,60	461868,50	0,00	0,00	27,70	-0,80
6: 6	93384,60	461871,50	0,00	0,00	27,70	-0,80
7: 7	93384,60	461874,50	0,00	0,00	27,70	-0,80
8: 8	93384,60	461877,50	0,00	0,00	27,70	-0,80
9: 9	93384,60	461880,50	0,00	0,00	27,70	-0,80
10: 10	93384,60	461883,50	0,00	0,00	27,70	-0,80
11: 11	93394,60	461856,50	0,00	0,00	27,70	-0,80
12: 12	93394,60	461859,50	0,00	0,00	27,70	-0,80
13: 13	93394,60	461862,50	0,00	0,00	27,70	-0,80
14: 14	93394,60	461865,50	0,00	0,00	27,70	-0,80
15: 15	93394,60	461868,50	0,00	0,00	27,70	-0,80
16: 16	93394,60	461871,50	0,00	0,00	27,70	-0,80
17: 17	93394,60	461874,50	0,00	0,00	27,70	-0,80
18: 18	93394,60	461877,50	0,00	0,00	27,70	-0,80
19: 19	93394,60	461880,50	0,00	0,00	27,70	-0,80
20: 20	93394,60	461883,50	0,00	0,00	27,70	-0,80

2.9 Excavation Data

Excavation level in [m. reference level] :

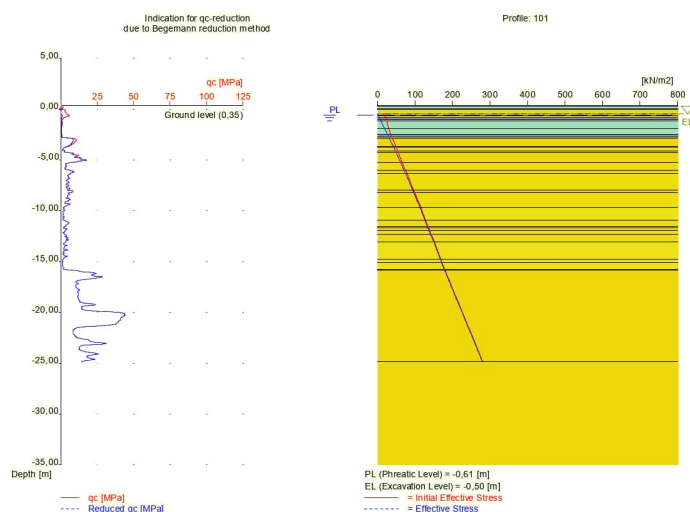
-0,50

Reduction model :

Begemann

Distance edge pile to excavation boundary [m] :

1,00



2.10 Overruled Parameters

User defined Factor xi3 [-] :

1,15

User defined Factor xi4 [-] :

0,92

2.11 Model Options

Use pilegroup for negative skin friction (standard)
Do not create intermediate results file
Use reduction for continuous flight auger piles (standard)
Use the influence of excavations (standard).

2.12 Model Options

Selected pile types :
-Fundex-GI 660

Selected profiles :
-101
-102
-DKM204
-DKM205
-DKMP206
-DKM207
-DKMP240

Trajectory
-begin [m] : -18,00
-end [m] : -22,00
-interval [m] : 0,50

3 Bearing Piles (EC7-NL): Results Preliminary Design, Indication Bearing Capacity

3.1 Errors and Warnings

Warning : The factor ξ_3 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

Warning : The factor ξ_4 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

The warning just below concerns at least one of the used soil profiles.

Warning : The positive skin friction zone contains compressible layers. The demands set by article 7.6.1.1 b are not met. A calculation of interaction is required to show that given schematization is valid.

The calculated pile settlement as mentioned in the report should be adapted based on that calculation.

Soil profile 101

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile 102

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM204

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM205

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP206

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM207

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP240

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

3.2 Remarks

When checking the survey and testing of soil according to NEN 9997-1+C2:2017 art. 3.2.3 section (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.

Note : The calculations performed are based on a single pile for limit state EQU/STR/GEO (= ultimate limit state). Due to the nature of preliminary design, a single pile is always assumed. A possible pileplan is disregarded when using the preliminary design option. Hence a non rigid superstructure is assumed and pile group effects are not considered.

3.3 Calculation Parameters

3.3.1 Pile Factors

γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8, Limit State EQU/STR/GEO) :	1,20
γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	

the Serviceability Limit State) :	1,00
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
Limit State EQU/STR/GEO) :	1,20
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
the Serviceability Limit State) :	1,00
xi3 (user defined) :	1,15
xi4 (user defined) :	0,92

3.3.2 Pile type : Fundex-GI 660

Pile type :	Screw pile, cast in place, with grout
Materialtype for pile :	Concrete
Slip layer :	None
Pile shape :	Round pile
beta (Shape factor: figure 7.i, NEN 9997-1+C2:2017	
art. 7.6.2.3(g) : Pile tip) :	1,00
s (NEN 9997-1+C2:2017 art. 7.6.2.3(h) : factor for	
the influence of the shape of the crossection of the pile base) :	1,00
Pile dimensions :	
Diameter [m] :	0,660

Number/Name CPT	Alpha_s Sand/ Gravel	Alpha_s Clay/Loam Peat	Alpha_p
1:101	0,0090	--	0,6300
7:102	0,0090	0,0250	0,6300
2:DKM204	0,0090	0,0250	0,6300
3:DKM205	0,0090	--	0,6300
5:DKMP206	0,0090	--	0,6300
4:DKM207	0,0090	--	0,6300
6:DKMP240	0,0090	--	0,6300

3.4 Results Bearing Forces for Pile type : Fundex-GI 660

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
1:101	-18.00	1780	1507	3287	2382	45	45	2337
1:101	-18.50	1962	1617	3579	2593	45	45	2548
1:101	-19.00	2427	1732	4159	3014	45	45	2969
1:101	-19.50	2569	1864	4433	3212	45	45	3167
1:101	-20.00	2579	2002	4581	3320	45	45	3275
1:101	-20.50	2440	2142	4582	3320	45	45	3275
1:101	-21.00	2197	2282	4479	3246	45	45	3201
1:101	-21.50	1813	2419	4232	3067	45	45	3022
1:101	-22.00	1890	2503	4393	3183	45	45	3138
7:102	-18.00	957	1102	2059	1492	42	42	1450
7:102	-18.50	933	1190	2123	1538	42	42	1496
7:102	-19.00	1361	1251	2612	1893	42	42	1851
7:102	-19.50	1643	1348	2991	2167	42	42	2125
7:102	-20.00	1960	1458	3418	2477	42	42	2435
7:102	-20.50	2007	1570	3577	2592	42	42	2550
7:102	-21.00	2055	1685	3740	2710	42	42	2668
7:102	-21.50	1713	1805	3518	2549	42	42	2507
7:102	-22.00	1729	1924	3653	2647	42	42	2605
2:DKM204	-18.00	773	1343	2116	1533	41	41	1492
2:DKM204	-18.50	1473	1400	2873	2082	41	41	2041
2:DKM204	-19.00	1363	1538	2901	2102	41	41	2061
2:DKM204	-19.50	1198	1678	2876	2084	41	41	2043
2:DKM204	-20.00	1198	1771	2969	2151	41	41	2110
2:DKM204	-20.50	1719	1847	3566	2584	41	41	2543
2:DKM204	-21.00	1712	1957	3669	2659	41	41	2618

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
2:DKM204	-21.50	1881	2063	3944	2858	41	41	2817
2:DKM204	-22.00	2009	2177	4186	3033	41	41	2992
3:DKM205	-18.00	662	1358	2020	1464	57	57	1407
3:DKM205	-18.50	1209	1404	2613	1893	57	57	1836
3:DKM205	-19.00	1419	1488	2907	2107	57	57	2050
3:DKM205	-19.50	1698	1587	3285	2380	57	57	2323
3:DKM205	-20.00	2145	1698	3843	2785	57	57	2728
3:DKM205	-20.50	2299	1831	4130	2993	57	57	2936
3:DKM205	-21.00	2304	1971	4275	3098	57	57	3041
3:DKM205	-21.50	2002	2111	4113	2980	57	57	2923
3:DKM205	-22.00	1757	2251	4008	2904	57	57	2847
5:DKMP206	-18.00	753	1329	2082	1509	40	40	1469
5:DKMP206	-18.50	682	1424	2106	1526	40	40	1486
5:DKMP206	-19.00	695	1473	2168	1571	40	40	1531
5:DKMP206	-19.50	1299	1516	2815	2040	40	40	2000
5:DKMP206	-20.00	1573	1608	3181	2305	40	40	2265
5:DKMP206	-20.50	1825	1717	3542	2567	40	40	2527
5:DKMP206	-21.00	1828	1857	3685	2670	40	40	2630
5:DKMP206	-21.50	1563	1997	3560	2580	40	40	2540
5:DKMP206	-22.00	1648	2095	3743	2712	40	40	2672
4:DKM207	-18.00	1617	1190	2807	2034	53	53	1981
4:DKM207	-18.50	1684	1314	2998	2172	53	53	2119
4:DKM207	-19.00	1680	1454	3134	2271	53	53	2218
4:DKM207	-19.50	1236	1594	2830	2051	53	53	1998
4:DKM207	-20.00	1156	1716	2872	2081	53	53	2028
4:DKM207	-20.50	1211	1811	3022	2190	53	53	2137
4:DKM207	-21.00	1258	1919	3177	2302	53	53	2249
4:DKM207	-21.50	1148	2031	3179	2304	53	53	2251
4:DKM207	-22.00	896	2129	3025	2192	53	53	2139
6:DKMP240	-18.00	2706	2082	4788	3470	49	49	3421
6:DKMP240	-18.50	2710	2205	4915	3562	49	49	3513
6:DKMP240	-19.00	2612	2328	4940	3580	49	49	3531
6:DKMP240	-19.50	2154	2450	4604	3336	49	49	3287
6:DKMP240	-20.00	2790	2548	5338	3868	49	49	3819
6:DKMP240	-20.50	2763	2683	5446	3946	49	49	3897
6:DKMP240	-21.00	2525	2823	5348	3875	49	49	3826
6:DKMP240	-21.50	2068	2963	5031	3646	49	49	3597
6:DKMP240	-22.00	1897	3082	4979	3608	49	49	3559

* Rc;net;d = Rc;d - Fnsf;d

3.5 Summary Net Bearing Capacity in kN

Number/Name CPT	Groundlevel [m R.L.]	Level [m R.L.]	Fundex-GI 660 Rc;net;d [kN]
1:101	0,35	-18,00	2337,00
1:101	0,35	-18,50	2548,00
1:101	0,35	-19,00	2969,00
1:101	0,35	-19,50	3167,00
1:101	0,35	-20,00	3275,00
1:101	0,35	-20,50	3275,00
1:101	0,35	-21,00	3201,00
1:101	0,35	-21,50	3022,00
1:101	0,35	-22,00	3138,00
7:102	0,58	-18,00	1450,00
7:102	0,58	-18,50	1496,00
7:102	0,58	-19,00	1851,00
7:102	0,58	-19,50	2125,00
7:102	0,58	-20,00	2435,00
7:102	0,58	-20,50	2550,00
7:102	0,58	-21,00	2668,00
7:102	0,58	-21,50	2507,00

Number/Name CPT	Groundlevel [m R.L.]	Level [m R.L.]	Fundex-GI 660 Rc;net;d [kN]
7:102	0,58	-22,00	2605,00
2:DKM204	3,29	-18,00	1492,00
2:DKM204	3,29	-18,50	2041,00
2:DKM204	3,29	-19,00	2061,00
2:DKM204	3,29	-19,50	2043,00
2:DKM204	3,29	-20,00	2110,00
2:DKM204	3,29	-20,50	2543,00
2:DKM204	3,29	-21,00	2618,00
2:DKM204	3,29	-21,50	2817,00
2:DKM204	3,29	-22,00	2992,00
3:DKM205	0,55	-18,00	1407,00
3:DKM205	0,55	-18,50	1836,00
3:DKM205	0,55	-19,00	2050,00
3:DKM205	0,55	-19,50	2323,00
3:DKM205	0,55	-20,00	2728,00
3:DKM205	0,55	-20,50	2936,00
3:DKM205	0,55	-21,00	3041,00
3:DKM205	0,55	-21,50	2923,00
3:DKM205	0,55	-22,00	2847,00
5:DKMP206	0,83	-18,00	1469,00
5:DKMP206	0,83	-18,50	1486,00
5:DKMP206	0,83	-19,00	1531,00
5:DKMP206	0,83	-19,50	2000,00
5:DKMP206	0,83	-20,00	2265,00
5:DKMP206	0,83	-20,50	2527,00
5:DKMP206	0,83	-21,00	2630,00
5:DKMP206	0,83	-21,50	2540,00
5:DKMP206	0,83	-22,00	2672,00
4:DKM207	3,20	-18,00	1981,00
4:DKM207	3,20	-18,50	2119,00
4:DKM207	3,20	-19,00	2218,00
4:DKM207	3,20	-19,50	1998,00
4:DKM207	3,20	-20,00	2028,00
4:DKM207	3,20	-20,50	2137,00
4:DKM207	3,20	-21,00	2249,00
4:DKM207	3,20	-21,50	2251,00
4:DKM207	3,20	-22,00	2139,00
6:DKMP240	1,51	-18,00	3421,00
6:DKMP240	1,51	-18,50	3513,00
6:DKMP240	1,51	-19,00	3531,00
6:DKMP240	1,51	-19,50	3287,00
6:DKMP240	1,51	-20,00	3819,00
6:DKMP240	1,51	-20,50	3897,00
6:DKMP240	1,51	-21,00	3826,00
6:DKMP240	1,51	-21,50	3597,00
6:DKMP240	1,51	-22,00	3559,00

End of Report

BIJLAGE 3: BEREKENINGSRAPPORTEN D-FOUNDATIONS VOOR DE VLEUGELWANDEN

N206 Veldschanstunnel

Fundex-GI palen 540/660 mm ξ_3 1,15 ξ_4 0,92

Vleugelwanden

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-5,0	611	305	916	664	45	45	619
102	-5,0	387	241	628	455	42	42	413
DKM204	-5,0	578	310	888	643	41	41	602
DKM205	-5,0	504	160	664	481	57	57	424
DKMP206	-5,0	605	306	911	660	40	40	620
DKM207	-5,0	686	202	888	643	53	53	590
DKMP240	-5,0	472	257	729	528	49	49	479
gemiddelde / ξ_3				699	582			535
var.coeff.				15,60%	15,61%			17,41%
minimum / ξ_4				683	569	42	42	527

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-5,5	474	378	852	617	45	45	572
102	-5,5	590	270	860	623	42	42	581
DKM204	-5,5	709	353	1062	770	41	41	729
DKM205	-5,5	577	198	775	562	57	57	505
DKMP206	-5,5	667	353	1020	739	40	40	699
DKM207	-5,5	527	311	838	607	53	53	554
DKMP240	-5,5	615	292	907	657	49	49	608
gemiddelde / ξ_3				784	654			607
var.coeff.				11,45%	11,47%			13,19%
minimum / ξ_4				842	702	57	57	645

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-6,0	640	410	1050	761	45	45	716
102	-6,0	595	316	911	660	42	42	618
DKM204	-6,0	655	409	1064	771	41	41	730
DKM205	-6,0	505	249	754	546	57	57	489
DKMP206	-6,0	647	400	1047	759	40	40	719
DKM207	-6,0	627	353	980	710	53	53	657
DKMP240	-6,0	619	359	978	709	49	49	660
gemiddelde / ξ_3				843	702			656
var.coeff.				11,26%	11,29%			12,82%
minimum / ξ_4				820	683	57	57	626

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-6,5	620	476	1096	794	45	45	749
102	-6,5	546	366	912	661	42	42	619
DKM204	-6,5	660	473	1133	821	41	41	780
DKM205	-6,5	509	306	815	591	57	57	534
DKMP206	-6,5	618	448	1066	772	40	40	732
DKM207	-6,5	663	404	1067	773	53	53	720
DKMP240	-6,5	534	415	949	688	49	49	639
		gemiddelde / ξ_3		874	729			682
		var.coeff.		11,49%	11,46%			12,81%
		minimum / ξ_4		886	738	57	57	681

Number/Name	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
101	-7,0	566	524	1090	790	45	45	745
102	-7,0	511	411	922	668	42	42	626
DKM204	-7,0	677	525	1202	871	41	41	830
DKM205	-7,0	520	354	874	633	57	57	576
DKMP206	-7,0	622	501	1123	814	40	40	774
DKM207	-7,0	661	470	1131	820	53	53	767
DKMP240	-7,0	532	461	993	720	49	49	671
		gemiddelde / ξ_3		911	759			693
		var.coeff.		11,50%	11,52%			11,79%
		minimum / ξ_4		950	792	57	57	735

<= positieve uitschieter

Report for D-Foundations 23.1

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



NOBLEO
bouw & infra

Company: Nobleo Bouw & Infra

Date of report: 24-6-2025

Time of report: 07:59:36

Report with version: 23.1.1.40340

Date of calculation: 24-6-2025

Time of calculation: 07:59:18

Calculated with version: 23.1.1.40340

File name: Veldschanstunnel fase DO

Project identification: N206 Europaweg Leiden
Veldschanstunnel, fase DO VLEUGELWANDEN
D-Foundations Veldschanstunnel fase DO

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2 Input Data

2.1 General Input Data

Model Bearing Piles (EC7-NL)

2.2 General Report Data

Geotechnical consultant : ir. Roel van der Putten
 Design engineer superstructure :
 Principal :
 Title 1 : N206 Europaweg Leiden
 Title 2 : Veldschanstunnel, fase DO VLEUGELWANDEN
 Title 3 : D-Foundations Veldschanstunnel fase DO
 Number of project :
 Location of project :

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.

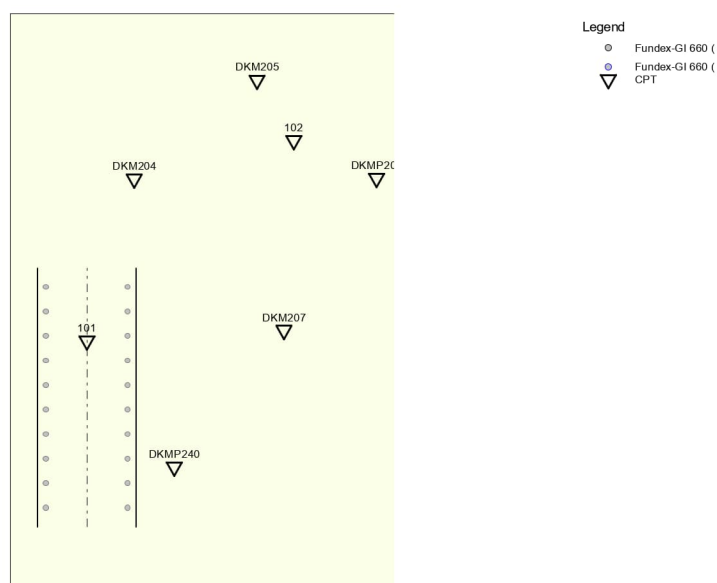
2.4 Superstructure

Rigidity of the superstructure : Rigid

2.5 General CPT Data

Number of CPT's : 7
 Timing of CPT's : CPT - Excavation - Install

2.5.1 View of CPT's in Foundation Plan



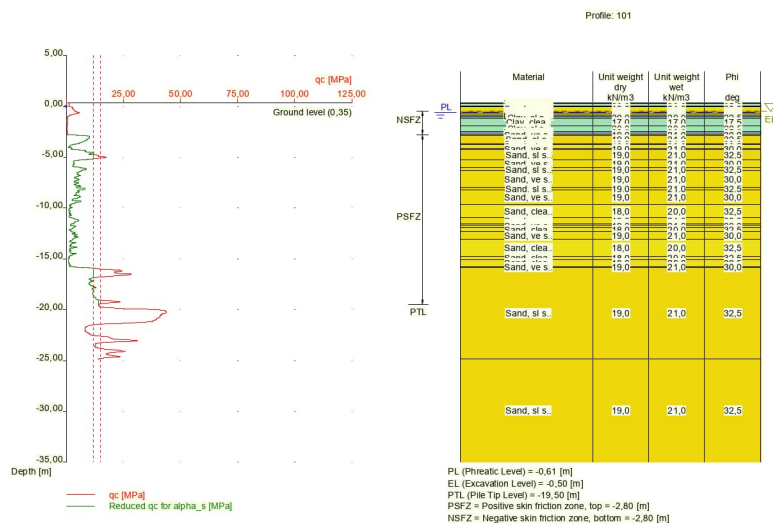
Name CPT	Pile tip level [m R.L.]	Top of pos. friction zone [m R.L.]	Bottom of neg. friction zone [m R.L.]	X-coor- dinate [m]	Y-coor- dinate [m]
101	-19,50	-2,80	-2,80	93389,60	461876,90
102	-19,50	-2,70	-2,70	93414,90	461901,40
DKM204	-19,50	-2,70	-2,70	93395,40	461896,70
DKM205	-19,50	-3,20	-3,20	93410,40	461908,80
DKMP206	-19,50	-2,60	-2,60	93425,00	461896,80
DKM207	-19,50	-3,10	-3,10	93413,70	461878,20
DKMP240	-19,50	-2,90	-2,90	93400,30	461861,50

2.6 Soil Data

Number of soil profiles (= number of CPT's) : 7

2.6.1 Soil Profile 101

Belonging to CPT	101
Surface level in [m. reference level] :	0,35
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,80
Bottom of negative skin friction zone in [m. reference level] :	-2,80
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	35

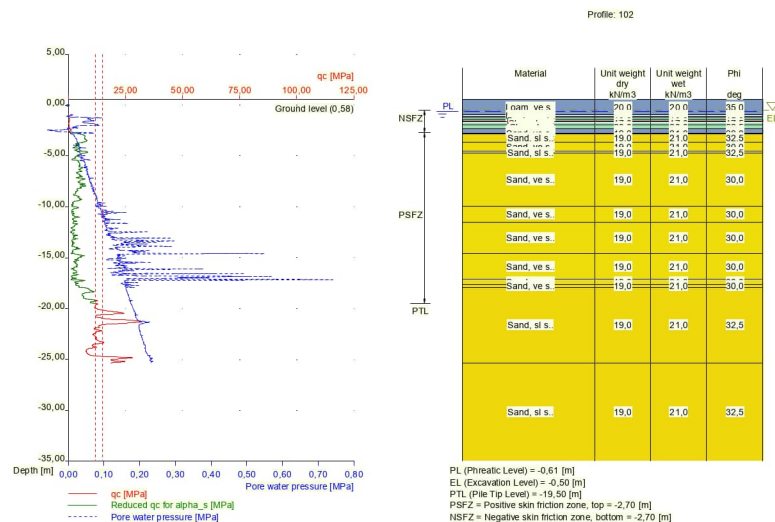


Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,350	20,00	20,00	35,00	Loam	--
2	0,340	20,00	20,00	35,00	Loam	--
3	0,240	20,00	20,00	22,50	Clay	--
4	0,040	20,00	20,00	35,00	Loam	--
5	-0,060	19,00	21,00	30,00	Sand	0,200

Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
6	-0,460	19,00	21,00	32,50	Sand	0,200
7	-0,660	19,00	21,00	30,00	Sand	0,200
8	-0,860	20,00	20,00	35,00	Loam	--
9	-1,060	20,00	20,00	22,50	Clay	--
10	-1,160	17,00	17,00	17,50	Clay	--
11	-1,960	20,00	20,00	22,50	Clay	--
12	-2,460	20,00	20,00	35,00	Loam	--
13	-2,760	19,00	21,00	30,00	Sand	0,200
14	-2,860	19,00	21,00	32,50	Sand	0,200
15	-3,660	19,00	21,00	30,00	Sand	0,200
16	-3,760	18,00	20,00	32,50	Sand	0,200
17	-4,160	19,00	21,00	30,00	Sand	0,200
18	-4,260	19,00	21,00	32,50	Sand	0,200
19	-5,260	19,00	21,00	30,00	Sand	0,200
20	-6,060	19,00	21,00	32,50	Sand	0,200
21	-6,360	19,00	21,00	30,00	Sand	0,200
22	-7,960	19,00	21,00	32,50	Sand	0,200
23	-8,260	19,00	21,00	30,00	Sand	0,200
24	-9,660	18,00	20,00	32,50	Sand	0,200
25	-10,960	19,00	21,00	30,00	Sand	0,200
26	-11,560	18,00	20,00	32,50	Sand	0,200
27	-11,660	19,00	21,00	30,00	Sand	0,200
28	-11,960	18,00	20,00	32,50	Sand	0,200
29	-12,360	19,00	21,00	30,00	Sand	0,200
30	-13,060	18,00	20,00	32,50	Sand	0,200
31	-14,760	18,00	20,00	32,50	Sand	0,200
32	-15,060	18,00	20,00	32,50	Sand	0,200
33	-15,760	19,00	21,00	30,00	Sand	0,200
34	-15,860	19,00	21,00	32,50	Sand	0,200
35	-24,860	19,00	21,00	32,50	Sand	0,200

2.6.2 Soil Profile 102

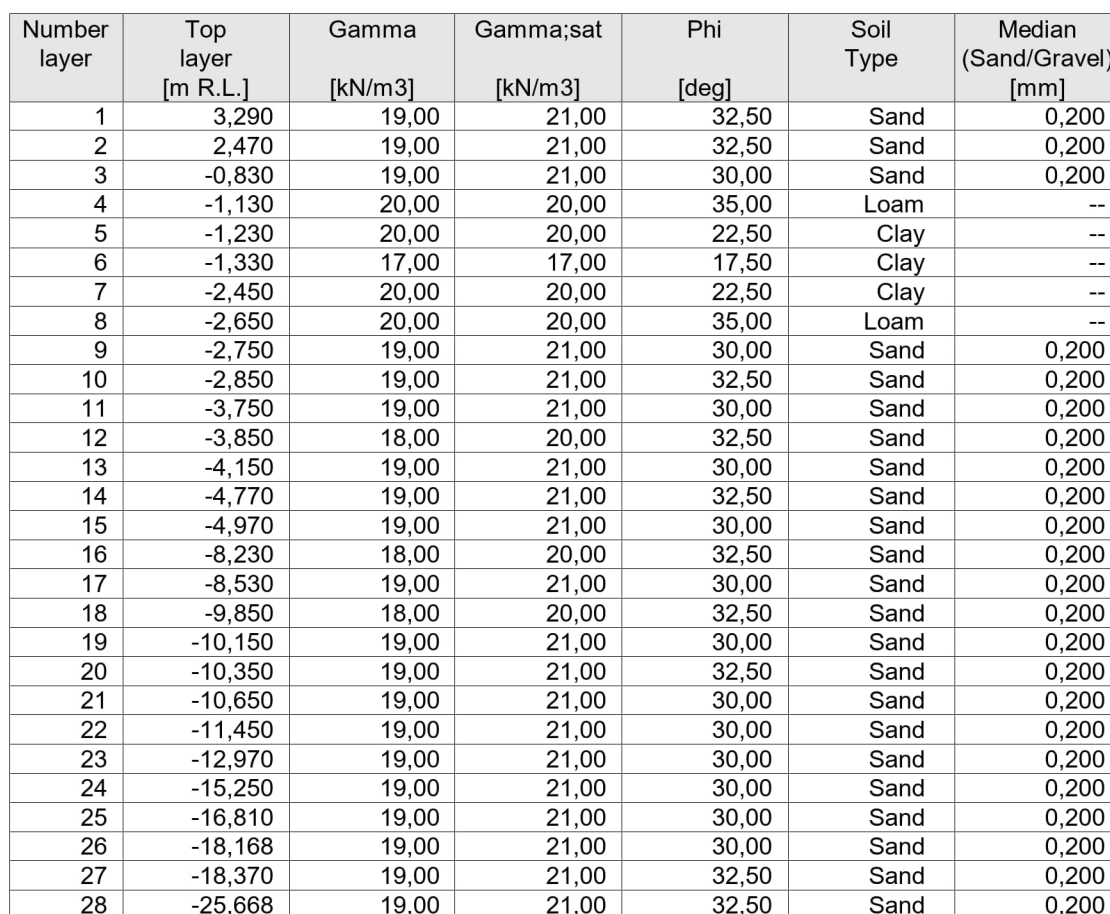
Belonging to CPT	102
Surface level in [m. reference level] :	0,58
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,70
Bottom of negative skin friction zone in [m. reference level] :	-2,70
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	20



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,580	20,00	20,00	35,00	Loam	--
2	-0,920	20,00	20,00	35,00	Loam	--
3	-1,120	20,00	20,00	22,50	Clay	--
4	-1,220	17,00	17,00	17,50	Clay	--
5	-1,420	13,00	13,00	15,00	Peat	--
6	-1,620	17,00	17,00	17,50	Clay	--
7	-1,920	20,00	20,00	22,50	Clay	--
8	-2,320	20,00	20,00	35,00	Loam	--
9	-2,720	19,00	21,00	30,00	Sand	0,200
10	-2,820	19,00	21,00	32,50	Sand	0,200
11	-3,620	19,00	21,00	30,00	Sand	0,200
12	-4,520	19,00	21,00	32,50	Sand	0,200
13	-4,720	19,00	21,00	30,00	Sand	0,200
14	-9,920	19,00	21,00	30,00	Sand	0,200
15	-11,520	19,00	21,00	30,00	Sand	0,200
16	-14,620	19,00	21,00	30,00	Sand	0,200
17	-17,120	19,00	21,00	30,00	Sand	0,200
18	-17,620	19,00	21,00	30,00	Sand	0,200
19	-17,920	19,00	21,00	32,50	Sand	0,200
20	-25,320	19,00	21,00	32,50	Sand	0,200

2.6.3 Soil Profile DKM204

Belonging to CPT	DKM204
Surface level in [m. reference level] :	3,29
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-2,70
Bottom of negative skin friction zone in [m. reference level] :	-2,70
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	28



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
21	-9,789	19,00	21,00	30,00	Sand	0,200
22	-11,189	19,00	21,00	30,00	Sand	0,200
23	-11,390	19,00	21,00	32,50	Sand	0,200
24	-11,590	19,00	21,00	30,00	Sand	0,200
25	-12,390	19,00	21,00	32,50	Sand	0,200
26	-12,590	19,00	21,00	30,00	Sand	0,200
27	-13,490	19,00	21,00	30,00	Sand	0,200
28	-14,290	19,00	21,00	30,00	Sand	0,200
29	-14,390	19,00	21,00	32,50	Sand	0,200
30	-14,590	19,00	21,00	30,00	Sand	0,200
31	-15,590	19,00	21,00	30,00	Sand	0,200
32	-15,690	19,00	21,00	32,50	Sand	0,200
33	-15,990	19,00	21,00	30,00	Sand	0,200
34	-16,590	19,00	21,00	30,00	Sand	0,200
35	-16,990	19,00	21,00	32,50	Sand	0,200
36	-17,190	19,00	21,00	30,00	Sand	0,200
37	-17,590	19,00	21,00	32,50	Sand	0,200
38	-17,790	19,00	21,00	30,00	Sand	0,200
39	-18,490	19,00	21,00	32,50	Sand	0,200
40	-29,430	19,00	21,00	32,50	Sand	0,200
41	-29,530	19,00	21,00	32,50	Sand	0,200

2.6.5 Soil Profile DKMP206

Belonging to CPT

Surface level in [m. reference level] :

Phreatic level in [m. reference level] :

Pile tip level in [m. reference level] :

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

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

OCR-value foundation layer :

Expected groundlevel settlement in [m] :

Number of layers in profile :

DKMP206

0,83

-0,61

-19,50

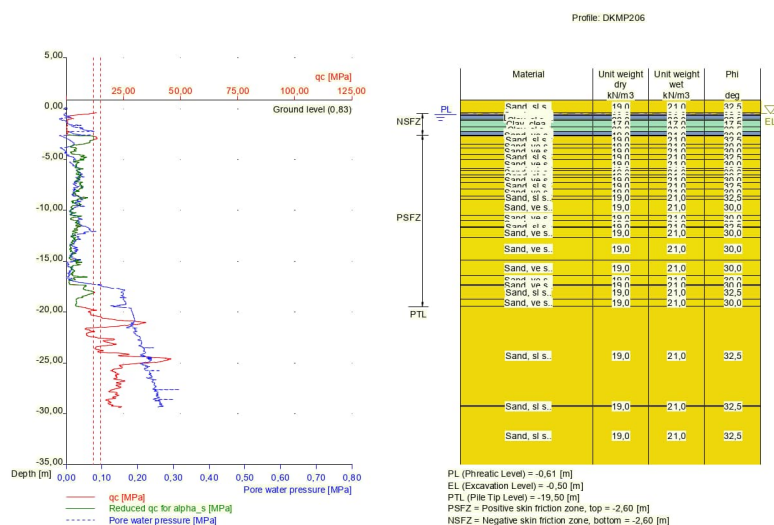
-2,60

-2,60

1,00

0,11

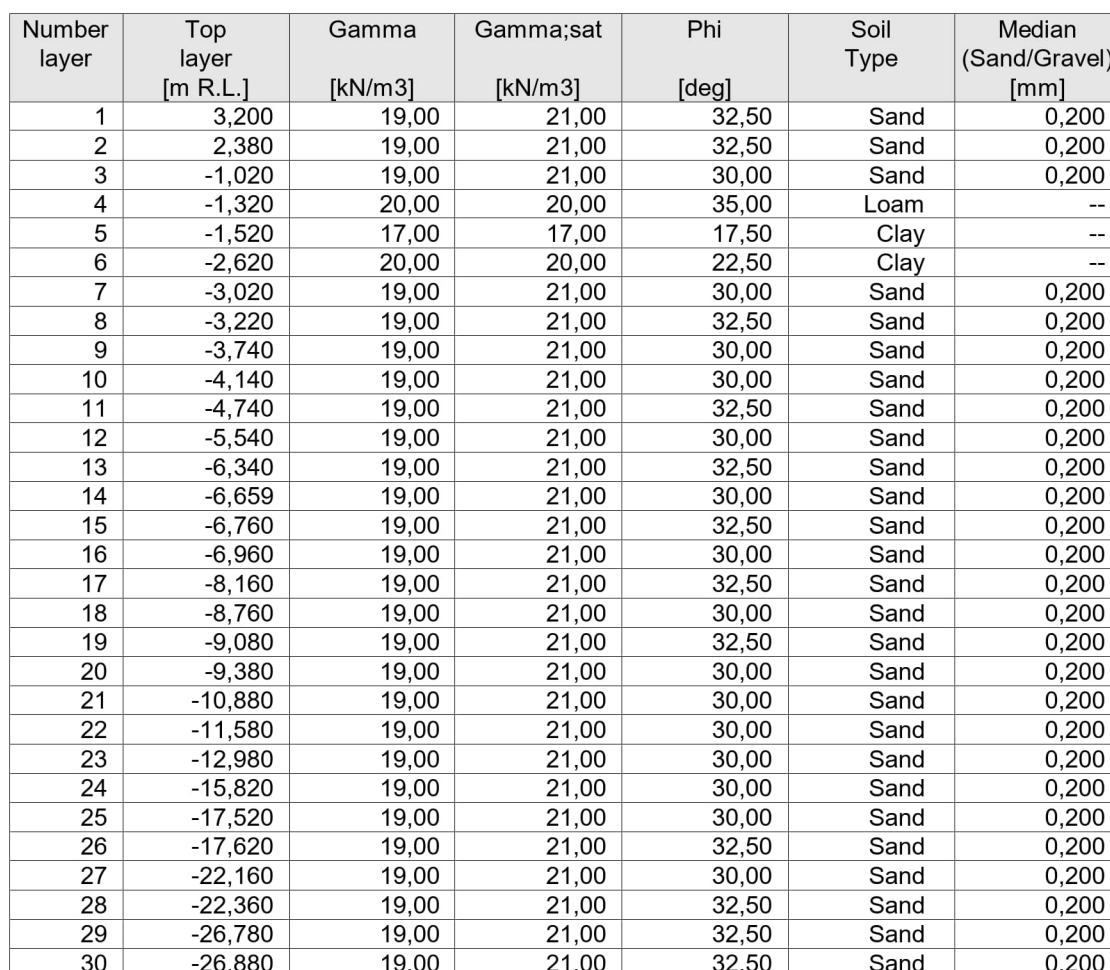
35



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
1	0,830	19,00	21,00	32,50	Sand	0,200
2	-0,390	19,00	21,00	32,50	Sand	0,200
3	-0,590	19,00	21,00	30,00	Sand	0,200
4	-0,690	20,00	20,00	35,00	Loam	--
5	-1,090	20,00	20,00	22,50	Clay	--
6	-1,190	17,00	17,00	17,50	Clay	--
7	-1,790	20,00	20,00	22,50	Clay	--
8	-2,290	20,00	20,00	35,00	Loam	--
9	-2,590	19,00	21,00	30,00	Sand	0,200
10	-2,690	19,00	21,00	32,50	Sand	0,200
11	-3,490	19,00	21,00	30,00	Sand	0,200
12	-3,890	19,00	21,00	30,00	Sand	0,200
13	-4,510	19,00	21,00	32,50	Sand	0,200
14	-5,010	19,00	21,00	30,00	Sand	0,200
15	-5,910	19,00	21,00	32,50	Sand	0,200
16	-6,110	19,00	21,00	30,00	Sand	0,200
17	-6,510	19,00	21,00	32,50	Sand	0,200
18	-6,810	19,00	21,00	30,00	Sand	0,200
19	-7,310	19,00	21,00	32,50	Sand	0,200
20	-7,910	19,00	21,00	30,00	Sand	0,200
21	-8,610	19,00	21,00	32,50	Sand	0,200
22	-8,910	19,00	21,00	30,00	Sand	0,200
23	-10,510	19,00	21,00	30,00	Sand	0,200
24	-11,010	19,00	21,00	30,00	Sand	0,200
25	-11,610	19,00	21,00	32,50	Sand	0,200
26	-11,710	19,00	21,00	30,00	Sand	0,200
27	-12,710	19,00	21,00	30,00	Sand	0,200
28	-14,910	19,00	21,00	30,00	Sand	0,200
29	-16,410	19,00	21,00	30,00	Sand	0,200
30	-17,310	19,00	21,00	30,00	Sand	0,200
31	-17,410	19,00	21,00	32,50	Sand	0,200
32	-18,710	19,00	21,00	30,00	Sand	0,200
33	-19,410	19,00	21,00	32,50	Sand	0,200
34	-29,210	19,00	21,00	32,50	Sand	0,200
35	-29,310	19,00	21,00	32,50	Sand	0,200

2.6.6 Soil Profile DKM207

Belonging to CPT	DKM207
Surface level in [m. reference level] :	3,20
Phreatic level in [m. reference level] :	-0,61
Pile tip level in [m. reference level] :	-19,50
Top of positive skin friction zone in [m. reference level] :	-3,10
Bottom of negative skin friction zone in [m. reference level] :	-3,10
OCR-value foundation layer :	1,00
Expected groundlevel settlement in [m] :	0,11
Number of layers in profile :	30



Number layer	Top layer [m R.L.]	Gamma [kN/m3]	Gamma;sat [kN/m3]	Phi [deg]	Soil Type	Median (Sand/Gravel) [mm]
21	-10,207	19,00	21,00	30,00	Sand	0,200
22	-11,826	19,00	21,00	30,00	Sand	0,200
23	-12,827	19,00	21,00	30,00	Sand	0,200
24	-12,927	19,00	21,00	32,50	Sand	0,200
25	-28,467	19,00	21,00	32,50	Sand	0,200
26	-28,567	19,00	21,00	32,50	Sand	0,200

2.7 Pile Types

2.7.1 Pile type : Fundex-GI 660

Pile type : Screw pile, cast in place, with grout

Materialtype for pile : Concrete

Slip layer : None

Pile shape : Round pile

beta (Shape factor) according to figure 7.i, NEN 9997-1+C2:2017.

s (factor for influence of the shape of the crossection of the pile base) according to NEN 9997-1+C2:2017.

Pile dimensions :
Diameter [m] : 0,660

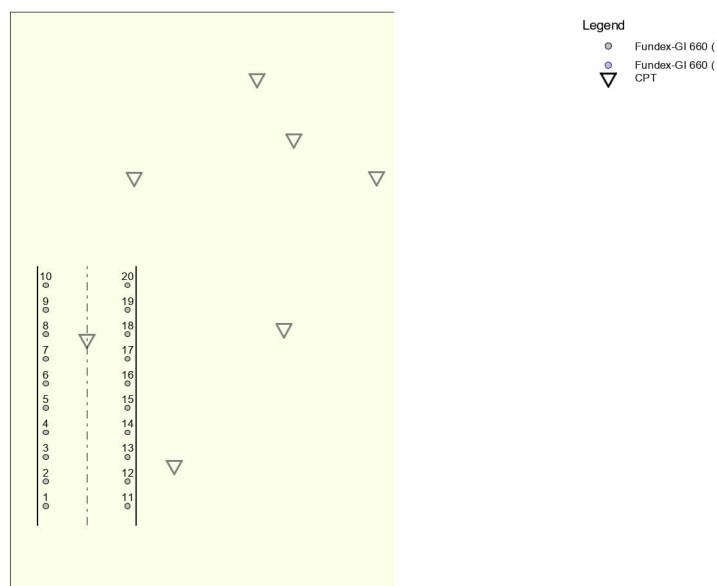
2.8 Foundation Plan

Number of piles : 20

Number of collaborating piles* : 20

* : 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 (EQU/STR/GEO) [kN]	Fc;d (SLS) [kN]	P0 [kN/m2]	Pile head level [m R.L.]
1: 1	93384,60	461856,50	0,00	0,00	27,70	-0,80
2: 2	93384,60	461859,50	0,00	0,00	27,70	-0,80
3: 3	93384,60	461862,50	0,00	0,00	27,70	-0,80
4: 4	93384,60	461865,50	0,00	0,00	27,70	-0,80
5: 5	93384,60	461868,50	0,00	0,00	27,70	-0,80
6: 6	93384,60	461871,50	0,00	0,00	27,70	-0,80
7: 7	93384,60	461874,50	0,00	0,00	27,70	-0,80
8: 8	93384,60	461877,50	0,00	0,00	27,70	-0,80
9: 9	93384,60	461880,50	0,00	0,00	27,70	-0,80
10: 10	93384,60	461883,50	0,00	0,00	27,70	-0,80
11: 11	93394,60	461856,50	0,00	0,00	27,70	-0,80
12: 12	93394,60	461859,50	0,00	0,00	27,70	-0,80
13: 13	93394,60	461862,50	0,00	0,00	27,70	-0,80
14: 14	93394,60	461865,50	0,00	0,00	27,70	-0,80
15: 15	93394,60	461868,50	0,00	0,00	27,70	-0,80
16: 16	93394,60	461871,50	0,00	0,00	27,70	-0,80
17: 17	93394,60	461874,50	0,00	0,00	27,70	-0,80
18: 18	93394,60	461877,50	0,00	0,00	27,70	-0,80
19: 19	93394,60	461880,50	0,00	0,00	27,70	-0,80
20: 20	93394,60	461883,50	0,00	0,00	27,70	-0,80

2.9 Excavation Data

Excavation level in [m. reference level] :

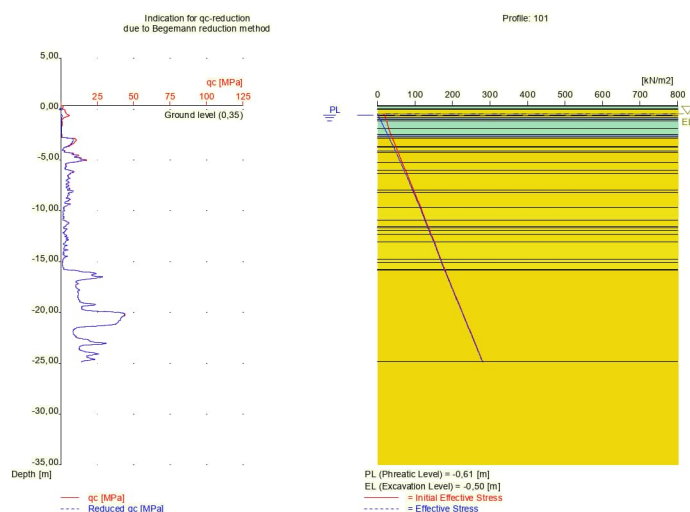
-0,50

Reduction model :

Begemann

Distance edge pile to excavation boundary [m] :

1,00



2.10 Overruled Parameters

User defined Factor xi3 [-] :

1,15

User defined Factor xi4 [-] :

0,92

2.11 Model Options

Use pilegroup for negative skin friction (standard)
Do not create intermediate results file
Use reduction for continuous flight auger piles (standard)
Use the influence of excavations (standard).

2.12 Model Options

Selected pile types :
-Fundex-GI 660

Selected profiles :
-101
-102
-DKM204
-DKM205
-DKMP206
-DKM207
-DKMP240

Trajectory
-begin [m] : -5,00
-end [m] : -7,00
-interval [m] : 0,50

3 Bearing Piles (EC7-NL): Results Preliminary Design, Indication Bearing Capacity

3.1 Errors and Warnings

Warning : The factor ξ_3 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

Warning : The factor ξ_4 (NEN 9997-1+C2:2017) is user defined. Evidence to support this from the NEN deviating value has to be provided.

The warning just below concerns at least one of the used soil profiles.

Warning : The positive skin friction zone contains compressible layers. The demands set by article 7.6.1.1 b are not met. A calculation of interaction is required to show that given schematization is valid.

The calculated pile settlement as mentioned in the report should be adapted based on that calculation.

Soil profile 101

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile 102

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM204

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM205

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP206

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKM207

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

Soil profile DKMP240

Warning : The lowest pile head level lies below the surface level. The maximum value for the top of the friction zones is therefor reset to -0,80 m relative to reference level.

3.2 Remarks

When checking the survey and testing of soil according to NEN 9997-1+C2:2017 art. 3.2.3 section (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.

Note : The calculations performed are based on a single pile for limit state EQU/STR/GEO (= ultimate limit state). Due to the nature of preliminary design, a single pile is always assumed. A possible pileplan is disregarded when using the preliminary design option. Hence a non rigid superstructure is assumed and pile group effects are not considered.

3.3 Calculation Parameters

3.3.1 Pile Factors

γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8,
Limit State EQU/STR/GEO) :
 γ_{mb} (NEN 9997-1+C2:2017, table A.6 A.7 A.8,

1,20

the Serviceability Limit State) :	1,00
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
Limit State EQU/STR/GEO) :	1,20
gamma;s (NEN 9997-1+C2:2017, table A.6 A.7 A.8,	
the Serviceability Limit State) :	1,00
xi3 (user defined) :	1,15
xi4 (user defined) :	0,92

3.3.2 Pile type : Fundex-GI 660

Pile type :	Screw pile, cast in place, with grout
Materialtype for pile :	Concrete
Slip layer :	None
Pile shape :	Round pile
beta (Shape factor: figure 7.i, NEN 9997-1+C2:2017	
art. 7.6.2.3(g) : Pile tip) :	1,00
s (NEN 9997-1+C2:2017 art. 7.6.2.3(h) : factor for	
the influence of the shape of the crossection of the pile base) :	1,00
Pile dimensions :	
Diameter [m] :	0,660

Number/Name CPT	Alpha_s Sand/ Gravel	Alpha_s Clay/Loam Peat	Alpha_p
1:101	0,0090	--	0,6300
7:102	0,0090	0,0250	0,6300
2:DKM204	0,0090	0,0250	0,6300
3:DKM205	0,0090	--	0,6300
5:DKMP206	0,0090	--	0,6300
4:DKM207	0,0090	--	0,6300
6:DKMP240	0,0090	--	0,6300

3.4 Results Bearing Forces for Pile type : Fundex-GI 660

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
1:101	-5.00	611	305	916	664	45	45	619
1:101	-5.50	474	378	852	617	45	45	572
1:101	-6.00	640	410	1050	761	45	45	716
1:101	-6.50	620	476	1096	794	45	45	749
1:101	-7.00	566	524	1090	790	45	45	745
7:102	-5.00	387	241	628	455	42	42	413
7:102	-5.50	590	270	860	623	42	42	581
7:102	-6.00	595	316	911	660	42	42	618
7:102	-6.50	546	366	912	661	42	42	619
7:102	-7.00	511	411	922	668	42	42	626
2:DKM204	-5.00	578	310	888	643	41	41	602
2:DKM204	-5.50	709	353	1062	770	41	41	729
2:DKM204	-6.00	655	409	1064	771	41	41	730
2:DKM204	-6.50	660	473	1133	821	41	41	780
2:DKM204	-7.00	677	525	1202	871	41	41	830
3:DKM205	-5.00	504	160	664	481	57	57	424
3:DKM205	-5.50	577	198	775	562	57	57	505
3:DKM205	-6.00	505	249	754	546	57	57	489
3:DKM205	-6.50	509	306	815	591	57	57	534
3:DKM205	-7.00	520	354	874	633	57	57	576
5:DKMP206	-5.00	605	306	911	660	40	40	620
5:DKMP206	-5.50	667	353	1020	739	40	40	699
5:DKMP206	-6.00	647	400	1047	759	40	40	719
5:DKMP206	-6.50	618	448	1066	772	40	40	732
5:DKMP206	-7.00	622	501	1123	814	40	40	774

Number/Name CPT	Level [m R.L.]	Rb;cal;max [kN]	Rs;cal;max [kN]	Rc;cal;max [kN]	Rc;d [kN]	F;nsf;k [kN]	Fnsf;d [kN]	Rc;net;d [kN]
4:DKM207	-5.00	686	202	888	643	53	53	590
4:DKM207	-5.50	527	311	838	607	53	53	554
4:DKM207	-6.00	627	353	980	710	53	53	657
4:DKM207	-6.50	663	404	1067	773	53	53	720
4:DKM207	-7.00	661	470	1131	820	53	53	767
6:DKMP240	-5.00	472	257	729	528	49	49	479
6:DKMP240	-5.50	615	292	907	657	49	49	608
6:DKMP240	-6.00	619	359	978	709	49	49	660
6:DKMP240	-6.50	534	415	949	688	49	49	639
6:DKMP240	-7.00	532	461	993	720	49	49	671

* Rc;net;d = Rc;d - Fnsf;d

3.5 Summary Net Bearing Capacity in kN

Number/Name CPT	Groundlevel [m R.L.]	Level [m R.L.]	Fundex-GI 660 Rc;net;d [kN]
1:101	0,35	-5,00	619,00
1:101	0,35	-5,50	572,00
1:101	0,35	-6,00	716,00
1:101	0,35	-6,50	749,00
1:101	0,35	-7,00	745,00
7:102	0,58	-5,00	413,00
7:102	0,58	-5,50	581,00
7:102	0,58	-6,00	618,00
7:102	0,58	-6,50	619,00
7:102	0,58	-7,00	626,00
2:DKM204	3,29	-5,00	602,00
2:DKM204	3,29	-5,50	729,00
2:DKM204	3,29	-6,00	730,00
2:DKM204	3,29	-6,50	780,00
2:DKM204	3,29	-7,00	830,00
3:DKM205	0,55	-5,00	424,00
3:DKM205	0,55	-5,50	505,00
3:DKM205	0,55	-6,00	489,00
3:DKM205	0,55	-6,50	534,00
3:DKM205	0,55	-7,00	576,00
5:DKMP206	0,83	-5,00	620,00
5:DKMP206	0,83	-5,50	699,00
5:DKMP206	0,83	-6,00	719,00
5:DKMP206	0,83	-6,50	732,00
5:DKMP206	0,83	-7,00	774,00
4:DKM207	3,20	-5,00	590,00
4:DKM207	3,20	-5,50	554,00
4:DKM207	3,20	-6,00	657,00
4:DKM207	3,20	-6,50	720,00
4:DKM207	3,20	-7,00	767,00
6:DKMP240	1,51	-5,00	479,00
6:DKMP240	1,51	-5,50	608,00
6:DKMP240	1,51	-6,00	660,00
6:DKMP240	1,51	-6,50	639,00
6:DKMP240	1,51	-7,00	671,00

End of Report

BIJLAGE 4: BEDDING EN MAXIMALE GRONDDRUK TEGEN PAALSCHACHT

Project: N206 Leiden
Onderdeel: Veldschanstunnel
Fundex-GI 540/660 mm

Projectcode: 000913
Omschrijving: Sondering 102
Datum: 17-6-2025



Bepaling bedding tegen paalschacht

conform theorie van Ménard en Brinch-Hansen

grondwaterstand [mNAP]: -0,61 paalschachtdiameter [m]: 0,66 factor groepseffect: 1,00

Karakteristieke waarden voor de bedding k_h en de maximale passieve gronddruk σ_p

Code	Grondtype			q_c [MPa]	γ [kN/m ³]	γ_{sat} [kN/m ³]	σ'_v [kN/m ²]	α [-]	β [-]	bedding		max. gronddruk		
		van [mNAP]	tot [mNAP]							E_m [kPa]	k_h [kN/m ³]	ϕ [°]	c' [kN/m ²]	$\sigma_{p,laag,d}$ [kN/m ²]
Zo	ZAND, ondiep	0,20	-0,80	10	17,5	19,5	8,75	1/3	0,7	7000	29000	38,0	0,0	95
Zo	ZAND, ondiep	-0,80	-1,00	10	17,5	19,5	16,93	1/3	0,7	7000	29000	38,0	0,0	216
Vo	VEEN, ondiep	-1,00	-1,90	0,4	11,3	11,3	18,47	1	3,0	1200	2300	23,8	2,0	120
KSd	KLEI schoon, slap, diep	-1,90	-2,70	0,6	15,9	15,9	21,41	2/3	2,0	1200	3300	23,3	0,5	115
ZL	ZAND los gepakt	-2,70	-3,75	5,8	17,0	19,0	27,45	1/3	0,7	4060	16750	30,0	0,0	257
ZKL	ZAND met kleilaagjes	-3,75	-9,50	4,3	17,4	17,4	52,40	1/2	1,0	4300	14250	32,1	0,0	739
KZ	KLEI, zwak zandig	-9,50	-14,60	2,2	18,7	18,7	95,86	2/3	2,0	4400	12000	27,9	5,7	1268
ZKL	ZAND met kleilaagjes	-14,60	-17,80	3,0	17,4	17,4	129,88	1/2	1,0	3000	10000	32,1	0,0	2312
ZL	ZAND los gepakt	-17,80	-19,50	8	17,0	19,0	147,67	1/3	0,7	5600	23250	30,0	0,0	2139
ZM	ZAND matig gepakt	-19,50	-21,00	14	18,0	20,0	159,62	1/3	0,7	9800	40750	32,5	0,0	3110

Rekenwaarden voor de bedding k_h en de maximale passieve gronddruk σ_p

Code	Grondtype			ondergrens				bovengrens			
		van [mNAP]	tot [mNAP]	$k_{h,laag,d}$ [kN/m ³]	$\phi_{laag,d}$ [°]	$c'_{laag,d}$ [kN/m ²]	σ_p [kN/m ²]	$k_{h,hoog,d}$ [kN/m ³]	$\phi_{hoog,d}$ [°]	$c'_{hoog,d}$ [kN/m ²]	$\sigma_{p,hoog,d}$ [kN/m ²]
Zo	ZAND, ondiep	0,20	-0,80	22250	33,0	0,0	63	37750	43,7	0	160
Zo	ZAND, ondiep	-0,80	-1,00	22250	33,0	0,0	144	37750	43,7	0	362
Vo	VEEN, ondiep	-1,00	-1,90	1800	20,7	1,3	85	3000	27,4	3,2	183
KSd	KLEI schoon, slap, diep	-1,90	-2,70	2500	20,3	0,3	86	4300	26,8	0,8	159
ZL	ZAND los gepakt	-2,70	-3,75	13000	26,1	0,0	184	22000	34,5	0	379
ZKL	ZAND met kleilaagjes	-3,75	-9,50	11000	27,9	0,0	496	18750	36,9	0	1191
KZ	KLEI, zwak zandig	-9,50	-14,60	9300	24,3	3,6	830	15750	32,1	9,12	2169
ZKL	ZAND met kleilaagjes	-14,60	-17,80	7700	27,9	0,0	1473	13000	36,9	0	4056
ZL	ZAND los gepakt	-17,80	-19,50	18000	26,1	0,0	1417	30250	34,5	0	3581
ZM	ZAND matig gepakt	-19,50	-21,00	31250	28,3	0,0	1941	53000	37,4	0	5634

Grondsoorten met bijbehorende parameters

Code	Grondtype	γ [kN/m ³]	γ_{sat} [kN/m ³]	ϕ [°]	c' [kN/m ²]	α [-]	β [-]
KHd	KLEI humeus, slap, diep	14,0	14,0	16,1	0,5	2/3	2,0
KHo	KLEI humeus, slap, ondiep	13,4	13,4	16,1	0,5	2/3	2,0
KMd	KLEI schoon, matig, diep	17,8	17,8	23,5	9,1	2/3	2,0
KMo	KLEI schoon, matig, ondiep	17,6	17,6	23,5	5,7	2/3	2,0
KSd	KLEI schoon, slap, diep	15,9	15,9	23,3	0,5	2/3	2,0
KZ	KLEI, zwak zandig	18,7	18,7	27,9	5,7	2/3	2,0
Vd	VEEN, diep	11,2	11,2	23,8	2,0	1	3,0
Vo	VEEN, ondiep	11,3	11,3	23,8	2,0	1	3,0
ZKL	ZAND met kleilaagjes	17,4	17,4	32,1	0,0	1/2	1,0
ZL	ZAND los gepakt	17,0	19,0	30,0	0,0	1/3	0,7
ZM	ZAND matig gepakt	18,0	20,0	32,5	0,0	1/3	0,7
Zo	ZAND, ondiep	17,5	19,5	38,0	0,0	1/3	0,7
ZOH	Ophoogzand	18,0	20,0	32,5	0,0	1/3	0,7
ZV	ZAND vast gepakt	19,0	21,0	35,0	0,0	1/3	0,7

Materiaalfactoren

RC1/RC2/RC3
tan ϕ 1,15 (tabel A.4a NEN9997-1)
 c' 1,6 (tabel A.4a NEN9997-1)
 k_h 1,3 (tabel A.4c NEN9997-1)

Tabel 2-1 Rheologische factoren volgens Ménard

Grondsoort	α	β
Veen	1	3,0
Klei	2/3	2,0
Silt	1/2	1,0
Zand	1/3	0,7
Grind	1/4	0,5