Netherlands Enterprise Agency

Geotechnical Report / Investigation Data

Geotechnical Borehole Locations
Wind Farm Site I
Hollandse Kust (zuid) Wind Farm Zone

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Document title: Geotechnical Report – Investigation Data
Geotechnical Borehole Locations

Document subtitle: Wind Farm Site I
Hollandse Kust (zuid) Wind Farm Zone

Author (s): Fugro Engineers B.V.
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HOLLANDSE KUST (ZUID) WIND FARM ZONE

Certification Report
Site Conditions
Geotechnical Investigations and Geological Ground Model

Netherlands Enterprise Agency

Report No.: CR-SC-DNVGL-SE-0190-02453-4_Geotechnical
Date: 2018-09-03

DNV GL
Renewables Certification
Tuborg Parkvej 8
2900 Hellerup
Denmark

Project name: Hollandse Kust (zuid) Wind Farm Zone
Report title: Certification Report
Site Conditions
Geotechnical Investigations and Geological Ground Model
Customer: Netherlands Enterprise Agency
Croeselaan 15
3521 BJ Utrecht The Netherlands
Contact person: Ruud de Bruijne (RVO)
Date of issue: 2018-09-03
Project No.: 10016925
Report No.: CR-SC-DNVGL-SE-0190-02453-4_Geotechnical
Applicable contract(s) governing the provision of this Report:

Objective: To confirm that the geotechnical and geological investigations at Hollandse Kust (Zuid) Wind Farm Zone (here: Wind Farm Sites (WFS) I and II) are in accordance with DNVGL-ST-0437 and DNVGL-ST-0126 and can be used within a Design Basis.

Prepared by:	Verified by:	Approved by:
Gehrmann-Vorbau	Hauschildt	Digitally signed by Asp, Erik Date: 2018.09.05 07:51:23 +02'00'
Jana Gehrmann-Vorbau Principal Engineer	Dr. Michael Hauschildt Senior Principal Engineer	Erik Asp Senior Principal Engineer

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3	2017-02-09	Update revision of document	Michael Wagner	Dr. Michael Hauschildt	Erik Asp
4	2018-09-03	Update revision of document	Jana Gehrmann-Vorbau	Dr. Michael Hauschildt	Erik Asp

Table of contents

1 EXECUTIVE SUMMARY

The Hollandse Kust (zuid) WFZ is located in the Dutch Sector of the North Sea, approximately 22 km from the coastline. As part of the tender preparations, the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) requested a geotechnical site investigation of wind farm sites (WFS) I and II of the Hollandse Kust (zuid) Wind Farm Zone (WFZ) which was based on previously performed geophysical site investigations. Further to the on-site investigations a corresponding laboratory test program was conducted.

DNV GL was assigned to validate the suitability of the conducted investigations and tests for the implementation of a geological ground model and their use within a Design Basis for Offshore Wind Turbine Structures in accordance DNVGL-ST-0437 and DNVGL-ST-0126.

The comprehensive geotechnical campaign and the advanced laboratory test program was defined as a joint effort between multiple parties and reviewed by DNV GL with the objective to reduce the need for boreholes and additional laboratory tests in later stages of development. With a proper CPT calibration and additional CPTs at each planned turbine location it is likely that additional boreholes may be omitted.

However, it is the responsibility of the designer to make the final decision, if additional boreholes or laboratory tests can be omitted to enable an economic and safe foundation design. Further, it is the responsibility of the designer to verify the applicability of the reported test results for the foundation design.

2 CERTIFICATION SCHEME

Document No.	Title
DNVGL-SE-0190:2015-12	Project certification of wind power plants

This report covers the geological survey, geotechnical in-situ testing and soil sampling with static laboratory testing in accordance with section 2.3.2 “Site assessment” of the given Service Specification.

3 LIST OF REPORTS

The appendices to this report comprise the detailed DNV GL certification reports which normally include reference standards/documents, list of design documentation as well as summary and conclusion of the DNV GL evaluation.

APPENDIX	Revision	Subject
A	0	Geotechnical Investigations and Geological Ground Model

4 CONDITIONS

The conditions identified during the technical evaluation are listed in the appendices. The conditions are assigned to the certification phases in which they need to be considered and evaluated.

The conditions listed in the following shall be addressed as part of the certification process.

For the Design Basis phase the following conditions shall be addressed:

- For the final layout of the wind farm zones the detailed geotechnical investigations need to be performed at at each specific (e.g. turbine) location.

5 OUTSTANDING ISSUES

No outstanding issues have been identified.

6 CONCLUSION

Under consideration of the conditions listed in section 4, the geotechnical investigation reports and the geological ground model fulfil the requirements as given in the evaluation criteria listed in section 2 of this report.

APPENDIX A
Geotechnical Investigations and Geological Ground Model

Evaluation of Geotechnical Investigations and Geological Ground Model for Hollandse Kust (zuid) Wind Farm Zone, Wind Farm Sites I and II

A1 Description of verified component, system or item

Within the wind farm area geotechnical and geological investigations have been performed. The results and the found site conditions are documented by the customer and build the basis for the verification of the current report.

A2 Interface to other systems/components

Knowledge obtained from the Geophysical Site Conditions has been considered during the assessment of the Geotechnical Investigations and the Geological Ground Model.

A3 Basis for the evaluation

Applied codes and standards:

Document No.	Revision	Title
DNVGL-ST-0437	November 2016	Loads and site conditions for wind turbines
DNVGL-ST-0126	April 2016	Support structures for wind turbines

A4 Documentation from customer

List of reports:

Document No.	Revision	Title
Fugro Report No.: N6196/02	3 14.10.2016	Geotechnical Report - Investigation Data, Seafloor In Situ Test Locations, Wind Farm Site I, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 562 pages
Fugro Report No.: N6196/04	3 14.10.2016	Geotechnical Report - Investigation Data, Seafloor In Situ Test Locations, Wind Farm Site II, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 507 pages
Fugro Report No.: N6196/01	4 14.11.2016	Geotechnical Report - Investigation Data, Geotechnical Borehole Locations, Wind Farm Site I, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 1501 pages
Fugro Report No.: N6196/03	4 14.11.2016	Geotechnical Report - Investigation Data, Geotechnical Borehole Locations, Wind Farm Site II, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 1433 pages
Fugro Report No.: N6196/09	3 14.11.2016	Geological Ground Model, Wind Farm Site I, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 336 pages

Document No.	Revision	Title
Fugro Report No.: N6196/10	4 02.08.2017	Geological Ground Model, Wind Farm Site II, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 319 pages
Fugro Report No.: N6196/13	4 30.01.2017	Geotechnical Report - Laboratory Test Data, Wind Farm Sites I&II, Hollandse Kust (zuid) Wind Farm Zone, Dutch Sector, North Sea, 1397 pages

A5 Evaluation work

DNV GL has evaluated that the above referenced documents from the customer provide sufficient information to get a good general understanding of the geotechnical and geological conditions in the given wind farm sites WFS I and WFS II.

At each wind farm site eight locations have been investigated by boreholes down to a depth of at least 50 m below mudline, supported by standard cone penetration tests (WFS I: at three locations; WFS II: at two locations) and seismic cone penetration tests (WFS I: at three locations; WFS II: at four locations). The assessment process by DNV GL has been documented in a Verification Comment Sheet (VCS Reference: VCS-08-Rev01-PD-644258).

Furthermore, cone penetration tests at twenty-six and twenty-three locations, respectively, distributed across WFS I and WFS II have been conducted.

The assessment process by DNV GL has been documented in a Verification Comment Sheet (VCS Reference: VCS-07-Rev01-PD-644258).

In addition to initial laboratory tests advanced geotechnical laboratory tests have been conducted for the soil units A, B1, B2, C1, C2 and D using samples from boreholes HKZ1-BH01-SA, HKZ1-BH02-SA, HKZ1-BH07-SA, HKZ1-BH08-SA and HKZ2-BH01-SA, HKZ2-BH03-SA, HKZ2-BH04-SA, HKZ2-BH07A-SA, HKZ2-BH08-SA, HKZ2-BH21-SA for WFS I and WFS II, respectively. The tests include geotechnical index tests, static and cyclic strength tests and dynamic tests. The exact numbers and results can be found in the corresponding report. Further, the test procedures are described and failure conditions are specified where necessary. The assessment process by DNV GL has been documented in a Verification Comment Sheet (VCS Reference: VCS-11-Rev02-PD-644258).

It is evaluated that the used equipment is state-of-the-art in offshore practice and the found results do not deviate from experienced values for parameters of the present soils.

The chosen sites of the conducted investigations are sufficient to develop an illustration of lateral and vertical soil and seabed variations.

It was evaluated that the geological ground model can be relied upon to establish general geological conditions, support discussions on site variability and establish the scope of a future geotechnical investigation campaign, e.g. with respect to park layout studies.

A6 Conditions to be considered in other certification phases

The conditions identified during the technical evaluation are listed in the following. The conditions are assigned to the certification phases in which they need to be considered and evaluated.

For the Design Basis phase the following conditions shall be addressed:

- For the final layout of the wind farm zones the detailed geotechnical investigations need to be performed at at each specific (e.g. turbine) location.

A7 Outstanding issues

No outstanding issues have been identified.

A8 Conclusion

The verification work performed by DNV GL confirms that the “Site assessment” as seen by the documentation from customer related to the Hollandse Kust (zuid) Wind Farm Zone as listed under section A4 fulfils the relevant demands set up in the Certification Scheme DNVGL-SE-0190:2015-12, section 2.3.2 and the related “Basis for the evaluation” listed in section A3 if the condition in chapter A6 is observed.

The geotechnical investigation reports and the geological ground model can be used to support the (preliminary) design of future offshore wind farms in the project area. The data presented in those reports can be used for establishing a Design Basis in accordance with DNVGL-ST-0437 and DNVGL-ST-0126.

About DNV GL

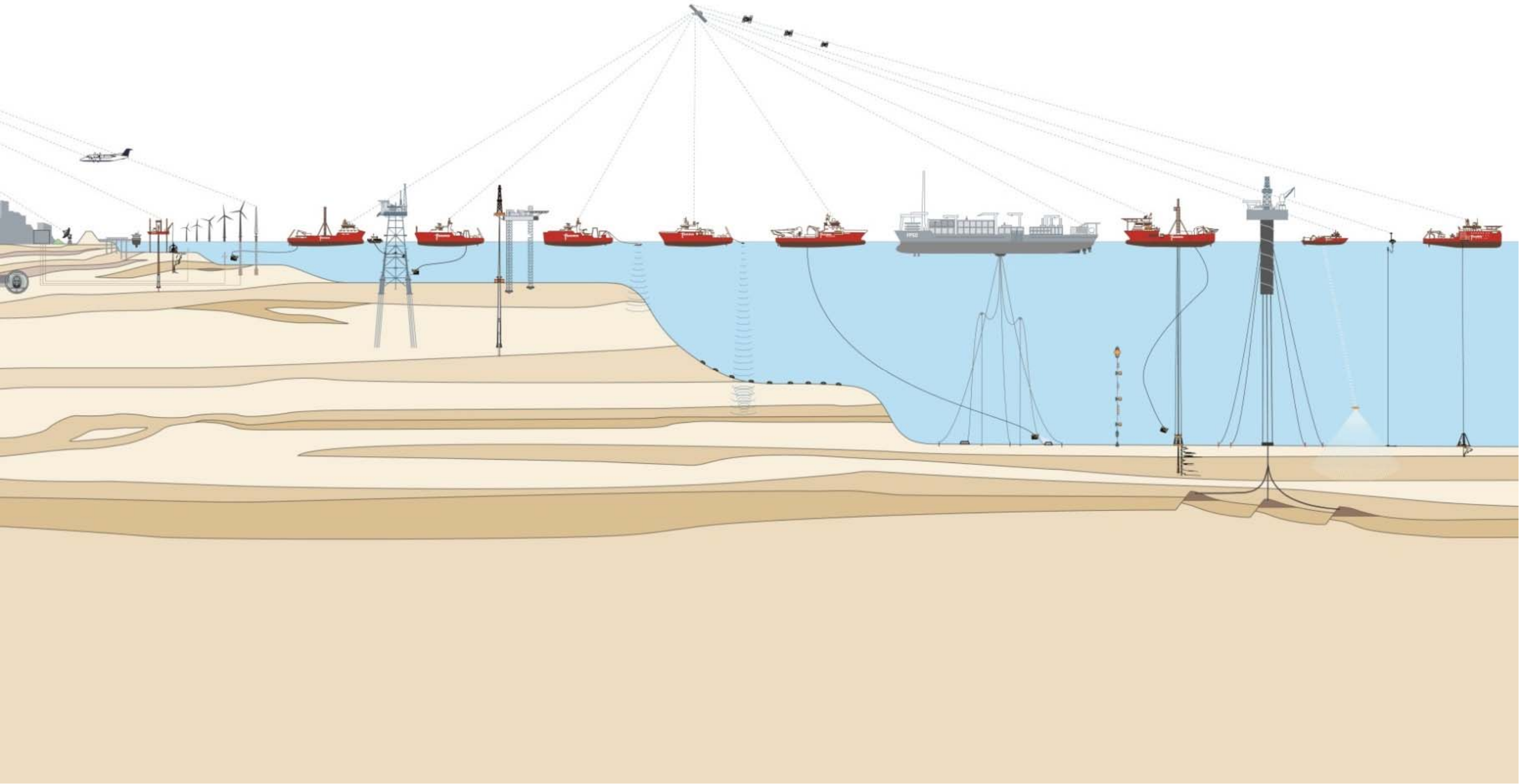
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

Geotechnical Report
Investigation Data
Geotechnical Borehole Locations
Wind Farm Site I
Hollandse Kust (zuid) Wind Farm Zone
Dutch Sector, North Sea

Client Reference No. WOZ 1600020
Fugro Report No. N6196/01

Issue 4

Rijksdienst voor Ondernemend Nederland (RVO)



Geotechnical Report
Investigation Data
Geotechnical Borehole Locations
Wind Farm Site I
Hollandse Kust (zuid) Wind Farm Zone
Dutch Sector, North Sea

Client Reference No. WOZ 1600020
Fugro Report No. N6196/01

Issue 4

Client	Rijksdienst voor Ondernemend Nederland (RVO)
Client Contact	R. de Bruijne
Client Address	Croeselaan 15 3521 BJ UTRECHT The Netherlands

Fugro Project Lead E. Schoute - Senior Project Engineer

Issue No.	Date	Report Status	Approved
4	14-Nov-2016	Final	MKL
3	24-Oct-2016	Fugro approved draft	MKL
2	02-Sep-2016	Fugro approved draft	MKL
1	18-Jul-2016	Provisional data – field report	-
0	Various	Provisional data – logs and results for individual locations	-

CONTENTS

SUMMARY

The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO), henceforth referred to as 'Client', has requested Fugro to perform a geotechnical investigation of wind farm sites (WFS) I to IV of the Hollandse Kust (zuid) Wind Farm Zone (WFZ). The Hollandse Kust (zuid) WFZ is located in the Dutch Sector of the North Sea, approximately 22 km from the coastline (refer to "Vicinity Map" on Page iii and "Detailed Location Plan" on Page iv).

The objective of the geotechnical investigation and associated laboratory testing programme for WFS I to WFS IV is to:

- Improve the geological and geotechnical understanding of Hollandse Kust (zuid) WFZ;
- Update an earlier geological and geophysical model;
- Provide a detailed geological ground model;
- Determine the vertical and lateral variation in seabed conditions;
- Provide relevant geotechnical data to progress the design of wind farm foundation elements, including, but not limited to foundations and cables.

The offshore phase of the geotechnical investigation included seafloor in situ testing, geotechnical borehole drilling with downhole sampling and/or in situ testing and geotechnical laboratory testing. An in-office programme of geotechnical laboratory testing and reporting of results followed the offshore phase.

This report is one of a set of Fugro reports which are delivered as part of this project. This particular report provides geotechnical results of the geotechnical borehole locations for WFS I and comprises the following:

- Eight geotechnical logs covering twelve boreholes at eight distinct locations including (combinations of) downhole sampling and/or in situ testing;
- Results of standard downhole cone penetration testing in three of the twelve boreholes (at three distinct locations);
- Results of downhole seismic cone penetration testing in four of the twelve boreholes (at three distinct locations);
- Results of geotechnical laboratory tests on a selection of samples.

The offshore phase of the geotechnical investigation which included the geotechnical borehole drilling at WFS I was conducted from the geotechnical drilling vessel Bucentaur between 8 July 2016 and 17 July 2016. The water depths at the investigated locations ranged from approximately 21 m to 25 m reduced to Lowest Astronomical Tide (LAT).

This report is one in a series of reports prepared as part of this project (refer to "List of Project Reports" on Pages v and vi). Two companion reports for WFS I contain results of seafloor in situ test locations, and describe a geological ground model for site WFS I including geological setting, stratigraphy, lateral variability, geohazards and basic geotechnical parameter values respectively.

SAMENVATTING

De Rijksdienst voor Ondernemend Nederland (RVO) heeft Fugro gecontracteerd voor een geotechnisch onderzoek in de windgebiedkavels WFS I t/m WFS IV van het Hollandse Kust (zuid) Windgebied. Het Windgebied Hollandse Kust (zuid) ligt in het Nederlandse deel van de Noordzee, ongeveer 22 km voor de kust (zie “Vicinity Map” op Page iii en “Detailed Location Plan” op Page iv).

Het doel van het geotechnisch onderzoek en bijbehorend programma van laboratoriumproeven voor WFS I t/m WFS IV is om:

- Inzicht te verkrijgen in de geologische en geotechnische omstandigheden in Windgebied Hollandse Kust (zuid);
- Het bestaande geofysische en geologische model te verfijnen;
- Een gedetailleerd geologisch grondmodel te genereren;
- De verticale en laterale variabiliteit van de grond te bepalen;
- Relevante geotechnische data voor de ontwikkeling van het ontwerp van windpark funderingsconstructies beschikbaar te stellen, inclusief maar niet gelimiteerd tot funderingen en kabels.

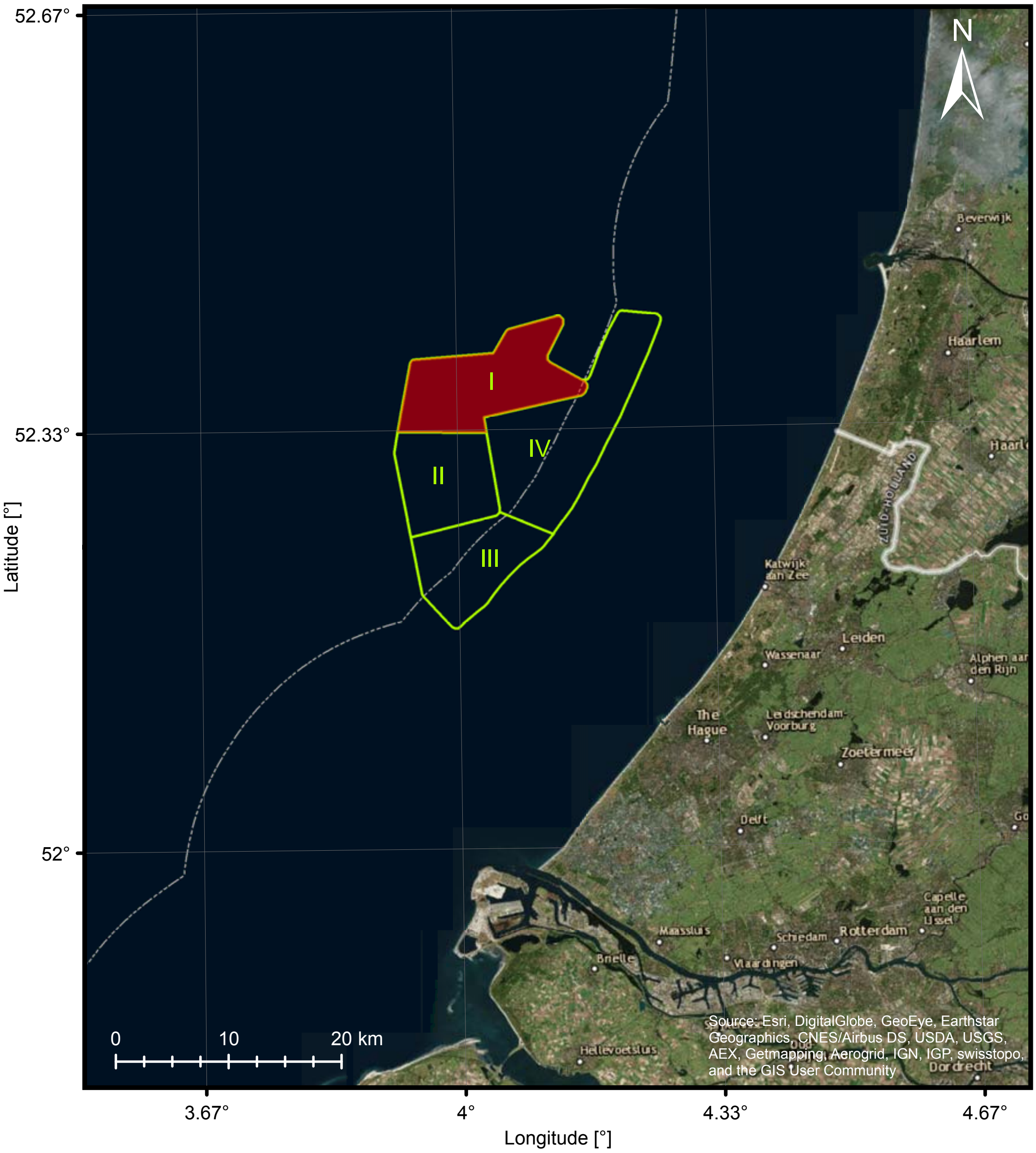
Het geotechnisch onderzoek bestaat uit sonderingen vanaf de zeebodem, geotechnische boorgaten met monsternames en/of in situ testen en geotechnische laboratoriumproeven, gevolgd door een geotechnisch laboratorium testprogramma en rapportage van de resultaten.

Dit rapport maakt deel uit van een serie van Fugro rapporten. Dit rapport bevat geotechnische onderzoeksresultaten van de geotechnische boorgaten voor WFS I en omvat het volgende:

- Acht geotechnische boorstaten voor twaalf boringen op acht afzonderlijke locaties waarin (een combinatie van) monstername en/of sonderingen zijn uitgevoerd;
- Resultaten van standaard sonderingen, uitgevoerd in drie van de twaalf boringen (op drie afzonderlijke locaties);
- Resultaten van seismische sonderingen, uitgevoerd in vier van de twaalf boringen (op drie afzonderlijke locaties);
- Resultaten van geotechnische laboratoriumproeven op een selectie van grond monsters.

Het geotechnisch onderzoek op de boorgatlocaties in WFS I is vanaf het geotechnisch boorschip Bucentaur uitgevoerd tussen 8 juli 2016 en 17 juli 2016. De waterdieptes op de boorgatlocaties varieerde van ongeveer 21 m tot 25 m beneden het laagste astronomische getij (LAT).

Dit rapport maakt deel uit van een serie van rapporten t.b.v. dit project (zie “List of Project Reports” op Pages v en vi). Twee andere rapporten die WFS I behandelen bevatten respectievelijk: de resultaten van de sonderingen vanaf de zeebodem en een geologisch grondmodel voor WFS I voorzien van informatie over het geologisch kader, stratigrafie, laterale variabiliteit, geo-risico’s en algemene geotechnische parameters.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

🟥 Investigation Area I (subject of this report)

🟩 Outline of Hollandse Kust (zuid) Investigation Areas (Roman numeral indicates area number)

---- 12 nautical mile boundary

Datum: ETRS 1989
Ellipsoid: GRS 1980

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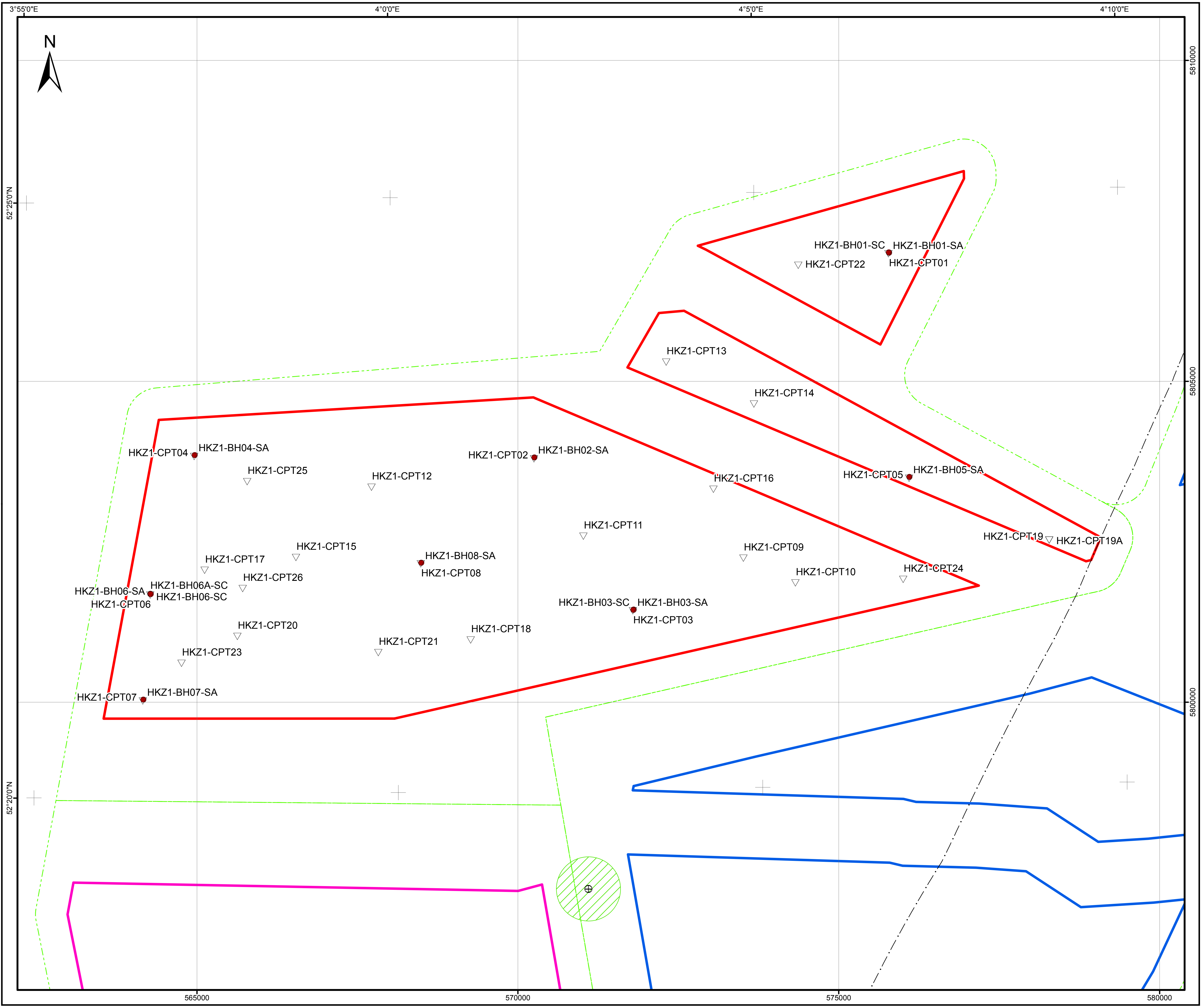
VICINITY MAP



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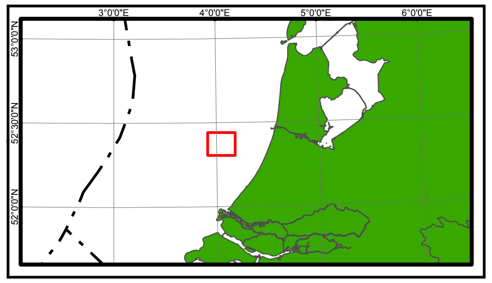
LEGEND:

●	Borehole Location - Downhole geotechnical
▽	Test Point - Seafloor In Situ Test
-·-·-	12 nautical mile boundary
⊕	Proposed Platform Locations
☐	Outline Investigation Areas
▨	Proposed Platform Exclusion Zone
🟥	Wind Farm Site I
☐	Wind Farm Site II
☐	Wind Farm Site IV

NOTES:

GEODETIC PARAMETERS:

DATUM	ETRS89
Ellipsoid	GRS80
Semi major axis	a = 6 378 137.000
Inverse flattening	1/f = 298.257222101
PROJECTION	UTM, Zone 31 North
Central Meridian (CM)	3° 00' 00" E
Latitude of Origin	0° 00' 00" N
False Easting	500 000 m
False Northing	000 000 m
Scale factor	0.9996
Units	metres / degrees



Rijksdienst voor Ondernemend Nederland (RVO)
Croeselaan 15, 3521 BJ, Utrecht - THE NETHERLANDS

Fugro
Prismastraat 4, 2631 RT, Nootdorp - THE NETHERLANDS

DETAILED LOCATION PLAN

SEAFLOOR IN SITU TEST LOCATIONS
HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Scale 1:55,000
at original A3 page size

Report Number	Title	Contents
N6196/01	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical laboratory tests.
N6196/02	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/03	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical laboratory tests.
N6196/04	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/05	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical and environmental laboratory tests.
N6196/06	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/07	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical and environmental laboratory tests.
N6196/08	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/09	Geological Ground Model Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/10	Geological Ground Model Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/11	Geological Ground Model Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.

LIST OF PROJECT REPORTS

Report Number	Title	Contents
N6196/12	Geological Ground Model Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/13	Geotechnical Report - Laboratory Test Data Wind Farm Sites I & II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Results of advanced static and cyclic laboratory tests.
N6196/14	Geotechnical Report - Laboratory Test Data Wind Farm Sites III & IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Results of advanced static and cyclic laboratory tests.

1. OVERVIEW

1.1 Purpose of Report

In 2013 more than 40 organisations and the Dutch government entered into the Energy Agreement for Sustainable Growth (‘Energieakkoord voor Duurzame Groei’). An important part of this agreement includes scaling up of offshore wind power development. The Ministry of Economic Affairs presented a road map outlining how the Government plans to achieve its offshore wind goals in accordance with the time line agreed upon in the Energy Agreement.

The road map sets out a schedule of tenders offering 700 MW of development each year in the period 2015 to 2019. The Dutch Government has developed a systematic framework under which offshore wind farm zones are designated. Any location outside these wind farm zones is not eligible to receive a permit. Within the designated wind farm zones the government decides the specific sites where wind farms can be constructed using a so-called Wind Farm Site Decision (‘Kavelbesluit’). This contains conditions for building and operating a wind farm on a specific site. The Dutch transmission system operator TenneT will be responsible for grid connection.

Winners of the site development tenders will be granted a permit to build a wind farm according to the Offshore Wind Energy Act (‘Wet Windenergie op Zee’), a SDE+ grant and offered a grid connection to the main land. The Ministry provides all relevant site data, which can be used for the preparation of bids for these tenders.

As part of the tender preparations, the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO), henceforth referred to as ‘Client’, has requested Fugro to perform a geotechnical site investigation of wind farm sites (WFS) I to IV of the Hollandse Kust (zuid) Wind Farm Zone (WFZ). The Hollandse Kust (zuid) WFZ is located in the Dutch Sector of the North Sea, approximately 22 km from the coastline (refer to “Vicinity Map” on Plate 1 and “Detailed Location Plan” on Plate 2).

The objective of the geotechnical investigation and associated laboratory test programme for WFS I to WFS IV is to:

- Improve the geological and geotechnical understanding of Hollandse Kust (zuid) WFZ;
- Update an earlier geological and geophysical model;
- Provide a detailed geological ground model;
- Determine the vertical and lateral variation in seabed conditions;
- Provide relevant geotechnical data to progress the design of windfarm foundation elements, including, but not limited to foundations and cables.

The offshore phase of the geotechnical investigation includes seafloor in situ testing, geotechnical borehole drilling with downhole sampling and in situ testing and geotechnical laboratory testing. An in-office programme of geotechnical laboratory testing and reporting of results followed the offshore phase.

1.2 Scope of Report

This report is one of a set of Fugro reports which will be delivered for this project. This particular report provides geotechnical results for WFS I and comprises the following:

- Eight geotechnical logs covering twelve boreholes at eight distinct locations including (combinations of) downhole sampling and/or in situ testing;
- Results of standard downhole cone penetration testing in three of the twelve boreholes (at three distinct locations);
- Results of downhole seismic cone penetration testing in four of the twelve boreholes (at three distinct locations);
- Results of geotechnical laboratory tests on a selection of samples.

The term ‘location’ used in this report refers to a specified target location. A location can consist of (a) single or multiple borehole(s) and test point(s) whereby the term ‘borehole’ is defined as a geotechnical borehole with associated downhole sampling and/or downhole in situ testing and ‘test point’ as an individual seafloor in situ testing operation. Boreholes and test points designated with a suffix ‘A’ refer to additional operations at a specific location. For instance, HKZ1-BH06**A**-SC is an additional borehole at location HKZ1-06 performed after borehole HKZ1-BH06-SC was terminated (refer to Section A for details) and HKZ1-CPT19**A** is an additional test performed at location 19, after the initial CPT at this location was terminated due to adverse weather conditions (refer to companion report N6196/02 for details (see “List of Project Reports” on Plates 3 and 4).

The suffix “-SA” and “-SC” were used to distinguish between different sampling and testing programmes at the individual borehole locations and represent “sampling” and “seismic testing” respectively.

This report includes geotechnical logs per location. As a result, multiple boreholes and test points may be combined into a single log. Results from seafloor in situ testing at the different locations have been considered for this report, refer to paragraph titled “Report Format” below for details.

Results presented in this report are for an area demarcated as Investigation Area I (Plates 1 and 2).

1.3 Report Format

This report is one in a series of reports prepared as part of this project (refer to “List of Project Reports” on Plates 3 and 4). Two companion reports for WFS I contain results of seafloor in situ test locations and describe a geological ground model for site WFS I including geological setting, stratigraphy, lateral variability, geohazards and basic geotechnical parameter values respectively.

This report uses and summarises information from sources listed in Section 3. The reader should consult the source information for details. Understanding of site conditions improves upon further data acquisition and interpretation. This means that some of the source interpretations may be superseded by information presented in this report. Similarly, interpretations given in this report may require updating in the future.

The principal sections of this report are the Summary, Main Text, Plates following Main Text, and Sections A, B and C. Comments are as follows:

- The Summary section allows a quick-scan management overview. It includes a selection of plates. The selected plates are duplicates from a larger set of Plates following Main Text;
- Section 2 of the Main Text focuses on methodology;
- Sections A, B and C provide the principal information as described in Section 1.2 “Scope of Report”. These sections should be read in conjunction with the Plates following Main Text, where applicable;
- Each of the Sections A, B and C start with primary information, which may consist of links to Plates following Main Text. Plate numbering starts with a section number, e.g. Plate B1-1 belongs to Section B1;
- Section D and Appendix 1 provide general practice statements and terminology. This background information supports the Main Text. It will be familiar to expert users of the type of information presented in this report.

1.4 Project Responsibilities and Use of Report

This report presents information according to a project specification determined and monitored by the Client. The Main Text section titled “Sources of Information and References” provides further details. Particularly, the Client selected and approved borehole locations and sample and test depths, monitored and approved data acquisition and supplied information for geotechnical project use

The report was prepared in accordance with Contract WOZ 1600020 between Rijksdienst voor Ondernemend Nederland and Fugro Engineers B.V., dated 15 June 2016. This report must be read in conjunction with Section D, “Use of Report”. This section includes information about report issue control.

Fugro understands that this report will be used for the purpose described in this Main Text section. That purpose was a significant factor in determining the scope and level of the services. Results must not be used if the purpose for which the report was prepared or the Client’s proposed development or activity changes. Results may possibly suit alternative use. Suitability must be verified.

2. INVESTIGATION PROGRAMME

2.1 Project-specific Data Acquisition

This report includes results from a project-specific geotechnical investigation. The Client planned the investigation programme. During the investigation, the Client's programme was adjusted to suit as-found conditions and operational constraints, such as minor deviations from target locations or changes in type of cone used. The scope of the report includes the results of the final programme.

The offshore part of the investigation which included the geotechnical borehole drilling was conducted from the geotechnical drilling vessel Bucentaur, between 8 July 2016 and 17 July 2016. The investigation included downhole sampling and in situ testing. Acquired data and recovered samples were processed in the site laboratory. Samples were stored on board in a temperature-controlled environment and transferred to shore for additional laboratory testing and storage.

The following sub-sections provide details.

2.2 Positioning Survey and Water Depth Measurement

The borehole locations are displayed on Plate 2. Coordinates and water depths at the borehole locations are presented on Plates 6 and 7. The coordinate reference system uses ETRS89 as datum with spheroid GRS80. The horizontal projection is Universal Transverse Mercator (UTM) with a Central Meridian of 3° east (Zone 31N), refer to Plate 5 for details.

Sub-surface positioning was performed using an ultra short baseline (USBL) system with a transmitter mounted on the seabed frame. Sound velocity profiles were regularly obtained by lowering a CTD-probe (measuring pressure, conductivity and temperature) to seafloor.

Lowest Astronomical Tide (LAT) and seafloor are used as vertical reference levels for water depth measurement and geotechnical sampling and testing. Water depths were measured using:

- A pressure sensor, i.e. CTD-probe, mounted on the seabed frame;
- An echo sounder mounted on the hull of the vessel;
- The drill string by direct sounding when drilling was initiated.

Charted bathymetric data was used as a verification of the water depth measurements (Fugro, 2016a to 2016d). Bathymetric data is included on Plates 6 and 7.

The user of the geodetic information presented must consider the accuracy of measurements, particularly where use may differ from original intentions. For example, the presented water depth measurements serve to establish the penetration depth below seafloor (BSF).

2.3 Drilling, Sampling and In Situ Testing

The drilling, sampling and in situ testing programme at eight locations included twelve boreholes (including re-drills, i.e. additional boreholes) with a combination of semi-continuous downhole sampling and/or in situ testing to depths ranging between approximately 6 m and 67 m BSF. Five boreholes included semi-continuous downhole sampling to 50 m BSF. Three boreholes included semi-continuous downhole sampling to depths of approximately 50 m BSF followed by alternating cone penetration testing and sampling to a target depth of 65 m BSF. Four boreholes, including one re-drill, included semi-continuous downhole (seismic) cone penetration testing to a target depth of 50 m BSF. The investigation depths and recoveries for each borehole are presented in Table 2.1.

Table 2.1: Sample and Test Recoveries

Borehole Location	Recovery Depth(1) [m]	Sample Recovery [m]	In Situ Test Recovery [m]	Number of SCPTs Performed [-]	Sample and Test Recovery [%]
HKZ1-BH01-SA	64.9	36.0	11.7	-	73
HKZ1-BH01-SC	45.9	3.1(2)	42.1	15	92(2)
HKZ1-BH02-SA	50.4	37.0	-	-	73
HKZ1-BH03-SA	66.5	38.6	13.1	-	78
HKZ1-BH03-SC	48.0	3.1(2)	46.8	16	97(2)
HKZ1-BH04-SA	50.8	34.6	-	-	68
HKZ1-BH05-SA	50.4	35.5	-	-	70
HKZ1-BH06-SA	65.1	37.6	10.0	-	73
HKZ1-BH06-SC	5.9	-	5.8	2	99
HKZ1-BH06A-SC	48.0 (-6.0)(3)	3.3(2)	41.1	14	98(2)(3)
HKZ1-BH07-SA	50.7	34.3	-	-	68
HKZ1-BH08-SA	50.7	33.7	-	-	66

Notes:
- : Values are rounded to nearest 0.1 m
(1) : Recovery depth is the deepest point for which logging, sample or test data are presented
(2) : Over-sampling not considered in Sample and Test Recovery calculation
(3) : Drill-out is excluded from Sample and Test Recovery calculation

The employed drilling method was rotary drilling with direct circulation. Bentonite-based mud was used as drill fluid. Borehole drilling included the use of a seabed frame equipped with a SEACLAM system, for re-entry and axial and lateral support of the drill string at seafloor.

Push sampling and in situ testing employed a WIP Sampler and WISON® downhole tools. The sampler was fitted with flush stainless steel Shelby tubes. Downhole tools were operated and retrieved by a hydraulic-electrical umbilical system which provides real-time control of the in situ testing and sampling process. Cone penetration tests (CPT) were performed using cone penetrometers with a 1000 mm^2 cone tip area. Seismic CPTs (SCPT) were performed using a double array cone. The seismic source consisted of a Hydraulic Underwater Shearwave Hammer (HUSH) box, consisting of a spring-driven steel mass hammered to a steel striking plate, mounted on the seabed frame.

Refer to Section A “Geotechnical Logs” and Section B “In Situ Test Results” for details and test results.

2.4 Sample Handling

Important stages in sample handling included:

- Measurement of sample recovery in sample tube;
- On-site sample extrusion, sample photography and geotechnical sample logging;
- On-site laboratory testing on selected sample sections;
- Sample packaging, labelling and storage in a temperature-controlled container on board;
- Sample offloading and transport to the Fugro geotechnical laboratory in Wallingford in the United Kingdom (UK).

Further details on sample handling are provided in Section C, “Geotechnical Laboratory Test Results”.

2.5 Laboratory Tests

On-site geotechnical laboratory testing included (where appropriate) visual soil classification and description of samples according to BS 5930 (BSI, 1999) and Clark & Walker (1977), sample photography, geotechnical index and index strength.

In-office laboratory testing included (where appropriate) geotechnical index, geochemical, (index) strength, compressibility and thermal conductivity.

Laboratory test results are provided in Section C, “Geotechnical Laboratory Test Results”, and summaries of selected test results are presented on the geotechnical logs in Section A.

2.6 Geotechnical Data Processing

Geotechnical data processing included:

- Preparation of geotechnical logs by interpreting and integrating sample descriptions, laboratory test results and CPT data, where applicable;
- Correlation of borehole and CPT data, where possible;
- Evaluation, basic verification where practicable and incorporation of selected information supplied by Client.

Further details on geotechnical data processing are described in Section A “Geotechnical Logs”, Section B “In Situ Test Results” and Section C “Geotechnical Laboratory Test Results”, where appropriate.

3. SOURCES OF INFORMATION AND REFERENCES

3.1 Client-supplied Information

This report summarises and relies on Client-supplied information:

- Deltares, 2015. *Geological study Hollandse Kust (Zuid) Wind Farm Zone, Final Report, Report No. 1221136-000-BGS-0006, 22 December 2015.* Utrecht: Deltares.
- Fugro Survey B.V., 2016a. *Geophysical Site Investigation Survey. Hollandse Kust (zuid) Wind Farm Development Zone - Wind Farm Site I. Report No. GH176-R1, Rev 01, 13 May 2016.*
- Fugro Survey B.V., 2016b. *Geophysical Site Investigation Survey. Hollandse Kust (zuid) Wind Farm Development Zone - Wind Farm Site II. Report No. GH176-R2, Rev 01, 13 May 2016.*
- Fugro Survey B.V., 2016c. *Geophysical Site Investigation Survey. Hollandse Kust (zuid) Wind Farm Development Zone - Wind Farm Site III. Report No. GH176-R3, Rev 01, 23 May 2016.*
- Fugro Survey B.V., 2016d. *Geophysical Site Investigation Survey. Hollandse Kust (zuid) Wind Farm Development Zone - Wind Farm Site IV. Report No. GH176-R4, Rev 01, 23 May 2016.*
- Periplus Archeomare, 2016. *Desk study archaeological assessment, Final Report (Rev 04), Report No. 15A024-01, 29 Januari 2016.* Amsterdam: Periplus Archeomare.
- REASeuro, 2016. *Unexploded Ordnance (UXO) - Desk Study, Final Report (Rev 02), 12 February 2016.* Riel: Riel Explosive Advice & Services Europe B.V.
- Rijksdienst voor Ondernemend Nederland, 2016a. *Wind Farm Zone Hollandse Kust (zuid) - Starting points & Assumptions - Part I General, Rev 05, 20 April 2016*.
- Rijksdienst voor Ondernemend Nederland, 2016b. *Soil Investigations Wind Farm Zones - Section IV-d. Scope of Work Geotechnical Survey. Hollandse Kust (zuid) Wind Farm Zone, Final, 13 June 2016.*
- Data from Geophysical Site Investigation Survey in digital file format (e.g. *.SEGY, *.XYZ-format):
  - Multibeam Echo Sounder (MBES) data
  - Sidescan Sonar (SSS) data
  - Magnetometer (MAG) data
  - Sparker data, Multichannel Seismic (MCS)
  - Pinger data, Sub-Bottom Profiler (SBP).

3.2 Fugro Information

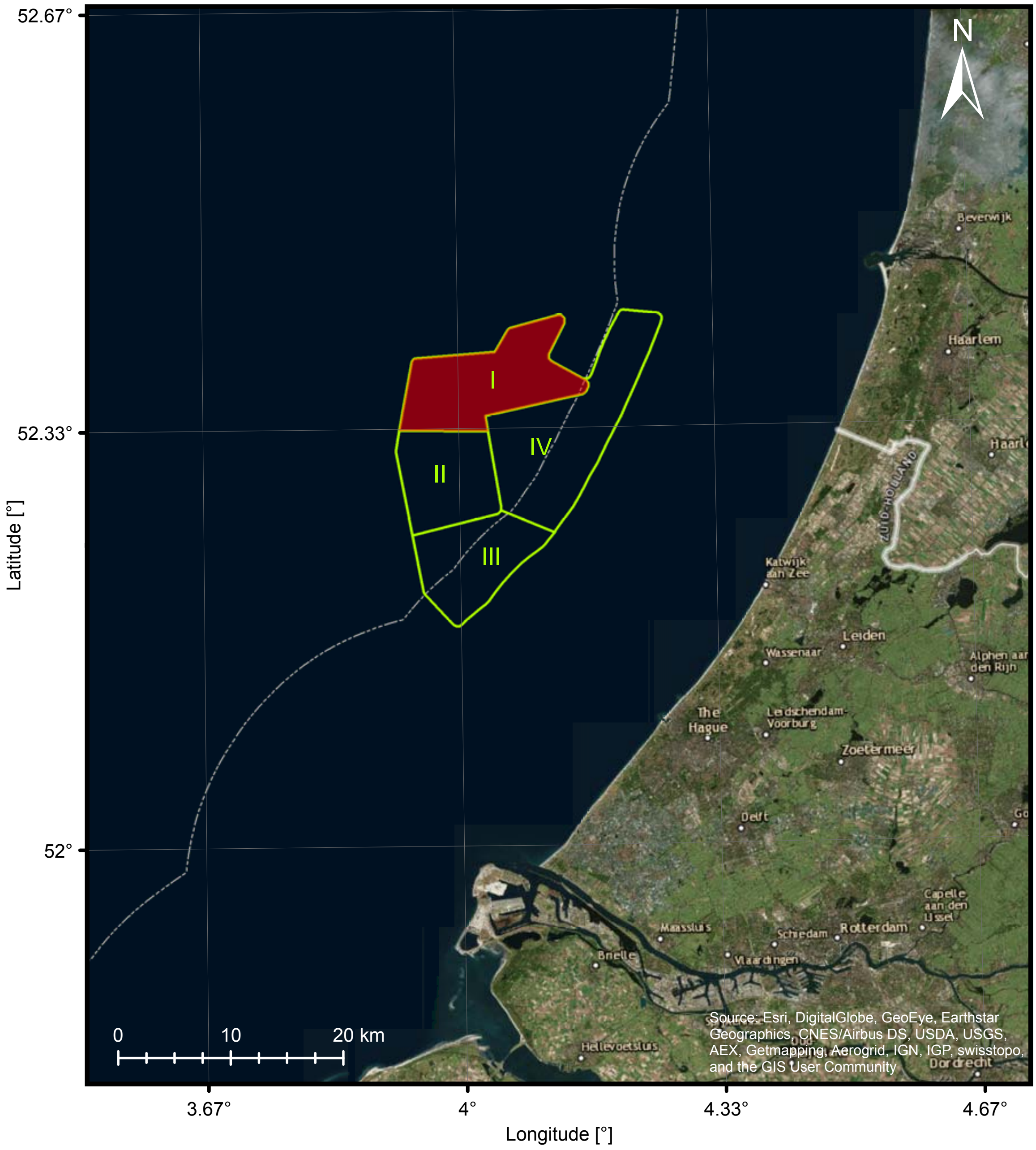
This report uses and summarises Fugro-held information:

- Fugro data base:
  - Information about regional geology
  - General geotechnical data
  - Previous geotechnical investigation data applicable to nearby sites.

3.3 References of Main Text

British Standards Institution, 1999. *BS 5930:1999 Code of practice for ground investigations.* London: BSI.

Clark, A.R. and Walker, B.F. 1977. A Proposed Scheme for the Classification and Nomenclature for Use in the Engineering Description of Middle Eastern Sedimentary Rocks. *Géotechnique,* Vol. 27, No. 1, pp. 94-99.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

🟥 Investigation Area I (subject of this report)

🟩 Outline of Hollandse Kust (zuid) Investigation Areas (Roman numeral indicates area number)

---- 12 nautical mile boundary

Datum: ETRS 1989
Ellipsoid: GRS 1980

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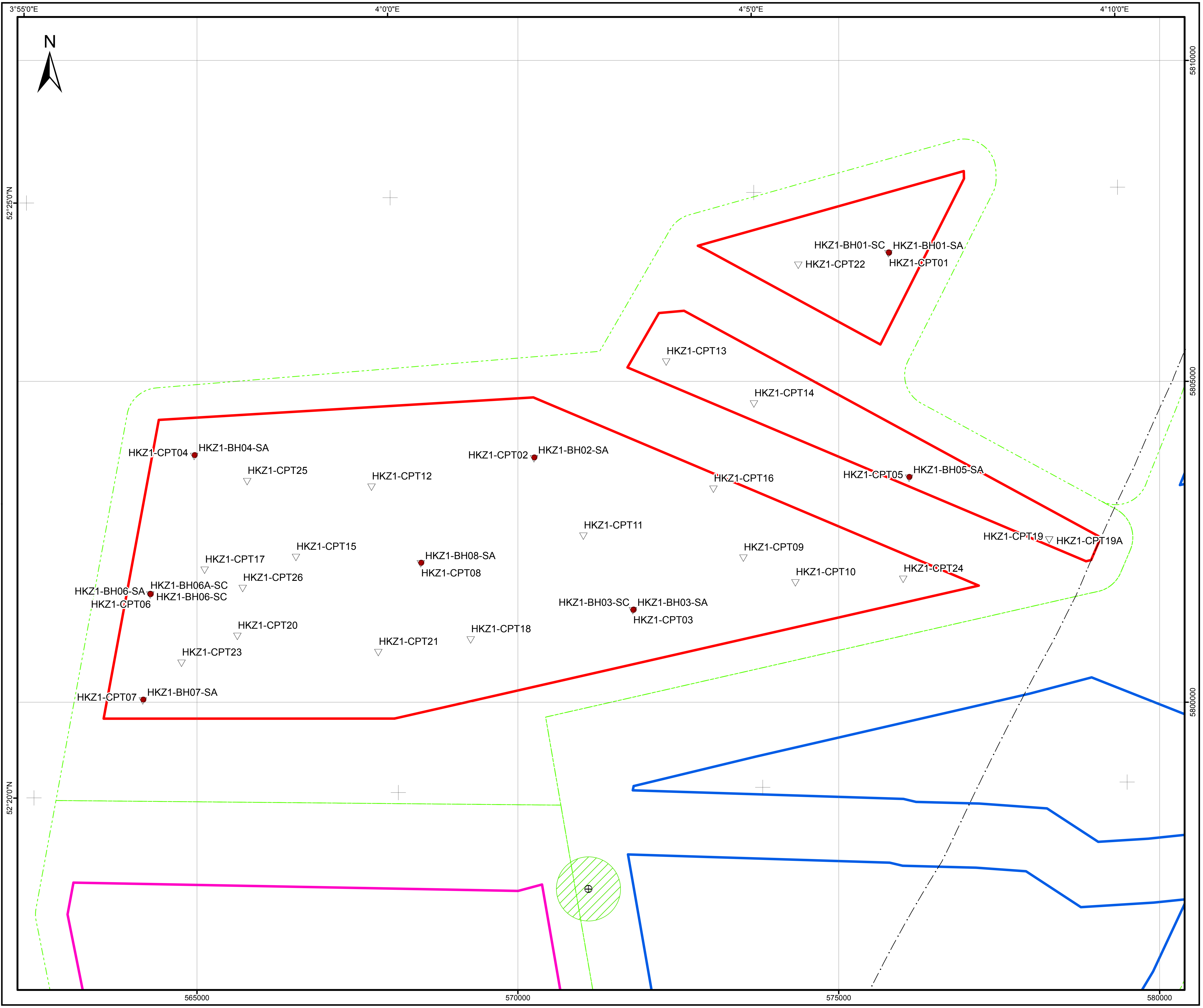
VICINITY MAP



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LEGEND:

- ● Borehole Location - Downhole geotechnical
- ▽ Test Point - Seafloor In Situ Test
- ‐ · ‐ · 12 nautical mile boundary
- ⊕ Proposed Platform Locations
- ⬚ Outline Investigation Areas
- ▨ Proposed Platform Exclusion Zone
- 🟥 Wind Farm Site I
- 🟪 Wind Farm Site II
- 🟦 Wind Farm Site IV

NOTES:

GEODETIC PARAMETERS:

DATUM	ETRS89
Ellipsoid	GRS80
Semi major axis	a = 6 378 137.000
Inverse flattening	1/f = 298.257222101
PROJECTION	UTM, Zone 31 North
Central Meridian (CM)	3° 00' 00" E
Latitude of Origin	0° 00' 00" N
False Easting	500 000 m
False Northing	000 000 m
Scale factor	0.9996
Units	metres / degrees

Rijksdienst voor Ondernemend Nederland (RVO)
Croeselaan 15, 3521 BJ, Utrecht - THE NETHERLANDS

Fugro
Prismastraat 4, 2631 RT, Nootdorp - THE NETHERLANDS

DETAILED LOCATION PLAN

SEAFLOOR IN SITU TEST LOCATIONS
HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Scale 1:55,000
at original A3 page size

0 500 1,000 1,500 metres

Fugro Report No. N6196/01	Issue 3	Plate 2

Report Number	Title	Contents
N6196/01	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical laboratory tests.
N6196/02	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/03	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical laboratory tests.
N6196/04	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/05	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical and environmental laboratory tests.
N6196/06	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/07	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from downhole (seismic) cone penetration tests and results from geotechnical and environmental laboratory tests.
N6196/08	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including geotechnical logs, results from seafloor cone penetration tests and pore pressure dissipation tests.
N6196/09	Geological Ground Model Wind Farm Site I Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/10	Geological Ground Model Wind Farm Site II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/11	Geological Ground Model Wind Farm Site III Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.

LIST OF PROJECT REPORTS

Report Number	Title	Contents
N6196/12	Geological Ground Model Wind Farm Site IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including stratigraphy, lateral soil variability, geohazards, geological analyses, biostratigraphic analyses, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6196/13	Geotechnical Report - Laboratory Test Data Wind Farm Sites I & II Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Results of advanced static and cyclic laboratory tests.
N6196/14	Geotechnical Report - Laboratory Test Data Wind Farm Sites III & IV Hollandse Kust (zuid) Wind Farm Zone - Dutch Sector, North Sea	Results of advanced static and cyclic laboratory tests.

LIST OF PROJECT REPORTS

DGPS Geodetic Parameters		
Datum		WGS84 (World Geodetic System 1984)
Spheroid		WGS84 (World Geodetic System 1984)
Semi-Major Axis, a		6378137.000 m
Inverse Flattening, 1/f		298.2572236
Transformation Parameters (from WGS 84 to Local Datum)		
Source Shift		
dX		+0.05375 m
dY		+0.05095 m
dZ		-0.08827 m
Rotation and Scale		
rX		-0.002231 ”
rY		-0.013494 ”
rZ		+0.02181 ”
dS (Scale Factor)		0.002663 ppm
Local Grid Geodetic Parameters		
Datum		ETRS89 (European Terrestrial Reference System 1989)
Spheroid		GRS80 (Geodetic Reference System 1980)
Semi-Major Axis, a		6378137.000 m
Inverse Flattening, 1/f		298.257222101
Local Projection Parameters		
Projection		UTM (Universal Transverse Mercator)
Hemisphere		Northern
Central Meridian (CM)		03° 00 ’ 00.0000” E
Latitude of Origin		00° 00 ’ 00.0000” N
False Easting		500000 m
False Northing		0 m
Scale Factor on CM		0.9996
Units		metres
Example Coordinates		
Local grid coordinates	Easting	569816.1 m
	Northing	5796550.0 m
Local geographical coordinates	Latitude	52° 18 ’ 53.4111” N
	Longitude	04° 01 ’ 27.0870” E
WGS84 geographical coordinates	Latitude	52° 18 ’ 53.4276” N
	Longitude	04° 01 ’ 27.1104” E

GEODETIC PARAMETERS

COORDINATES

Location	Penetration Depth [m]	Easting [m]	Northing [m]	Latitude [deg]	Longitude [deg]
HKZ1-BH01-SA	64.9	575786	5807003	52°24'28.8" N	4°6'50.8" E
HKZ1-BH01-SC	46.0	575782	5807009	52°24'29.0" N	4°6'50.6" E
HKZ1-BH02-SA	50.5	570257	5803814	52°22'48.3" N	4°1'55.9" E
HKZ1-BH03-SA	66.5	571804	5801442	52°21'30.8" N	4°3'15.8" E
HKZ1-BH03-SC	48.0	571800	5801440	52°21'30.7" N	4°3'15.6" E
HKZ1-BH04-SA	51.0	564965	5803849	52°22'51.8" N	3°57'16.0" E
HKZ1-BH05-SA	50.5	576102	5803510	52°22'35.6" N	4°7'4.7" E
HKZ1-BH06-SA	65.2	564274	5801688	52°21'42.1" N	3°56'38.0" E
HKZ1-BH06-SC	5.9	564279	5801684	52°21'42.0" N	3°56'38.3" E
HKZ1-BH06A-SC	48.0	564274	5801683	52°21'42.0" N	3°56'38.0" E

Datum	: ETRS89	Projection	: Universal Transverse Mercator
Ellipsoid	: GRS80	Central Meridian	: 3° E

Penetration Depth: deepest point reached by drilling, sampling or in situ testing, relative to seafloor

WATER DEPTH

Location	Date	Echo Sounder Reduced [m]	CTD Probe Reduced [m]	Drill String Reduced [m]	Bathymetry Chart Reduced [m]
HKZ1-BH01-SA	16-Jul-2016	22.0	21.8	22.5	22.0
HKZ1-BH01-SC	16-Jul-2016	22.0	21.7	21.9	21.9
HKZ1-BH02-SA	14-Jul-2016	23.0	22.8	23.4	23.1
HKZ1-BH03-SA	13-Jul-2016	22.0	21.7	22.1	21.9
HKZ1-BH03-SC	14-Jul-2016	22.0	21.7	22.0	21.9
HKZ1-BH04-SA	12-Jul-2016	23.5	23.2	24.0	23.2
HKZ1-BH05-SA	15-Jul-2016	22.0	21.8	22.2	22.0
HKZ1-BH06-SA	10-Jul-2016	22.7	22.6	23.1	22.6
HKZ1-BH06-SC	10-Jul-2016	22.7	22.6	23.0	22.7
HKZ1-BH06A-SC	16-Jul-2016	22.7	22.5	23.1	22.7

Reduced water depths are relative to Lowest Astronomical Tide (LAT)

GeODin/Coordinates and Water Depth_Downhole.GLO/2016-10-20 17:09:15

COORDINATES AND WATER DEPTH

COORDINATES

Location	Penetration Depth [m]	Easting [m]	Northing [m]	Latitude [deg]	Longitude [deg]
HKZ1-BH07-SA	51.0	564164	5800041	52°20'48.9" N	3°56'31.0" E
HKZ1-BH08-SA	51.0	568496	5802172	52°21'55.9" N	4°0'21.5" E

Datum	: ETRS89	Projection	: Universal Transverse Mercator
Ellipsoid	: GRS80	Central Meridian	: 3° E

Penetration Depth: deepest point reached by drilling, sampling or in situ testing, relative to seafloor

WATER DEPTH

Location	Date	Echo Sounder Reduced [m]	CTD Probe Reduced [m]	Drill String Reduced [m]	Bathymetry Chart Reduced [m]
HKZ1-BH07-SA	10-Jul-2016	24.6	24.4	25.0	24.5
HKZ1-BH08-SA	09-Jul-2016	23.9	23.7	24.2	23.8

Reduced water depths are relative to Lowest Astronomical Tide (LAT)

GeODin/Coordinates and Water Depth_Downhole.GLO/2016-10-20 17:09:15

COORDINATES AND WATER DEPTH

SECTION A: GEOTECHNICAL LOGS

TEXT – SECTION A: Page

A. GEOTECHNICAL LOGS

LIST OF PLATES IN SECTION A: Plate

A. GEOTECHNICAL LOGS

A.1 COMMENTS ON RESULTS

A total of eight geotechnical logs covering twelve separate boreholes at eight distinct locations are presented in this section. The eight logs include results of downhole sampling and/or in situ testing in single boreholes.

For the geotechnical logs from the boreholes with downhole sampling and in situ testing, the adjacent (seismic) cone penetration test ((S)CPT) data (either semi-continuous downhole or continuous from seafloor) have been included for reference purposes. Individual test results of the seafloor CPTs can be found in a companion report. Refer to Plates 3 and 4 following Main Text titled “List of Project Reports” for details.

Table A.1 below presents an overview of the distance between the boreholes which include sampling and in situ testing and the associated nearby borehole/test point which includes (seismic) CPTs only.

Table A.1: Lateral Distance between Sample/CPT Borehole and (S)CPT Borehole/Test Point

Boreholes with Downhole Sampling and In Situ Testing	Boreholes with Downhole In Situ Testing or Seafloor Cone Penetration Testing	Distance between Locations [m]
HKZ1-BH01-SA	HKZ1-BH01-SC/HKZ1-CPT01	6.2/3.2
HKZ1-BH02-SA	HKZ1-CPT02	5.2
HKZ1-BH03-SA	HKZ1-BH03-SC/HKZ1-CPT03	5.2/3.8
HKZ1-BH04-SA	HKZ1-CPT04	2.4
HKZ1-BH05-SA	HKZ1-CPT05	4.0
HKZ1-BH06-SA	HKZ1-BH06A-SC/HKZ1-CPT06	4.6/5.2
HKZ1-BH07-SA	HKZ1-CPT07	4.1
HKZ1-BH08-SA	HKZ1-CPT08	2.4

Borehole HKZ1-BH06-SC was terminated at 6 m below seafloor (BSF) due to adverse weather conditions causing the vessel to drift off position. An additional borehole was drilled within approximately 5 m distance from the intended location. Information from both boreholes (original and additional) is combined into a single geotechnical log.

In order to maximise recovery and sample quality, and to prevent damage to equipment if adverse soil conditions were expected, the most suitable combination of sampler and sample tube was selected prior to deployment. WIP Sampler was used and samples are marked with a ‘W’ on the geotechnical logs. Sampling recoveries are in line with expected recoveries for the encountered soil conditions and used sampling techniques.

Liner samples were taken in borehole HKZ1-BH01-SA at 16.5 m BSF and in borehole HKZ1-BH02-SA at 35.0 m BSF). These samples were retained within the liner for further processing and testing in the in-office laboratory. Top and bottom descriptions as well as water content and index strength testing were performed on these samples.

The information at the bottom of the geotechnical logs, including date commenced, coordinates, water depth, and recovery and penetration depths, is applicable to the location listed first in the legend.

Strata descriptions presented on the geotechnical logs are an interpretation of the available data sources, including sample descriptions, laboratory tests and CPT data where available. The strata descriptions may differ from the individual sample descriptions, presented in report Section C titled "Geotechnical Laboratory Test Results". The sample descriptions are based on on-site visual classification of the individual samples, whereas the strata descriptions consider additional data sources.

The graphic log in the geotechnical logs represents the principal and secondary soil fractions for layers assessed present at a particular location. In general, strata with a thickness >2000 mm ('very thick beds' and thicker) are presented in the geotechnical logs as separate main soil layers including a graphic log and strata descriptions. Strata with a thickness between 600 mm and 2000 mm ('thick beds') are not presented as separate main soil layers but may be included in main strata descriptions as sub-layers and presented in the graphic log. Strata with a thickness <600 mm ('medium beds' and thinner) are not presented as separate main soil layers nor as sub-layers in the graphic log. Where relevant, such strata are included in the strata description as secondary stratigraphic description, e.g. "...with closely spaced thin laminae of..." It may be noted that therefore, the graphic representation of strata containing frequent thin laminae to medium thin beds is a simplification of the complex nature of layers containing such features.

Soil parameters such as undrained shear strength, Atterberg limits and particle size distribution data may suggest a different principal soil type than presented in the graphic logs. This is typically the result of soil layers containing frequent thin laminae to medium beds of material different from the principal soil type.

The geotechnical logs present unit weight values from (1) direct measurement using volume-mass calculations and (2) derived from water content measurements. Unit weight values derived from water content measurements assume (a) full saturation and (b) typical values for the density of solid particles of 2.65 Mg/m^3 for coarse-grained cohesionless material and 2.70 Mg/m^3 for fine-grained cohesive material. Occasionally there may be a difference between unit weight values derived from water content measurements and direct measurements. This is primarily applicable to coarse-grained cohesionless soils in the top of the soil profile. The difference in derived and measured unit weight may be attributed to the use of a 2" diameter WIP sample tube with a core catcher, which may have increased sample disturbance and/or the large "unit weight ring" (100 ml) used for the unit weight determination by the volume-mass method combined with the presence of shells and shell fragments in sand. Unit weight values derived from water content measurements are in agreement with the expected range for unit weights of soils tested.

The geotechnical logs present undrained shear strength for fine-grained cohesive soils and relative density for coarse-grained cohesionless soils. For this classification, soil behaviour type parameters (I_c and I_{SBT}) according to Robertson (2009) and Robertson (2010) were used. Refer to document titled "Cone Penetration Test Interpretation" in Appendix 1 for details.

Relative density (D_r) presented on the geotechnical logs is derived from CPT data using an empirical relationship as recommended by Jamiolkowski et al. (2003) and earth pressure coefficient values (K_0) of 0.5 and 1.0. D_r is calculated and plotted where soil behaviour type indices I_c and I_{SBT} <2.60. It may be noted that the relation proposed by Jamiolkowski has limited applicability in layers with a high percentage of fines (i.e. >10 %

silt and/or clay fractions) and in layers from seafloor to about 2 m to 3 m BSF. Relative density interpretation for these layers should be used with caution.

Undrained shear strength is calculated and plotted where soil behaviour type indices I_c and I_{SBT} >2.05. For deriving undrained shear strength (s_u) values from CPT data (net cone resistance), typical cone factors (N_k) of 15 to 20 have been used. Site, layer or test type specific N_k assessment was beyond the scope of this report. Such assessment may be appropriate for specific use of CPT derived strength values.

Note that for specific intervals derived D_r values as well as derived s_u values are presented. In Figure 3 and Figure 4 of document titled "Cone Penetration Test Interpretation" in Appendix 1, classification charts are presented using I_c (Robertson, 2009) and I_{SBT} (Robertson, 2010). Soil type 5 in both graphs (representing soil type "SAND mixtures - silty sand to sandy silt") with I_c/I_{SBT} boundaries of 2.05 and 2.60 may behave drained, partially drained or undrained. For these intervals both CPT derived s_u and D_r are presented.

Carbonate content descriptive terms for individual strata are typically based on in-office laboratory determination of carbonate content. Occasionally, a carbonate content test yielded a result which would label the soil differently than the general term presented for a soil stratum based on site descriptions. This was the case for Sample 31BagB and Sample 43BagA in HKZ1-BH03-SA, Sample 26BagB in HKZ1-BH06-SA, and Sample 02BagB in HKZ1-BH07-SA. The difference may be attributed to the presence of shells and shell fragments within the test specimen. If this was expected, test results were not considered for the carbonate content descriptive terms of the main strata. Individual results of carbonate content determinations are presented graphically in the geotechnical logs and on plates titled "Laboratory Classification Test Results" in Section C2.1

Minor constituents are shown graphically on the geotechnical logs when occurrence is estimated to be >5 % (from descriptive term 'with' onwards). Organic content is shown in the graphic log when soil can be described as 'organic' (i.e. organic content of 5 % to 10 % for fine-grained cohesive soils; organic content of 3 % to 5 % for coarse-grained cohesionless soils).

Some organic content laboratory tests (dichromate oxidation method) show results which would indicate very organic soils. However, some of these tests have been performed on soils with laminae and thin beds of organic material. For these cases, organic content test results were not considered in the main strata descriptions.

For determination of particle size distributions (PSD), a combination of wet sieving and a sedimentation test (pipette method) was only performed on specimens for which sieving yielded >15 % fines (fraction <0.063 mm). Where a sedimentation test was not carried out, and no data from Atterberg limits testing are available, the relative composition of the fine fraction cannot be assessed from the PSDs and hence, secondary soil type is given as 'silt' (e.g.: a specimen containing 13 % fines would be described as 'silty').

In the geotechnical log of location HKZ1-BH01-SA, the stratum from 20.8 m to 21.6 m BSF is described as "medium dense dark grey sand" whereas field descriptions in Section C2 suggest the material to be "dark grey very sandy clay". Interpretation of in situ test (CPT) data supports the decision to change field descriptions.

A.2 PRACTICE FOR GEOTECHNICAL LOG

Approach

Purpose: Support of planning and design of subsea structures, e.g. foundations and cables

General Procedure:
- Refer to document titled “Geotechnical Log” presented in Appendix 1
- According to BSI (1999) and Clark & Walker (1977)

Results

Data Processing and Interpretation:
- UNIPLOT software
- GeODin® software
- Graphical scales selected to suit general presentation of data
- No display of data outside of chart limits, i.e. some values may not be shown
- Geotechnical description is an interpretation of processed data available at the time of preparation; for example, interfaces between strata may be more gradual than a log indicates
- Level of detail and accuracy in geotechnical description and interpretation depend on factors such as investigation system(s), logging/ test data, sample size, quality, coverage, availability of supplementary information, and project requirements

Data Format(s):
- PDF for viewing and printing (this primary document)
- AGS 4.0 (AGS, 2011) digital tabular data (separate deliverables, secondary to the final issue of this document)

Matching Test, Sample and Logging Data: Geotechnical log based on in situ test and sample data acquired in borehole

Ground Description:
- According to documents titled “Soil Description” and "Cone Penetration Test Interpretation” presented in Appendix 1, as applicable
- Sample description updated to BSI (1999)
- CPT interpretation using Robertson (1990, 2009, and 2010) methodology, updated to BSI (1999)

Unit Weight derived from In Situ Test: Not applicable

Relative Density derived from In Situ Test: If applicable:
- refer to document titled “Cone Penetration Test Interpretation” presented in Appendix 1
- according to Jamiolkowski et al. (2003) for saturated coarse-grained, cohesionless soil behaviour, Ticino Sand correlation
- based on earth pressure coefficient values K_0 = 0.5 and 1.0
- relative density calculated for cone embedment >10d, where d is diameter of cone penetrometer
- relative density calculated where soil behaviour type indices I_c and I_{SBT} <2.60

Undrained Shear Strength derived from In Situ Test: If applicable:
- refer to document titled “Cone Penetration Test Interpretation” presented in Appendix 1
- applies to interpreted fine-grained, cohesive soil behaviour
- refer to document titled “Cone Penetration Test Interpretation” presented in Appendix 1
- applies to interpreted fine-grained, cohesive soil behaviour
- based on cone factors of N_k = 15 and 20
- undrained shear strength calculated for cone embedment >10d, where d is diameter of cone penetrometer
- undrained shear strength calculated where soil behaviour type indices I_c and I_{SBT} >2.05

Coordinates and Water Depth:	Applicable to borehole location listed first
Water Depth Reference:	As obtained from CTD readings at start of drilling, testing or sampling, reduced to LAT
Depth Reference Correction:	None applied, downhole sampling assumed continuous from sampling depth with no continuity gaps, downhole CPT continuous from CPT depth

A.3 PRACTICE FOR GEOTECHNICAL BOREHOLE

Borehole Stage Control

General Procedure:	– According to ISO (2014) – Refer to document titled “Geotechnical Borehole” presented in Appendix 1
Set-up Stage:	Location as directed by Client
Depth Reference Level:	Seafloor, particularly: – No evidence for extremely soft ground at seafloor but no specific measurements performed – Base of seabed frame assumed level with seafloor at start of drilling, sampling and testing – Depth accuracy assessment of “Downhole – Favourable”; refer to document titled Positioning Survey and Depth Measurement presented in Appendix 1
Drilling Stage:	Open-hole rotary drilling
Borehole Geophysical Logging:	Not applicable
Sampling and In Situ Testing:	– Locations with sampling only: semi-continuous push sampling to target depth with maximum untested section of 0.5 m – Locations with combined sampling and cone penetration testing: semi-continuous push sampling to 50 m depth with maximum untested section of 0.5 m followed by alternate 3 m cone penetration testing and 2 m push sampling in fine-grained cohesive soil and alternate 3 m cone penetration testing and 1 m push sampling in coarse-grained cohesionless soil with maximum untested section of 0.5 m – Locations with (seismic) cone penetration testing only: semi-continuous cone penetration test with maximum untested section of 1.0 m to target depth. Seismic tests and oversampling at selected depths in a selection of boreholes. – Sequences of sampling and in situ testing were adjusted to suit operations and site-specific constraints
Borehole Water Level Monitoring:	Not applicable
Borehole Termination Stage:	Whichever occurs first: – as instructed by Client – reaching target borehole depth – circumstances at the discretion of the equipment operator, such as risk of equipment damage or risk to personnel safety
Test Site Restoration:	– No borehole backfill – Local seabed disturbance – Possibility of local seafloor depression(s) and drill cuttings on seafloor

Drilling

Working Platform:	Specialist geotechnical drilling vessel Bucentaur
Drilling Method:	Open hole rotary drilling
Type and Make of Drill Rig:	Bucentaur equipment including 35 m high derrick, WIRTH B3-5 power swivel and 13.5 tons drill winch
Drill Support:	SEACLAM seabed frame
Drill Pipe:	API-type 4.5 inch ID
Drill Bit:	9 inch OD 5 wing drag bit or 6 chisel claw bit
Core Barrel:	Not applicable
Drill Fluid:	Bentonite
Initial Borehole Orientation:	Vertical

In Situ Test – CPT

Refer to sub-section “Practice for Cone Penetration Test” presented in report section titled “In Situ Test Results”

In Situ Test – SCPT

Refer to sub-section “Practice for Seismic Cone Penetration Test” presented in report section titled “In Situ Test Results”

Push Sampling

Sampling System:	Downhole WIP Sampler
Sampler Insertion Equipment:	Jacking unit with maximum thrust capacity of 60 kN to 80 kN and penetration rate of about 20 mm/s
Reaction Equipment:	Self-weight of drill pipes, drill collars and SEACLAM seabed frame
Open-Tube Sampler:	– Thin-walled 3 inch cylindrical sample tube, 76 mm OD, 72 mm ID – Thick-walled 3 inch cylindrical sample tube, 80 mm OD, 72 mm ID – Thick-walled 2 inch cylindrical sample tube, 60 mm OD, 53 mm ID – Liner 3 inch cylindrical PVC grey liner, 76 mm ID, 66 mm ID
Core Catcher:	Applicable in case of limited sample recovery in coarse-grained cohesionless soils
Push Sampling Termination:	Whichever occurs first: – reaching maximum permissible sample tube penetration – reaching maximum capacity of sample insertion equipment and/or sample tube – reaching maximum capacity of reaction equipment – circumstances at the discretion of the equipment operator, such as risk of equipment damage or risk to personnel safety

Sample Handling

Refer to sub-section “Practice for Sample Handling and Laboratory Testing” presented in report section titled “Geotechnical Laboratory Test Results”

A.4 REFERENCES

AGS Association of Geotechnical and Geoenvironmental Specialists, 2011. *Electronic Transfer of Geotechnical and Geoenvironmental Data.* AGS Edition 4.0.

BSI British Standards Institution, 1999. *BS 5930 Code of Practice for Site Investigations*", London: BSI.

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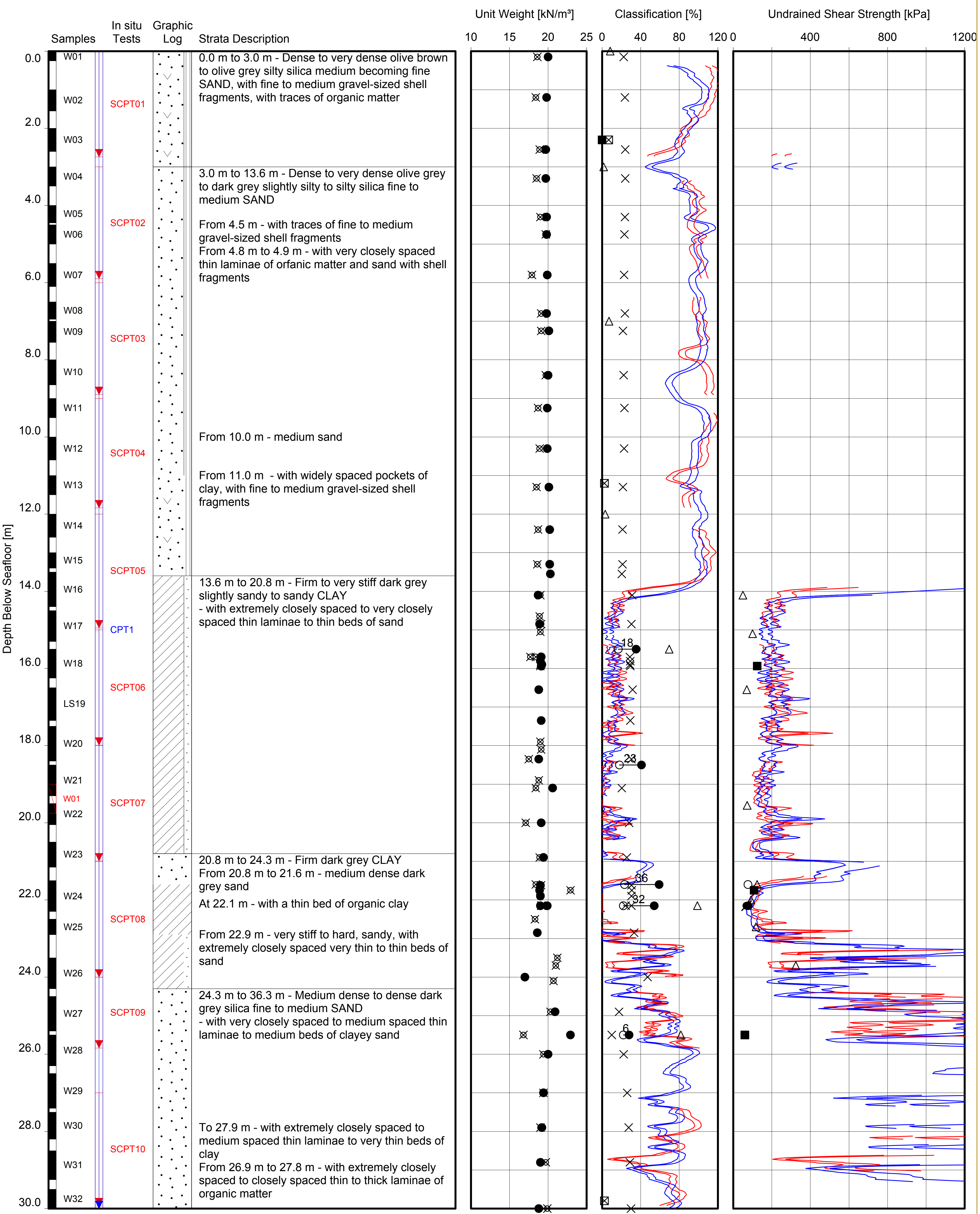
HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Samples	In situ Tests	Graphic Log	Strata Description
W01 W02 W03	SCPT01		0.0 m to 3.0 m - Dense to very dense olive brown to olive grey silty silica medium becoming fine SAND, with fine to medium gravel-sized shell fragments, with traces of organic matter
W04 W05 W06 W07 W08 W09 W10 W11 W12 W13 W14 W15	SCPT02 SCPT03 SCPT04 SCPT05		3.0 m to 13.6 m - Dense to very dense olive grey to dark grey slightly silty to silty silica fine to medium SAND From 4.5 m - with traces of fine to medium gravel-sized shell fragments From 4.8 m to 4.9 m - with very closely spaced thin laminae of orfanic matter and sand with shell fragments From 10.0 m - medium sand From 11.0 m - with widely spaced pockets of clay, with fine to medium gravel-sized shell fragments
W16 W17 W18 LS19 W20 W21 W01 W22	CPT1 SCPT06 SCPT07		13.6 m to 20.8 m - Firm to very stiff dark grey slightly sandy to sandy CLAY - with extremely closely spaced to very closely spaced thin laminae to thin beds of sand
W23 W24 W25 W26	SCPT08		20.8 m to 24.3 m - Firm dark grey CLAY From 20.8 m to 21.6 m - medium dense dark grey sand At 22.1 m - with a thin bed of organic clay From 22.9 m - very stiff to hard, sandy, with extremely closely spaced very thin to thin beds of sand
W27 W28 W29 W30 W31 W32	SCPT09 SCPT10		24.3 m to 36.3 m - Medium dense to dense dark grey silica fine to medium SAND - with very closely spaced to medium spaced thin laminae to medium beds of clayey sand To 27.9 m - with extremely closely spaced to medium spaced thin laminae to very thin beds of clay From 26.9 m to 27.8 m - with extremely closely spaced to closely spaced thin to thick laminae of organic matter



● Derived from water content
⊠ Derived from volume mass calculation
Derived from CPT (Mayne 2010)

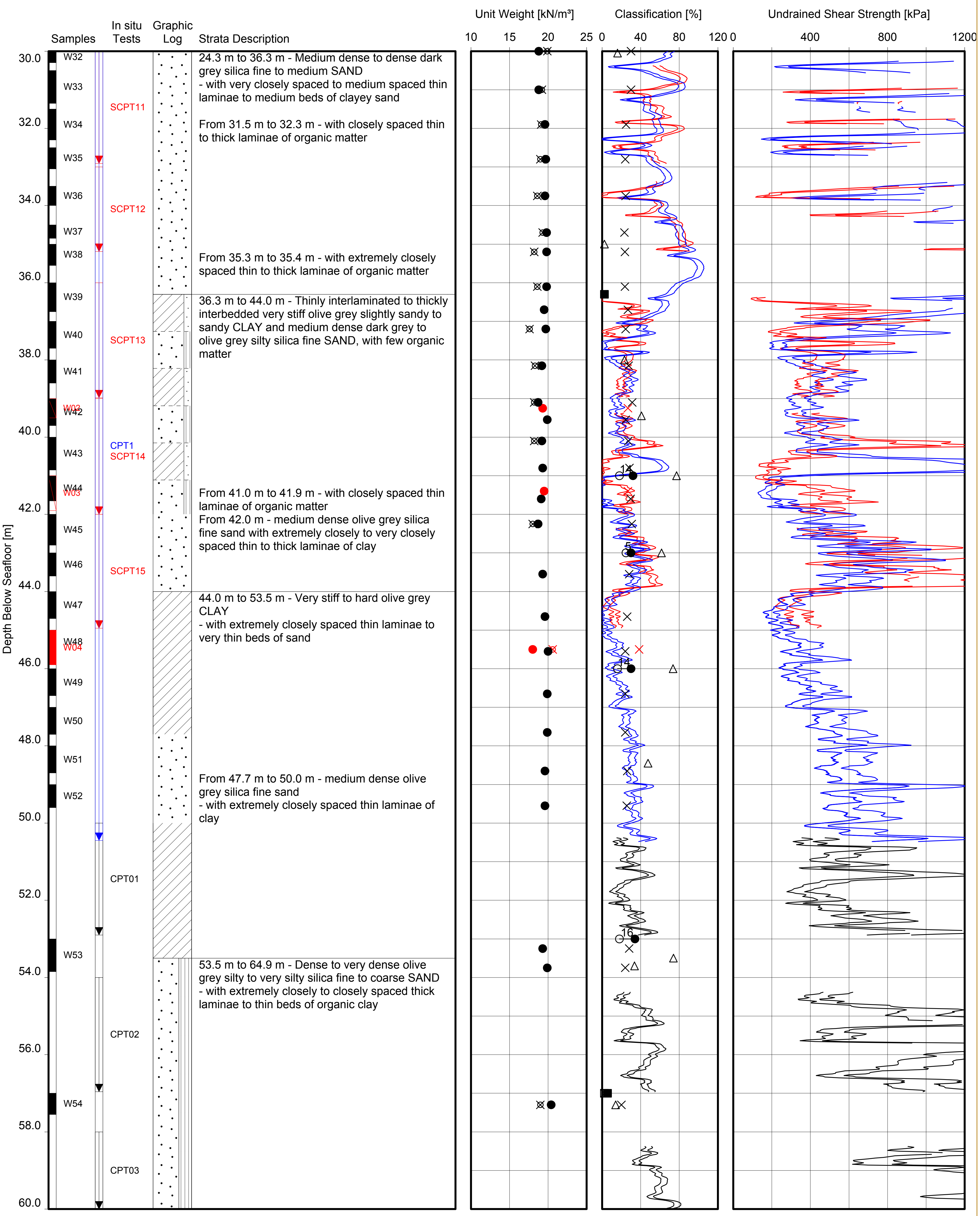
× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
Derived from CPT
Ø Slashed symbol refers to test on remoulded soil

Date commenced : 15-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 64.9 m below seafloor
Penetration depth : to 64.9 m below seafloor
Water depth : 21.8 m
Coordinates : 575786 m E 5807003 m N

Location(s):
HKZ1-BH01-SA
HKZ1-BH01-SC
HKZ1-CPT01

GEOTECHNICAL LOG



24.3 m to 36.3 m - Medium dense to dense dark grey silica fine to medium SAND
- with very closely spaced to medium spaced thin laminae to medium beds of clayey sand

From 31.5 m to 32.3 m - with closely spaced thin to thick laminae of organic matter

From 35.3 m to 35.4 m - with extremely closely spaced thin to thick laminae of organic matter

36.3 m to 44.0 m - Thinly interlaminated to thickly interbedded very stiff olive grey slightly sandy to sandy CLAY and medium dense dark grey to olive grey silty silica fine SAND, with few organic matter

From 41.0 m to 41.9 m - with closely spaced thin laminae of organic matter
From 42.0 m - medium dense olive grey silica fine sand with extremely closely to very closely spaced thin to thick laminae of clay

44.0 m to 53.5 m - Very stiff to hard olive grey CLAY
- with extremely closely spaced thin laminae to very thin beds of sand

From 47.7 m to 50.0 m - medium dense olive grey silica fine sand
- with extremely closely spaced thin laminae of clay

53.5 m to 64.9 m - Dense to very dense olive grey silty to very silty silica fine to coarse SAND
- with extremely closely to closely spaced thick laminae to thin beds of organic clay

Date commenced : 15-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 64.9 m below seafloor
Penetration depth : to 64.9 m below seafloor
Water depth : 21.8 m
Coordinates : 575786 m E 5807003 m N

Location(s):
HKZ1-BH01-SA
HKZ1-BH01-SC
HKZ1-CPT01

● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

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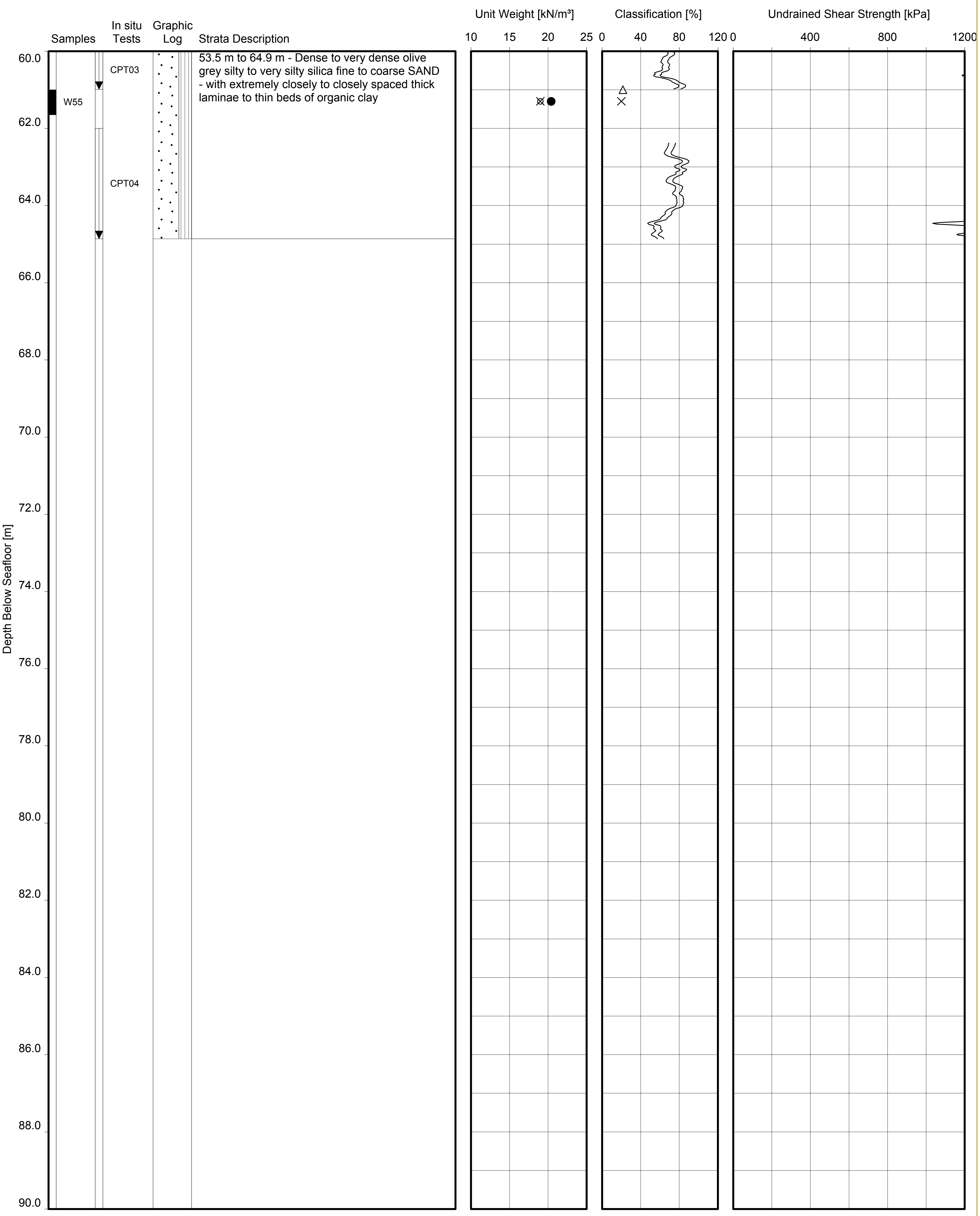


53.5 m to 64.9 m - Dense to very dense olive grey silty to very silty silica fine to coarse SAND - with extremely closely to closely spaced thick laminae to thin beds of organic clay

Date commenced	: 15-Jul-2016
Method	: Rotary borehole drilling and sampling
Recovery depth	: to 64.9 m below seafloor
Penetration depth	: to 64.9 m below seafloor
Water depth	: 21.8 m
Coordinates	: 575786 m E 5807003 m N

Location(s):
HKZ1-BH01-SA
HKZ1-BH01-SC
HKZ1-CPT01

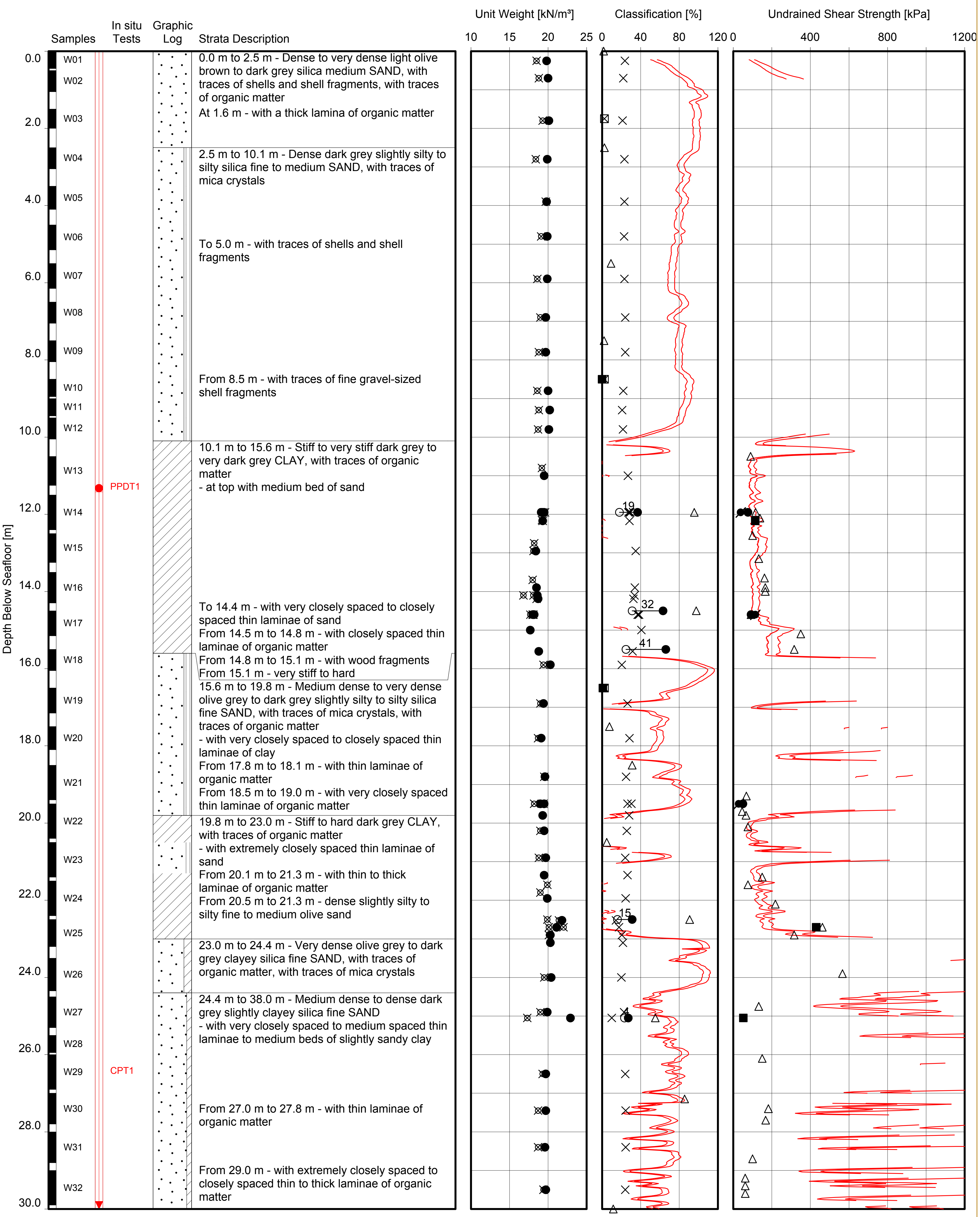
● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:23



0.0 m to 2.5 m - Dense to very dense light olive brown to dark grey silica medium SAND, with traces of shells and shell fragments, with traces of organic matter
At 1.6 m - with a thick lamina of organic matter

2.5 m to 10.1 m - Dense dark grey slightly silty to silty silica fine to medium SAND, with traces of mica crystals

To 5.0 m - with traces of shells and shell fragments

From 8.5 m - with traces of fine gravel-sized shell fragments

10.1 m to 15.6 m - Stiff to very stiff dark grey to very dark grey CLAY, with traces of organic matter
- at top with medium bed of sand

To 14.4 m - with very closely spaced to closely spaced thin laminae of sand
From 14.5 m to 14.8 m - with closely spaced thin laminae of organic matter
From 14.8 m to 15.1 m - with wood fragments
From 15.1 m - very stiff to hard

15.6 m to 19.8 m - Medium dense to very dense olive grey to dark grey slightly silty to silty silica fine SAND, with traces of mica crystals, with traces of organic matter
- with very closely spaced to closely spaced thin laminae of clay
From 17.8 m to 18.1 m - with thin laminae of organic matter
From 18.5 m to 19.0 m - with very closely spaced thin laminae of organic matter

19.8 m to 23.0 m - Stiff to hard dark grey CLAY, with traces of organic matter
- with extremely closely spaced thin laminae of sand
From 20.1 m to 21.3 m - with thin to thick laminae of organic matter
From 20.5 m to 21.3 m - dense slightly silty to silty fine to medium olive sand

23.0 m to 24.4 m - Very dense olive grey to dark grey clayey silica fine SAND, with traces of organic matter, with traces of mica crystals

24.4 m to 38.0 m - Medium dense to dense dark grey slightly clayey silica fine SAND
- with very closely spaced to medium spaced thin laminae to medium beds of slightly sandy clay

From 27.0 m to 27.8 m - with thin laminae of organic matter

From 29.0 m - with extremely closely spaced to closely spaced thin to thick laminae of organic matter

Date commenced : 14-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.4 m below seafloor
Penetration depth : to 50.5 m below seafloor
Water depth : 22.8 m
Coordinates : 570257 m E 5803814 m N

Location(s):
HKZ1-BH02-SA
HKZ1-CPT02

● Derived from water content
⊠ Derived from volume mass calculation
↯ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
↯ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
↯ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

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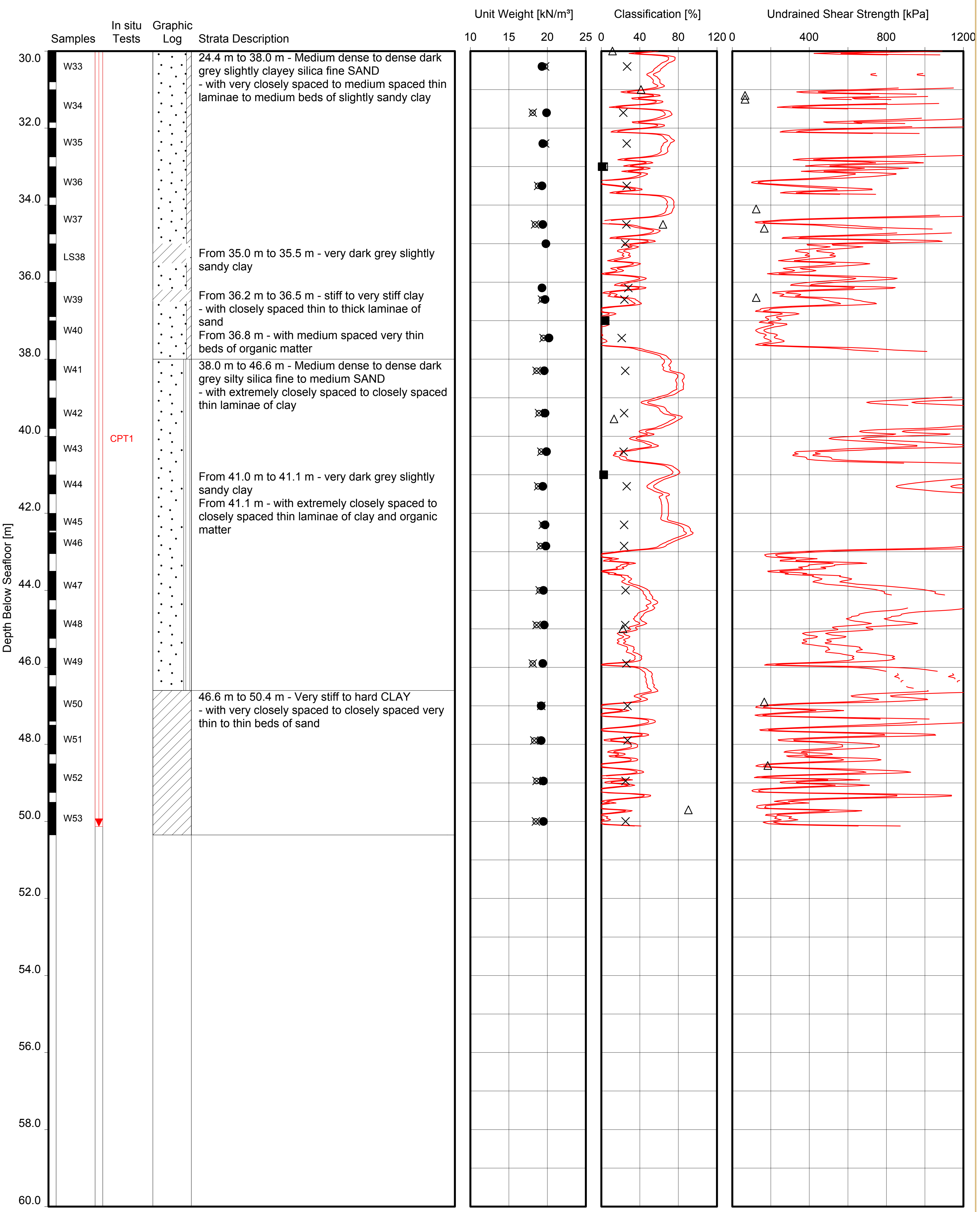

24.4 m to 38.0 m - Medium dense to dense dark grey slightly clayey silica fine SAND
- with very closely spaced to medium spaced thin laminae to medium beds of slightly sandy clay

From 35.0 m to 35.5 m - very dark grey slightly sandy clay

From 36.2 m to 36.5 m - stiff to very stiff clay
- with closely spaced thin to thick laminae of sand
From 36.8 m - with medium spaced very thin beds of organic matter

38.0 m to 46.6 m - Medium dense to dense dark grey silty silica fine to medium SAND
- with extremely closely spaced to closely spaced thin laminae of clay

From 41.0 m to 41.1 m - very dark grey slightly sandy clay
From 41.1 m - with extremely closely spaced to closely spaced thin laminae of clay and organic matter

46.6 m to 50.4 m - Very stiff to hard CLAY
- with very closely spaced to closely spaced very thin to thin beds of sand

Date commenced : 14-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.4 m below seafloor
Penetration depth : to 50.5 m below seafloor
Water depth : 22.8 m
Coordinates : 570257 m E 5803814 m N

Location(s):
HKZ1-BH02-SA
HKZ1-CPT02

●	Derived from water content
⊠	Derived from volume mass calculation
⚡	Derived from CPT (Mayne 2010)

×	Water content
○	Plastic limit
●	Liquid limit
○—●	Plasticity index
△	Percentage fines
⊠	Carbonate content
■	Organic content
⚡	Relative density derived from CPT

△	Pocket penetrometer
○	Torvane
▽	Fallcone
⊞	Hand vane
⊕	Laboratory vane
●	UU-triaxial
■	CU-triaxial
◪	Direct simple shear
◆	In situ vane shear test
⚡	Derived from CPT
∅	Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

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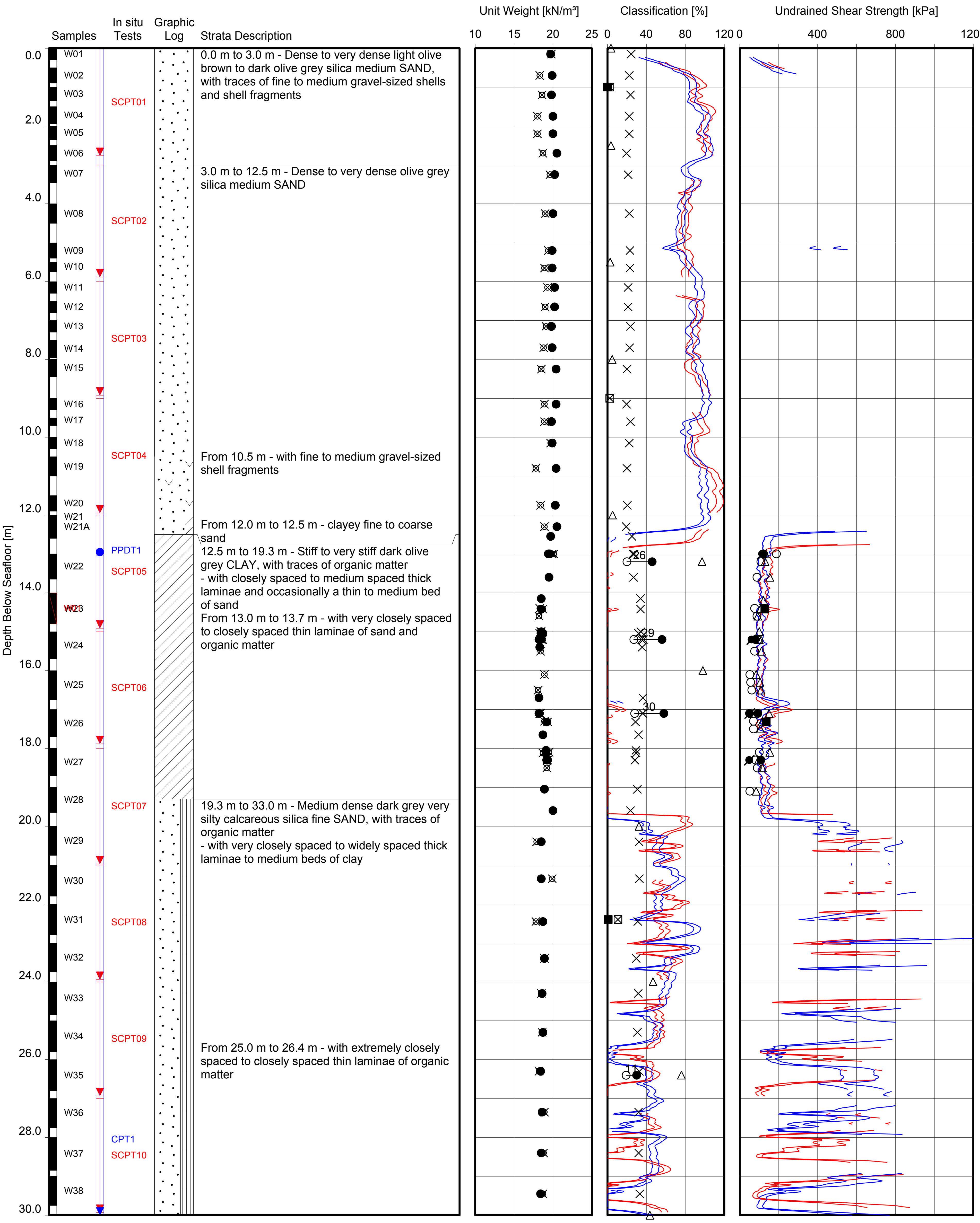


0.0 m to 3.0 m - Dense to very dense light olive brown to dark olive grey silica medium SAND, with traces of fine to medium gravel-sized shells and shell fragments

3.0 m to 12.5 m - Dense to very dense olive grey silica medium SAND

From 10.5 m - with fine to medium gravel-sized shell fragments

From 12.0 m to 12.5 m - clayey fine to coarse sand

12.5 m to 19.3 m - Stiff to very stiff dark olive grey CLAY, with traces of organic matter
- with closely spaced to medium spaced thick laminae and occasionally a thin to medium bed of sand
From 13.0 m to 13.7 m - with very closely spaced to closely spaced thin laminae of sand and organic matter

19.3 m to 33.0 m - Medium dense dark grey very silty calcareous silica fine SAND, with traces of organic matter
- with very closely spaced to widely spaced thick laminae to medium beds of clay

From 25.0 m to 26.4 m - with extremely closely spaced to closely spaced thin laminae of organic matter

Date commenced : 13-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 66.5 m below seafloor
Penetration depth : to 66.5 m below seafloor
Water depth : 21.7 m
Coordinates : 571804 m E 5801442 m N

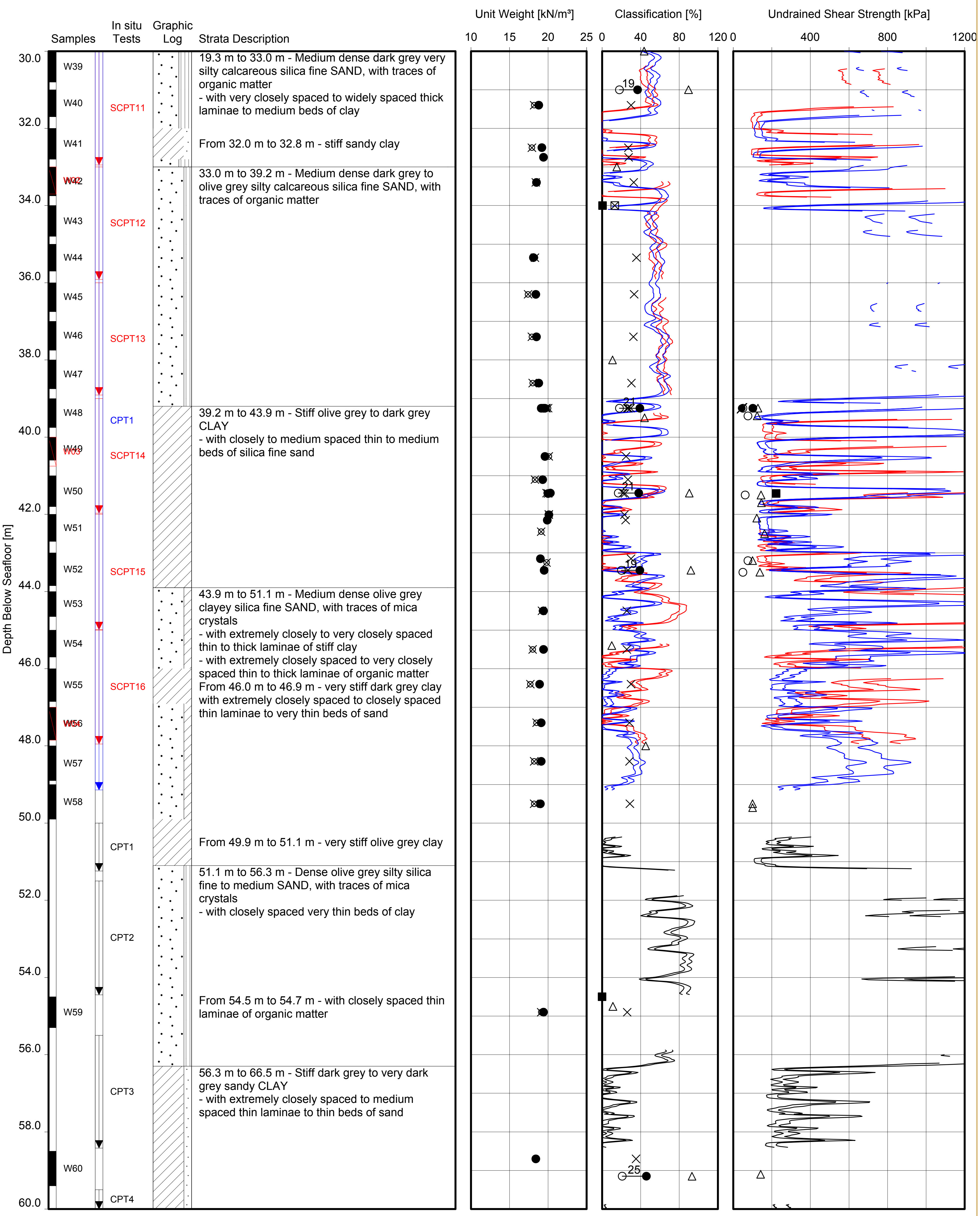
Location(s):
HKZ1-BH03-SA
HKZ1-BH03-SC
HKZ1-CPT03

● Derived from water content
⊠ Derived from volume mass calculation
Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG



19.3 m to 33.0 m - Medium dense dark grey very silty calcareous silica fine SAND, with traces of organic matter
- with very closely spaced to widely spaced thick laminae to medium beds of clay

From 32.0 m to 32.8 m - stiff sandy clay

33.0 m to 39.2 m - Medium dense dark grey to olive grey silty calcareous silica fine SAND, with traces of organic matter

39.2 m to 43.9 m - Stiff olive grey to dark grey CLAY
- with closely to medium spaced thin to medium beds of silica fine sand

43.9 m to 51.1 m - Medium dense olive grey clayey silica fine SAND, with traces of mica crystals
- with extremely closely to very closely spaced thin to thick laminae of stiff clay
- with extremely closely spaced to very closely spaced thin to thick laminae of organic matter

From 46.0 m to 46.9 m - very stiff dark grey clay with extremely closely spaced to closely spaced thin laminae to very thin beds of sand

From 49.9 m to 51.1 m - very stiff olive grey clay

51.1 m to 56.3 m - Dense olive grey silty silica fine to medium SAND, with traces of mica crystals
- with closely spaced very thin beds of clay

From 54.5 m to 54.7 m - with closely spaced thin laminae of organic matter

56.3 m to 66.5 m - Stiff dark grey to very dark grey sandy CLAY
- with extremely closely spaced to medium spaced thin laminae to thin beds of sand

Date commenced	: 13-Jul-2016
Method	: Rotary borehole drilling and sampling
Recovery depth	: to 66.5 m below seafloor
Penetration depth	: to 66.5 m below seafloor
Water depth	: 21.7 m
Coordinates	: 571804 m E 5801442 m N

Location(s):
HKZ1-BH03-SA
HKZ1-BH03-SC
HKZ1-CPT03

●	Derived from water content	×	Water content	△	Pocket penetrometer
⊠	Derived from volume mass calculation	○	Plastic limit	○	Torvane
ϟ	Derived from CPT (Mayne 2010)	●	Liquid limit	▽	Fallcone
		○—●	Plasticity index	⊞	Hand vane
		△	Percentage fines	⊕	Laboratory vane
		⊠	Carbonate content	●	UU-triaxial
		■	Organic content	■	CU-triaxial
		ϟ	Relative density derived from CPT	◪	Direct simple shear
				◆	In situ vane shear test
				ϟ	Derived from CPT
				Ø	Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

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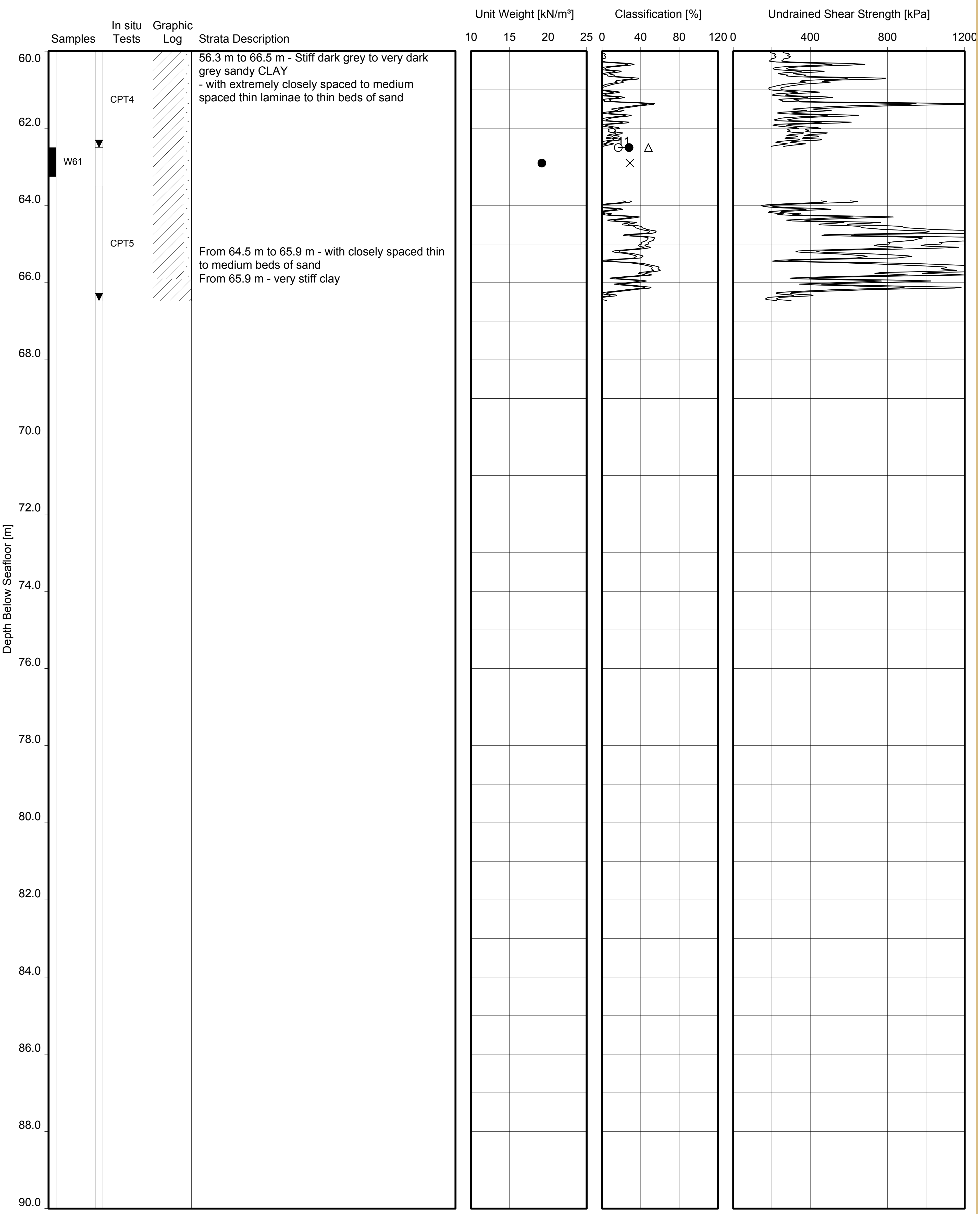


Date commenced : 13-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 66.5 m below seafloor
Penetration depth : to 66.5 m below seafloor
Water depth : 21.7 m
Coordinates : 571804 m E 5801442 m N

Location(s):
HKZ1-BH03-SA
HKZ1-BH03-SC
HKZ1-CPT03

● Derived from water content
⊠ Derived from volume mass calculation
Derived from CPT (Mayne 2010)

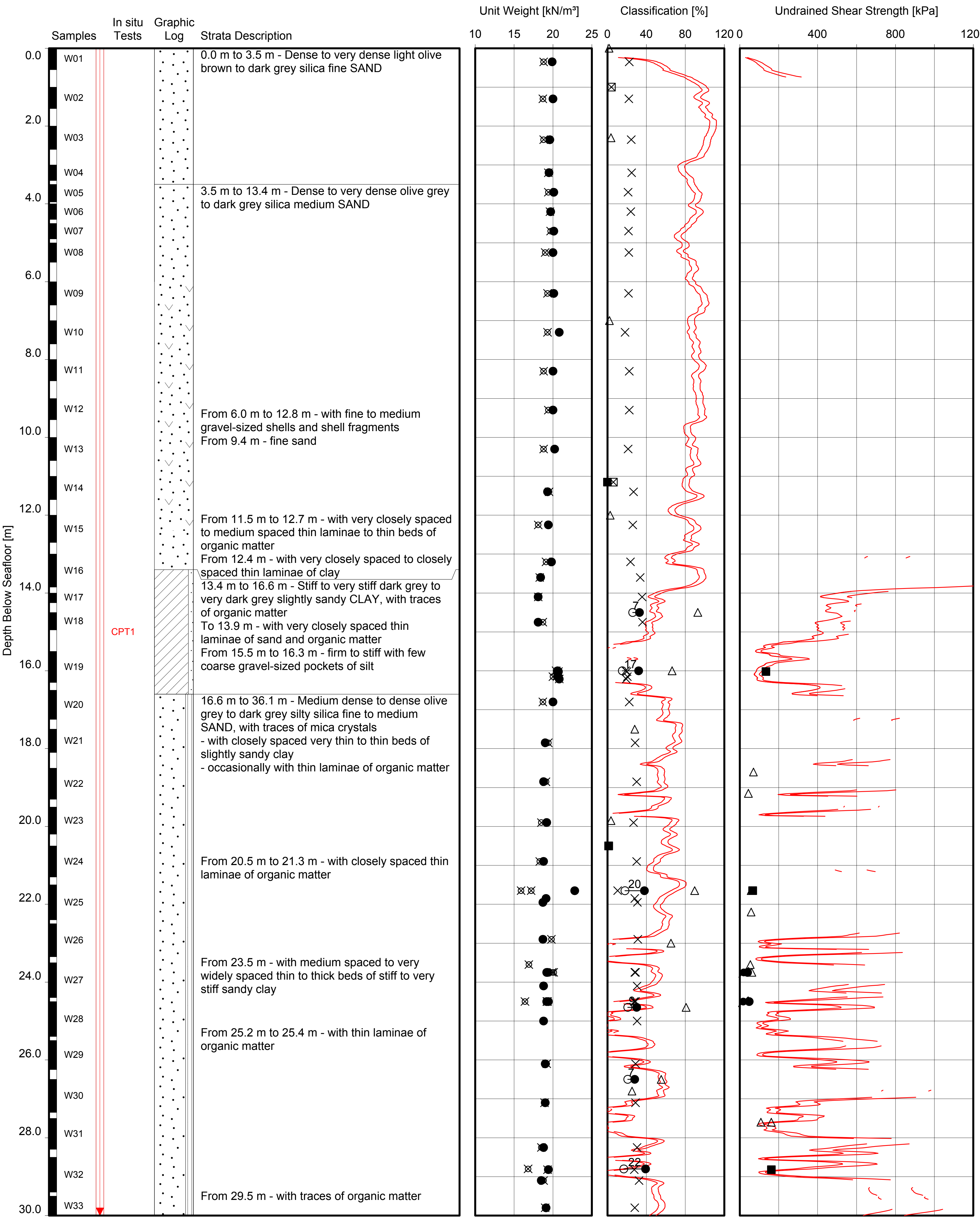
× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
Derived from CPT
⌀ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:26



0.0 m to 3.5 m - Dense to very dense light olive brown to dark grey silica fine SAND

3.5 m to 13.4 m - Dense to very dense olive grey to dark grey silica medium SAND

From 6.0 m to 12.8 m - with fine to medium gravel-sized shells and shell fragments

From 9.4 m - fine sand

From 11.5 m to 12.7 m - with very closely spaced to medium spaced thin laminae to thin beds of organic matter

From 12.4 m - with very closely spaced to closely spaced thin laminae of clay

13.4 m to 16.6 m - Stiff to very stiff dark grey to very dark grey slightly sandy CLAY, with traces of organic matter

To 13.9 m - with very closely spaced thin laminae of sand and organic matter

From 15.5 m to 16.3 m - firm to stiff with few coarse gravel-sized pockets of silt

16.6 m to 36.1 m - Medium dense to dense olive grey to dark grey silty silica fine to medium SAND, with traces of mica crystals

- with closely spaced very thin to thin beds of slightly sandy clay
- occasionally with thin laminae of organic matter

From 20.5 m to 21.3 m - with closely spaced thin laminae of organic matter

From 23.5 m - with medium spaced to very widely spaced thin to thick beds of stiff to very stiff sandy clay

From 25.2 m to 25.4 m - with thin laminae of organic matter

From 29.5 m - with traces of organic matter

Date commenced : 12-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.8 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 23.2 m
Coordinates : 564965 m E 5803849 m N

Location(s):
HKZ1-BH04-SA
HKZ1-CPT04

● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

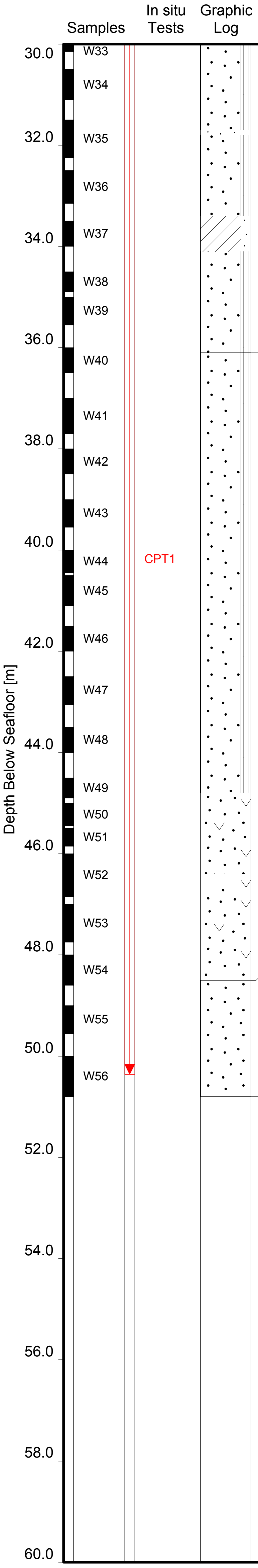
× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
Ø Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:26



Strata Description

16.6 m to 36.1 m - Medium dense to dense olive grey to dark grey silty silica fine to medium SAND, with traces of mica crystals
- with closely spaced very thin to thin beds of slightly sandy clay
- occasionally with thin laminae of organic matter
From 31.7 m to 31.8 m - with extremely closely spaced thin laminae of organic matter

36.1 m to 48.5 m - Dense olive grey to dark grey silty silica fine to medium SAND, with traces of mica crystals

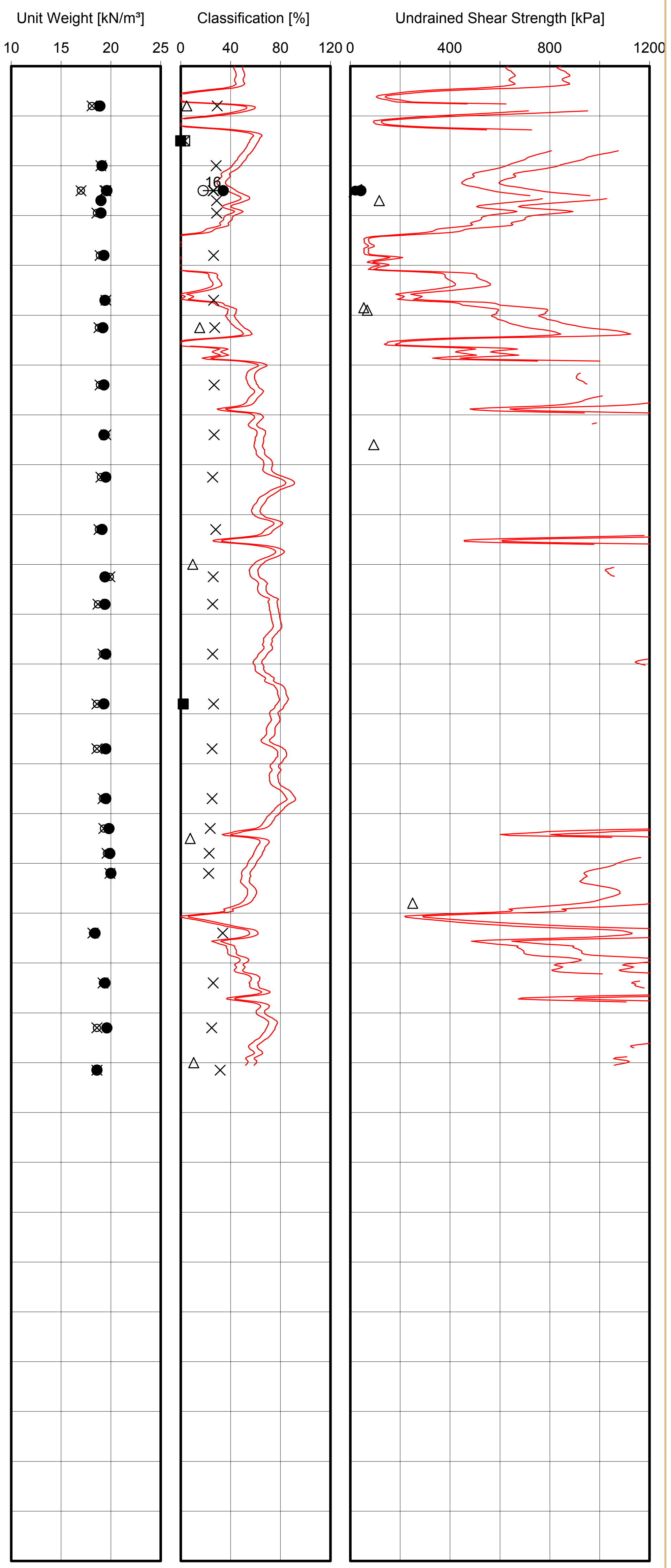
At 43.0 m - with a thick lamina of organic matter

From 43.3 m to 44.0 m - with closely spaced thin laminae of organic matter

From 44.8 m - with shell fragments

From 46.0 m to 46.4 m - with closely spaced thin laminae of clay
From 46.4 m to 46.7 m - with many fine to medium gravel-sized shell fragments
From 46.7 m - with organic matter becoming with traces of organic matter

48.5 m to 50.8 m - Medium dense to dense olive grey to dark grey silica fine to medium SAND, with traces of organic matter
- with medium spaced thin beds of silt
- at top with thin bed of very stiff dark grey clay
From 49.4 m to 49.6 m - with very closely spaced thin laminae of organic matter



Date commenced : 12-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.8 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 23.2 m
Coordinates : 564965 m E 5803849 m N

Location(s):
HKZ1-BH04-SA
HKZ1-CPT04

● Derived from water content
⊠ Derived from volume mass calculation
ϟ Derived from CPT (Mayne 2010)

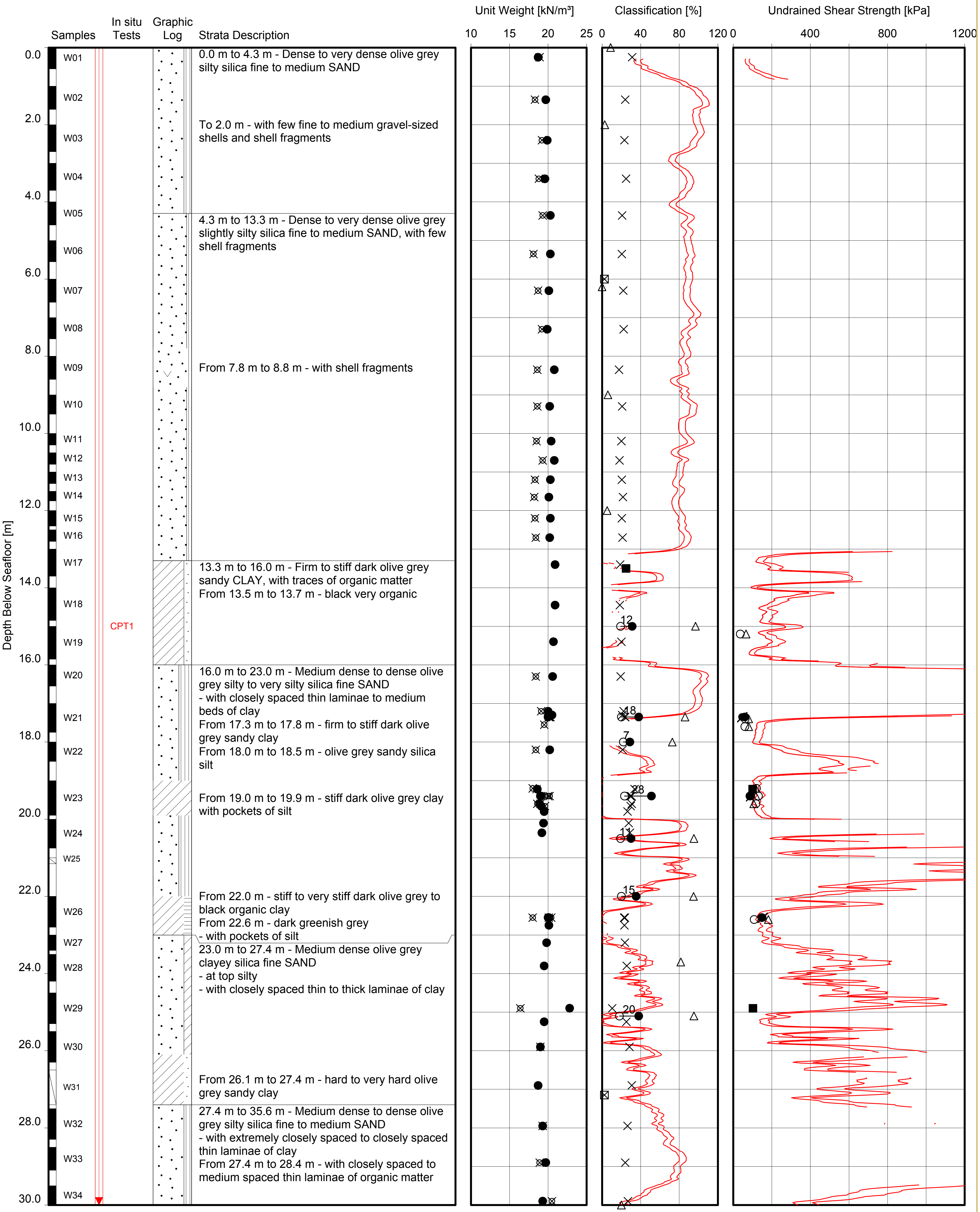
× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
ϟ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
ϟ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:26



0.0 m to 4.3 m - Dense to very dense olive grey silty silica fine to medium SAND

To 2.0 m - with few fine to medium gravel-sized shells and shell fragments

4.3 m to 13.3 m - Dense to very dense olive grey slightly silty silica fine to medium SAND, with few shell fragments

From 7.8 m to 8.8 m - with shell fragments

13.3 m to 16.0 m - Firm to stiff dark olive grey sandy CLAY, with traces of organic matter
From 13.5 m to 13.7 m - black very organic

16.0 m to 23.0 m - Medium dense to dense olive grey silty to very silty silica fine SAND
- with closely spaced thin laminae to medium beds of clay
From 17.3 m to 17.8 m - firm to stiff dark olive grey sandy clay
From 18.0 m to 18.5 m - olive grey sandy silica silt

From 19.0 m to 19.9 m - stiff dark olive grey clay with pockets of silt

From 22.0 m - stiff to very stiff dark olive grey to black organic clay
From 22.6 m - dark greenish grey
- with pockets of silt

23.0 m to 27.4 m - Medium dense olive grey clayey silica fine SAND
- at top silty
- with closely spaced thin to thick laminae of clay

From 26.1 m to 27.4 m - hard to very hard olive grey sandy clay

27.4 m to 35.6 m - Medium dense to dense olive grey silty silica fine to medium SAND
- with extremely closely spaced to closely spaced thin laminae of clay
From 27.4 m to 28.4 m - with closely spaced to medium spaced thin laminae of organic matter

Date commenced	: 15-Jul-2016
Method	: Rotary borehole drilling and sampling
Recovery depth	: to 50.4 m below seafloor
Penetration depth	: to 50.5 m below seafloor
Water depth	: 21.8 m
Coordinates	: 576102 m E 5803510 m N

Location(s):
HKZ1-BH05-SA
HKZ1-CPT05

● Derived from water content
⊠ Derived from volume mass calculation
↯ Derived from CPT (Mayne 2010)

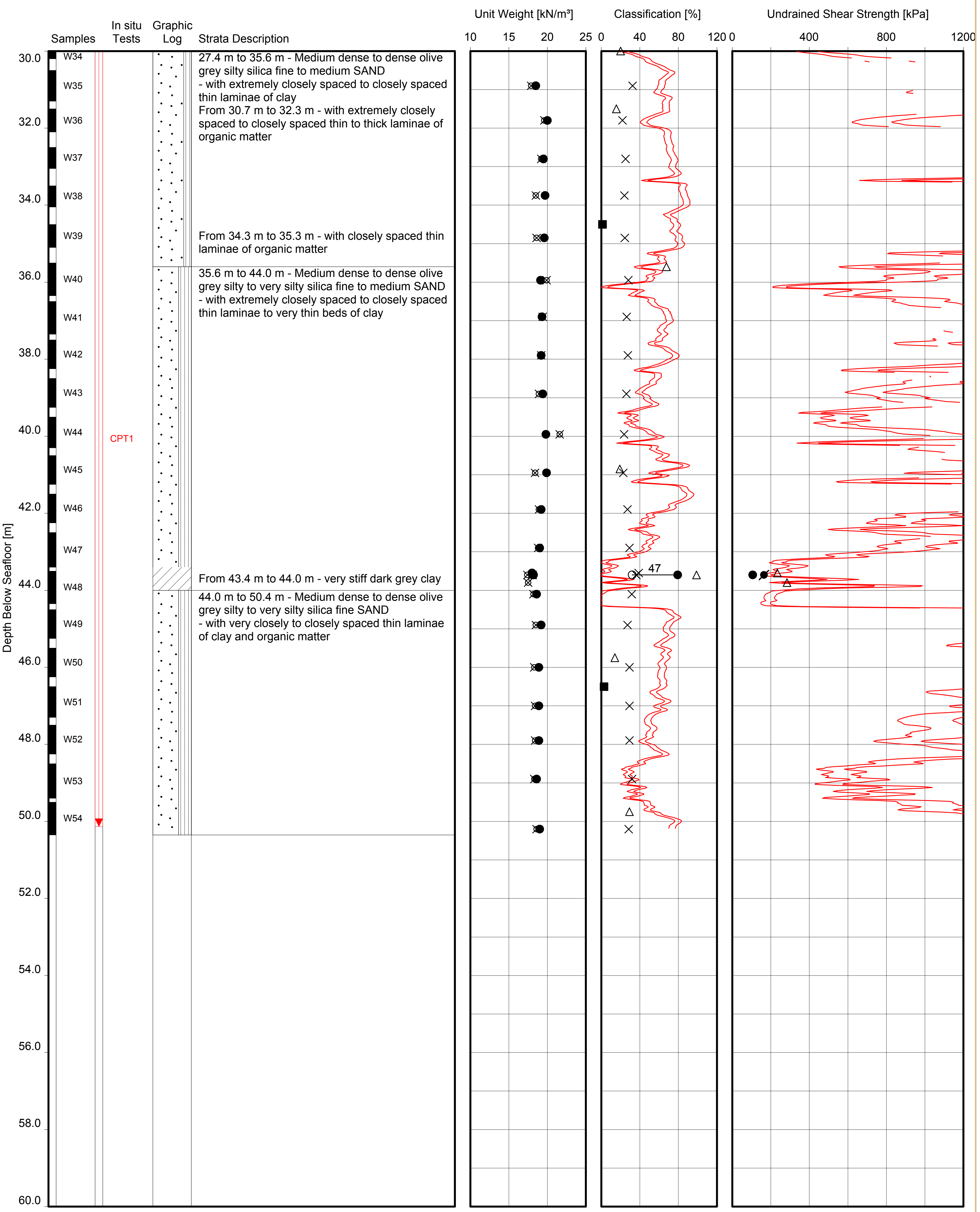
× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
↯ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
↯ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:26



27.4 m to 35.6 m - Medium dense to dense olive grey silty silica fine to medium SAND
- with extremely closely spaced to closely spaced thin laminae of clay
From 30.7 m to 32.3 m - with extremely closely spaced to closely spaced thin to thick laminae of organic matter

From 34.3 m to 35.3 m - with closely spaced thin laminae of organic matter

35.6 m to 44.0 m - Medium dense to dense olive grey silty to very silty silica fine to medium SAND
- with extremely closely spaced to closely spaced thin laminae to very thin beds of clay

From 43.4 m to 44.0 m - very stiff dark grey clay

44.0 m to 50.4 m - Medium dense to dense olive grey silty to very silty silica fine SAND
- with very closely to closely spaced thin laminae of clay and organic matter

Date commenced : 15-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.4 m below seafloor
Penetration depth : to 50.5 m below seafloor
Water depth : 21.8 m
Coordinates : 576102 m E 5803510 m N

Location(s):
HKZ1-BH05-SA
HKZ1-CPT05

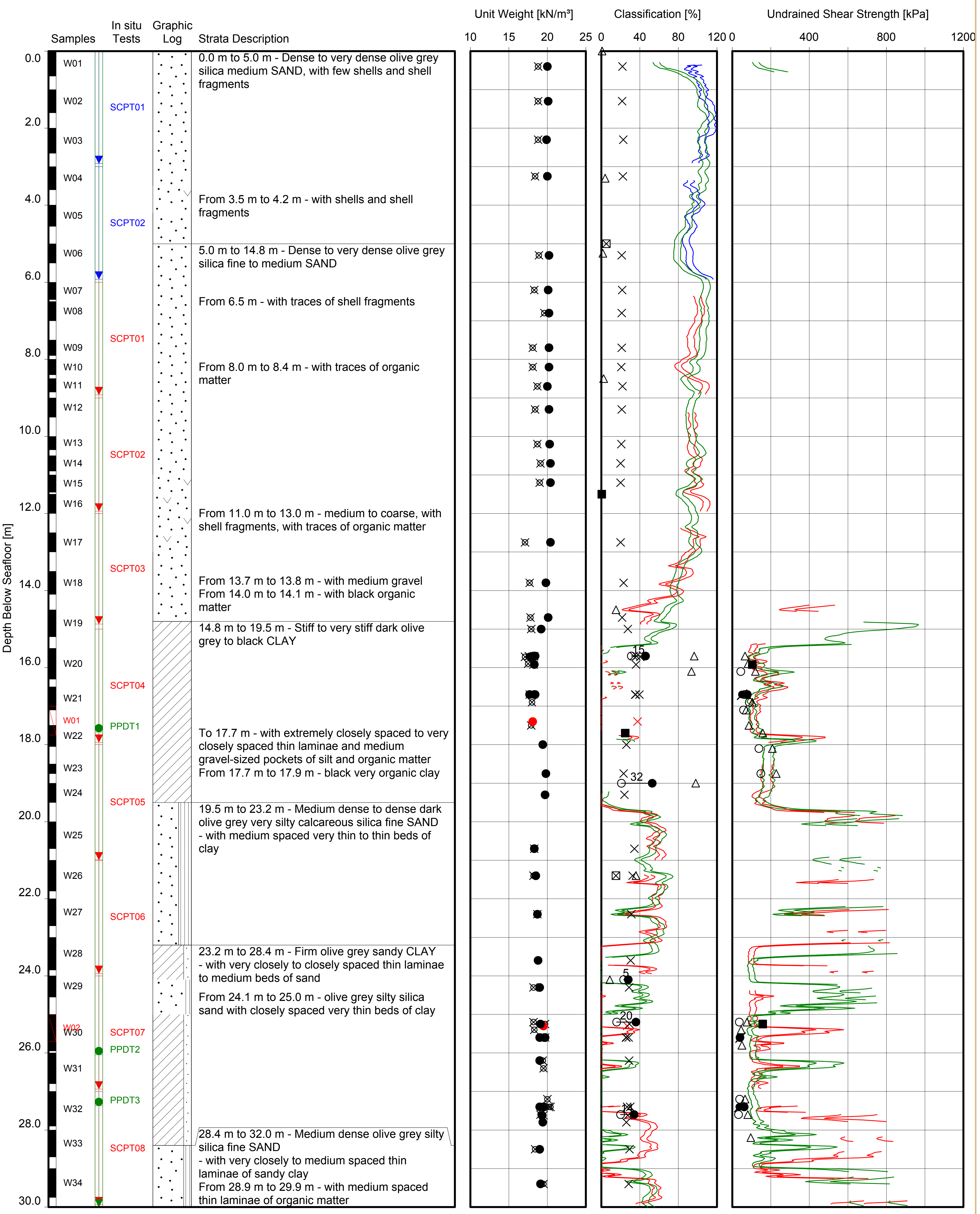
● Derived from water content
⊠ Derived from volume mass calculation
⸸ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⸸ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⸸ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:27



0.0 m to 5.0 m - Dense to very dense olive grey silica medium SAND, with few shells and shell fragments

From 3.5 m to 4.2 m - with shells and shell fragments

5.0 m to 14.8 m - Dense to very dense olive grey silica fine to medium SAND

From 6.5 m - with traces of shell fragments

From 8.0 m to 8.4 m - with traces of organic matter

From 11.0 m to 13.0 m - medium to coarse, with shell fragments, with traces of organic matter

From 13.7 m to 13.8 m - with medium gravel
From 14.0 m to 14.1 m - with black organic matter

14.8 m to 19.5 m - Stiff to very stiff dark olive grey to black CLAY

To 17.7 m - with extremely closely spaced to very closely spaced thin laminae and medium gravel-sized pockets of silt and organic matter
From 17.7 m to 17.9 m - black very organic clay

19.5 m to 23.2 m - Medium dense to dense dark olive grey very silty calcareous silica fine SAND - with medium spaced very thin to thin beds of clay

23.2 m to 28.4 m - Firm olive grey sandy CLAY - with very closely to closely spaced thin laminae to medium beds of sand

From 24.1 m to 25.0 m - olive grey silty silica sand with closely spaced very thin beds of clay

28.4 m to 32.0 m - Medium dense olive grey silty silica fine SAND
- with very closely to medium spaced thin laminae of sandy clay
From 28.9 m to 29.9 m - with medium spaced thin laminae of organic matter

Date commenced	: 10-Jul-2016
Method	: Rotary borehole drilling and sampling
Recovery depth	: to 65.1 m below seafloor
Penetration depth	: to 65.2 m below seafloor
Water depth	: 22.6 m
Coordinates	: 564274 m E 5801688 m N

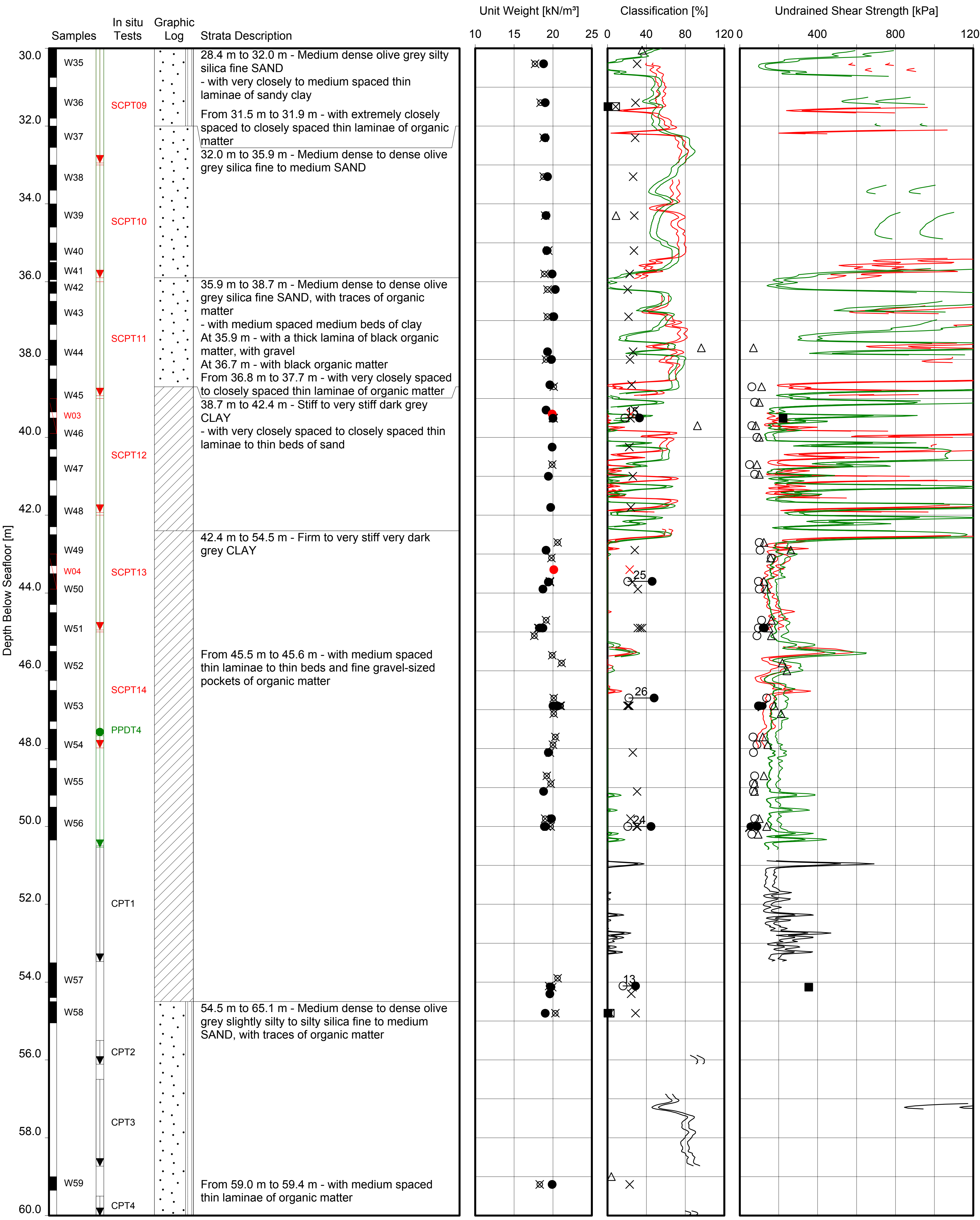
Location(s):
HKZ1-BH06-SA
HKZ1-BH06A-SC
HKZ1-BH06-SC
HKZ1-CPT06

● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
Ø Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG



28.4 m to 32.0 m - Medium dense olive grey silty silica fine SAND
- with very closely to medium spaced thin laminae of sandy clay
From 31.5 m to 31.9 m - with extremely closely spaced to closely spaced thin laminae of organic matter

32.0 m to 35.9 m - Medium dense to dense olive grey silica fine to medium SAND

35.9 m to 38.7 m - Medium dense to dense olive grey silica fine SAND, with traces of organic matter
- with medium spaced medium beds of clay
At 35.9 m - with a thick lamina of black organic matter, with gravel
At 36.7 m - with black organic matter
From 36.8 m to 37.7 m - with very closely spaced to closely spaced thin laminae of organic matter

38.7 m to 42.4 m - Stiff to very stiff dark grey CLAY
- with very closely spaced to closely spaced thin laminae to thin beds of sand

42.4 m to 54.5 m - Firm to very stiff very dark grey CLAY

From 45.5 m to 45.6 m - with medium spaced thin laminae to thin beds and fine gravel-sized pockets of organic matter

54.5 m to 65.1 m - Medium dense to dense olive grey slightly silty to silty silica fine to medium SAND, with traces of organic matter

From 59.0 m to 59.4 m - with medium spaced thin laminae of organic matter

Date commenced : 10-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 65.1 m below seafloor
Penetration depth : to 65.2 m below seafloor
Water depth : 22.6 m
Coordinates : 564274 m E 5801688 m N

Location(s):
HKZ1-BH06-SA
HKZ1-BH06A-SC
HKZ1-BH06-SC
HKZ1-CPT06

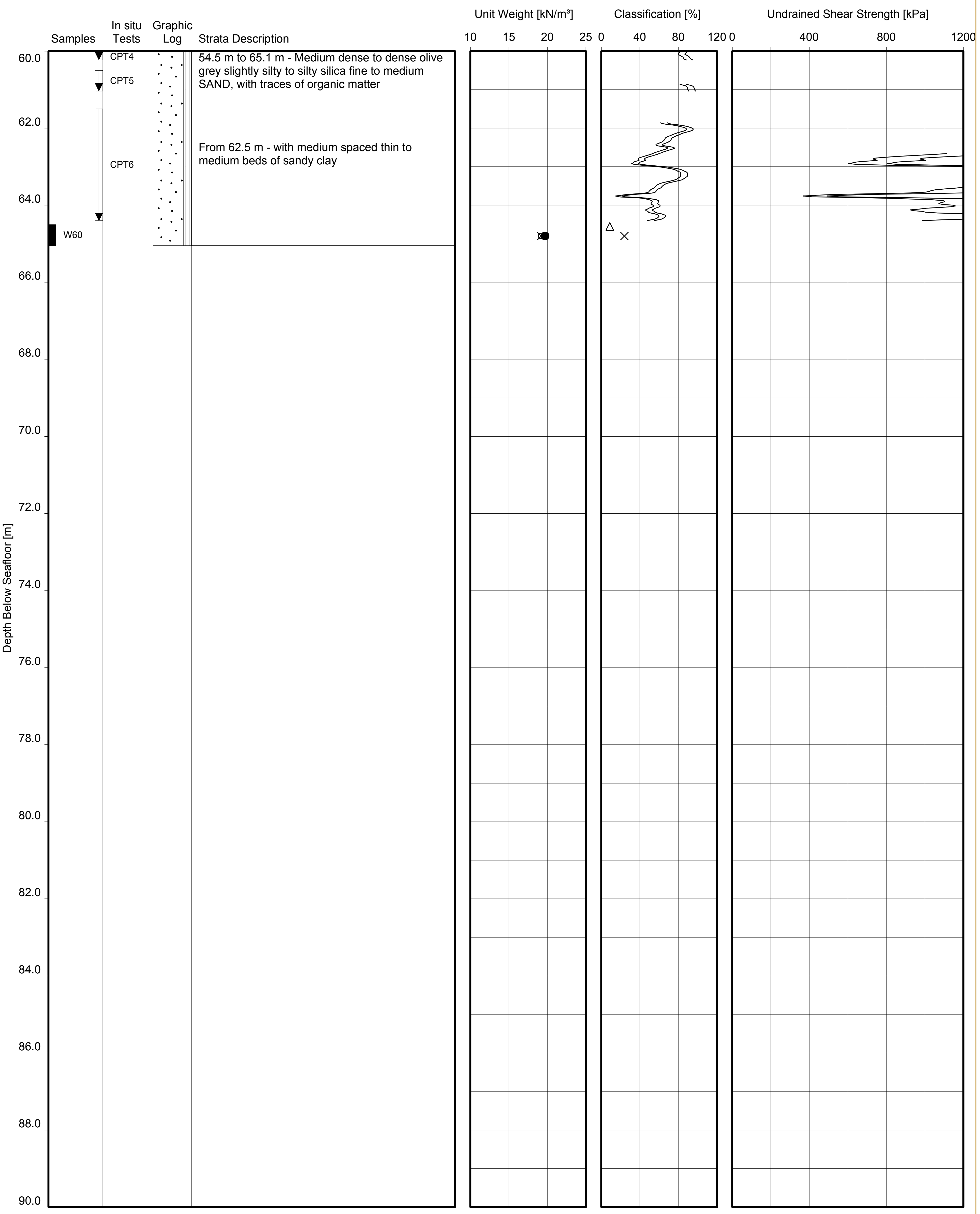
- ● Derived from water content
- ⊠ Derived from volume mass calculation
- ↯ Derived from CPT (Mayne 2010)

- × Water content
- ○ Plastic limit
- ● Liquid limit
- ○—● Plasticity index
- △ Percentage fines
- ⊠ Carbonate content
- ■ Organic content
- ↯ Relative density derived from CPT

- △ Pocket penetrometer
- ○ Torvane
- ▽ Fallcone
- ⊞ Hand vane
- ⊕ Laboratory vane
- ● UU-triaxial
- ■ CU-triaxial
- ◩ Direct simple shear
- ◆ In situ vane shear test
- ↯ Derived from CPT
- Ø Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:27



54.5 m to 65.1 m - Medium dense to dense olive grey slightly silty to silty silica fine to medium SAND, with traces of organic matter

From 62.5 m - with medium spaced thin to medium beds of sandy clay

Date commenced : 10-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 65.1 m below seafloor
Penetration depth : to 65.2 m below seafloor
Water depth : 22.6 m
Coordinates : 564274 m E 5801688 m N

Location(s):
HKZ1-BH06-SA
HKZ1-BH06A-SC
HKZ1-BH06-SC
HKZ1-CPT06

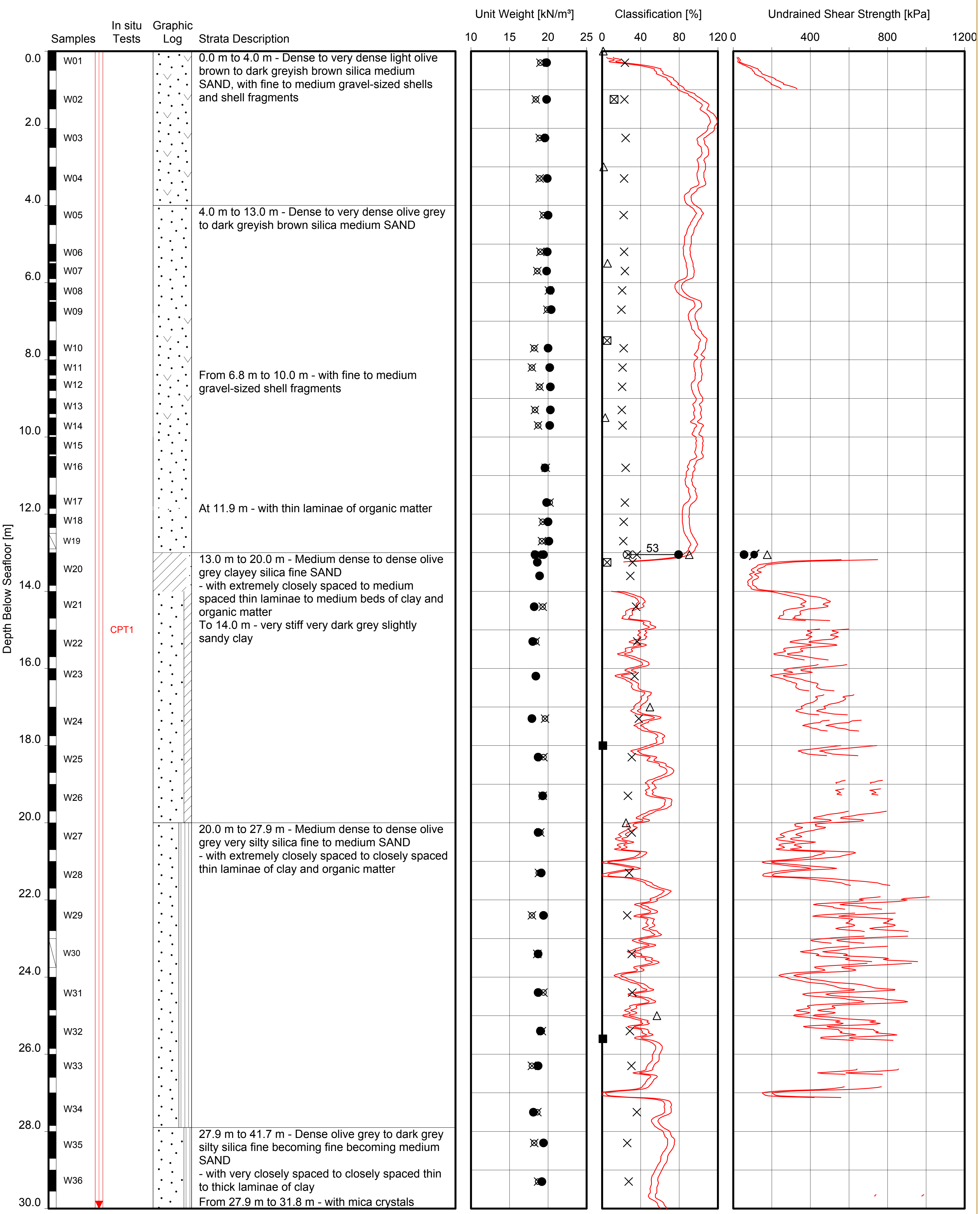
●	Derived from water content
⊠	Derived from volume mass calculation
⚡	Derived from CPT (Mayne 2010)

×	Water content
○	Plastic limit
●	Liquid limit
○—●	Plasticity index
△	Percentage fines
⊠	Carbonate content
■	Organic content
⚡	Relative density derived from CPT

△	Pocket penetrometer
○	Torvane
▽	Fallcone
⊞	Hand vane
⊕	Laboratory vane
●	UU-triaxial
■	CU-triaxial
◪	Direct simple shear
◆	In situ vane shear test
⚡	Derived from CPT
∅	Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



0.0 m to 4.0 m - Dense to very dense light olive brown to dark greyish brown silica medium SAND, with fine to medium gravel-sized shells and shell fragments

4.0 m to 13.0 m - Dense to very dense olive grey to dark greyish brown silica medium SAND

From 6.8 m to 10.0 m - with fine to medium gravel-sized shell fragments

At 11.9 m - with thin laminae of organic matter

13.0 m to 20.0 m - Medium dense to dense olive grey clayey silica fine SAND
- with extremely closely spaced to medium spaced thin laminae to medium beds of clay and organic matter
To 14.0 m - very stiff very dark grey slightly sandy clay

20.0 m to 27.9 m - Medium dense to dense olive grey very silty silica fine to medium SAND
- with extremely closely spaced to closely spaced thin laminae of clay and organic matter

27.9 m to 41.7 m - Dense olive grey to dark grey silty silica fine becoming fine becoming medium SAND
- with very closely spaced to closely spaced thin to thick laminae of clay
From 27.9 m to 31.8 m - with mica crystals

Date commenced : 09-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.7 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 24.4 m
Coordinates : 564164 m E 5800041 m N

Location(s):
HKZ1-BH07-SA
HKZ1-CPT07

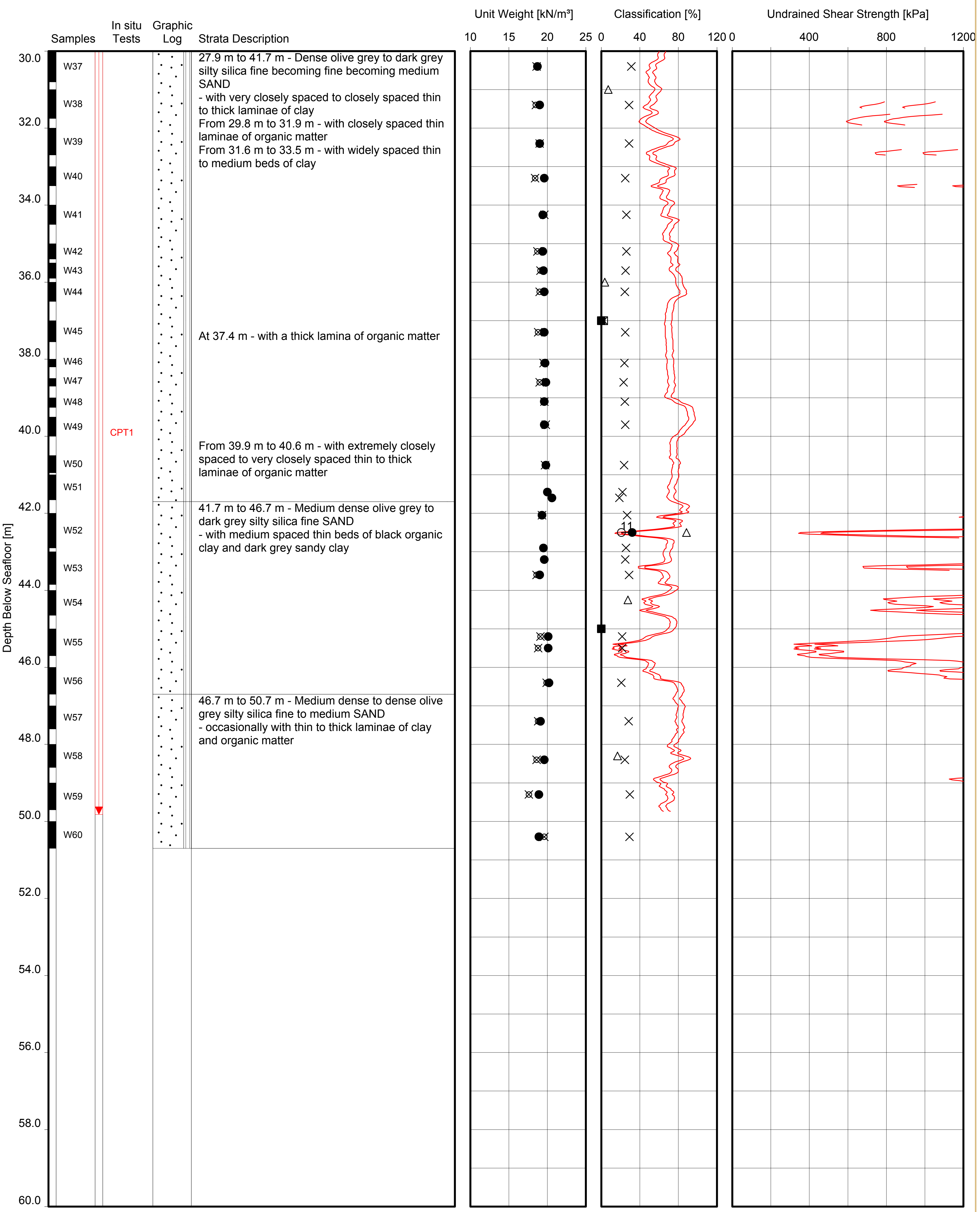
- ● Derived from water content
- ⊠ Derived from volume mass calculation
- ⚡ Derived from CPT (Mayne 2010)

- × Water content
- ○ Plastic limit
- ● Liquid limit
- ○—● Plasticity index
- △ Percentage fines
- ⊠ Carbonate content
- ■ Organic content
- ⚡ Relative density derived from CPT

- △ Pocket penetrometer
- ○ Torvane
- ▽ Fallcone
- ⊞ Hand vane
- ⊕ Laboratory vane
- ● UU-triaxial
- ■ CU-triaxial
- ◪ Direct simple shear
- ◆ In situ vane shear test
- ⚡ Derived from CPT
- ⌀ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:27



27.9 m to 41.7 m - Dense olive grey to dark grey silty silica fine becoming fine becoming medium SAND
- with very closely spaced to closely spaced thin to thick laminae of clay
From 29.8 m to 31.9 m - with closely spaced thin laminae of organic matter
From 31.6 m to 33.5 m - with widely spaced thin to medium beds of clay

At 37.4 m - with a thick lamina of organic matter

From 39.9 m to 40.6 m - with extremely closely spaced to very closely spaced thin to thick laminae of organic matter

41.7 m to 46.7 m - Medium dense olive grey to dark grey silty silica fine SAND
- with medium spaced thin beds of black organic clay and dark grey sandy clay

46.7 m to 50.7 m - Medium dense to dense olive grey silty silica fine to medium SAND
- occasionally with thin to thick laminae of clay and organic matter

Date commenced : 09-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.7 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 24.4 m
Coordinates : 564164 m E 5800041 m N

Location(s):
HKZ1-BH07-SA
HKZ1-CPT07

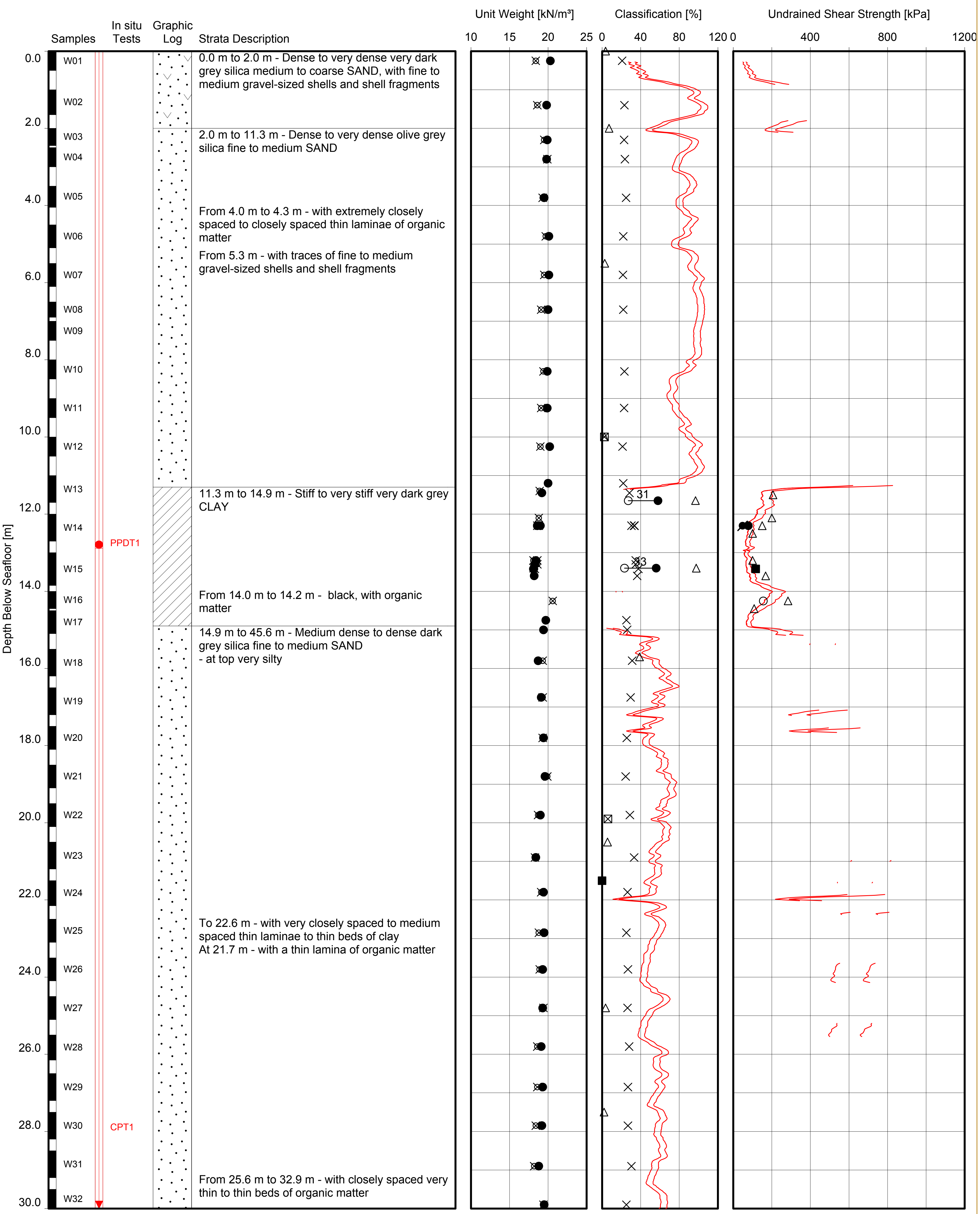
● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

GeODin/Composite Geotechnical Log.GLO/2016-11-09 12:27



0.0 m to 2.0 m - Dense to very dense very dark grey silica medium to coarse SAND, with fine to medium gravel-sized shells and shell fragments

2.0 m to 11.3 m - Dense to very dense olive grey silica fine to medium SAND

From 4.0 m to 4.3 m - with extremely closely spaced to closely spaced thin laminae of organic matter

From 5.3 m - with traces of fine to medium gravel-sized shells and shell fragments

11.3 m to 14.9 m - Stiff to very stiff very dark grey CLAY

From 14.0 m to 14.2 m - black, with organic matter

14.9 m to 45.6 m - Medium dense to dense dark grey silica fine to medium SAND
- at top very silty

To 22.6 m - with very closely spaced to medium spaced thin laminae to thin beds of clay
At 21.7 m - with a thin lamina of organic matter

From 25.6 m to 32.9 m - with closely spaced very thin to thin beds of organic matter

Date commenced : 08-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.7 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 23.7 m
Coordinates : 568496 m E 5802172 m N

Location(s):
HKZ1-BH08-SA
HKZ1-CPT08

● Derived from water content
⊠ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
∅ Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

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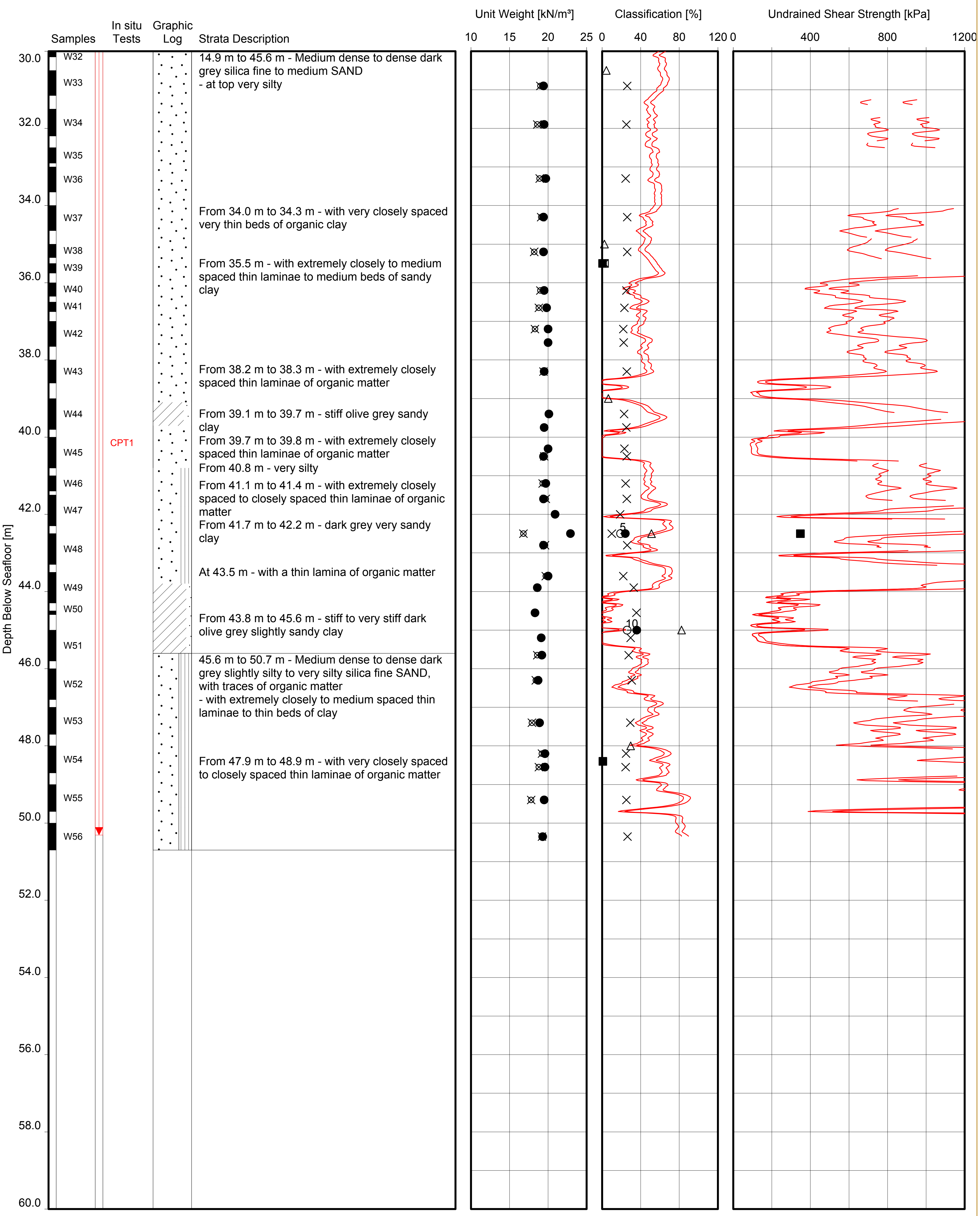

14.9 m to 45.6 m - Medium dense to dense dark grey silica fine to medium SAND
- at top very silty

From 34.0 m to 34.3 m - with very closely spaced very thin beds of organic clay

From 35.5 m - with extremely closely to medium spaced thin laminae to medium beds of sandy clay

From 38.2 m to 38.3 m - with extremely closely spaced thin laminae of organic matter

From 39.1 m to 39.7 m - stiff olive grey sandy clay

From 39.7 m to 39.8 m - with extremely closely spaced thin laminae of organic matter

From 40.8 m - very silty

From 41.1 m to 41.4 m - with extremely closely spaced to closely spaced thin laminae of organic matter

From 41.7 m to 42.2 m - dark grey very sandy clay

At 43.5 m - with a thin lamina of organic matter

From 43.8 m to 45.6 m - stiff to very stiff dark olive grey slightly sandy clay

45.6 m to 50.7 m - Medium dense to dense dark grey slightly silty to very silty silica fine SAND, with traces of organic matter
- with extremely closely to medium spaced thin laminae to thin beds of clay

From 47.9 m to 48.9 m - with very closely spaced to closely spaced thin laminae of organic matter

Date commenced : 08-Jul-2016
Method : Rotary borehole drilling and sampling
Recovery depth : to 50.7 m below seafloor
Penetration depth : to 51.0 m below seafloor
Water depth : 23.7 m
Coordinates : 568496 m E 5802172 m N

Location(s):
HKZ1-BH08-SA
HKZ1-CPT08

● Derived from water content
☒ Derived from volume mass calculation
⚡ Derived from CPT (Mayne 2010)

× Water content
○ Plastic limit
● Liquid limit
○—● Plasticity index
△ Percentage fines
⊠ Carbonate content
■ Organic content
⚡ Relative density derived from CPT

△ Pocket penetrometer
○ Torvane
▽ Fallcone
⊞ Hand vane
⊕ Laboratory vane
● UU-triaxial
■ CU-triaxial
◪ Direct simple shear
◆ In situ vane shear test
⚡ Derived from CPT
Ø Slashed symbol refers to test on remoulded soil

GEOTECHNICAL LOG

SECTION B: IN SITU TEST RESULTS

SECTION B1: CONE PENETRATION TESTS

TEXT – SECTION B1: Page

LIST OF PLATES IN SECTION B1: Plate

LIST OF PLATES IN SECTION B1 (cont'd): Plate

HKZ1-BH06-SC

HKZ1-BH06A-SC

B1 CONE PENETRATION TESTS

B1.1 COMMENTS ON RESULTS

Cone penetration tests (CPTs) were performed using CP10 cone penetrometers with a 1000 mm^2 cone tip area. The used cone type measures cone resistance (q_c), sleeve friction (f_s) and pore pressure (u_2).

Soil unit weight is derived from in situ test data using Mayne et al. (2010). Unit weight values are presented on plates titled “Cone Penetration Test; I_c, I_{SBT}, Q_{tn}, F_r and γ”.

A value of 10 kN/m^3 was used as an average density of seawater and drill fluid to calculate the theoretical hydrostatic pressure at the bottom of a borehole. The hydrostatic pressure is used for comparison with the cone measurements prior to testing and when calculating total cone resistance.

Deck measurements, referred to as “zero reading”, were taken before the start and after the end of each test to check the cone performance during testing and condition of the equipment. Plates titled “Cone Penetration Test: Zero Load Drift” present the results of this comparison. This zero load verification showed satisfactory cone performance during testing at the various locations.

Typically, CPTs show negative pore pressures upon penetration of dense to very dense and/or (silty) fine sands. This is not uncommon. This is primarily related to the piezocone filter located at the cylindrical extension above the base of the cone (u_2 location). During cone penetration negative pore pressures exist around the u_2 location (Lunne et al., 1997) such that cavitation occurs. Particularly, this may occur at the time of penetration of dense sands, silty fine sands or overconsolidated clay layers. Loss of saturation usually causes a negative or sluggish pore pressure response during penetration of ground below the zone causing desaturation of the pore pressure filter around the pressure sensor. Negative pore pressure measurements affect derived values such as net cone resistance and pore pressure ratio. The influence of the negative pore pressure is to be considered when using the derived values.

B1.2 PRACTICE FOR CONE PENETRATION TEST

Test Overview

General Procedure:	– According to ISO (2014) for test practice – According to ISO (2003) for metrological confirmation – Refer to document titled “Cone Penetration Test” presented in Appendix 1
Target Application Class:	Class 3 of ISO (2014), refer to document titled “Cone Penetration Test” presented in Appendix 1
Set-up Stage:	Location as directed by Client
Additional Measurements:	Seismic downhole testing in accordance with sub-section "Practice for SCPT” presented in Section B2
Test Stage:	Refer to document titled “Geotechnical Borehole” presented in Appendix 1
Test Termination:	Refer to document titled “Cone Penetration Test” presented in Appendix 1
Drill-Out:	Refer to document titled “Geotechnical Borehole” presented in Appendix 1
Test Site Restoration:	Refer to sub-section "Practice for Geotechnical Borehole" presented in Section A

CPT Apparatus

Thrust Machine:	WISON® wireline hydraulic jacking unit, nominal 100 kN thrust capacity and 3 m (CP10) stroke
Reaction Equipment:	Self-weight of drill pipes, drill collars and SEACLAM seabed frame
Push Rod:	36 mm (CP10) push rod outer diameter
Penetrometer Type:	– Type CP10-CF50PB10 piezo-cone penetrometer, 50 kN load sensors (100 kN for overloading), 10 MPa pressure sensor, HDPE filter in cylindrical extension above base of cone, 1,000 mm^2 cone base area, 15,000 mm^2 sleeve area, cone net area ratio of 0.75 and a sleeve net area ratio of 0.00006 – Type CP10-CF50PB10/SN2 piezo-cone penetrometer, 50 kN load sensors (100 kN for overloading), 10 MPa pressure sensor, HDPE filter in cylindrical extension above base of cone, with non-directional inclinometer, 1,000 mm^2 cone base area, 15,000 mm^2 sleeve area, net area ratio of 0.75 and a sleeve net area ratio of 0.00006

Test Results

Data Processing and Management:	– Refer to document titled “Cone Penetration Test” presented in Appendix 1 – UNIPLOT software – Graphical scales selected to suit general presentation of data and requirements of standards, where practicable – No display of data outside of chart limits, i.e. some values may not be shown
Data Format(s):	– PDF for viewing and printing (this primary document) – ASCII (ANSI, 2007) digital tabular data (separate deliverables, secondary to the final issue of this document) – AGS 4.0 (AGS, 2011) digital tabular data (separate deliverables, secondary to the final issue of this document)
Water Depth Reference:	Refer to sub-section "Practice for Geotechnical Log" presented in Section A
Depth Reference Level:	Seafloor, refer to sub-section "Practice for Geotechnical Borehole" (in Section A) for depth accuracy assessment
Depth Correction for Penetrometer Inclination:	Not applicable

Parameter Values for Data Processing:	– Refer to plate(s) titled "Cone Penetration Test; I_c, I_{SBT}, Q_{tn}, F_r and γ" showing soil behaviour type index, soil unit weight and supplementary normalised parameter values – Soil unit weight calculated according to Mayne et al. (2010) – Hydrostatic pore pressure conditions with zero at seafloor and unit weight of (pore)water of 10 kN/m^3

B1.3 REFERENCES

AGS Association of Geotechnical and Geoenvironmental Specialists, 2011. Electronic Transfer of Geotechnical and Geoenvironmental Data. AGS Edition 4.0.

American National Standards Institute, Inc. 2007, *Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)*, 14 June 2007, ANSI.

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International Organization for Standardization, 2003. *ISO 10012:2003 Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment*. Geneva: ISO.

International Organization for Standardization, 2014. *ISO 19901-8:2014 Petroleum and Natural Gas Industries - Specific Requirements for Offshore Structures – Part 8: Marine Soil Investigations*. Geneva: ISO.

Lunne, T., Robertson, P.K. and Powell, J.J.M., 1997. *Cone Penetration Testing in Geotechnical Practice*, London: Blackie Academic & Professional.

Mayne, P.W., Peuchen, J. and Bouwmeester, D. 2010. Soil Unit Weight Estimated from CPTu in Offshore Soils. In Gourvenec, S. and White, D. Eds., *Frontiers in Offshore Geotechnics II: Proceedings of the 2nd International Symposium on Frontiers in Offshore Geotechnics*, Perth, Australia, 8-10 November 2010, Boca Raton: CRC Press, pp. 371-376.

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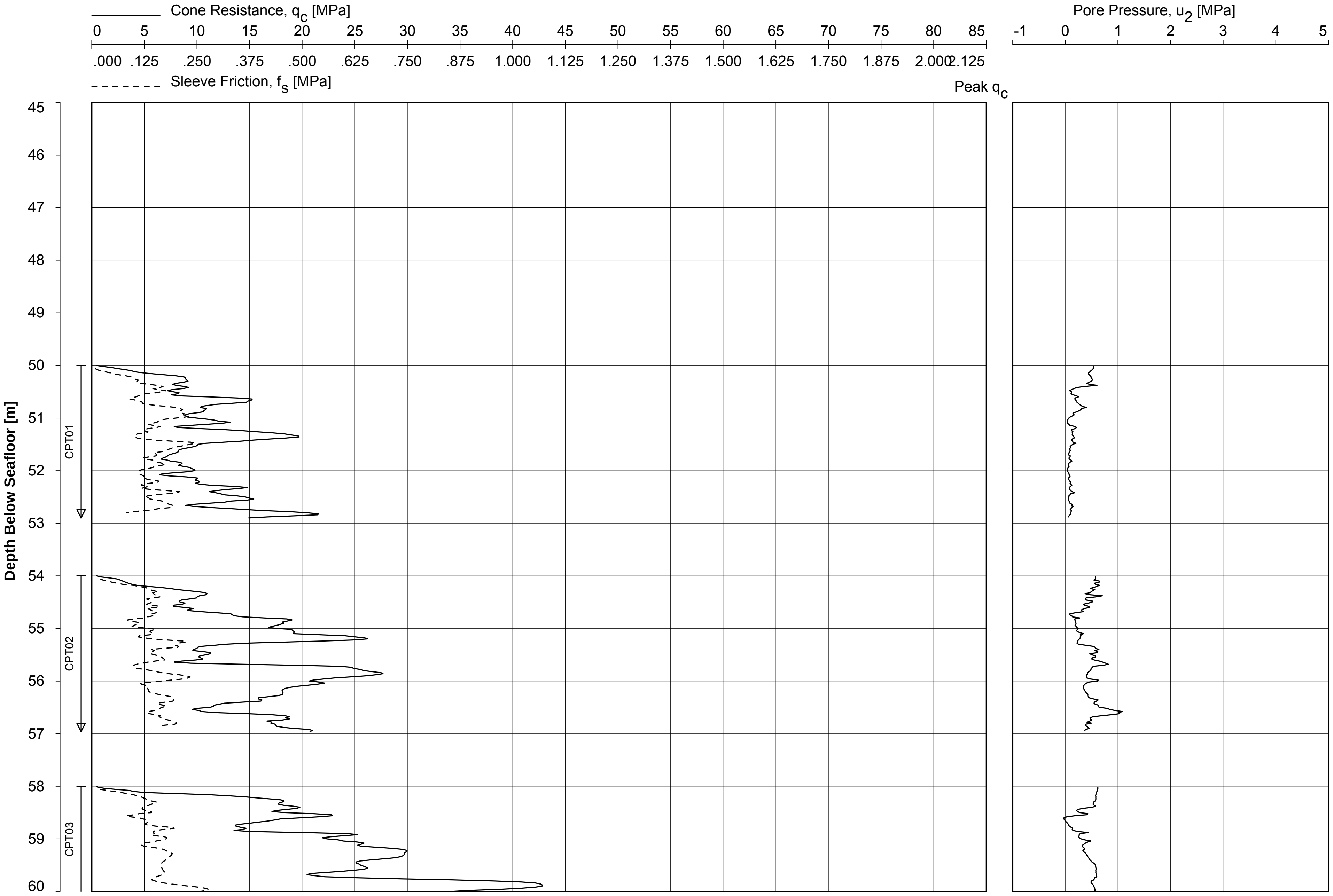

Date Of Testing : 16-Jul-2016

Water Depth [m LAT] : 21.8

Coordinates [m] : E 575786 N 5807003

CONE PENETRATION TEST

HKZ1-BH01-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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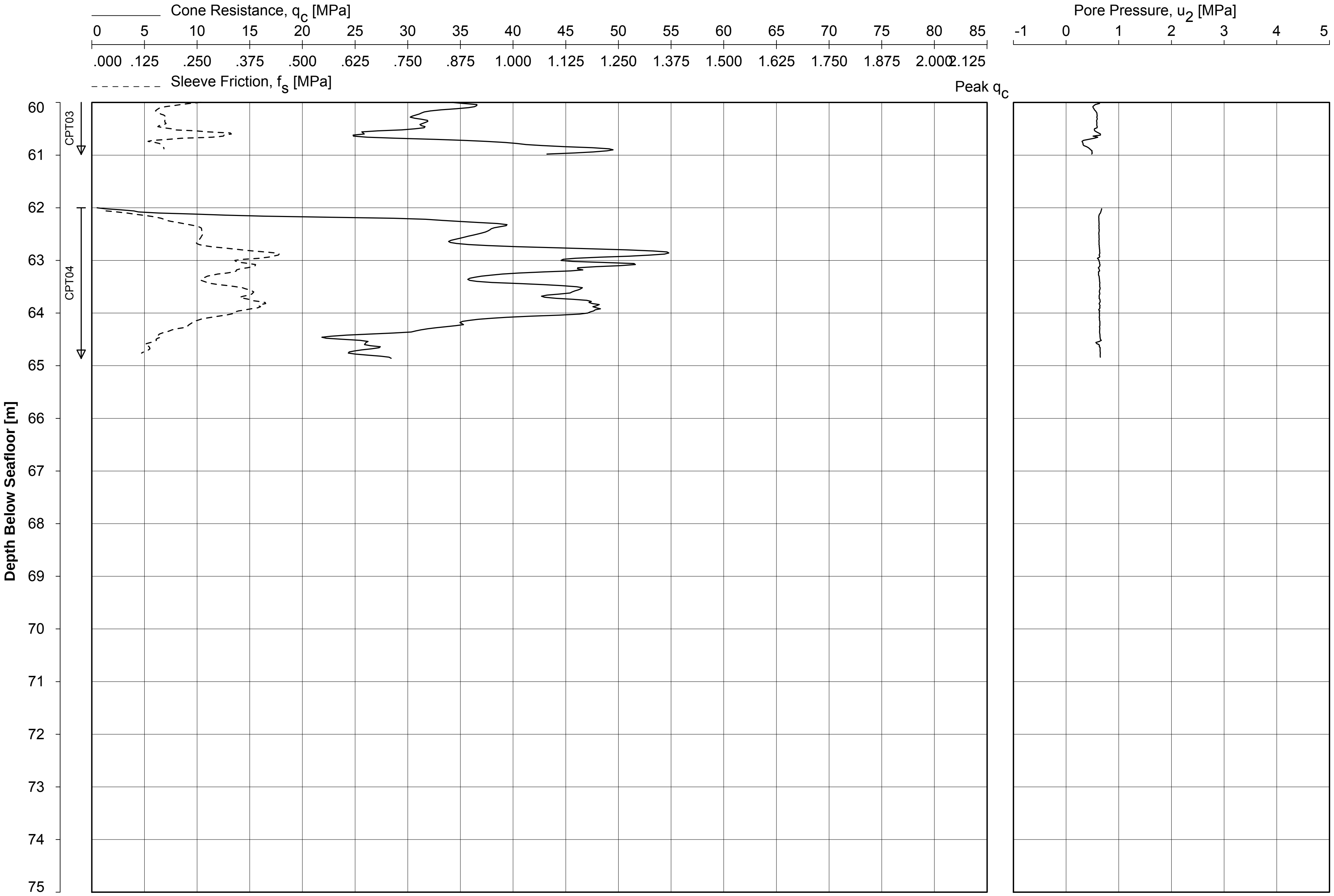

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.8
Coordinates [m] : E 575786 N 5807003

CONE PENETRATION TEST

HKZ1-BH01-SA

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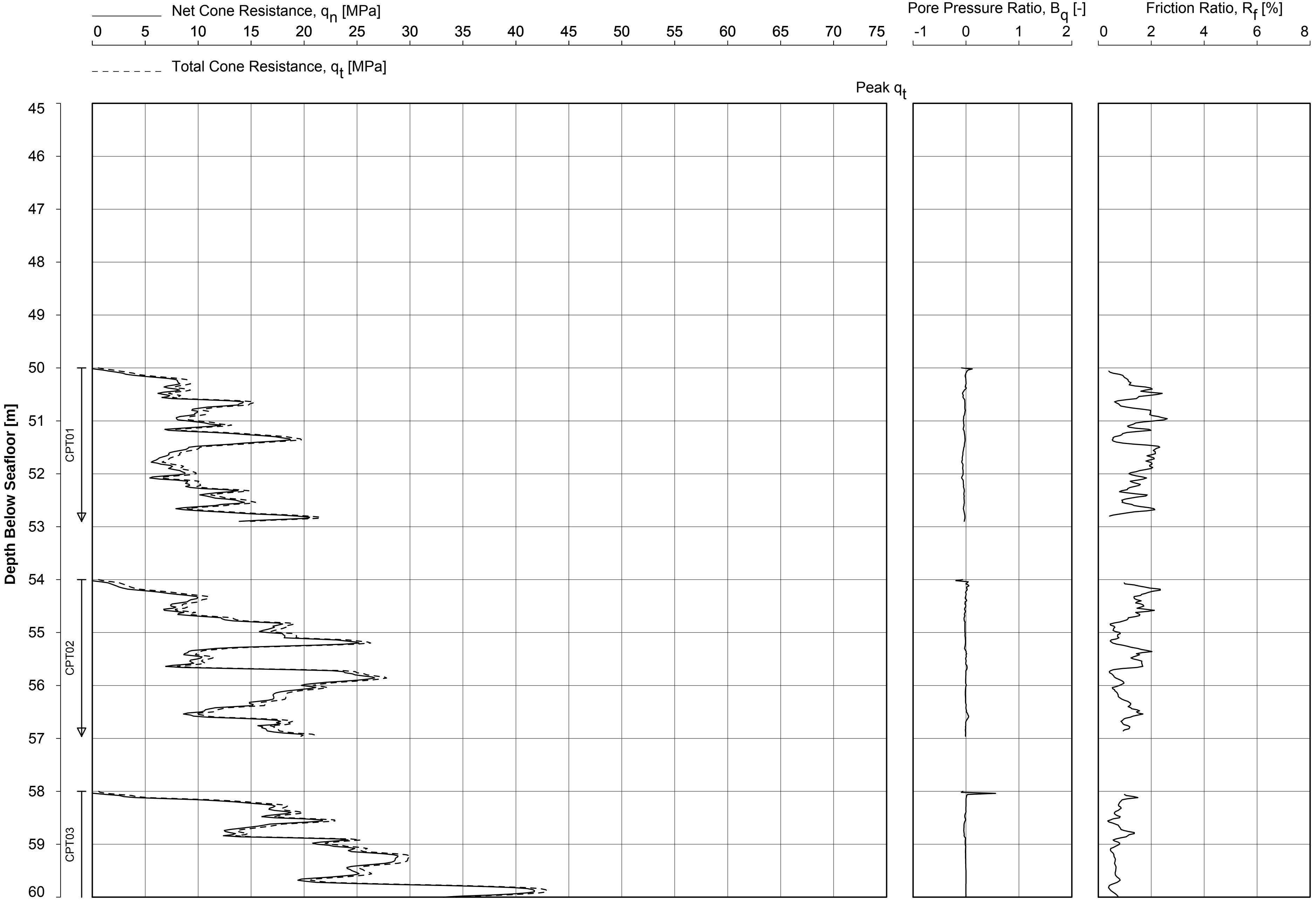

Date Of Testing	:	16-Jul-2016
Water Depth [m LAT]	:	21.8
Coordinates [m]	:	E 575786 N 5807003

CONE PENETRATION TEST

HKZ1-BH01-SA

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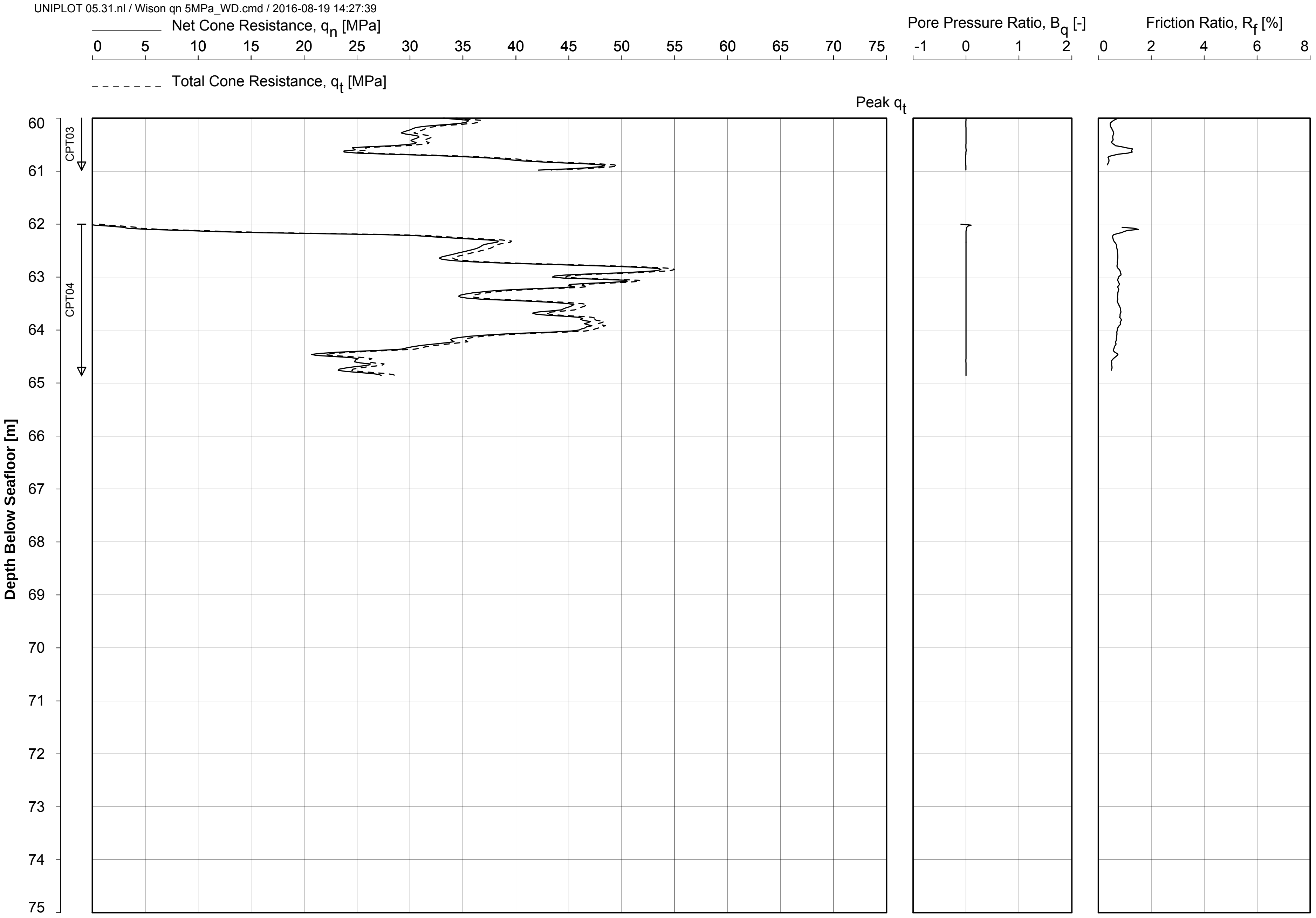

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.8
Coordinates [m] : E 575786 N 5807003

CONE PENETRATION TEST

HKZ1-BH01-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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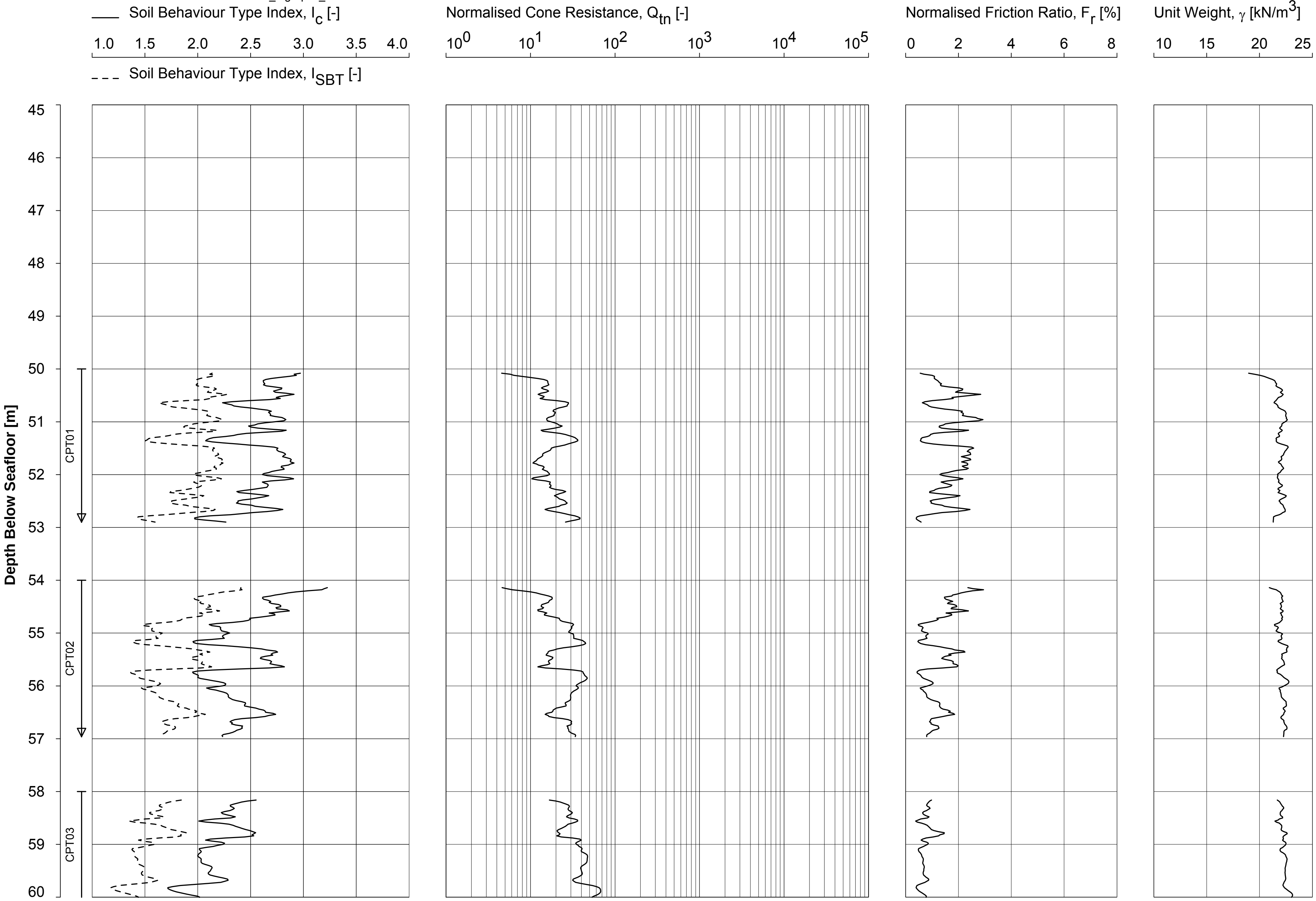
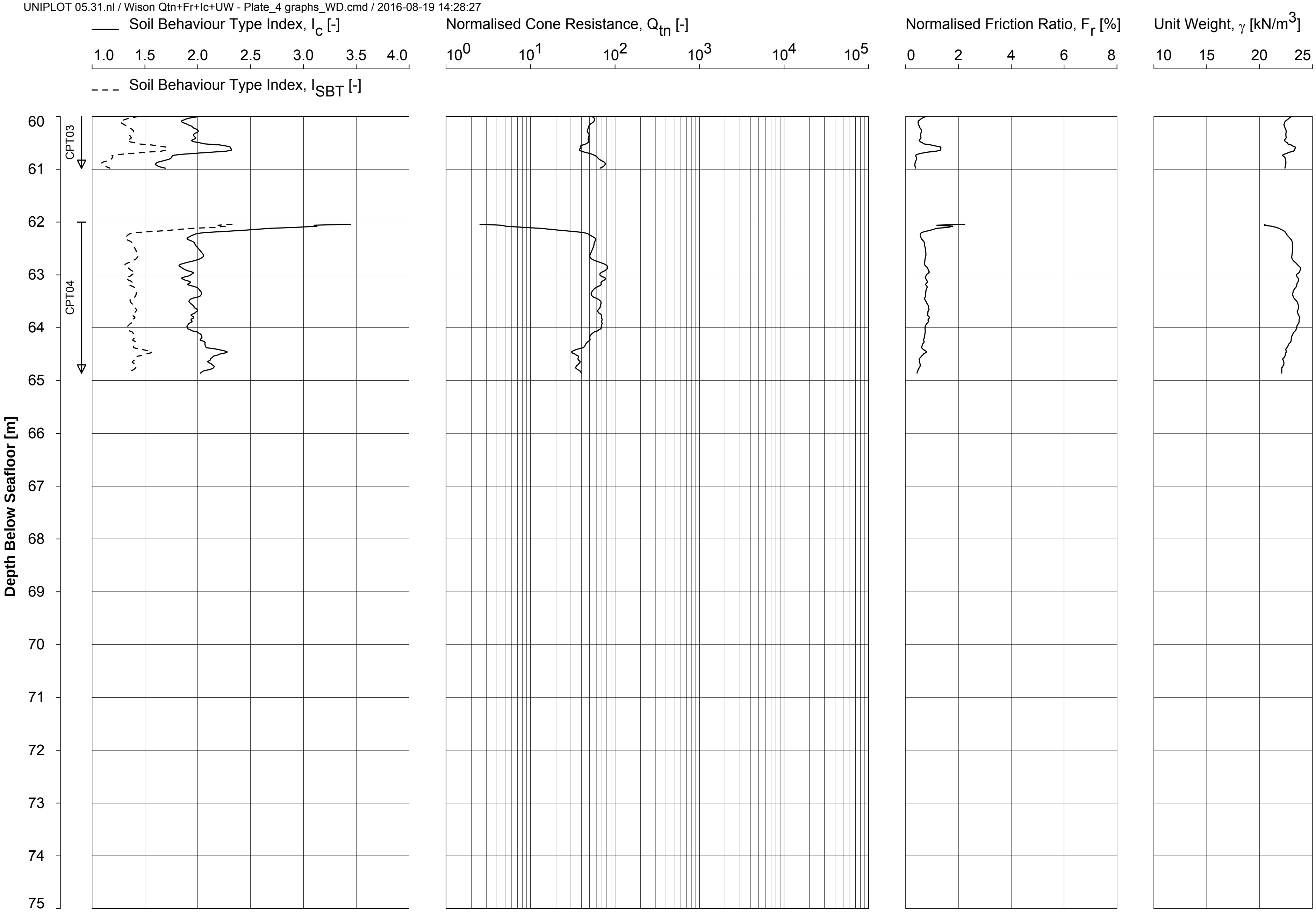


Date of Testing	: 16-Jul-2016		Probe Type	:	CP10-CF50PB10
Water Depth [m LAT]	: 21.8		Cone Base Area [mm^2]	:	1007
Coordinates [m]	: E 575786	N 5807003	Ground Water [kN/m^3]	:	10.0

CONE PENETRATION TEST

HKZ1-BH01-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.8
Coordinates [m] : E 575786 N 5807003

Probe Type : CP10-CF50PB10
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH01-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

CONE PENETRATION TEST - ZERO DRIFT

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH01-SA	CPT01	0.375	0.000	0.005	-0.007	-0.004	0.000	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH01-SA	CPT02	0.373	0.000	0.005	0.009	-0.003	0.001	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH01-SA	CPT03	0.380	0.000	0.005	-0.006	-0.003	0.000	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH01-SA	CPT04	0.396	0.001	0.005	-0.023	-0.006	0.000	CP10-CF50PB10	1706-1924	0.750

Key:

q_c : cone resistance

f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test. Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

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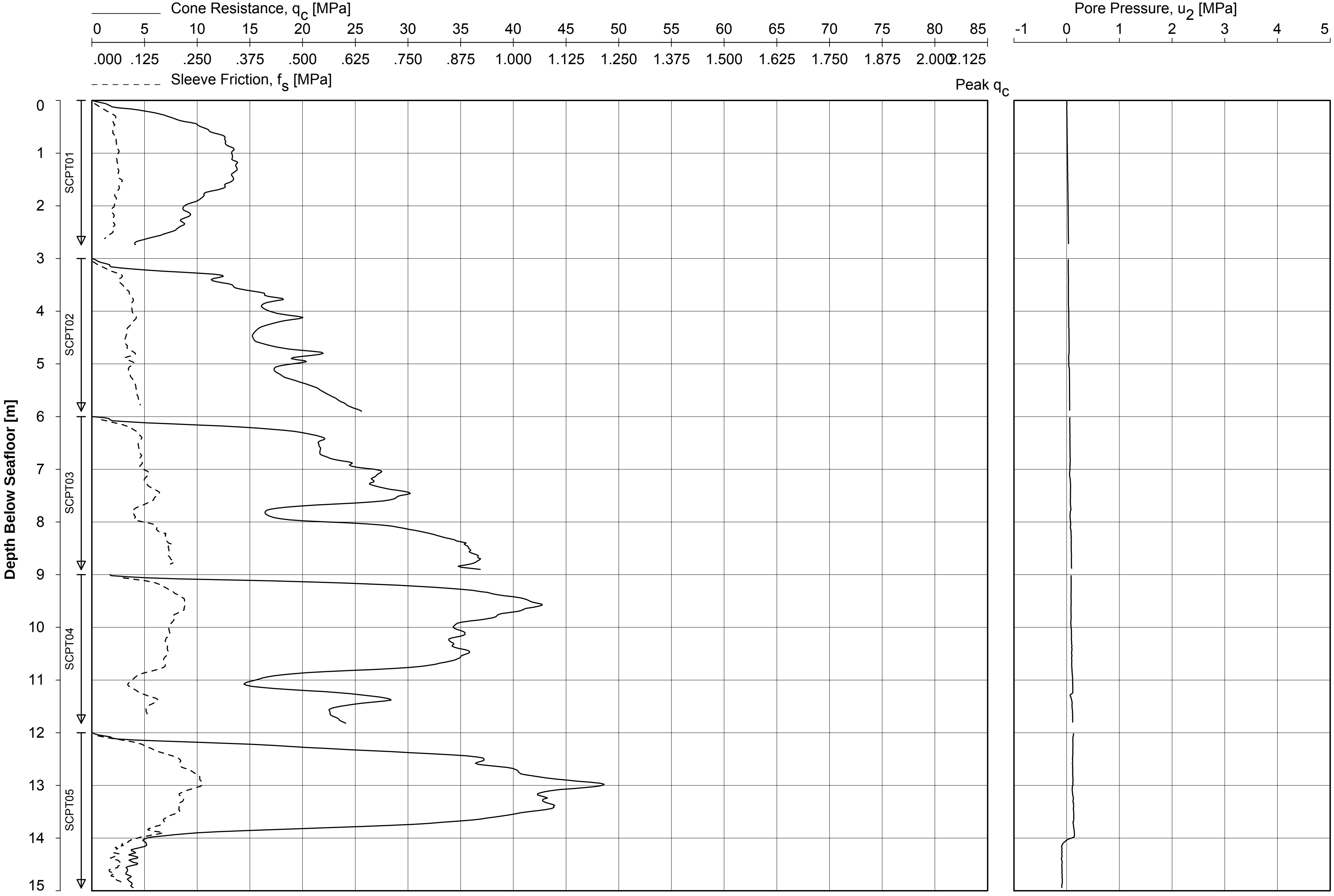

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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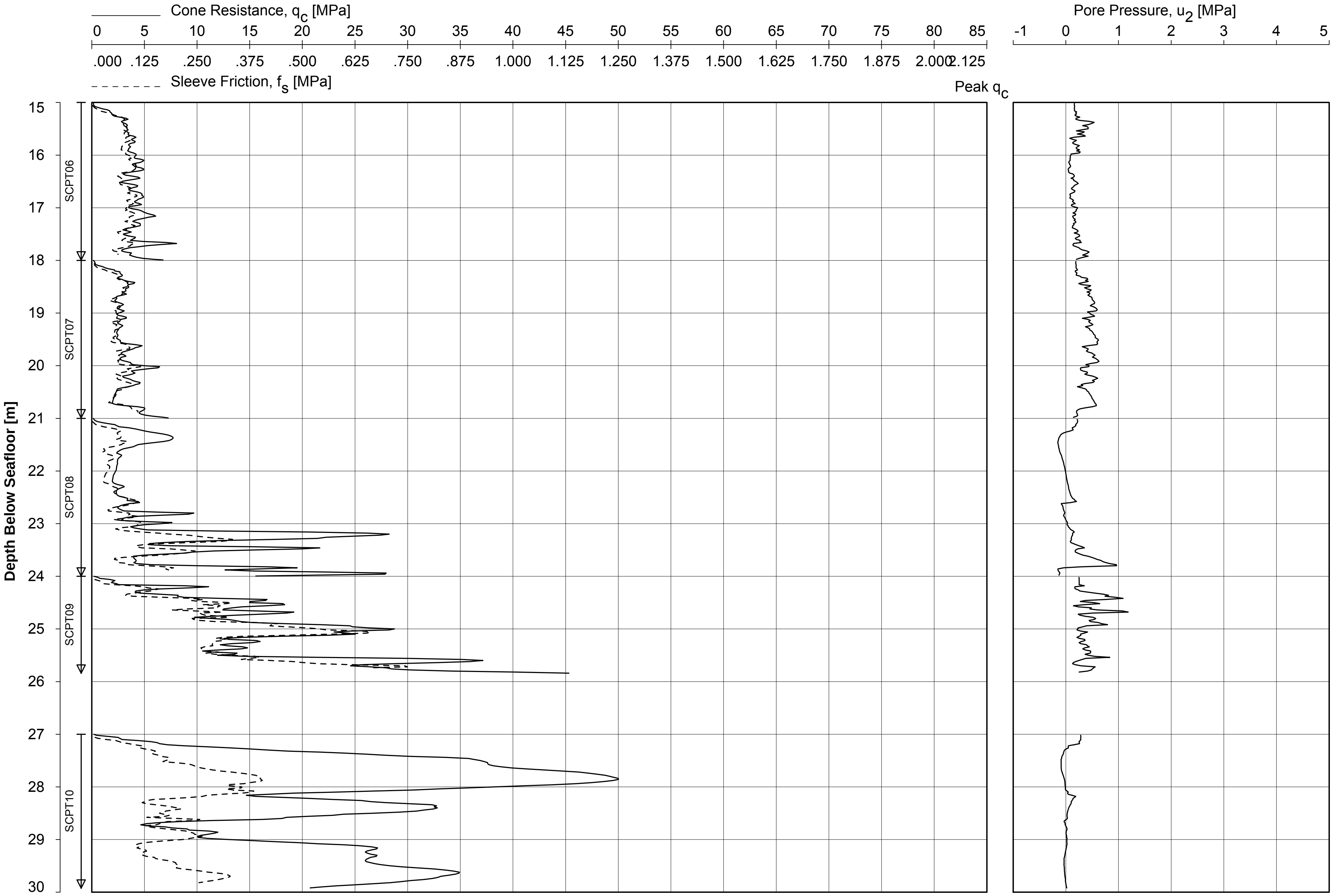

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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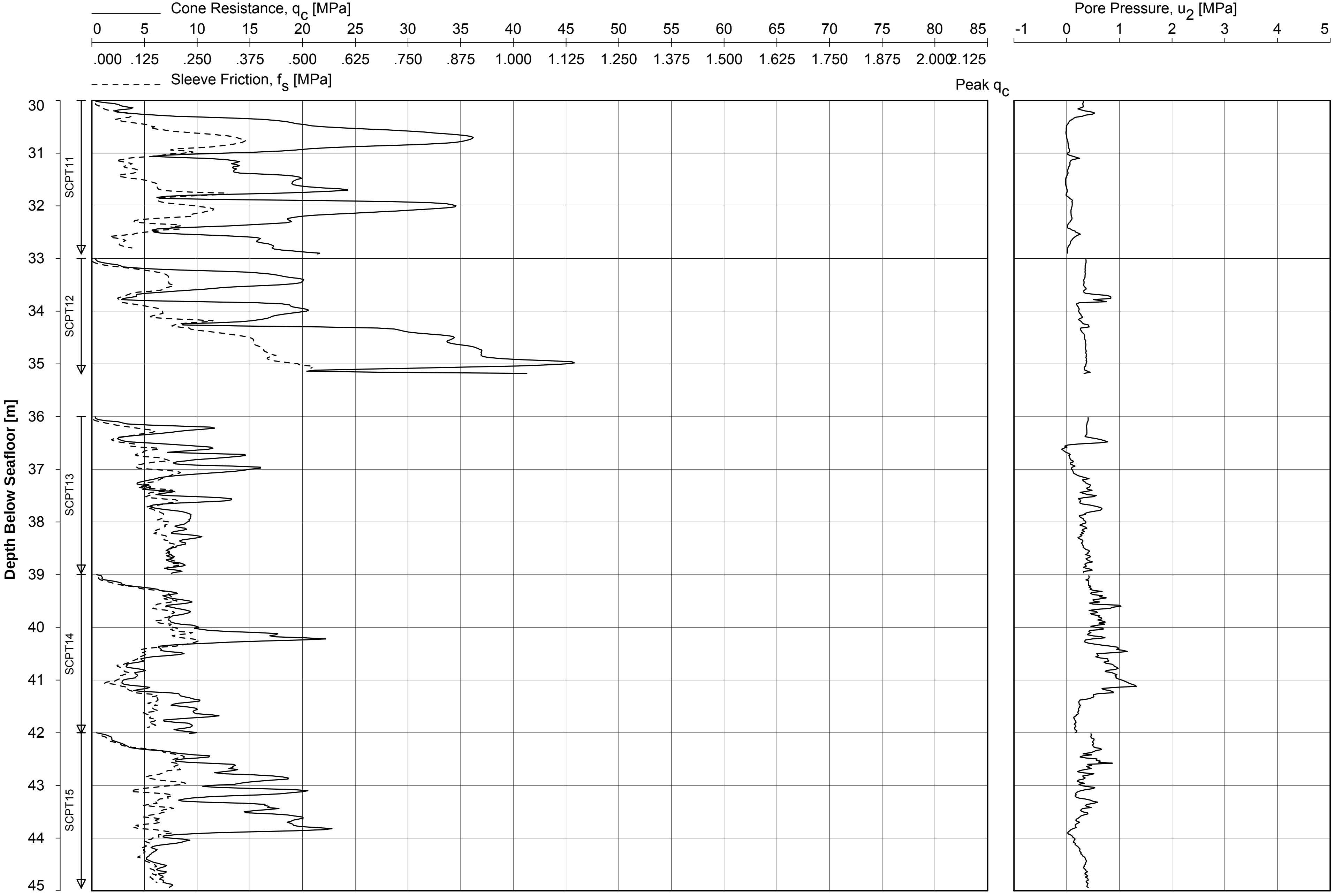

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

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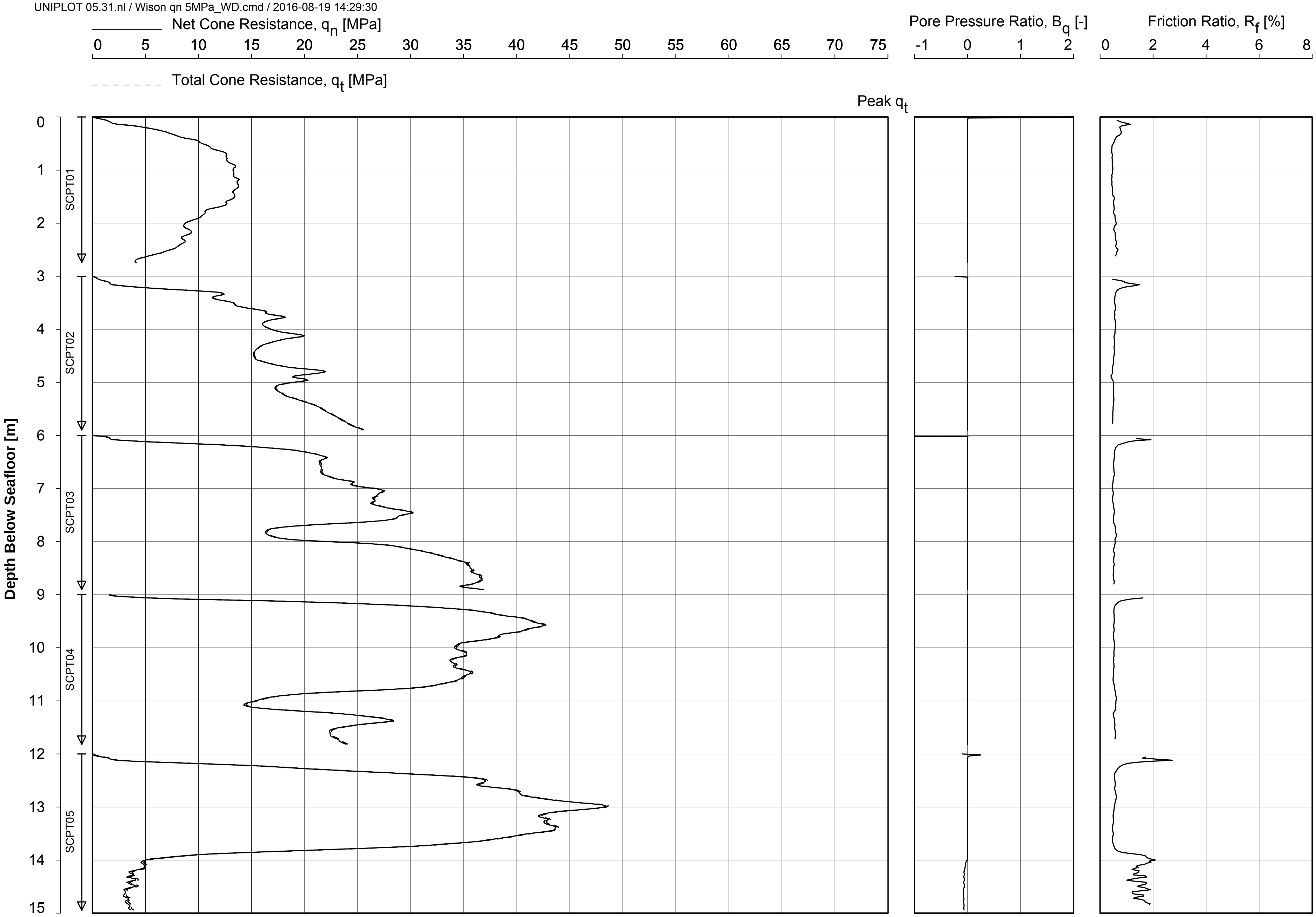
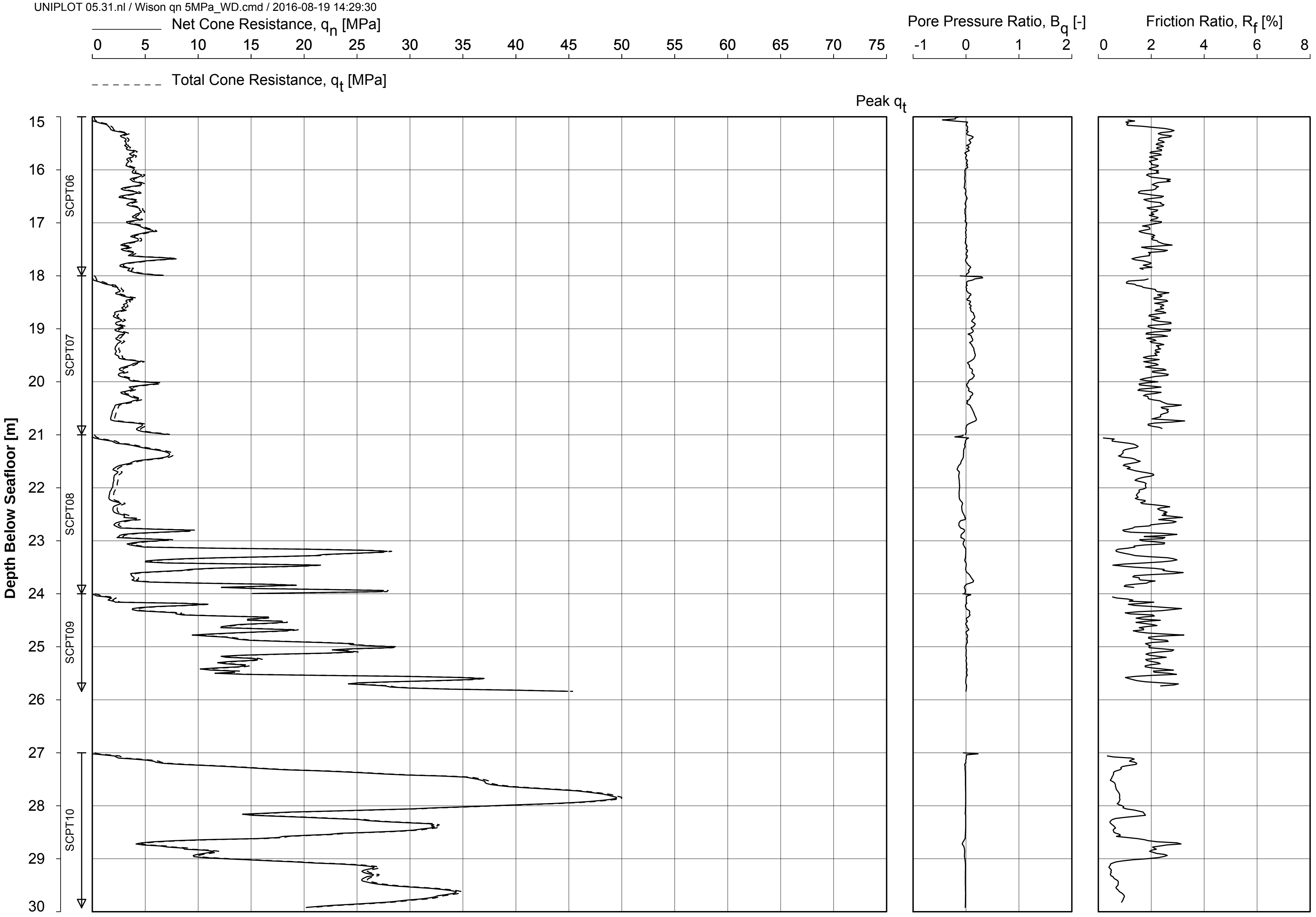


Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



Date Of Testing	:	16-Jul-2016
Water Depth [m LAT]	:	21.7
Coordinates [m]	:	E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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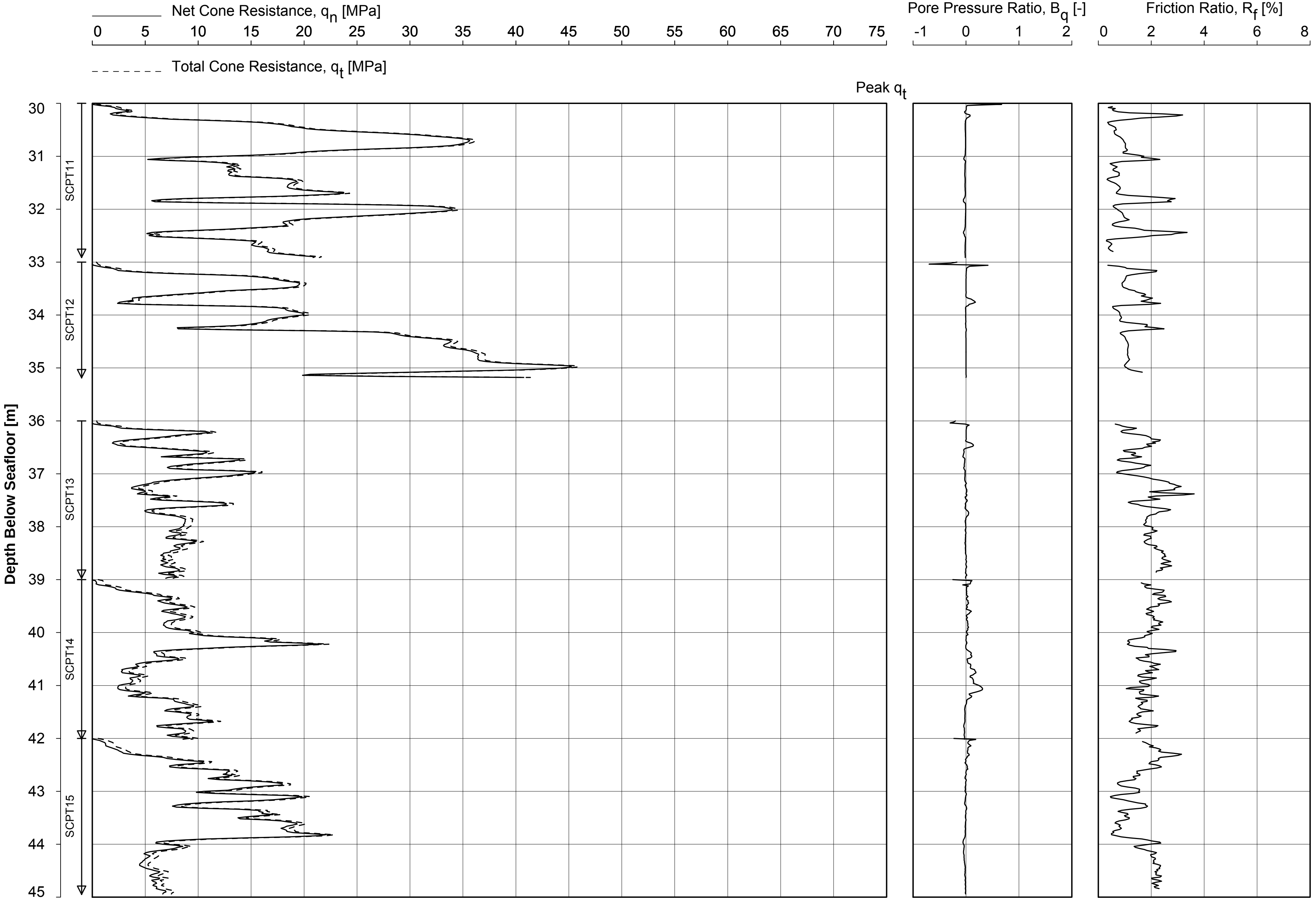

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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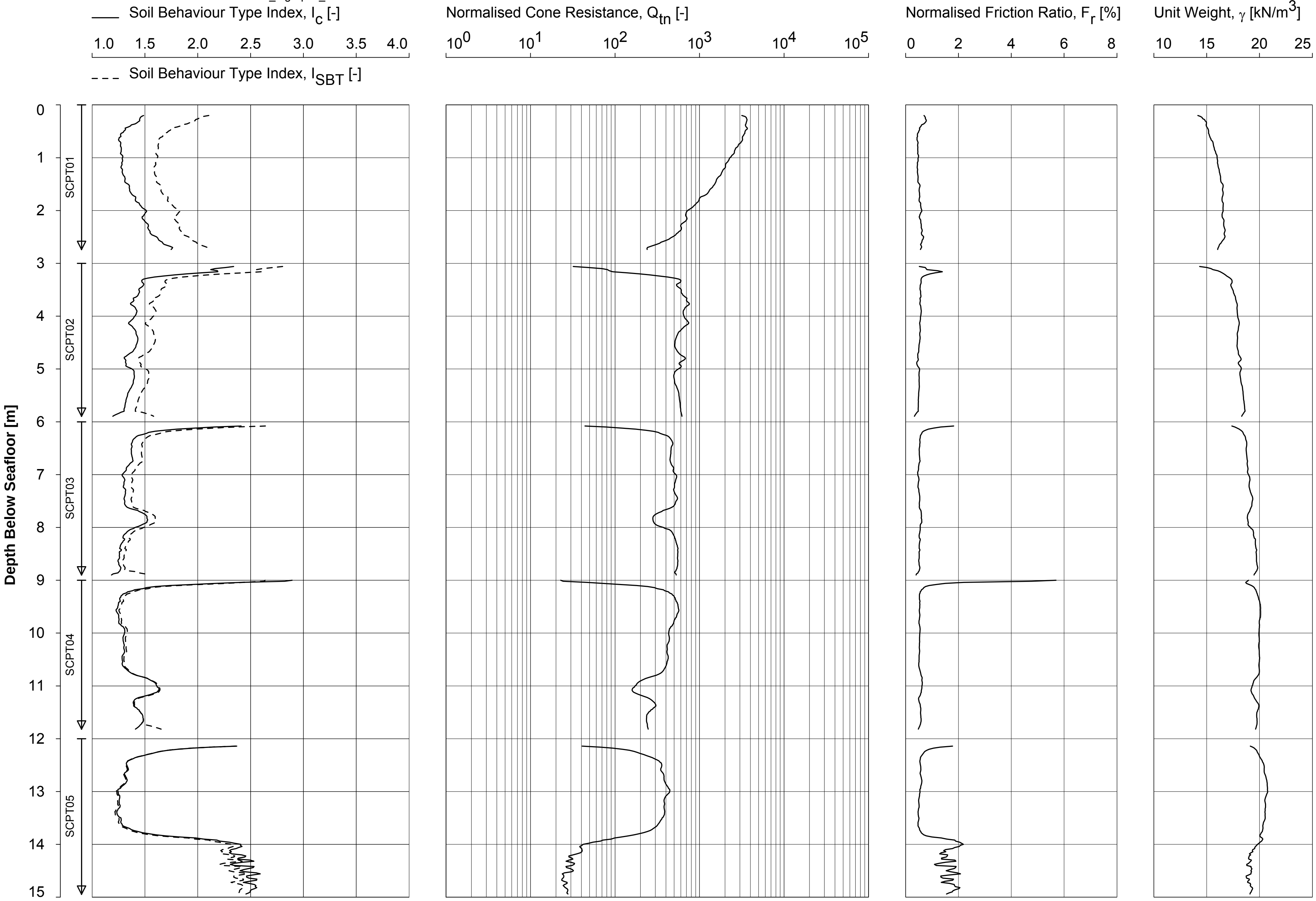

Date of Testing	:	16-Jul-2016
Water Depth [m LAT]	:	21.7
Coordinates [m]	:	E 575782 N 5807009

Probe Type	:	CP10-CF50PB20SN2
Cone Base Area [mm^2]	:	1007
Ground Water [kN/m^3]	:	10.0

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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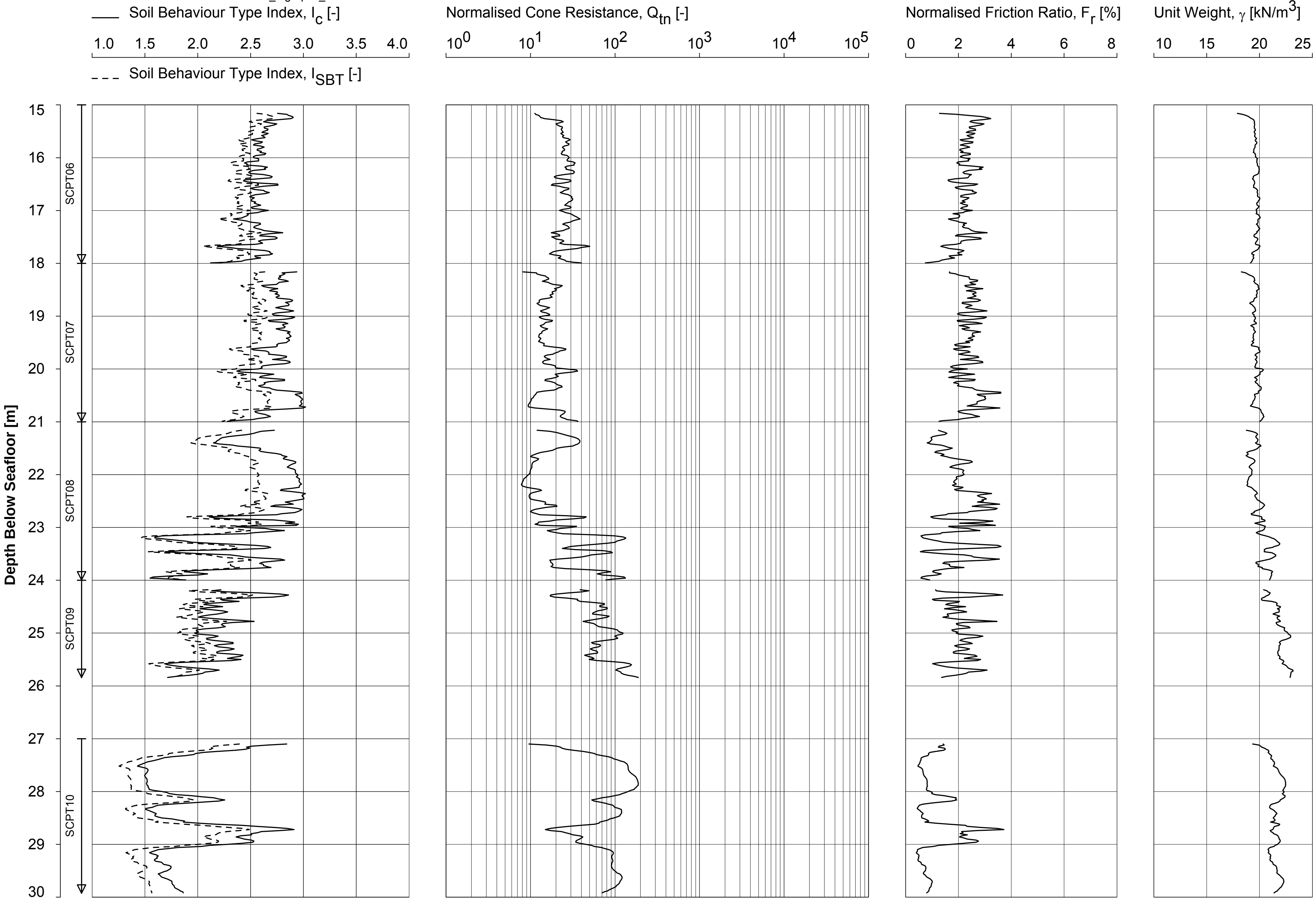

Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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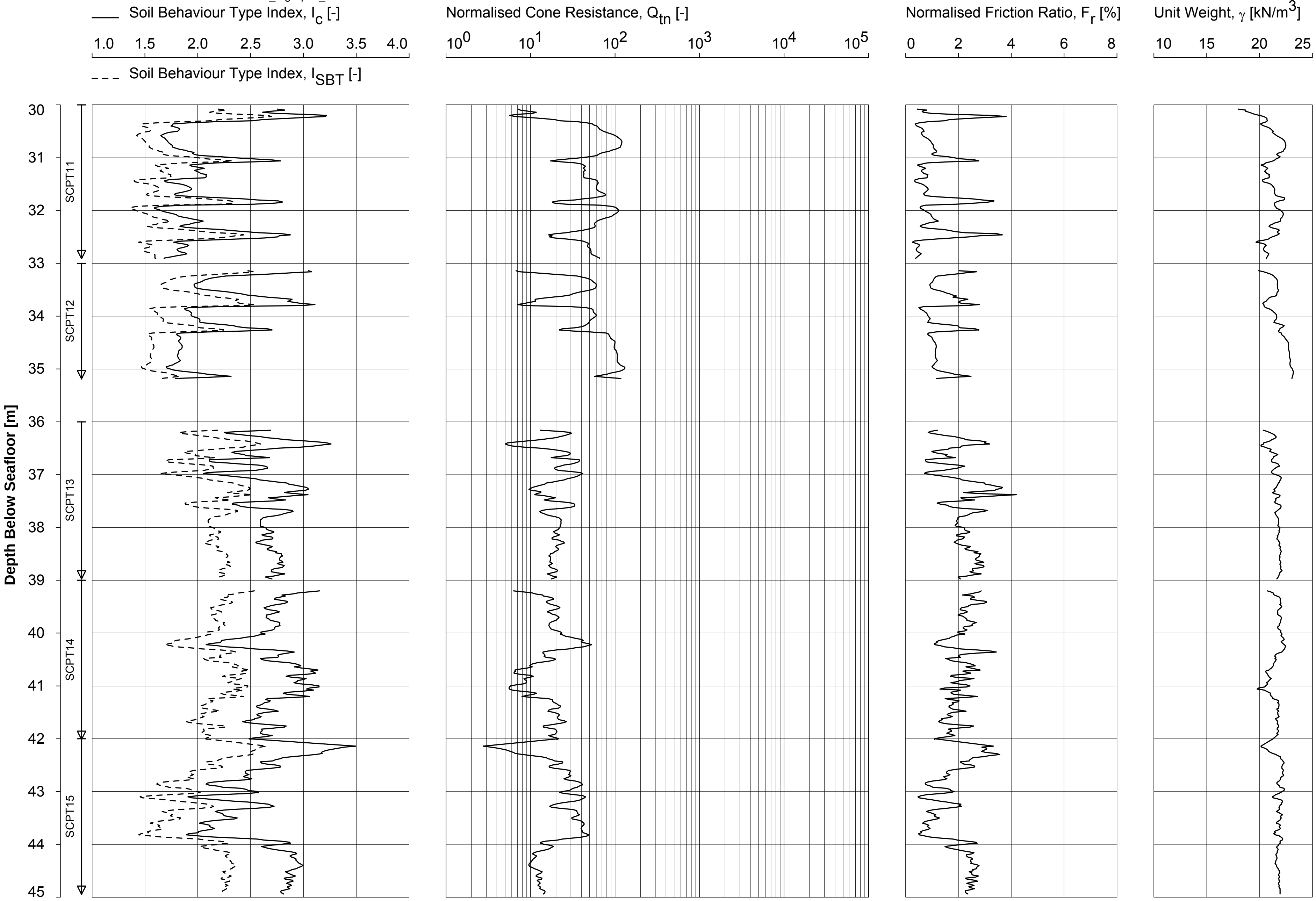


Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 575782 N 5807009

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH01-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison QaQc zero load - landscape.cmd / 2016-08-19 14:29:49

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

CONE PENETRATION TEST - ZERO DRIFT

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH01-SC	SCPT01	0.042	0.002	-0.016	0.001	0.001	-0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT02	0.038	0.002	-0.017	0.014	0.000	0.000	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT03	0.044	0.002	-0.020	-0.002	-0.001	0.004	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT04	0.044	0.002	-0.016	-0.019	0.000	0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT05	0.028	0.003	-0.020	0.027	-0.002	0.004	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT06	0.049	0.002	-0.022	0.011	0.000	0.004	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT07	0.048	0.000	-0.021	0.016	-0.001	0.004	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT08	0.060	0.000	-0.018	0.003	-0.003	-0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT09	0.037	-0.001	-0.020	0.025	-0.001	0.006	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT10	0.061	-0.002	-0.019	-0.006	-0.001	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT11	0.066	-0.002	-0.013	-0.004	0.001	-0.005	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT12	0.069	0.001	-0.023	-0.005	-0.001	0.005	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT13	0.068	0.001	-0.017	0.021	0.000	-0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT14	0.067	0.001	-0.024	-0.001	0.001	0.006	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH01-SC	SCPT15	0.076	0.001	-0.019	-0.001	0.000	0.006	CP10-CF50PB20SN2	1706-1888	0.750

Key:

q_c : cone resistance

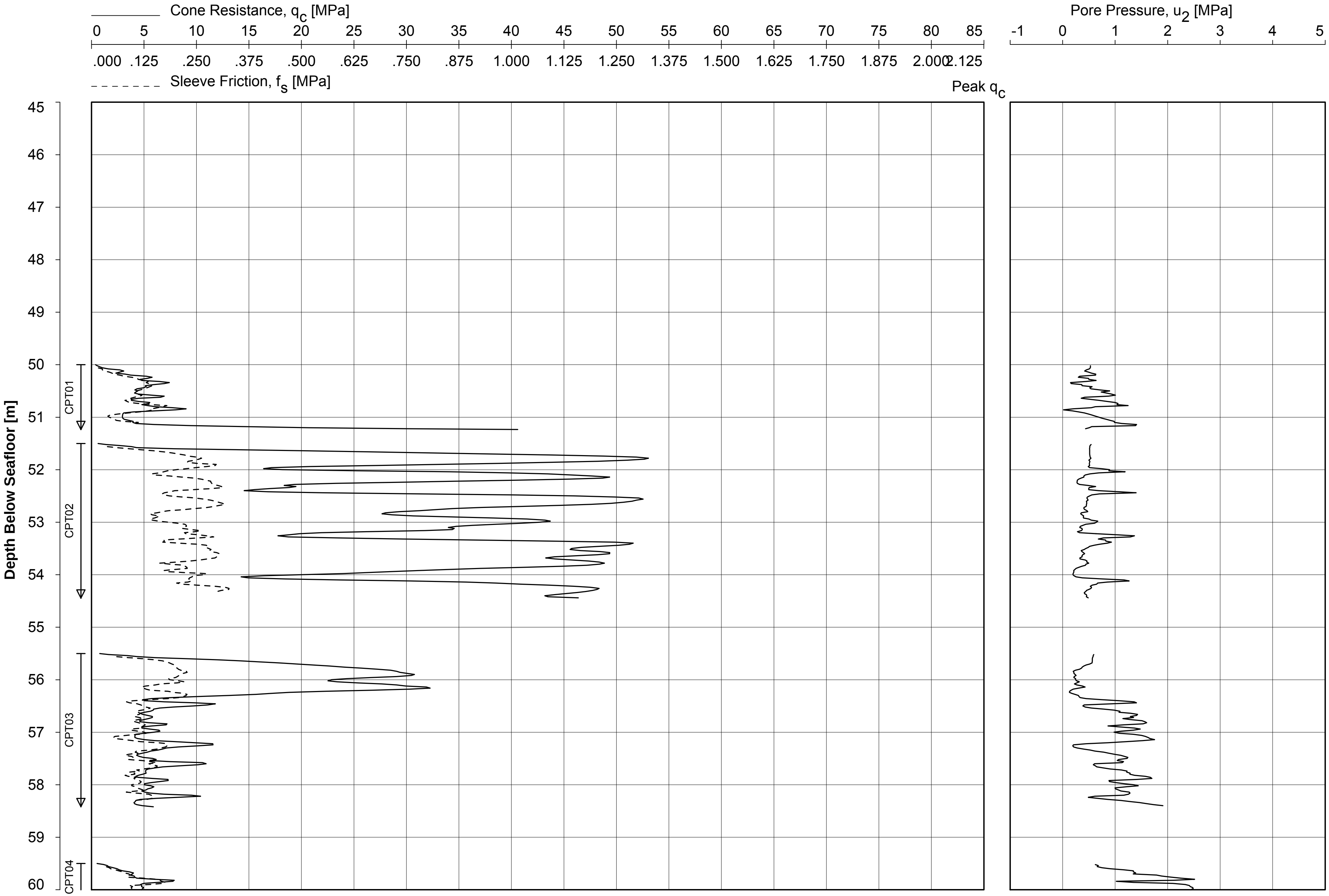
f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test.
   Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:50:44



Date Of Testing : 13-Jul-2016

Water Depth [m LAT] : 21.7

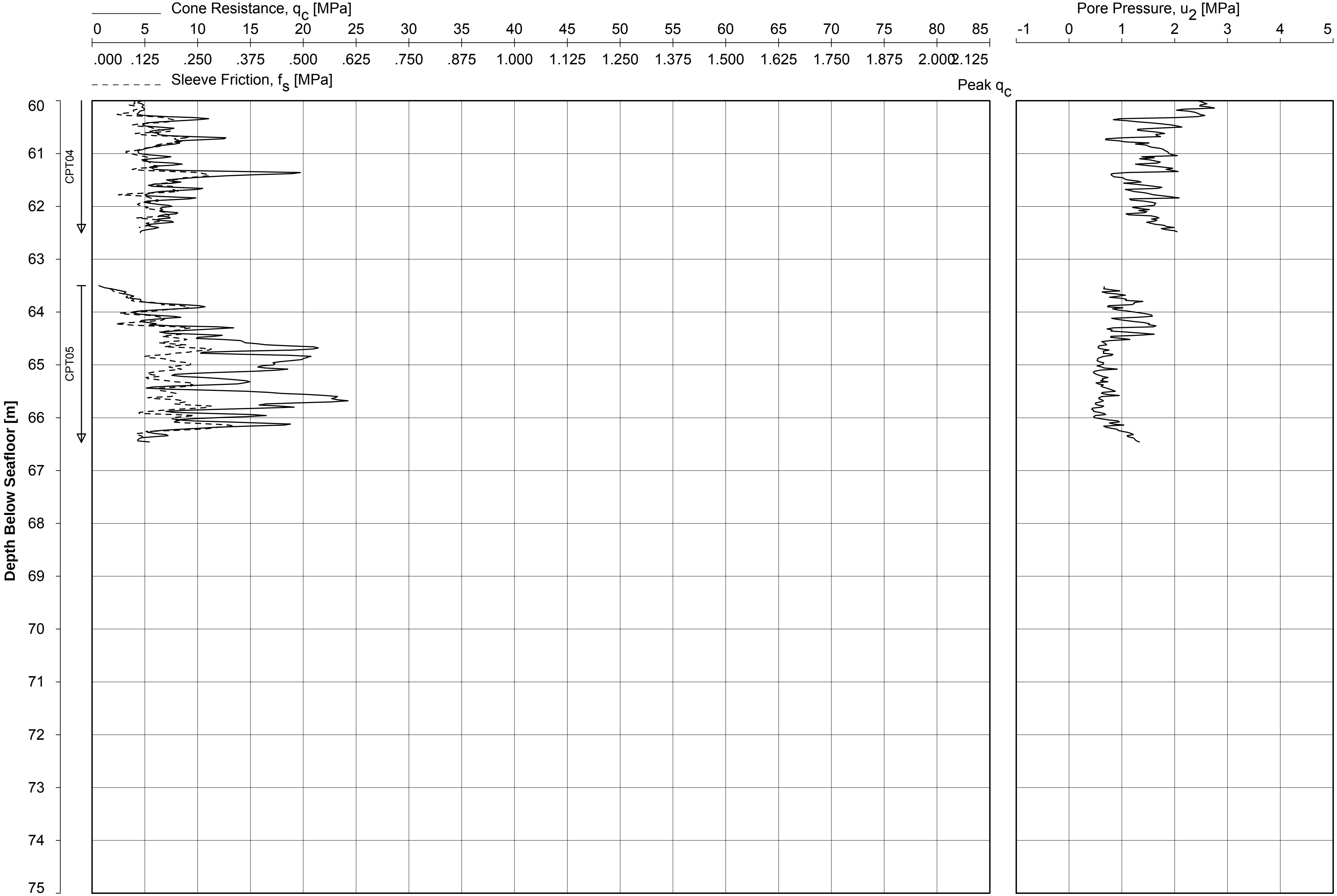
Coordinates [m] : E 571804 N 5801442

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:50:44



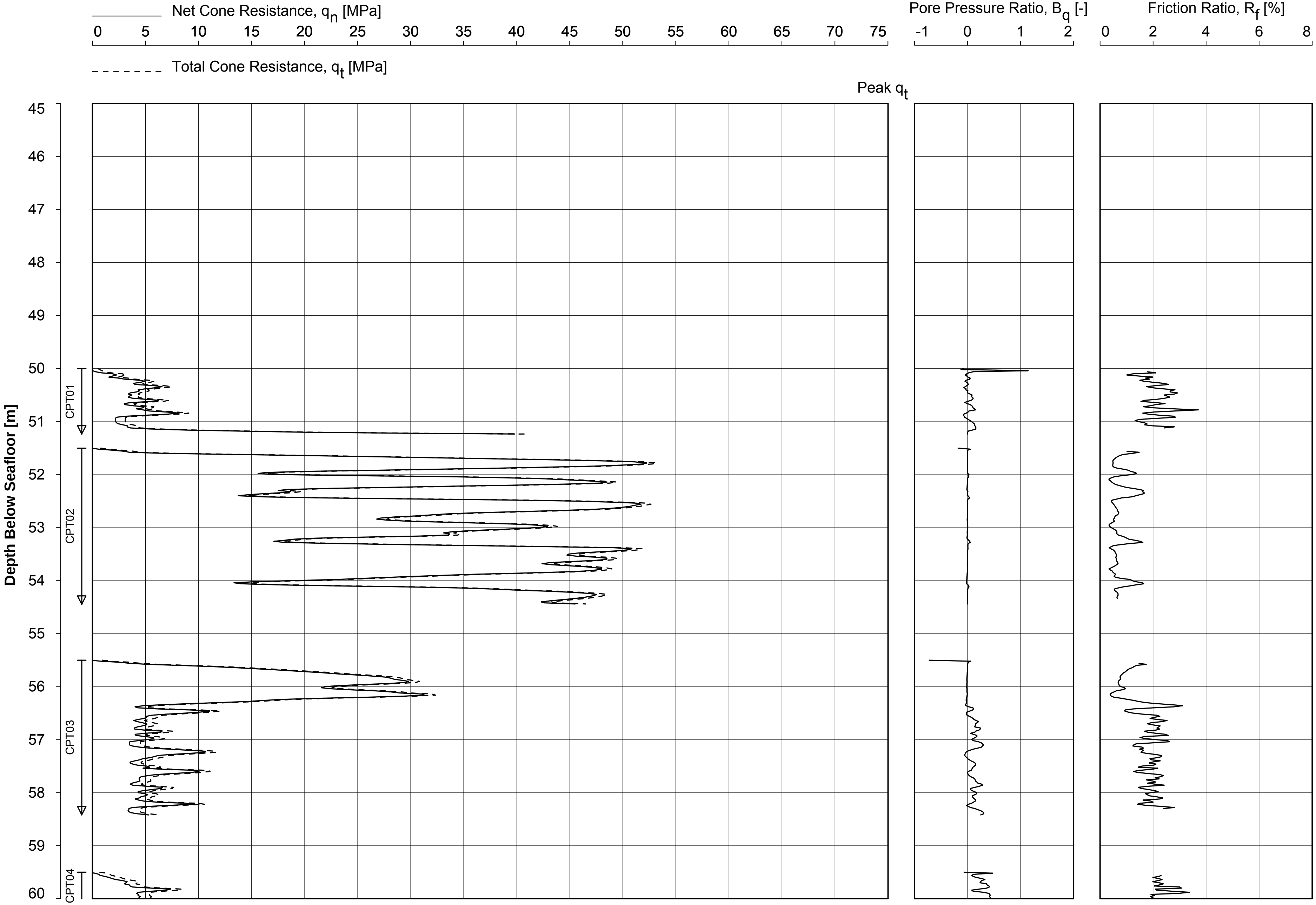
Date Of Testing	: 13-Jul-2016
Water Depth [m LAT]	: 21.7
Coordinates [m]	: E 571804 N 5801442

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 15:50:59



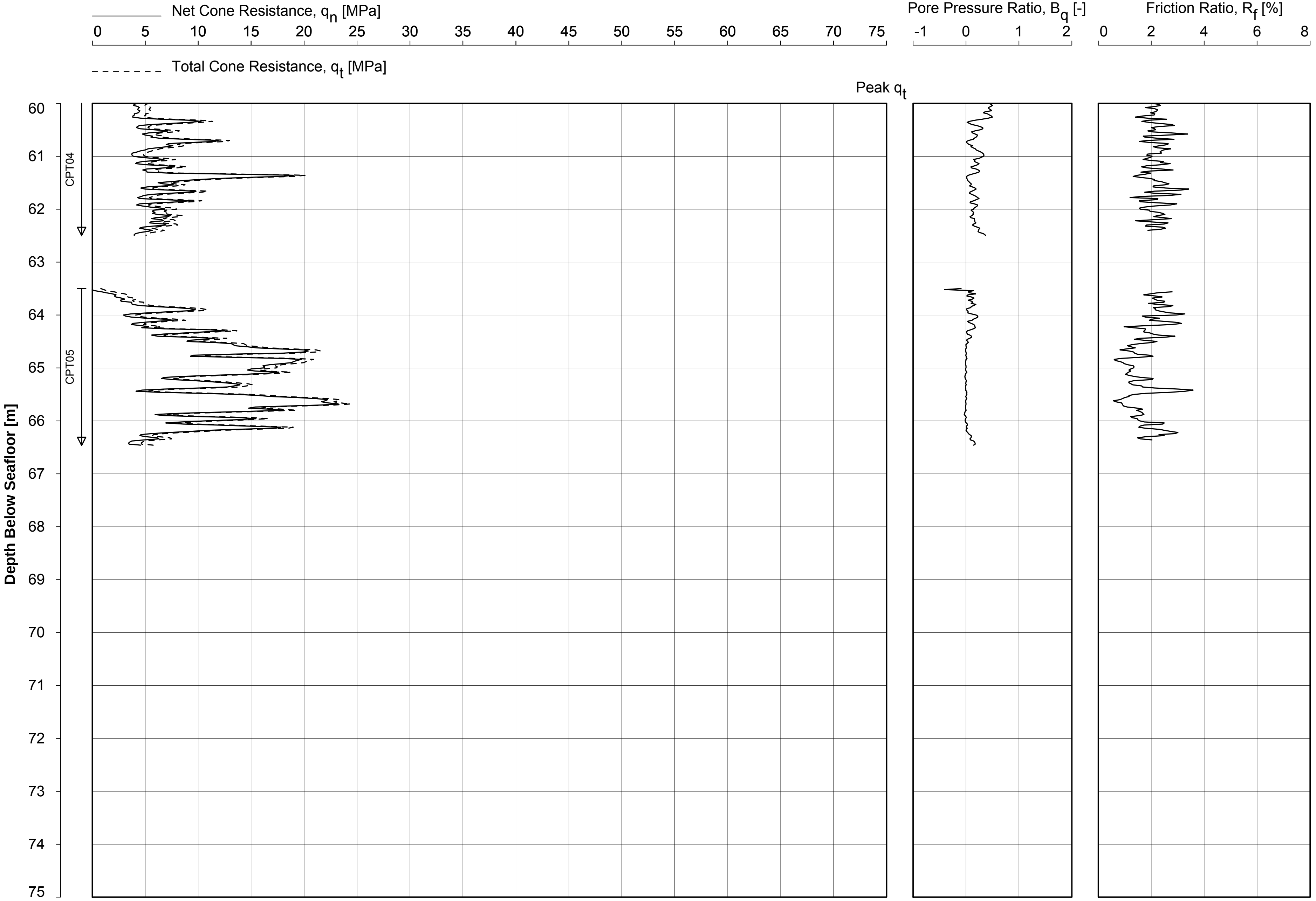
Date Of Testing : 13-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571804 N 5801442

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 15:50:59



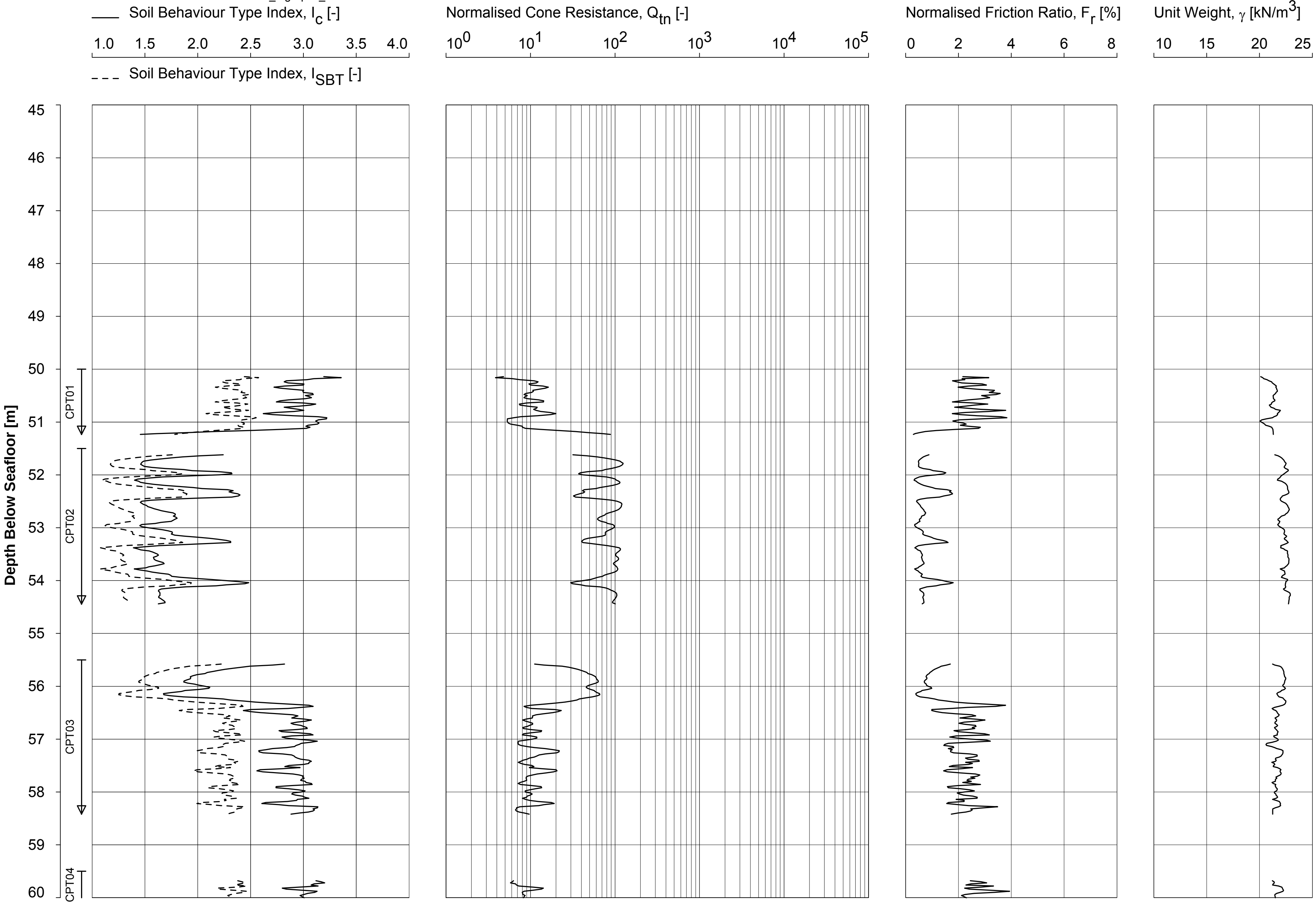
Date Of Testing	:	13-Jul-2016
Water Depth [m LAT]	:	21.7
Coordinates [m]	:	E 571804 N 5801442

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:51:13



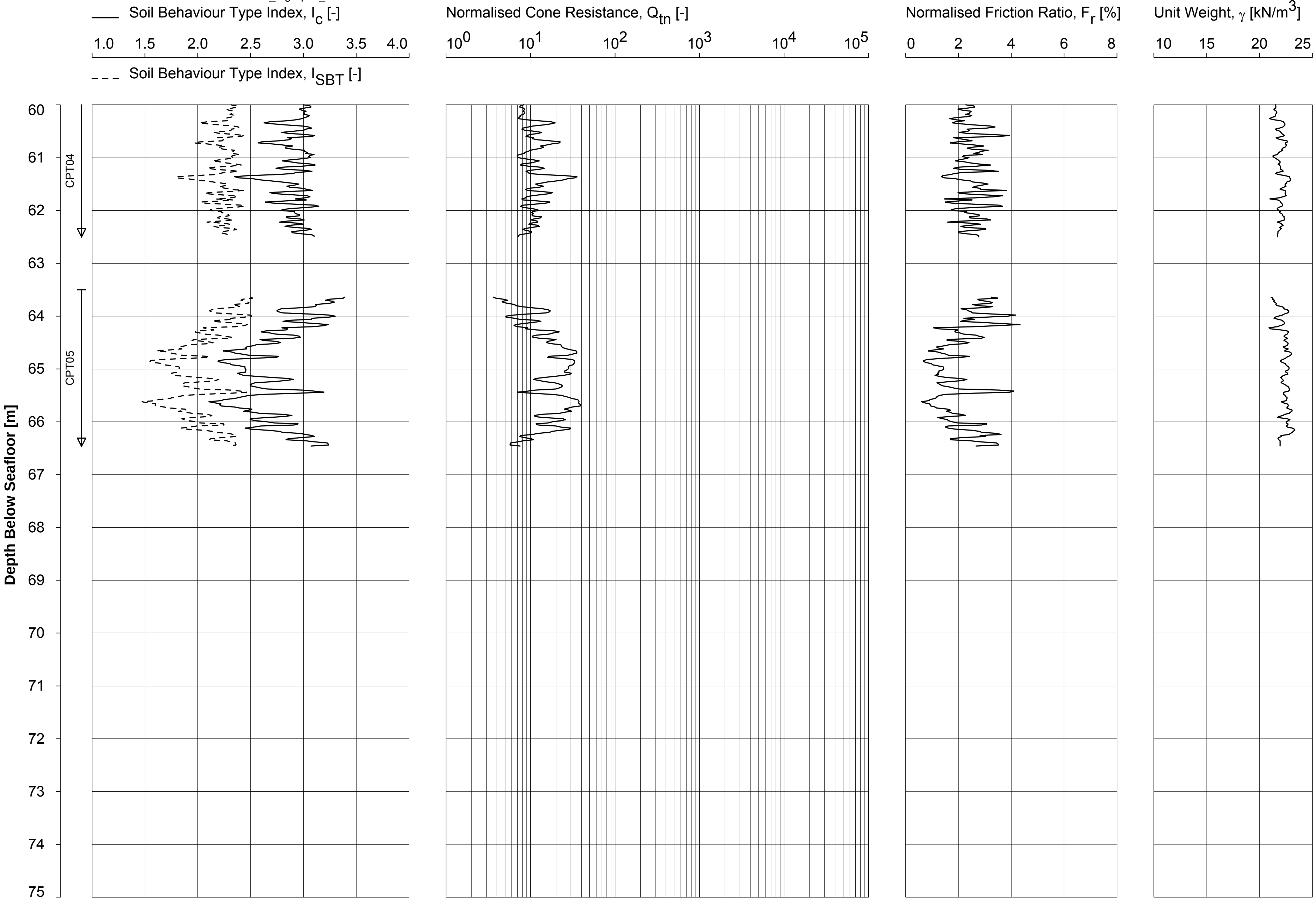
Date of Testing	: 13-Jul-2016		Probe Type	: CP10-CF50PB10
Water Depth [m LAT]	: 21.7		Cone Base Area [mm^2]	: 1007
Coordinates [m]	: E 571804	N 5801442	Ground Water [kN/m^3]	: 10.0

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:51:14



Date of Testing : 13-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571804 N 5801442

Probe Type : CP10-CF50PB10
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison QaQc zero load - landscape.cmd / 2016-08-19 15:51:23

CONE PENETRATION TEST - ZERO DRIFT

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH03-SA	CPT01	0.386	0.000	0.005	-0.067	0.001	0.000	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH03-SA	CPT02	0.311	0.004	0.004	0.007	-0.010	0.007	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH03-SA	CPT03	0.371	-0.001	0.004	-0.010	-0.003	0.000	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH03-SA	CPT04	0.379	0.001	0.011	-0.006	-0.003	-0.006	CP10-CF50PB10	1706-1924	0.750
HKZ1-BH03-SA	CPT05	0.382	0.000	0.005	-0.016	-0.002	0.000	CP10-CF50PB10	1706-1924	0.750

Key:

q_c : cone resistance

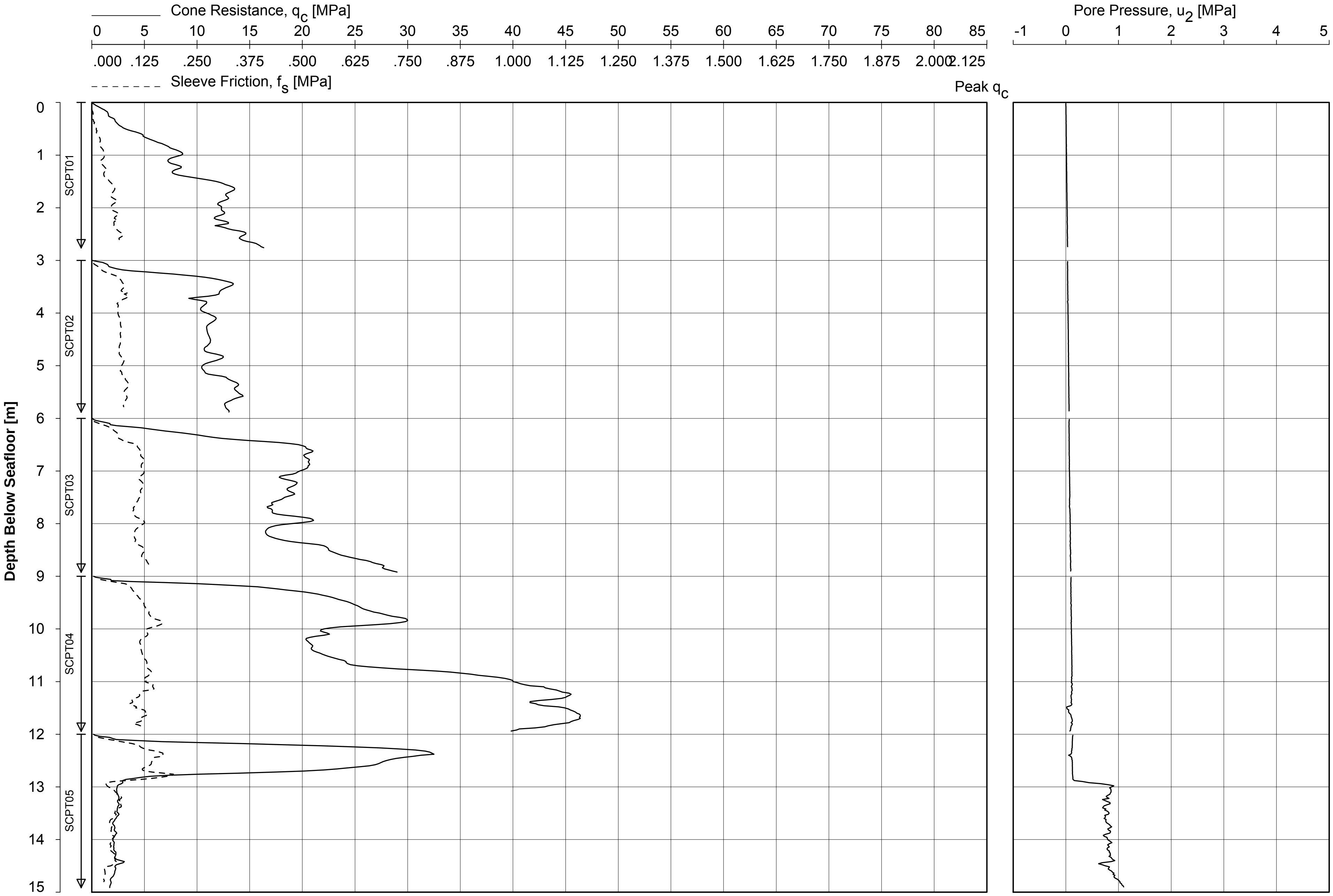
f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test.
   Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented
   in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:52:08



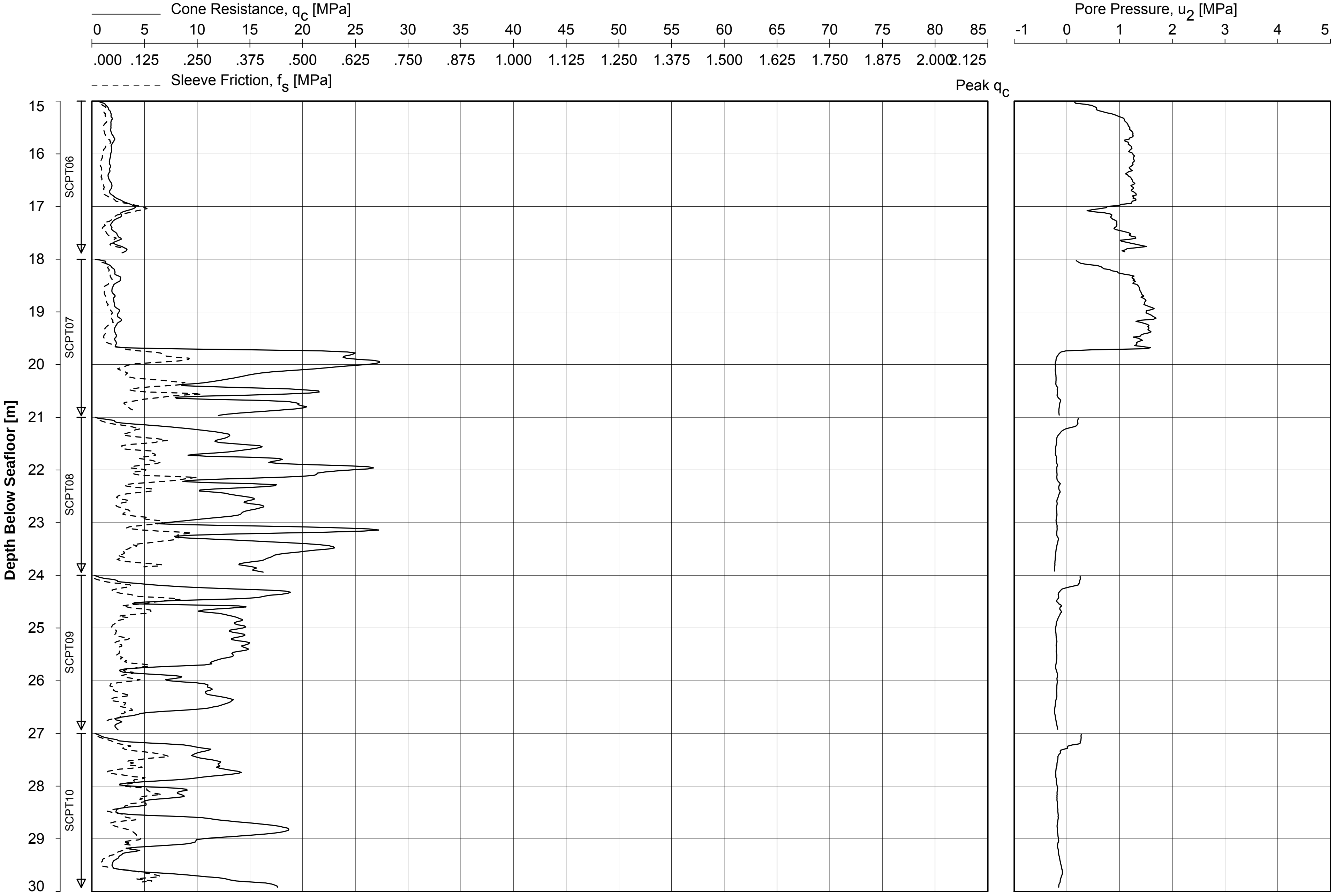
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:52:08



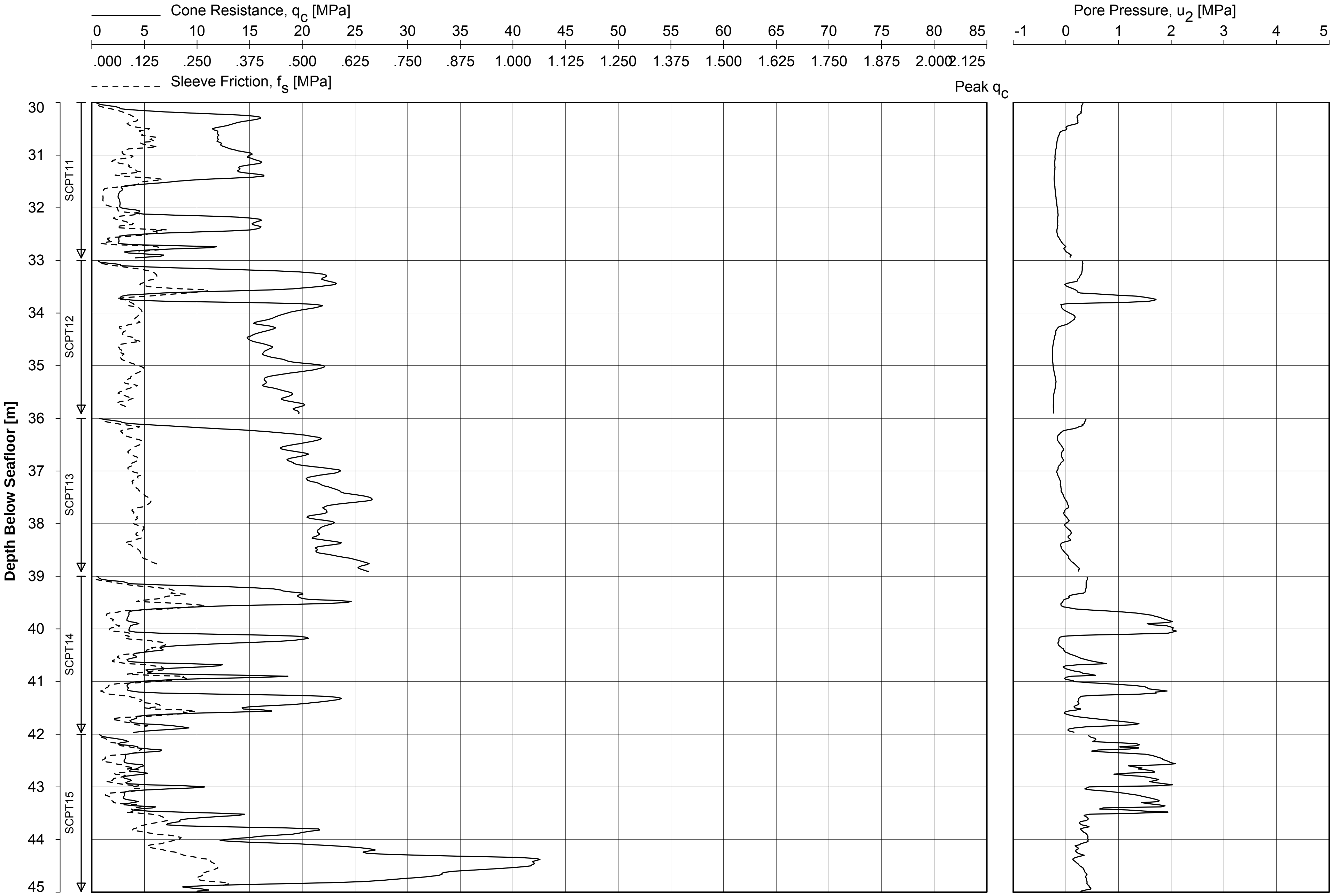
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:52:08



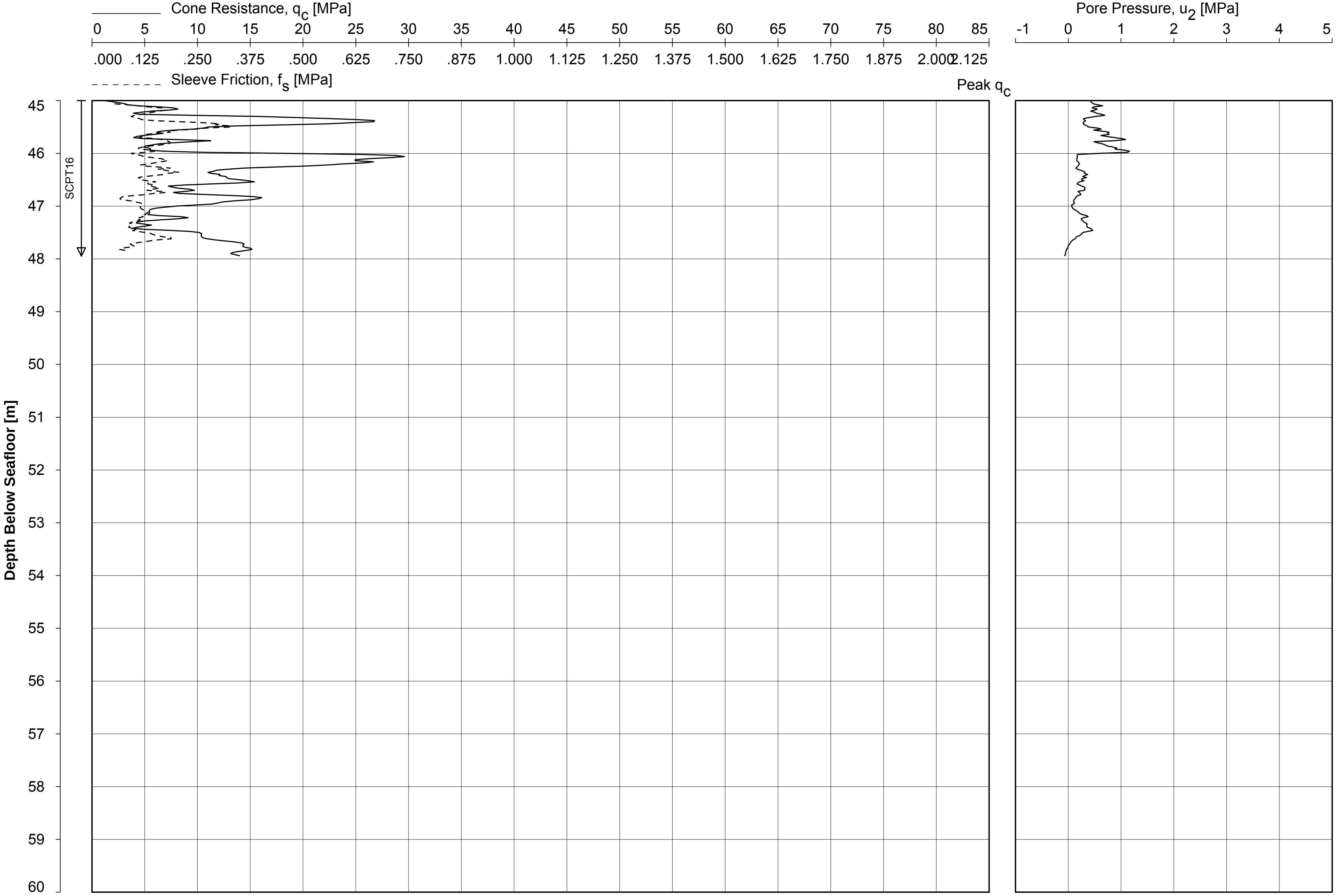
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 15:52:08



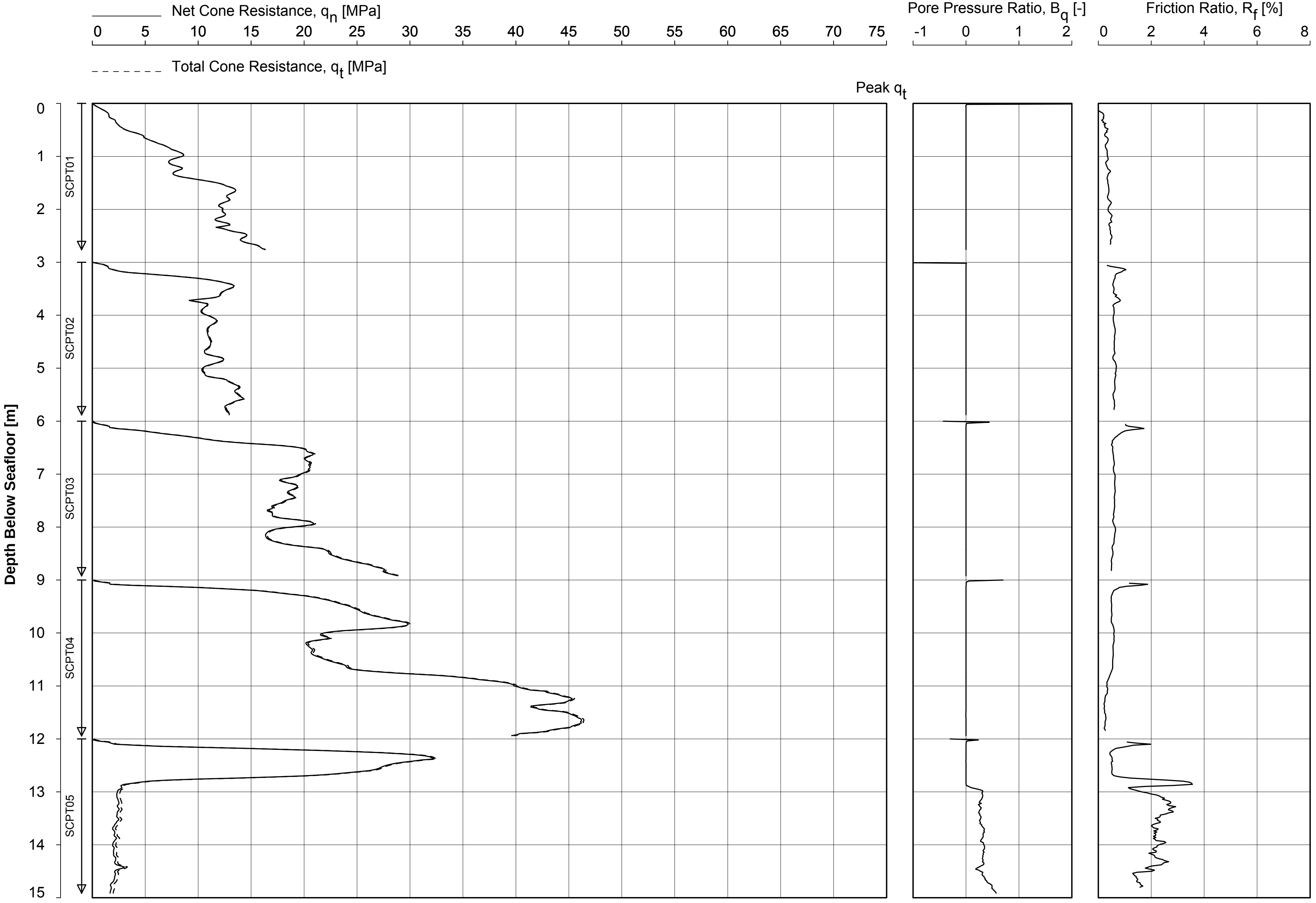
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 15:52:21



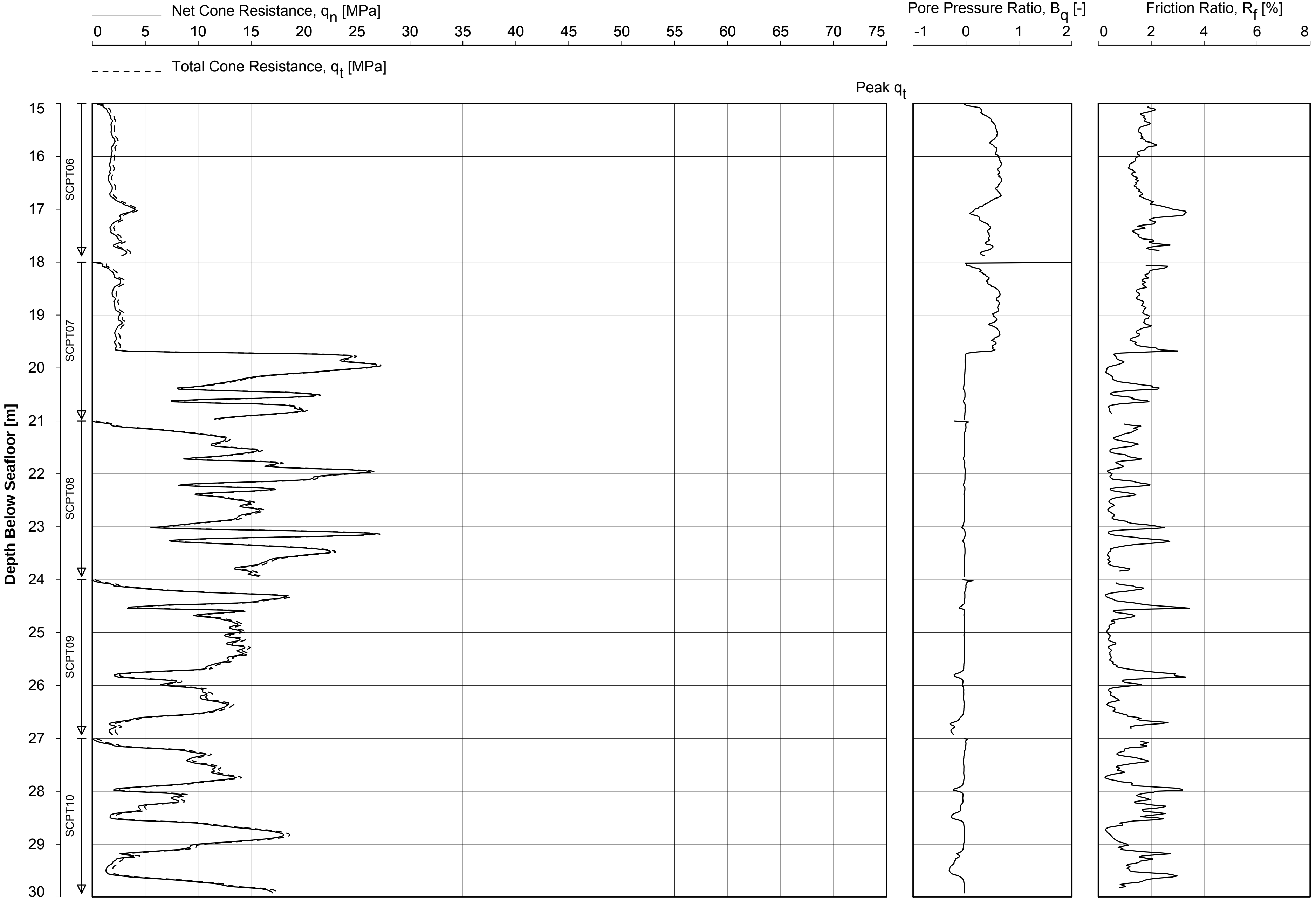
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 15:52:21

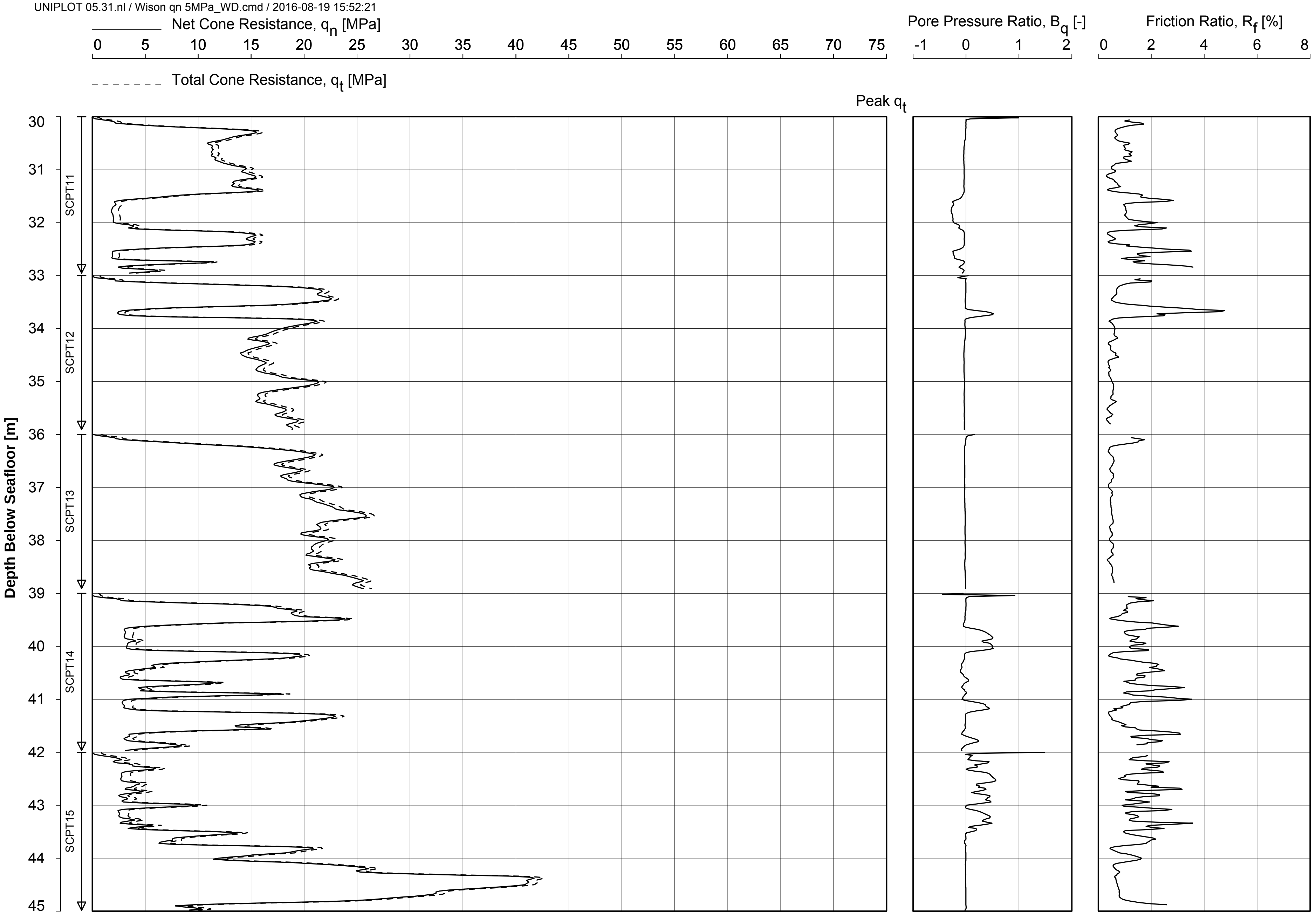


Date Of Testing	:	14-Jul-2016
Water Depth [m LAT]	:	21.7
Coordinates [m]	:	E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



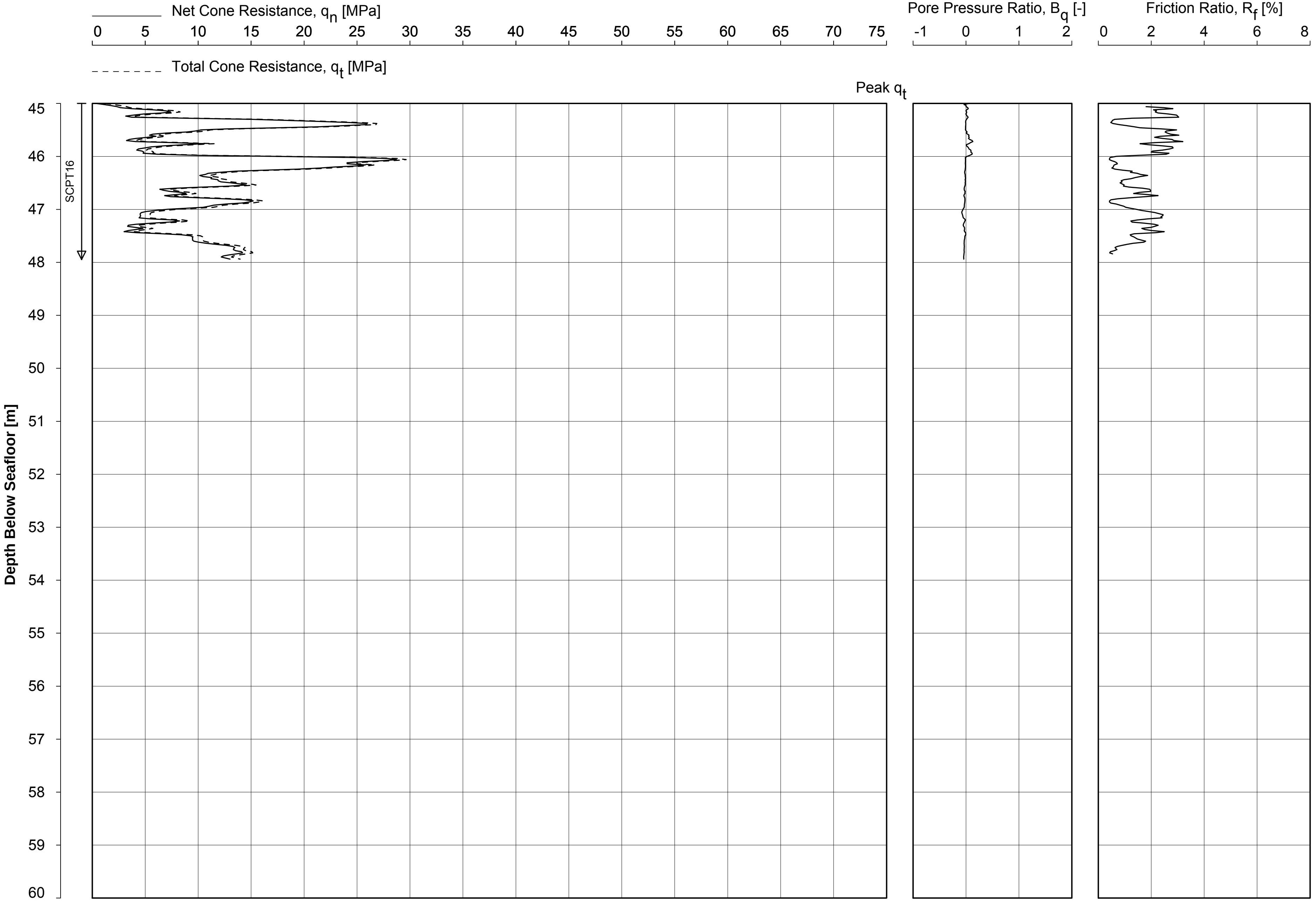
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 15:52:21



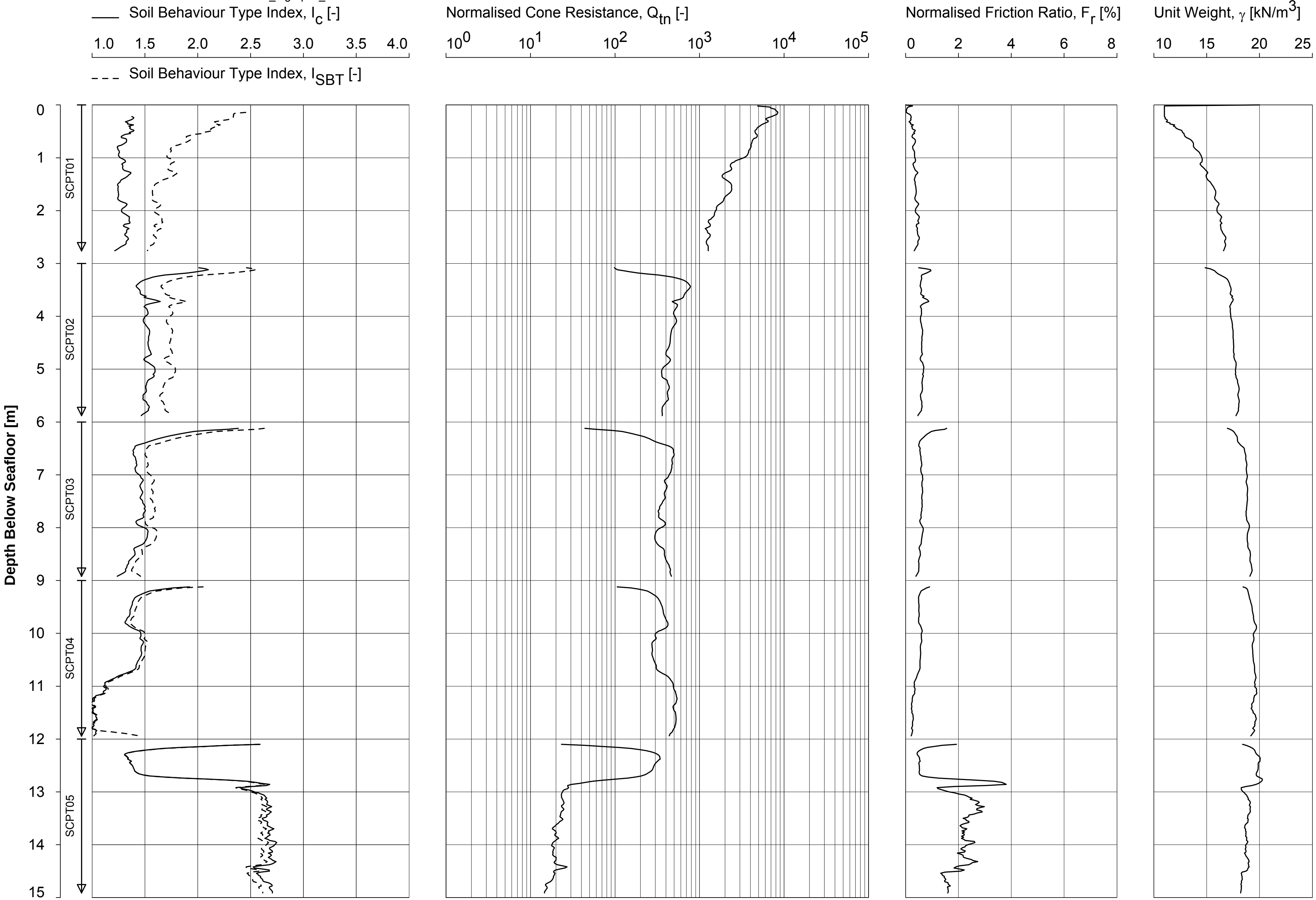
Date Of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:52:33



Date of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

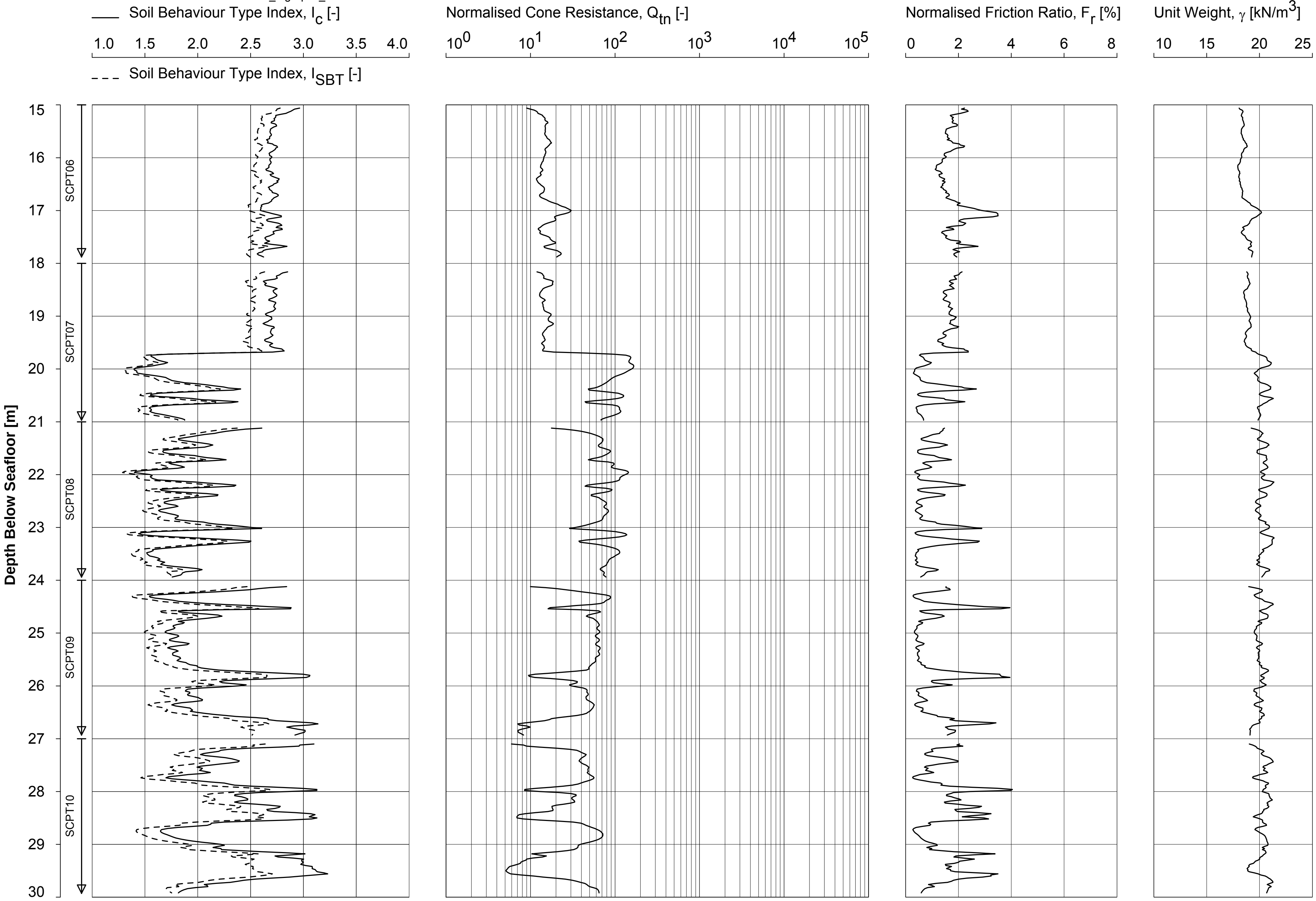
Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:52:33



Date of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

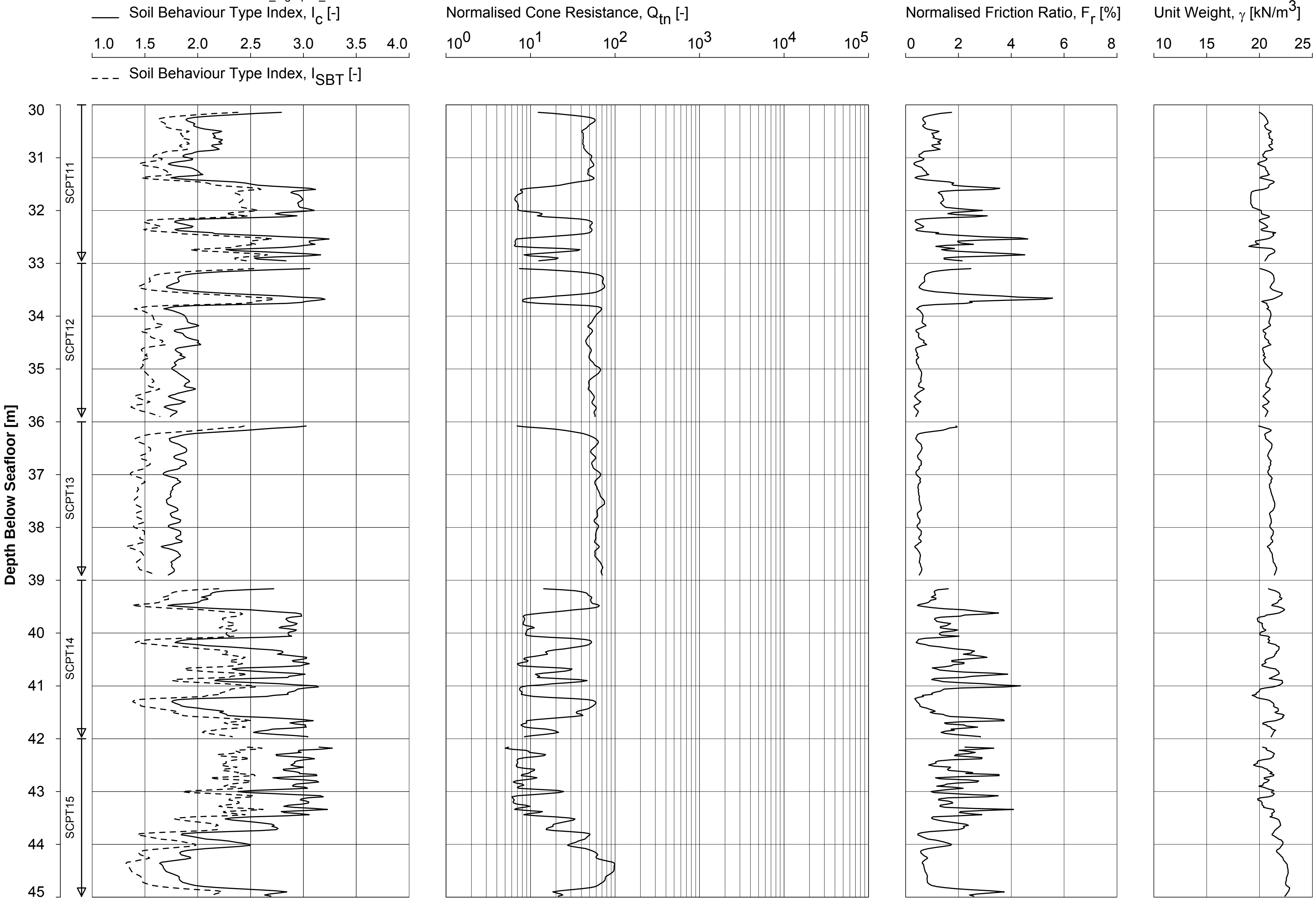
Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:52:34



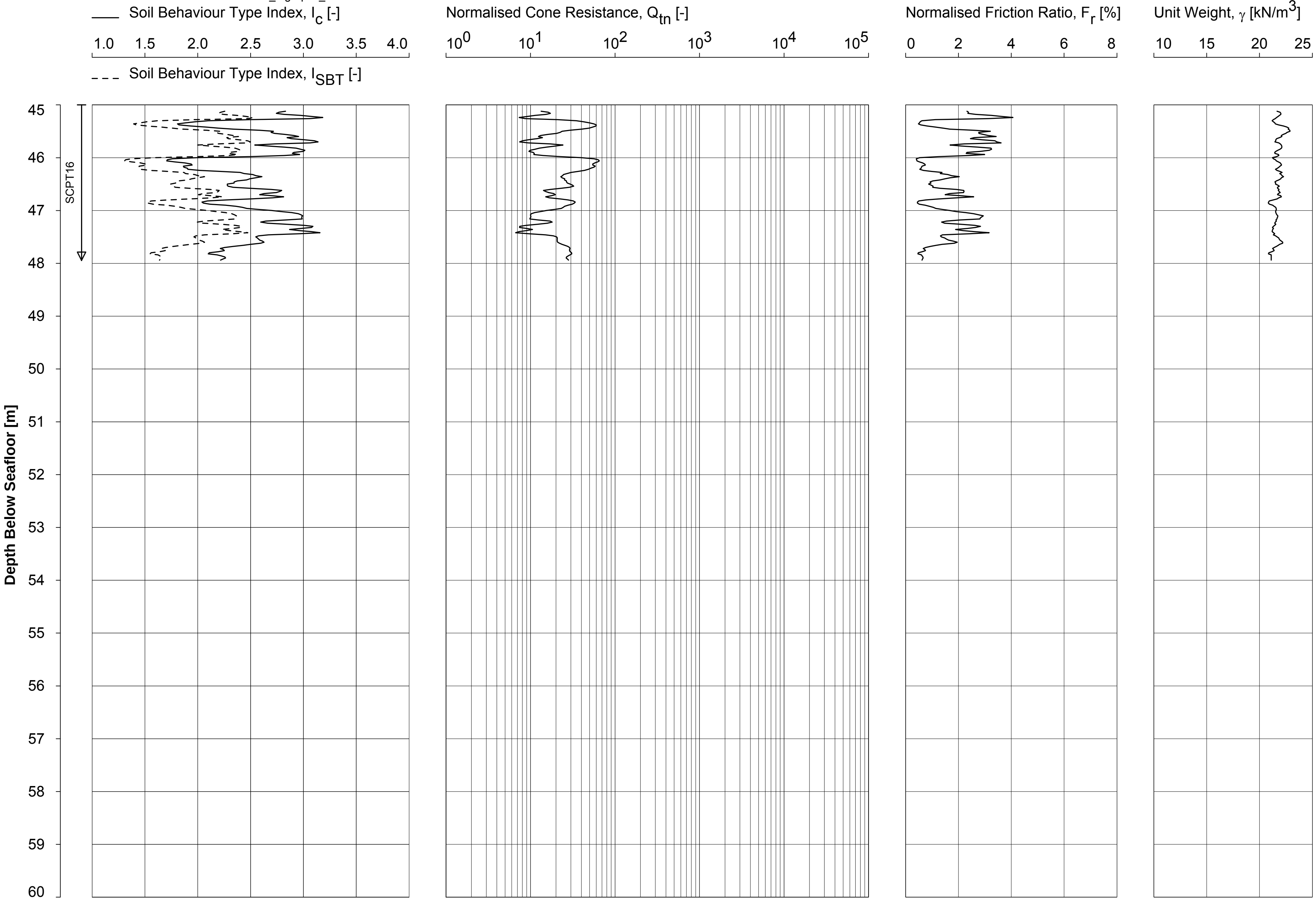
Date of Testing	: 14-Jul-2016		Probe Type	: CP10-CF50PB20SN2
Water Depth [m LAT]	: 21.7		Cone Base Area [mm^2]	: 1007
Coordinates [m]	: E 571800	N 5801440	Ground Water [kN/m^3]	: 10.0

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 15:52:34



Date of Testing : 14-Jul-2016
Water Depth [m LAT] : 21.7
Coordinates [m] : E 571800 N 5801440

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH03-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison QaQc zero load - landscape.cmd / 2016-08-19 15:52:44

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

CONE PENETRATION TEST - ZERO DRIFT

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH03-SC	SCPT01	0.025	0.001	-0.018	-0.041	0.004	0.000	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT02	-0.009	0.003	-0.018	-0.010	0.000	-0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT03	-0.006	0.003	-0.019	0.002	-0.001	-0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT04	0.010	0.002	-0.016	-0.024	0.000	-0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT05	0.019	0.002	-0.020	-0.001	0.001	0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT06	0.019	0.002	-0.019	0.002	-0.001	0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT07	0.031	0.001	-0.018	-0.019	0.000	0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT08	0.030	0.001	-0.019	0.011	0.001	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT09	0.031	0.001	-0.020	0.010	0.000	0.000	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT10	0.036	0.001	-0.024	0.033	0.001	0.004	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT11	0.040	0.001	-0.022	-0.003	0.000	0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT12	0.042	0.001	-0.021	-0.001	0.000	0.006	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT13	0.046	0.001	-0.019	-0.001	-0.001	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT14	0.047	0.001	-0.021	-0.002	0.000	-0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT15	0.050	0.002	-0.019	-0.015	0.000	0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH03-SC	SCPT16	0.041	0.001	-0.016	-0.004	-0.001	-0.002	CP10-CF50PB20SN2	1706-1888	0.750

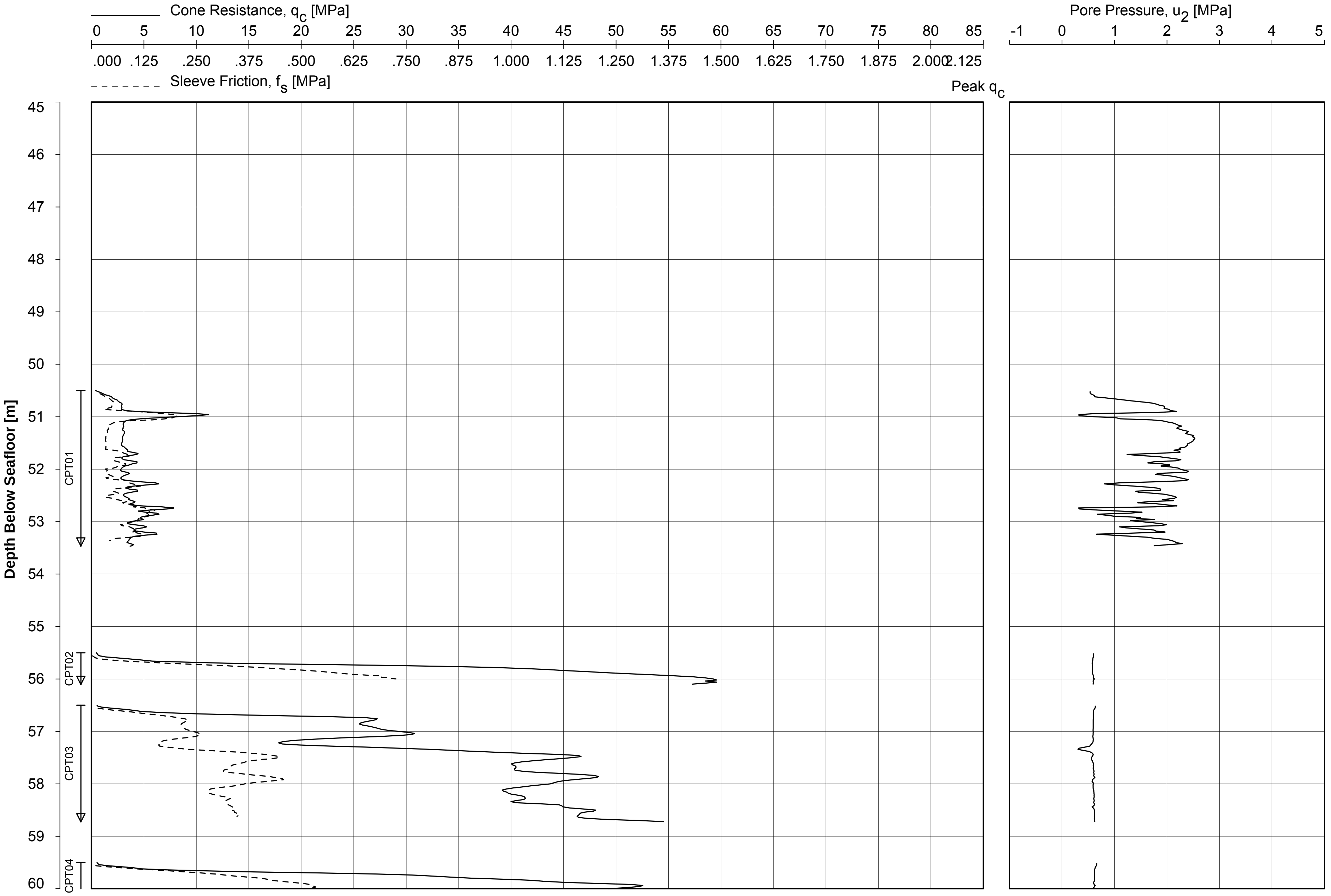
Key:

q_c : cone resistance f_s : sleeve friction u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test. Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 16:01:03



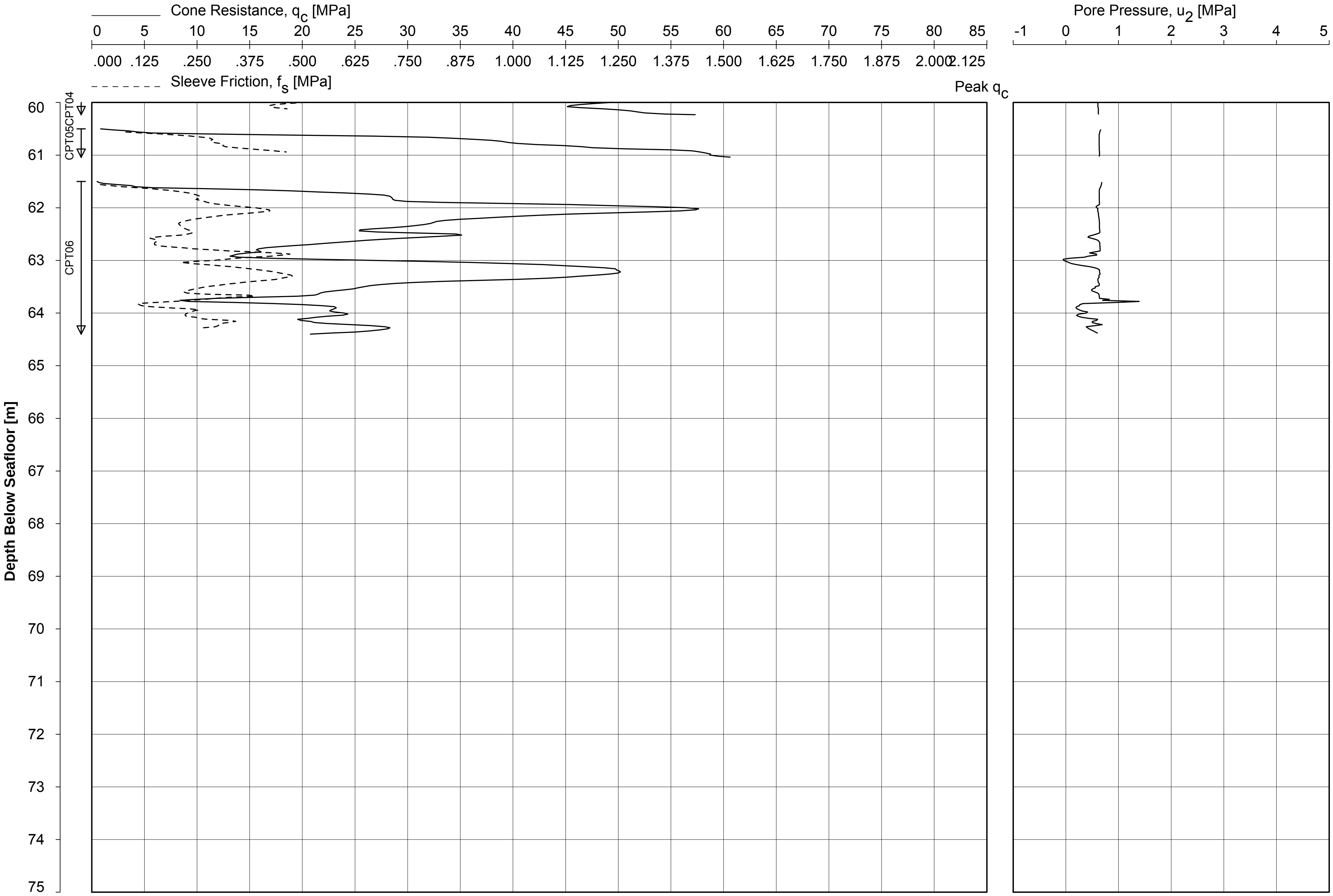
Date Of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564274 N 5801688

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 16:01:04

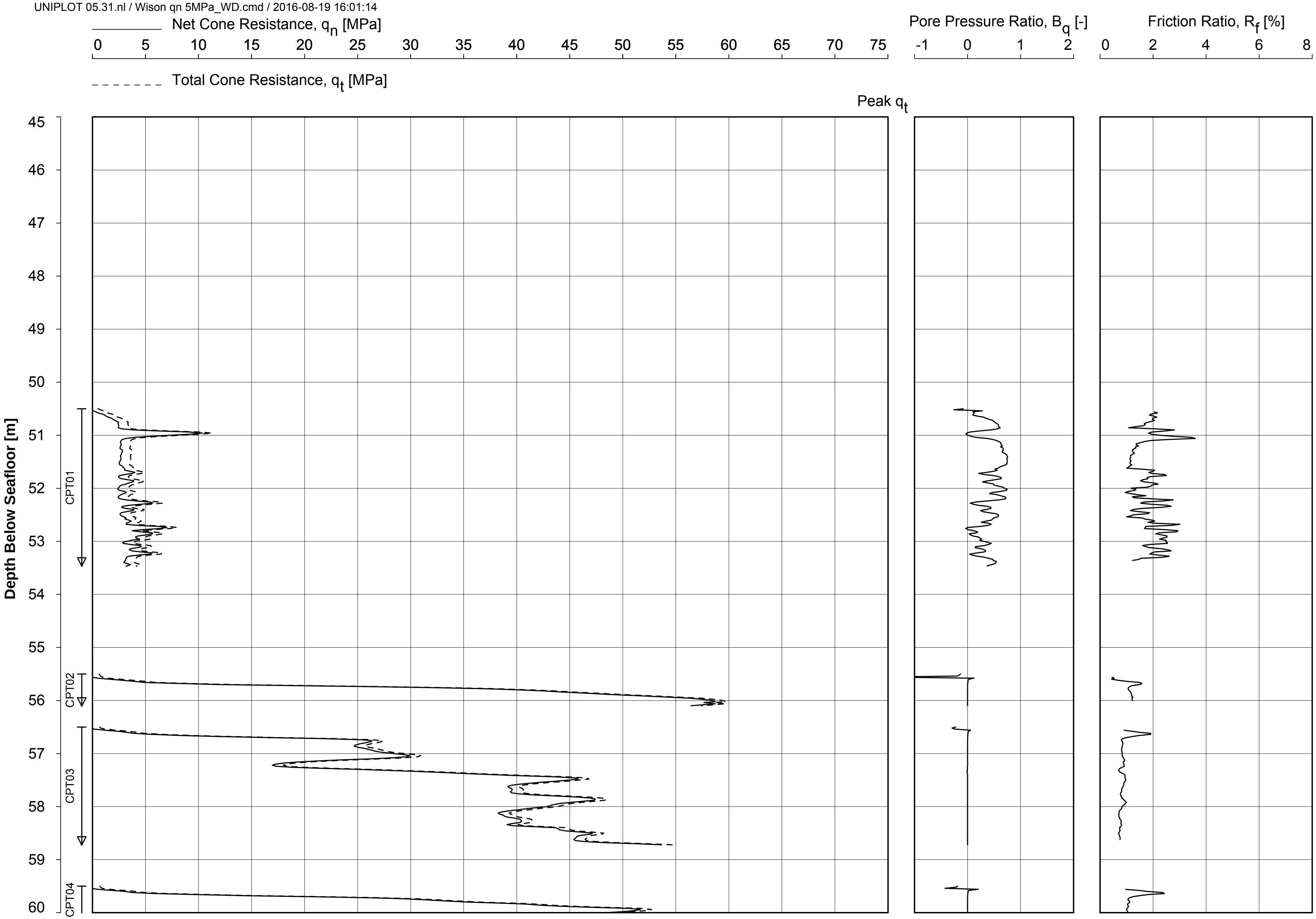


Date Of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564274 N 5801688

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



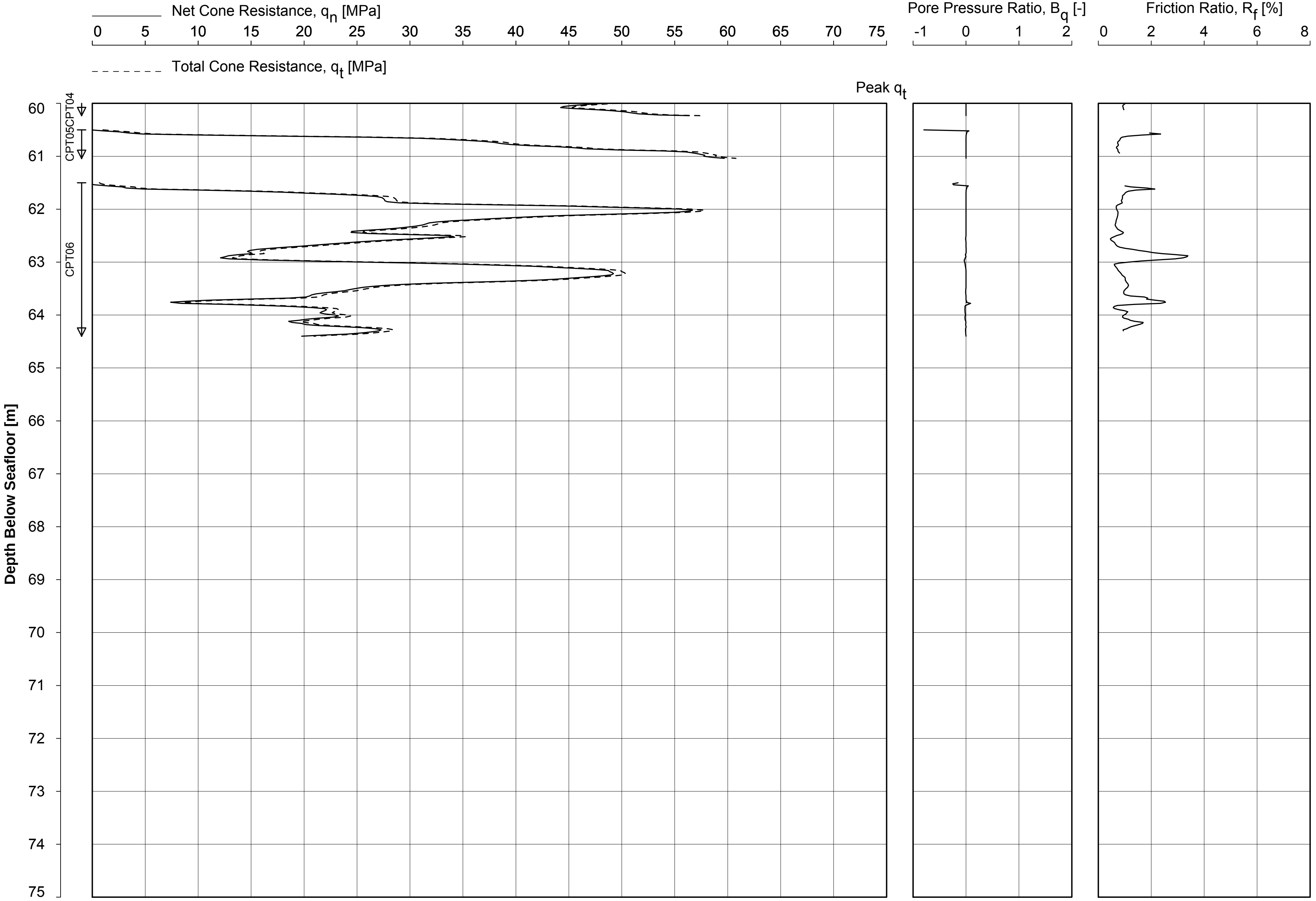
Date Of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564274 N 5801688

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qn 5MPa_WD.cmd / 2016-08-19 16:01:14



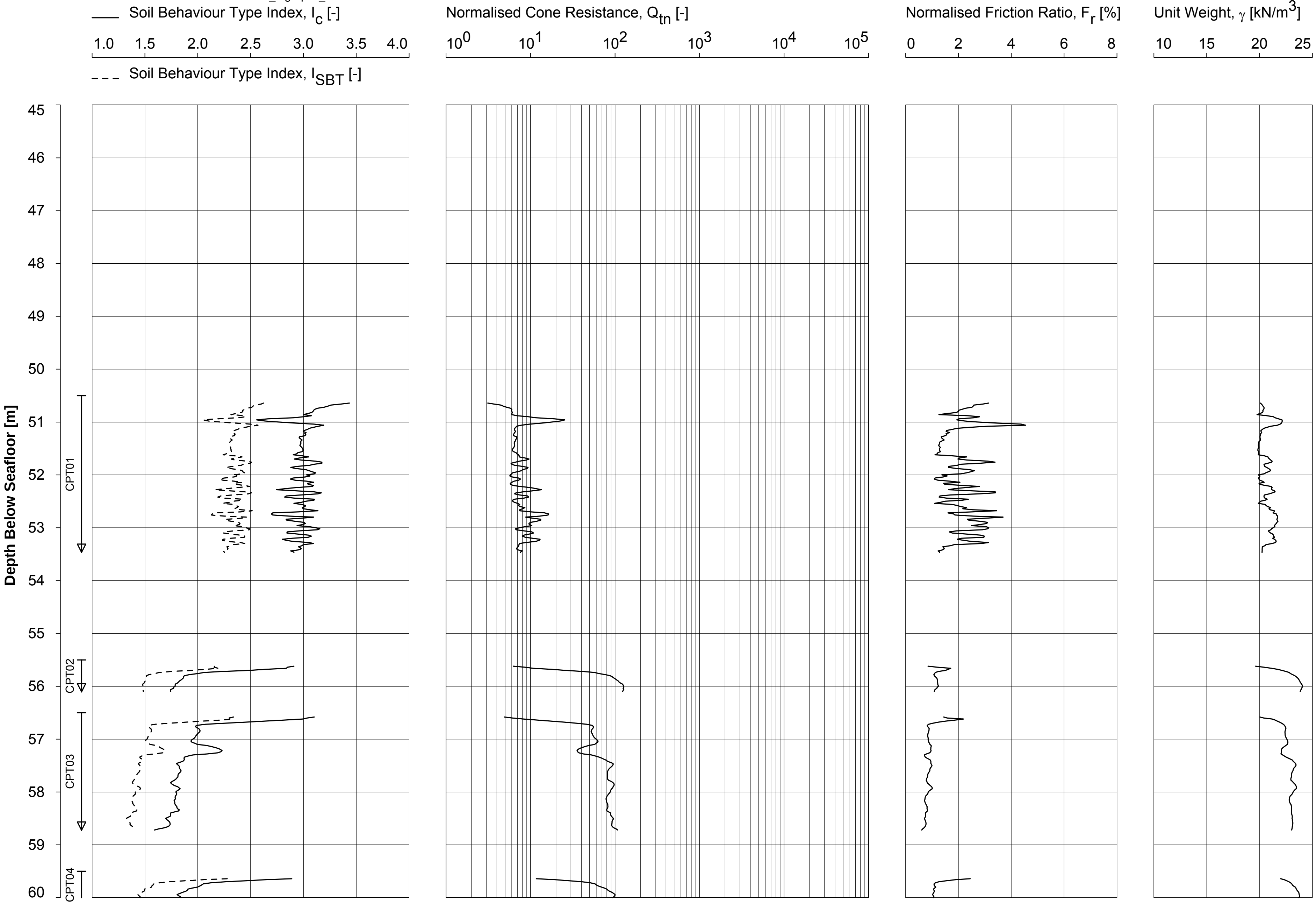
Date Of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564274 N 5801688

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 16:01:24



Date of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564274 N 5801688

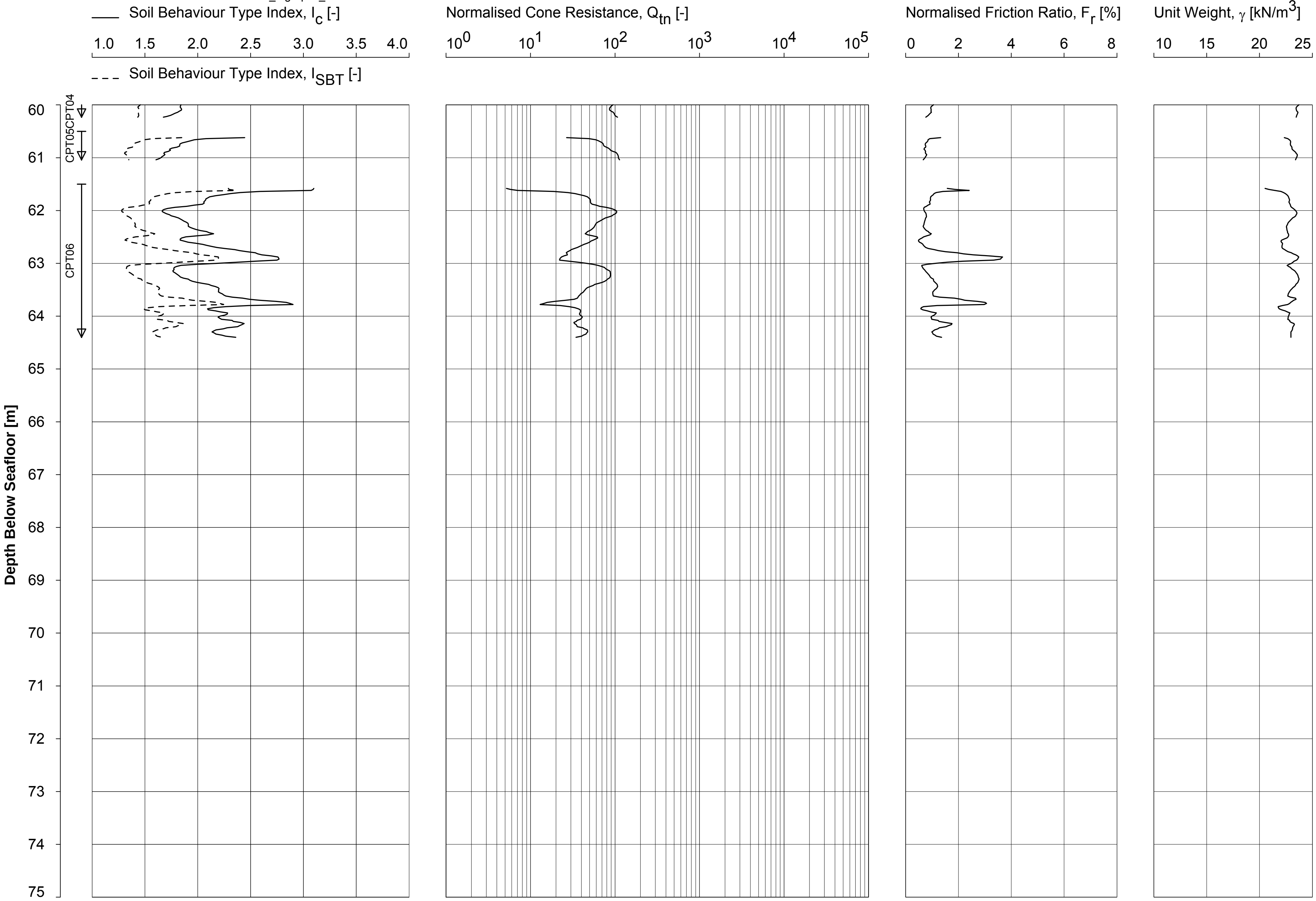
Probe Type : CP10-CF50PB10
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison Qtn+Fr+Ic+UW - Plate_4 graphs_WD.cmd / 2016-08-19 16:01:24



Date of Testing	: 10-Jul-2016	Probe Type	: CP10-CF50PB10
Water Depth [m LAT]	: 22.6	Cone Base Area [mm^2]	: 1007
Coordinates [m]	: E 564274 N 5801688	Ground Water [kN/m^3]	: 10.0

CONE PENETRATION TEST

HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

CONE PENETRATION TEST - ZERO DRIFT

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH06-SA	CPT01	-0.040	0.000	-0.009	-0.003	-0.001	0.000	CP10-CF50PB10	1706-2149	0.750
HKZ1-BH06-SA	CPT02	-0.033	0.000	-0.010	-0.027	0.000	0.001	CP10-CF50PB10	1706-2149	0.750
HKZ1-BH06-SA	CPT03	-0.036	0.003	-0.010	0.013	-0.003	0.002	CP10-CF50PB10	1706-2149	0.750
HKZ1-BH06-SA	CPT04	-0.024	0.003	-0.010	-0.035	-0.003	0.001	CP10-CF50PB10	1706-2149	0.750
HKZ1-BH06-SA	CPT05	-0.031	0.002	-0.010	-0.002	-0.001	0.003	CP10-CF50PB10	1706-2149	0.750
HKZ1-BH06-SA	CPT06	-0.027	0.002	-0.010	-0.044	-0.003	0.002	CP10-CF50PB10	1706-2149	0.750

Key:

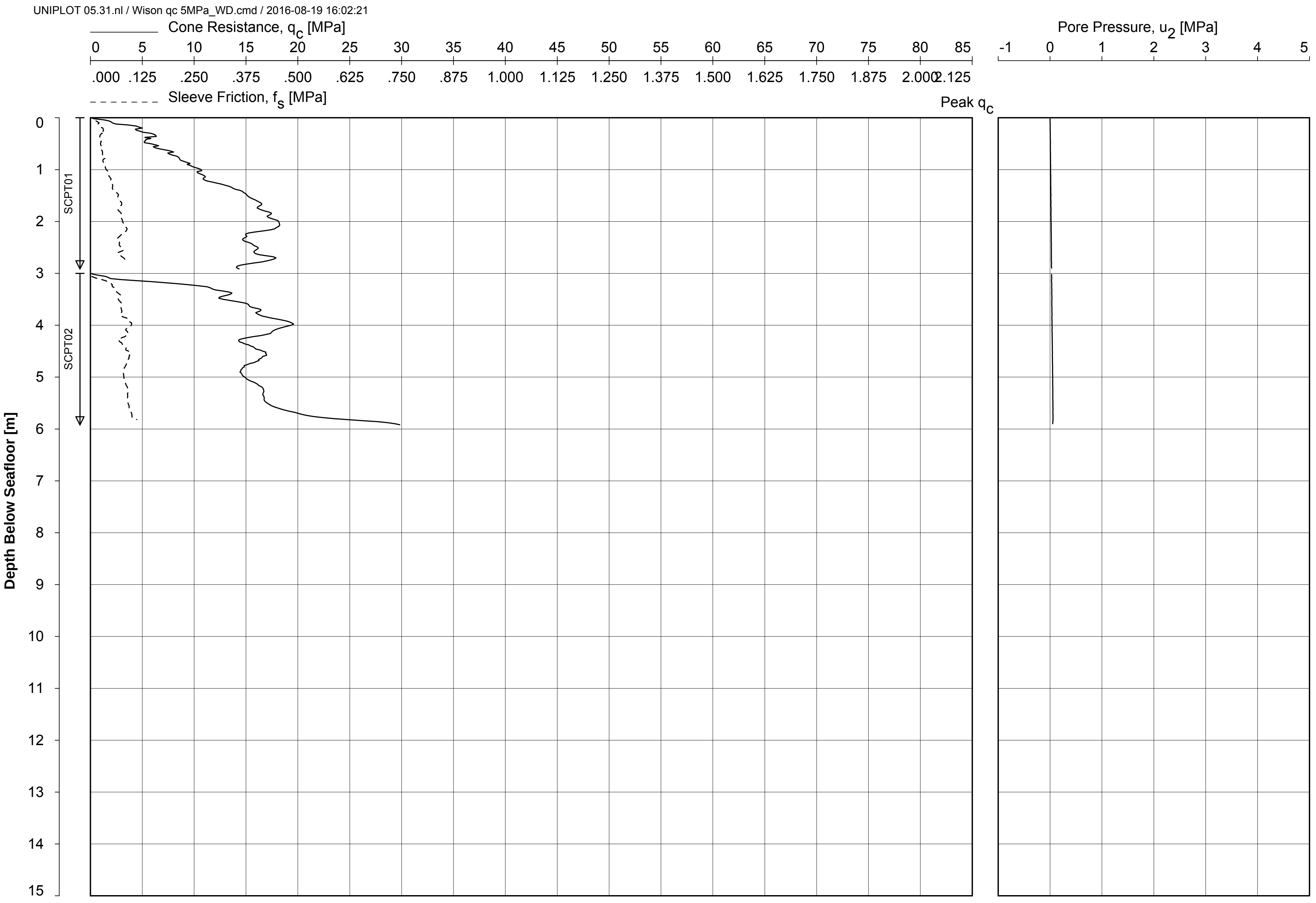
q_c : cone resistance

f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test. Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.



Date Of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564279 N 5801684

CONE PENETRATION TEST

HKZ1-BH06-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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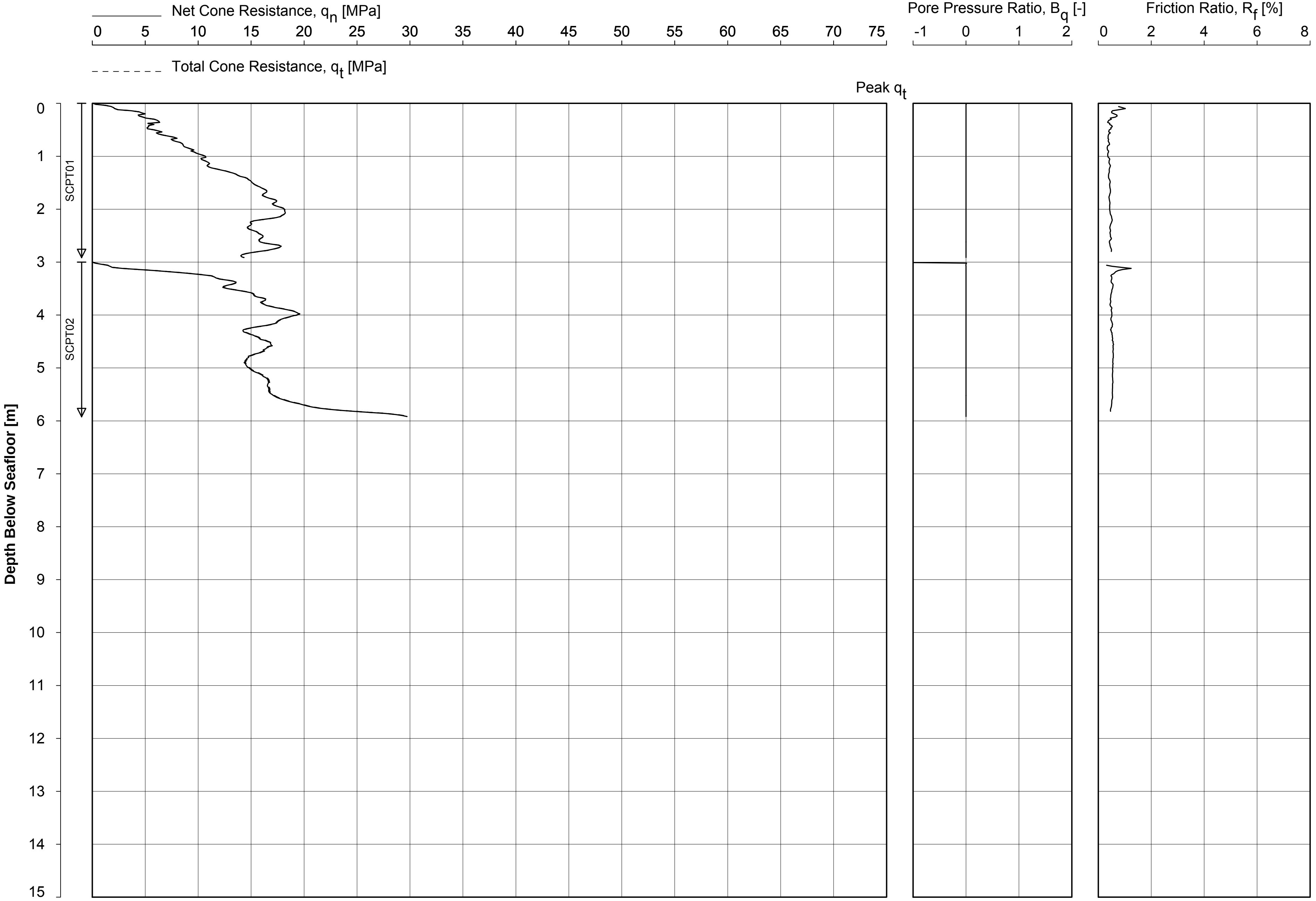

Date Of Testing	:	10-Jul-2016
Water Depth [m LAT]	:	22.6
Coordinates [m]	:	E 564279 N 5801684

CONE PENETRATION TEST

HKZ1-BH06-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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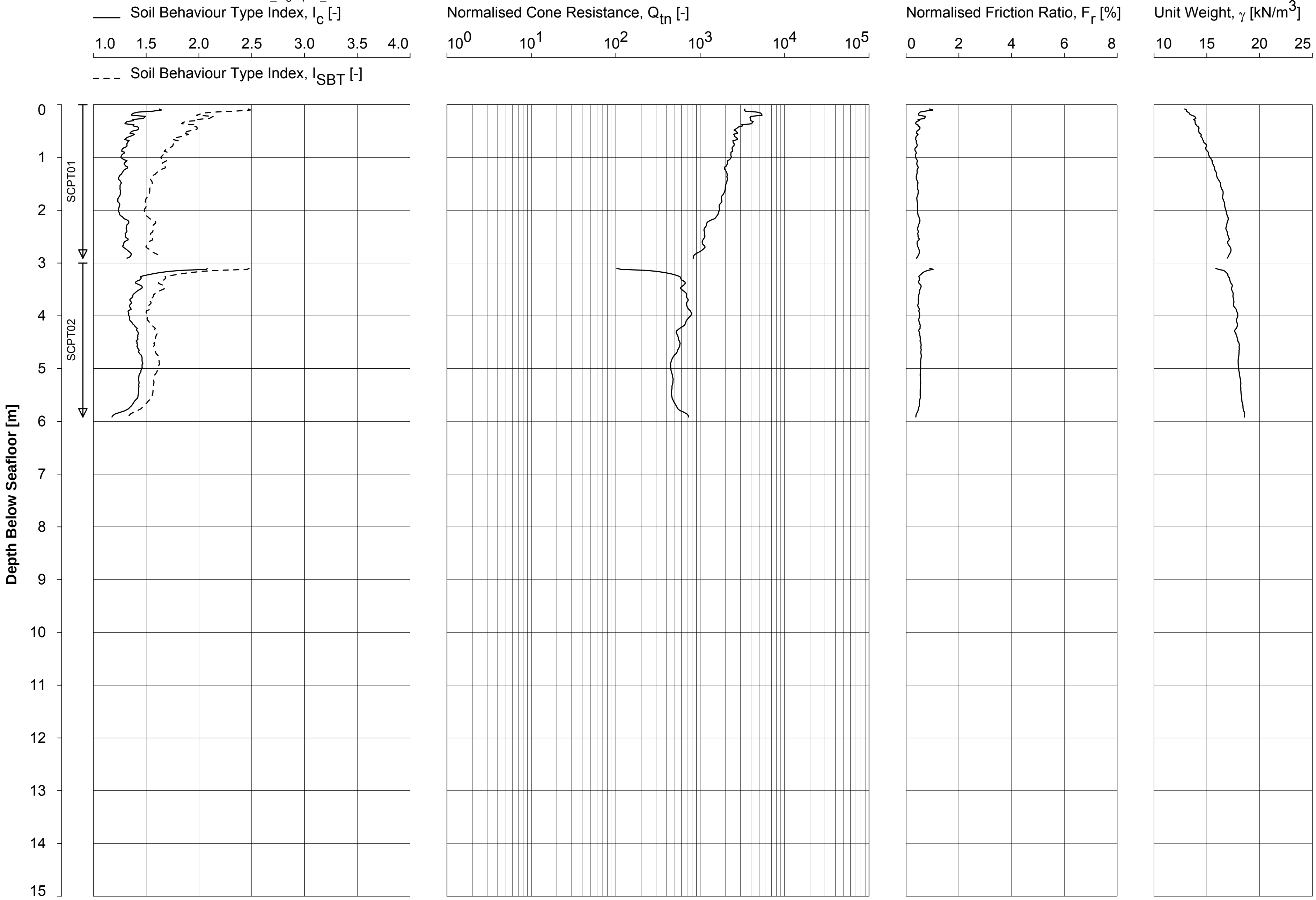

Date of Testing : 10-Jul-2016
Water Depth [m LAT] : 22.6
Coordinates [m] : E 564279 N 5801684

Probe Type : CP10-CF50PB10SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison QaQc zero load - landscape.cmd / 2016-08-19 16:02:46

CONE PENETRATION TEST - ZERO DRIFT

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH06-SC	SCPT01	0.093	0.002	-0.028	0.010	0.000	0.000	CP10-CF50PB10SN2	1706-2366	0.750
HKZ1-BH06-SC	SCPT02	0.084	0.004	-0.028	0.022	-0.001	0.000	CP10-CF50PB10SN2	1706-2366	0.750

Key:

q_c : cone resistance

f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test. Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

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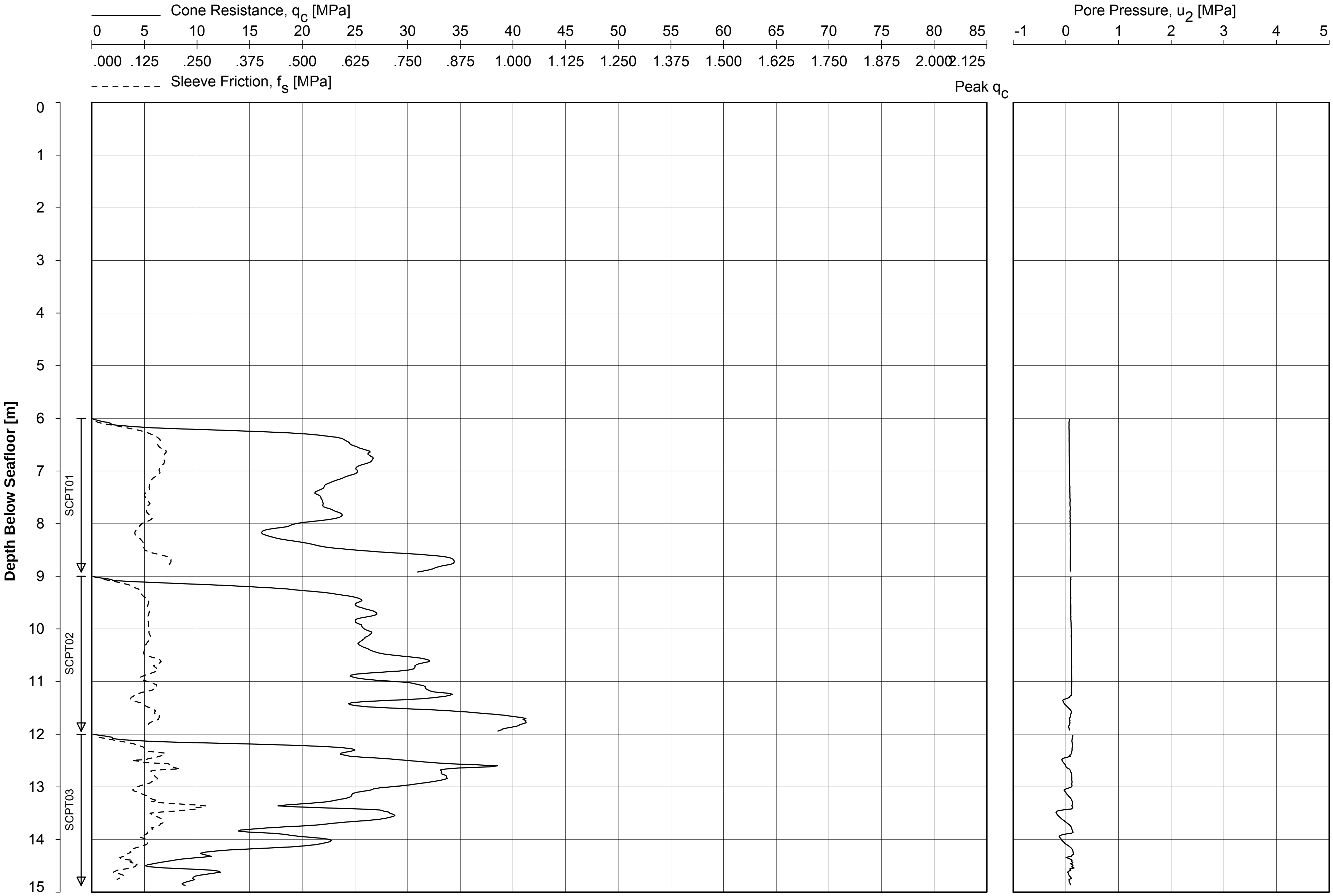

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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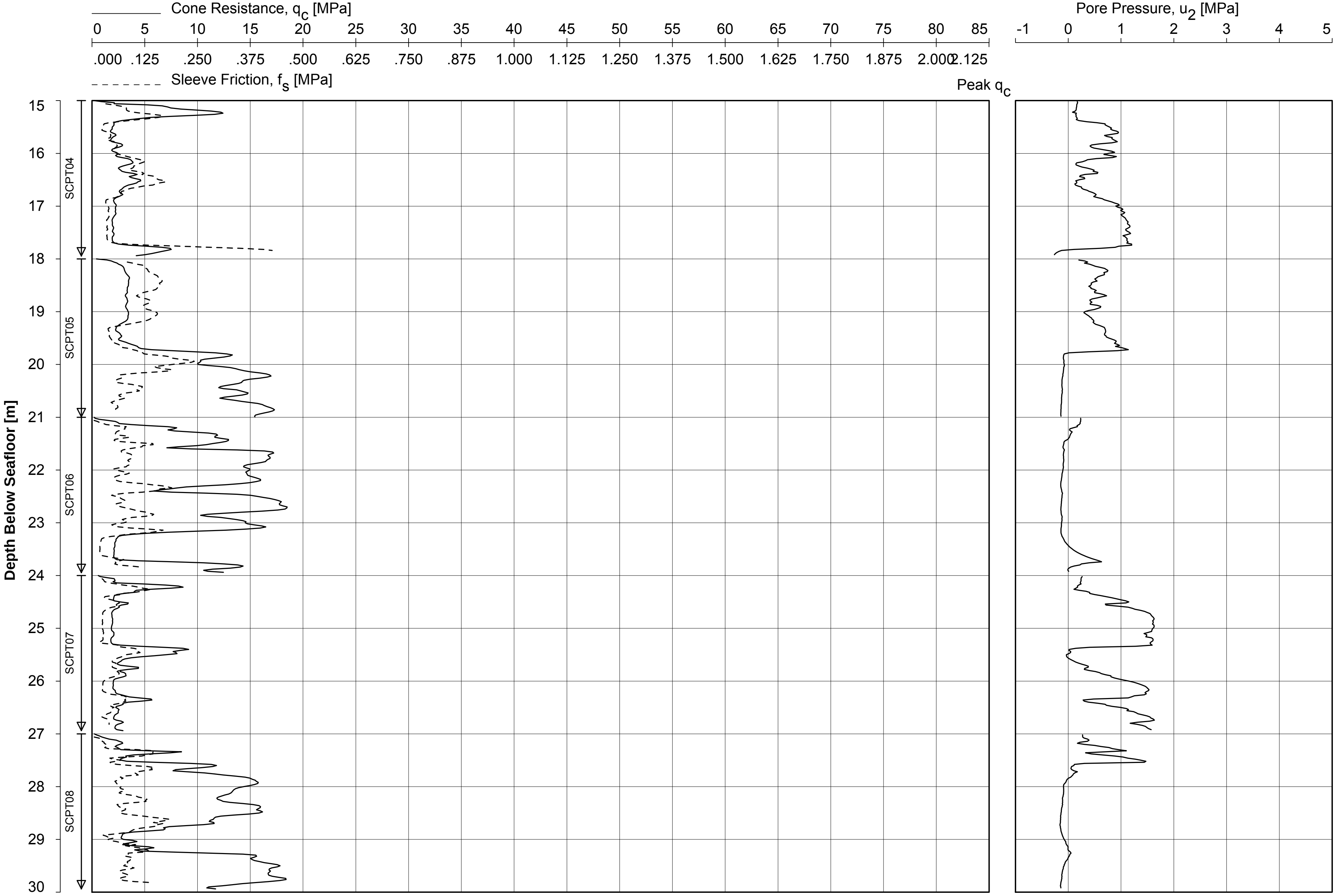


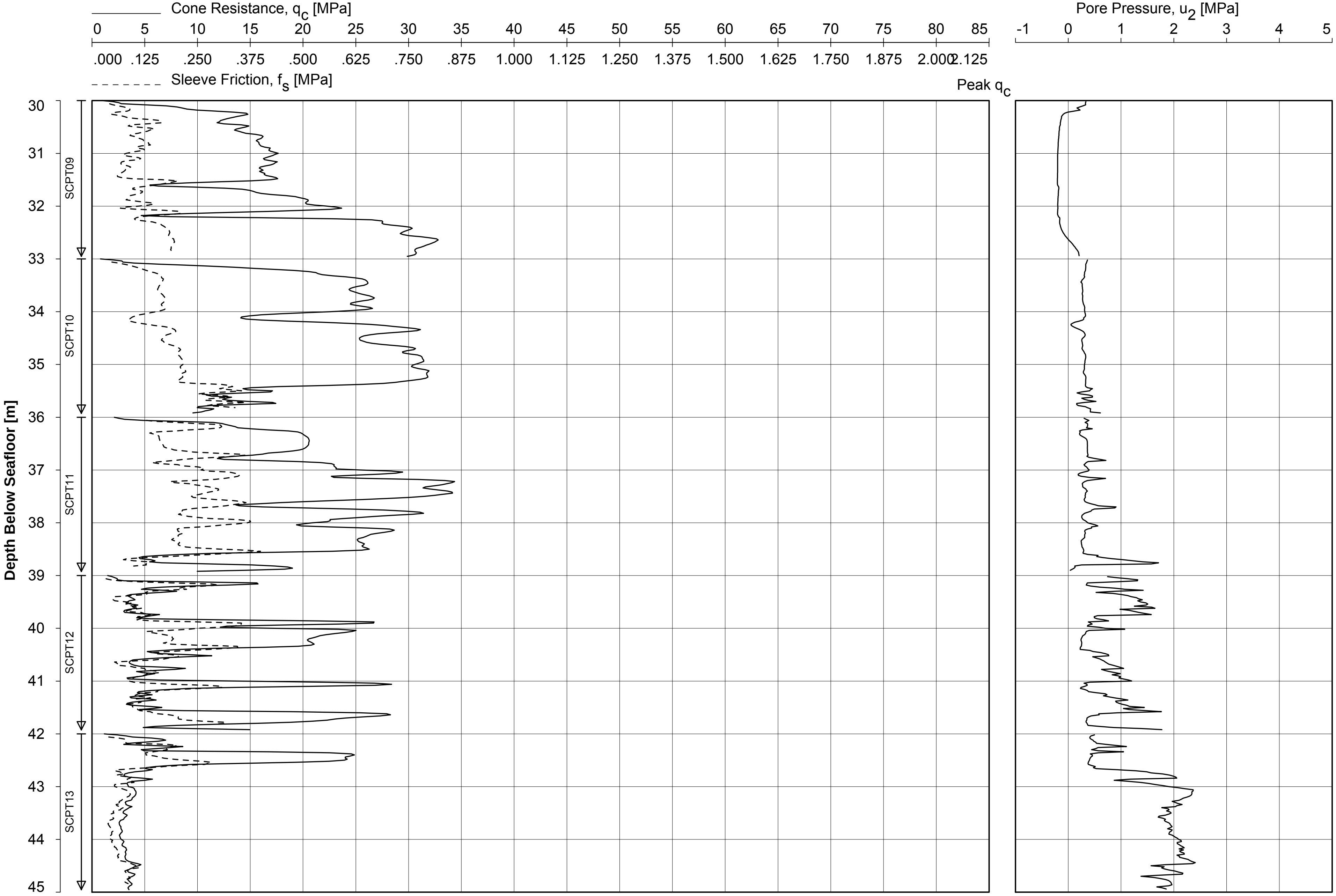
Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison qc 5MPa_WD.cmd / 2016-08-19 16:03:25



Date Of Testing	: 16-Jul-2016	
Water Depth [m LAT]	: 22.5	
Coordinates [m]	: E 564274	N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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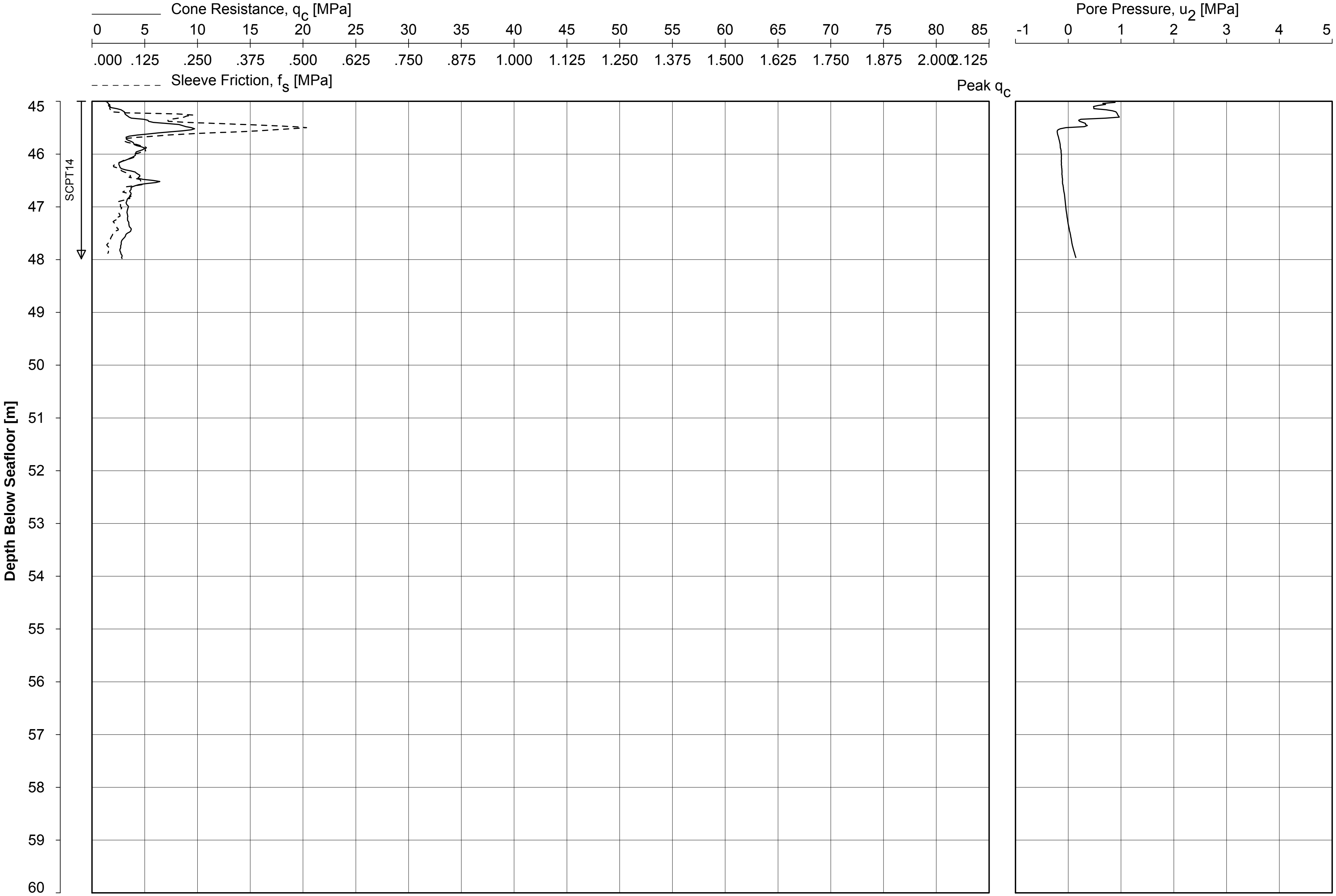

Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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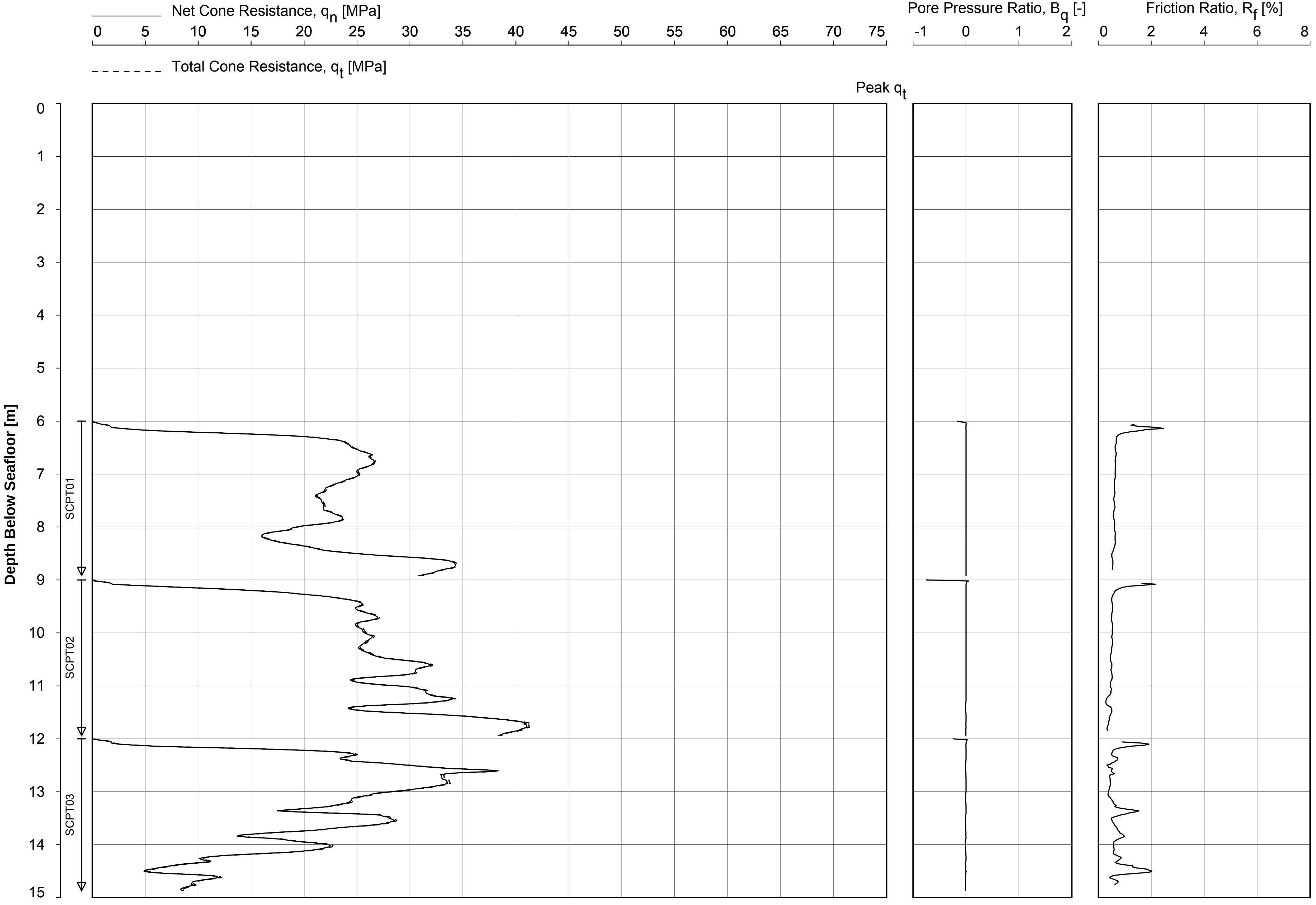
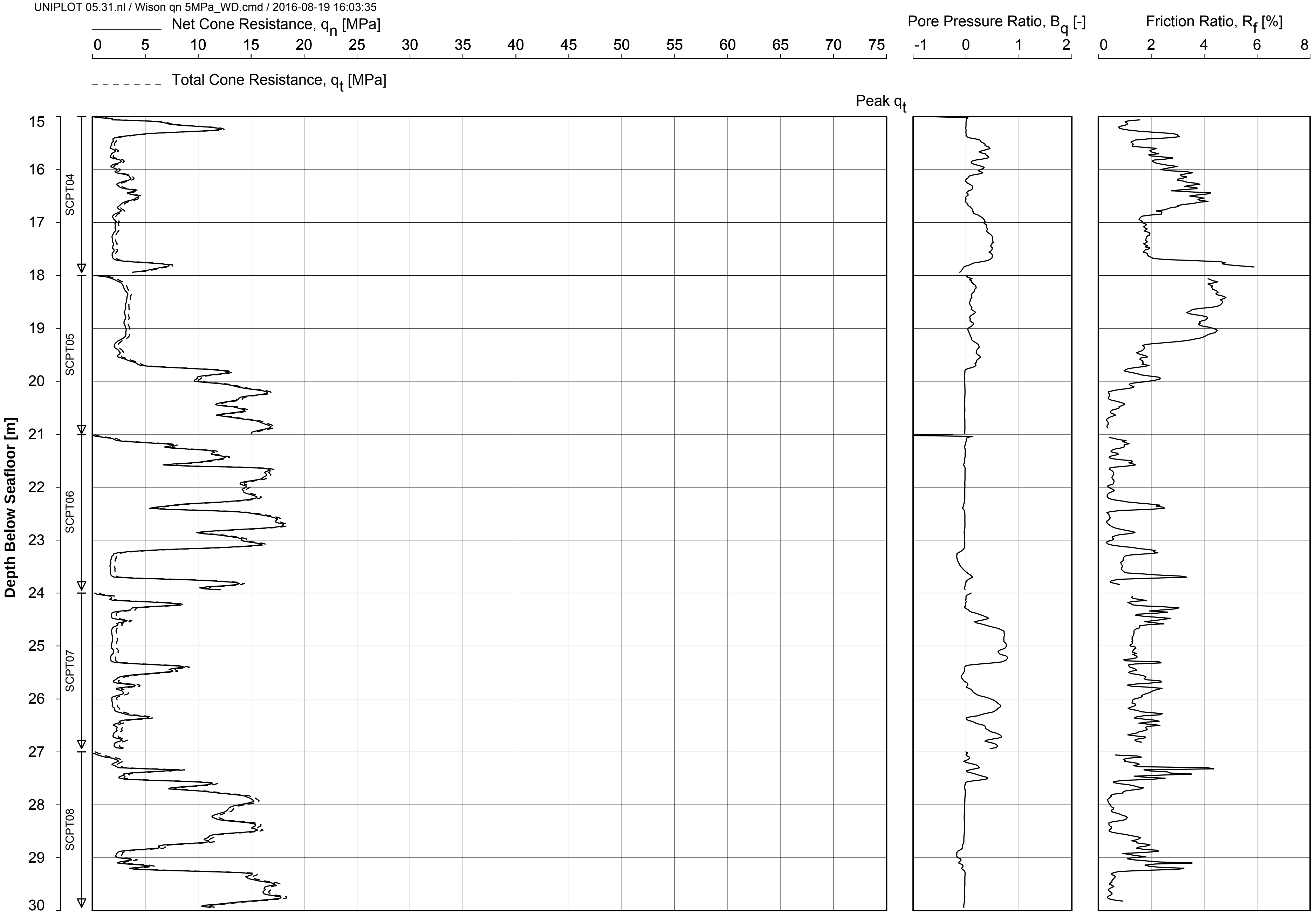


Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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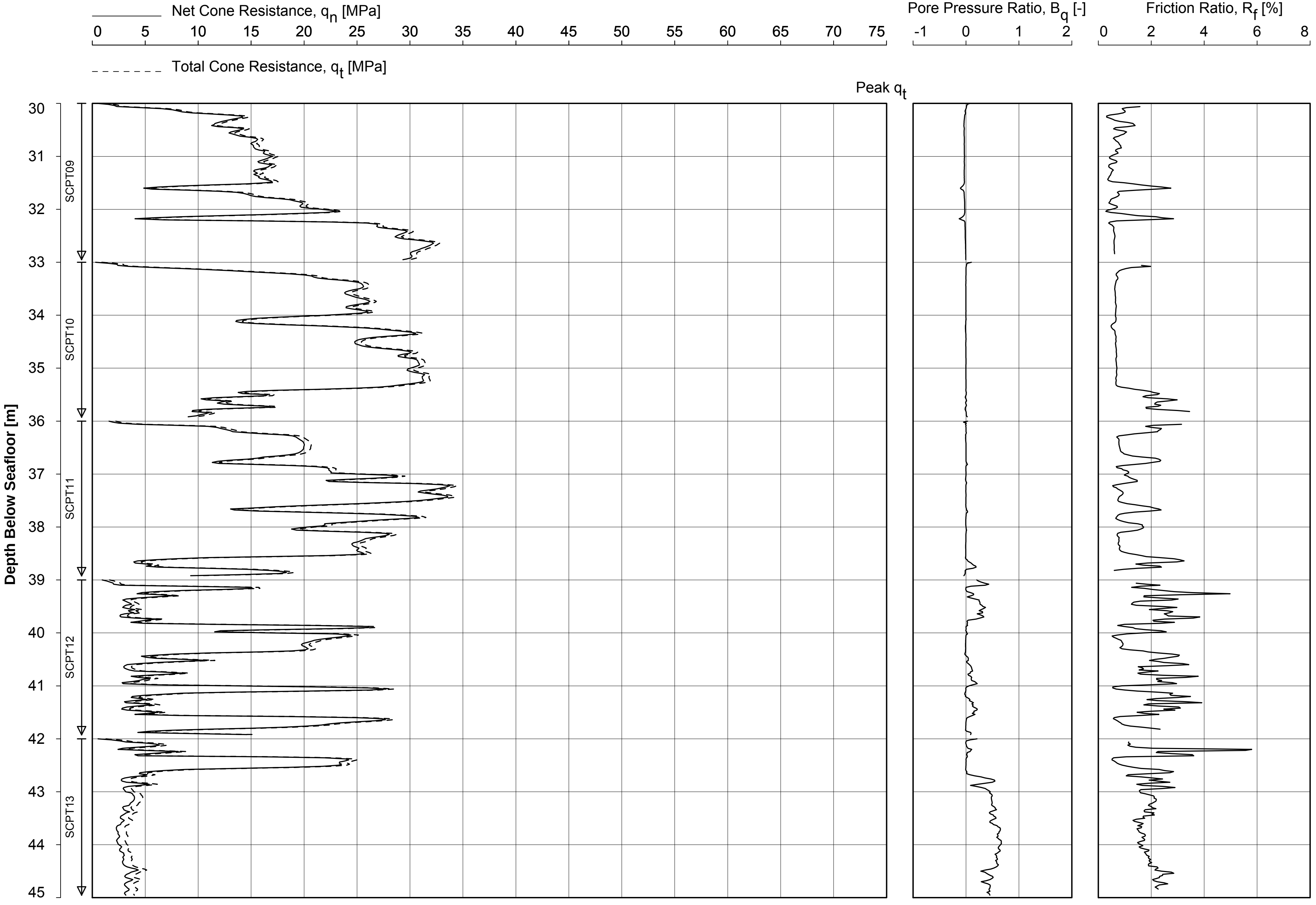
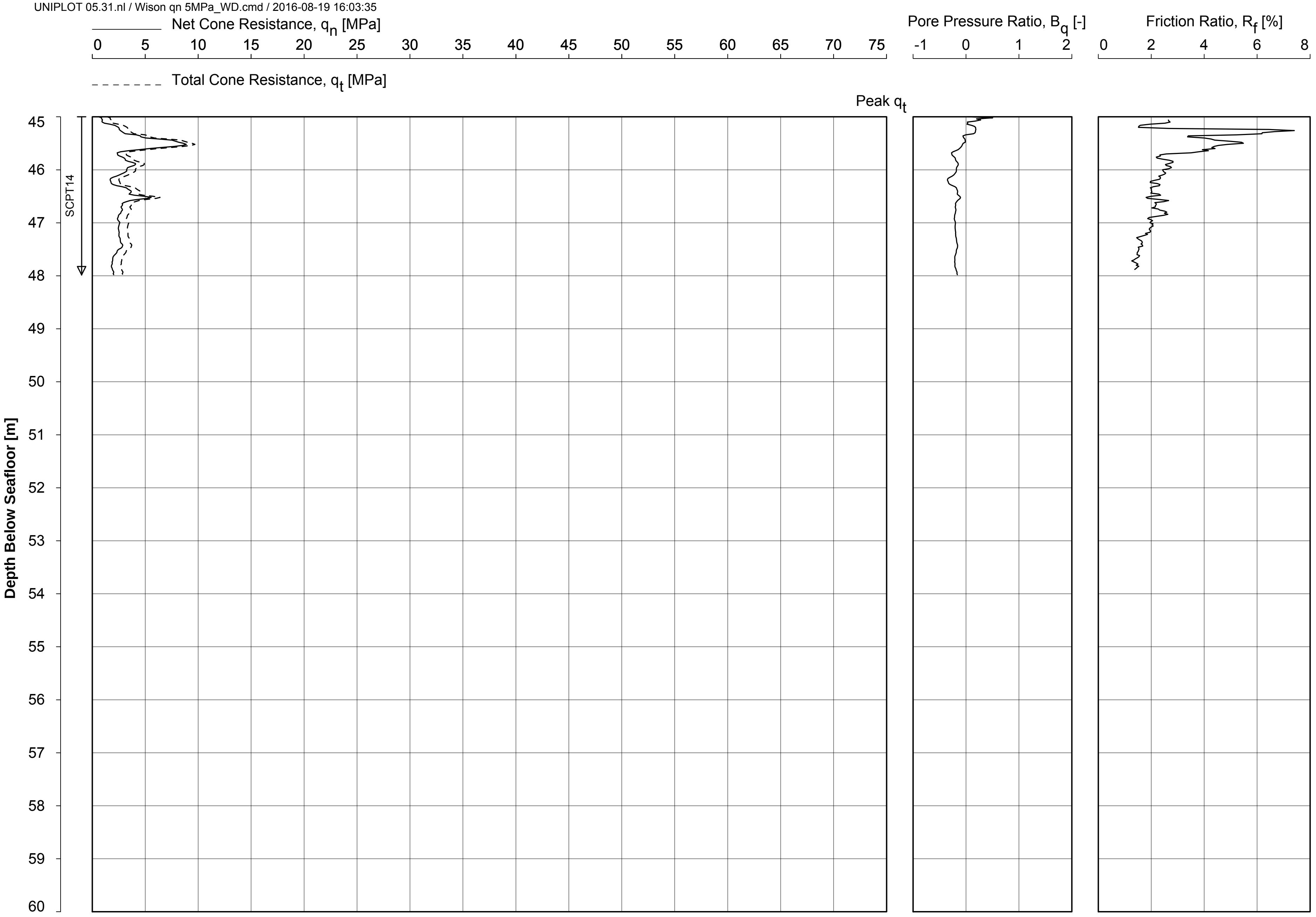


Date Of Testing	:	16-Jul-2016
Water Depth [m LAT]	:	22.5
Coordinates [m]	:	E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

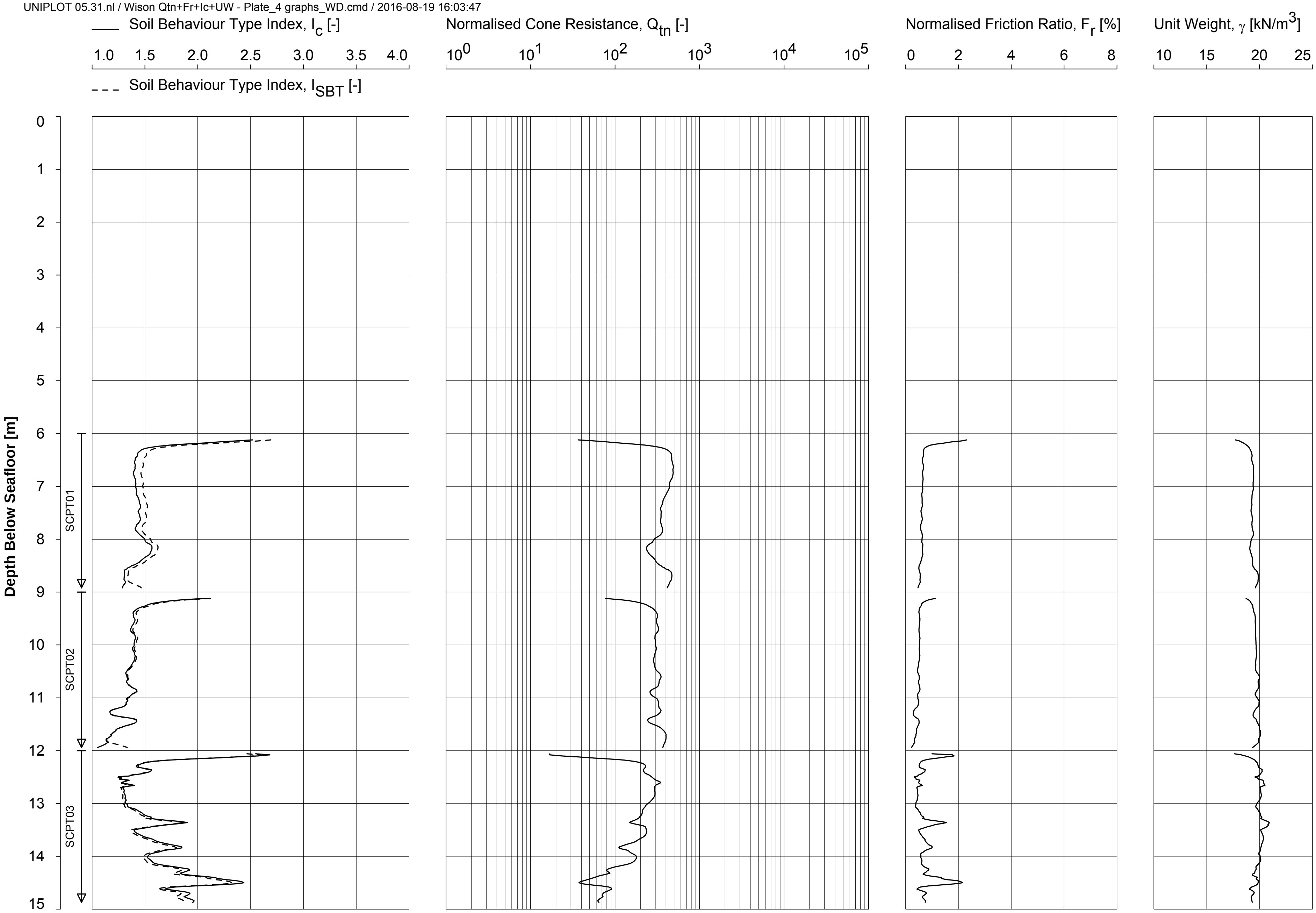


Date Of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



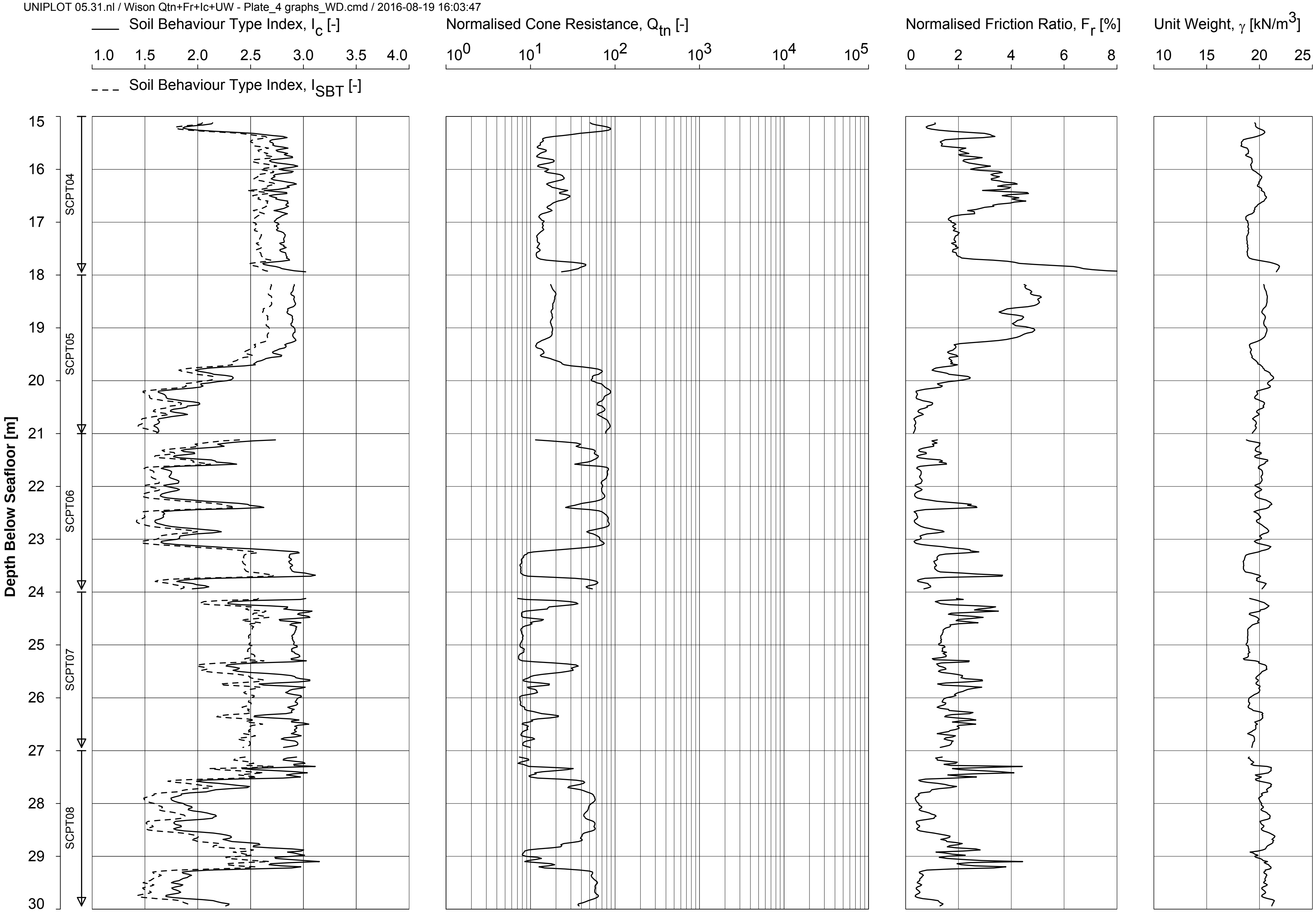
Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA



Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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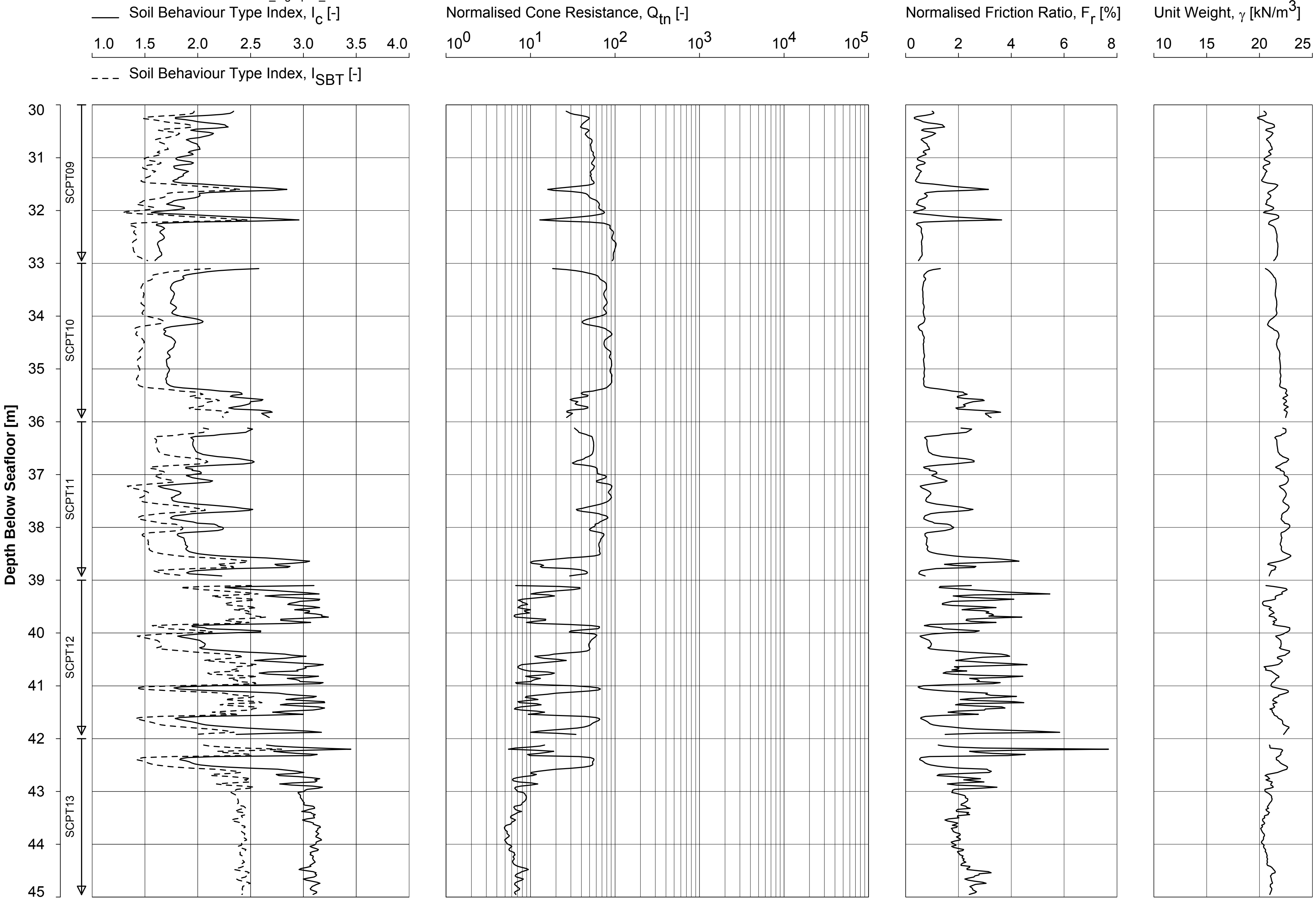

Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

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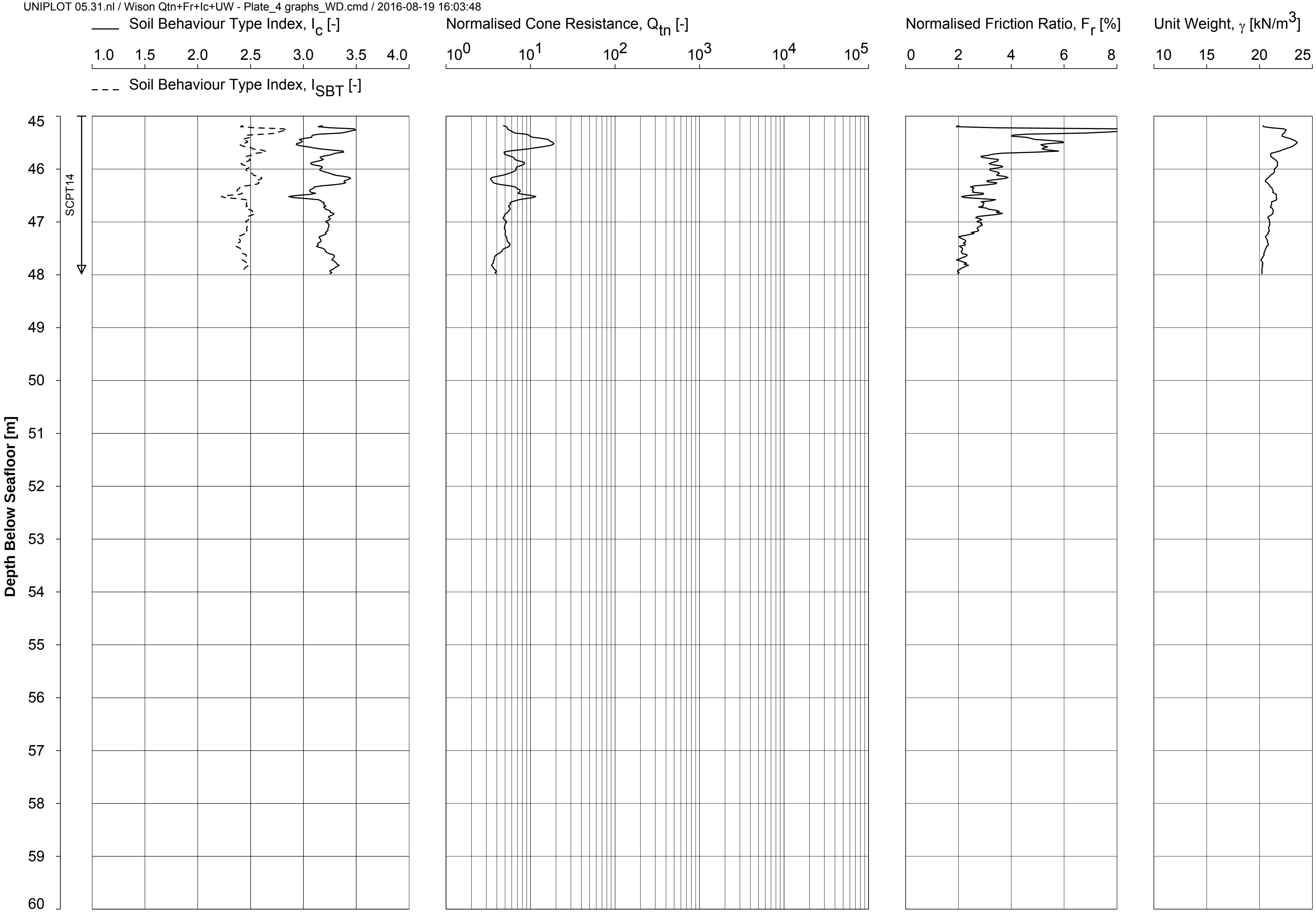


Date of Testing : 16-Jul-2016
Water Depth [m LAT] : 22.5
Coordinates [m] : E 564274 N 5801683

Probe Type : CP10-CF50PB20SN2
Cone Base Area [mm^2] : 1007
Ground Water [kN/m^3] : 10.0

CONE PENETRATION TEST

HKZ1-BH06A-SC

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

UNIPLOT 05.31.nl / Wison QaQc zero load - landscape.cmd / 2016-08-19 16:03:57

CONE PENETRATION TEST - ZERO DRIFT

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Borehole/ Location	Test No.	Zero Reading at Start of Test			Zero Drift			Probe		Net Area Ratio
		q_c [MPa]	f_s [MPa]	u [MPa]	q_c [MPa]	f_s [MPa]	u [MPa]			a [-]
HKZ1-BH06A-SC	SCPT01	0.083	0.002	-0.020	0.008	-0.001	0.005	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT02	0.073	0.001	-0.020	0.007	-0.001	0.003	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT03	0.076	0.001	-0.016	0.014	-0.001	-0.001	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT04	0.070	0.001	-0.018	0.012	0.000	-0.008	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT05	0.079	0.001	-0.018	0.007	-0.002	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT06	0.070	0.000	-0.025	---	---	---	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT07	0.075	0.001	-0.020	0.032	0.001	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT08	---	---	---	---	---	---	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT09	0.076	0.001	-0.018	0.008	0.000	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT10	0.073	0.001	-0.019	0.008	0.000	0.008	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT11	0.075	0.001	-0.019	0.023	-0.001	0.002	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT12	0.079	0.001	-0.023	0.002	0.001	0.010	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT13	0.077	0.001	-0.019	0.021	-0.001	0.000	CP10-CF50PB20SN2	1706-1888	0.750
HKZ1-BH06A-SC	SCPT14	0.077	0.001	-0.020	-0.011	0.000	0.004	CP10-CF50PB20SN2	1706-1888	0.750

Key:

q_c : cone resistance

f_s : sleeve friction

u : pore water pressure

Note:

1. Zero Drift is the difference between the zero output at the start of the test and the zero output at the end of the test. Offshore tests may show Reference Readings. The Zero Reading or Reference Reading at Start of Test is a value presented in units of measurement result. The value itself is a conversion from system output, usually in mV or in bits. It has no explicit physical meaning.
2. --- : Zero Drift was not monitored. The drift can be assessed from the start values of successive tests.

SECTION B2: SEISMIC CONE PENETRATION TESTS

TEXT – SECTION B2: Page

B2. SEISMIC CONE PENETRATION TESTS

LIST OF PLATES IN SECTION B2: Plate

HKZ1-BH01-SC

HKZ1-BH03-SC

HKZ1-BH06-SC

HKZ1-BH06A-SC

B2. SEISMIC CONE PENETRATION TESTS

B2.1 COMMENTS ON RESULTS

Seismic cone penetration tests (SCPT) were performed in downhole mode. Seismic cones include geophones in addition to the standard sensor set of a 1000 mm^2 (CP10) cone. Arrival of shear waves is recorded using two sets of geophone arrays (dual geophone). The upper array (x_1-y_1 geophones) and the lower array (x_2-y_2 geophones) are 500 mm apart, with the lower positioned 238 mm above the cone tip.

Seismic data was stacked and filtered to improve the signal-to-noise ratio. A band pass filter of 10 Hz to 100 Hz was applied to all tests. Shear wave velocities were interpreted from travel times of seismic waves in the 0.5 m interval between the geophone arrays using a cross correlation technique. These interpreted shear wave velocities were subsequently compared to shear wave velocities calculated from CPT data in accordance with Robertson and Cabal (2010). Measured and CPT derived values are generally in line with each other.

Sea water wave interference effects can prevent accurate interpretation of test results obtained close to seafloor, i.e. typical in the depth range from 0 m to 5 m below seafloor (BSF). Further, seismic velocities for the upper few metres below seafloor may show influence from the seabed frame used to support geotechnical drilling, sampling and testing. Therefore interpretation of seismic test data in the first 5 m BSF should be done with caution.

Signal interference may also result from shear wave refraction and reflection. For example, refraction can occur along an interface between a low-velocity upper layer and a high-velocity lower layer. Signal interference for this data set appears limited and cannot be excluded. Refer to document titled “Cone Penetration Test Interpretation” and “Seismic Downhole Test” presented in Appendix 1 for further details.

On the plates titled “Recorded Shear Wave Traces versus Depth” the recorded X -component traces are shown in red colour and the Y-component traces are shown in blue colour.

B2.2 PRACTICE FOR SEISMIC CONE PENETRATION TEST

CPT Practice	Refer to sub-section titled “Practice for Cone Penetration Test” presented in report Section B1

SCPT Stage Control

General Procedure:	– Refer to document titled “Seismic Downhole Test” presented in Appendix 1 – According to ISO (2014)
Target Accuracy:	Average shear wave velocity of ± 10 %, for a straight-line slant distance from source to receiver and assumed zero depth uncertainty
Test Method:	Average shear wave velocity (in between the two receivers)
Set-up Stage:	Location as directed by Client
Test Stage:	– SCPT at selected depths, typically at ~2 or ~3 m depth below bottom of borehole – On-site monitoring of seismic trace quality
Test Stage Termination:	Refer to document titled “Seismic Downhole Test” presented in Appendix 1
Test Sequence Termination:	Whichever occurs first: – according to document titled “Seismic Downhole Test” presented in Appendix 1 – according to sub-section titled “Practice for Cone Penetration Test” presented in report Section B1 – as instructed by Client

SCPT Apparatus

Seismic Cone Penetrometer Type:	– Seismic cone penetrometers based on a CP10 lead cone with dual seismic probe – Dual array with 3 geophone seismic receivers with natural frequency of 28 Hz, in lower and upper array for every dimension, 6 receivers in total – 500 mm fixed distance between both arrays – X and Y axes represent the orientation of two horizontal perpendicular geophones
Seismic Source:	– Hydraulic Underwater Shearwave Hammer (HUSH) box, consisting of a spring-driven steel mass hammered to a steel striking plate, mounted on the seabed frame – Mass and spring horizontally mounted, giving single near-horizontal strike direction, tangential relative to axis of borehole
Seismic Source Offset:	0.75 m radial offset
Striking Plate:	Steel beam with vertical fins to improve beam/soil contact
Time Break Unit:	HUSH-box mounted piezo-trigger
Seismic Recorder:	SECAS, PC-based 6 channel seismograph with digital storage facilities

Test Results

Data Processing and Management:	– Refer to document titled “Seismic Downhole Test” and "Cone Penetration Test Interpretation" presented in Appendix 1 – SC3-RAV software for seismic data processing – UNIPLOT software for CPT-based prediction of shear wave velocity – Graphical scales selected to suit general presentation of data and requirements of standards, where practicable – No display of data outside of chart limits, i.e. some values may not be shown

Data Format(s):	– PDF for viewing and printing (this primary document) – Excel digital tabular data (separate deliverables, secondary to the final issue of this document)
Seismic Frequency Filter(s):	Band pass filter of 10 Hz to 100 Hz
Shear Wave Velocity – Measured:	– Calculation from records with adjoining depth increments – Assumed travel path takes account of seismic source offset and is straight line from source to receiver
Shear Wave Velocity – CPT-based Correlation:	According to Robertson and Cabal (2010), refer to document titled "Cone Penetration Test Interpretation" presented in Appendix 1
Pressure Wave Velocity:	Not considered
Low-Strain Shear Modulus – Inferred:	Not applicable
Low-Strain Shear Modulus – CPT-based Correlation:	Not applicable
Parameter Values for Data Processing:	Refer to plate(s) titled “Cone Penetration Test; I_c, I_{SBT}, Q_{tn}, F_r and γ”

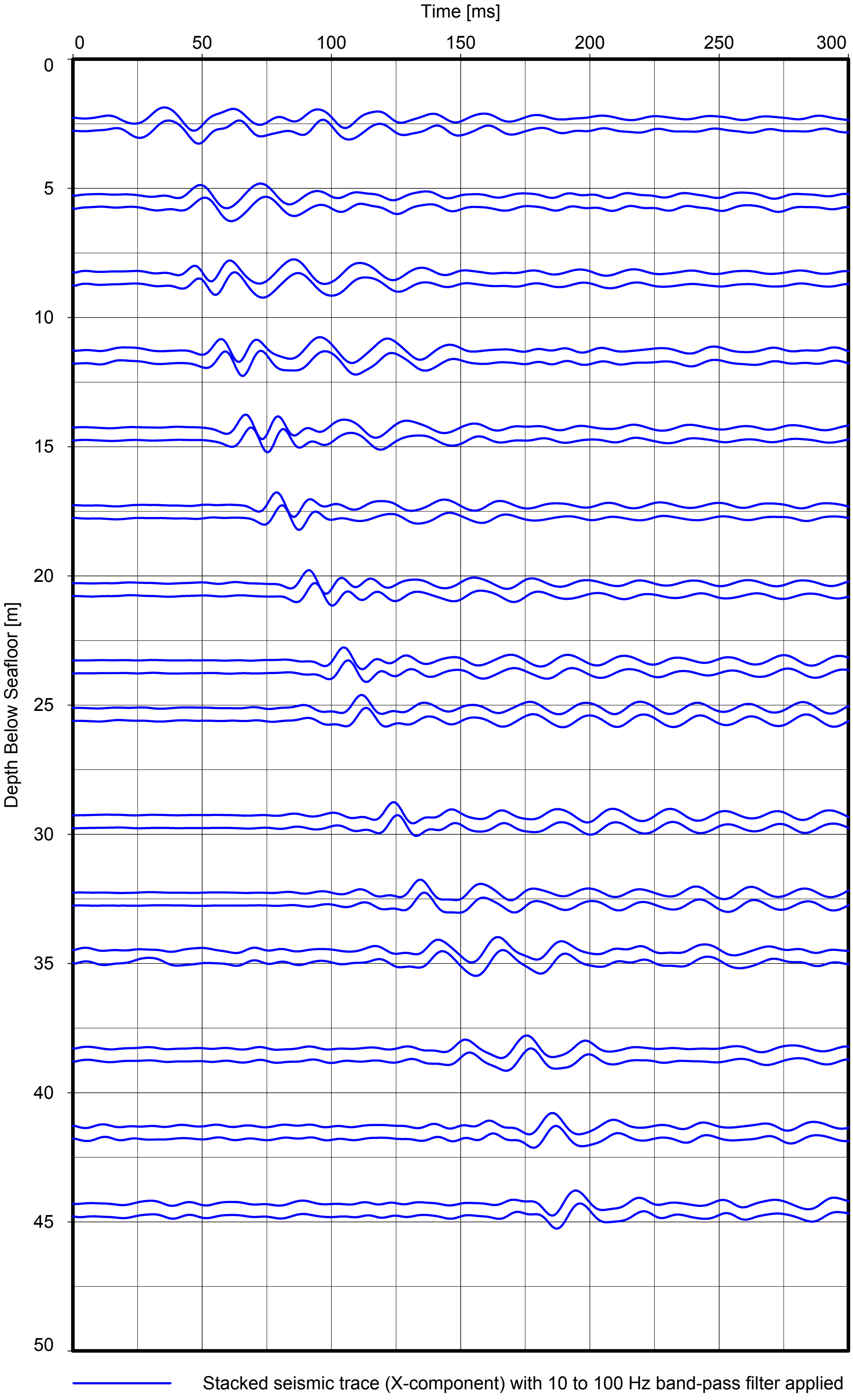
B2.3 REFERENCES

Computer Program *SC3-RAV*, Processing of Seismic Downhole Data.

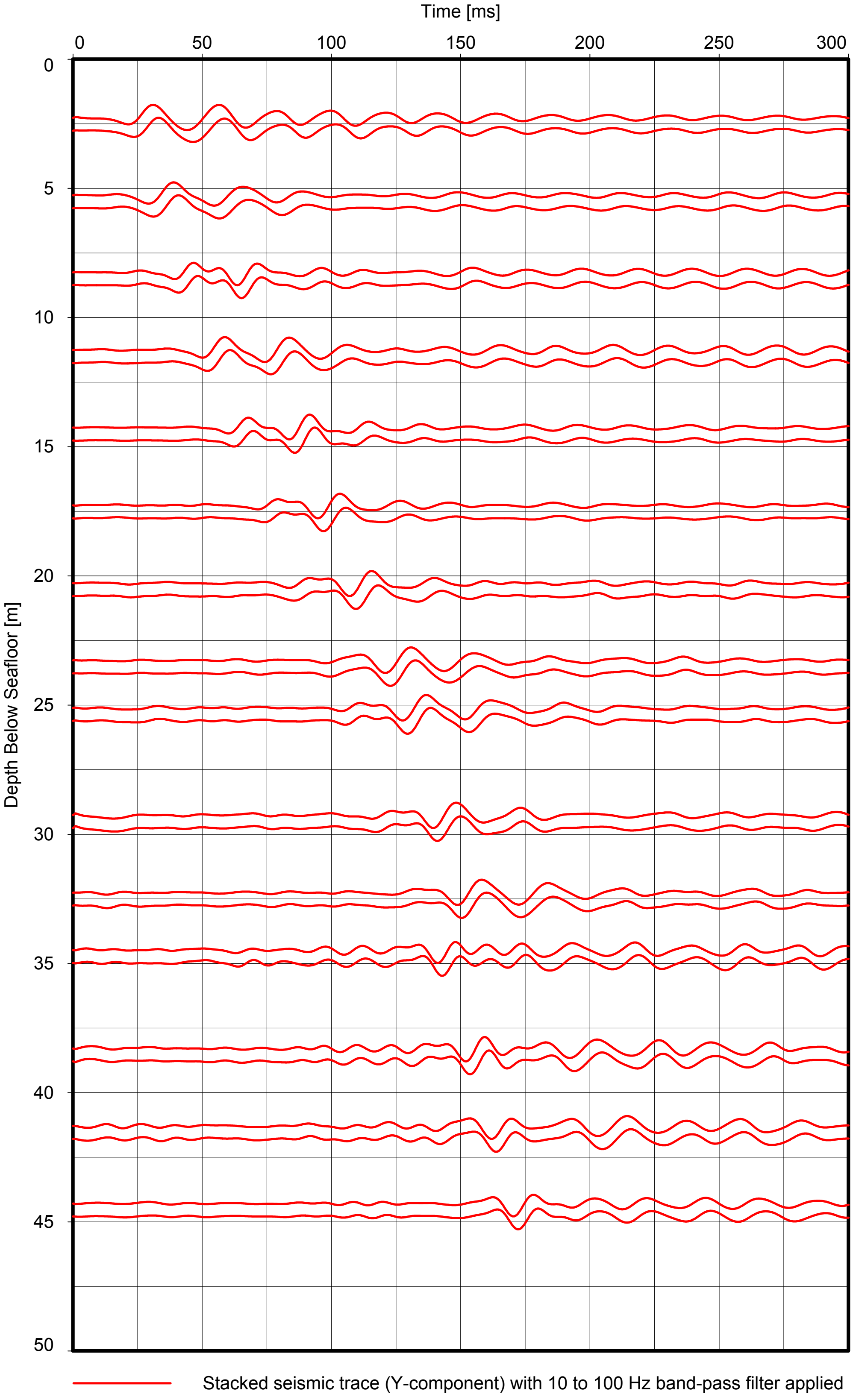
Computer Program *UNIPLOT*, Processing of CPT data.

International Organization for Standardization, 2014. *ISO 19901-8:2014 Petroleum and Natural Gas Industries - Specific Requirements for Offshore Structures – Part 8: Marine Soil Investigations.* Geneva: ISO.

Robertson, P.K. and Cabal, K.L., 2010. *Guide to Cone Penetration Testing for Geotechnical Engineering*, 4th ed., Signal Hill: Gregg Drilling & Testing, Inc.

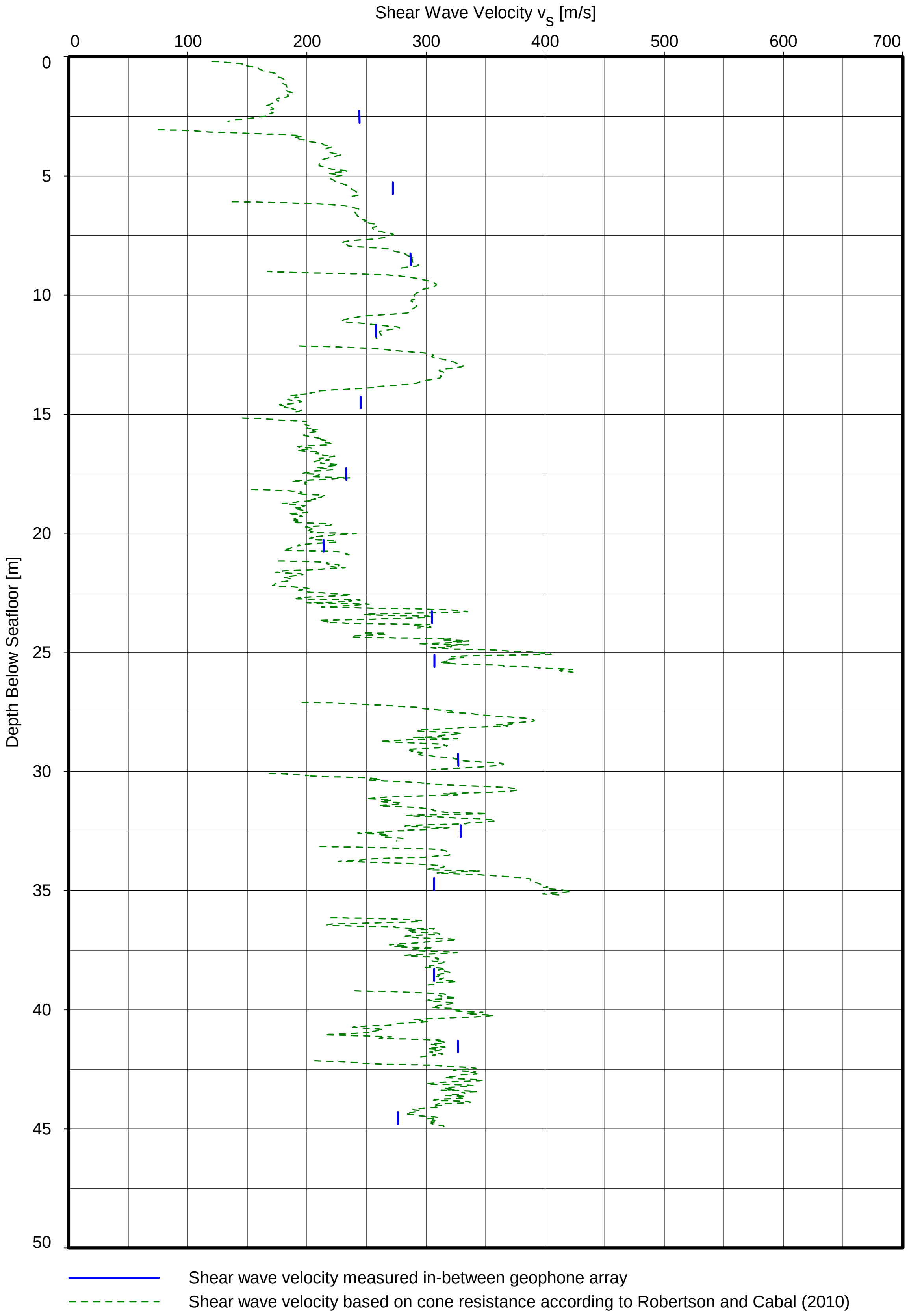


RECORDED SHEAR WAVE TRACES VERSUS DEPTH (X-COMPONENT)
LOCATION HKZ1-BH01-SC



RECORDED SHEAR WAVE TRACES VERSUS DEPTH (Y-COMPONENT)
LOCATION HKZ1-BH01-SC

PPPWIN 03.26.nl/HKZ1-BH01-SC_Y_traces.ppp/2016-07-17 04:25:13



SHEAR WAVE VELOCITY VERSUS DEPTH

LOCATION HKZ1-BH01-SC

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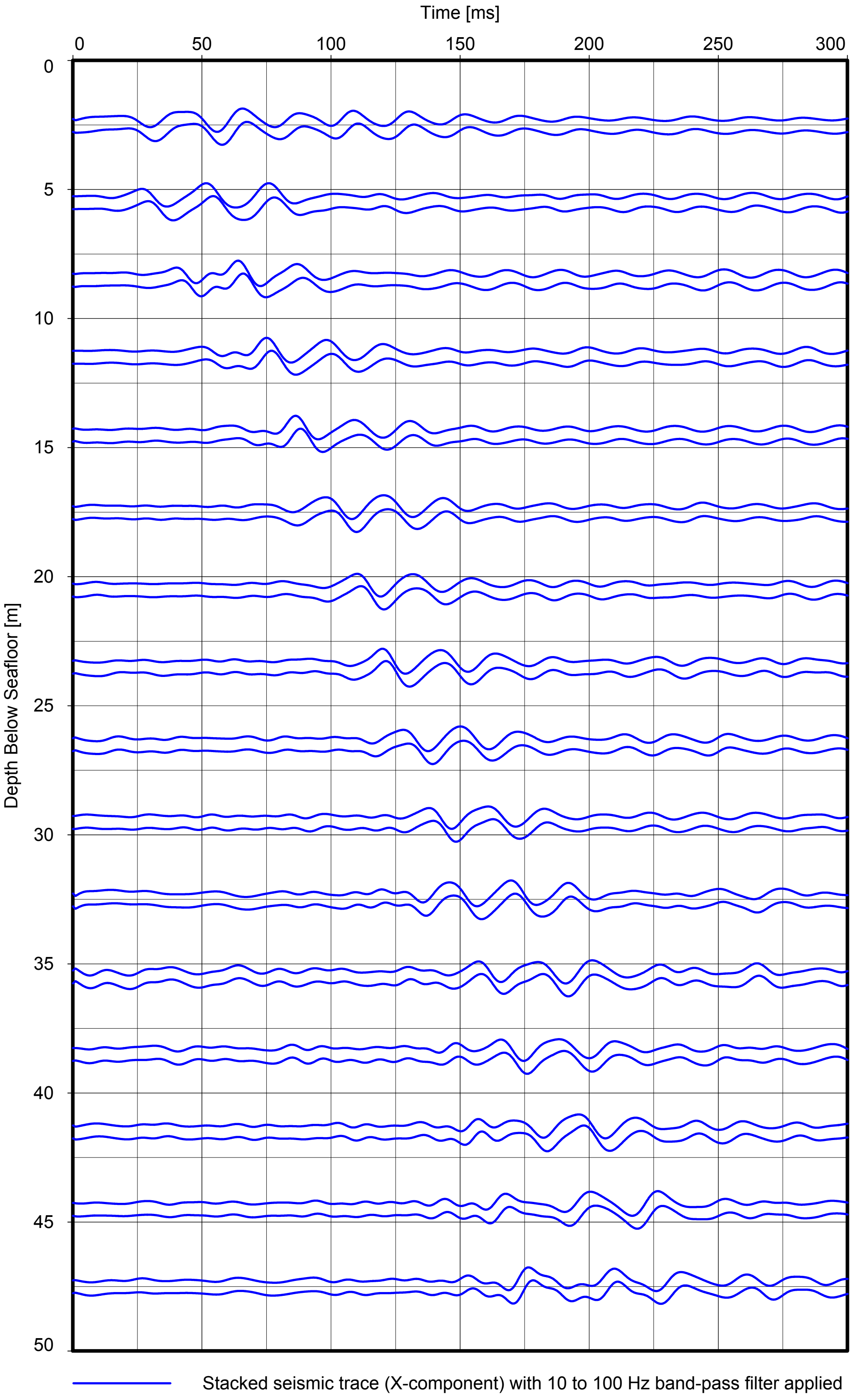

RECORDED SHEAR WAVE TRACES VERSUS DEPTH (X-COMPONENT)

LOCATION HKZ1-BH03-SC

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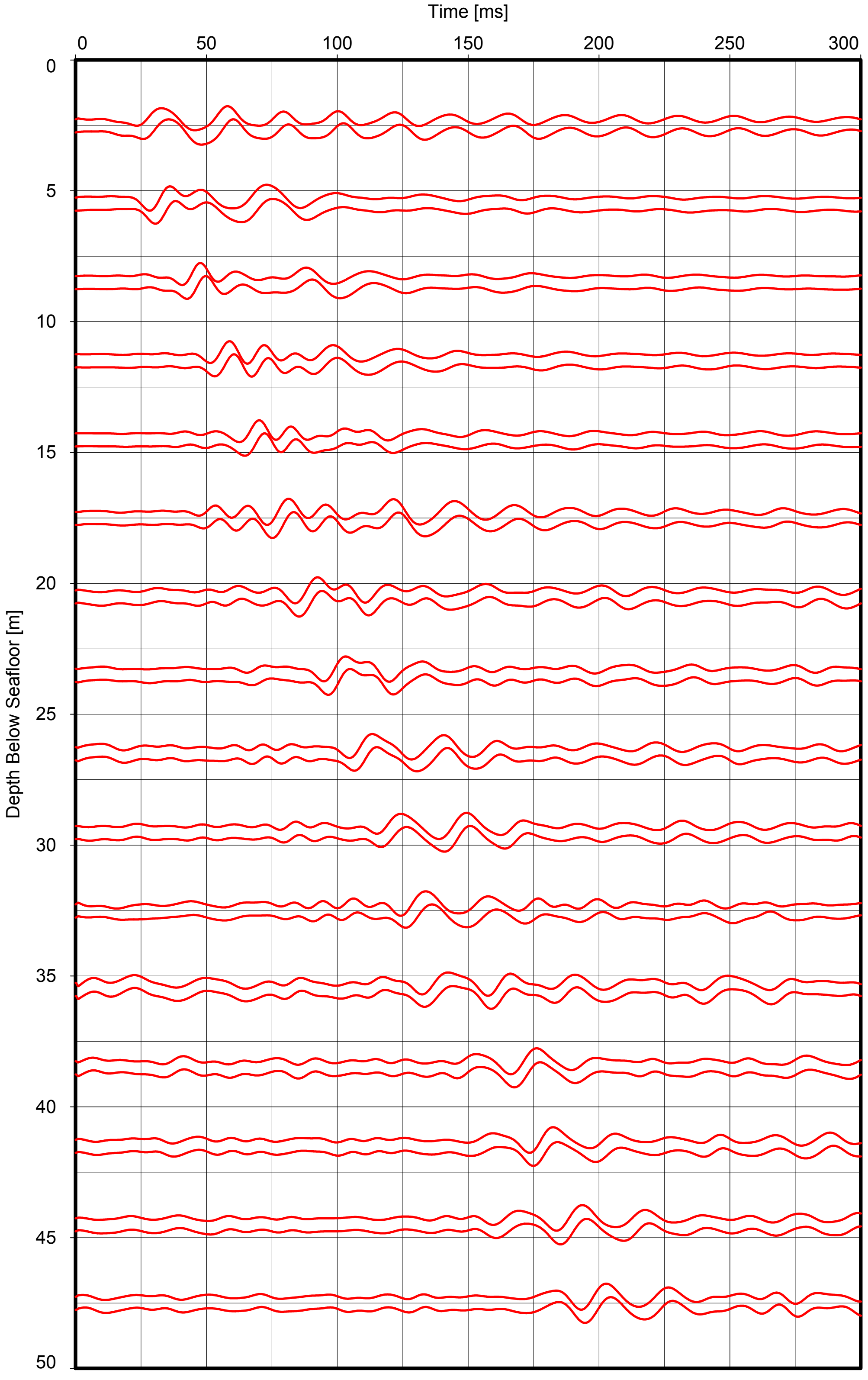
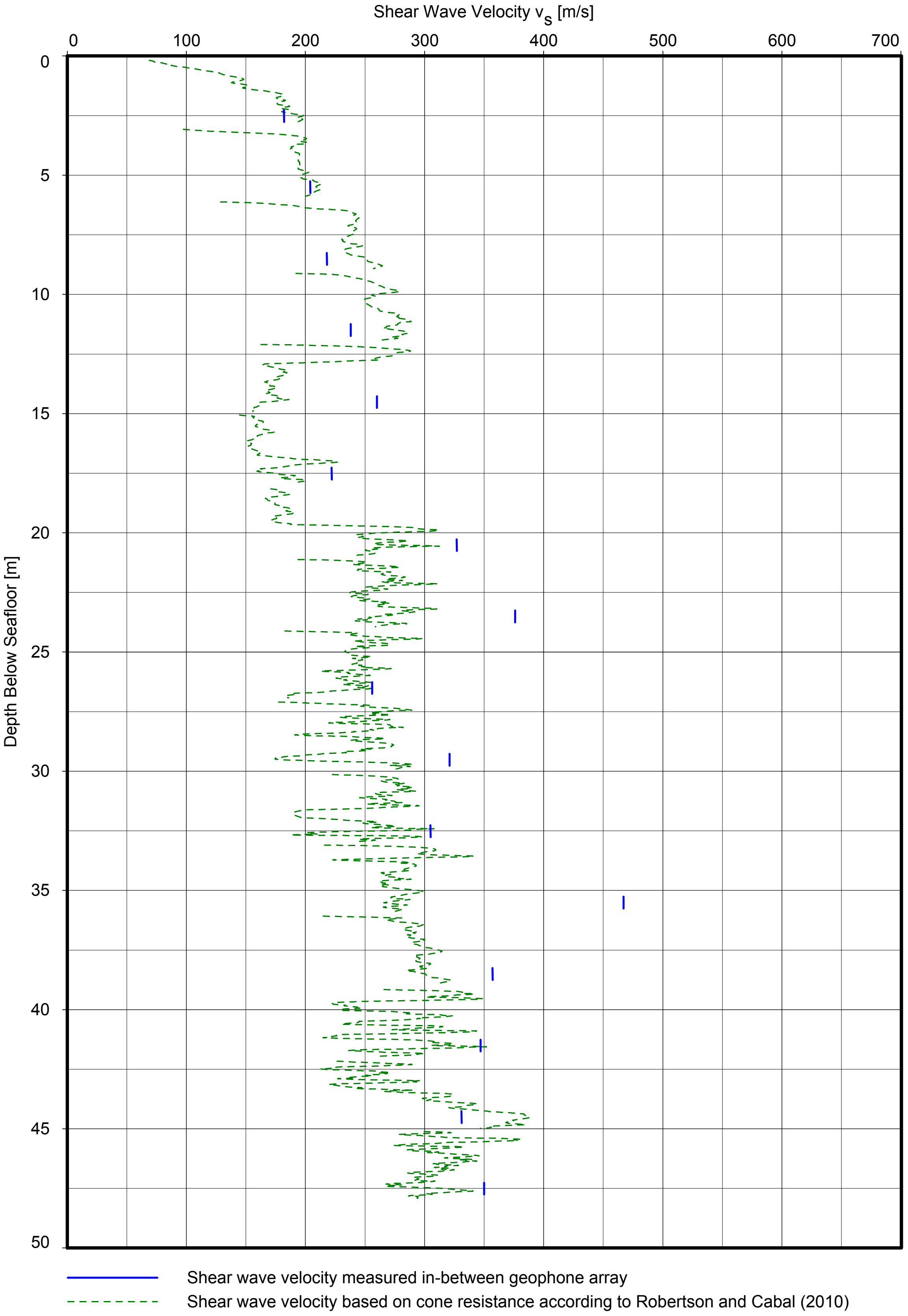


Stacked seismic trace (Y-component) with 10 to 100 Hz band-pass filter applied

RECORDED SHEAR WAVE TRACES VERSUS DEPTH (Y-COMPONENT)

LOCATION HKZ1-BH03-SC



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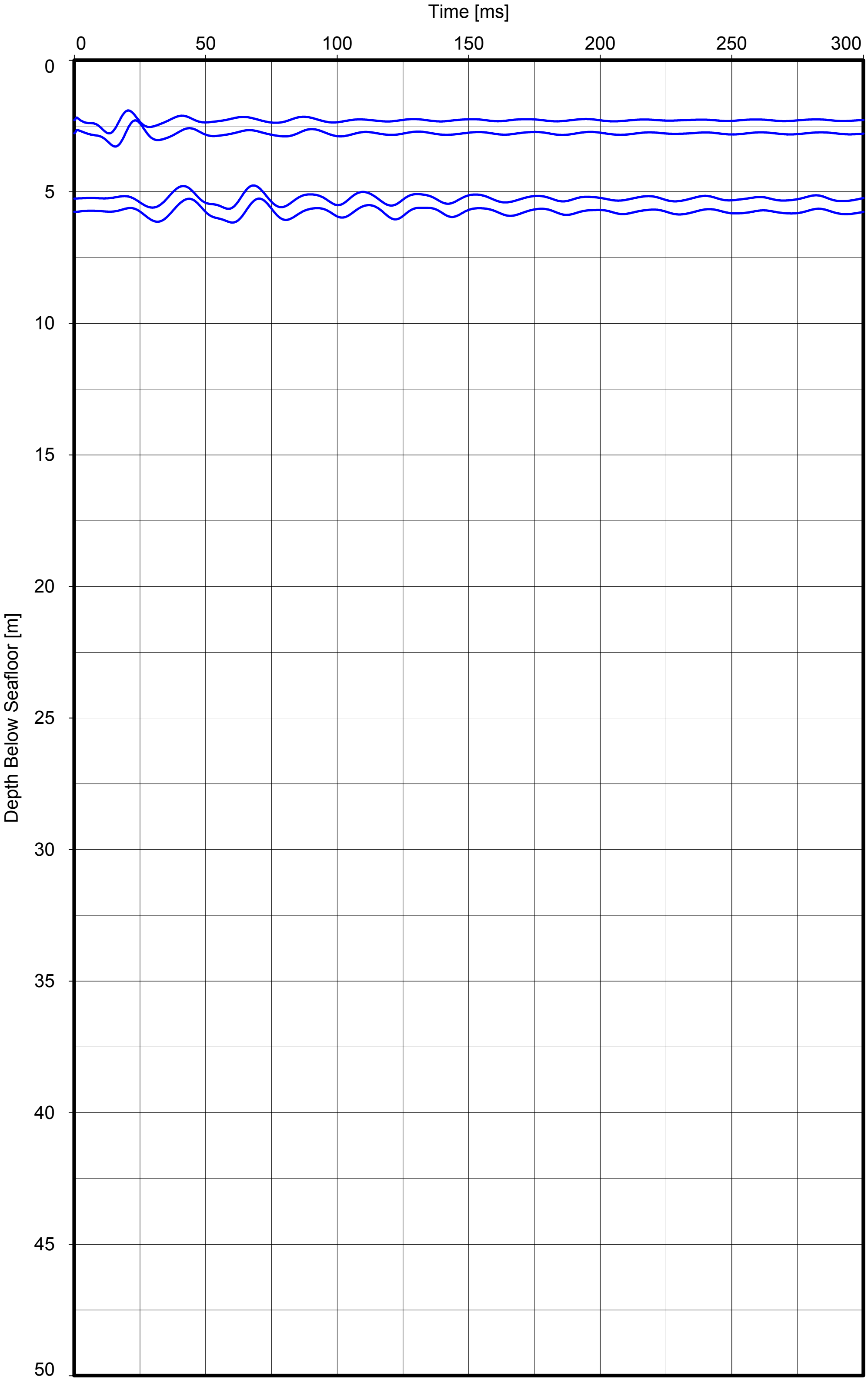

Stacked seismic trace (X-component) with 10 to 100 Hz band-pass filter applied

RECORDED SHEAR WAVE TRACES VERSUS DEPTH (X-COMPONENT)

LOCATION HKZ1-BH06-SC

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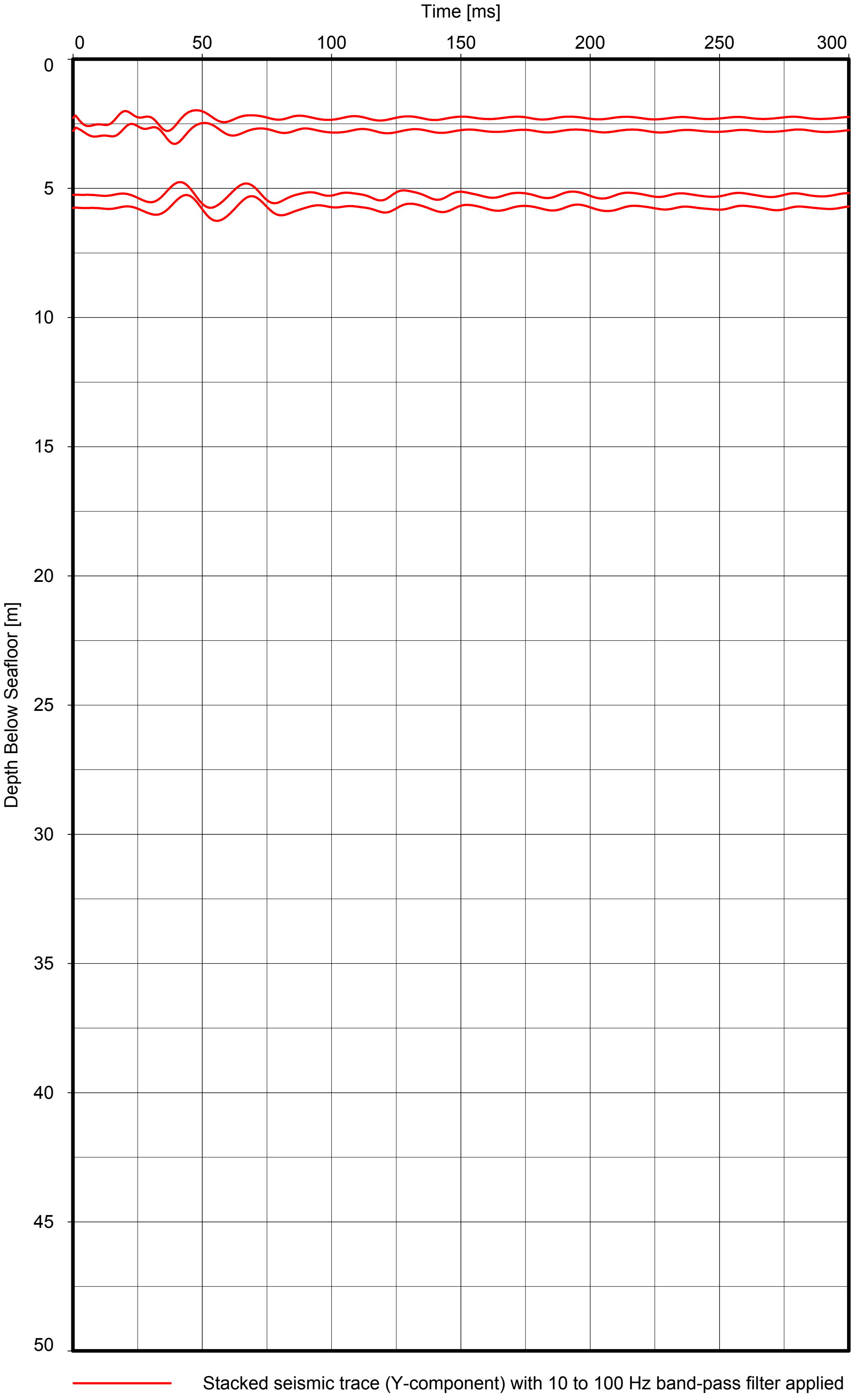

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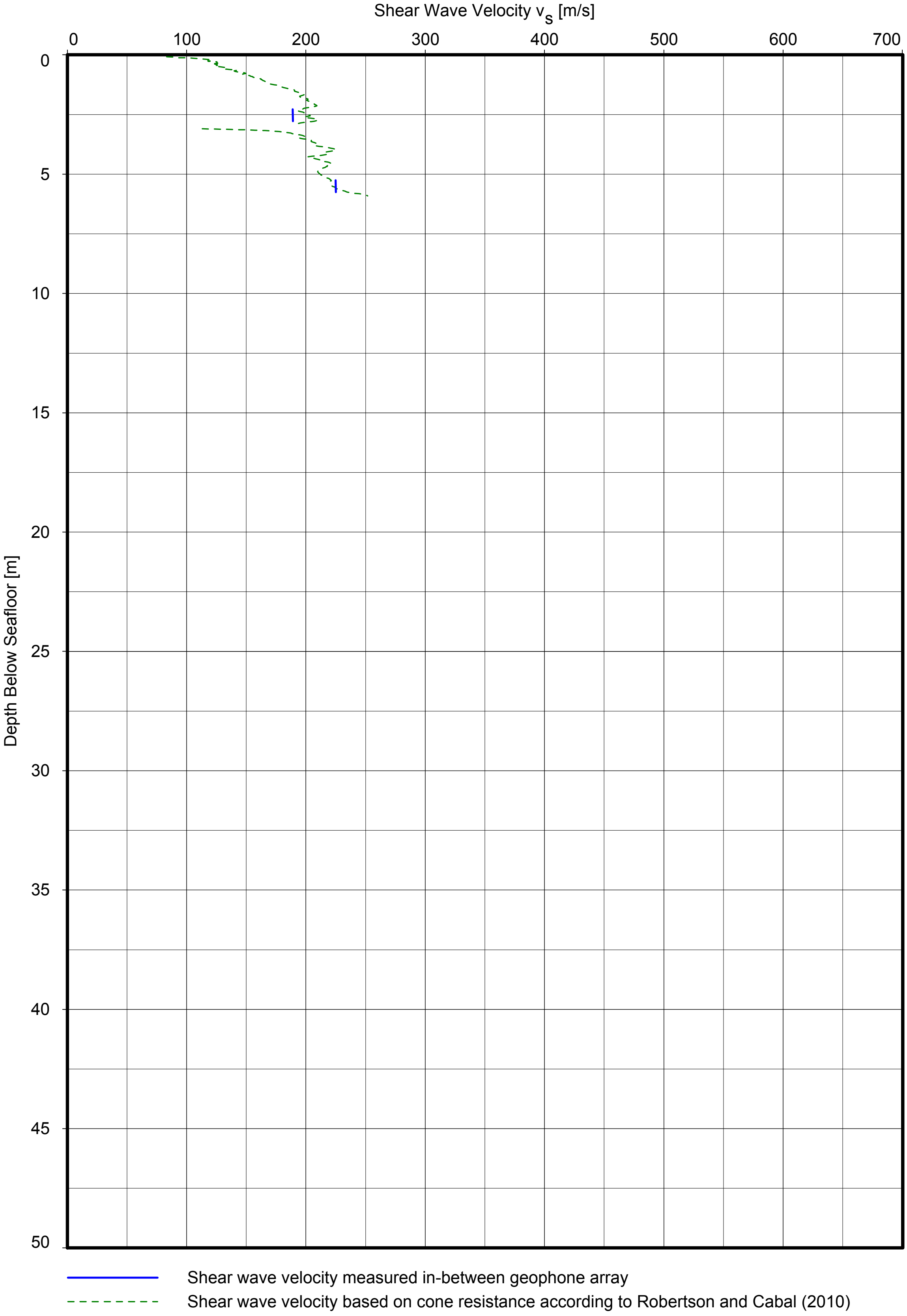
LOCATION HKZ1-BH06-SC



SHEAR WAVE VELOCITY VERSUS DEPTH

LOCATION HKZ1-BH06-SC

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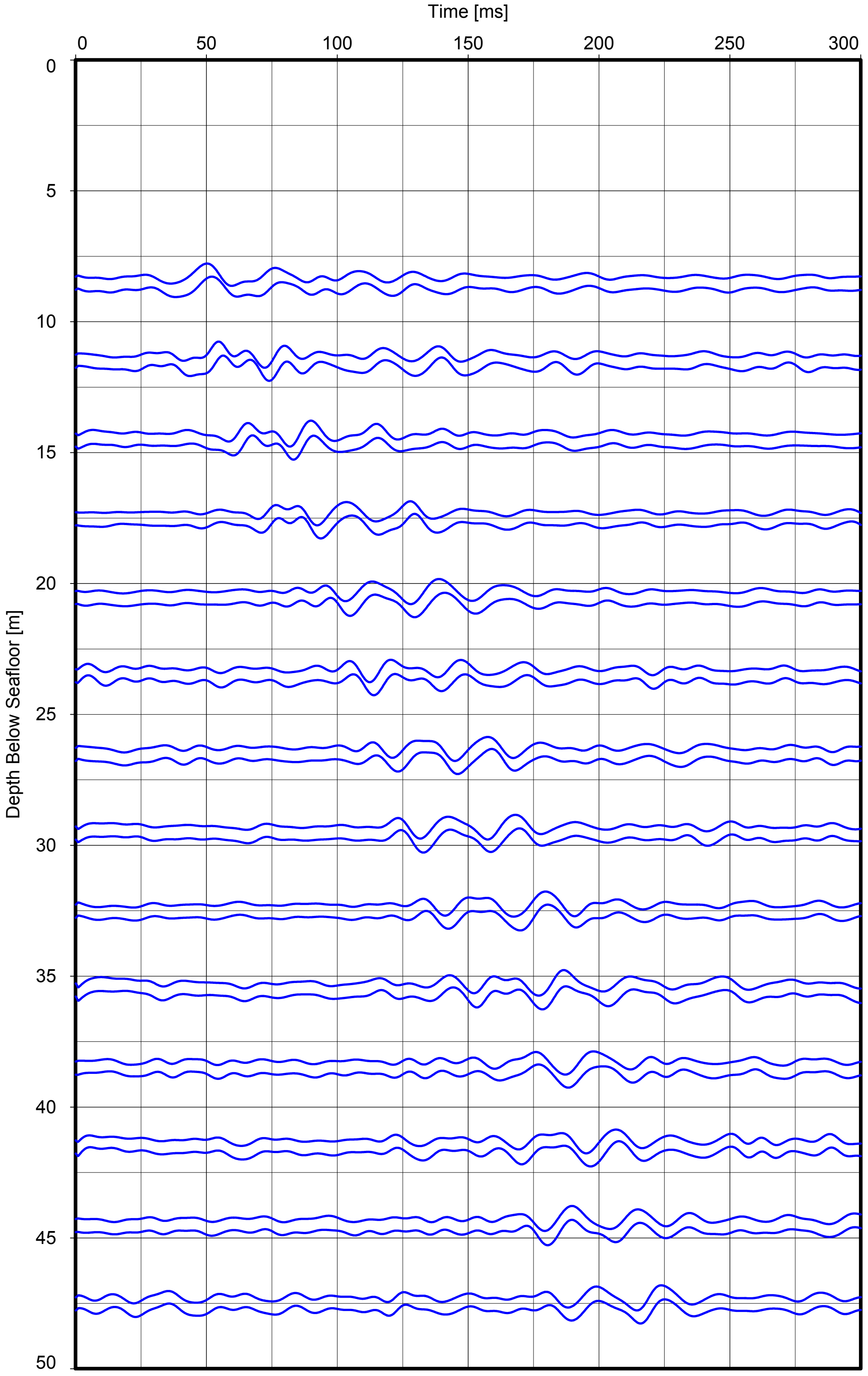

Stacked seismic trace (X-component) with 10 to 100 Hz band-pass filter applied

RECORDED SHEAR WAVE TRACES VERSUS DEPTH (X-COMPONENT)

LOCATION HKZ1-BH06A-SC

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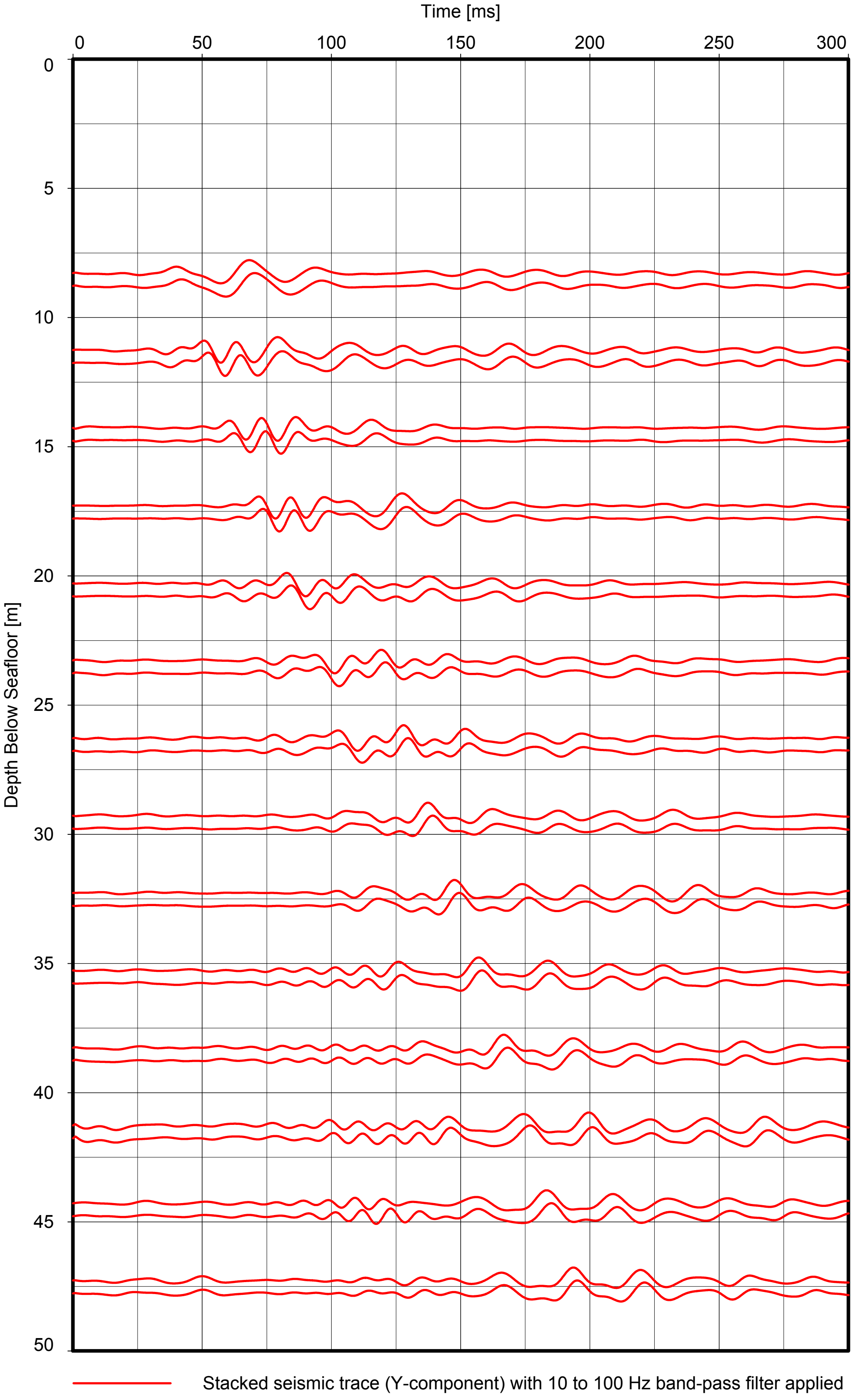

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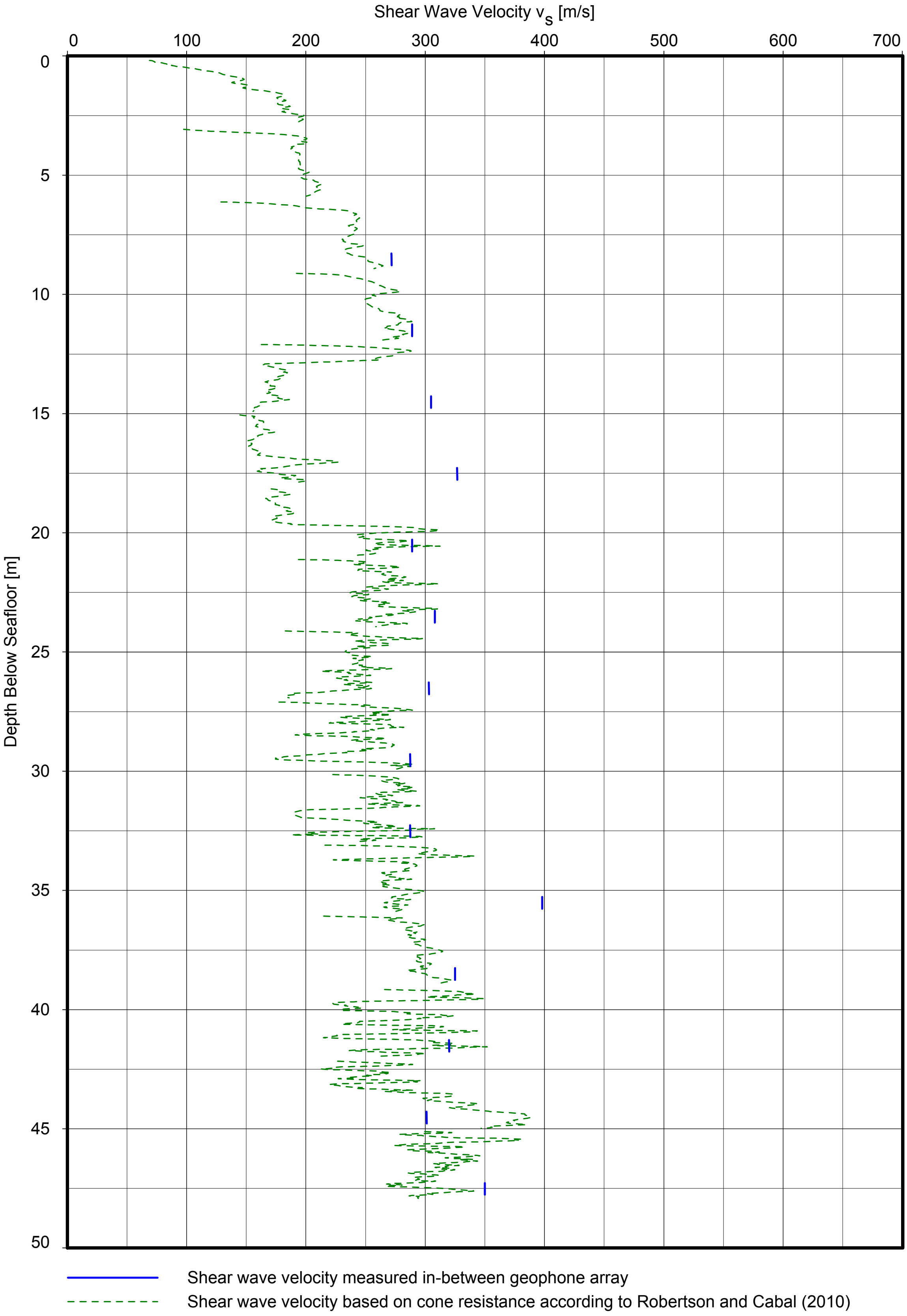

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LOCATION HKZ1-BH06A-SC

SECTION C: GEOTECHNICAL LABORATORY TEST RESULTS

SECTION C1: LABORATORY TESTING OVERVIEW

TEXT – SECTION C1: Page

C1. LABORATORY TESTING OVERVIEW

LIST OF PLATES IN SECTION C1: Plate

C1. LABORATORY TESTING OVERVIEW

C1.1 SUMMARY OF LABORATORY TESTS

Main Text Section 2.5 titled “Laboratory Tests” presents a brief overview of the geotechnical laboratory test programme. This section presents results from the laboratory tests performed both on-site and in-office. Table C1.1 presents a summary of the quantity of each laboratory test completed, along with references to the adopted test procedures.

Table C1.1: Overview of Laboratory Test Programme

Test Type	Quantity	Test Procedure
Index Tests		
Density of Solid Particles (Small Pycnometer)	57	BS1377:Part 2:1990:Clause 8.3 (BSI, 1990a)
Particle Size Analysis (Sieving and Pipette)	141	BS1377:Part 2:1990:Clause 9.2+9.4 (BSI, 1990a)/ Fugro in-house procedure
Minimum and Maximum Index Dry Unit Weight	16	DGI #000 96-07-02 (DGI, 1996)
Atterberg Limits	55	BS1377:Part 2:1990:Clauses 4+5 (BSI, 1990a)
Carbonate Content	28	DETS in-house procedure
Organic Content (dichromate)	30	DETS in-house procedure
Triaxial Tests		
Unconsolidated Undrained Triaxial compression - Undisturbed (UU)	24	BS1377:Part 7:1990:Clause 8 (BSI, 1990c)
Unconsolidated Undrained Triaxial compression - Remoulded (UUr)	24	BS1377:Part 7:1990:Clause 8 (BSI, 1990c)
Isotropically Consolidated Undrained Triaxial in compression (CIUc)	12	BS1377:Part 8:1990:Clauses 4+5.4+6+7 (BSI, 1990d)/ Fugro in-house procedures
Isotropically Consolidated Undrained Triaxial in compression (CIUc) with bender element testing	8	BS1377:Part 8:1990:Clauses 4+5.4+6+7 (BSI, 1990d)/ Fugro in-house procedures
Isotropically Consolidated Drained Triaxial in compression (CIDc)	18	BS1377:Part 8:1990:Clauses 4+5.3+6+8 (BSI, 1990d)/ Fugro in-house procedures
Isotropically Consolidated Drained Triaxial in compression (CIDc) with bender element testing	10	BS1377:Part 8:1990:Clauses 4+5.3+6+8 (BSI, 1990d)/ Fugro in-house procedures
Ring Shear Tests		
Ring Shear (Soil-Soil Interface)	11	BS1377:Part 7:1990:Clause 6 (BSI, 1990c)
Ring Shear (Soil-Steel Interface)	18	Jardine et al. (2005)/ICP Method
Compressibility Tests		
Incremental Loading (IL) Oedometer	7	BS1377:Part 5:1990:Clause 3 (BSI, 1990b)
Constant Rate of Strain (CRS)	13	Fugro in-house procedures based on ASTM D4186-12 (ASTM, 2012)
Other Tests		
Thermal Conductivity	10	ASTM D5334-14 (ASTM, 2014)/ Fugro in-house procedure
Microscopic Photography	20	Fugro in-house procedure

For further details on test procedure and methodology refer to the document “Geotechnical Laboratory Tests” presented in Appendix 1. Note that water content, unit weight, torvane and pocket penetrometer tests are not presented in this table.

Laboratory test results are presented per test type in sub-sections of this report section. Selected test results are also presented on the geotechnical logs presented in Section A. Effective vertical in situ stress presented on Summary Plates following Section C1 is calculated using unit weight profiles based on on-site laboratory test data.

C1.2 QUALITY OF RESULTS

In general, laboratory test results are considered to be of good quality and in line with expectations for used sampling techniques and laboratory test methods.

Results of geotechnical laboratory tests are generally consistent with the visual descriptions and in situ test interpretations. It is noted that the majority of the (index) strength test results correlate reasonably well with the shear strength derived from in situ tests, although some scatter is observed. This is likely attributed to heterogeneity of the test specimens in combination with differences between the various test techniques used. The pocket penetrometer test for example, tends to show higher shear strength values than other methods, however is considered to be less accurate for very stiff to hard (structured) sandy clays.

According to ISO (2014), an indication of sample quality may be derived from the recompression stage in an oedometer or CIU triaxial compression test (refer to document “Geotechnical Laboratory Tests” presented in Appendix 1). The method applies to a limited range of soil conditions. In general, soil properties of tested specimens fall outside of this range.

The normalized sample quality parameter ($\Delta e/e_0$) for CIUc triaxial test specimens ranges between 0.01 and 0.20. ISO (2014) undisturbed sample quality indication for these specimens classifies as “very good to excellent” to “very poor”. This indication must be used with caution for soils outside the specified range.

The normalized sample quality parameter ($\Delta e/e_0$) for compressibility test specimens ranges between 0.02 and 0.16. ISO (2014) undisturbed sample quality indication for these specimens classifies as “very good to excellent” to “very poor”. This indication must be used with caution for soils outside the specified range.

C1.3 PRACTICE FOR SAMPLE HANDLING AND LABORATORY TESTING

Practice

Procedure:	According to ISO (2014)
Data Processing and Management:	– Laboratory-specific software and GeODin® software, as applicable – Graphical scales selected to suit general presentation of data – No display of data outside of chart limits, i.e. some values may not be shown
Data Format(s):	– PDF for viewing and printing (this primary document) – AGS 4.0 (AGS, 2011) digital tabular data (separate deliverables, secondary to the final issue of this document)

Initial Sample Handling

Open-Tube Sampler:	Identification/labelling and transfer of sample tube to site laboratory

Site Geotechnical Laboratory

Test Programme:	Geotechnical description, geotechnical index and index strength
Programme Adjustment:	Assessment of feasibility of a test (by sample inspection) and, if required, selection of alternative test specimen if adequate test completion proves impracticable
Ground Description:	– Geotechnical sample description is an interpretation of processed data available at the time of preparation – Level of detail and accuracy in geotechnical description and interpretation depend on factors such as test data, sample size, quality, coverage, availability of supplementary information, and project requirements
Laboratory Air Temperature:	Typically about 20°C
Tube Sample:	– Sample extrusion – Visual geotechnical description including visual carbonate content assessment – Photography of selected sample section(s) – Geotechnical index (water content, unit weight) and index strength testing (pocket penetrometer, torvane, unconsolidated undrained triaxial compression - undisturbed) – Selection and labelling of geotechnical sample sections for undisturbed preservation and/or disturbed preservation

Sample Protection

Packaging of Selected Sample Sections:	– Undisturbed sample sections wrapped in aluminium and/or plastic foil, and waxed into labelled cardboard tubes – Disturbed sample sections placed in double set of plastic bags, and labelled – Placement in labelled shipping container
On-Site Sample Storage:	– Onboard storage area – Storage temperature within the range +2°C and +35°C – Protection from direct sunlight

Sample Transport

Fugro Sample Transport:	– Shipping containers off-loading from drilling vessel at port of demobilisation – Road freight and air freight to Fugro-nominated laboratory
Client Sample Transport	Not applicable

Office Geotechnical Laboratory

Test Programme	Geotechnical index, geochemical, (index) strength, compressibility, thermal conductivity, and micro photography
Programme Adjustment	– Assessment of feasibility of a test (by sample inspection) prior to start of specimen preparation – Decision by laboratory: (1) to proceed with test, (2) not to proceed with test, (3) to advise adjustments to test procedure – Selection by laboratory of alternative test specimen if decision is “not to proceed” or when adequate test completion proves impracticable
Ground Description	– No update of geotechnical sample descriptions made with in-office laboratory data or in situ test data, i.e. retention of original recorded data – Geotechnical sample description is an interpretation of processed data available at the time of preparation – Level of detail and accuracy in geotechnical sample description and interpretation depend on factors such as test data, sample size, quality, coverage, availability of supplementary information, and project requirements
Laboratory Air Temperature	Typically about 20°C
Sample Waxed in Cardboard Tube	– Removal of sample from tube by cutting – Photography of selected sample section(s) – Geotechnical and geochemical index testing, (index) strength testing, compressibility testing (refer to Table C1.1 for details) – If applicable, selection and labelling of left-over sample sections for undisturbed preservation and/or disturbed preservation
Sample in Plastic Bags	– Geotechnical and geochemical index testing, (index) strength testing, thermal conductivity, microphotography (refer to Table C1.1 for details) – If applicable, selection and labelling of left-over sample sections for disturbed preservation)

Sample Storage and Disposition

Sample Storage:	– Storage period of 12 months after arrival of samples in laboratory – Storage temperature within the range +2°C and +35°C – Protection from direct sunlight
Transport:	Not applicable
Final Disposition:	In accordance with in-office laboratory procedures

C1.4 INDEX LABORATORY TESTS

Individual on-site sample descriptions together with results of geotechnical index tests are presented on plates titled “Laboratory Classification Test Results” in Section C2.1. On-site sample descriptions and index strength presented in Section C2.1 do not consider results from in-office laboratory testing or in situ test data.

Particle size distribution (PSD) was determined using (a combination of) two different methods: wet sieving and sedimentation (pipette method). A combination of wet sieving and sedimentation was carried out on specimens for which sieving yielded >15 % fines (fraction <0.063 mm). PSD data is provided as percentage fines on plates titled “Laboratory Classification Test Results” in Section C2.1. Individual PSD curves are presented on plates in Section C2.2. Due to rounding errors, small differences may exist between PSD data presented on the plates in Section C2.1 and on the plates in Section C2.2.

Unit weight values derived from water content measurements assume (a) full saturation and (b) typical values for the density of solid particles of 2.65 Mg/m^3 for coarse-grained cohesionless material and 2.70 Mg/m^3 for fine-grained cohesive material. Results from the particle density tests support selected values.

Liquid limit as part of Atterberg limits testing was determined using the cone penetrometer method. Results of the Atterberg limits tests are presented in Section C2.3. Individual test results are included on plates titled “Laboratory Classification Test Results” in Section C2.1. One scheduled Atterberg limits test could not be performed as the specimen was assessed to be non-plastic (HKZ1-BH06-SA, Sample 48BagD).

The minimum and maximum index dry density (MM) test that was scheduled on Sample 39BagB from HKZ1-BH06-SA was performed on Sample 39BagA. Six minimum and maximum index dry density tests could not be performed as the sample material included significant quantities of fine-grained material.

C1.5 SAMPLE PHOTOGRAPHS

For some samples, only one sample photograph (either the intact or split) is available. This is indicated in the notes section on the plates in Section C3. At two occasions, a liner sample was taken which was preserved as a whole. Hence, no photographs were taken. This is indicated on the plates in Section C3.

C1.6 TRIAXIAL TESTS

A total of 24 unconsolidated undrained (UU) triaxial compression tests were performed on undisturbed specimens, of which 13 were tested on-site. In-office, 24 UU triaxial tests were performed on remoulded specimens. A summary table of UU triaxial test results is presented on Plates C1-1 to C1-3. Individual test results are presented in Section C4.1.

All UU triaxial tests were performed at a cell pressure of 1000 kPa and with a rate of strain of 1 %/min. When no distinct specimen failure was reached prior to 20 % axial deformation, undrained shear strength (s_u) was taken as half the deviator stress at 20 % axial strain.

Processing of bedding errors at the start of a test may result in a minor reduction (1 % to 2 %) of the final achieved axial strain of such test.

Unconsolidated undrained triaxial compression test results are generally in reasonable agreement with soil descriptions and with the s_u range derived from in situ test data (cone penetration tests) and other index strength test data. Occasionally, the remoulded shear strength is higher than s_u measured in undisturbed conditions. This is not uncommon in overconsolidated structured clays. Comments are as follows:

- The soil unit from which samples were tested was occasionally described as including a fissured structure. The clay structure may result in local discontinuities which serve as preferential shear planes during testing, thereby reducing the measured undisturbed undrained shear strength;
- Undisturbed test specimens may have included laminae and/or pockets of coarser material (silt and/or fine sand) which may not necessarily develop the same pore pressures over time as the fine-grained materials in the specimen. In contrast to the undisturbed specimen, the remoulded specimen is ‘artificially’ homogeneous, and can therefore develop more homogenous pore pressures over time, potentially resulting in a higher undrained shear strength measurement;
- Stress relief and swelling of the samples during sampling and/or sample handling may have resulted in sample disturbance of the undisturbed specimen. Sample disturbance will tend to reduce the undisturbed sample shear strength.

Twenty isotropically consolidated undrained triaxial compression (CIUc) tests were performed. Tests were carried out as single stage tests. Results of the CIUc triaxial tests are summarised on Plate C1-4 and individual test results are presented in Section C4.2.

Minimum and maximum index dry density (MM) tests were scheduled to be performed prior to the CID tests. Five MM tests could not be performed, refer to the section titled “Index Laboratory Tests”. The CID tests on these samples were cancelled and CIUc triaxial tests were performed instead. Additional PSDs and Atterberg limits tests were performed on these specimens to further assess the soil properties of the sample material. Only for a number of the re-scheduled CID (to CIUc) triaxial tests sample photographs are available. The tests were carried out on reconstituted specimens and it was not always possible to have a suitable specimen remaining for a post-test sample photograph.

Overall, s_u values derived from the CIU triaxial tests compare with those from UU triaxial tests results. CIU triaxial tests show expected behavior for soils tested. Variation in soil response can be related to soil properties of the specimen. Specimens from (overconsolidated) “clean” clay units show a sharp initial increase in deviator stress q, a non-linear p’/q relationship and an initial increase of pore water pressure followed by a decrease proportional to the overconsolidation ratio (the higher the overconsolidation ratio, the larger the pore water pressure decrease). Specimens with (significant) silt and sand fraction show a more gradual increase in q and pore pressure which remains fairly constant upon further loading.

Twenty-eight isotropically consolidated drained (CID) triaxial tests were performed. Tests were carried out on three separate reconstituted specimens with different consolidation pressures. Test material was not re-used for subsequent specimen preparation. Results of the CID triaxial tests are summarised on Plates C1-5 to C1-7 and are presented in Section C4.3.

Failure envelopes for the CID triaxial tests have been derived considering a best fit tangent line to the Mohr's circles at peak deviator stress for each set of test results.

The CID triaxial test results show behaviour during shearing which is typical for the selected initial sample density, sample grading and fines content. Test specimens with low (dry) densities generally show contractive behaviour during shearing and resulting effective angle of internal friction (φ') values of 30-33. Specimens prepared at higher (dry) densities generally show dilative behaviour and resulting values for $\varphi'>35$.

Bender element (BE) tests were performed as part of eight CIU triaxial tests and ten CID triaxial tests to measure shear wave velocity (v_s) and to assess shear modulus at small strain (G_{max}). A BE test involves triggering a shear wave, conducted at various frequencies, through the specimen during post-saturation and post-consolidation stages. Used frequencies are generally in the range of 1000 Hz to 10 000 Hz in order to find the frequency with the optimum coupling from sender to receiver elements, and hence the strongest received signal. The optimum frequency can vary between tests. On the plates in Sections C4.2 and C4.3, the range of measured respectively assessed v_s and G_{max} values for the applied frequencies are presented. The highest values for v_s and G_{max} measured during post-consolidation (post-saturation in case post-consolidation results are not available) tests are presented in the CIU and CID triaxial test results summary tables on Plates C1-4 to C1-7. Bender element tests as part of CID triaxial tests were carried out on the specimen, which was consolidated to the estimated vertical effective in situ stress.

In general, BE test results with a wavelength ratio >3 (wavelength ratio is defined as the peak-to-peak arrival time over the input wave period) are considered to be of good quality and hence, are presented in Sections C4.2 and C4.3. In some instances, test results with a wavelength ratio between 2 and 3 are also presented, but only when corresponding G_{max} values are comparable to the G_{max} values with wavelength ratio >3. With wavelength ratio <2, values of G_{max} become increasingly inconsistent and are not presented.

Shear wave velocities measured in the performed bender element tests tend to be lower than those inferred for in situ conditions (refer to Section B2). Reasons include:

- Different methods for determination of shear wave velocity: seismic downhole and/or CPT-based correlation versus bender elements;
- Approximation of specimen density versus in situ soil density has inherent uncertainties;
- Used method for specimen preparation is different than in situ soil deposition;
- In situ soil includes long-term stress history and time effects (aging).

C1.7 RING SHEAR TESTS

Results of ring shear (RS) tests are summarised on Plates C1-8 to C1-10 for soil-soil interface and soil-steel interface tests, and are presented in full in Section C5.

Eighteen soil-soil interface RS tests were performed according to Clause 6 of BS1377:Part 7 (BSI, 1990c). Each test consists of three stages, each with a doubling of the applied normal stress. Each specimen was sheared at two different rates (0.16°/min and 674°/min).

Eleven soil-steel interface RS tests were performed according to the ICP method (Jardine et al., 2005). Each test consists of two stages. In Stage 1 the specimen is consolidated to the estimated in situ effective horizontal stress and sheared at a rate of 500 mm/min. In Stage 2, the specimen is consolidated to 1.67 times the consolidation pressure used for the first stage, and subsequently sheared at a rate of 0.018 mm/min.

C1.8 COMPRESSIBILITY TESTS

Compressibility testing was performed to aid in the evaluation of stress history and settlement parameters of the soil under one-dimensional loading conditions. Thirteen constant rate of strain (CRS) and seven incremental loading (IL) compressibility tests were performed on undisturbed fine-grained cohesive specimens. Test results are summarised on Plate C1-11, individual test results are presented in Section C6.

Both test types (CRS and IL) included an unload-reload loop and have been interpreted for OCR and compression/swelling indices. Preconsolidation pressure (σ'_p) has been assessed with the graphical Casagrande method (Casagrande, 1936). Interpretation results are included in the summary table presented on Plate C1-11. The interpreted values indicate some scatter of the assessed OCR values within boreholes and between CRS and IL compressibility tests performed on the same wax samples. Assessed OCR values are indicative and should be used with caution. Interpretation of OCR can be influenced by:

- Difference in test methodology between IL and CRS compressibility tests;
- Uncertainty in interpretation of preconsolidation for overconsolidated soils (Boone, 2010);
- Difference between individual specimens due to soil heterogeneity and the frequent occurrence of additional soil bodies for certain layers.

C1.9 THERMAL CONDUCTIVITY TESTS

Thermal conductivity is defined as the amount of heat that passes through a unit cross-sectional area of a substance, under a unit thermal gradient, per unit time. After the sample reaches temperature equilibration, the thermal needle probe is inserted. After temperature equilibration is confirmed by probe measurements, a current is passed through the heater element in the probe. As a result, the temperature of the probe and the surrounding soil increases. Results are plotted as temperature versus logarithm of time for the heating and cooling phases. The thermal conductivity is calculated from a suitable linear part of the curve (last 2/3 of the measurements), using the following formula (Brandon & Mitchell, 1989):

$$k=\frac{P}{4\pi(T_2-T_1)}\ln\left(\frac{t_2}{t_1}\right)$$

where:

k = Thermal conductivity [W/(m·K)]

P = Applied power [W/m]

T_2-T_1 = Temperature change over selected time interval [K]

t_1, t_2 = Start and end of time interval [s]

Thermal conductivity tests were performed on batch samples. Batch samples were prepared for individual locations only and were selected from samples from the first 8.5 m below seafloor (BSF). In case the (provisionally) assessed layer thickness of the top soil unit was less than approximately 5 m, a thermal conductivity test has also been scheduled on a batch sample from the top of the underlying soil unit. All tests were carried out on coarse-grained cohesionless material. Two samples were mixed together to form a batch. Occasionally a third sample was added in case insufficient material was available from the initial two samples, refer to Plate C1-12 for a list of samples used per batch. To verify uniformity of samples for batching, PSDs were determined for each sample prior to batching (refer to Section C2.2 for PSD results). Microscopic inspections were carried out prior to batching to assess uniformity of samples in terms of composition, angularity and sphericity (refer to Paragraph C1.10 'Sample Micro Photographs' for more details about micro photographs).

Specimens for thermal conductivity testing were prepared according to a Fugro in-house method. The system comprises a pressure controller and a sample pedestal complete with porous stone and water inlet mounted on a vibrating table. A test specimen is prepared on the pedestal in a 66 mm inner diameter section of clear liner by using Ladd under-compaction in six layers (Ladd, 1978) at an initial water content of 10 %. The specimen was then saturated by pumping water in from the bottom at a slow rate, with control of the pressure head used (approximately 12 kPa) and with measurement of the volume of water added, until water appeared at the upper surface of the sample. By this point, the specimen was assumed to have reached full saturation.

Thermal conductivity tests were performed using a KD2 Pro Thermal Properties Analyzer (Decagon Devices, Inc.) with a TR-1 thermal needle probe (100 mm length, 2.4 mm diameter) according procedures described in ASTM D5334-14 (ASTM, 2014) supplemented by various in-house methods. Using this method, a heating element and a temperature measuring element are inserted into a soil specimen. Heating and cooling intervals were one minute each. The tests were performed in duplicate.

After performing a thermal conductivity test at an initial (low) dry density, vibration was turned on to compact the specimen further to a next dry density. Dry densities for each test have been assessed by linear measurement, i.e. the height of the sand column in the liner after vibrating. In total, a series of five tests were performed per batch sample to cover a range of dry densities from approximately 1.3 Mg/m^3 to 1.8 Mg/m^3.

Results of the thermal conductivity tests are summarized on Plate C1-12. Heating and cooling curves are presented on plates in Section C7.

C1.10 SAMPLE MICRO PHOTOGRAPHS

Sample micro photographs were made for each sample intended for batching for thermal conductivity testing to assess uniformity of samples in terms of composition, angularity and sphericity. Per batch of samples, one basic and one more detailed set of sample micro photographs (the latter including microscopic sample descriptions) were prepared. Sample micro photographs are presented in Section C8. The basic set comprises reflected light photographs taken from an unwashed sample with a field of view (FOV) of 10 mm and one photograph taken from a washed sample, with a FOV of 5 mm. Unwashed photographs were taken to provide a visual indication of fines content in the sample. The detailed set of photos includes a hand specimen description, a microscopic sample description, and four reflected light micro photographs, i.e. washed, unwashed; 5 mm FOV, 10 mm FOV.

C1.11 REFERENCES

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SUMMARY OF UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Location	Sample No.	Depth [m BSF]	Test Type	σ'_{v0} [kPa]	w [%]	γ_1 [kN/m^3]	γ_2 [kN/m^3]	s_u [kPa]	s_u/σ'_{v0} [-]	ε_a [%]	ε_{50} [%]
HKZ1-BH01-SA	W24	22.15	Undisturbed	215	24.4	19.9	19.2	75	0.35	3.3	0.4
	W24	22.15	Remoulded	215	30.2	19.0	19.2	69	-	19.7	-
HKZ1-BH02-SA	W14	11.95	Remoulded	119	28.4	19.3	19.6	38	-	20.0	-
	W14	11.95	Undisturbed	119	29.1	19.1	19.4	76	0.64	20.0	4.8
	W17	14.60	Undisturbed	142	38.5	18.0	18.0	93	0.65	5.5	2.1
	W17	14.60	Remoulded	142	36.6	18.2	18.1	114	-	17.0	-
	W22	19.50	Remoulded	189	26.4	19.5	19.4	27	-	20.0	-
	W22	19.50	Undisturbed	189	30.2	19.0	19.4	49	0.26	19.9	5.8
HKZ1-BH03-SA	W22	13.00	Remoulded	132	26.0	19.6	19.9	113	-	20.0	-
	W22	13.00	Undisturbed	132	27.6	19.4	20.1	122	0.92	10.1	1.3
	W24	15.20	Undisturbed	151	36.8	18.2	18.7	80	0.53	2.5	0.9
	W24	15.20	Remoulded	151	35.2	18.4	18.5	60	-	20.0	-
	W26	17.10	Remoulded	167	36.5	18.2	18.3	50	-	20.0	-
	W26	17.10	Undisturbed	167	36.4	18.2	18.4	93	0.55	3.2	0.7
	W27	18.30	Remoulded	178	28.5	19.2	19.3	47	-	20.0	-
	W27	18.30	Undisturbed	178	28.2	19.3	19.2	108	0.61	3.7	1.2
	W48	39.25	Remoulded	360	25.9	19.6	19.7	43	-	19.9	-
	W48	39.25	Undisturbed	360	27.3	19.4	19.8	101	0.28	6.8	3.2
HKZ1-BH04-SA	W27	23.75	Undisturbed	229	28.2	19.3	20.1	39	0.17	12.8	2.5
	W27	23.75	Remoulded	229	28.8	19.2	19.9	20	-	20.0	-
	W28	24.50	Remoulded	235	29.0	19.2	19.2	18	-	20.0	-

Key:

σ'_{v0} = estimated effective in situ vertical stress
w = water content
γ_1 = unit weight derived from water content
γ_2 = unit weight derived from volume mass calculation

s_u = undrained shear strength
ε_a = axial strain at failure
ε_{50} = axial strain at 50% of maximum deviator stress

Note(s):
- The column presenting undrained shear strength includes undisturbed (s_u) and remoulded ($s_{u;r}$) values

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SUMMARY OF UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

Location	Sample No.	Depth [m BSF]	Test Type	σ'_{v0} [kPa]	w [%]	γ_1 [kN/m^3]	γ_2 [kN/m^3]	s_u [kPa]	s_u/σ'_{v0} [-]	ε_a [%]	ε_{50} [%]
	W28	24.50	Undisturbed	235	27.5	19.4	19.3	47	0.20	20.0	2.0
	W36	32.50	Remoulded	308	26.3	19.6	19.5	21	-	19.9	-
	W36	32.50	Undisturbed	308	26.0	19.6	19.4	43	0.14	19.2	2.1
HKZ1-BH05-SA	W21	17.35	Undisturbed	183	23.8	20.0	20.2	60	0.33	18.6	5.0
	W21	17.35	Remoulded	183	23.7	20.0	20.3	46	-	20.0	-
	W23	19.40	Undisturbed	204	30.2	19.0	20.2	86	0.42	7.8	1.2
	W23	19.40	Remoulded	204	29.4	19.1	20.0	92	-	17.2	-
	W26	22.55	Undisturbed	235	22.8	20.1	20.4	147	0.63	18.5	2.5
	W26	22.55	Remoulded	235	23.7	20.0	20.1	152	-	19.8	-
	W48	43.60	Remoulded	439	36.5	18.2	18.1	163	-	9.4	-
	W48	43.60	Undisturbed	439	36.3	18.2	18.0	107	0.24	6.0	0.4
HKZ1-BH06-SA	W21	16.70	Remoulded	168	35.1	18.4	18.0	51	-	19.8	-
	W21	16.70	Undisturbed	168	35.8	18.3	17.7	79	0.47	3.3	0.5
	W30	25.60	Remoulded	248	26.1	19.6	19.7	42	-	20.0	-
	W30	25.60	Undisturbed	248	25.7	19.7	19.4	40	0.16	10.9	3.6
	W32	27.40	Remoulded	265	29.9	19.0	20.2	35	-	20.0	-
	W32	27.40	Undisturbed	265	26.8	19.5	20.4	62	0.23	17.5	3.8
	W51	44.90	Remoulded	432	35.8	18.3	18.1	118	-	20.0	-
	W51	44.90	Undisturbed	432	33.6	18.6	18.2	126	0.29	6.4	1.3
	W53	46.90	Remoulded	451	21.5	20.4	20.9	118	-	20.0	-
	W53	46.90	Undisturbed	451	20.4	20.6	21.0	97	0.22	20.0	10.3

Key:

σ'_{v0} = estimated effective in situ vertical stress
w = water content
γ_1 = unit weight derived from water content
γ_2 = unit weight derived from volume mass calculation
s_u = undrained shear strength
ε_a = axial strain at failure
ε_{50} = axial strain at 50% of maximum deviator stress

Note(s):
- The column presenting undrained shear strength includes undisturbed (s_u) and remoulded ($s_{u;r}$) values

SUMMARY OF UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Location	Sample No.	Depth [m BSF]	Test Type	σ'_{v0} [kPa]	w [%]	γ_1 [kN/m^3]	γ_2 [kN/m^3]	s_u [kPa]	s_u/σ'_{v0} [-]	ε_a [%]	ε_{50} [%]
	W56	50.00	Remoulded	481	30.8	18.9	19.2	53	-	19.9	-
	W56	50.00	Undisturbed	481	29.9	19.0	19.2	88	0.18	18.3	6.3
HKZ1-BH07-SA	W20	13.05	Remoulded	133	27.4	19.4	18.5	107	-	9.8	-
	W20	13.05	Undisturbed	133	35.9	18.3	18.6	56	0.42	16.7	0.5
HKZ1-BH08-SA	W14	12.30	Remoulded	124	33.1	18.6	18.6	48	-	20.0	-
	W14	12.30	Undisturbed	124	30.4	19.0	18.8	78	0.63	2.8	0.6

Key:

σ'_{v0} = estimated effective in situ vertical stress
w = water content
γ_1 = unit weight derived from water content
γ_2 = unit weight derived from volume mass calculation

s_u = undrained shear strength
ε_a = axial strain at failure
ε_{50} = axial strain at 50% of maximum deviator stress

Note(s):
- The column presenting undrained shear strength includes undisturbed (s_u) and remoulded ($s_{u;r}$) values

																	At Peak Deviator Stress			At Peak Principal Effective Stress Ratio		
Location	Sample No.	Depth [m BSF]	Specimen	Test Type	σ'_{v0} [kPa]	w_i [%]	γ_1 [kN/m^3]	γ_2 [kN/m^3]	ρ_s [Mg/m^3]	$\Delta e/e_0$ [-]	γ_{pc} [kN/m^3]	$\sigma'_{v;pc}$ [kPa]	$\sigma'_{r;pc}$ [kPa]	$\varepsilon_{v;pc}$ [%]	v_s [m/s]	G_{max} [MPa]	s_u [kPa]	ε_a [%]	s_u/σ'_{v0} [-]	s_u [kPa]	ε_a [%]	s_u/σ'_{v0} [-]
HKZ1-BH01-SA	W18	15.94	Undisturbed	ic+be	160	29.1	19.1	19.0	2.70	0.02	19.1	170	170	0.73	193.0	70.3	123	10.8	0.77	123	11.3	0.77
	W24	21.75	Undisturbed	ic	212	30.9	18.9	19.0	2.70	0.04	29.6	210	210	1.85	-	-	108	3.5	0.51	108	3.0	0.51
	W28	25.50	Undisturbed	ic+be	246	10.2	22.9	16.8	2.70	0.08	19.7	240	240	3.37	201.2	81.2	61	20.0	0.25	54	15.5	0.22
HKZ1-BH02-SA	W14	12.17	Undisturbed	ic	121	28.3	19.3	19.3	2.70	0.03	19.4	120	120	1.08	-	-	114	2.8	0.94	107	2.0	0.88
	W25	22.70	Undisturbed	ic	220	17.5	21.1	22.0	2.70	0.10	22.3	185	185	2.62	-	-	430	16.5	1.96	249	5.0	1.13
	W27	25.05	Reconstituted	ic	242	10.0	22.9	17.3	2.70	0.09	19.9	220	220	3.37	-	-	53	0.8	-	24	12.7	-
HKZ1-BH03-SA	W23	14.42	Undisturbed	ic	144	34.1	18.5	18.7	2.70	0.03	18.9	140	140	1.41	-	-	129	2.5	0.89	121	1.9	0.84
	W26	17.32	Undisturbed	ic	169	28.6	19.2	19.3	2.70	0.01	19.3	165	165	0.40	-	-	137	1.9	0.81	136	1.6	0.80
	W50	41.46	Undisturbed	ic	381	23.5	20.0	20.0	2.70	0.08	20.4	325	325	3.11	-	-	222	4.9	0.58	214	3.4	0.56
HKZ1-BH04-SA	W19	16.02	Undisturbed	ic	159	19.8	20.7	20.7	2.70	0.04	20.8	155	155	1.23	-	-	134	7.3	0.84	125	3.3	0.78
	W25	21.65	Reconstituted	ic+be	210	10.4	22.8	15.9	2.70	0.16	19.4	190	190	7.38	204.0	82.6	66	20.0	-	61	11.5	-
	W32	28.82	Undisturbed	ic	274	27.7	19.4	19.3	2.70	0.16	20.0	235	235	6.93	-	-	162	14.0	0.59	146	8.5	0.53
HKZ1-BH05-SA	W23	19.22	Undisturbed	ic+be	202	33.5	18.6	18.5	2.70	0.06	18.7	205	205	2.68	182.9	63.9	100	6.3	0.49	96	5.3	0.47
	W29	24.90	Reconstituted	ic+be	258	10.4	22.8	16.4	2.70	0.14	19.7	255	255	6.24	226.1	102.8	102	20.0	-	89	10.5	-
HKZ1-BH06-SA	W20	15.92	Undisturbed	ic	161	36.1	18.3	18.2	2.70	0.08	18.6	160	160	3.97	-	-	105	8.5	0.65	102	4.3	0.63
	W30	25.25	Undisturbed	ic+be	245	29.2	19.1	19.7	2.70	0.20	20.7	230	230	8.56	46.7	4.4	158	17.0	0.64	153	12.8	0.62
	W46	39.51	Undisturbed	ic+be	379	23.6	20.0	20.1	2.70	0.14	20.7	335	335	5.49	80.8	13.4	222	9.0	0.59	215	7.0	0.57
	W57	54.13	Undisturbed	ic	521	25.5	19.7	19.9	2.70	0.18	20.7	445	445	6.96	-	-	354	19.5	0.68	275	7.5	0.53
HKZ1-BH08-SA	W15	13.42	Undisturbed	ic+be	135	37.8	18.1	18.3	2.70	0.03	18.5	130	130	1.44	200.7	76.0	115	1.9	0.85	111	1.4	0.82
	W48	42.50	Reconstituted	ic	416	10.2	22.9	16.8	2.70	0.09	19.6	380	380	3.64	-	-	349	20.3	-	334	16.8	-

Key:

ac = Anisotropically Consolidated Undrained
ic = Isotropically Consolidated Undrained
c/e = in compression/extension
+be = with piezoceramic bender element
σ'_{v0} = estimated effective in situ vertical stress
w_i = initial water content
γ_1 = initial unit weight derived from water content
γ_2 = initial unit weight derived from volume mass calculation
ρ_s = density of solid particles
e_0 = initial void ratio
Δe = change in void ratio from initial conditions to estimated effective in situ vertical stress conditions
γ_{pc} = unit weight immediately before shearing stage
$\sigma'_{v;pc}$ = effective vertical stress immediately before shearing stage
$\sigma'_{r;pc}$ = effective radial stress immediately before shearing stage
$\varepsilon_{v;pc}$ = volumetric strain immediately before shearing stage
v_s = shear wave velocity immediately before shearing stage
G_{max} = shear modulus at small strain immediately before shearing stage
s_u = undrained shear strength
ε_a = axial strain

Note(s):
- v_s and G_{max} values represent the highest values for the tested range of frequencies
-* = v_s and G_{max} values immediately before consolidation stage, refer to Main Text Section C for details

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SUMMARY OF CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

SUMMARY OF CONSOLIDATED DRAINED TRIAXIAL TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Location	Sample No.	Depth [m BSF]	Test Type	Stage 1		Stage 2		Stage 3		Bender Element	
				$w_{1,i}$ [%]	$\gamma_{1,i}$ [kN/m^3]	$w_{2,i}$ [%]	$\gamma_{2,i}$ [kN/m^3]	$w_{3,i}$ [%]	$\gamma_{3,i}$ [kN/m^3]	v_s [m/s]	G_{max} [MPa]
HKZ1-BH01-SA	14BagA&B	12.00	CIDc+BE	9.9	18.3	9.9	18.3	9.9	18.3	117.7*	28.6*
HKZ1-BH01-SA	37BagB	34.50	CIDc	9.9	17.6	9.9	17.5	9.9	17.6	-	-
HKZ1-BH01-SA	54BagB	57.30	CIDc	10.4	16.5	10.4	16.5	10.4	16.4	-	-
HKZ1-BH02-SA	07BagA	5.50	CIDc	10.2	17.8	10.2	17.8	10.2	17.9	-	-
HKZ1-BH02-SA	21BagB	18.70	CIDc+BE	9.8	16.7	10.0	16.7	9.4	16.7	194.2	74.4
HKZ1-BH02-SA	23BagA	20.50	CIDc	10.0	16.8	10.2	16.8	10.0	16.8	-	-
HKZ1-BH02-SA	41BagB	38.30	CIDc	10.3	17.6	10.0	17.5	10.3	17.5	-	-
HKZ1-BH02-SA	48BagC	45.00	CIDc	10.5	16.2	10.5	16.2	10.5	16.2	-	-
HKZ1-BH03-SA	14BagA	7.50	CIDc+BE	10.2	17.9	10.4	17.8	10.1	17.8	192.1	75.0
HKZ1-BH03-SA	33BagA	24.00	CIDc+BE	10.0	16.2	9.6	16.2	9.5	16.2	168.8	56.0
HKZ1-BH03-SA	42BagA	33.00	CIDc	10.3	15.9	10.3	15.9	10.3	15.9	-	-

Location	Sample No.	Depth [m BSF]	Test Type	Stage 1			Stage 2			Stage 3			Mohr's Envelope	
				p' [kPa]	$w_{1,f}$ [%]	$\gamma_{1,f}$ [kN/m^3]	p' [kPa]	$w_{2,f}$ [%]	$\gamma_{2,f}$ [kN/m^3]	p' [kPa]	$w_{3,f}$ [%]	$\gamma_{3,f}$ [kN/m^3]	φ' [°]	c' [kPa]
HKZ1-BH01-SA	14BagA&B	12.00	CIDc+BE	130	20.7	20.3	260	20.5	20.3	520	20.3	20.3	35	20
HKZ1-BH01-SA	37BagB	34.50	CIDc	240	22.9	19.8	480	22.5	19.9	960	21.9	20.0	30	19
HKZ1-BH01-SA	54BagB	57.30	CIDc	365	26.5	19.3	730	26.1	19.4	1460	24.6	19.6	30	0
HKZ1-BH02-SA	07BagA	5.50	CIDc	55	22.8	19.9	110	22.7	19.9	220	22.2	20.0	34	4
HKZ1-BH02-SA	21BagB	18.70	CIDc+BE	135	26.3	19.3	270	26.1	19.4	540	25.1	19.5	31	13
HKZ1-BH02-SA	23BagA	20.50	CIDc	95	26.3	19.3	190	26.1	19.3	380	25.9	19.4	33	13
HKZ1-BH02-SA	41BagB	38.30	CIDc	255	23.3	19.8	510	23.1	19.8	1020	23.0	19.8	32	55
HKZ1-BH02-SA	48BagC	45.00	CIDc	230	26.2	19.3	460	24.7	19.5	920	23.7	19.6	31	6
HKZ1-BH03-SA	14BagA	7.50	CIDc+BE	80	22.7	19.9	160	22.6	19.9	320	22.3	20.0	36	6
HKZ1-BH03-SA	33BagA	24.00	CIDc+BE	155	27.6	19.3	310	25.6	19.6	620	24.5	19.7	32	10
HKZ1-BH03-SA	42BagA	33.00	CIDc	180	30.2	18.9	360	29.3	19.0	720	29.3	19.0	30	42

Notes:

- v_s and G_{max} values represent the highest values for the tested range of frequencies
- * = v_s and G_{max} values immediately before consolidation stage, refer to Main Text Section C for details

Key:

CIDc = isotropically consolidated drained triaxial compression test
$w_{\#,i\,/\,\#,f}$ = initial / after-consolidation water content per stage
$\gamma_{\#,i\,/\,\#,f}$ = initial / after-consolidation unit weight per stage
BSF = below seafloor
+BE = with piezoceramic bender element

p' = effective consolidation pressure
φ' = effective angle of internal friction
c' = effective cohesion
v_s = shear wave velocity immediately before shearing stage
G_{max} = shear modulus at small strain immediately before shearing stage

SUMMARY OF CONSOLIDATED DRAINED TRIAXIAL TEST RESULTS

Location	Sample No.	Depth	Test Type	Stage 1		Stage 2		Stage 3		Bender Element	
		[m BSF]		$w_{1,i}$ [%]	$\gamma_{1,i}$ [kN/m³]	$w_{2,i}$ [%]	$\gamma_{2,i}$ [kN/m³]	$w_{3,i}$ [%]	$\gamma_{3,i}$ [kN/m³]	v_s [m/s]	G_{max} [MPa]
HKZ1-BH03-SA	57BagA	48.00	CIDc	9.3	16.1	9.3	16.1	9.3	16.1	-	-
HKZ1-BH03-SA	59BagC	54.75	CIDc	10.4	16.8	10.1	16.8	10.1	16.8	-	-
HKZ1-BH04-SA	10BagA	7.00	CIDc+BE	10.8	18.2	10.1	18.2	10.1	18.2	197.9	80.2
HKZ1-BH04-SA	34BagB	30.80	CIDc	10.2	16.5	10.2	16.5	10.2	16.5	-	-
HKZ1-BH04-SA	56BagA	50.00	CIDc	10.3	16.2	9.7	16.2	10.0	16.2	-	-
HKZ1-BH05-SA	07BagB	6.20	CIDc+BE	10.0	17.8	10.6	17.8	10.3	17.7	198.5	80.0
HKZ1-BH05-SA	45BagC	40.85	CIDc	10.1	17.5	9.9	17.6	9.9	17.6	-	-
HKZ1-BH06-SA	03BagB	2.30	CIDc	10.2	18.2	10.2	18.3	10.2	18.3	-	-
HKZ1-BH06-SA	26BagB	21.40	CIDc	10.3	15.7	10.3	15.7	10.3	15.7	-	-
HKZ1-BH06-SA	39BagB	34.00	CIDc+BE	10.0	16.5	9.8	16.5	10.4	16.5	216.1	91.7
HKZ1-BH06-SA	59BagA	59.00	CIDc	10.2	18.1	10.2	18.1	9.9	18.1	-	-

Location	Sample No.	Depth	Test Type	Stage 1			Stage 2			Stage 3			Mohr’s Envelope	
		[m BSF]		p' [kPa]	$w_{1,f}$ [%]	$\gamma_{1,f}$ [kN/m³]	p' [kPa]	$w_{2,f}$ [%]	$\gamma_{2,f}$ [kN/m³]	p' [kPa]	$w_{3,f}$ [%]	$\gamma_{3,f}$ [kN/m³]	φ' [°]	c' [kPa]
HKZ1-BH03-SA	57BagA	48.00	CIDc	260	26.0	19.5	520	24.9	19.6	1040	24.2	19.8	33	0
HKZ1-BH03-SA	59BagC	54.75	CIDc	295	26.0	19.3	590	24.9	19.5	1180	24.6	19.5	31	12
HKZ1-BH04-SA	10BagA	7.00	CIDc+BE	75	21.7	20.1	150	21.1	20.2	300	20.6	20.3	36	17
HKZ1-BH04-SA	34BagB	30.80	CIDc	190	27.3	19.2	380	27.0	19.3	760	26.4	19.3	31	33
HKZ1-BH04-SA	56BagA	50.00	CIDc	285	27.9	19.1	570	27.0	19.2	1140	26.0	19.4	32	12
HKZ1-BH05-SA	07BagB	6.20	CIDc+BE	70	22.6	19.9	140	22.7	19.9	280	23.0	19.8	36	5
HKZ1-BH05-SA	45BagC	40.85	CIDc	285	23.5	19.8	570	23.0	19.8	1140	22.7	19.9	33	54
HKZ1-BH06-SA	03BagB	2.30	CIDc	25	21.3	20.1	50	21.1	20.2	100	20.8	20.2	42	3
HKZ1-BH06-SA	26BagB	21.40	CIDc	160	30.3	18.9	320	29.1	19.0	640	27.4	19.3	33	0
HKZ1-BH06-SA	39BagB	34.00	CIDc+BE	225	26.8	19.3	450	26.6	19.3	900	26.4	19.3	32	6
HKZ1-BH06-SA	59BagA	59.00	CIDc	480	21.3	20.2	960	20.9	20.2	1920	20.3	20.3	31	139

Notes:

- v_s and G_{max} values represent the highest values for the tested range of frequencies
- * = v_s and G_{max} values immediately before consolidation stage, refer to Main Text Section C for details

Key:

CIDc = isotropically consolidated drained triaxial compression test
$w_{\#,i\,/\,\#,f}$ = initial / after-consolidation water content per stage
$\gamma_{\#,i\,/\,\#,f}$ = initial / after-consolidation unit weight per stage
BSF = below seafloor
+BE = with piezoceramic bender element

p’ = effective consolidation pressure
φ' = effective angle of internal friction
c' = effective cohesion
v_s = shear wave velocity immediately before shearing stage
G_{max} = shear modulus at small strain immediately before shearing stage

SUMMARY OF CONSOLIDATED DRAINED TRIAXIAL TEST RESULTS

Location	Sample No.	Depth	Test Type	Stage 1		Stage 2		Stage 3		Bender Element	
		[m BSF]		$w_{1,i}$ [%]	$\gamma_{1,i}$ [kN/m³]	$w_{2,i}$ [%]	$\gamma_{2,i}$ [kN/m³]	$w_{3,i}$ [%]	$\gamma_{3,i}$ [kN/m³]	v_s [m/s]	G_{max} [MPa]
HKZ1-BH07-SA	14BagA	9.50	CIDc	10.3	18.5	10.3	18.5	10.3	18.5	-	-
HKZ1-BH07-SA	24BagA	17.00	CIDc+BE	10.2	15.7	10.0	15.7	10.3	15.6	154.4	45.8
HKZ1-BH07-SA	44BagA	36.00	CIDc+BE	10.3	17.3	10.7	17.3	9.7	17.3	259.8	135.3
HKZ1-BH08-SA	11BagB	9.25	CIDc	9.7	17.8	10.1	17.8	10.1	17.8	-	-
HKZ1-BH08-SA	23BagA	20.50	CIDc+BE	11.4	16.6	10.3	16.6	9.9	16.6	206.2	83.1
HKZ1-BH08-SA	38BagA	35.00	CIDc	10.1	16.4	10.1	16.4	10.1	16.4	-	-

Location	Sample No.	Depth	Test Type	Stage 1			Stage 2			Stage 3			Mohr's Envelope	
		[m BSF]		p' [kPa]	$w_{1,f}$ [%]	$\gamma_{1,f}$ [kN/m³]	p' [kPa]	$w_{2,f}$ [%]	$\gamma_{2,f}$ [kN/m³]	p' [kPa]	$w_{3,f}$ [%]	$\gamma_{3,f}$ [kN/m³]	φ' [°]	c' [kPa]
HKZ1-BH07-SA	14BagA	9.50	CIDc	110	20.2	20.4	220	20.0	20.4	440	19.7	20.4	37	17
HKZ1-BH07-SA	24BagA	17.00	CIDc+BE	120	30.0	18.8	240	28.1	19.1	480	28.7	19.0	32	0
HKZ1-BH07-SA	44BagA	36.00	CIDc+BE	250	24.2	19.6	500	24.4	19.6	1000	23.5	19.8	32	32
HKZ1-BH08-SA	11BagB	9.25	CIDc	85	22.5	19.9	170	22.5	19.9	340	22.3	20.0	35	12
HKZ1-BH08-SA	23BagA	20.50	CIDc+BE	60	27.4	19.2	320	26.6	19.3	640	25.9	19.4	31	20
HKZ1-BH08-SA	38BagA	35.00	CIDc	225	27.2	19.1	450	26.9	19.2	900	26.4	19.3	31	23

Notes:
- v_s and G_{max} values represent the highest values for the tested range of frequencies
- * = v_s and G_{max} values immediately before consolidation stage, refer to Main Text Section C for details

Key:

CIDc = isotropically consolidated drained triaxial compression test
$w_{\#,i\,/\,\#,f}$ = initial / after-consolidation water content per stage
$\gamma_{\#,i\,/\,\#,f}$ = initial / after-consolidation unit weight per stage
BSF = below seafloor
+BE = with piezoceramic bender element

p' = effective consolidation pressure
φ' = effective angle of internal friction
c' = effective cohesion
v_s = shear wave velocity immediately before shearing stage
G_{max} = shear modulus at small strain immediately before shearing stage

SUMMARY OF SOIL-SOIL INTERFACE RING SHEAR TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Location	Sample No.	Depth	Interface	Index Properties		Setup conditions		Slow Shear			Fast Shear		
		[m BSF]		w_i [%]	w_f [%]	Stage	σ'_n [kPa]	φ'_R [°]	τ_n [kPa]	τ_n/σ'_n [-]	φ'_R [°]	τ_n [kPa]	τ_n/σ'_n [-]
HKZ1-BH01-SA	46BagA	43.00	S-S	8.4	26.9	1	200	5.8	111.0	0.56	29.0	108.7	0.54
						2	400	28.5	223.9	0.56	29.3	223.3	0.56
						3	800	28.4	459.1	0.57	29.9	453.6	0.57
HKZ1-BH02-SA	16WaxD	14.10	S-S	32.8	30.3	1	135	17.6	42.8	0.32	7.6	17.8	0.13
						2	270	16.3	78.9	0.29	7.1	33.7	0.12
						3	540	15.8	153.1	0.28	8.1	76.8	0.14
HKZ1-BH03-SA	07BagA	3.00	S-S	8.4	19.4	1	30	34.6	20.5	0.68	20.2	10.9	0.36
						2	60	33.2	39.5	0.66	32.9	39.0	0.65
						3	120	31.0	72.2	0.60	30.0	69.6	0.58
HKZ1-BH03-SA	24WaxA	15.00	S-S	27.2	30.0	1	145	24.0	64.5	0.44	15.9	41.3	0.28
						2	290	22.3	119.1	0.41	13.5	69.6	0.24
						3	580	21.3	226.6	0.39	18.3	192.4	0.33
HKZ1-BH04-SA	30BagA	26.50	S-S	18.0	17.3	1	145	24.0	64.5	0.44	15.9	41.3	0.28
						2	290	22.3	119.1	0.41	13.5	69.6	0.24
						3	580	21.3	226.6	0.39	18.4	192.4	0.33
HKZ1-BH05-SA	15BagA	12.00	S-S	8.7	20.6	1	120	29.2	67.0	0.56	28.5	65.2	0.54
						2	240	30.4	140.7	0.59	28.6	130.8	0.55
						3	480	30.4	282.0	0.59	29.8	274.9	0.57
HKZ1-BH06-SA	12BagA	9.00	S-S	8.5	20.7	1	90	31.9	56.1	0.62	18.9	30.8	0.34
						2	180	29.7	102.5	0.57	26.1	88.0	0.49
						3	360	29.7	205.4	0.57	27.6	188.5	0.52

Key:

S-S = Soil - Soil interface
w_i = initial water content
w_f = final water content
σ'_n = normal effective stress
BSF = below seafloor

τ_n = residual shear stress
φ'_R = angle of residual shear resistance
Slow Shear Rate : 0.16°/min
Fast Shear Rate : 674°/min

SUMMARY OF SOIL-SOIL INTERFACE RING SHEAR TEST RESULTS

Location	Sample No.	Depth	Interface	Index Properties		Setup conditions		Slow Shear			Fast Shear		
		[m BSF]		w_i [%]	w_f [%]	Stage	σ'_n [kPa]	φ'_R [°]	τ_n [kPa]	τ_n/σ'_n [-]	φ'_R [°]	τ_n [kPa]	τ_n/σ'_n [-]
HKZ1-BH06-SA	35BagB	30.05	S-S	8.8	24.6	1	140	29.5	79.2	0.57	26.1	68.6	0.49
						2	280	30.0	161.8	0.58	27.7	147.2	0.53
						3	560	30.5	329.7	0.59	30.2	326.3	0.58
HKZ1-BH07-SA	07BagA	5.50	S-S	9.6	20.0	1	55	31.4	33.6	0.61	31.8	34.1	0.62
						2	110	32.7	70.6	0.64	31.3	66.8	0.61
						3	220	32.3	138.9	0.63	30.9	131.9	0.60
HKZ1-BH07-SA	27BagA	20.00	S-S	9.5	18.1	1	190	30.2	110.6	0.58	28.0	101.2	0.53
						2	380	30.5	223.6	0.59	27.6	199.0	0.52
						3	760	31.5	465.0	0.61	28.9	419.0	0.55
HKZ1-BH08-SA	07BagA	5.50	S-S	9.1	20.7	1	55	29.4	31.0	0.56	29.2	30.7	0.56
						2	115	31.3	66.8	0.58	30.0	69.8	0.61
						3	220	30.9	131.6	0.60	29.6	130.6	0.59

Key:

S-S = Soil - Soil interface
w_i = initial water content
w_f = final water content
σ'_n = normal effective stress
BSF = below seafloor

τ_n = residual shear stress
φ'_R = angle of residual shear resistance
Slow Shear Rate : 0.16°/min
Fast Shear Rate : 674°/min

SUMMARY OF SOIL-STEEL INTERFACE RING SHEAR TEST RESULTS

Location	Sample No.	Depth	Interface	Index Properties		Stage 1		Stage 2							
		[m BSF]		w_i [%]	w_f [%]	σ_n [kPa]	Δh [mm]	σ_n [kPa]	Δh [mm]	τ_{peak} [kPa]	τ_{peak}/σ_n [-]	δ_{peak} [°]	τ_r [kPa]	τ_r/σ_n [-]	δ_r [°]
HKZ1-BH01-SA	9BagA	7.00	S-ST	9.3	16.2	90	0.66	150	1.41	82.3	0.55	28.7	79.4	0.53	27.8
HKZ1-BH01-SA	29BagA	26.50	S-ST	23.4	21.8	150	0.68	250	1.16	147.3	0.59	30.5	142.0	0.57	29.6
HKZ1-BH01-SA	46BagA	43.00	S-ST	9.9	23.1	200	0.67	335	1.29	183.2	0.55	28.7	173.1	0.52	27.3
HKZ1-BH02-SA	09BagA	7.50	S-ST	9.4	24.6	75	0.69	125	1.23	69.0	0.55	28.8	62.3	0.50	26.4
HKZ1-BH02-SA	16WaxD	14.10	S-ST	33.6	31.5	150	0.67	250	0.89	112.2	0.45	24.2	112.1	0.45	24.1
HKZ1-BH02-SA	29BagB	26.30	S-ST	17.8	19.3	150	0.72	250	0.91	157.5	0.63	32.3	144.9	0.58	30.1
HKZ1-BH03-SA	7BagA	3.00	S-ST	9.1	17.9	40	0.67	65	0.86	36.5	0.56	29.1	33.7	0.52	27.2
HKZ1-BH03-SA	24WaxA	15.00	S-ST	34.8	26.5	145	0.67	240	0.81	115.2	0.48	25.7	108.4	0.45	24.4
HKZ1-BH04-SA	30BagA	26.50	S-ST	23.4	18.6	185	0.63	310	0.97	191.4	0.62	31.7	185.1	0.60	30.8
HKZ1-BH04-SA	44BagA	40.00	S-ST	9.0	19.5	125	0.66	210	1.38	113.6	0.54	28.4	105.2	0.50	26.6
HKZ1-BH05-SA	15BagA	12.00	S-ST	9.4	20.0	105	0.68	175	1.29	89.3	0.51	27.0	86.7	0.50	26.3
HKZ1-BH05-SA	24BagB	20.20	S-ST	36.2	33.8	155	0.68	260	1.34	75.7	0.29	16.2	46.5	0.18	10.6
HKZ1-BH05-SA	50BagB	45.75	S-ST	11.2	26.8	225	0.73	375	1.29	235.5	0.63	32.2	231.6	0.62	31.7
HKZ1-BH06-SA	12BagA	9.00	S-ST	9.6	19.2	105	0.67	175	1.08	106.0	0.61	31.2	103.1	0.59	30.5
HKZ1-BH06-SA	35BagB	30.05	S-ST	9.0	21.0	130	0.68	215	1.25	126.7	0.59	30.5	122.8	0.57	29.7
HKZ1-BH07-SA	07BagA	5.50	S-ST	10.2	19.0	65	0.66	110	0.98	59.0	0.54	28.1	54.4	0.49	26.2
HKZ1-BH07-SA	27BagA	20.00	S-ST	10.5	17.3	95	0.66	160	1.19	85.2	0.53	28.1	79.0	0.49	26.3
HKZ1-BH08-SA	07BagA	5.50	S-ST	9.5	21.2	70	0.66	115	1.01	61.6	0.54	28.2	57.0	0.50	26.4

Key:

S-ST = Soil - Steel interface
w_i = initial water content
w_f = final water content
σ_n = normal stress
BSF = below seafloor

Δh = vertical displacement during shearing stage
τ_{peak} = peak shear stress
τ_r = residual shear stress
δ_{peak} = peak interface friction angle
δ_r = residual interface friction angle

SUMMARY OF COMPRESSIBILITY TEST RESULTS

Location	Sample No.	Depth [m BSF]	Test Type	σ'_{v0} [kPa]	w_i [%]	e_0 [-]	ρ_s [Mg/m^3]	$\Delta e/e_0$ [-]	σ'_p [kPa]	OCR [-]	C_c [-]	C_s [-]	CR [-]	RR [-]	RR/CR [-]
HKZ1-BH01-SA	W18	15.70	il	157	28.7	0.832	2.67	0.08	322	2.0	0.375	0.036	0.205	0.020	0.098
	W18	15.81	crs	158	29.2	0.773	2.67	0.08	395	2.5	0.235	0.021	0.133	0.012	0.090
	W24	21.62	crs	211	30.2	0.806	2.70	0.03	574	2.7	0.374	0.036	0.207	0.020	0.097
HKZ1-BH02-SA	W16	14.10	il	138	33.5	0.953	2.70	0.02	525	3.8	0.373	0.033	0.191	0.017	0.089
	W16	14.19	crs	138	32.4	0.895	2.70	0.06	399	2.9	0.366	0.030	0.193	0.016	0.083
	W25	22.52	crs	218	14.5	0.416	2.70	0.11	388	1.8	0.087	0.010	0.061	0.007	0.115
HKZ1-BH03-SA	W24	15.00	il	149	34.3	0.979	2.70	0.05	505	3.4	0.492	0.038	0.249	0.019	0.076
	W24	15.04	crs	149	32.1	0.903	2.70	0.03	397	2.7	0.402	0.031	0.211	0.016	0.076
	W27	18.12	crs	176	29.8	0.838	2.70	0.09	320	1.8	0.313	0.020	0.170	0.011	0.065
	W51	42.01	crs	387	23.2	0.625	2.70	0.15	647	1.7	0.220	0.008	0.135	0.005	0.037
HKZ1-BH04-SA	W19	16.15	il	160	20.3	0.593	2.70	0.08	500	3.1	0.139	0.007	0.087	0.004	0.046
	W19	16.21	crs	161	19.3	0.537	2.70	0.08	262	1.6	0.110	0.006	0.072	0.004	0.056
HKZ1-BH05-SA	W23	19.60	il	206	30.7	0.823	2.70	0.08	270	1.3	0.222	0.028	0.122	0.015	0.123
	W23	19.66	crs	207	29.8	0.753	2.70	0.09	240	1.2	0.219	0.023	0.125	0.013	0.104
HKZ1-BH06-SA	W20	15.70	il	159	36.3	1.057	2.70	0.05	370	2.3	0.383	0.020	0.186	0.010	0.054
	W20	15.72	crs	159	40.3	1.179	2.70	0.07	315	2.0	0.423	0.031	0.194	0.014	0.072
	W32	27.62	crs	267	27.6	0.739	2.69	0.09	373	1.4	0.231	0.011	0.133	0.006	0.045
	W50	43.72	crs	420	25.7	0.693	2.64	0.16	498	1.2	0.233	0.029	0.138	0.017	0.123
HKZ1-BH08-SA	W15	13.20	il	133	34.7	0.972	2.70	0.05	365	2.8	0.453	0.043	0.230	0.022	0.096
	W15	13.30	crs	134	34.7	0.916	2.66	0.07	411	3.1	0.420	0.030	0.219	0.016	0.073

Key:

il = incremental loading
crs = constant rate of strain
w_i = initial water content
ρ_s = density of solid particles
e_0 = initial void ratio
Δe = change in void ratio from initial conditions to estimated effective in situ vertical stress conditions

σ'_{v0} = estimated effective in situ vertical stress
σ'_p = effective preconsolidation pressure
OCR= overconsolidation ratio
C_c = compression index
C_s = swelling index

CR = primary compression ratio
RR = recompression ratio

Note(s):
- Preconsolidation pressure is assessed according to Casagrande (1936)

Test No.	Location	Batched Samples	Sample Depth [m BSF]	$\gamma_{d;i}$ [kN/m^3]	P_1 [W/m]	k_1 [W/(m.K)]	P_2 [W/m]	k_2 [W/(m.K)]
TC01	HKZ1-BH01-SA	1BagA	0.00	13.3	3.930	1.925	3.910	1.988
		4BagA	3.00	14.4	3.910	2.023	3.890	2.058
		2BagB	1.30	14.7	3.890	2.058	3.870	2.082
				15.2	3.870	2.199	3.870	2.230
				15.8	3.860	2.175	3.850	2.172
TC02	HKZ1-BH02-SA	1BagA	0.00	13.2	3.810	1.904	3.800	1.957
		4BagA	2.50	14.0	3.800	1.951	3.790	1.991
				14.8	3.790	2.073	3.770	2.123
				15.7	3.770	2.148	3.760	2.172
				16.5	3.760	2.088	3.750	2.130
TC03	HKZ1-BH03-SA	1BagA	0.00	13.1	3.790	1.936	3.770	1.965
		6BagA	2.50	13.6	3.770	2.003	3.750	2.037
				14.5	3.750	2.034	3.740	2.085
				15.7	3.740	2.139	3.730	2.186
				16.5	3.730	2.308	3.730	2.355
TC04	HKZ1-BH03-SA	10BagA	5.50	13.5	3.860	1.883	3.850	1.928
		13BagA	7.00	14.1	3.840	1.980	3.830	2.046
		16BagA	9.00	14.9	3.830	2.103	3.820	2.158
				15.8	3.810	2.220	3.800	2.265
				17.0	3.800	2.197	3.790	2.220
TC05	HKZ1-BH04-SA	1BagA	0.00	13.2	3.740	1.885	3.730	1.982
		3BagA	2.00	13.8	3.720	1.872	3.710	1.912
				14.7	3.710	2.008	3.700	2.052
				15.7	3.700	2.221	3.690	2.254
				16.4	3.700	2.265	3.690	2.320
TC06	HKZ1-BH05-SA	1BagA	0.00	13.0	3.700	1.872	3.700	1.936
		3BagA	2.00	13.8	3.690	1.912	3.680	1.963
				14.7	3.680	1.695	3.670	1.866
				15.6	3.670	2.013	3.660	2.065
				16.4	3.670	2.004	3.660	2.067
TC07	HKZ1-BH06-SA	1BagA	0.00	13.2	3.880	1.972	3.860	1.983
		4BagB	3.30	13.9	3.860	2.002	3.850	2.019
		1BagB	0.35	14.7	3.840	2.604	3.830	2.104
				15.5	3.830	2.004	3.810	2.058
				16.0	3.810	1.945	3.800	2.082
TC08	HKZ1-BH06-SA	6BagB	5.25	13.3	4.080	1.943	4.050	2.016
		11BagA	8.50	14.0	4.010	2.008	4.000	2.022
				14.8	3.990	2.077	3.980	2.124
				15.7	3.970	2.203	3.960	2.295
				16.3	3.950	1.966	3.930	1.997
TC09	HKZ1-BH07-SA	1BagA	0.00	13.5	3.780	1.958	3.760	1.989
		4BagB	3.00	14.1	3.760	2.083	3.750	2.122
		1BagB	0.25	14.7	3.740	2.109	3.740	2.214
				15.4	3.730	2.219	3.730	2.228
				16.2	3.720	2.047	3.710	2.085
TC10	HKZ1-BH08-SA	1BagA	0.00	13.0	3.630	1.913	3.620	1.937
		3BagA	2.00	14.0	3.610	1.808	3.610	1.999
		2BagB	1.35	14.8	3.610	1.993	3.600	2.071
				15.7	3.600	2.080	3.590	2.170
				16.2	3.580	2.078	3.580	2.146

Key

$\gamma_{d;I}$ = initial specimen dry unit weight

P_1 = Applied power (measurement 1)

k_1 = Thermal conductivity (measurement 1)

P_2 = Applied power (measurement 2)

K_2 = Thermal conductivity (measurement 2)

SUMMARY OF THERMAL CONDUCTIVITY TEST RESULTS

SECTION C2: INDEX LABORATORY TESTS

LIST OF PLATES IN SECTION C2:

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH01-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
01	0.0 m to 0.3 m - olive brown calcareous silica medium SAND, with fine gravel-sized shell fragments - at bottom: one coarse gravel-sized pocket of clay	0.00												9				
		0.15	22.4	20.0	18.6													
02	1.0 m to 1.3 m - olive brown calcareous silica medium SAND, with fine to medium gravel-sized shell fragments	1.00																
		1.20	23.5	19.8	18.4													
	1.3 m to 1.6 m - olive grey calcareous silica medium SAND, with fine to medium gravel-sized shell fragments, with traces of organic matter	1.30																
03	2.0 m to 2.6 m - olive grey calcareous silica medium SAND, with fine to medium gravel-sized shell fragments, with traces of organic matter - at 2.4 m: with many fine to coarse gravel-sized shells and shell fragments	2.00																
		2.30							7	0								
		2.55	24.1	19.7	18.9													
04	3.0 m to 3.5 m - dark grey calcareous silica medium SAND	3.00						2.65						2				
		3.30	24.2	19.7	18.5													
05	4.0 m to 4.5 m - olive grey calcareous silica fine to medium SAND	4.00																
		4.30	23.5	19.8	19.0													
06	4.5 m to 5.0 m - olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments - from 4.8 m to 4.9 m: with very closely spaced thin laminae of organic matter and sand with fine to coarse gravel-sized shell fragments	4.50																
		4.75	23.2	19.8	19.7													

Key:
w : water content
γ_1 : unit weight derived from water content
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$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
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LOCATION HKZ1-BH01-SA

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Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
07	5.5 m to 6.1 m - olive grey calcareous silica fine to medium SAND, with few fine gravel-sized shell fragments - at 5.7 m: with fine to medium gravel-sized shell fragments	5.50																
		5.80	22.8	19.9	17.9													
08	6.5 m to 7.0 m - olive grey calcareous silica medium SAND, with few fine to medium gravel-sized shell fragments	6.50																
		6.80	23.7	19.8	19.1													
09	7.0 m to 7.6 m - dark grey to olive grey calcareous silica fine to medium SAND, with few fine gravel-sized shell fragments	7.00				13.9	16.7	2.66						7				
		7.25	21.6	20.1	19.1													
10	8.0 m to 8.7 m - dark grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments	8.00																
		8.40	22.5	20.0	19.7													
11	9.0 m to 9.5 m - dark grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments	9.00																
		9.25	23.0	19.9	18.7													
12	10.0 m to 10.6 m - dark grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	10.00																
		10.30	22.8	19.9	18.9													
13	11.0 m to 11.2 m - dark grey calcareous silica fine to medium SAND, with fine to medium gravel-sized shell fragments	11.00																
	11.2 m to 11.5 m - dark grey calcareous silica medium to coarse SAND, with many fine to medium gravel-sized shell fragments	11.20							2									

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No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		11.30	21.8	20.1	18.5													
14	12.0 m to 12.6 m - dark grey calcareous silica medium to coarse SAND, with fine to medium gravel-sized shell fragments - at 12.2 m: with one coarse gravel-sized pocket of clay	12.00				13.1	16.0	2.65										
		12.40	21.2	20.2	18.7													
15	13.0 m to 13.4 m - dark grey calcareous silica medium to coarse SAND, with traces of fine gravel-sized shell fragments - at top many fine to medium gravel-sized shell fragments - at 13.2 m: many fine to medium gravel-sized shell fragments	13.00																
		13.30	21.3	20.2	18.6													
16	13.5 m to 13.6 m - dark grey calcareous silica medium to coarse SAND, with few fine gravel-sized shell fragments	13.50																
	13.6 m to 14.4 m - firm very dark grey CLAY	13.55	20.5	20.3														
		14.10	31.2	18.7	19.0										50			
17	14.5 m to 15.3 m - stiff dark grey CLAY - with extremely closely to very closely spaced thin laminae of sand	14.50																
		14.65			18.9													
		14.85	30.6	18.9	19.1													
		15.05			19.0													
		15.10													100			
18	15.5 m to 16.3 m - dark grey CLAY - with extremely closely to very closely spaced thin laminae of sand	15.50						2.67			17	35	18	70				
		15.70	28.7	19.1	17.7 18.4													
		15.81	29.2	19.0	19.1													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH01-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		15.90	28.9	19.2	19.0													
		15.94	29.1	19.1	19.0													
19	16.5 m to 16.6 m - firm dark grey slightly sandy CLAY	16.50																
	16.6 m to 17.3 m - no description	16.55	31.5	18.8											71			
	17.3 m to 17.4 m - dark grey CLAY - with thin laminae of sand	17.30																
		17.35	29.2	19.1														
20	17.5 m to 18.4 m - dark grey CLAY - with extremely closely to very closely spaced thin laminae of sand	17.50																
		17.90			19.0													
		18.10			19.1													
		18.35	30.3	18.8	17.5													
21	18.5 m to 19.3 m - dark grey CLAY - with extremely closely to very closely spaced thin laminae of sand	18.50									18	41	23					
		18.90			18.8													
		19.10	20.4	20.6	18.4													
22	19.5 m to 20.1 m - firm dark grey CLAY, with traces of mica crystals - with extremely closely to very closely spaced thin to thick laminae of sand	19.50																
		19.55													72			
		20.00	28.0	19.1	17.1													
23	20.5 m to 21.1 m - dark grey very sandy CLAY	20.50																
		20.90	25.8	19.4	18.9													

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No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
24	21.5 m to 22.3 m - stiff dark grey CLAY - at 22.1 m: one very thin bed of organic matter and extremely closely spaced thin laminae of sand	21.50																
		21.60			18.4						23	59	36		125	75		
		21.62	30.2	19.0	19.1													
		21.75	30.9	18.9	19.0 22.9													
		21.90	30.5	19.0														
		22.00													92			
		22.15	24.4	19.9	19.2												75	
		22.15	30.2	19.0	19.2 19.1						22	54	32	99			69r	
25	22.5 m to 22.7 m - dark grey CLAY	22.50			18.3													
	22.7 m to 22.8 m - stiff slightly cemented olive CLAY	22.65																
		22.70													119			
	22.8 m to 22.9 m - dark grey to very dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay	22.75																
		22.85	33.3	18.6														
26	23.5 m to 24.3 m - hard dark grey sandy calcareous CLAY - with few very thin beds of sand	23.50			21.2													
		23.70			21.0										325			
		24.00	47.0	17.0														
		24.10			20.7													
27	24.5 m to 25.4 m - olive grey clayey calcareous silica fine SAND, with traces of mica crystals - with medium spaced very thin beds of clay	24.50																

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		24.90	17.6	20.9	20.3													
28	25.5 m to 26.3 m - dark grey clayey calcareous silica fine SAND - with few thick laminae of clay	25.50	10.2	22.9	16.8			2.68			22	28	6	82				
		26.00	22.4	20.0	19.4													
29	26.5 m to 26.9 m - dark grey clayey calcareous silica fine SAND - with few very thin beds of clay	26.50																
	26.9 m to 27.4 m - dark grey calcareous silica fine SAND - with few thin to thick laminae of clay - with few thin laminae of organic matter	26.90																
		27.00	26.0	19.4	19.4													
30	27.5 m to 28.2 m - dark grey calcareous silica fine SAND - at 27.8 m: with one thick laminae of clay - at 27.9 m: with one thin laminae of organic matter	27.50																
		27.90	27.5	19.2	19.0													
31	28.5 m to 29.3 m - dark grey calcareous silica fine SAND - with very closely spaced thin to thick laminae of clayey sand	28.50																
		28.80	28.6	19.0	19.7													
32	29.5 m to 30.3 m - dark grey calcareous silica fine SAND - with very closely spaced thin to thick laminae of clayey sand - at 29.8 m: with one very thin bed of clay	29.50																
		29.80							2									
		30.00	30.1	18.8	19.9													
		30.05												16				
33	30.5 m to 31.4 m - olive grey slightly clayey calcareous silica fine SAND - with medium spaced very thin beds of clay	30.50																

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Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
		31.00	30.1	18.8	19.2													
34	31.5 m to 32.3 m - dark grey slightly clayey calcareous silica fine SAND - with few thin laminae of clay - with few thin to thick laminae of organic matter	31.50																
		31.90	24.8	19.6	19.1													
35	32.5 m to 33.1 m - dark grey calcareous silica fine SAND	32.50																
		32.80	24.2	19.7	19.0													
36	33.5 m to 34.0 m - dark grey silty calcareous silica fine SAND - with medium spaced thin to thick laminae of clay	33.50																
		33.75	24.4	19.6	18.6													
37	34.5 m to 34.9 m - dark grey silty calcareous silica fine SAND	34.50				12.7	16.5											
		34.70	23.3	19.8	19.3													
38	35.0 m to 35.3 m - dark grey silty calcareous silica fine SAND	35.00						2.64						3				
		35.20	23.7	19.8	18.2													
	35.3 m to 35.4 m - dark grey fine SAND - with extremely closely spaced thin to thick laminae of organic matter	35.30																
	35.4 m to 35.6 m - olive grey silty silica fine SAND	35.40																
39	36.0 m to 36.3 m - olive grey silica fine SAND	36.00																
		36.10	23.7	19.8	18.6													
	36.3 m to 36.8 m - dark grey silica fine SAND, with traces of organic matter - with very thin beds to thin beds of clay	36.30								2								
		36.70	26.8	19.5														

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40	37.0 m to 37.4 m - dark grey silica medium to coarse SAND - with many pockets of medium gravel-sized clay	37.00																
		37.20	24.3	19.7	17.6													
	37.4 m to 37.7 m - dark grey CLAY - with extremely closely spaced thin laminae of sand	37.35																
41	38.0 m to 38.1 m - dark grey silica fine SAND	38.00												23				
	38.1 m to 38.6 m - thinly interlaminated dark grey CLAY and dark grey silica fine SAND, with traces of organic matter	38.10																
		38.15	27.6	19.2	18.3													
42	39.0 m to 39.3 m - olive grey silty silica fine SAND	39.00																
		39.10	31.1	18.7	18.2													
	39.3 m to 39.7 m - olive grey silica fine SAND - with thin to thick laminae of clay	39.25																
		39.45												41				
		39.55	24.5	19.9														
43	40.0 m to 40.2 m - silica fine SAND	40.00																
		40.10	27.1	19.2	18.2													
	40.2 m to 40.9 m - thinly to thickly interlaminated olive grey sandy CLAY and olive grey silty silica fine SAND	40.15																
		40.80	28.3	19.3														
44	41.0 m to 41.7 m - thinly to thickly interlaminated olive grey CLAY and olive grey silty silica fine SAND	41.00									18	32	14	77				
		41.60	29.8	19.1														
45	42.0 m to 42.8 m - olive grey silica fine SAND - with thin to thick laminae of clay	42.00																

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		42.25	30.6	18.7	18.0													
46	43.0 m to 43.6 m - olive grey silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay	43.00						2.64			25	30	5	62				
		43.55	27.9	19.3														
47	44.0 m to 44.7 m - olive grey CLAY - with extremely closely spaced thin laminae of sand	44.00																
		44.65	25.9	19.6														
48	45.0 m to 45.6 m - olive grey CLAY - with extremely closely spaced thin laminae of sand	45.00																
		45.55	23.8	20.0														
49	46.0 m to 46.7 m - olive grey CLAY - with extremely closely spaced thin laminae to very thin beds of sand	46.00						2.67			16	30	14	74				
		46.65	24.1	19.9														
50	47.0 m to 47.7 m - olive grey CLAY - with extremely closely spaced thin laminae of sand	47.00																
		47.65	24.0	19.9														
51	48.0 m to 48.7 m - olive grey silica fine SAND - with extremely closely spaced thin laminae of clay	48.00																
		48.45						2.67						48				
		48.65	26.0	19.6														
52	49.0 m to 49.6 m - olive grey silica fine SAND - with extremely closely spaced thin laminae of clay	49.00																
		49.55	25.8	19.6														
53	53.0 m to 53.5 m - olive grey CLAY - with extremely closely spaced thin laminae of sand	53.00						2.67			18	34	16					
		53.25	28.1	19.3														

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GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
	53.5 m to 53.9 m - olive grey silica fine SAND - with extremely closely spaced thin laminae of clay	53.50												74				
		53.50												74				
		53.70												34				
		53.75	24.0	19.9														
54	57.0 m to 57.6 m - olive grey silica medium SAND, with traces of fine gravel-sized shell fragments, with traces of organic matter - with closely spaced thick laminae of clay	57.00							3	6								
		57.30	20.1	20.4	19.0	13.6	17.6	2.66						14				
55	61.0 m to 61.7 m - olive grey silica medium to coarse SAND, with traces of organic matter - with closely spaced very thin beds of clay	61.00												22				
		61.30	19.9	20.4	19.0													

Key:

w : water content
γ_1 : unit weight derived from water content
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ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
10d : d refers to test on disturbed soil

GeODin/LCTR.GLO/2016-10-24 16:28

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH01-SC

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
01	19.0 m to 19.8 m - dark grey calcareous CLAY - with extremely closely spaced thin laminae of sand	19.00																
02	39.0 m to 39.5 m - dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay	39.00																
		39.25	26.9	19.3														
03	41.0 m to 41.9 m - dark grey calcareous CLAY, with traces of mica crystals - with extremely closely to very closely spaced thin laminae of sand - with thin laminae of organic matter	41.00																
		41.40	26.7	19.5														
04	45.0 m to 45.9 m - dark grey calcareous CLAY - with extremely closely spaced thin laminae of sand	45.00																
		45.50	38.5	18.0	20.6													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
01	0.0 m to 0.5 m - light olive brown calcareous silica fine to medium SAND, with traces of fine to medium gravel-sized shells and shell fragments	0.00												2				
		0.25	23.6	19.8	18.5													
02	0.5 m to 1.1 m - light olive brown to dark grey calcareous silica fine to medium SAND, with traces of fine to medium gravel-sized shell fragments	0.50																
		0.70	22.0	20.0	18.8													
03	1.5 m to 2.0 m - dark grey calcareous silica fine to medium SAND, with traces of fine to medium gravel-sized shell fragments - with one thick lamina of organic matter	1.50																
		1.75							3									
		1.80	21.4	20.1	19.3													
04	2.5 m to 3.1 m - dark grey calcareous silica fine SAND, with traces of fine gravel-sized shell fragments	2.50						2.65						3				
		2.80	23.1	19.9	18.4													
05	3.5 m to 4.1 m - dark grey calcareous silica fine SAND, with traces of fine gravel-sized shell fragments - with one thin lamina of organic matter	3.50																
		3.90	23.3	19.8	19.7													
06	4.5 m to 5.2 m - dark grey calcareous silica fine SAND, with traces of fine gravel-sized shell fragments	4.50																
		4.80	22.8	19.9	19.1													
07	5.5 m to 6.2 m - dark grey calcareous silica fine SAND	5.50				13.1	16.2							9				
		5.90	23.1	19.9	18.6													
08	6.5 m to 7.1 m - dark grey calcareous silica fine SAND, with traces of mica crystals	6.50																
		6.90	23.8	19.7	19.0													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
09	7.5 m to 8.1 m - dark grey calcareous silica fine SAND	7.50				13.0	15.0							2				
		7.80	23.9	19.7	18.8													
10	8.5 m to 9.0 m - dark grey to grey calcareous silica fine SAND, with traces of fine gravel-sized shell fragments, with traces of organic matter	8.50							2	0								
		8.80	22.1	20.0	18.6													
11	9.0 m to 9.5 m - dark grey calcareous silica medium SAND	9.00																
		9.30	20.8	20.2	18.8													
12	9.5 m to 10.1 m - dark grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	9.50																
		9.80	21.7	20.1	18.7													
13	10.5 m to 11.3 m - stiff dark grey calcareous CLAY, with traces of organic matter - with very closely to closely spaced thin laminae of fine sand	10.50													91			
		10.80			19.2													
		11.00	26.7	19.5														
14	11.5 m to 12.4 m - stiff dark grey calcareous CLAY, with traces of organic matter - with few thin laminae of sand	11.50																
		11.95	28.4	19.3	19.6												38r	
		11.95	27.0 29.1	19.1 19.5	19.4			2.67			18	37	19	96	117		76	
		12.10													138			
		12.15			19.2													
		12.17	28.3	19.3	19.3													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
15	12.5 m to 13.3 m - stiff dark grey to very dark grey calcareous CLAY, with traces of organic matter - with very closely spaced thin laminae of sand	12.50																
		12.55													100			
		12.75			18.2													
		12.95	34.8	18.4	18.1													
		13.15													131			
16	13.5 m to 14.3 m - very stiff platy very dark grey calcareous CLAY, with traces of organic matter - with very closely to closely spaced thin laminae of sand	13.50																
		13.65													163			
		13.70			18.0													
		13.90	34.1	18.5											167			
		14.00													167			
		14.10	33.5	18.6	16.8 18.1													
		14.19	32.4	18.7	18.5													
17	14.5 m to 14.8 m - stiff very dark grey calcareous CLAY - with few thin laminae of organic matter	14.50									31	63	32	98				
		14.60	38.5	18.0	18.0												93	
		14.60	37.2 36.6	18.2 18.1	18.1 17.7										92		114r	
	14.8 m to 15.1 m - wood debris	14.80																
		15.00	40.9	17.7														
	15.1 m to 15.2 m - hard very dark grey calcareous CLAY	15.05																
		15.10													350			

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
18	15.5 m to 15.6 m - hard very dark grey calcareous CLAY	15.50									25	66	41		317			
		15.55	31.4	18.8														
	15.6 m to 16.1 m - olive grey calcareous silica fine SAND	15.60																
		15.90	20.3	20.3	19.4													
19	16.5 m to 16.8 m - dark grey slightly clayey calcareous silica fine SAND, with traces of mica crystals, with traces of organic matter	16.50							2	1								
	16.8 m to 17.2 m - dark grey calcareous silica fine SAND, with traces of mica crystals - with one thin lamina of organic matter	16.80																
		16.90	26.2	19.4	19.0													
20	17.5 m to 17.8 m - dark grey silica fine SAND, with traces of mica crystals	17.50												8				
	17.8 m to 18.1 m - dark grey slightly clayey calcareous silica fine SAND, with traces of mica crystals - with few thin laminae of organic matter	17.80	28.3	19.1	18.7													
21	18.5 m to 19.0 m - dark grey slightly clayey calcareous silica fine SAND - with closely spaced very thin beds of clay - with very closely spaced thin laminae of organic matter	18.50						2.65						31				
		18.70				12.2	14.9											
		18.80	24.9	19.6	19.5													
	19.0 m to 19.4 m - dark grey very clayey calcareous silica fine SAND - with very thin beds of clay	18.95																
		19.30													69			
22	19.5 m to 19.7 m - firm dark grey calcareous CLAY	19.50	26.4	19.5	19.4												27r	
		19.50	30.2	19.0	19.4 18.2												49	

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
	19.7 m to 19.8 m - dark grey calcareous silica fine SAND	19.70													46			
	19.8 m to 20.1 m - firm dark grey calcareous CLAY - with closely spaced thin laminae of sand	19.80	27.9	19.3											67			
	20.1 m to 20.4 m - dark grey clayey calcareous silica fine SAND - with few thin laminae of organic matter	20.10													75			
		20.20	25.4	19.5	19.0													
23	20.5 m to 21.3 m - dark grey calcareous silica fine SAND, with traces of mica crystals - with few thin to thick laminae of organic matter	20.50				12.8	15.1	2.65						5				
		20.90	24.1	19.7	18.8													
	21.3 m to 21.4 m - stiff dark grey calcareous CLAY - with extremely closely spaced thin laminae of sand	21.30																
		21.35	26.5	19.5														
		21.40													150			
24	21.5 m to 22.4 m - stiff to very stiff very dark grey calcareous CLAY, with traces of organic matter - with extremely closely spaced thin to thick laminae of sand and silt	21.50																
		21.60			19.9										75			
		21.80			19.0													
		21.95	24.5	19.9														
		22.10													219			
25	22.5 m to 23.0 m - hard dark grey slightly sandy calcareous CLAY	22.50			19.9			2.62			16	31	15	91				
		22.52	14.5	21.8	21.4													
		22.70	17.5	21.1	22.0 20.1										463			

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		22.90	20.5	20.3	20.1										317			
	23.0 m to 23.2 m - dark grey slightly clayey calcareous silica fine SAND	22.95																
		23.10	21.7	20.3														
26	23.5 m to 24.1 m - dark grey slightly clayey calcareous silica fine SAND - with closely spaced thin to thick laminae of clay - with one very thin bed of silt	23.50																
		23.90													567			
		24.00	20.1	20.4	19.5													
	24.1 m to 24.4 m - dark grey slightly clayey calcareous silica fine SAND - with closely spaced thin to thick laminae of clay	24.05																
27	24.5 m to 25.3 m - dark grey clayey calcareous silica fine SAND, with traces of organic matter - with closely to medium spaced thin to thick laminae of clay	24.50																
		24.75													131			
		24.90	22.7	19.9	19.0													
		25.05	10.0	22.9	17.3			2.67			23	27	4	55				
28	25.5 m to 26.0 m - dark grey slightly clayey calcareous silica fine SAND - with few thin to thick laminae of clay	25.50																
29	26.0 m to 26.9 m - dark grey clayey calcareous silica fine SAND - with closely to medium spaced thin laminae of clay	26.00																
		26.10													150			
		26.50	24.1	19.7	19.3													

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FUGRO

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
30	27.0 m to 27.8 m - dark grey slightly clayey calcareous silica fine SAND - with closely to medium spaced very thin beds to thin beds of clay - with few thin laminae of organic matter	27.00																
		27.15												85				
		27.40													181			
		27.45	24.2	19.7	18.7													
		27.70													169			
31	28.0 m to 28.8 m - dark grey slightly clayey calcareous silica fine SAND - with closely to medium spaced thick laminae of stiff clay	28.00																
		28.40	24.5	19.6	18.7													
		28.70													100			
32	29.0 m to 29.9 m - dark grey slightly clayey calcareous silica fine SAND - with closely to medium spaced very thin beds to thin beds of clay - with few thin laminae of organic matter	29.00																
		29.20													63			
		29.40													63			
		29.50	24.2	19.7	19.4													
		29.60													63			
33	30.0 m to 30.8 m - dark grey calcareous silica fine SAND, with traces of mica crystals - at top slightly clayey - with very closely to closely spaced thin to thick laminae of with organic matter	30.00												12				
		30.40	26.9	19.3	19.7													

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LABORATORY CLASSIFICATION TEST RESULTS
LOCATION HKZ1-BH02-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
34	31.0 m to 31.9 m - dark grey calcareous silica fine SAND - with closely to medium spaced thick laminae of firm clay	31.00												41				
		31.15													67			
		31.25													67			
		31.60	22.8	19.9	18.1													
35	32.0 m to 32.8 m - dark grey calcareous silica fine SAND - with few thin laminae of organic matter - at top one very thin bed of clay	32.00																
		32.40	26.2	19.4	19.7													
36	33.0 m to 33.3 m - dark grey calcareous silica fine SAND - with extremely closely spaced thin laminae of clayey organic matter	33.00							2	1								
	33.3 m to 33.8 m - dark grey calcareous silica fine SAND - with few thin to thick laminae of organic matter - with few thick laminae of clay	33.25																
		33.50	26.5	19.3	18.8													
37	34.0 m to 34.8 m - dark grey silica fine SAND, with traces of organic matter - with a medium bed of clayey sand	34.00																
		34.10													125			
		34.50	25.8	19.4	18.4			2.66						64				
		34.60													167			
38	35.0 m to 35.1 m - very dark grey slightly sandy calcareous CLAY	35.00	24.7	19.8														
	35.1 m to 35.7 m - no description	35.05																
	35.7 m to 35.7 m - very dark grey slightly clayey calcareous silica fine to medium SAND, with organic matter	35.65																

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I_P : plasticity index
Fines : mass percentage of material passing 63 μm or 75 μm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
39	36.0 m to 36.2 m - dark grey silica medium SAND - with extremely closely to very closely spaced thin laminae of organic matter	36.00																
	36.2 m to 36.5 m - stiff dark grey calcareous CLAY - with closely spaced thin to thick laminae of sand	36.15	28.0	19.3														
		36.40													125			
		36.45	24.0	19.7	19.3													
	36.5 m to 36.9 m - dark grey slightly clayey organic medium to coarse SAND	36.50																
40	37.0 m to 37.5 m - dark grey slightly clayey organic fine SAND, with traces of organic matter - with very closely to closely spaced thin laminae of sand - with one thick lamina of organic matter	37.00								4								
		37.45	21.3	20.2	19.5													
41	38.0 m to 38.6 m - dark grey calcareous silica fine SAND - with few thin laminae of clay	38.00																
		38.30	24.6	19.6	18.6	12.9	15.3	2.65										
42	39.0 m to 39.8 m - dark grey silica fine to medium SAND - with extremely closely to closely spaced thin to thick laminae of organic matter - with few thick laminae of medium sand	39.00																
		39.40	23.8	19.7	18.9													
		39.55												13				
43	40.0 m to 40.2 m - dark grey silica fine to medium SAND - with closely spaced thin beds of organic matter	40.00																
	40.2 m to 40.7 m - dark grey silica medium SAND - with extremely closely to closely spaced thick laminae to very thin beds of clay	40.15																
		40.40	23.0	19.9	19.2													

Key:
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$\gamma_{d;max}$: maximum index dry unit weight
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Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
44	41.0 m to 41.1 m - very dark grey slightly sandy organic calcareous CLAY	41.00								3								
	41.1 m to 41.5 m - dark grey calcareous silica fine to medium SAND - with few thin laminae of organic matter	41.10																
		41.30	26.3	19.4	18.8													
45	42.0 m to 42.5 m - dark grey calcareous silica fine to medium SAND - at top very closely spaced thin laminae of organic matter	42.00																
		42.30	23.7	19.7	19.4													
46	42.5 m to 43.1 m - dark grey calcareous silica fine to medium SAND - with few extremely closely spaced thin laminae of clay and organic matter	42.50																
		42.85	23.7	19.8	19.1													
47	43.5 m to 44.0 m - dark grey calcareous silica fine to medium SAND - with extremely closely spaced thin laminae of clay - with one very thin bed of clay	43.50																
	44.0 m to 44.3 m - dark grey medium SAND	43.95																
		44.00	25.3	19.5	19.0													
48	44.5 m to 45.3 m - dark grey to grey silica medium SAND - with extremely closely spaced thin laminae of clay	44.50																
		44.90	24.7	19.6	18.6													
		45.00				11.3	15.3	2.63						22				
49	45.5 m to 46.1 m - dark grey calcareous silica fine SAND - with few thin laminae of clay	45.50																
		45.90	26.1	19.4	18.1													

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Fugro Report No. N6196/01 (3)

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH02-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
	46.1 m to 46.2 m - dark grey SAND - with extremely closely spaced thin laminae of organic matter	46.05																
50	46.5 m to 46.8 m - dark grey clayey calcareous silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay - with few thin laminae of organic matter	46.50																
	46.8 m to 46.9 m - very stiff dark grey CLAY - with extremely closely spaced thin laminae of silt	46.80																
	46.9 m to 47.4 m - dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay and organic matter	46.90													167			
		47.00	27.4	19.2	19.2													
51	47.5 m to 48.3 m - dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay - with few thin laminae of organic matter	47.50																
		47.90	27.0	19.2	18.3													
52	48.5 m to 49.3 m - dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay and organic matter - with closely spaced thin beds of clay	48.50																
		48.55													183			
		48.95	25.1	19.5	18.6													
53	49.5 m to 50.4 m - dark grey calcareous silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay and organic matter - with very thin to thin beds of clay	49.50																
		49.70												90				
		50.00	25.3	19.5	18.5													

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FUGRO

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_p [%]	Fines [%]	PP	TV	UU	LV
01	0.0 m to 0.3 m - light olive brown to dark olive grey calcareous silica fine to medium SAND, with traces of organic matter	0.00												4				
		0.15	24.2	19.7	19.8													
02	0.5 m to 0.9 m - dark olive grey calcareous silica medium SAND, with traces of organic matter, with traces of fine gravel-sized shell fragments	0.50																
		0.70	22.6	19.9	18.3													
03	1.0 m to 1.4 m - dark olive grey calcareous silica medium SAND, with traces of organic matter, with traces of fine gravel-sized shell fragments	1.00							2	0								
		1.20	23.4	19.8	18.6													
04	1.5 m to 2.0 m - olive grey to dark olive grey calcareous silica medium SAND, with traces of organic matter, with traces of fine to medium gravel-sized shell fragments	1.50																
		1.75	22.3	20.0	18.0													
05	2.0 m to 2.4 m - olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shells and shell fragments	2.00																
		2.20	22.5	20.0	18.0													
06	2.5 m to 2.9 m - olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shell fragments	2.50						2.65						4				
		2.70	19.6	20.5	18.7													
07	3.0 m to 3.5 m - olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	3.00				13.8	15.9											
		3.25	21.1	20.2	19.6													
08	4.0 m to 4.5 m - olive grey calcareous silica fine to medium SAND	4.00																
		4.25	22.3	20.0	19.0													

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
09	5.0 m to 5.4 m - dark greyish brown calcareous silica fine to medium SAND, with traces of organic matter, with traces of shell fragments	5.00																
		5.20	23.0	19.9	19.4													
10	5.5 m to 5.8 m - olive grey calcareous silica fine to medium SAND	5.50												3				
		5.65	23.1	19.9	18.9													
11	6.0 m to 6.3 m - olive grey calcareous silica fine to medium SAND	6.00																
		6.15	21.1	20.2	19.3													
12	6.5 m to 6.8 m - olive grey calcareous silica fine to medium SAND	6.50																
		6.65	21.2	20.2	19.0													
13	7.0 m to 7.3 m - olive grey calcareous silica fine to medium SAND	7.00																
		7.15	23.5	19.8	19.1													
14	7.5 m to 8.0 m - olive grey calcareous silica fine to medium SAND	7.50				13.5	15.7											
		7.70	22.9	19.9	18.8													
15	8.0 m to 8.5 m - olive grey calcareous silica medium SAND	8.00						2.65						5				
		8.25	19.8	20.4	18.5													
16	9.0 m to 9.3 m - olive grey calcareous silica medium SAND	9.00							2									
		9.15	19.7	20.4	18.9													
17	9.5 m to 9.7 m - olive grey calcareous silica medium SAND	9.50																
		9.60	23.4	19.8	18.9													

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Fugro Report No. N6196/01 (3)

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_p [%]		PP	TV	UU	LV
18	10.0 m to 10.3 m - olive grey calcareous silica medium SAND	10.00																
		10.15	22.6	19.9	19.7													
19	10.5 m to 11.0 m - olive grey slightly gravelly calcareous silica medium to coarse SAND, with fine to medium gravel-sized shell fragments - at bottom organic matter	10.50																
		10.80	20.0	20.4	17.8													
20	11.5 m to 11.8 m - olive grey slightly gravelly calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments	11.50																
	11.8 m to 11.9 m - olive grey calcareous silica fine to medium SAND - with extremely closely spaced thin laminae of shell fragments	11.75	20.2	20.3	18.4													
21	no recovery	12.00												5				
21A	12.0 m to 12.5 m - olive grey calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments	12.00																
		12.30	19.4	20.5	18.9													
	12.5 m to 12.6 m - dark olive grey CLAY	12.45																
		12.55	25.2	19.7														
22	13.0 m to 13.7 m - stiff to very stiff dark olive grey CLAY - with very closely to closely spaced thin laminae of sand and organic matter	13.00	26.0	19.6	19.9												113r	
		13.00	27.6	19.4	20.1										132	188	122	
		13.20									20	46	26	97	130	108		
		13.60	26.8	19.5											153	88		
23	14.0 m to 14.8 m - stiff to very stiff dark olive grey slightly sandy CLAY, with traces of organic matter	14.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
		14.15	33.9	18.5														
		14.20													122			
		14.40			18.3										108	75		
		14.42	34.1	18.5	18.7													
		14.60			18.2										92	88		
24	15.0 m to 15.7 m - stiff to very stiff dark olive grey CLAY - with thick laminae of sand	15.00	34.3	18.5	18.4 18.5										100			
		15.04	32.1	18.7	18.3													
		15.20	36.8	18.2	18.7												80	
		15.20	35.2	18.4	18.5						27	56	29		100	95	60r	
		15.40	35.5	18.3														
		15.50			18.4										112	75		
25	16.0 m to 16.8 m - firm to stiff dark olive grey calcareous CLAY, with traces of organic matter - with medium spaced to closely spaced thick laminae of sand	16.00												98				
		16.10			18.9										84	53		
		16.30													105	55		
		16.50			18.1										108	63		
		16.70	36.4	18.2														
26	17.0 m to 17.7 m - firm to stiff dark olive grey slightly sandy calcareous CLAY, with traces of organic matter - at top thin laminae of silt	17.00																
		17.10	36.5	18.2	18.3												50r	
		17.10	36.4	18.2	18.4			2.60			28	58	30		150	50	93	
		17.30			18.9										116	70		

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		17.32	28.6	19.2	19.3													
		17.50													107	70		
		17.65	32.1	18.7														
27	18.0 m to 18.7 m - stiff to very stiff dark olive grey slightly sandy calcareous CLAY	18.00																
		18.05	29.3	19.1														
		18.10			19.5										153	100		
		18.12	29.8	19.1	18.7													
		18.30	28.5	19.2	19.3												47r	
		18.30	28.2	19.3	19.2										95	80	108	
		18.50			19.2										116	90		
28	19.0 m to 19.3 m - firm to stiff dark olive grey CLAY - with one coarse gravel-sized pocket of silt	19.00																
		19.05	30.8	18.9														
		19.10													84	53		
	19.3 m to 19.7 m - dark grey silty calcareous silica fine SAND, with traces of mica crystals - with extremely closely spaced thick laminae of clay	19.30																
		19.60	23.5	20.0														
29	20.0 m to 20.8 m - dark grey slightly silty calcareous silica fine SAND, with traces of organic matter - with medium spaced thick laminae of clay	20.00												32				
		20.40	32.4	18.5	17.9													
30	21.0 m to 21.8 m - dark grey silty calcareous silica fine SAND - with medium spaced thick laminae of clay	21.00																
		21.35	32.6	18.5	19.9													

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
31	22.0 m to 22.8 m - dark grey silty calcareous silica fine SAND, with traces of organic matter - with medium spaced thick laminae of clay	22.00																
		22.40							11	1								
		22.45	31.3	18.7	17.8													
32	23.0 m to 23.8 m - dark grey silty calcareous silica fine SAND - with very closely spaced thick laminae of clay	23.00																
		23.40	29.6	18.9	18.9													
33	24.0 m to 24.9 m - dark grey silty calcareous silica fine SAND - at bottom traces of organic matter - with medium spaced thin laminae of clay - at 24.4 m: with a thin bed of clay	24.00				11.4	15.0	2.68						47				
		24.30	31.6	18.6	18.5													
34	25.0 m to 25.5 m - dark grey silty calcareous silica fine SAND - with extremely closely spaced thin laminae of organic matter	25.00																
		25.30	30.8	18.7	18.6													
	25.5 m to 25.8 m - dark grey sandy calcareous CLAY	25.50																
35	26.0 m to 26.4 m - dark grey silty calcareous silica fine SAND - with extremely closely to closely spaced thin laminae of organic matter	26.00																
		26.30	33.0	18.4	18.2													
	26.4 m to 26.8 m - dark grey very sandy calcareous CLAY - with closely spaced thin beds of sand	26.40									19	30	11	76				
36	27.0 m to 27.7 m - dark grey silty calcareous silica fine SAND	27.00																
		27.35	32.0	18.6	18.9													

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
	27.7 m to 27.8 m - dark grey calcareous CLAY	27.70																
37	28.0 m to 28.9 m - very thinly interbedded dark grey calcareous CLAY and dark grey silty fine SAND	28.00																
		28.40	32.2	18.5	18.8													
38	29.0 m to 29.8 m - dark grey silty calcareous silica fine SAND	29.00																
		29.45	33.3	18.4	18.7													
39	30.0 m to 30.2 m - dark grey silty calcareous silica fine SAND	30.00												44				
	30.2 m to 30.7 m - dark grey calcareous CLAY	30.20																
	30.7 m to 30.8 m - dark grey silty calcareous silica fine SAND	30.65																
40	31.0 m to 31.2 m - dark grey calcareous CLAY	31.00									18	37	19	90				
	31.2 m to 31.7 m - dark grey silty calcareous silica fine SAND	31.20																
		31.40	30.2	18.8	18.2													
41	32.0 m to 32.8 m - thinly interbedded dark grey silty calcareous silica fine SAND and dark grey calcareous CLAY	32.00																
		32.50	27.3	19.2	17.9													
		32.75	27.6	19.4														
42	33.0 m to 33.8 m - dark grey silty calcareous silica fine SAND	33.00				11.2	14.3	2.68						15				
		33.40	32.8	18.5	18.4													
43	34.0 m to 34.8 m - dark grey silty calcareous silica fine SAND, with traces of organic matter	34.00							13	1								
44	35.0 m to 35.7 m - dark grey silty calcareous silica fine SAND	35.00																

Key:
w : water content
γ_1 : unit weight derived from water content
γ_2 : unit weight derived from volume mass calculation
$\gamma_{d;min}$: minimum index dry unit weight
$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
10d : d refers to test on disturbed soil

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		35.35	35.5	18.1	18.3													
45	36.0 m to 36.8 m - dark grey silty calcareous silica fine SAND, with traces of organic matter	36.00																
		36.30	33.0	18.4	17.4													
46	37.0 m to 37.8 m - dark grey silty calcareous silica fine SAND, with traces of organic matter	37.00																
		37.40	32.4	18.5	17.9													
47	38.0 m to 38.4 m - dark olive grey calcareous silica fine SAND, with traces of organic matter	38.00												11				
	38.4 m to 38.8 m - olive grey calcareous silica fine SAND, with traces of organic matter	38.40																
		38.60	30.3	18.8	18.0													
48	39.0 m to 39.2 m - olive grey calcareous silica fine SAND	39.00																
	39.2 m to 39.5 m - firm to stiff olive grey slightly sandy calcareous CLAY	39.15																
		39.25	25.9	19.6	19.7												43r	
		39.25	29.4 27.3	19.4 19.1	19.8 20.0						18	39	21		128	50	101	
		39.45													123	75		
	39.5 m to 39.8 m - olive grey calcareous silica fine SAND - with closely spaced thin laminae of silt	39.50						2.68						44				
49	40.0 m to 40.2 m - soft to firm olive grey calcareous CLAY - with very closely spaced thin laminae of sand	40.00																
	40.2 m to 40.3 m - olive grey calcareous silica fine SAND	40.20																
	40.3 m to 40.5 m - olive grey calcareous CLAY - with very closely spaced thin laminae of sand	40.30																
	40.5 m to 40.6 m - olive grey calcareous silica fine SAND	40.45																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		40.50	24.7	19.6	20.1													
50	41.0 m to 41.4 m - olive grey calcareous silica fine SAND	41.00																
		41.10	26.8	19.3	18.3													
	41.4 m to 41.7 m - firm to stiff olive grey sandy calcareous CLAY	41.40																
		41.45	21.6	20.3	19.8						17	38	21	91				
		41.46	23.5	20.0	20.0													
		41.50													143	63		
	41.7 m to 41.8 m - olive grey calcareous silica fine SAND - with extremely closely spaced to very closely spaced thin laminae of silt	41.65																
		41.70													147			
51	42.0 m to 42.3 m - stiff dark grey calcareous CLAY	42.00			20.1													
		42.01	23.2	20.1	20.1													
		42.10													122			
		42.15	24.5	19.9														
	42.3 m to 42.5 m - dark grey slightly sandy CLAY - with very closely spaced thin laminae of sand	42.30																
	42.5 m to 42.7 m - Very stiff dark grey calcareous CLAY	42.45			19.1													
		42.50													163			
	42.7 m to 42.7 m - dark grey slightly clayey calcareous silica fine SAND	42.65																
52	43.0 m to 43.2 m - dark grey slightly clayey calcareous silica fine SAND	43.00																
		43.15	29.9	19.0														

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
	43.2 m to 43.8 m - firm to stiff dark grey calcareous CLAY - with few thin laminae of sand	43.20													100	75		
		43.25			19.8													
		43.45	26.6	19.5				2.71			20	39	19	92				
		43.50													138	50		
	43.8 m to 43.9 m - dark grey slightly sandy calcareous CLAY - with extremely closely spaced thin laminae of sand	43.75																
53	44.0 m to 44.1 m - dark grey slightly clayey calcareous silica fine SAND	44.00																
	44.1 m to 44.3 m - olive grey silica fine SAND	44.10																
	44.3 m to 44.4 m - olive grey silica fine SAND - with extremely closely spaced thick laminae of organic matter	44.25																
	44.4 m to 44.7 m - olive grey silica fine SAND	44.35																
		44.50	25.8	19.4	19.2													
54	45.0 m to 45.3 m - olive grey slightly clayey silica fine SAND - with one thin lamina of sand	45.00																
	45.3 m to 45.4 m - very stiff olive grey calcareous CLAY - with medium gravel-sized pockets of sand and silt	45.25																
	45.4 m to 45.6 m - olive grey silica fine SAND - with very closely spaced thin laminae of organic matter	45.40												10				
		45.50	25.8	19.4	18.0													
	45.6 m to 45.7 m - dark grey slightly clayey silica fine SAND, with traces of mica crystals	45.60																
55	46.0 m to 46.9 m - dark grey CLAY - with extremely closely to closely spaced thin laminae to very thin beds of sand	46.00																

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FUGRO

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		46.40	29.8	18.9	17.7													
56	47.0 m to 47.9 m - olive grey clayey silica fine SAND, with traces of mica crystals - with few thin laminae of clay	47.00																
		47.40	28.3	19.1	18.5													
57	48.0 m to 48.9 m - olive grey silica fine SAND, with traces of mica crystals - with extremely closely to very closely spaced thin to thick laminae of clay	48.00						2.67						45				
		48.40	28.3	19.1	18.2													
58	49.0 m to 49.9 m - olive grey silica fine SAND - at bottom slightly clayey - with extremely closely to very closely spaced thin to thick laminae of stiff clay	49.00																
		49.50	28.9	19.0	18.2										100			
		49.60													100			
59	54.5 m to 54.8 m - olive grey silica fine SAND - at bottom slightly clayey - with closely spaced thin laminae of organic matter	54.50								0								
	54.8 m to 55.3 m - olive grey silica fine SAND - with closely spaced thin laminae of organic matter	54.75				12.7	15.7	2.66						11				
		54.90	26.0	19.4	19.1													
60	58.5 m to 59.4 m - stiff dark grey sandy CLAY - with extremely closely to very closely spaced thin laminae to very thin beds of sand	58.50																
		58.70	35.2	18.4														
		59.10													142			
		59.15									21	46	25	93				

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FUGRO

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SA

GeODin/LCTR.GLO/2016-10-24 16:28

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
61	62.5 m to 63.3 m - very dark grey CLAY - with extremely closely to very closely spaced thin to thick laminae of sand	62.50									17	28	11	48				
		62.90	28.8	19.2														

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH03-SC

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
01	14.0 m to 14.8 m - dark olive grey calcareous CLAY, with traces of organic matter - with closely spaced thin laminae of silt	14.00																
02	33.0 m to 33.5 m - dark grey silty calcareous silica fine SAND	33.00																
	33.5 m to 33.7 m - dark grey calcareous CLAY	33.50																
03	40.0 m to 40.2 m - dark grey silty calcareous silica fine SAND	40.00																
	40.2 m to 40.8 m - dark grey calcareous CLAY	40.20																
04	47.0 m to 47.4 m - olive grey very sandy CLAY	47.00																
	47.4 m to 47.9 m - olive grey silty silica fine SAND	47.35																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
01	0.0 m to 0.6 m - light olive brown to dark olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	0.00												2				
		0.35	22.5	19.9	18.8													
02	1.0 m to 1.6 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shells and shell fragments - at top dark olive grey	1.00							4									
		1.30	22.1	20.0	18.7													
03	2.0 m to 2.6 m - olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments - from 2.4 m: with fine to medium gravel-sized shells and shell fragments	2.00																
		2.30						2.66						4				
		2.35	24.4	19.6	18.8													
04	3.0 m to 3.4 m - dark grey slightly silty calcareous silica fine SAND	3.00																
		3.20	25.0	19.5	19.4													
05	3.5 m to 4.0 m - olive grey calcareous silica fine to medium SAND	3.50																
		3.70	21.4	20.1	19.4													
06	4.0 m to 4.4 m - olive grey calcareous silica fine to medium SAND	4.00																
		4.20	24.1	19.7	19.6													
07	4.5 m to 4.9 m - olive grey calcareous silica fine SAND	4.50																
		4.70	21.7	20.1	19.7													
08	5.0 m to 5.5 m - olive grey calcareous silica fine to medium SAND - at bottom organic matter	5.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
		5.25	21.9	20.0	19.0													
09	6.0 m to 6.6 m - olive grey calcareous silica medium SAND, with traces of fine gravel-sized shell fragments	6.00																
		6.30	21.8	20.1	19.3													
10	7.0 m to 7.6 m - olive grey calcareous silica medium SAND, with few fine gravel-sized shell fragments	7.00				13.1	16.0							2				
		7.30	17.8	20.8	19.3													
11	8.0 m to 8.6 m - olive grey calcareous silica medium SAND, with fine to medium gravel-sized shell fragments	8.00																
		8.30	22.4	20.0	18.8													
12	9.0 m to 9.4 m - olive grey calcareous silica medium SAND, with many fine gravel to medium gravel-sized shells and shell fragments	9.00																
		9.30	22.5	20.0	19.4													
	9.4 m to 9.6 m - dark grey calcareous silica fine SAND, with traces of fine gravel-sized shell fragments	9.35																
13	10.0 m to 10.6 m - dark grey silica fine SAND, with traces of fine gravel-sized shell fragments - at top fine gravel-sized shell fragments	10.00																
		10.30	21.3	20.2	18.8													
14	11.0 m to 11.6 m - dark grey calcareous silica fine SAND - at top many fine to medium gravel-sized shell fragments - at bottom thin laminae of organic matter	11.00																
		11.15							6	0								
		11.40	26.6	19.3	19.5													
15	12.0 m to 12.4 m - olive grey calcareous silica fine SAND - with a very thin bed of organic matter	12.00						2.65						3				
		12.25	26.1	19.4	18.1													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
	12.4 m to 12.7 m - olive grey calcareous silica medium to coarse SAND, with many fine to medium gravel-sized shell fragments at top - with very closely to closely spaced thin laminae of clay and organic matter	12.35																
16	13.0 m to 13.4 m - dark grey calcareous silica fine SAND	13.00																
		13.20	23.7	19.8	19.1													
	13.4 m to 13.9 m - dark grey slightly sandy CLAY - with very closely spaced thin laminae of sand and organic matter	13.35																
		13.60	33.8	18.4	18.3													
17	14.0 m to 14.3 m - dark grey very sandy calcareous CLAY	14.00																
		14.10	35.5	18.1	18.1													
18	14.5 m to 15.0 m - dark grey sandy calcareous CLAY, with traces of organic matter	14.50									26	33	7	93				
		14.75	35.9	18.1	18.7													
19	15.5 m to 16.3 m - very dark grey slightly sandy to sandy calcareous CLAY, with traces of organic matter - with few coarse gravel-sized pockets of silt	15.50																
		16.00	18.9	20.6	20.4			2.70			15	32	17	66				
		16.02	19.8	20.7	20.7													
		16.15	20.3	20.6	20.5 20.0													
		16.21	19.3	20.8	20.8													
20	16.5 m to 16.6 m - dark grey slightly sandy to sandy calcareous CLAY, with traces of organic matter	16.50																
	16.6 m to 17.3 m - olive grey slightly clayey calcareous silica fine SAND, with traces of mica crystals - with a thick lamina of cemented silt	16.55																

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I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
10d : d refers to test on disturbed soil

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

Sample No.	Sample Ground Description	Test Depth [m]	w [%]	Unit Weight [kN/m³] γ_1	Unit Weight [kN/m³] γ_2	Unit Weight [kN/m³] γ_d min.	Unit Weight [kN/m³] γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits w_P [%]	Atterberg Limits w_L [%]	Atterberg Limits I_p [%]	Fines [%]	s_u [kPa] PP	s_u [kPa] TV	s_u [kPa] UU	s_u [kPa] LV
		16.80	22.4	20.0	18.7													
21	17.5 m to 18.1 m - dark grey slightly clayey calcareous silica fine SAND - with few fine to medium gravel-sized pockets of silt	17.50												28				
		17.85	28.5	19.0	19.4													
22	18.5 m to 19.3 m - dark grey slightly clayey calcareous silica fine SAND - with closely spaced thin beds of firm clay	18.50																
		18.60													71			
		18.85	30.2	18.8	19.1													
		19.15													44			
23	19.5 m to 20.2 m - olive grey calcareous silica fine SAND, with traces of mica crystals	19.50																
		19.85												4				
		19.90	27.0	19.2	18.5													
24	20.5 m to 21.3 m - olive grey calcareous silica fine SAND, with traces of mica crystals - at top slightly clayey - with few thin laminae of organic matter	20.50								1								
		20.90	30.0	18.8	18.3													
25	21.5 m to 22.4 m - olive grey calcareous silica fine SAND - with closely spaced very thin to thin beds of firm slightly sandy clay	21.50																
		21.65	10.4	22.8	15.9 17.2						18	38	20	90	58			
		21.85	28.1	19.1														
		21.95	30.7	18.7														
		22.20													58			

Key:
w : water content
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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
26	22.5 m to 23.4 m - olive grey slightly clayey calcareous silica fine SAND - with closely spaced very thin to thin beds of firm slightly sandy clay	22.50																
		22.90	31.2	18.7	19.8													
		23.00												65				
27	23.5 m to 24.0 m - firm dark grey slightly sandy calcareous CLAY	23.50																
		23.55			16.9										54			
		23.75	28.2	19.3	20.1												39	
		23.75	28.8	19.2	19.9										63		20r	
	24.0 m to 24.4 m - dark grey clayey calcareous silica fine SAND, with traces of mica crystals	24.00																
		24.10	30.3	18.8														
28	24.5 m to 24.9 m - dark grey calcareous CLAY - at bottom slightly sandy	24.50	29.0	19.2	19.2												18r	
		24.50	27.5	19.4	19.3 16.4												47	
		24.65									21	30	9	81				
	24.9 m to 25.4 m - dark grey slightly clayey calcareous silica fine SAND - at bottom few thin laminae of organic matter	24.90																
		25.00	30.4	18.8														
29	25.5 m to 26.0 m - dark grey slightly clayey calcareous silica fine SAND	25.50																
	26.0 m to 26.3 m - thinly laminated dark grey very sandy calcareous CLAY	25.95																
		26.10	28.9	19.0	19.2													

Key:
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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
30	26.5 m to 26.8 m - dark grey sandy calcareous CLAY - with few thin laminae of sand	26.50						2.69			21	28	7	55				
	26.8 m to 27.4 m - dark grey slightly clayey calcareous silica fine SAND	26.80												25				
		27.10	28.8	19.0	18.9													
31	27.5 m to 28.3 m - dark grey clayey calcareous silica fine SAND - with medium spaced very thin to thin beds of stiff to very stiff clay	27.50																
		27.60													108			
		27.60													163			
		28.25	30.4	18.8	18.5													
32	28.5 m to 28.6 m - dark grey slightly clayey calcareous silica fine SAND	28.50																
	28.6 m to 29.0 m - dark grey slightly sandy calcareous CLAY	28.55																
		28.80			16.8						17	39	22					
		28.82	27.7	19.4	19.3													
	29.0 m to 29.4 m - dark grey slightly clayey calcareous silica SAND	29.00																
		29.10	32.3	18.5	18.8													
	29.4 m to 29.4 m - dark grey slightly sandy calcareous CLAY	29.35																
33	29.5 m to 30.2 m - dark grey calcareous silica fine SAND	29.50																
		29.80	28.0	19.1	19.0													
34	30.5 m to 31.1 m - olive grey calcareous silica fine SAND	30.50																
		30.80	29.1	18.9	18.1	12.2	14.8	2.66						5				

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
35	31.5 m to 32.3 m - dark grey calcareous silica fine SAND - from 31.7 to 31.8: with extremely closely spaced thin laminae of with organic matter	31.50							3	0								
		32.00	28.3	19.1	19.0													
36	32.5 m to 32.8 m - stiff dark grey slightly sandy calcareous CLAY	32.50	26.3	19.6	19.5												21r	
		32.50	26.0	19.6	19.4 17.0						18	34	16				43	
		32.70	28.6	19.0											117			
	32.8 m to 33.2 m - dark grey calcareous silica fine SAND, with traces of mica crystals	32.75																
		32.95	28.7	19.0	18.6													
37	33.5 m to 34.0 m - dark grey calcareous silica fine SAND - with one thin lamina of organic matter	33.50																
		33.80	26.5	19.3	18.9													
38	34.5 m to 34.8 m - dark grey calcareous silica fine SAND	34.50																
		34.70	26.2	19.4	19.5													
	34.8 m to 34.9 m - firm dark grey calcareous CLAY	34.75																
		34.85													53			
		34.90													69			
39	35.0 m to 35.6 m - dark grey calcareous silica fine SAND, with traces of mica crystals - with one thick lamina of clay	35.00																
		35.25	27.3	19.2	18.8									15				
40	36.0 m to 36.1 m - dark grey calcareous CLAY	36.00																
	36.1 m to 36.5 m - dark grey calcareous silica fine SAND, with traces of mica crystals	36.05																

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample No.	Sample Ground Description	Test Depth [m]	w [%]	Unit Weight γ_1 [kN/m³]	Unit Weight γ_2 [kN/m³]	Unit Weight γ_d min. [kN/m³]	Unit Weight γ_d max. [kN/m³]	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits w_P [%]	Atterberg Limits w_L [%]	Atterberg Limits I_P [%]	Fines [%]	s_u [kPa] PP	s_u [kPa] TV	s_u [kPa] UU	s_u [kPa] LV
		36.40	26.7	19.3	18.9													
41	37.0 m to 37.7 m - olive grey calcareous silica fine SAND - with medium spaced thin laminae to thin beds of stiff slightly sandy clay	37.00																
		37.40	26.8	19.3	19.5													
		37.60													94			
42	38.0 m to 38.5 m - dark grey calcareous silica fine SAND, with traces of mica crystals - with one thin lamina of clay	38.00																
		38.25	25.4	19.5	19.0													
43	39.0 m to 39.6 m - dark grey calcareous silica fine SAND, with traces of mica crystals	39.00																
		39.30	27.8	19.1	18.8													
44	40.0 m to 40.5 m - dark grey calcareous silica fine SAND, with traces of mica crystals	40.00				12.7	16.0	2.65						10				
		40.25	26.1	19.4	19.9													
45	40.5 m to 41.1 m - dark grey calcareous silica fine SAND, with traces of mica crystals	40.50																
		40.80	25.7	19.4	18.7													
46	41.5 m to 42.0 m - olive grey calcareous silica fine SAND, with traces of mica crystals	41.50																
		41.80	25.6	19.5	19.2													
47	42.5 m to 43.1 m - olive grey calcareous silica fine SAND, with traces of mica crystals - at bottom one thick lamina organic matter	42.50																
		42.80	26.4	19.3	18.6					2								
48	43.5 m to 44.0 m - dark grey calcareous silica fine to medium SAND - with few thin laminae of organic matter	43.50																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_p [%]	Fines [%]	PP	TV	UU	LV
		43.70	25.1	19.5	18.6													
49	44.5 m to 44.9 m - dark grey calcareous silica fine to medium SAND - at bottom few fine gravel-sized shell fragments	44.50																
		44.70	25.1	19.5	19.2													
50	45.0 m to 45.5 m - dark grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	45.00																
		45.30	23.6	19.8	19.3													
51	45.5 m to 45.9 m - dark grey calcareous silica fine to medium SAND, with traces of shell fragments - with thick laminae of clay	45.50												8				
		45.80	22.9	19.9	19.6													
52	46.0 m to 46.4 m - dark grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments - with few thin laminae of clay	46.00																
		46.20	22.3	20.0	19.9													
	46.4 m to 46.7 m - dark grey slightly gravelly calcareous silica fine to medium SAND, with many fine to medium gravel-sized shell fragments	46.40																
	46.7 m to 46.8 m - very stiff dark grey calcareous CLAY, with organic matter	46.65																
	46.8 m to 46.9 m - dark grey slightly clayey calcareous silica fine to medium SAND	46.80													250			
53	47.0 m to 47.8 m - dark grey calcareous silica fine SAND - at bottom traces of organic matter	47.00																
		47.40	33.6	18.4	18.2													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH04-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample No.	Sample Ground Description	Test Depth [m]	w [%]	Unit Weight [kN/m³] γ_1	Unit Weight [kN/m³] γ_2	Unit Weight [kN/m³] γ_d min.	Unit Weight [kN/m³] γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits w_P [%]	Atterberg Limits w_L [%]	Atterberg Limits I_p [%]	Fines [%]	s_u [kPa] PP	s_u [kPa] TV	s_u [kPa] UU	s_u [kPa] LV
54	48.0 m to 48.6 m - dark grey calcareous silica fine to medium SAND - at bottom with extremely closely spaced thin laminae of silt	48.00																
		48.40	26.1	19.4	19.2													
55	49.0 m to 49.4 m - dark grey calcareous silica fine to medium SAND, with traces of organic matter	49.00																
		49.30	24.7	19.6	18.6													
	49.4 m to 49.6 m - dark grey calcareous silica fine to medium SAND - with very closely spaced thin laminae of organic matter	49.40																
56	50.0 m to 50.2 m - olive grey calcareous silica fine to medium SAND, with traces of organic matter	50.00				11.8	15.1	2.65						10				
		50.15	31.7	18.6	18.6													
	50.2 m to 50.8 m - olive grey silica fine to medium SAND - with extremely to very closely spaced thin laminae to thin beds of clay	50.20																

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample No.	Sample Ground Description	Test Depth [m]	w [%]	Unit Weight [kN/m³] γ_1	Unit Weight [kN/m³] γ_2	Unit Weight [kN/m³] γ_d min.	Unit Weight [kN/m³] γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits w_P [%]	Atterberg Limits w_L [%]	Atterberg Limits I_P [%]	Fines [%]	s_u [kPa] PP	s_u [kPa] TV	s_u [kPa] UU	s_u [kPa] LV
01	0.0 m to 0.6 m - light olive brown calcareous silica fine to medium SAND, with few fine to medium gravel-sized shells and shell fragments	0.00												9				
		0.25	31.3	18.7	18.9													
02	1.0 m to 1.6 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shells and shell fragments	1.00																
		1.35	23.9	19.7	18.3													
03	2.0 m to 2.7 m - olive grey slightly silty calcareous silica fine SAND	2.00						2.66						3				
		2.40	23.0	19.9	19.2													
04	3.0 m to 3.7 m - olive grey slightly silty calcareous silica fine SAND - from 3.6 m: with organic matter	3.00																
		3.40	24.7	19.6	18.8													
05	4.0 m to 4.6 m - olive grey calcareous silica fine to medium SAND - at top slightly silty fine sand	4.00																
		4.35	20.6	20.3	19.3													
06	5.0 m to 5.6 m - olive grey calcareous silica fine to medium SAND, with fine gravel-sized shell fragments	5.00																
		5.35	20.4	20.3	18.1													
07	6.0 m to 6.2 m - olive grey calcareous silica medium SAND	6.00							2									
	6.2 m to 6.6 m - olive grey calcareous silica fine to medium SAND	6.20				13.8	16.0							0				
		6.30	21.9	20.1	18.7													
08	7.0 m to 7.6 m - olive grey slightly silty calcareous silica fine SAND	7.00																
		7.30	22.6	19.9	19.2													

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FUGRO

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
09	8.0 m to 8.6 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments	8.00																
		8.35	17.7	20.8	18.6													
10	9.0 m to 9.5 m - olive grey slightly silty calcareous silica fine SAND	9.00												6				
		9.30	20.8	20.2	18.6													
11	10.0 m to 10.3 m - olive grey calcareous silica fine to medium SAND, with few fine gravel-sized shell fragments	10.00																
		10.20	19.9	20.4	18.5													
12	10.5 m to 10.8 m - olive grey slightly silty calcareous silica fine SAND	10.50																
		10.70	18.1	20.8	19.3													
13	11.0 m to 11.3 m - olive grey slightly silty calcareous silica fine SAND	11.00																
		11.20	20.4	20.3	18.3													
14	11.5 m to 11.8 m - olive grey slightly silty calcareous silica fine SAND	11.50																
		11.65	21.7	20.1	18.2													
15	12.0 m to 12.4 m - olive grey slightly silty calcareous silica fine SAND	12.00				13.3	16.2							5				
		12.20	20.4	20.3	18.3													
16	12.5 m to 12.8 m - olive grey slightly silty calcareous silica fine SAND	12.50																
		12.70	21.1	20.2	18.4													
17	13.0 m to 13.3 m - olive grey slightly silty calcareous silica fine SAND	13.00																
	13.3 m to 13.5 m - olive grey sandy CLAY	13.30																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		13.40	18.8	20.9														
	13.5 m to 13.7 m - black organic CLAY, with many organic matter	13.50								25								
18	14.0 m to 14.9 m - olive grey sandy CLAY, with traces of organic matter	14.00																
		14.45	18.5	20.9														
19	15.0 m to 15.9 m - firm olive grey sandy CLAY	15.00						2.66			19	31	12	97				
		15.20													67	35		
		15.40	19.8	20.7														
20	16.0 m to 16.6 m - olive grey slightly silty silica fine SAND	16.00																
		16.30	19.0	20.6	18.4													
21	17.0 m to 17.3 m - olive grey slightly silty silica fine SAND	17.00																
		17.20	22.4	20.0	19.1													
	17.3 m to 17.8 m - firm to stiff dark olive grey sandy CLAY	17.30	20.6	20.5														
		17.35	23.8	20.0	20.2												60	
		17.35	23.7	20.0	20.3 20.1						20	38	18	86			46r	
		17.40													79	63		
		17.55			19.5													
		17.60													79	60		
22	18.0 m to 18.5 m - olive grey sandy silica SILT	18.00									22	29	7	73				
		18.20	21.1	20.2	18.4													
23	19.0 m to 19.9 m - stiff dark olive grey CLAY - with pockets of medium gravel-sized silt	19.00																

Key:
w : water content
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$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_P : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

Sample No.	Sample Ground Description	Test Depth [m]	w [%]	Unit Weight [kN/m³] γ_1	Unit Weight [kN/m³] γ_2	Unit Weight [kN/m³] γ_d min.	Unit Weight [kN/m³] γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits w_P [%]	Atterberg Limits w_L [%]	Atterberg Limits I_p [%]	Fines [%]	s_u [kPa] PP	s_u [kPa] TV	s_u [kPa] UU	s_u [kPa] LV
		19.20			18.0										117	120		
		19.22	33.5	18.6	18.5													
		19.40	30.2	19.0	20.2												86	
		19.40	29.4	19.1	20.0						23	51	28		118	130	92r	
		19.60	30.7	18.9	18.6 19.0										107	118		
		19.66	29.8	19.1	19.6													
		19.80	26.6	19.5														
	19.9 m to 19.9 m - grey silica fine SAND - with thick laminae of clay	19.85																
24	20.0 m to 20.2 m - olive grey very sandy silica SILT	20.00																
		20.10	27.6	19.4														
	20.2 m to 20.5 m - olive grey CLAY - with very closely spaced to closely spaced thin laminae of silt	20.20																
		20.35	29.0	19.2														
	20.5 m to 20.8 m - olive grey very sandy calcareous silica SILT - with closely spaced thin laminae of clay	20.50						2.65			19	30	11	95				
25	21.0 m to 21.2 m - olive grey very sandy calcareous silica SILT - with very closely spaced thin laminae of clay	21.00																
26	22.0 m to 22.4 m - dark olive grey calcareous CLAY	22.00									20	35	15	95				
	22.4 m to 22.6 m - black organic CLAY	22.40																
	22.6 m to 22.8 m - stiff to very stiff dark greenish grey calcareous CLAY - with pockets of silt	22.55	22.8	20.1	20.4												147	

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
		22.55	23.7	20.0	20.1 18.0												152r	
		22.60													181	108		
		22.75	23.0	20.1														
27	23.0 m to 23.4 m - olive grey sandy calcareous silica SILT, with traces of organic matter - with very closely spaced thin laminae of clay	23.00																
		23.20	23.7	19.8														
28	23.5 m to 24.2 m - olive grey slightly silty calcareous silica fine SAND, with traces of organic matter - at top sandy Silt - with extremely closely spaced thin laminae of clay	23.50																
		23.70												81				
		23.80	25.6	19.5														
29	24.5 m to 25.3 m - olive grey sandy calcareous silica SILT - with extremely closely spaced to very closely spaced thin to thick laminae of clay	24.50																
		24.90	10.4	22.8	16.4													
		25.10						2.69			18	38	20	95				
		25.25	25.1	19.5														
30	25.5 m to 25.7 m - olive grey sandy calcareous silica SILT - with very closely spaced thin laminae of clay	25.50																
	25.7 m to 26.1 m - olive grey very silty calcareous silica fine SAND	25.70																
		25.90	28.5	19.0	19.0													
	26.1 m to 26.3 m - olive grey sandy calcareous silica SILT - with very closely spaced thin laminae of clay	26.10																
31	26.5 m to 27.4 m - olive grey sandy calcareous silica SILT - with closely spaced thin to thick laminae of clay	26.50																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH05-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		26.90	30.8	18.7														
		27.15							2									
32	27.5 m to 28.3 m - olive grey silty calcareous silica fine SAND - with medium spaced to closely spaced thin laminae of organic matter	27.50																
		27.95	26.4	19.3	19.3													
33	28.5 m to 29.1 m - olive grey silty calcareous silica fine SAND - at 28.7 m: with thin laminae of clay	28.50																
		28.90	24.2	19.7	18.9													
34	29.5 m to 30.0 m - olive grey slightly silty calcareous silica fine SAND	29.50																
		29.90	26.7	19.3	20.5													
	30.0 m to 30.2 m - olive grey calcareous silica fine SAND	30.00												20				
35	30.5 m to 31.3 m - olive grey silica fine SAND from 30.7 m: with extremely closely spaced thin to thick laminae of organic matter	30.50																
		30.90	32.2	18.5	17.9													
36	31.5 m to 32.1 m - olive grey silica fine SAND - with closely spaced thin laminae of organic matter	31.50												16				
		31.80	22.2	20.0	19.6													
37	32.5 m to 33.1 m - olive grey slightly silty silica fine SAND	32.50																
		32.80	25.4	19.5	19.2													
38	33.5 m to 34.1 m - olive grey slightly silty silica fine SAND at 34.0 m: with thick laminae of clay	33.50																
		33.75	23.9	19.7	18.5													

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LOCATION HKZ1-BH05-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
39	34.5 m to 35.1 m - olive grey slightly silty silica fine SAND - with closely spaced thin laminae of organic matter	34.50								1								
		34.85	24.5	19.6	18.6													
40	35.5 m to 35.6 m - olive grey slightly silty silica fine SAND, with organic matter	35.50																
	35.6 m to 36.4 m - olive grey slightly silty silica fine SAND - with medium spaced thick laminae of clay	35.60						2.66						68				
		35.95	28.0	19.1	19.9													
41	36.5 m to 37.4 m - olive grey slightly silty silica fine SAND - with closely spaced thick laminae to very thin beds of clay	36.50																
		36.90	26.6	19.3	19.4													
42	37.5 m to 38.3 m - olive grey slightly silty silica fine SAND - with medium spaced thick laminae of clay	37.50																
		37.90	27.5	19.2	19.2													
43	38.5 m to 39.3 m - olive grey very silty silica fine SAND	38.50																
		38.90	26.1	19.4	18.9													
44	39.5 m to 40.3 m - olive grey silty silica fine SAND - with closely spaced to medium spaced thick laminae of clay	39.50																
		39.95	23.6	19.8	21.6													
45	40.5 m to 41.3 m - olive grey slightly silty silica fine SAND - at 40.8 m: with very thin bed of clay	40.50																
		40.85				12.5	14.8							19				
		40.95	22.9	19.9	18.4													
46	41.5 m to 42.3 m - olive grey slightly silty silica fine SAND - at 41.9 m: with very thin bed of clay	41.50																
		41.90	27.3	19.2	18.9													

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LOCATION HKZ1-BH05-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_p [%]	w_L [%]	I_p [%]	Fines [%]	PP	TV	UU	LV
47	42.5 m to 43.4 m - olive grey silty silica fine SAND - at 43.3 m: with very thin bed of clay	42.50																
		42.90	29.1	19.0	18.8													
48	43.5 m to 44.0 m - very stiff dark grey CLAY	43.50																
		43.55	38.8	18.0											233			
		43.60	36.5	18.2	18.1												163r	
		43.60	36.3	18.2	18.0 17.4						32	79	47	99			107	
		43.80			17.5										283			
	44.0 m to 44.4 m - olive grey slightly silty silica fine SAND, with traces of mica crystals - with very closely spaced to closely spaced thin laminae of clay	44.00																
		44.10	31.6	18.6	18.2													
49	44.5 m to 45.3 m - olive grey slightly silty silica fine SAND, with traces of mica crystals - with few thin laminae of organic matter	44.50																
		44.90	27.1	19.2	18.5													
50	45.5 m to 46.3 m - olive grey slightly silty silica fine SAND - with few thin laminae of organic matter - at 45.8 m: with extremely closely spaced thin laminae of organic matter and thin laminae of medium sand	45.50																
		45.75				11.1	14.1	2.65						14				
		46.00	29.3	18.9	18.3													
51	46.5 m to 46.6 m - olive grey slightly silty silica fine SAND - with few thin laminae of clay	46.50								3								
	46.6 m to 46.7 m - black organic silica medium SAND - with very closely spaced thin laminae of organic matter	46.55																

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Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
	46.7 m to 47.3 m - olive grey slightly silty silica fine SAND - with few thin laminae of clay	46.65																
		47.00	29.3	18.9	18.4													
52	47.5 m to 48.3 m - olive grey silica fine SAND - with few thin laminae of clay	47.50																
		47.90	29.4	18.9	18.4													
53	48.5 m to 49.4 m - olive grey silica fine SAND - with very closely spaced thin to thick laminae of clay - with few thin laminae of organic matter	48.50																
		48.90	32.1	18.6	18.3													
54	49.5 m to 50.0 m - olive grey silica fine SAND - with closely spaced thin laminae of clay - with few thin laminae of organic matter	49.50																
		49.75												29				
	50.0 m to 50.4 m - olive grey silica fine SAND - with few thin laminae of organic matter	50.00																
		50.20	28.6	19.0	18.6													

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
01	0.0 m to 0.7 m - light olive brown to dark olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shell fragments	0.00												1				
		0.40	22.1	20.0	18.8													
02	1.0 m to 1.6 m - dark olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shell fragments	1.00																
		1.30	21.6	20.1	18.8													
03	2.0 m to 2.7 m - dark olive grey to olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	2.00																
		2.30	23.0	19.9	18.8													
04	3.0 m to 3.6 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments	3.00																
		3.25	22.4	20.0	18.4													
		3.30						2.65						4				
05	4.0 m to 4.6 m - olive grey calcareous silica fine to medium SAND - from 4.1 m to 4.2 m: with many medium gravel-sized shells and shell fragments	4.00																
06	5.0 m to 5.5 m - olive grey calcareous silica fine to medium SAND	5.00							5									
		5.25												2				
		5.30	21.2	20.2	18.9													
07	6.0 m to 6.5 m - olive grey calcareous silica fine to medium SAND	6.00																
		6.20	21.6	20.1	18.3													
08	6.5 m to 7.0 m - olive grey calcareous silica fine to medium SAND, with traces of fine gravel-sized shell fragments	6.50																

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LOCATION HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
		6.80	21.3	20.2	19.6													
09	7.5 m to 7.9 m - olive grey calcareous silica medium SAND, with traces of fine gravel-sized shell fragments	7.50																
		7.70	21.3	20.2	18.1													
10	8.0 m to 8.4 m - olive grey calcareous silica medium SAND, with traces of fine gravel-sized shell fragments, with pieces of organic matter	8.00																
		8.20	20.9	20.2	18.1													
11	8.5 m to 8.9 m - olive grey calcareous silica medium SAND, with traces of fine gravel-sized shell fragments	8.50												2				
		8.70	22.2	20.0	18.7													
12	9.0 m to 9.5 m - olive grey silica medium SAND	9.00				13.3	16.0											
		9.30	21.2	20.2	18.4													
13	10.0 m to 10.4 m - olive grey silica medium SAND, with traces of fine gravel-sized shell fragments	10.00																
		10.20	20.7	20.3	18.7													
14	10.5 m to 10.9 m - olive grey silica medium SAND, with traces of fine gravel-sized shell fragments	10.50																
		10.70	20.0	20.4	19.1													
15	11.0 m to 11.5 m - olive grey calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments, with organic matter	11.00																
		11.20	20.1	20.4	19.0													
16	11.5 m to 12.0 m - olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shell fragments, with organic matter	11.50								0								
17	12.5 m to 13.0 m - olive grey calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments, with organic matter	12.50																

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LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
		12.75	20.0	20.4	17.1													
18	13.5 m to 14.0 m - olive grey calcareous silica medium SAND, with few fine to medium gravel-sized shell fragments - from 13.7 m to 13.8 m: with medium gravel	13.50																
		13.80	23.1	19.8	17.7													
	14.0 m to 14.1 m - organic matter	13.95																
	14.1 m to 14.1 m - olive grey calcareous silica medium SAND, with few fine to medium gravel-sized shell fragments	14.05																
19	14.5 m to 14.8 m - olive grey calcareous silica medium SAND, with fine to medium gravel-sized shell fragments, with organic matter	14.50												15				
		14.70	21.5	20.1	17.8													
	14.8 m to 15.2 m - olive grey silty silica fine SAND, with traces of fine to medium gravel-sized shell fragments, with traces of organic matter	14.75																
		15.00	27.5	19.2	17.9													
20	15.5 m to 16.4 m - firm to stiff dark olive grey sandy calcareous CLAY - with extremely closely to very closely spaced thin laminae of silt and organic matter	15.50																
		15.70	33.8 36.3	18.4 18.2	18.3 17.6						31	46	15	97	66			
		15.72	40.3	17.8	17.1													
		15.90			17.5										83			
		15.92	36.1	18.3	18.2													
		16.10												93	121	45		

Key:
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$\gamma_{d;max}$: maximum index dry unit weight
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Org.Cont. : organic matter content
w_P : plastic limit
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I_P : plasticity index
Fines : mass percentage of material passing 63 μm or 75 μm sieve

PP : pocket penetrometer
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LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
21	16.5 m to 17.1 m - firm to stiff dark olive grey slightly sandy calcareous CLAY - with extremely closely to very closely spaced thin laminae of silt and organic matter	16.50																
		16.70	35.1	18.4	18.0												51r	
		16.70	39.6 35.8	18.3 17.7	17.7										77	65	79	
		16.90			18.0										104	88		
		17.10													72	58		
22	17.5 m to 17.7 m - stiff dark olive grey slightly sandy calcareous CLAY - with very closely spaced thin laminae of silt	17.50			17.9										86			
	17.7 m to 17.9 m - very stiff black organic CLAY	17.70								25					158			
	17.9 m to 18.0 m - Stiff to very stiff dark greenish grey CLAY	17.85																
		18.00	26.1	19.4														
		18.10													208	138		
23	18.5 m to 18.8 m - stiff to very stiff dark greenish grey calcareous CLAY, at top with a cobble	18.50																
		18.75	23.4	19.8											228	148		
24	19.0 m to 19.5 m - dark greenish grey calcareous CLAY - with fine gravel-sized pockets and closely spaced thin laminae of silt	19.00									21	53	32	98				
		19.30	24.1	19.7														
25	20.0 m to 20.7 m - dark olive grey silty calcareous silica fine SAND	20.00																
		20.70	34.3	18.3	18.3													

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
26	21.0 m to 21.8 m - dark olive grey silty calcareous silica fine SAND - with medium spaced very thin beds of clay	21.00																
		21.40	32.3	18.5	18.2	10.5	14.4	2.68	15					36				
27	22.0 m to 22.7 m - dark olive grey silty calcareous silica fine SAND - with medium spaced very thin beds of clay	22.00																
		22.40	31.1	18.7	18.7													
28	23.0 m to 23.2 m - dark olive grey silty calcareous silica fine SAND	23.00																
	23.2 m to 23.9 m - firm dark grey calcareous CLAY	23.20																
		23.60	30.3	18.8														
29	24.0 m to 24.1 m - olive grey silty calcareous silica fine SAND	24.00																
	24.1 m to 24.6 m - olive grey very sandy calcareous silica SILT - with closely spaced very thin beds of clay	24.10									23	28	5	9				
		24.30	28.8	19.0	18.2													
30	25.0 m to 26.0 m - soft to firm olive grey calcareous CLAY - with very closely spaced thin laminae of sand	25.00																
		25.20			18.2						16	36	20		75	35		
		25.25	29.2	19.1	19.7													
		25.40			18.3										47			
		25.60	26.1	19.6	19.7												42r	
		25.60	28.5 25.7	19.7 19.0	19.4												40	
		25.80													50			

Key:

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
31	26.0 m to 26.8 m - olive grey very sandy calcareous CLAY - with closely spaced thin laminae of sand	26.00																
		26.20	28.7	19.0	19.4													
		26.40			19.5													
32	27.0 m to 27.9 m - soft to firm olive grey very sandy calcareous CLAY - with very closely spaced thin laminae of sand	27.00																
		27.20			20.0										67	38		
		27.40	29.9	19.0	20.2												35r	
		27.40	26.8	19.5	20.4												62	
		27.60			19.1			2.69			20	34	14		79	33		
		27.62	27.6	19.3	19.5													
		27.80	26.0	19.4														
33	28.0 m to 28.4 m - stiff olive grey slightly sandy calcareous CLAY - with closely to very closely spaced thin laminae of sand	28.00																
		28.20													97			
	28.4 m to 28.7 m - olive grey calcareous silica fine SAND - with closely to very closely spaced thin laminae of sandy clay	28.40																
		28.50	29.1	19.0	18.4													
34	29.0 m to 29.8 m - olive grey clayey calcareous silica fine SAND - with medium spaced thin laminae of organic matter	29.00																
		29.40	28.3	19.1	19.5													
35	30.0 m to 30.1 m - olive grey sandy CLAY	30.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
	30.1 m to 30.8 m - olive grey slightly silty calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of sand and clay	30.05				10.6	14.6							36				
		30.40	30.4	18.8	17.7													
36	31.0 m to 31.5 m - olive grey slightly silty calcareous silica fine SAND	31.00																
		31.40	28.6	19.0	18.4													
	31.5 m to 31.8 m - olive grey calcareous silica fine SAND - with closely to extremely closely spaced thin laminae of organic matter	31.50							8	1								
37	32.0 m to 32.6 m - olive grey calcareous silica fine SAND - at top clayey - at 32.4 m: with a very thin bed of clay	32.00																
		32.30	28.4	19.0	18.8													
38	33.0 m to 33.7 m - olive grey calcareous silica fine SAND	33.00																
		33.30	26.6	19.3	18.8													
39	34.0 m to 34.6 m - olive grey calcareous silica fine SAND	34.00				12.1	14.9											
		34.30	27.7	19.1	19.0									9				
40	35.0 m to 35.4 m - olive grey calcareous silica fine SAND	35.00																
		35.20	27.2	19.2	19.4													
41	35.5 m to 36.0 m - olive grey calcareous silica fine SAND - at 35.9 m: with thick laminae of organic matter with gravel	35.50																
		35.80	22.8	19.9	18.9													
42	36.0 m to 36.3 m - olive grey silica fine SAND	36.00																
		36.20	20.7	20.3	19.3													
43	36.5 m to 36.7 m - olive grey silica fine SAND	36.50																

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s_u : undrained shear strength
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
	36.7 m to 36.8 m - black organic material	36.65																
	36.8 m to 37.1 m - olive grey silica fine SAND - at bottom thin laminae of organic matter	36.75																
		36.90	21.5	20.1	19.3													
44	37.5 m to 37.7 m - olive grey slightly clayey calcareous silica fine SAND - with closely spaced to very closely spaced thin laminae of organic matter	37.50																
	37.7 m to 37.9 m - firm olive grey calcareous CLAY	37.70						2.69						96	71			
		37.80	26.5	19.3														
	37.9 m to 38.2 m - olive grey calcareous silica fine SAND	37.85																
		38.00	23.2	19.8	19.1													
45	38.5 m to 38.7 m - olive grey calcareous silica fine SAND	38.50																
		38.65	25.0	19.6														
	38.7 m to 39.0 m - firm to stiff dark grey calcareous CLAY	38.70			20.1										113	63		
	39.0 m to 39.1 m - olive grey calcareous silica fine SAND	38.95																
	39.1 m to 39.4 m - stiff olive grey calcareous CLAY - with very closely spaced thin laminae of sand	39.10													100	75		
		39.30	28.0	19.1														
46	39.5 m to 40.1 m - firm to stiff olive grey calcareous CLAY - with closely spaced thin to thick laminae of sand	39.50			20.0						18	33	15					
		39.51	23.6	20.0	20.1													
		39.70												93	81	63		
		40.00													100	88		
	40.1 m to 40.3 m - olive grey calcareous silica fine SAND - with a very thin bed of clay	40.10																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		40.25	22.5	19.9														
47	40.5 m to 41.1 m - firm to stiff dark grey calcareous CLAY - with closely spaced very thin beds of sand	40.50																
		40.70			19.9										88	50		
		40.95													100	75		
		41.00	25.8	19.4														
48	41.5 m to 42.3 m - dark grey calcareous CLAY - with closely spaced thin beds of sand - from 42.05 m: with thin laminae of sand	41.50																
		41.80	23.9	19.7														
49	42.5 m to 43.3 m - stiff to very stiff grey CLAY	42.50																
		42.70			20.6										125	100		
		42.90	28.1	19.1											263	105		
		43.10			19.8										158	163		
50	43.5 m to 44.3 m - stiff grey CLAY, with traces of organic matter - at 44.1 m: with a thin bed of organic matter	43.50																
		43.70			19.6			2.64			21	46	25		124	95		
		43.72	25.7	19.4	19.6													
		43.90	31.3	18.7											138	100		
51	44.5 m to 45.4 m - stiff to very stiff very dark grey CLAY - with medium spaced thin laminae and fine gravel-sized pockets of organic matter	44.50																
		44.70			19.1										163	113		
		44.90	35.8	18.3	18.1												118r	
		44.90	31.4 33.6	18.6 18.7	18.2										150	95	126	

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GeODin/LCTR.GLO/2016-10-24 16:29

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
		45.10			17.6										163	88		
52	45.5 m to 45.6 m - black organic matter	45.50																
	45.6 m to 46.0 m - very stiff very dark grey CLAY	45.60			19.9													
		45.80			21.1										219			
	46.0 m to 46.3 m - very stiff dark grey very sandy CLAY - with medium spaced thin laminae of sand	46.00													242			
53	46.5 m to 47.3 m - stiff to very stiff dark grey CLAY	46.50																
		46.70			20.1						22	48	26			138		
		46.90	21.5	20.4	20.9												118r	
		46.90	22.4 20.4	20.6 20.0	21.0										175	100	97	
		47.10			20.1										213			
54	47.5 m to 48.3 m - firm to stiff dark grey CLAY	47.50																
		47.70			20.3										118	68		
		47.90			20.0										144	88		
		48.10	26.0	19.4	19.6											70		
55	48.5 m to 49.2 m - firm to stiff dark olive grey calcareous CLAY	48.50																
		48.70			19.2										125	75		
		48.90			19.7										76	70		
		49.10	30.3	18.8											75	70		
56	49.5 m to 50.4 m - firm to stiff olive grey calcareous CLAY - at top sandy	49.50																
		49.80	23.6	19.8	19.0										100	75		

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_p [%]	[%]	PP	TV	UU	LV
		50.00	30.8	18.9	19.2												53r	
		50.00	29.9	19.0	19.2 19.7						21	45	24		138	63	88	
		50.20													94	63		
57	53.5 m to 54.4 m - stiff very dark grey sandy calcareous CLAY, with traces of mica crystals - with closely spaced thin laminae of sand	53.50																
		53.90			20.6													
		54.10			19.5						16	29	13					
		54.13	25.5	19.7	19.9													
		54.30	24.4	19.6														
58	54.5 m to 55.1 m - olive grey clayey calcareous silica fine to medium SAND, with traces of organic matter	54.50																
		54.80	29.0	19.0	20.3				3	1								
59	59.0 m to 59.4 m - olive grey silica medium SAND - with medium spaced thin laminae of organic matter	59.00						2.65						4				
		59.20	23.0	19.9	18.3													
60	64.5 m to 64.6 m - dark grey sandy calcareous CLAY, with traces of organic matter	64.50																
	64.6 m to 65.1 m - olive grey calcareous silica fine SAND	64.55												9				
		64.80	24.0	19.7	19.2													

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GeODin/LCTR.GLO/2016-10-24 16:29

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH06A-SC

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_p [%]		PP	TV	UU	LV
01	17.0 m to 17.7 m - dark grey CLAY	17.00																
		17.40	37.7	18.1														
	17.7 m to 17.8 m - black organic matter	17.65																
02	25.0 m to 25.7 m - dark grey slightly sandy calcareous CLAY, with traces of mica crystals	25.00																
		25.30	26.8	19.5														
03	39.0 m to 39.8 m - dark grey calcareous CLAY - with medium spaced thin to thick laminae of sand	39.00																
		39.40	24.0	19.9														
	39.8 m to 39.9 m - olive grey calcareous silica fine SAND	39.80																
04	43.0 m to 43.3 m - grey calcareous CLAY	43.00																
	43.3 m to 43.8 m - dark grey calcareous CLAY	43.30																
		43.40	22.7	20.1														
	43.8 m to 43.9 m - very dark grey calcareous CLAY	43.80																

Key:

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Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
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I_p : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
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LV : laboratory vane
s_u : undrained shear strength
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
01	0.0 m to 0.5 m - light olive brown medium SAND, with traces of fine gravel-sized shells and shell fragments	0.00												1				
		0.30	23.6	19.8	19.0													
02	1.0 m to 1.5 m - olive brown calcareous silica fine SAND, with many fine to medium gravel-sized shells and shell fragments	1.00																
		1.25	23.1	19.8	18.4				12									
03	2.0 m to 2.5 m - olive brown calcareous silica medium SAND, with traces of fine gravel-sized shells and shell fragments	2.00																
		2.25	24.4	19.6	18.9													
04	3.0 m to 3.6 m - olive brown calcareous silica medium SAND, with traces of fine to medium gravel-sized shells and shell fragments	3.00						2.65						2				
		3.30	22.7	19.9	18.9													
05	4.0 m to 4.5 m - olive brown calcareous silica medium SAND	4.00																
		4.25	22.5	20.0	19.4													
06	5.0 m to 5.5 m - olive brown calcareous silica fine to medium SAND	5.00																
		5.20	22.9	19.9	19.0													
07	5.5 m to 5.9 m - dark greyish brown calcareous silica fine to medium SAND	5.50				13.7	16.0							6				
		5.70	23.4	19.8	18.6													
08	6.0 m to 6.5 m - olive grey calcareous silica fine SAND	6.00																
		6.20	20.7	20.3	20.1													
09	6.5 m to 6.8 m - dark greyish brown calcareous silica fine SAND	6.50																

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
		6.70	20.1	20.4	19.9													
	6.8 m to 7.0 m - dark greyish brown calcareous silica medium to coarse SAND - at top many fine to medium gravel-sized shell fragments	6.80																
10	7.5 m to 7.9 m - olive grey calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments - at 7.8 m: with many fine gravel to medium gravel-sized shell fragments	7.50							5									
		7.70	22.3	20.0	18.2													
11	8.0 m to 8.4 m - dark greyish brown calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments	8.00																
		8.20	21.1	20.2	17.9													
12	8.5 m to 8.8 m - dark greyish brown calcareous silica medium to coarse SAND, with traces of fine to medium gravel-sized shell fragments	8.50																
		8.70	20.7	20.3	18.9													
13	9.0 m to 9.4 m - olive grey calcareous silica medium SAND, with traces of fine to medium gravel-sized shell fragments	9.00																
		9.30	20.3	20.3	18.3													
14	9.5 m to 10.0 m - olive grey calcareous silica medium to coarse SAND, with few fine to medium gravel-sized shell fragments	9.50				13.9	16.3							3				
		9.70	21.1	20.2	18.7													
15	10.0 m to 10.5 m - olive grey calcareous silica fine to medium SAND	10.00																
16	10.5 m to 11.1 m - olive grey calcareous silica fine to medium SAND	10.50																
		10.80	24.4	19.6	19.7													

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w_P : plastic limit
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
17	11.5 m to 11.9 m - olive grey calcareous silica medium SAND - at bottom one thin lamina of organic matter and shell fragments	11.50																
		11.70	23.6	19.8	20.2													
18	12.0 m to 12.4 m - olive grey calcareous silica fine to medium SAND	12.00																
		12.20	22.2	20.0	19.3													
19	12.5 m to 12.9 m - olive grey calcareous silica fine to medium SAND	12.50																
		12.70	21.8	20.1	19.2													
20	13.0 m to 13.4 m - very stiff very dark grey calcareous CLAY - at bottom slightly sandy	13.00																
		13.05	27.4	19.4	18.5												107r	
		13.05	35.9	18.3	18.6 18.7						26	79	53	91	175		56	
		13.25	31.5	18.6					5									
	13.4 m to 13.9 m - olive grey calcareous silica fine to medium SAND - at top slightly clayey - with very closely spaced thin laminae of clay	13.35																
		13.60	29.2	18.9														
21	14.0 m to 14.7 m - olive grey slightly clayey to clayey calcareous silica fine SAND - with few thin laminae of organic matter	14.00																
		14.40	35.1	18.2	19.3													
22	15.0 m to 15.7 m - olive grey clayey calcareous silica fine SAND - with very closely to closely spaced thin laminae of clay and organic matter	15.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		15.30	36.5	18.0	18.4													
23	16.0 m to 16.3 m - olive grey clayey calcareous silica fine SAND - with very closely spaced thin laminae of clay	16.00																
		16.20	33.5	18.4														
24	17.0 m to 17.8 m - olive grey clayey calcareous silica fine SAND - with very closely spaced thin laminae of clay and organic matter	17.00				11.9	14.9							50				
		17.30	38.1	17.9	19.6													
25	18.0 m to 18.7 m - olive grey calcareous silica fine SAND - at bottom thin to thick laminae of organic matter	18.00								1								
		18.30	30.9	18.7	19.4													
26	19.0 m to 19.7 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thick laminae of clay and organic matter	19.00																
		19.30	26.6	19.3	19.3													
27	20.0 m to 20.7 m - olive grey calcareous silica fine SAND - with very closely to closely spaced thin to thick laminae of clay and organic matter	20.00				12.1	14.9	2.63						25				
		20.25	30.8	18.7	19.0													
28	21.0 m to 21.5 m - olive grey calcareous silica fine SAND - with very closely spaced thin laminae of clay and organic matter	21.00																
		21.30	27.8	19.1	18.8													
	21.5 m to 21.7 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay	21.45																
29	22.0 m to 22.8 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thin to thick laminae of clay and organic matter	22.00																

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GeODin/LCTR.GLO/2016-10-24 16:29

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		22.40	25.9	19.4	17.9													
30	23.0 m to 23.8 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay and organic matter	23.00																
		23.40	30.7	18.7	18.6													
31	24.0 m to 24.9 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of clay and organic matter	24.00																
		24.40	31.1	18.7	19.4													
32	25.0 m to 25.4 m - olive grey calcareous silica fine SAND - with very closely spaced thin laminae of clay and organic matter	25.00												57				
	25.4 m to 25.9 m - olive grey calcareous silica fine SAND - with closely spaced thin laminae to thick laminae of organic matter - with few thin laminae of clay	25.35																
		25.40	28.7	19.0	19.2													
		25.60								1								
33	26.0 m to 26.6 m - olive grey calcareous silica fine SAND, with traces of mica crystals	26.00																
		26.30	30.6	18.7	17.9													
34	27.0 m to 27.9 m - olive grey calcareous silica fine SAND - with extremely closely to very closely spaced thin laminae of organic matter	27.00																
		27.50	36.1	18.1	18.6													
35	28.0 m to 28.7 m - olive grey calcareous silica fine SAND, with traces of mica crystals	28.00																
		28.30	26.1	19.4	18.2													
36	29.0 m to 29.6 m - olive grey calcareous silica fine SAND, with traces of mica crystals	29.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
		29.30	27.5	19.2	18.7													
37	30.0 m to 30.8 m - olive grey calcareous silica fine SAND, with traces of mica crystals - with few thin laminae of organic matter	30.00																
		30.40	31.3	18.7	18.6													
38	31.0 m to 31.8 m - olive grey calcareous silica fine SAND, with traces of mica crystals - with few thin laminae of organic matter	31.00												7				
		31.40	28.8	19.0	18.5													
39	32.0 m to 32.7 m - olive grey calcareous silica fine SAND	32.00																
		32.40	28.8	19.0	19.0													
40	33.0 m to 33.5 m - olive grey calcareous silica fine SAND, with traces of organic matter	33.00																
		33.30	24.8	19.6	18.4													
41	34.0 m to 34.5 m - olive grey calcareous silica fine SAND, with traces of organic matter	34.00																
		34.25	26.0	19.4	19.6													
42	35.0 m to 35.4 m - olive grey calcareous silica fine to medium SAND - at 35.1 m: with gravel	35.00																
		35.20	26.0	19.4	18.7													
43	35.5 m to 35.9 m - olive grey calcareous silica fine to medium SAND	35.50																
		35.70	25.1	19.5	19.1													
44	36.0 m to 36.5 m - olive grey calcareous silica fine to medium SAND	36.00				13.0	15.5	2.65						4				
		36.25	24.5	19.6	19.0													

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
45	37.0 m to 37.6 m - olive grey calcareous silica fine to medium SAND - at 37.4 m: with thick laminae of organic matter	37.00							2	0								
		37.30	24.8	19.6	18.8													
46	38.0 m to 38.2 m - olive grey silica fine to medium SAND	38.00																
		38.10	24.2	19.7	19.5													
47	38.5 m to 38.7 m - olive grey silica fine to medium SAND	38.50																
		38.60	23.4	19.8	19.0													
48	39.0 m to 39.3 m - olive grey silica fine to medium SAND	39.00																
		39.10	24.5	19.6	19.6													
49	39.5 m to 39.9 m - dark grey silica fine to medium SAND	39.50																
		39.70	24.6	19.6	19.8													
	39.9 m to 40.0 m - organic matter	39.90																
50	40.5 m to 40.6 m - organic matter	40.50																
	40.6 m to 41.0 m - olive grey silica fine to medium SAND - at 40.9 m: with thick laminae of organic matter	40.55																
		40.75	23.5	19.8	19.7													
51	41.0 m to 41.2 m - olive grey silica fine to medium SAND	41.00																
	41.2 m to 41.4 m - black organic CLAY, with organic matter	41.20																
	41.4 m to 41.5 m - olive grey calcareous silica medium to coarse SAND	41.40																
		41.45	22.0	20.0														
	41.5 m to 41.7 m - dark grey slightly silty calcareous silica fine SAND	41.50																

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HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_P [%]		PP	TV	UU	LV
		41.60	18.8	20.6														
52	42.0 m to 42.1 m - dark grey very silty calcareous silica fine SAND	42.00																
		42.05	26.7	19.3	19.3													
	42.1 m to 42.9 m - dark grey sandy calcareous CLAY - at 42.6 m: with coarse gravel-sized pockets of very sandy clay	42.10																
		42.50									21	32	11	88				
		42.90	25.5	19.5														
53	43.0 m to 43.3 m - dark grey sandy calcareous CLAY	43.00																
		43.20	24.6	19.6														
	43.3 m to 43.9 m - dark grey slightly silty calcareous silica fine SAND - with closely spaced thick laminae of clay	43.30																
		43.60	28.8	19.0	18.6													
54	44.0 m to 44.7 m - dark grey silty calcareous silica fine SAND - at top organic matter - with one thick lamina of clay	44.00																
		44.25												28				
55	45.0 m to 45.3 m - dark grey slightly silty calcareous silica fine SAND, with traces of organic matter	45.00								0								
		45.20	21.8	20.1	19.1													
	45.3 m to 45.7 m - olive grey silica medium SAND - with extremely closely spaced thin laminae of clay	45.30																
		45.50	21.7	20.1	18.8													
56	46.0 m to 46.7 m - olive grey silica medium SAND, with traces of organic matter - with closely spaced thin to thick laminae of clay	46.00																

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH07-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		46.40	20.8	20.2	19.9													
57	47.0 m to 47.6 m - olive grey silty silica fine SAND	47.00																
		47.40	28.3	19.1	18.8													
58	48.0 m to 48.6 m - olive grey silty silica fine SAND - from 48.2 m to 48.3 m: with thick laminae of organic matter	48.00																
		48.30						2.66						17				
		48.40	24.4	19.6	18.6													
59	49.0 m to 49.7 m - olive grey silty silica fine SAND, with traces of organic matter	49.00																
		49.30	29.7	18.9	17.6													
60	50.0 m to 50.7 m - olive grey silty silica fine SAND at 50.2 m - with thick laminae of organic matter	50.00																
		50.40	29.1	18.9	19.6													

Key:
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_p [%]	Fines [%]	PP	TV	UU	LV
01	0.0 m to 0.5 m - olive calcareous silica medium to coarse SAND, with many fine to medium gravel-sized shells and shell fragments	0.00												4				
		0.25	20.7	20.3	18.4													
02	1.0 m to 1.7 m - dark grey calcareous silica medium SAND, with shells and shell fragments - with two closely spaced thin beds of shells and shell fragments	1.00																
		1.40	23.4	19.8	18.6													
03	2.0 m to 2.5 m - very dark greyish brown calcareous silica fine SAND	2.00						2.66						7				
		2.30	22.9	19.9	19.5													
04	2.5 m to 3.0 m - very dark grey calcareous silica fine SAND	2.50																
		2.80	23.4	19.8	19.9													
05	3.5 m to 4.1 m - very dark grey calcareous silica fine SAND, with traces of organic matter - at bottom few thin laminae of organic matter	3.50																
		3.80	25.0	19.5	19.3													
06	4.5 m to 5.1 m - olive grey calcareous silica fine SAND	4.50																
		4.80	21.8	20.1	19.7													
07	5.5 m to 6.1 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shells and shell fragments	5.50				13.5	15.8							3				
		5.80	21.7	20.1	19.5													
08	6.5 m to 6.9 m - olive grey calcareous silica fine SAND	6.50																
		6.70	22.0	20.0	19.1													

Key:
w : water content
γ_1 : unit weight derived from water content
γ_2 : unit weight derived from volume mass calculation
$\gamma_{d;min}$: minimum index dry unit weight
$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
w_L : liquid limit
I_p : plasticity index
Fines : mass percentage of material passing 63 µm or 75 µm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_u : undrained shear strength
10r : r refers to test on remoulded soil
10d : d refers to test on disturbed soil

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
09	7.0 m to 7.5 m - olive grey calcareous silica fine to medium SAND, with traces of fine to medium gravel-sized shell fragments	7.00																
10	8.0 m to 8.5 m - olive grey calcareous silica fine to medium SAND, with few fine to medium gravel-sized shell fragments	8.00																
		8.30	23.0	19.9	19.4													
11	9.0 m to 9.5 m - olive grey calcareous silica fine to medium SAND, with traces of shell fragments	9.00																
		9.25	22.9	19.9	19.1	12.9	15.5											
12	10.0 m to 10.5 m - olive grey calcareous silica fine SAND	10.00							2					3				
		10.25	21.3	20.2	19.0													
13	11.0 m to 11.3 m - olive grey calcareous silica fine SAND, with few fine to medium gravel-sized shell fragments - at bottom one coarse gravel-sized rock fragment	11.00																
		11.20	22.1	20.0														
	11.3 m to 11.7 m - very stiff very dark grey CLAY - at top very sandy - with few thin laminae of sand	11.30																
		11.40			18.9													
		11.45	28.6	19.2														
		11.50													206			
		11.65									27	58	31	97				
14	12.0 m to 12.7 m - stiff to very stiff very dark grey CLAY	12.00																
		12.10			18.8										200			
		12.30	33.1	18.6	18.6												48r	
		12.30	33.5 30.4	19.0 18.6	18.8										150		78	

Key:

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ρ_s : density of solid particles

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w_P : plastic limit

w_L : liquid limit

I_P : plasticity index

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GeODin/LCTR.GLO/2016-10-24 16:29

LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		12.50													100			
15	13.0 m to 13.9 m - stiff to very stiff very dark grey CLAY - at bottom traces of organic matter	13.00																
		13.20	34.7	18.4	18.6 18.1										100			
		13.30	34.7	18.3	18.6													
		13.40			18.1			2.66			23	56	33	98				
		13.42	37.8	18.1	18.3													
		13.60	36.4	18.2											169			
16	14.0 m to 14.2 m - black CLAY, with organic matter	14.00																
	14.2 m to 14.5 m - stiff to very stiff very dark grey calcareous CLAY	14.20																
		14.25			20.6										283	155		
		14.45													108			
17	14.5 m to 14.9 m - dark grey sandy calcareous CLAY	14.50																
		14.75	25.3	19.7														
	14.9 m to 15.1 m - dark grey calcareous silica fine SAND	14.90																
		15.00	26.1	19.4														
18	15.5 m to 16.2 m - dark grey silty calcareous silica fine SAND	15.50																
		15.70												39				
		15.80	31.1	18.7	19.3													
19	16.5 m to 17.2 m - dark grey calcareous silica fine SAND - with very closely to closely spaced very thin beds of clay	16.50																
		16.75	29.5	19.1	19.3													

Key:
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_p [%]	w_L [%]	I_p [%]	Fines [%]	PP	TV	UU	LV
20	17.5 m to 17.6 m - dark grey calcareous CLAY	17.50																
	17.6 m to 18.1 m - dark grey calcareous silica fine SAND	17.55																
		17.80	25.7	19.4	19.3													
21	18.5 m to 19.1 m - dark grey calcareous silica fine SAND - with very closely spaced thin to very thin beds of clay	18.50																
		18.80	24.5	19.6	19.9													
22	19.5 m to 20.1 m - dark grey slightly silty calcareous silica fine SAND - with very closely spaced very thin beds of clay	19.50																
		19.80	28.8	19.0	18.7													
		19.90							6									
23	20.5 m to 21.2 m - dark grey slightly silty calcareous silica fine SAND - at 20.9 m: with one thin laminae of organic matter	20.50				12.3	14.9	2.65						6				
		20.90	33.1	18.4	18.3													
24	21.5 m to 22.2 m - dark grey slightly silty calcareous silica fine SAND - from 21.7 m to 21.8 m: with one very thin bed of dark grey clay	21.50								0								
		21.80	26.3	19.4	19.1													
25	22.5 m to 23.1 m - dark grey slightly silty calcareous silica fine SAND - from 22.5 m to 22.6 m: with one thin bed of dark grey clay	22.50																
		22.85	25.4	19.5	18.8													
26	23.5 m to 24.1 m - dark grey slightly silty calcareous silica fine SAND	23.50																
		23.80	26.6	19.3	18.9													

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Org.Cont. : organic matter content
w_p : plastic limit
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I_p : plasticity index
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
27	24.5 m to 25.1 m - dark grey slightly silty calcareous silica fine SAND	24.50																
		24.80	26.6	19.3	19.4									4				
28	25.5 m to 26.2 m - dark grey slightly silty calcareous silica fine SAND - from 25.6 m to 25.7 m: with one thin bed of organic matter	25.50																
		25.80	28.1	19.1	18.6													
29	26.5 m to 27.2 m - dark grey slightly silty calcareous silica fine SAND - from 27.1 m to 27.2 m: with one thin bed of organic matter	26.50																
		26.85	26.7	19.3	18.6													
30	27.5 m to 28.2 m - dark grey slightly silty calcareous silica fine SAND - at bottom traces of organic matter	27.50												2				
		27.85	27.0	19.2	18.4													
31	28.5 m to 29.2 m - dark grey slightly silty calcareous silica fine SAND - from 28.6 m to 28.7 m: with one thin bed of organic matter	28.50																
		28.90	30.6	18.8	18.2													
32	29.5 m to 30.2 m - dark grey slightly silty calcareous silica fine SAND - at 30.1 m: with one very thin bed of organic matter	29.50																
		29.90	25.1	19.5	19.4													
33	30.5 m to 31.2 m - dark grey slightly silty calcareous silica fine SAND - with closely spaced very thin beds of organic matter	30.50												4				
		30.90	26.0	19.4	19.0													

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γ_1 : unit weight derived from water content
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$\gamma_{d;max}$: maximum index dry unit weight
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w_P : plastic limit
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
34	31.5 m to 32.2 m - dark grey slightly silty calcareous silica fine SAND	31.50																
		31.90	25.1	19.5	18.6													
35	32.5 m to 32.9 m - dark grey calcareous silica fine SAND - with closely spaced thin laminae of organic matter	32.50																
36	33.0 m to 33.7 m - dark grey calcareous silica medium SAND, with traces of organic matter	33.00																
		33.30	24.3	19.7	18.9													
37	34.0 m to 34.7 m - dark grey calcareous silica medium SAND - from 34.0 m to 34.3 m: with very closely spaced very thin beds of organic matter	34.00																
		34.30	26.1	19.4	19.1													
38	35.0 m to 35.4 m - dark grey calcareous silica medium SAND	35.00				12.9	15.4	2.64						2				
		35.20	26.1	19.4	18.2													
39	35.5 m to 35.8 m - dark grey calcareous silica medium SAND, with traces of organic matter	35.50							2	0								
40	36.0 m to 36.4 m - dark grey calcareous silica medium SAND, with traces of organic matter	36.00																
		36.20	25.1	19.5	19.0													
41	36.5 m to 36.8 m - dark grey calcareous silica medium SAND - at bottom very closely spaced thick laminae of clay	36.50																
		36.65	23.4	19.8	18.8													
42	37.0 m to 37.7 m - dark grey calcareous silica fine to medium SAND - from 37.3 m to 37.4 m: with a very thin bed of organic matter	37.00																
		37.20	22.0	20.0	18.3													

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$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
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I_P : plasticity index
Fines : mass percentage of material passing 63 μm or 75 μm sieve

PP : pocket penetrometer
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s_u : undrained shear strength
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Sample				Unit Weight [kN/m³]							Atterberg Limits				s_u [kPa]			
No.	Ground Description	Test Depth [m]	w [%]	γ_1	γ_2	γ_d min.	γ_d max.	ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	w_P [%]	w_L [%]	I_P [%]	Fines [%]	PP	TV	UU	LV
		37.55	22.4	20.0														
43	38.0 m to 38.6 m - dark grey calcareous silica fine to medium SAND, with traces of organic matter - at 38.2 m: with extremely closely spaced thin laminae of organic matter	38.00																
		38.30	25.6	19.5	19.4													
44	39.0 m to 39.1 m - dark grey calcareous silica fine to medium SAND - with extremely closely spaced thin laminae of organic matter	39.00												6				
	39.1 m to 39.7 m - olive grey calcareous CLAY	39.10																
		39.40	22.8	20.1														
	39.7 m to 39.8 m - dark grey silty calcareous silica fine SAND - with extremely closely spaced thin laminae of organic matter	39.70																
		39.75	25.3	19.5														
45	40.0 m to 40.2 m - dark grey very silty calcareous silica fine SAND	40.00																
	40.2 m to 40.4 m - dark grey CLAY	40.20																
		40.30	23.3	20.0														
	40.4 m to 40.8 m - dark grey very silty calcareous silica fine SAND	40.35																
		40.50	25.7	19.4	19.5													
46	41.0 m to 41.1 m - dark grey CLAY	41.00																
	41.1 m to 41.4 m - dark grey slightly silty silica fine SAND - with extremely closely to closely spaced thin laminae of organic matter	41.05																
		41.20	24.3	19.7	19.3													

Key:
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$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth [m]	w [%]	Unit Weight [kN/m³]				ρ_s [Mg/m³]	Carb. Cont. [%]	Org. Cont. [%]	Atterberg Limits			Fines [%]	s_u [kPa]			
No.	Ground Description			γ_1	γ_2	γ_d min.	γ_d max.				w_P [%]	w_L [%]	I_p [%]		PP	TV	UU	LV
47	41.5 m to 41.7 m - dark grey slightly silty silica fine SAND, with traces of organic matter	41.50																
		41.60	25.8	19.4	19.7													
	41.7 m to 42.2 m - dark grey very sandy calcareous CLAY	41.70																
		42.00	18.7	20.9														
	42.2 m to 42.3 m - dark grey slightly silty silica fine SAND	42.20																
48	42.5 m to 43.3 m - dark grey very silty silica fine SAND, with traces of organic matter	42.50	10.2	22.9	16.8			2.65			19	24	5	51				
		42.80	26.0	19.4	19.6													
49	43.5 m to 43.8 m - dark grey very silty silica fine SAND - at top thin laminae of organic matter	43.50																
		43.60	22.1	20.0	19.7													
	43.8 m to 44.3 m - dark grey sandy CLAY	43.75																
		43.90	33.0	18.6														
50	44.5 m to 44.6 m - dark olive grey slightly sandy CLAY	44.50																
		44.55	35.8	18.3														
51	45.0 m to 45.6 m - dark olive grey sandy CLAY	45.00									26	36	10	83				
		45.20	29.5	19.1														
	45.6 m to 45.8 m - dark grey very silty silica fine SAND	45.60																
		45.65	27.5	19.2	18.6													
52	46.0 m to 46.8 m - dark grey very silty silica fine SAND - at top medium gravel-sized pockets of organic matter	46.00																
		46.30	30.8	18.7	18.4													
53	47.0 m to 47.7 m - dark grey very silty silica fine SAND	47.00																

Key:

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γ_1 : unit weight derived from water content
γ_2 : unit weight derived from volume mass calculation
$\gamma_{d;min}$: minimum index dry unit weight
$\gamma_{d;max}$: maximum index dry unit weight
ρ_s : density of solid particles

Carb.Cont. : carbonate content
Org.Cont. : organic matter content
w_P : plastic limit
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I_p : plasticity index
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LABORATORY CLASSIFICATION TEST RESULTS

LOCATION HKZ1-BH08-SA

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

GeODin/LCTR.GLO/2016-10-24 16:29

Sample		Test Depth	w	Unit Weight [kN/m³]				ρ_s	Carb. Cont.	Org. Cont.	Atterberg Limits			Fines	s_u [kPa]			
No.	Ground Description	[m]	[%]	γ_1	γ_2	γ_d min.	γ_d max.	[Mg/m³]	[%]	[%]	w_P [%]	w_L [%]	I_P [%]	[%]	PP	TV	UU	LV
		47.40	29.2	18.9	17.9													
54	48.0 m to 48.4 m - dark grey very silty silica fine SAND - with very closely to closely spaced thin laminae of organic matter	48.00												30				
		48.20	24.7	19.6	19.2													
	48.4 m to 48.7 m - dark grey slightly silty silica fine SAND - with very closely to closely spaced thin laminae of organic matter	48.40								1								
		48.55	24.4	19.6	18.8													
55	49.0 m to 49.7 m - dark grey slightly silty silica fine SAND - with medium spaced very thin beds of clay	49.00																
		49.40	25.4	19.5	17.8													
56	50.0 m to 50.7 m - dark grey slightly silty silica fine SAND - at bottom thick laminae to very thin beds of clay	50.00																
		50.35	26.6	19.3	19.2													

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$\gamma_{d;max}$: maximum index dry unit weight
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w_P : plastic limit
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Fines : mass percentage of material passing 63 μm or 75 μm sieve

PP : pocket penetrometer
TV : torvane
UU : unconsolidated undrained triaxial test
LV : laboratory vane
s_U : undrained shear strength
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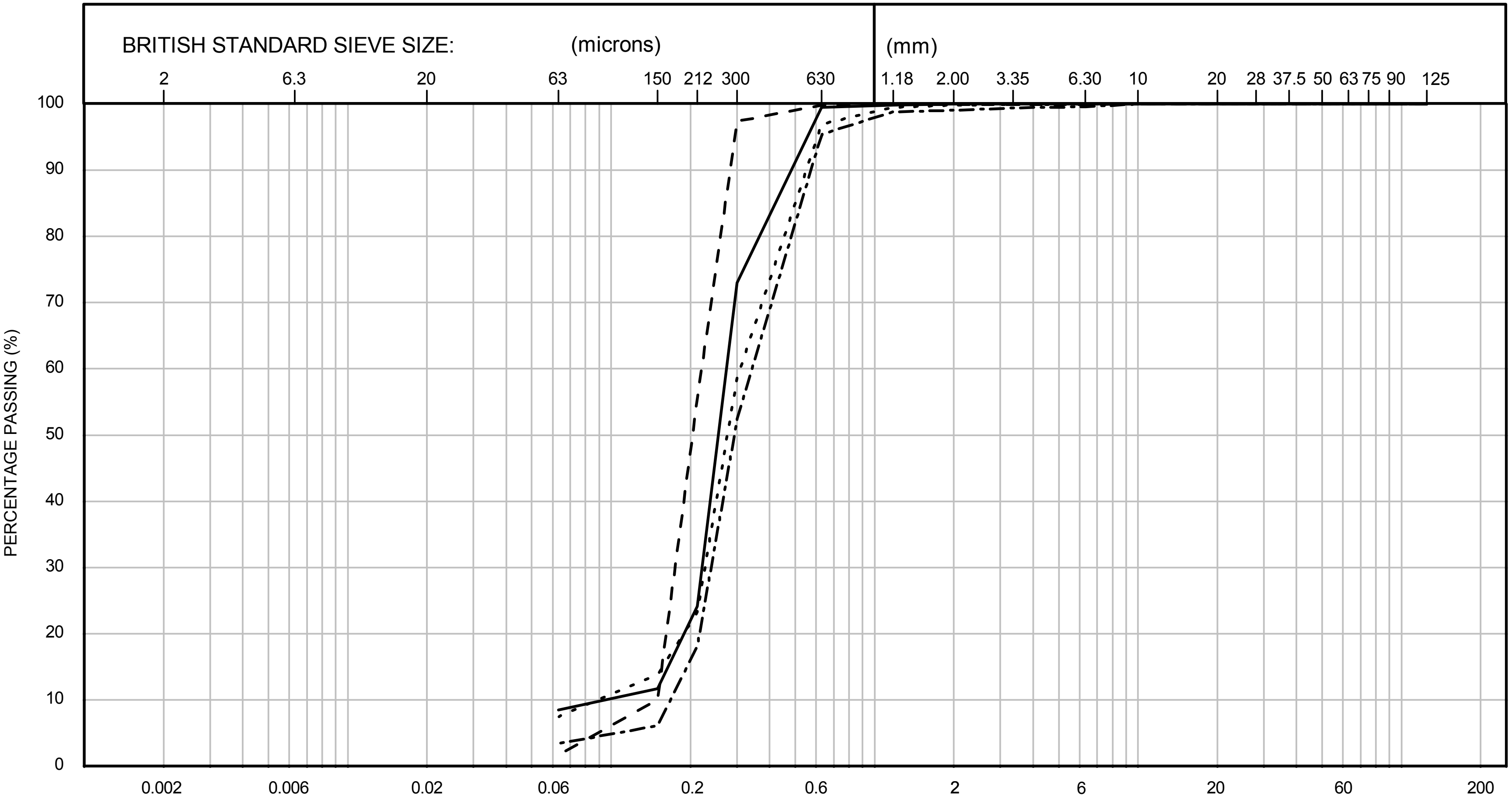
10d : d refers to test on disturbed soil

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 24/08/2016

Approved by: PH Date: 27/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH01-SA_01BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH01-SA	01BagA	0.00	9.2	N/A	0	8	92	0	0
├ ─ ─┤	HKZ1-BH01-SA	04BagA	3.00	9.2	N/A	0	1	99	0	0
├ · · ·┤	HKZ1-BH01-SA	09BagA	7.00	9.2	N/A	0	7	93	0	0
├─·─┤	HKZ1-BH01-SA	14BagA&B	12.00	9.2	N/A	0	3	97	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

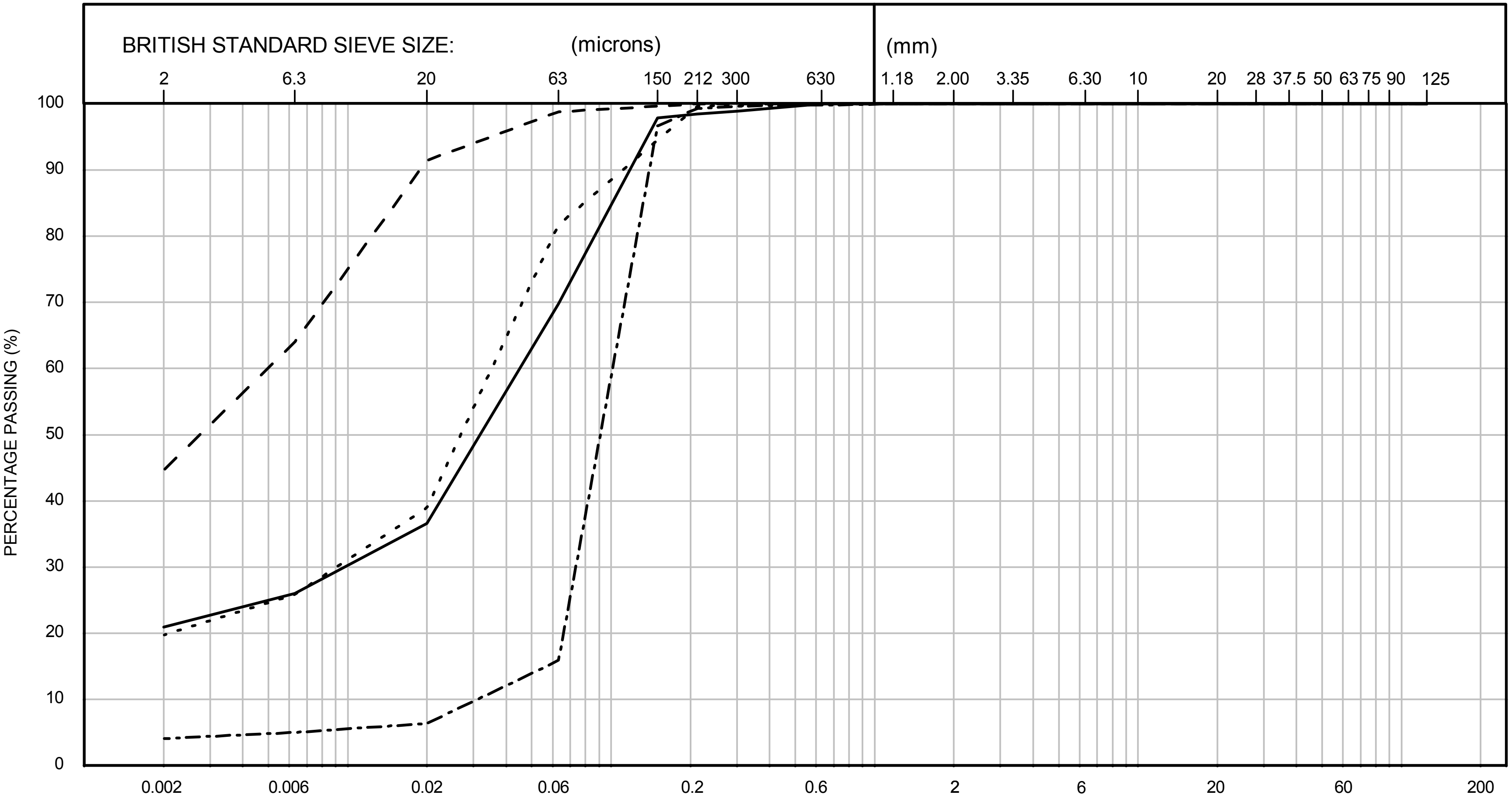
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 27/09/2016 Template Issue: 5:0 Drawn by: ALB Date: 26/08/2016

Approved by: PH Date: 03/10/2016 Filename: J11335 \ CLASS \ HKZ1-BH01-SA_18BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH01-SA	18BagA	15.50	9.2/9.4	N/A	21	46	33	0	0
├ ─ ─┤	HKZ1-BH01-SA	24WaxE	22.15	9.4	N/A	45	53	2	0	0
├ · · ·┤	HKZ1-BH01-SA	28BagA	25.50	9.4	N/A	20	58	22	0	0
├ ─·─┤	HKZ1-BH01-SA	32BagC	30.05	9.2/9.4	N/A	4	11	85	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

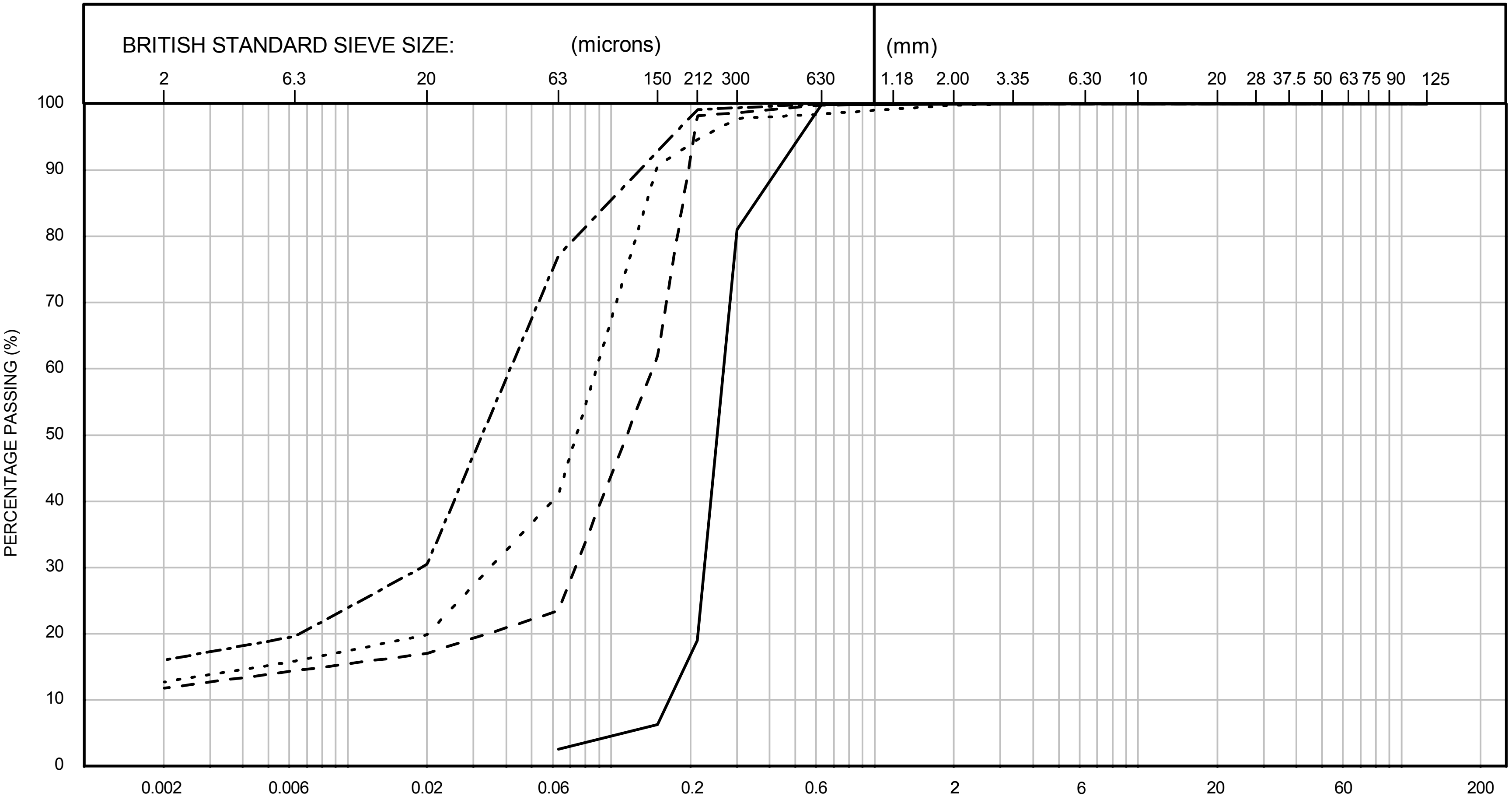
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 08/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH01-SA_38BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH01-SA	38BagA	35.00	9.2	N/A	0	2	98	0	0
├ ─ ─ ┤	HKZ1-BH01-SA	41BagA	38.00	9.2/9.4	N/A	12	11	77	0	0
├ · · · ┤	HKZ1-BH01-SA	42BagC	39.45	9.2/9.4	N/A	13	26	61	0	0
├ ─ · ─ ┤	HKZ1-BH01-SA	44BagA	41.00	9.4	N/A	16	57	27	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

FUGRO

Plate C2.2-3

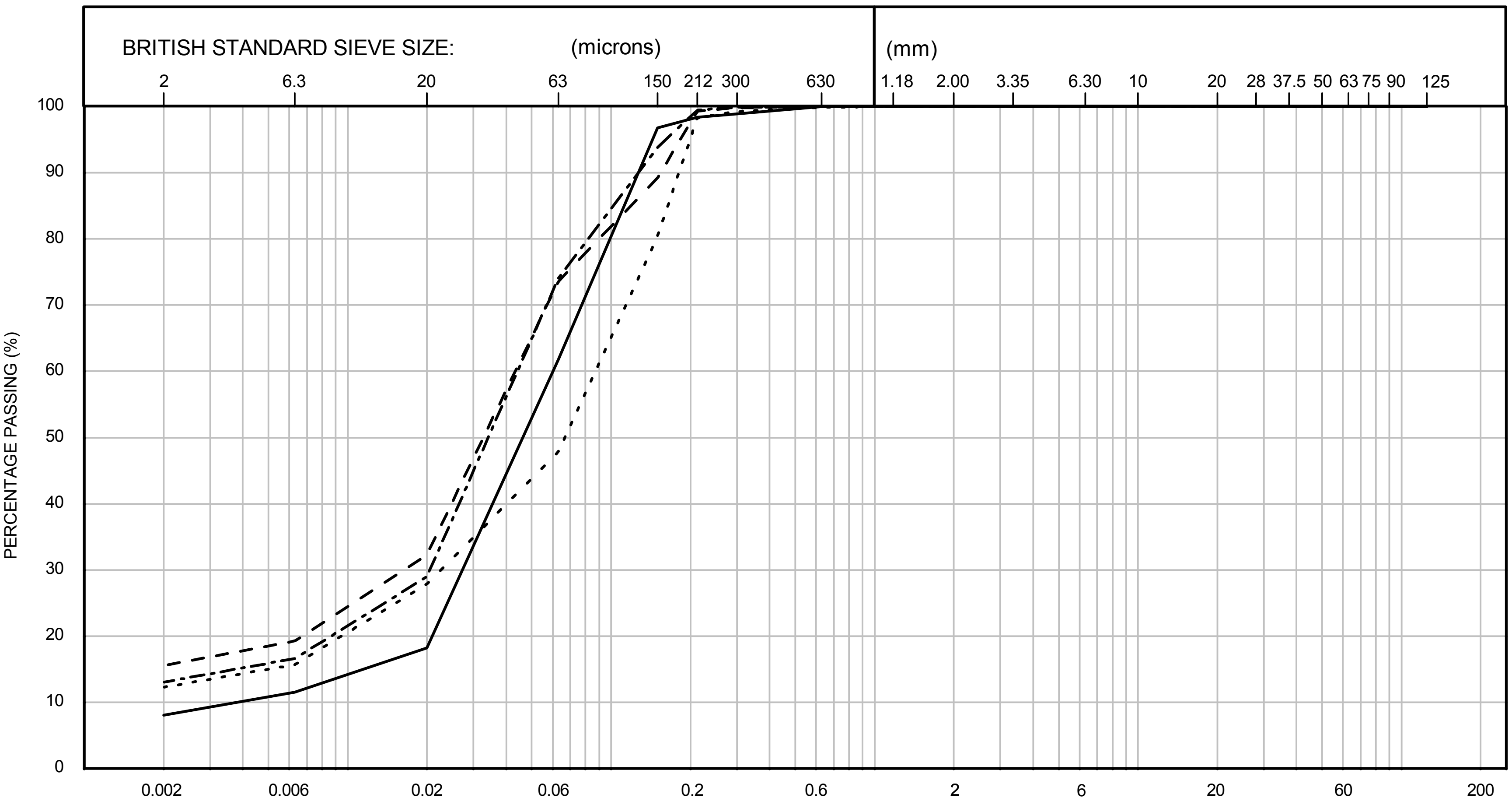
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 26/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH01-SA_46BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH01-SA	46BagA	43.00	9.2/9.4	N/A	8	50	42	0	0
├ ─ ─┤	HKZ1-BH01-SA	49BagA	46.00	9.2/9.4	N/A	16	55	29	0	0
├ · · ·┤	HKZ1-BH01-SA	51BagC	48.45	9.2/9.4	N/A	12	34	54	0	0
├ ─·─·┤	HKZ1-BH01-SA	53BagC	53.50	9.2/9.4	N/A	13	57	30	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

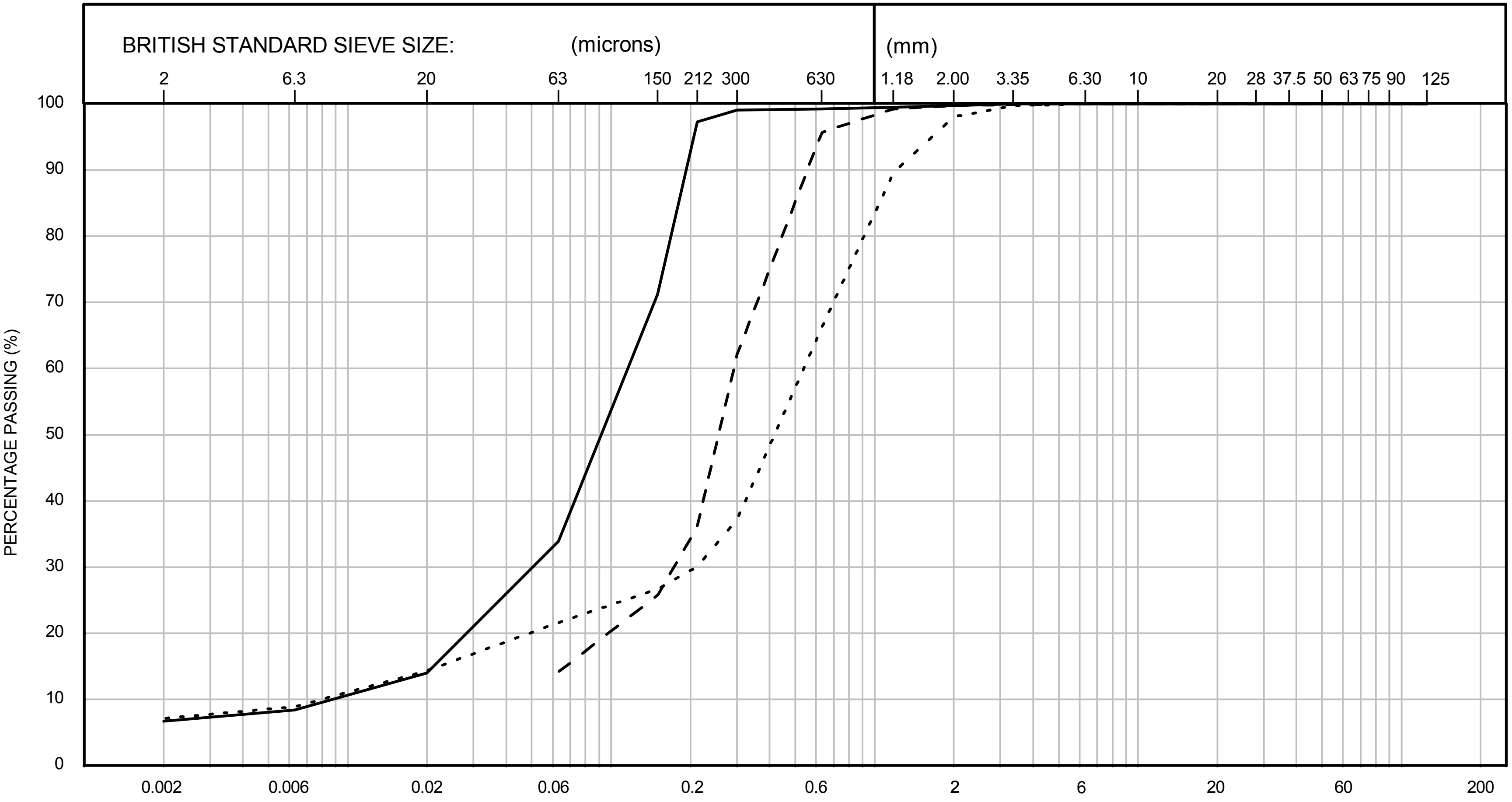
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 30/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH01-SA_53BagD_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH01-SA	53BagD	53.70	9.2/9.4	N/A	7	25	68	0	0
├ ─ ─┤	HKZ1-BH01-SA	54BagB	57.30	9.2	N/A	0	14	86	0	0
├ · · ·┤	HKZ1-BH01-SA	55BagA	61.00	9.2/9.4	N/A	7	13	79	1	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

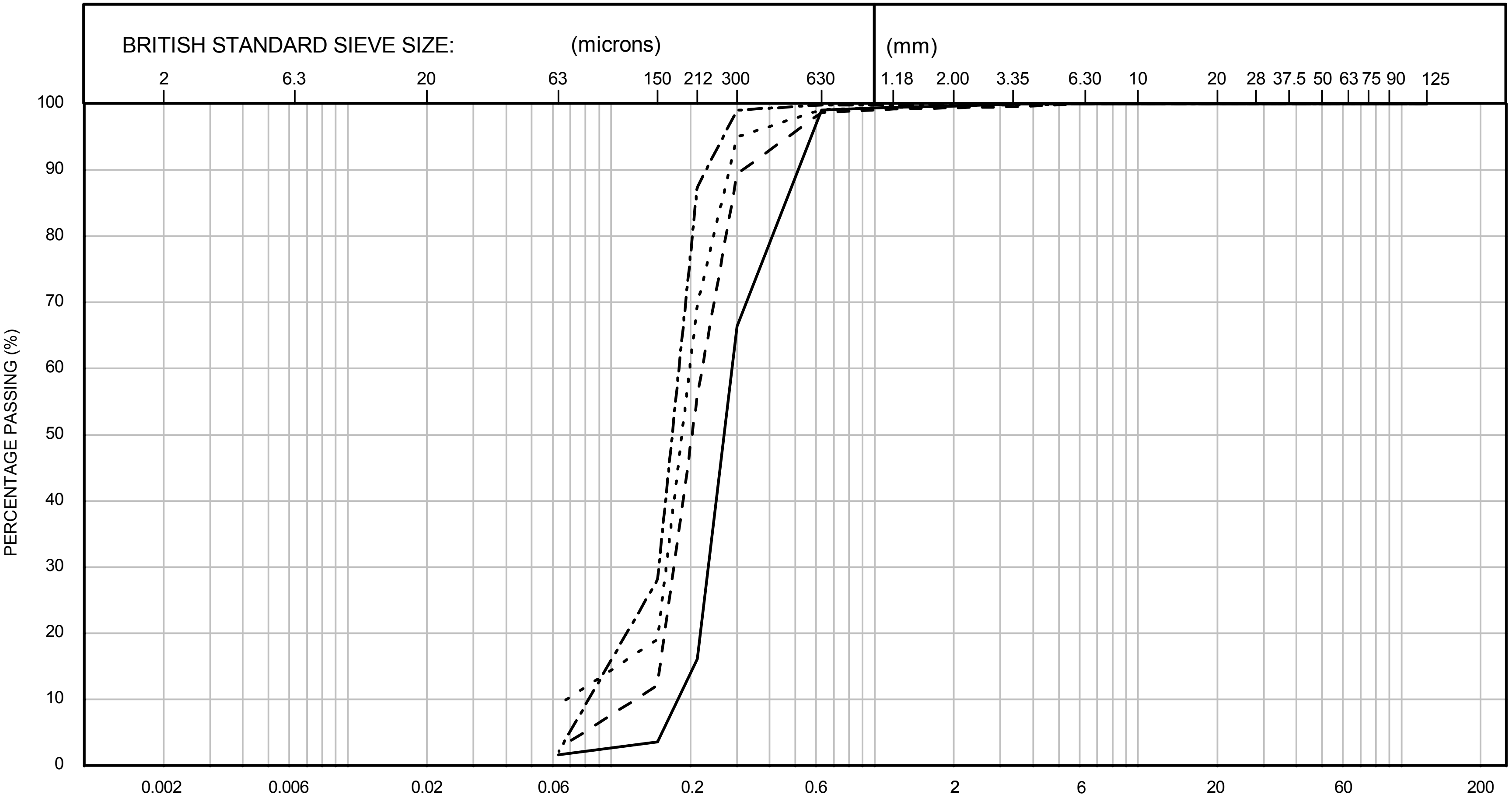
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by:	PH	Date:	31/08/2016	Template Issue: 5:0	Drawn by: ALB Date: 23/08/2016
Approved by:	PH	Date:	20/09/2016	Filename: J11335 \ CLASS \ HKZ1-BH02-SA_01BagA_ps.OPJ	

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
——	HKZ1-BH02-SA	01BagA	0.00	9.2	N/A	0	1	99	0	0
– –	HKZ1-BH02-SA	04BagA	2.50	9.2	N/A	0	2	98	0	0
· · ·	HKZ1-BH02-SA	07BagA	5.50	9.2	N/A	0	9	91	0	0
–·–·–	HKZ1-BH02-SA	09BagA	7.50	9.2	N/A	0	2	98	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

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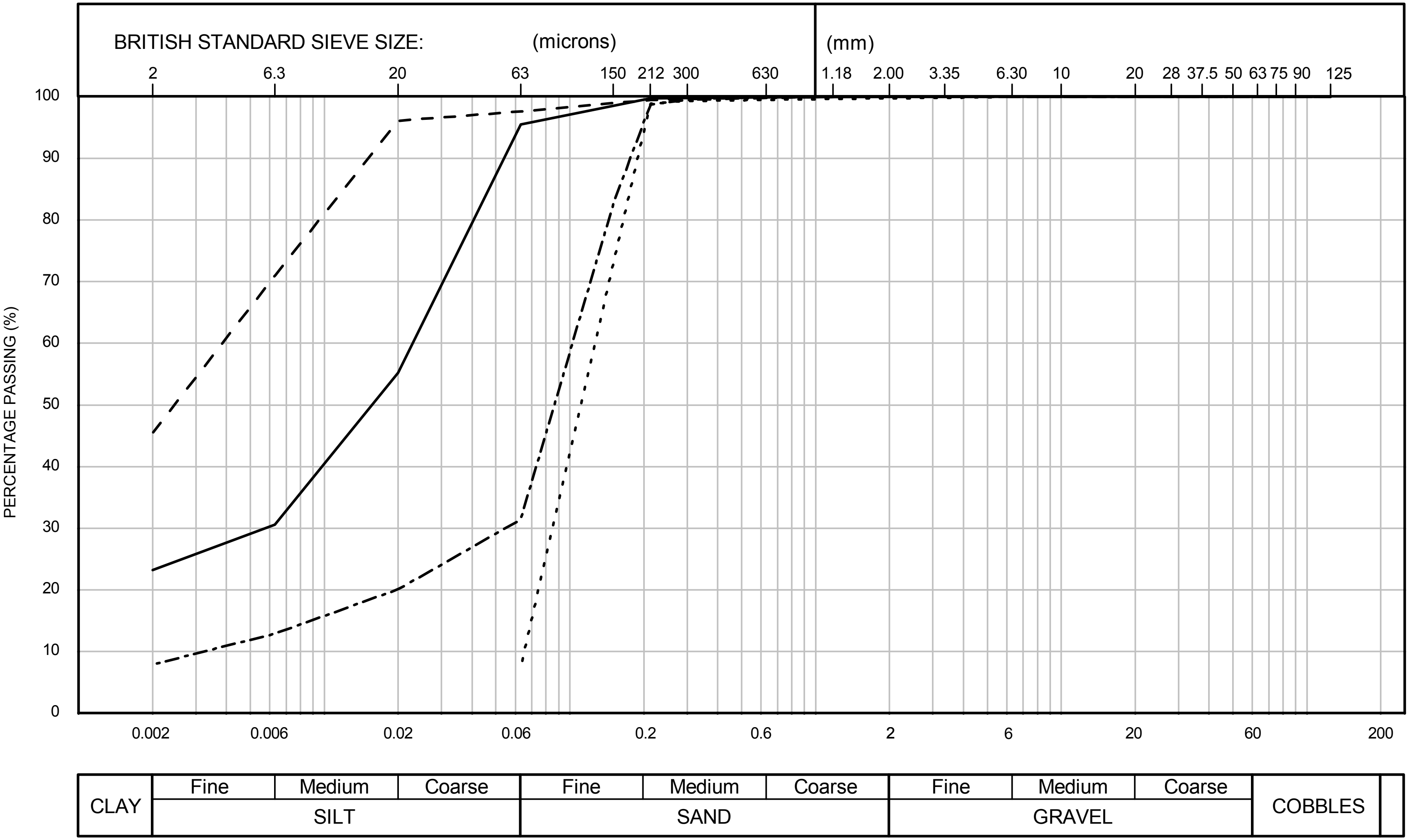
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 26/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH02-SA_14BagUUC_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
|——|	HKZ1-BH02-SA	14BagUUC	11.95	9.4	N/A	23	69	8	0	0
|– –|	HKZ1-BH02-SA	17BagA	14.50	9.4	N/A	45	52	3	0	0
|· · ·|	HKZ1-BH02-SA	20BagA	17.50	9.2	N/A	0	7	93	0	0
|–·–|	HKZ1-BH02-SA	21BagA	18.50	9.2/9.4	N/A	8	22	70	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

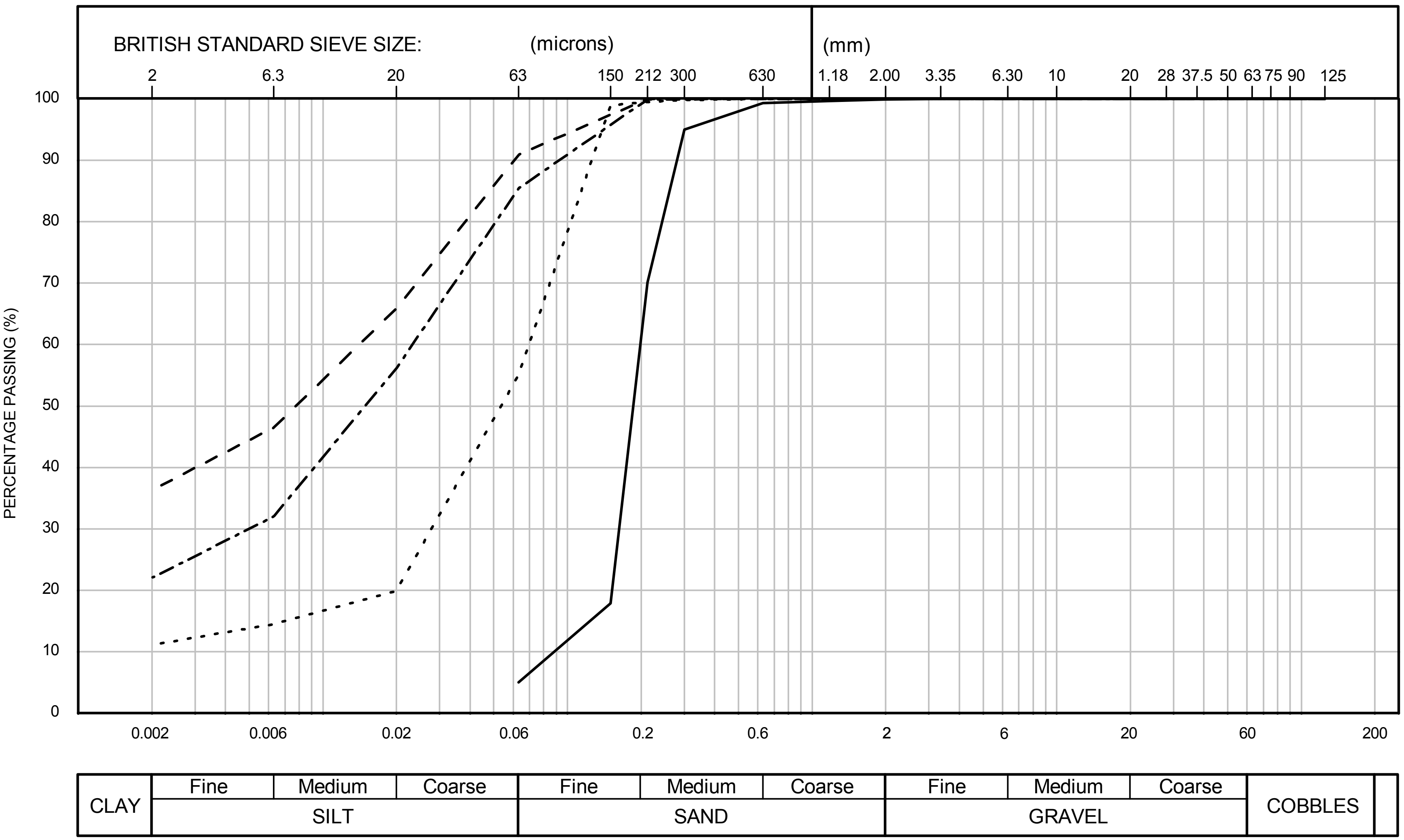
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 26/08/2016

Approved by: PH Date: 27/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH02-SA_23BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH02-SA	23BagA	20.50	9.2	N/A	0	5	95	0	0
├ ─ ─┤	HKZ1-BH02-SA	25WaxA	22.50	9.4	N/A	36	52	12	0	0
├ · · ·┤	HKZ1-BH02-SA	27BagC	25.05	9.2/9.4	N/A	11	41	48	0	0
├ ─ · ─┤	HKZ1-BH02-SA	30BagB	27.15	9.4	N/A	22	61	17	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Plate C2.2-8

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 19/08/2016

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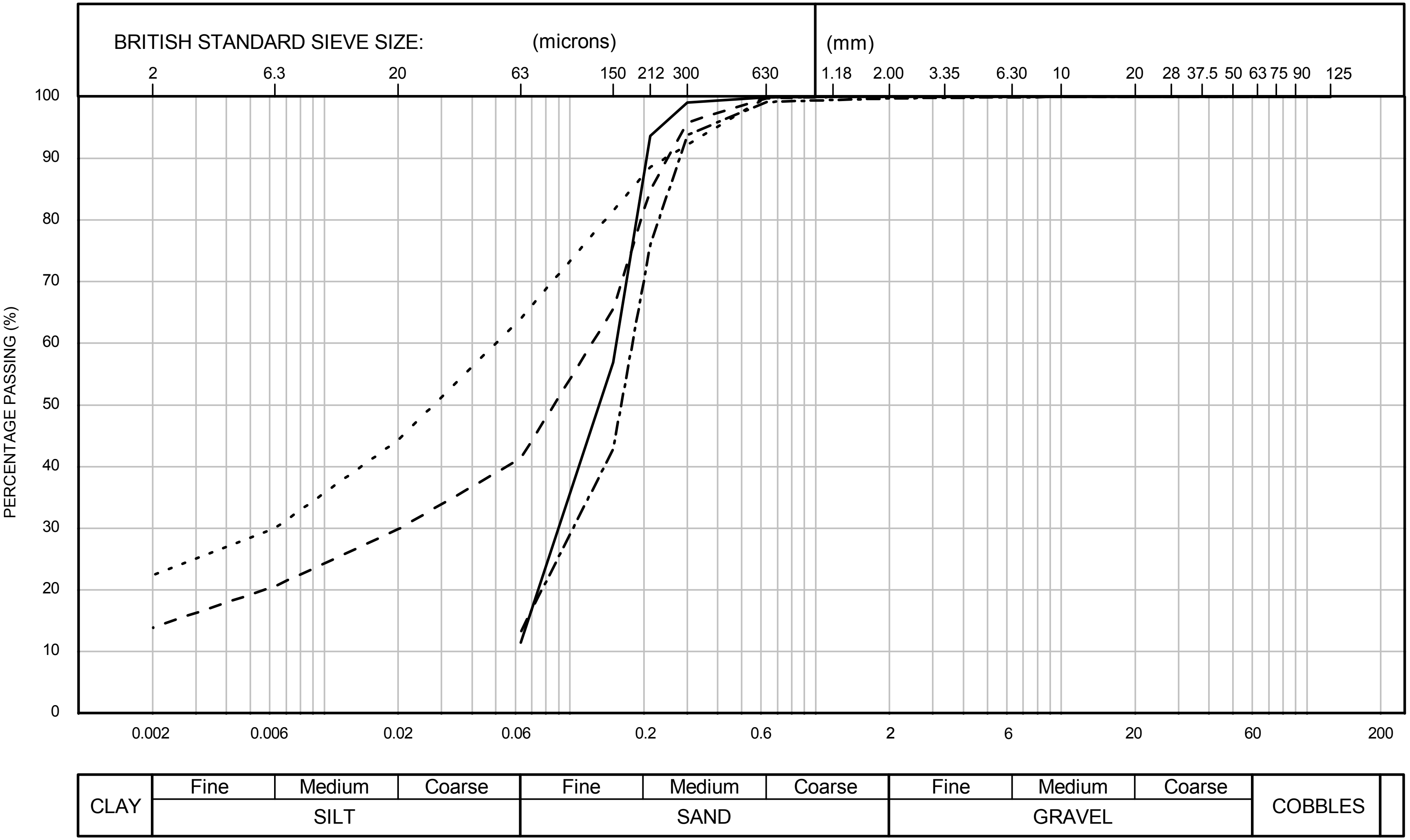
Fugro Report No. N6196/01 (3)

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
|—|	HKZ1-BH02-SA	33BagA	30.00	9.2	N/A	0	11	89	0	0
|– –|	HKZ1-BH02-SA	34BagA	31.00	9.2/9.4	N/A	14	26	60	0	0
|· · ·|	HKZ1-BH02-SA	37BagC	34.50	9.4	N/A	22	40	38	0	0
|–·–|	HKZ1-BH02-SA	42BagC	39.55	9.2	N/A	0	13	87	0	0

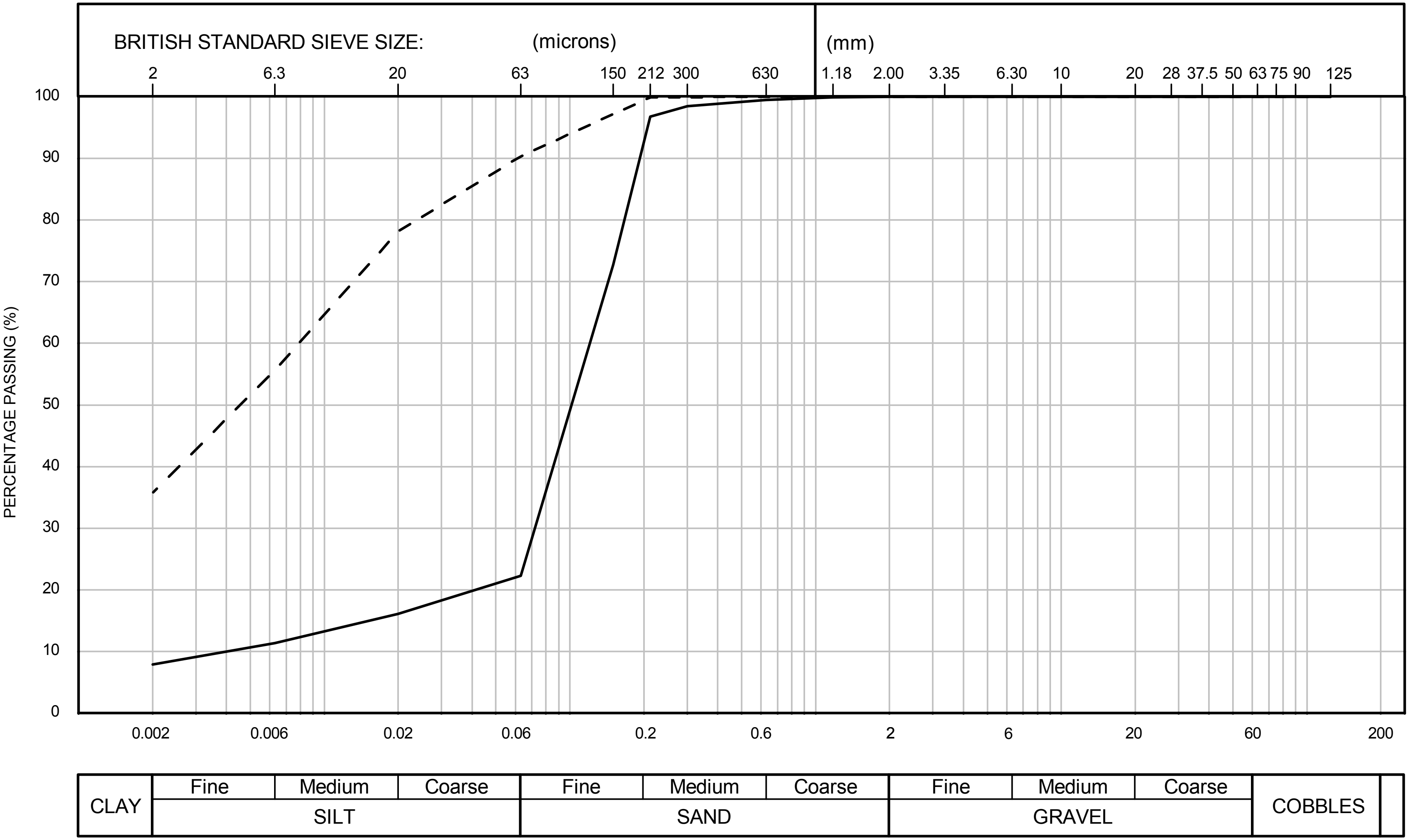
* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH02-SA	48BagC	45.00	9.2/9.4	N/A	8	13	79	0	0
├ ─ ┤	HKZ1-BH02-SA	53BagB	49.70	9.4	N/A	36	53	11	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

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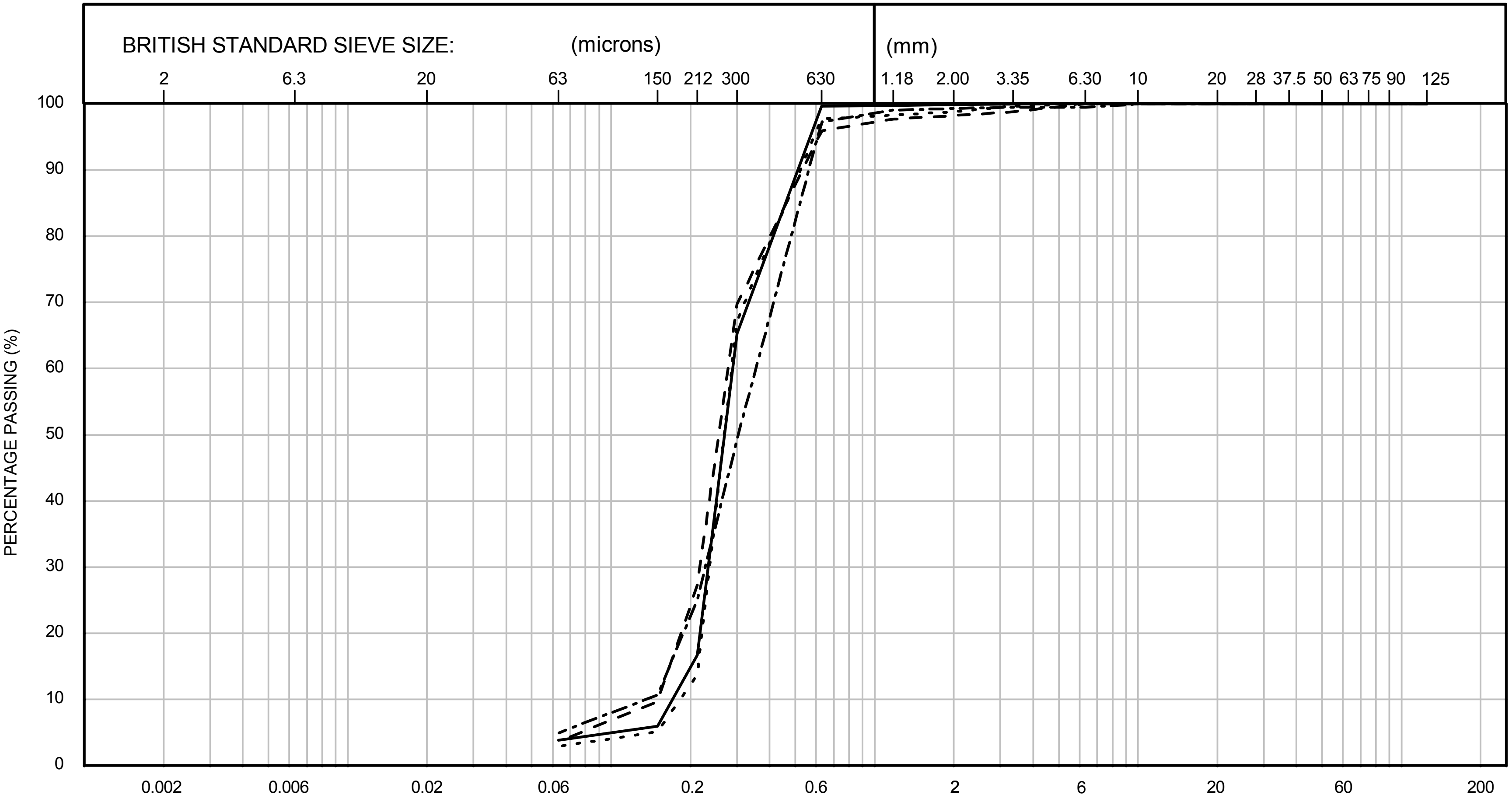
PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH03-SA	01BagA	0.00	9.2	N/A	0	3	97	0	0
├ ─ ─┤	HKZ1-BH03-SA	06BagA	2.50	9.2	N/A	0	3	96	1	0
├ · · ·┤	HKZ1-BH03-SA	10BagA	5.50	9.2	N/A	0	2	97	1	0
├─·─┤	HKZ1-BH03-SA	15BagA	8.00	9.2	N/A	0	4	96	0	0

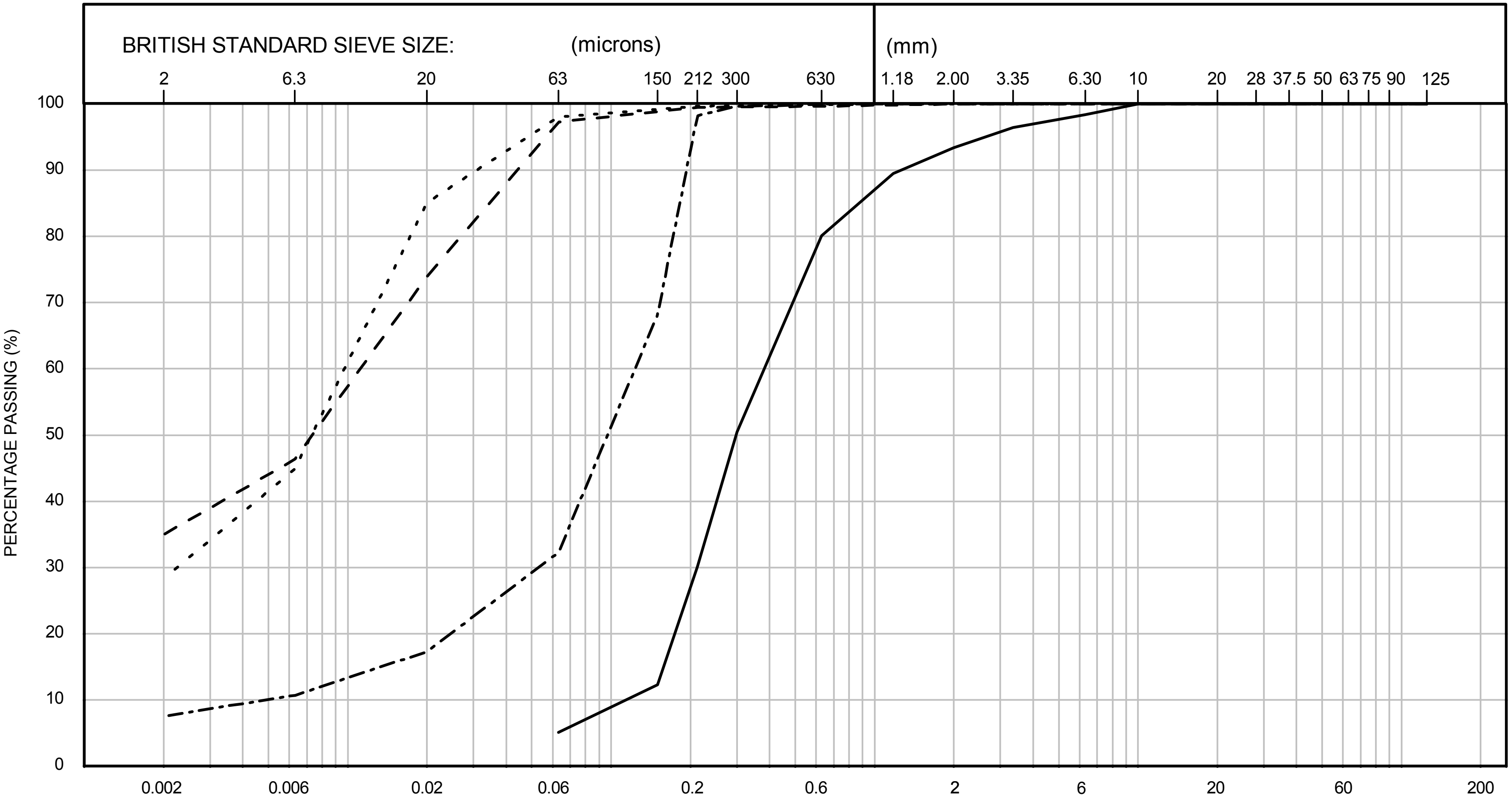
* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├─┤	HKZ1-BH03-SA	21ABagA	12.00	9.2	N/A	0	5	89	6	0
├ – –┤	HKZ1-BH03-SA	22BagB	13.20	9.4	N/A	35	60	5	0	0
├ · · ·┤	HKZ1-BH03-SA	25BagA	16.00	9.4	N/A	28	68	4	0	0
├ – · –┤	HKZ1-BH03-SA	29BagA	20.00	9.2/9.4	N/A	8	23	69	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

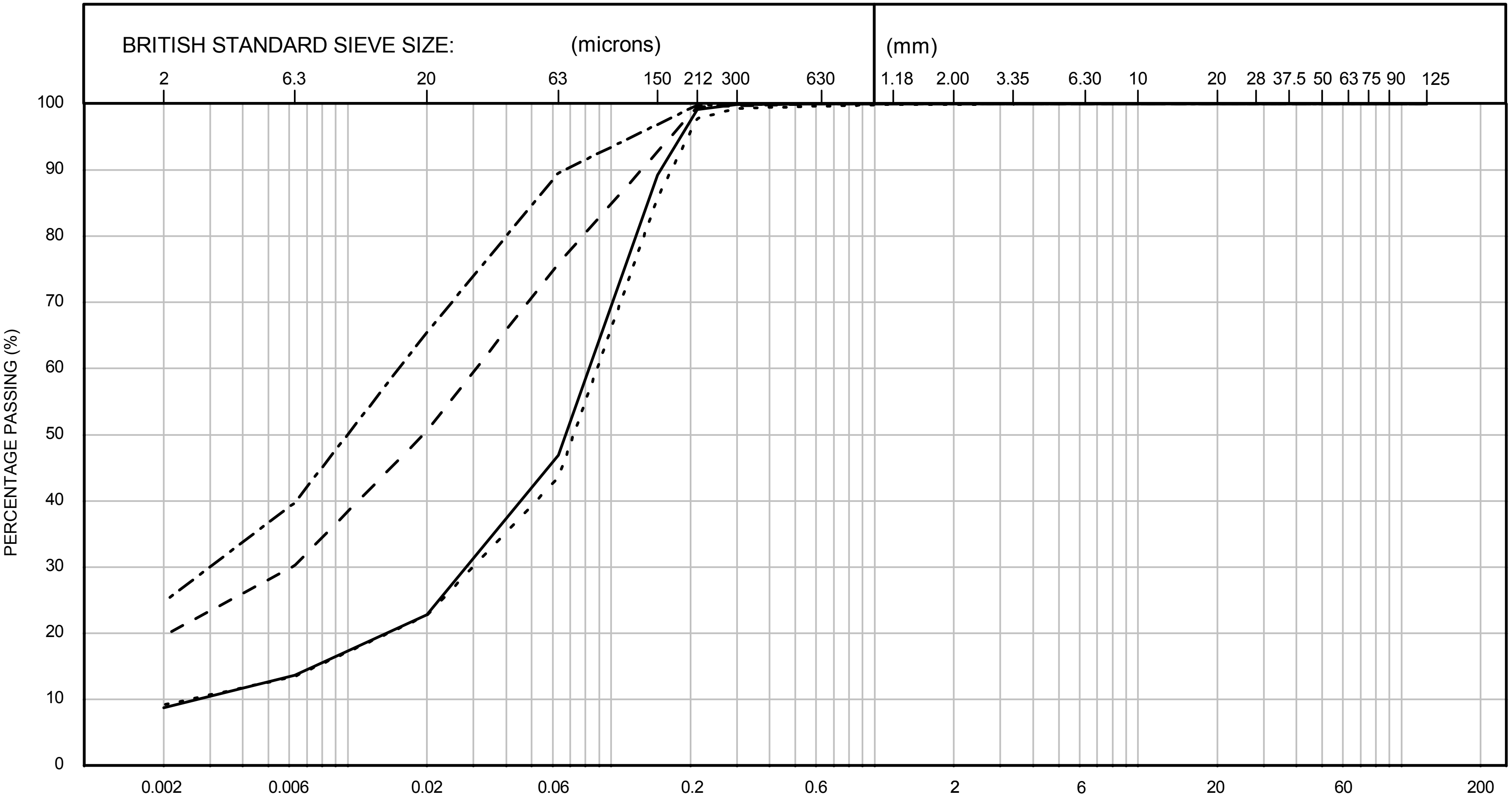
9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 03/10/2016 Template Issue: 5:0 Drawn by: ALB Date: 03/10/2016

Approved by: PH Date: 03/10/216 Filename: J11335 \ CLASS \ HKZ1-BH03-SA_33BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH03-SA	33BagA	24.00	9.2/9.4	N/A	9	36	55	0	0
├ ─ ─┤	HKZ1-BH03-SA	35BagB	26.40	9.4	N/A	20	54	26	0	0
├ · · ·┤	HKZ1-BH03-SA	39BagA	30.00	9.2/9.4	N/A	9	32	59	0	0
├ ─·─┤	HKZ1-BH03-SA	40BagA	31.00	9.4	N/A	25	63	12	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

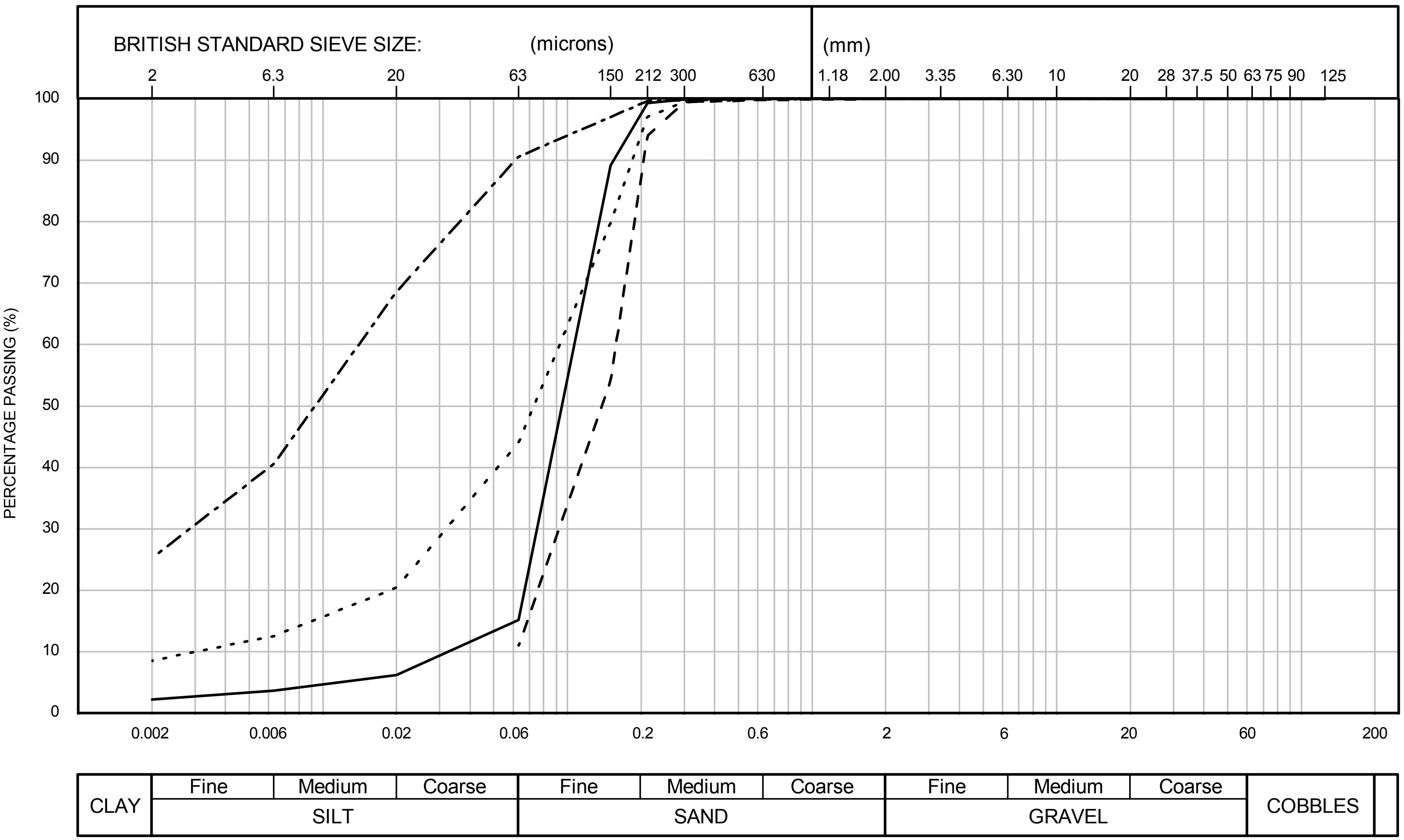
9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH03-SA	42BagA	33.00	9.2/9.4	N/A	2	12	86	0	0
├ ─ ─┤	HKZ1-BH03-SA	47BagA	38.00	9.2	N/A	0	10	90	0	0
├ · · ·┤	HKZ1-BH03-SA	48BagD	39.50	9.2/9.4	N/A	9	33	58	0	0
├ ·─·┤	HKZ1-BH03-SA	50WaxC	41.45	9.4	N/A	25	63	12	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

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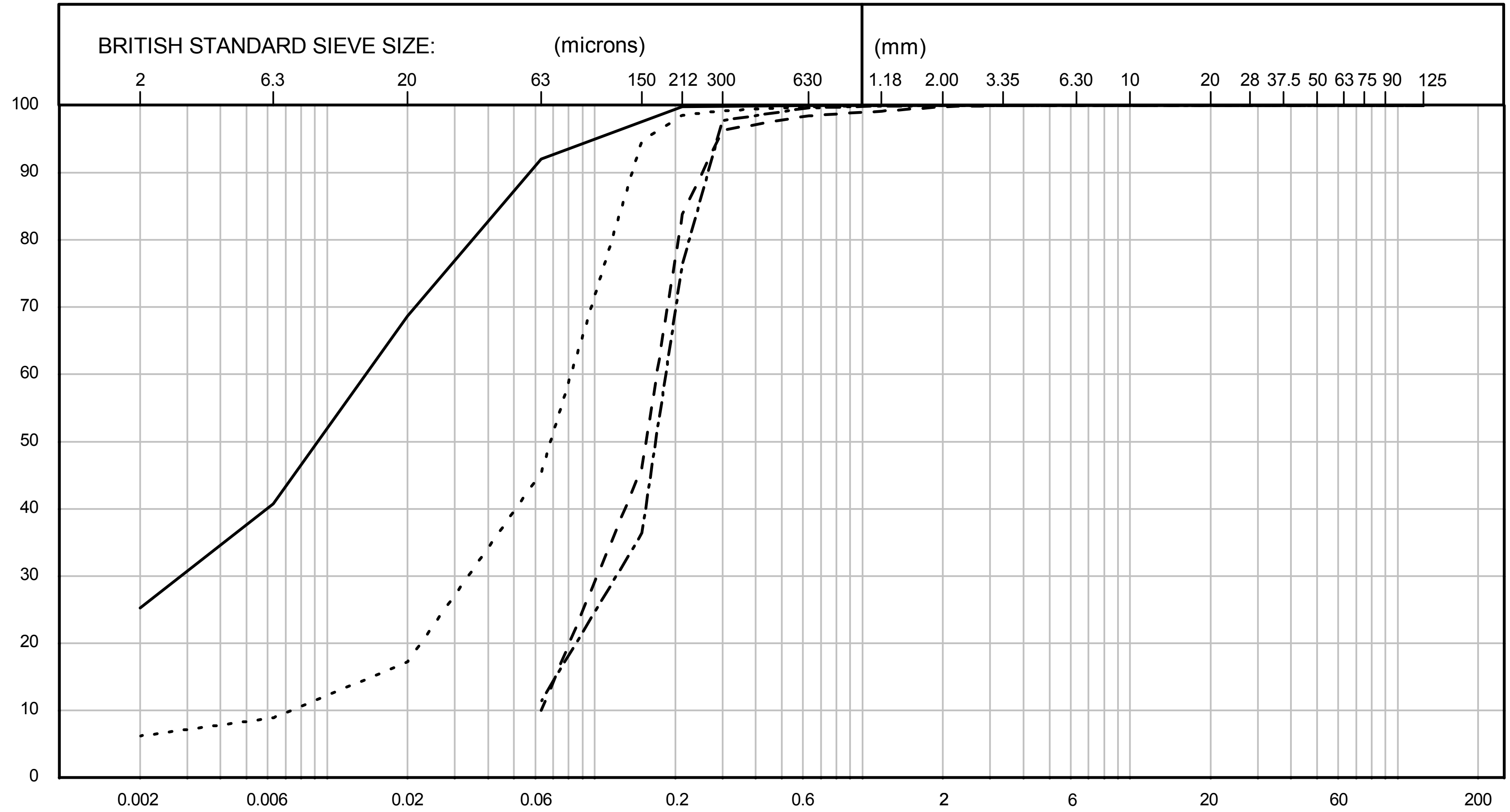
Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH03-SA_52BagD_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH03-SA	52BagD	43.45	9.4	N/A	25	65	10	0	0
├ ─ ─┤	HKZ1-BH03-SA	54BagC	45.40	9.2	N/A	0	9	91	0	0
├ · · ·┤	HKZ1-BH03-SA	57BagA	48.00	9.2/9.4	N/A	6	37	57	0	0
├ ─·─┤	HKZ1-BH03-SA	59BagC	54.75	9.2	N/A	0	11	89	0	0

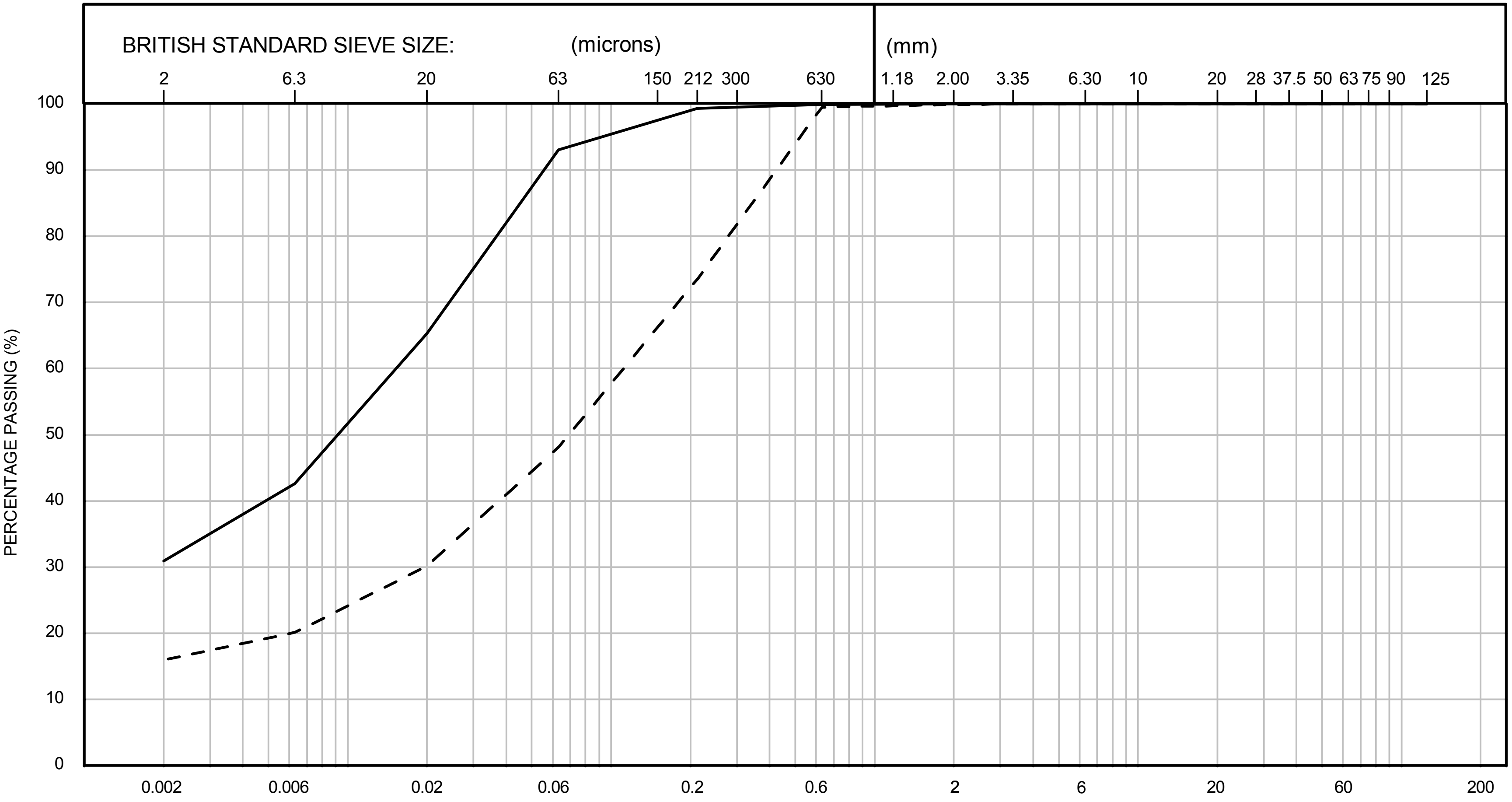
* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├─┤	HKZ1-BH03-SA	60BagD	59.15	9.4	N/A	31	60	9	0	0
├ ─ ┤	HKZ1-BH03-SA	61BagA	62.50	9.4	N/A	16	30	54	0	0

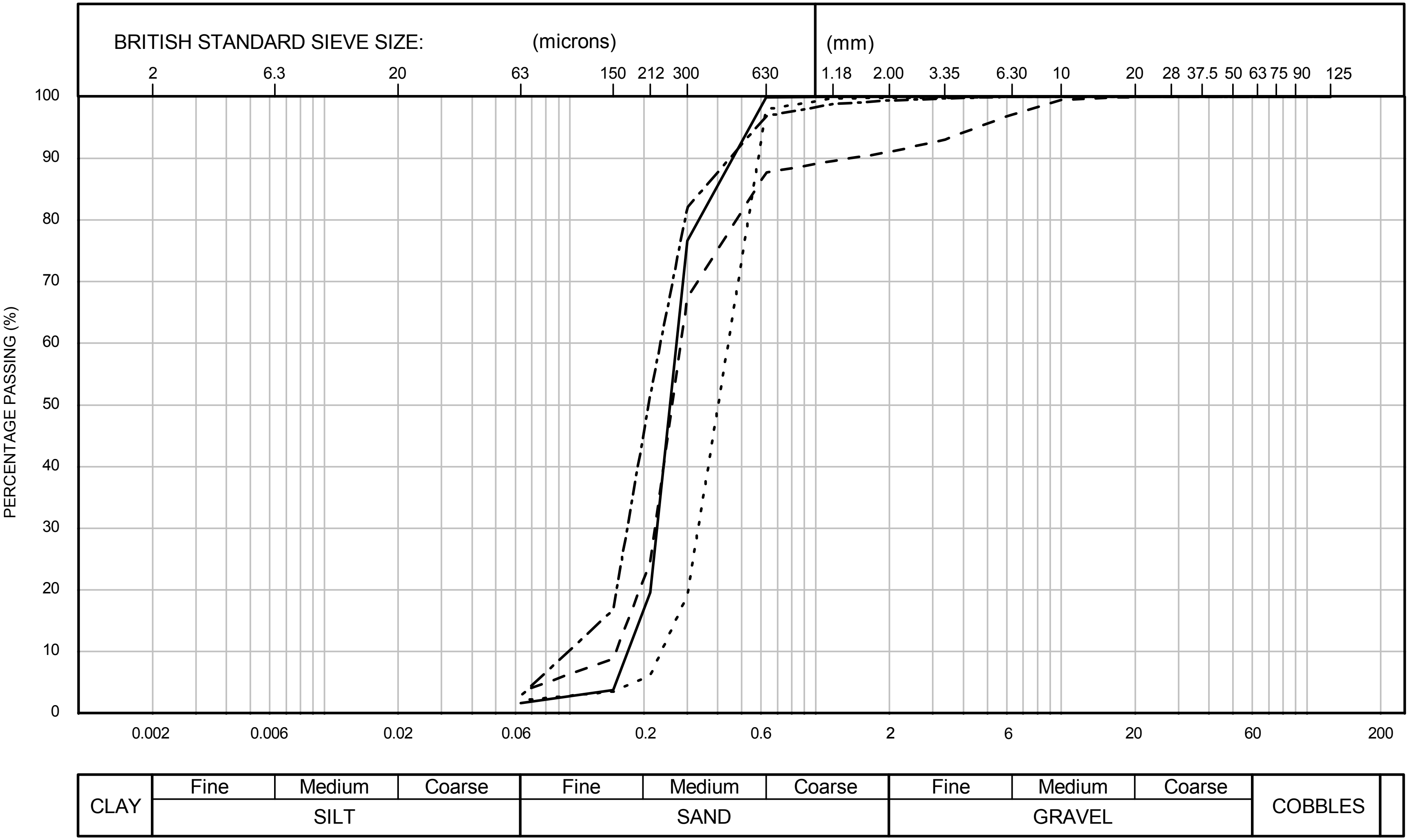
* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH04-SA	01BagA	0.00	9.2	N/A	0	1	99	0	0
├ ─ ─┤	HKZ1-BH04-SA	03BagB	2.30	9.2	N/A	0	3	88	9	0
├ · · ·┤	HKZ1-BH04-SA	10BagA	7.00	9.2	N/A	0	2	98	0	0
├─ · ─┤	HKZ1-BH04-SA	15BagA	12.00	9.2	N/A	0	2	98	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

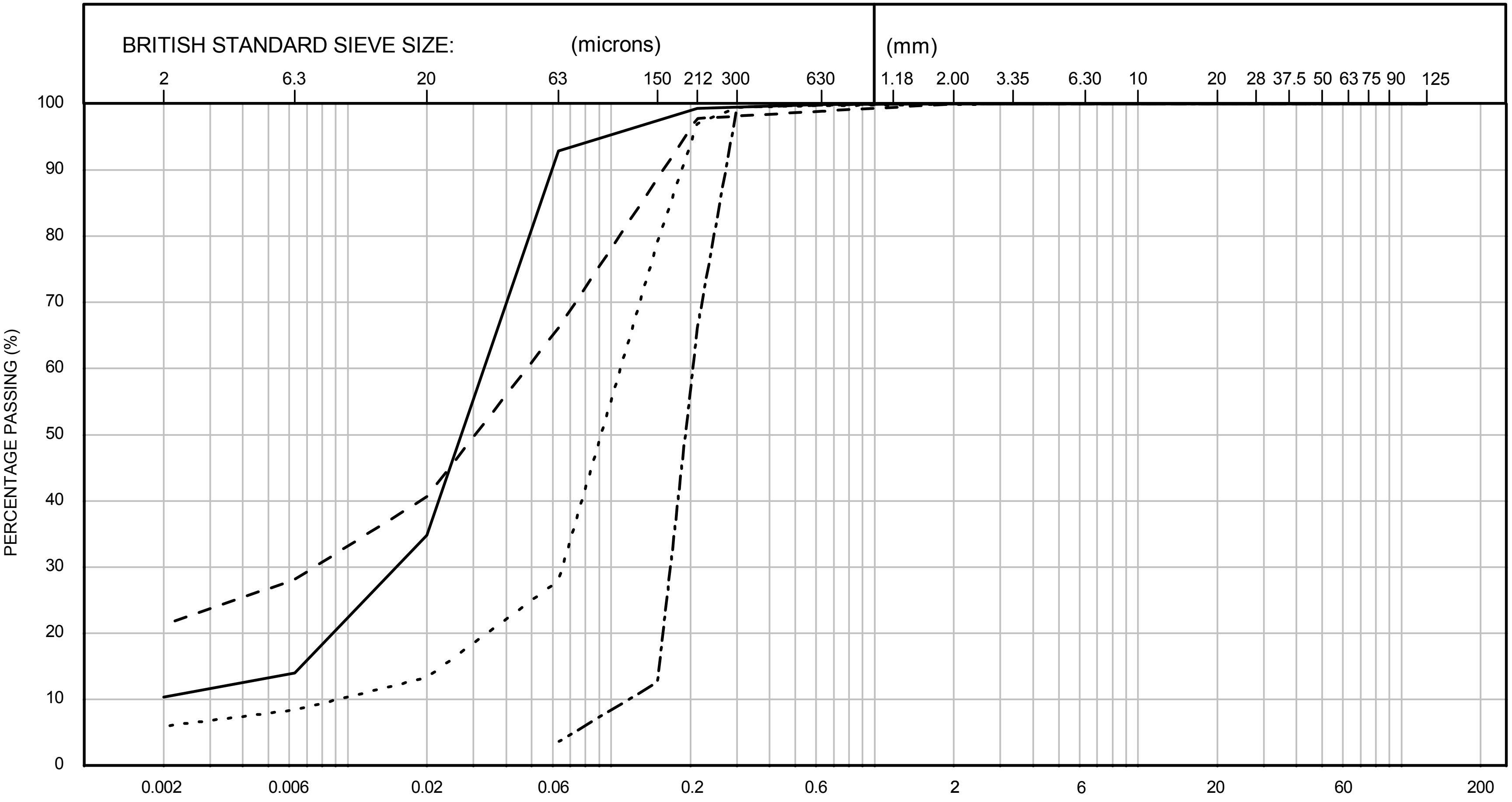
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 15/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH04-SA_18BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH04-SA	18BagA	14.50	9.4	N/A	10	78	12	0	0
├ ─ ─┤	HKZ1-BH04-SA	19WaxC	16.00	9.4	N/A	21	43	36	0	0
├ · · ·┤	HKZ1-BH04-SA	21BagA	17.50	9.2/9.4	N/A	6	21	73	0	0
├ ─·─┤	HKZ1-BH04-SA	23BagB	19.85	9.2	N/A	0	3	97	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

FUGRO

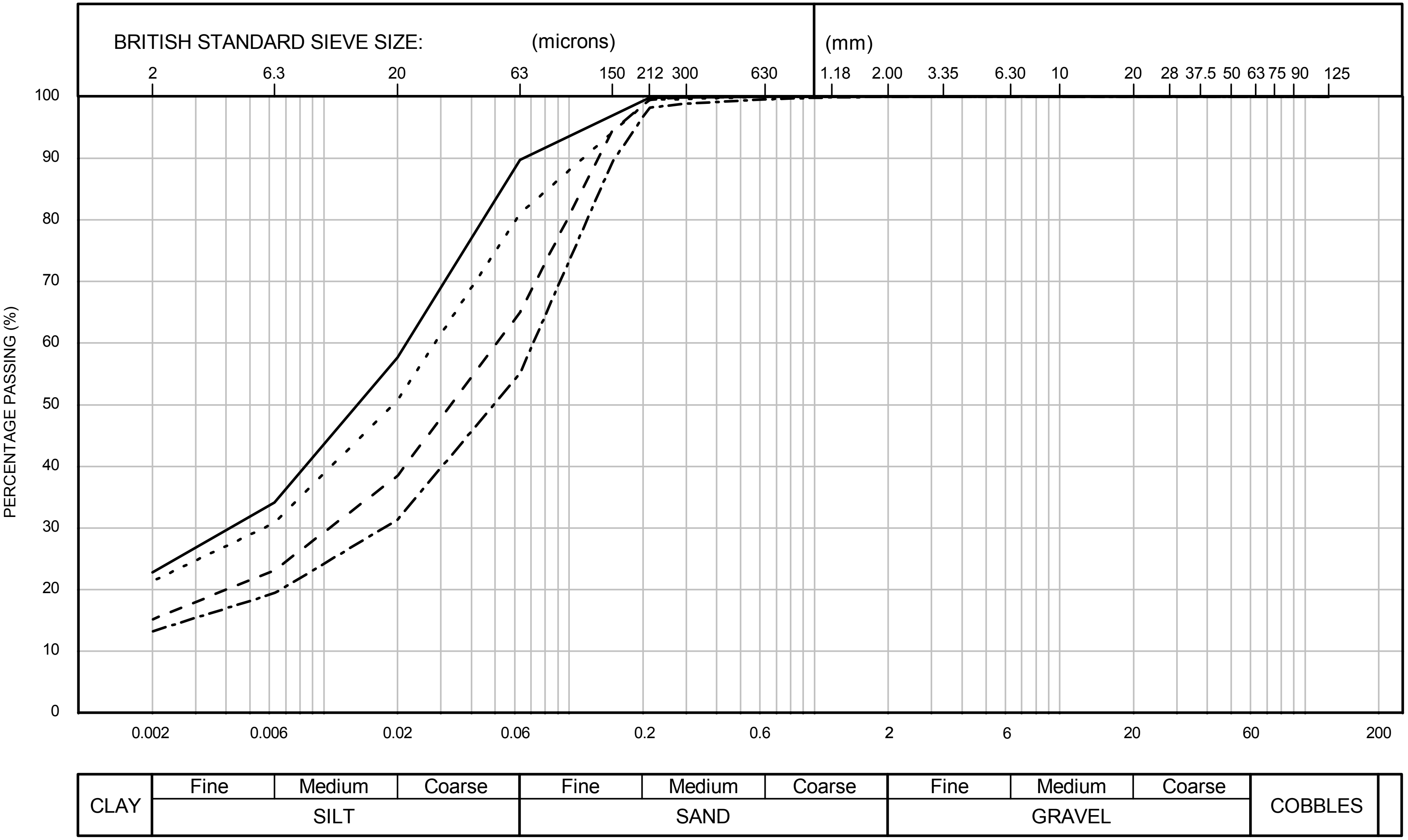
Plate C2.2-18

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 19/09/2016

Approved by: PH Date: 27/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH04-SA_25WaxB_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH04-SA	25WaxB	21.65	9.4	N/A	23	64	13	0	0
├ – –┤	HKZ1-BH04-SA	26BagC	23.00	9.2/9.4	N/A	15	48	37	0	0
├ · · ·┤	HKZ1-BH04-SA	28BagB	24.65	9.4	N/A	21	57	22	0	0
├ – · –┤	HKZ1-BH04-SA	30BagA	26.50	9.2/9.4	N/A	13	40	47	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

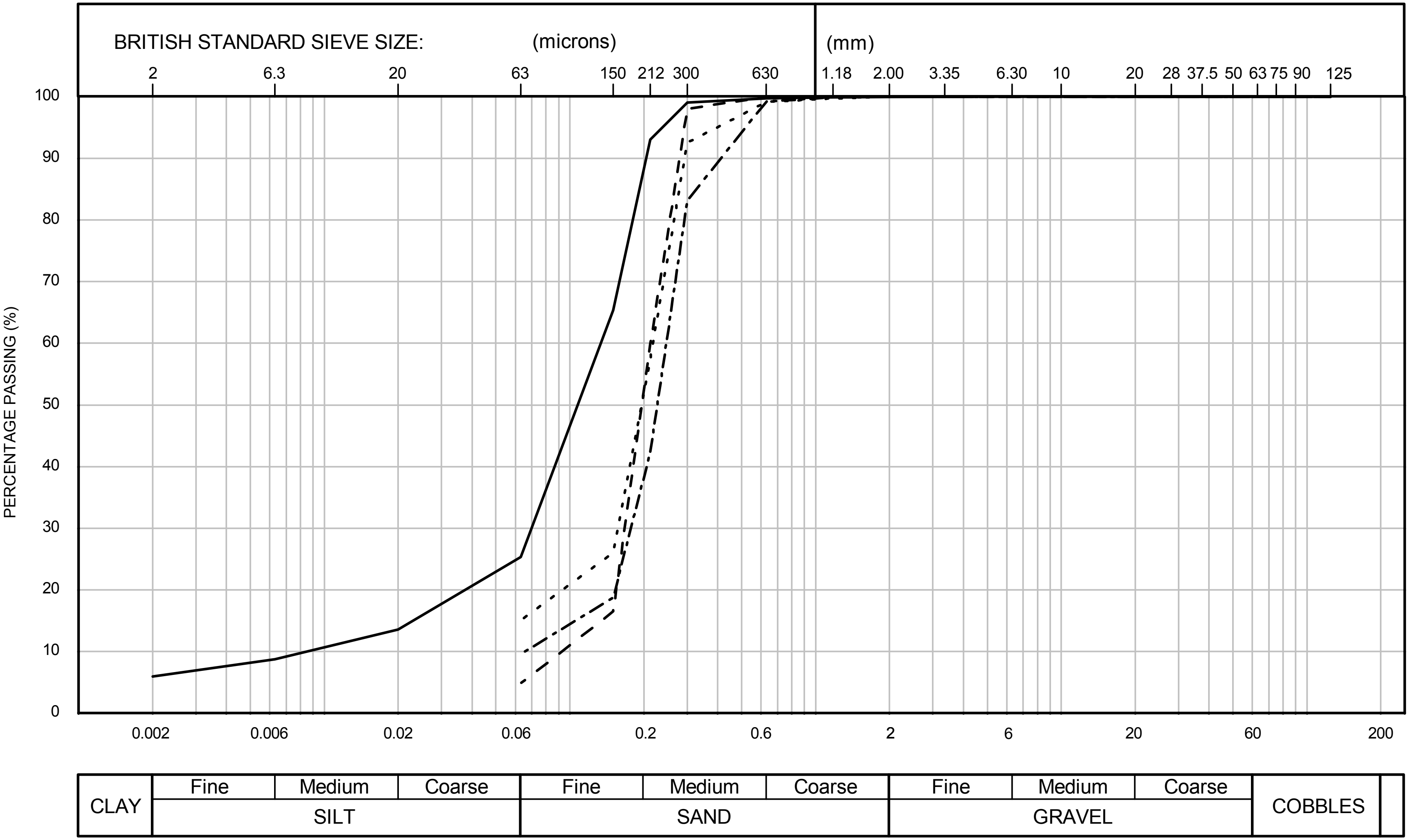
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 22/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH04-SA_30BagB_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
|—|	HKZ1-BH04-SA	30BagB	26.80	9.2/9.4	N/A	6	18	76	0	0
|– –|	HKZ1-BH04-SA	34BagB	30.80	9.2	N/A	0	4	96	0	0
|· · ·|	HKZ1-BH04-SA	39BagB	35.25	9.2	N/A	0	15	85	0	0
|–·–|	HKZ1-BH04-SA	44BagA	40.00	9.2	N/A	0	9	91	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

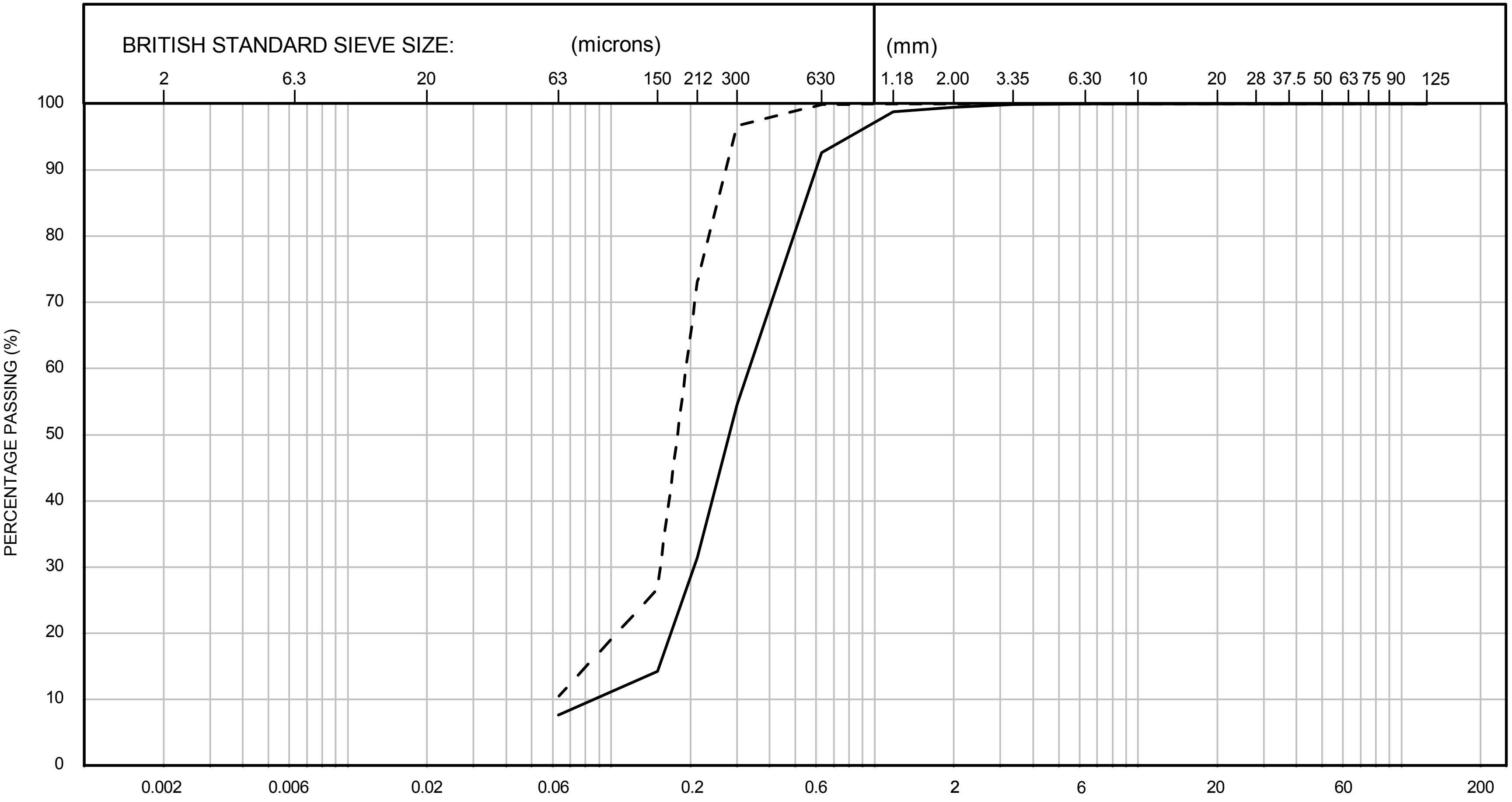
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 17/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH04-SA_51BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH04-SA	51BagA	45.50	9.2	N/A	0	7	93	0	0
├ ─ ─┤	HKZ1-BH04-SA	56BagA	50.00	9.2	N/A	0	10	90	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:	
9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

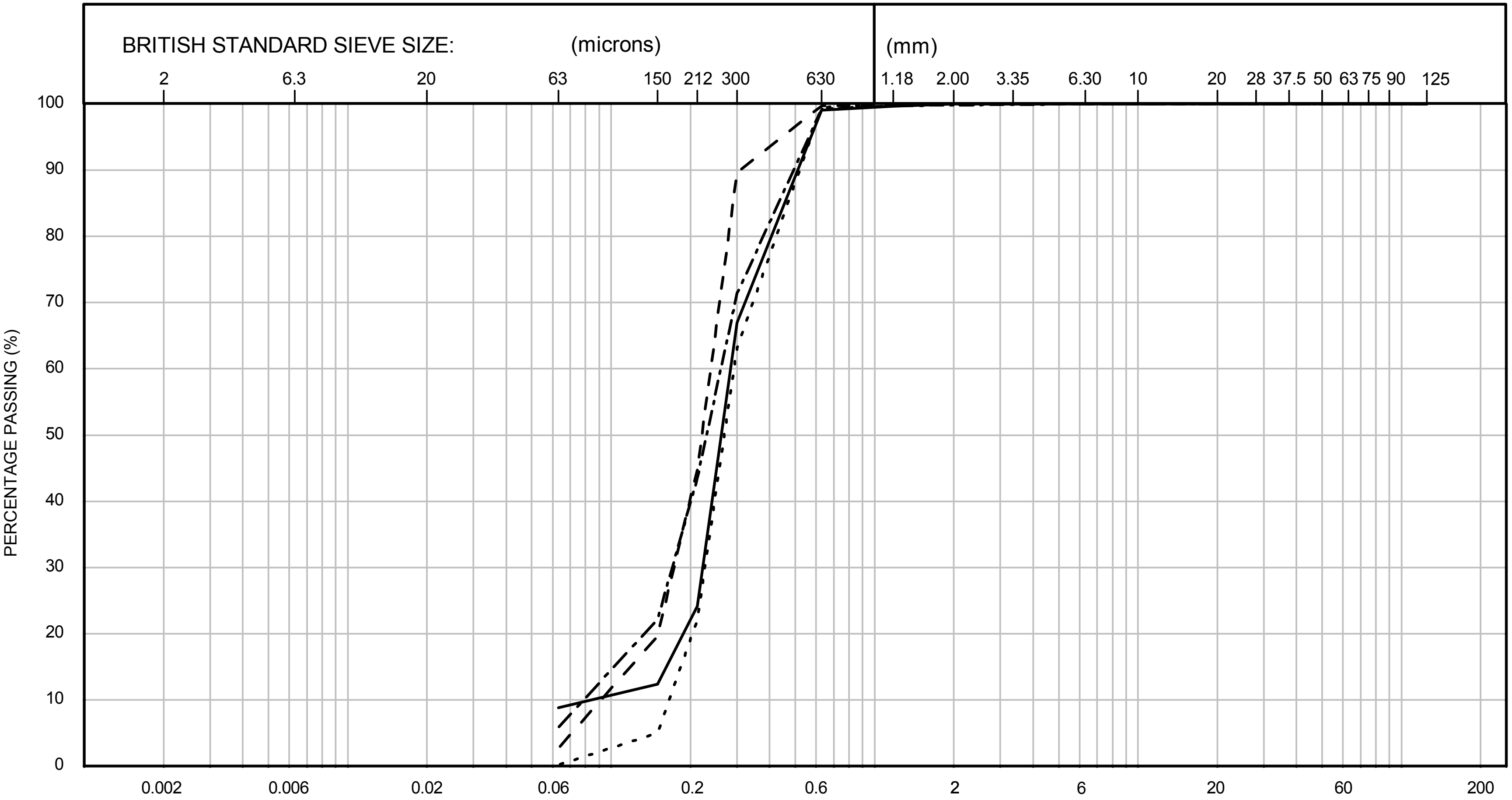
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 19/08/2016

Approved by: PH Date: 27/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH05-SA_01BagA_ps.OPJ

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH05-SA	01BagA	0.00	9.2	N/A	0	8	92	0	0
├ ─ ─┤	HKZ1-BH05-SA	03BagA	2.00	9.2	N/A	0	2	98	0	0
├ · · ·┤	HKZ1-BH05-SA	07BagB	6.20	9.2	N/A	0	0	100	0	0
├─ · ─┤	HKZ1-BH05-SA	10BagA	9.00	9.2	N/A	0	5	95	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

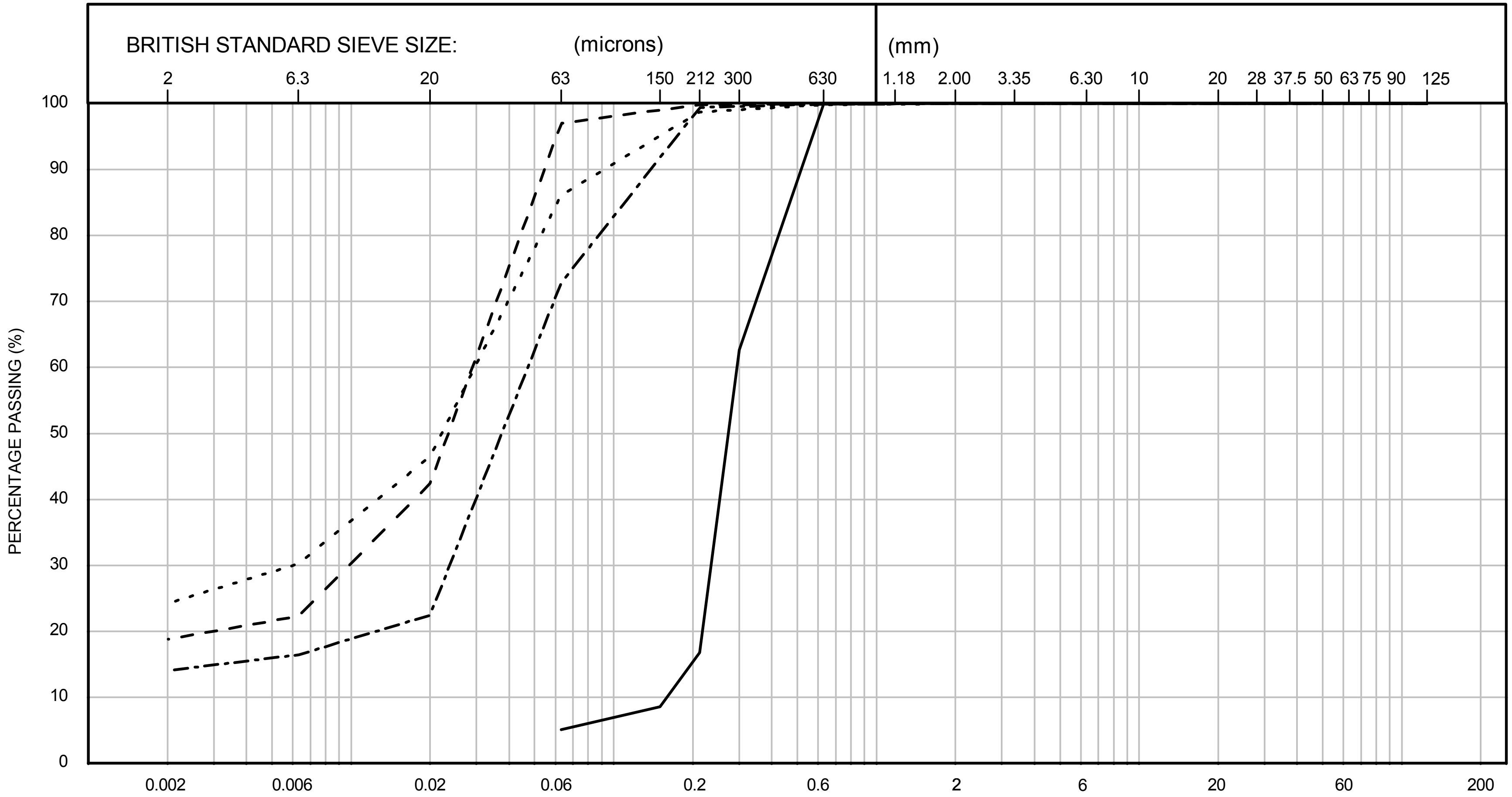
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 26/08/2016

Approved by: PH Date: 12/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH05-SA_15BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH05-SA	15BagA	12.00	9.2	N/A	0	5	95	0	0
├ ─ ─┤	HKZ1-BH05-SA	19BagA	15.00	9.4	N/A	19	74	7	0	0
├ · · ·┤	HKZ1-BH05-SA	21WaxC	17.35	9.4	N/A	24	59	17	0	0
├ ─·─┤	HKZ1-BH05-SA	22BagA	18.00	9.4	N/A	14	55	31	0	0

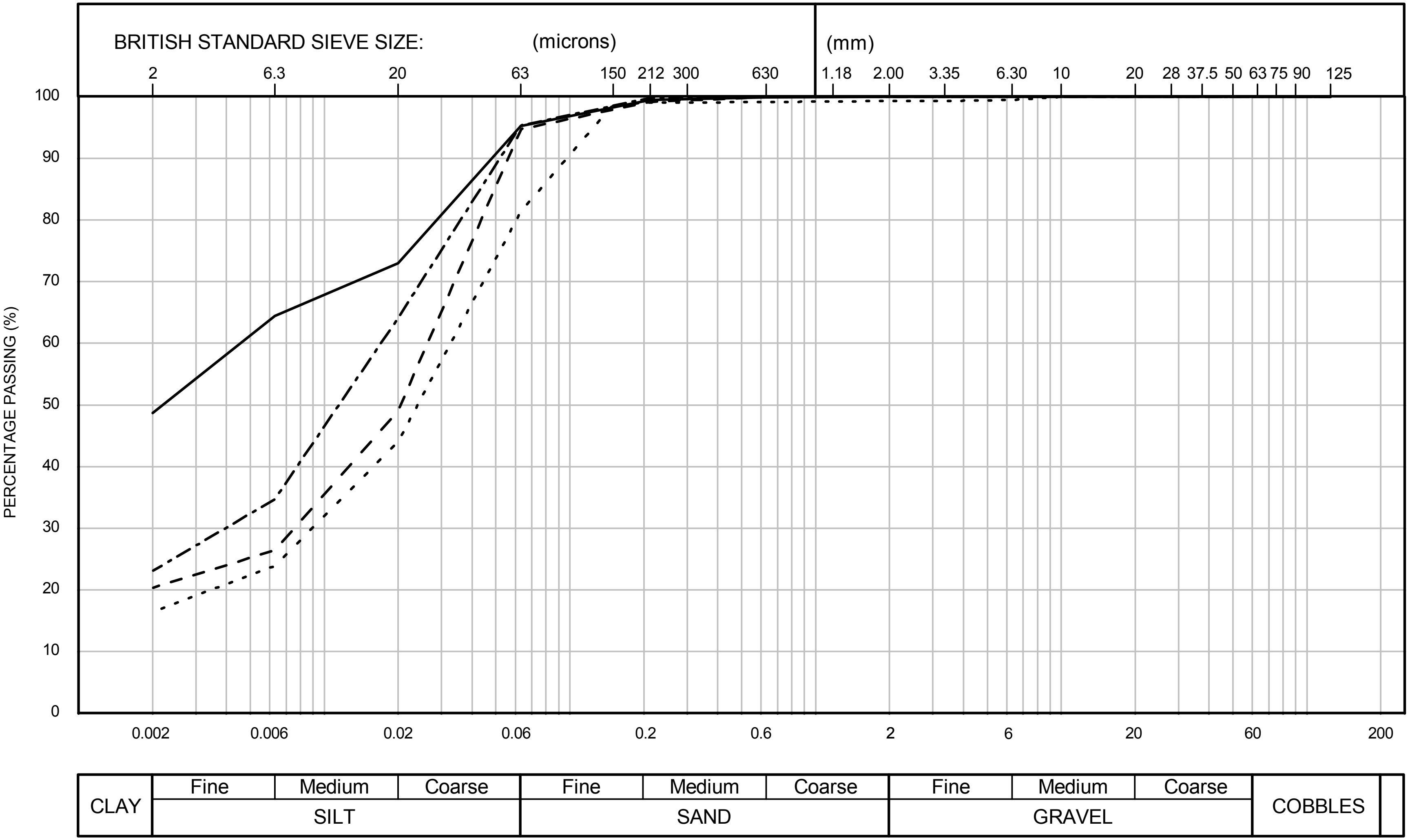
* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH05-SA	24BagC	20.50	9.4	N/A	49	44	7	0	0
├ ─ ─┤	HKZ1-BH05-SA	26BagA	22.00	9.4	N/A	20	71	9	0	0
├ · · ·┤	HKZ1-BH05-SA	28BagB	23.70	9.2/9.4	N/A	16	62	22	0	0
├ ─ · ─┤	HKZ1-BH05-SA	29BagD	25.10	9.4	N/A	23	70	7	0	

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

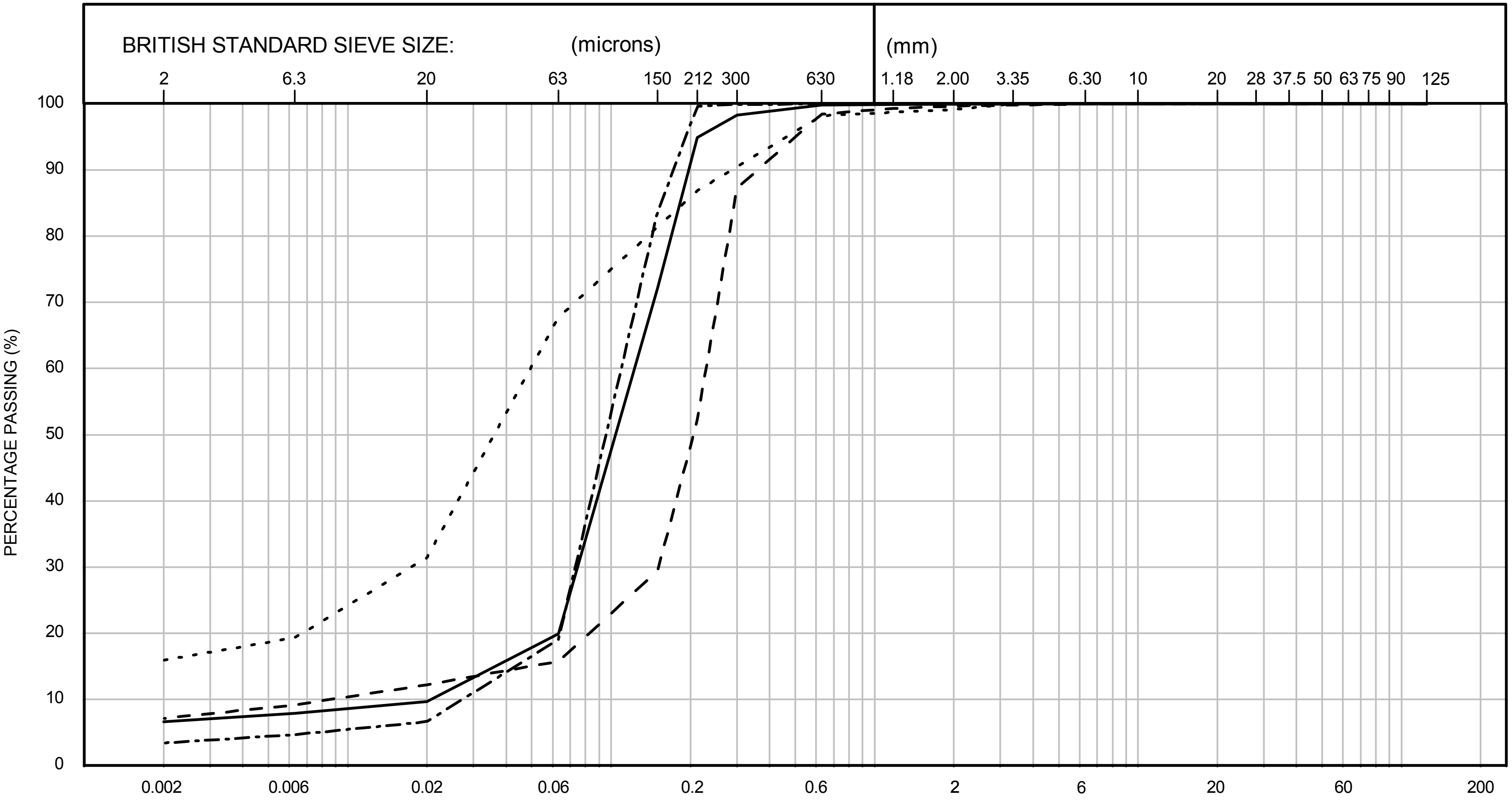
Checked by: PH Date: 27/09/2016 Template Issue: 5:0 Drawn by: ALB Date: 23/09/2016

Approved by: PH Date: 03/10/2016 Filename: J11335 \ CLASS \ HKZ1-BH05-SA_34BagB_ps.OPJ

Fugro Report No. N6196/01 (3)

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
|——|	HKZ1-BH05-SA	34BagB	30.00	9.2/9.4	N/A	7	12	81	0	0
|– –|	HKZ1-BH05-SA	36BagA	31.50	9.2/9.4	N/A	7	8	85	0	0
|· · ·|	HKZ1-BH05-SA	40BagB	35.60	9.4	N/A	16	49	35	0	0
|–·–|	HKZ1-BH05-SA	45BagC	40.85	9.2/9.4	N/A	3	14	83	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

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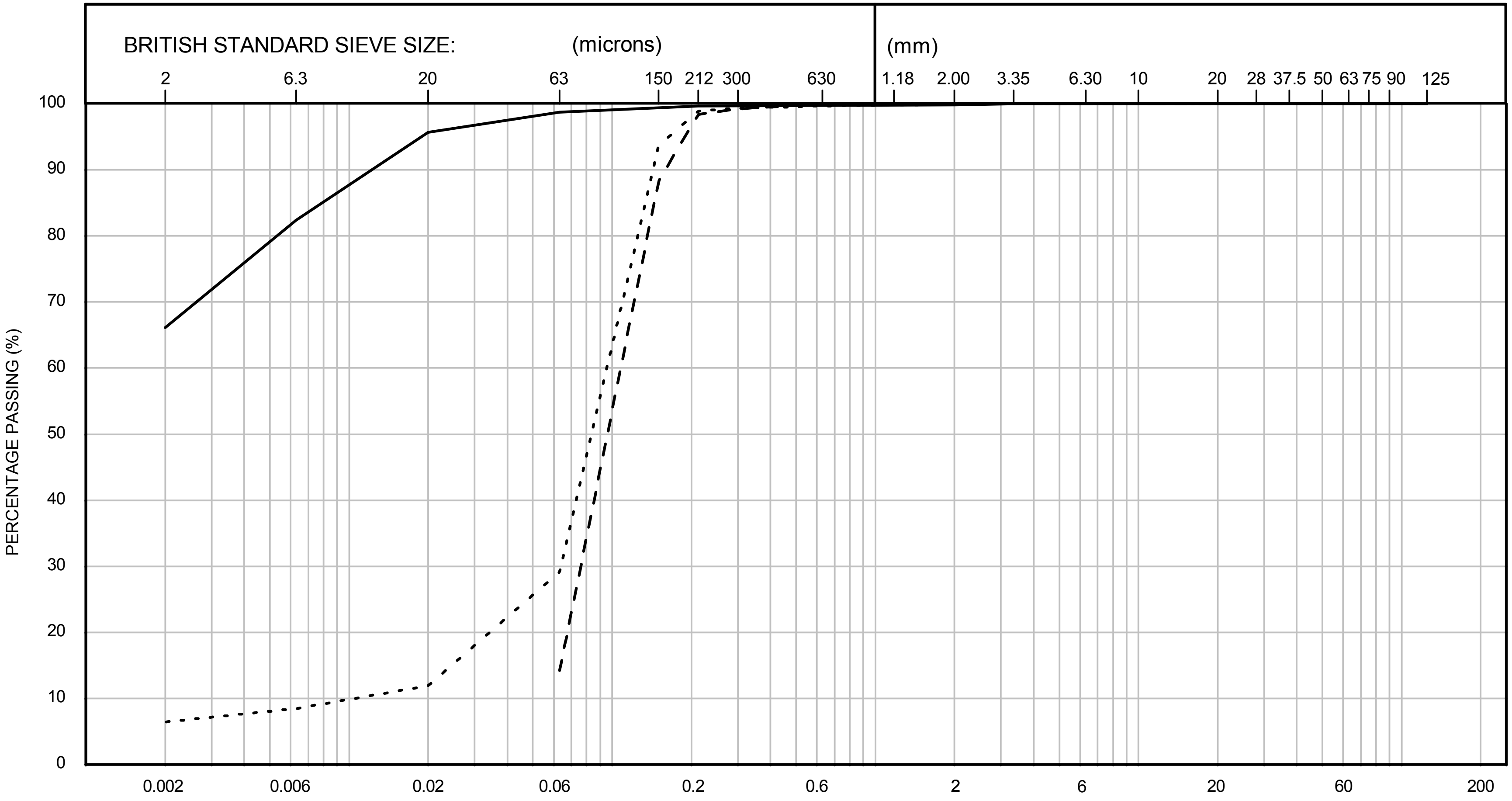
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSr Date: 26/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH05-SA_48WaxB_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH05-SA	48WaxB	43.60	9.4	N/A	66	32	2	0	0
├ ─ ─┤	HKZ1-BH05-SA	50BagB	45.75	9.2	N/A	0	14	86	0	0
├ · · ·┤	HKZ1-BH05-SA	54BagB	49.75	9.2/9.4	N/A	6	21	73	0	0
├ ─·─·┤										

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

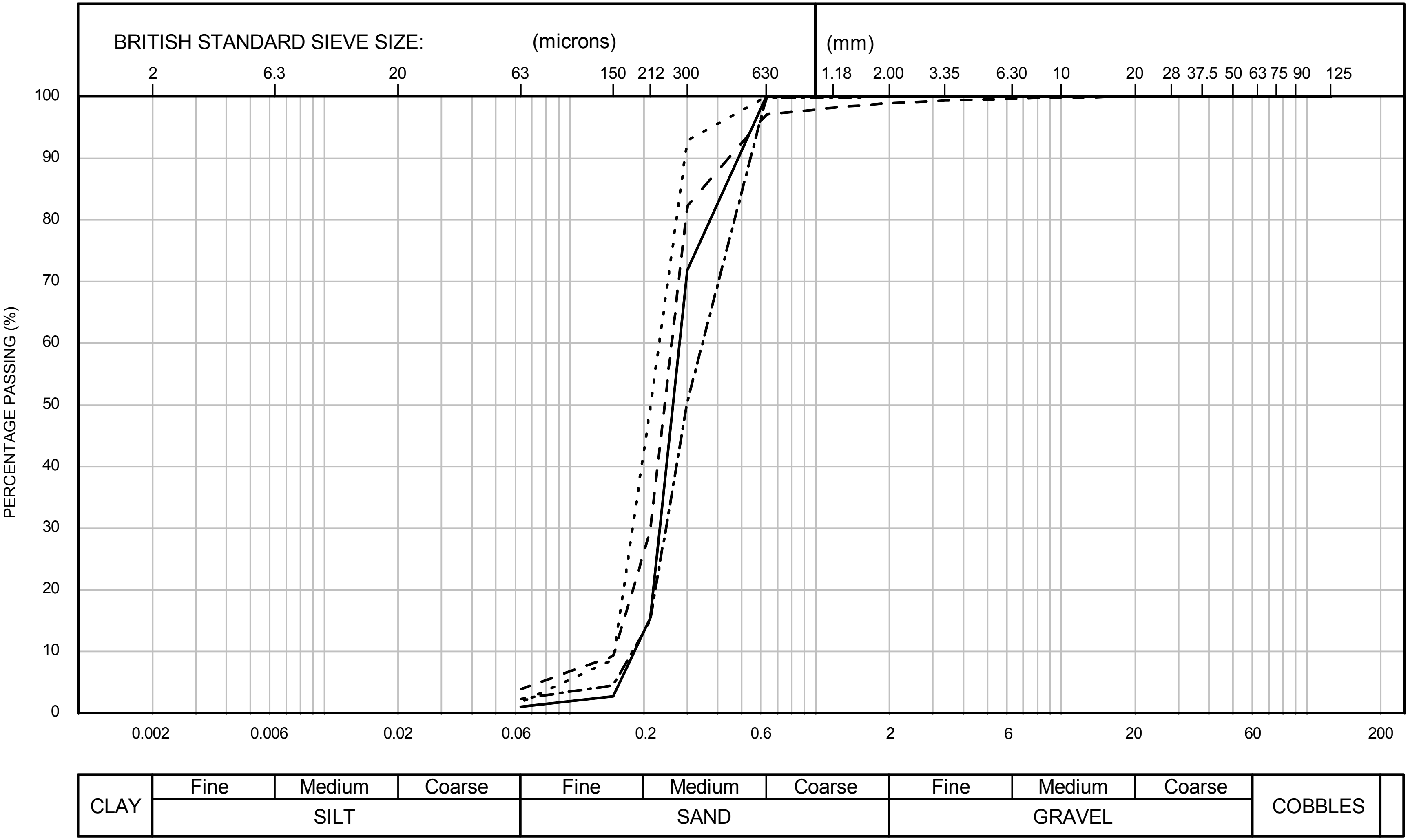
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 08/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH06-SA_01BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH06-SA	01BagA	0.00	9.2	N/A	0	1	99	0	0
├ ─ ─┤	HKZ1-BH06-SA	04BagB	3.30	9.2	N/A	0	3	96	1	0
├ · · ·┤	HKZ1-BH06-SA	06BagB	5.25	9.2	N/A	0	1	99	0	0
├ ─·─┤	HKZ1-BH06-SA	11BagA	8.50	9.2	N/A	0	2	98	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

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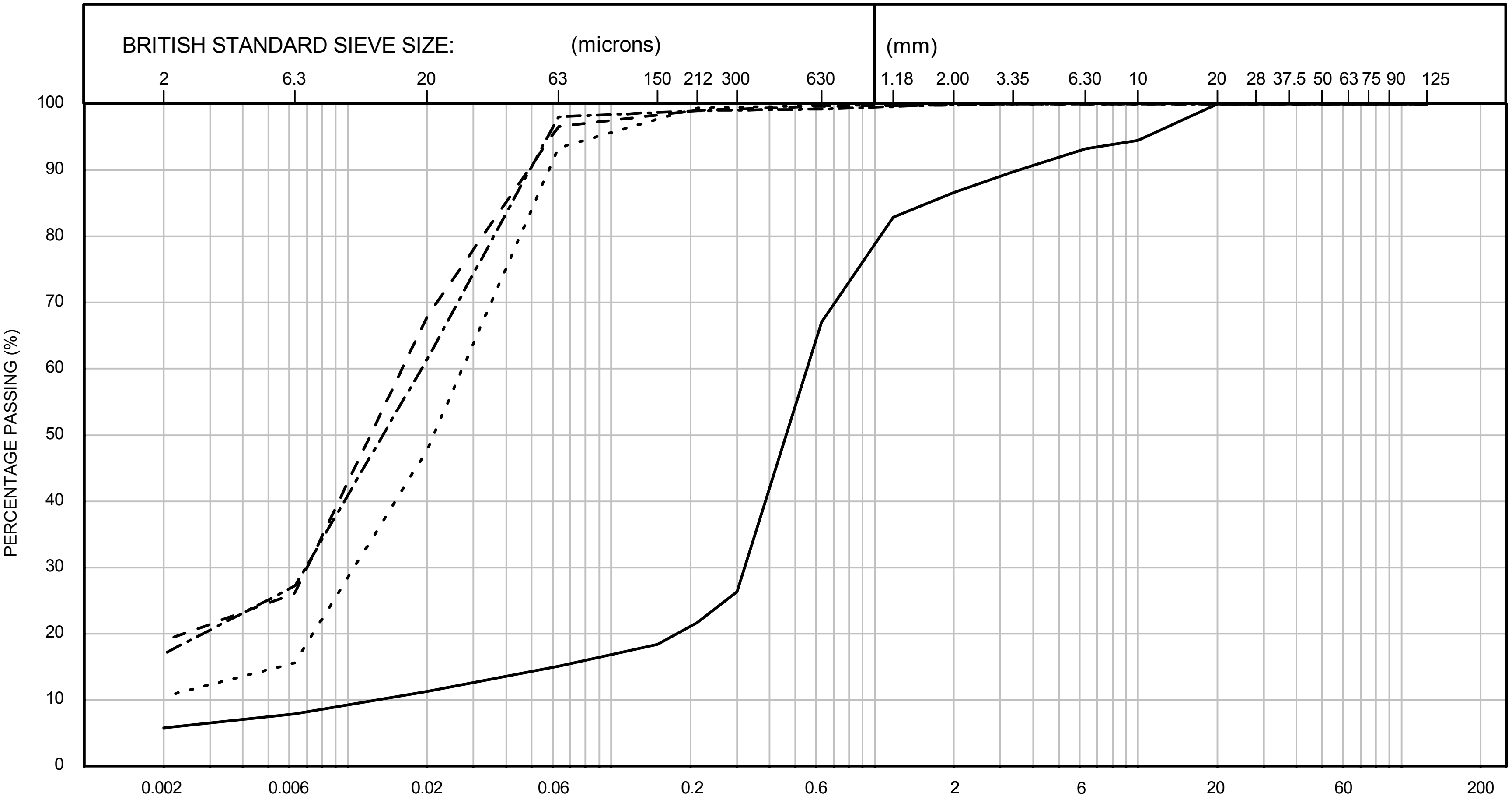
Plate C2.2-27

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH06-SA	19BagA	14.50	9.2/9.4	N/A	6	9	72	13	0
├ – –┤	HKZ1-BH06-SA	20WaxB	15.70	9.4	N/A	19	75	6	0	0
├ · · ·┤	HKZ1-BH06-SA	20BagD	16.10	9.4	N/A	11	79	10	0	0
├ –·–┤	HKZ1-BH06-SA	24BagA	19.00	9.4	N/A	17	78	5	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

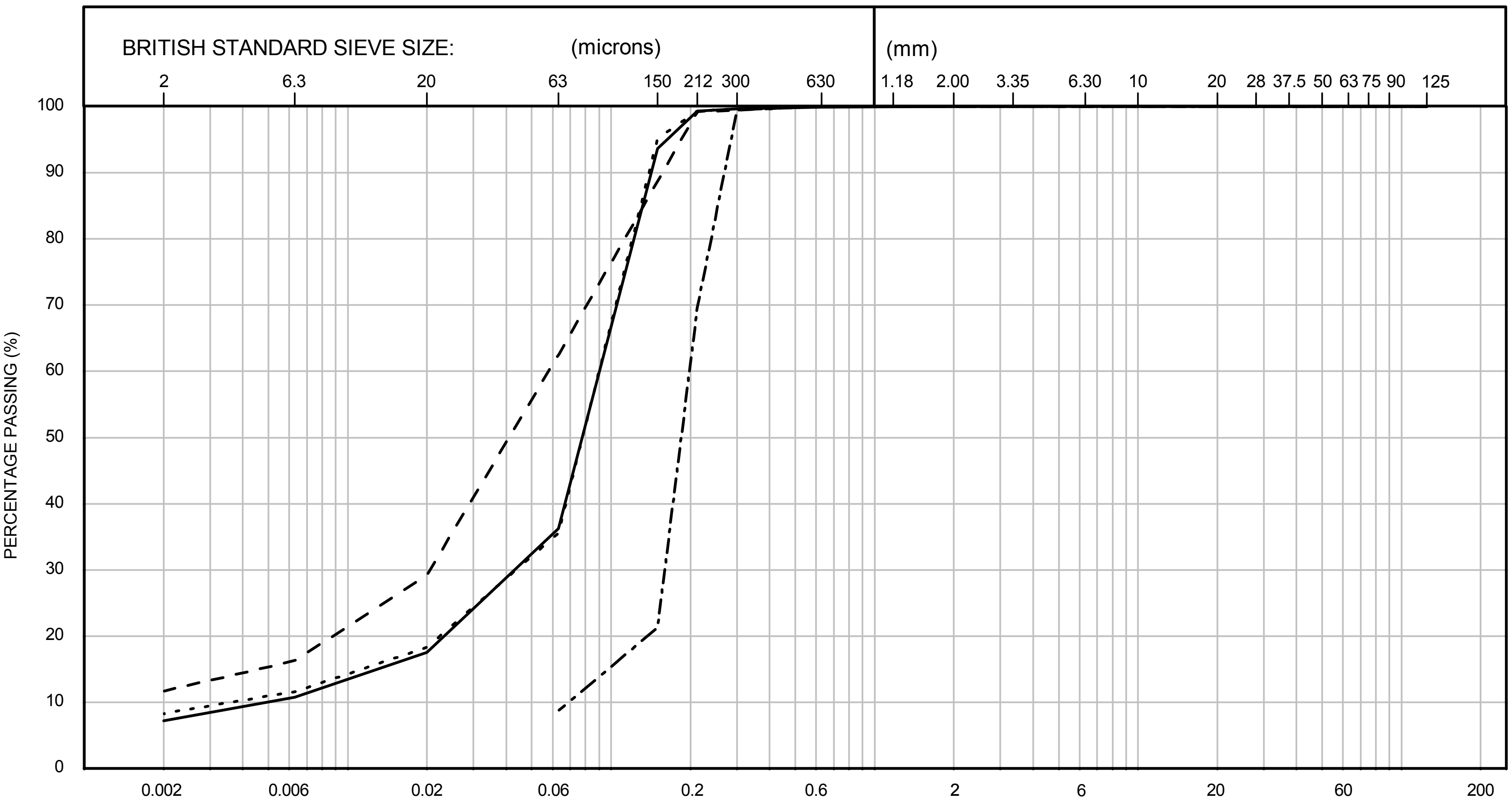
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 20/09/2016 Template Issue: 5:0 Drawn by: ALB Date: 19/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH06-SA_26BagB_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

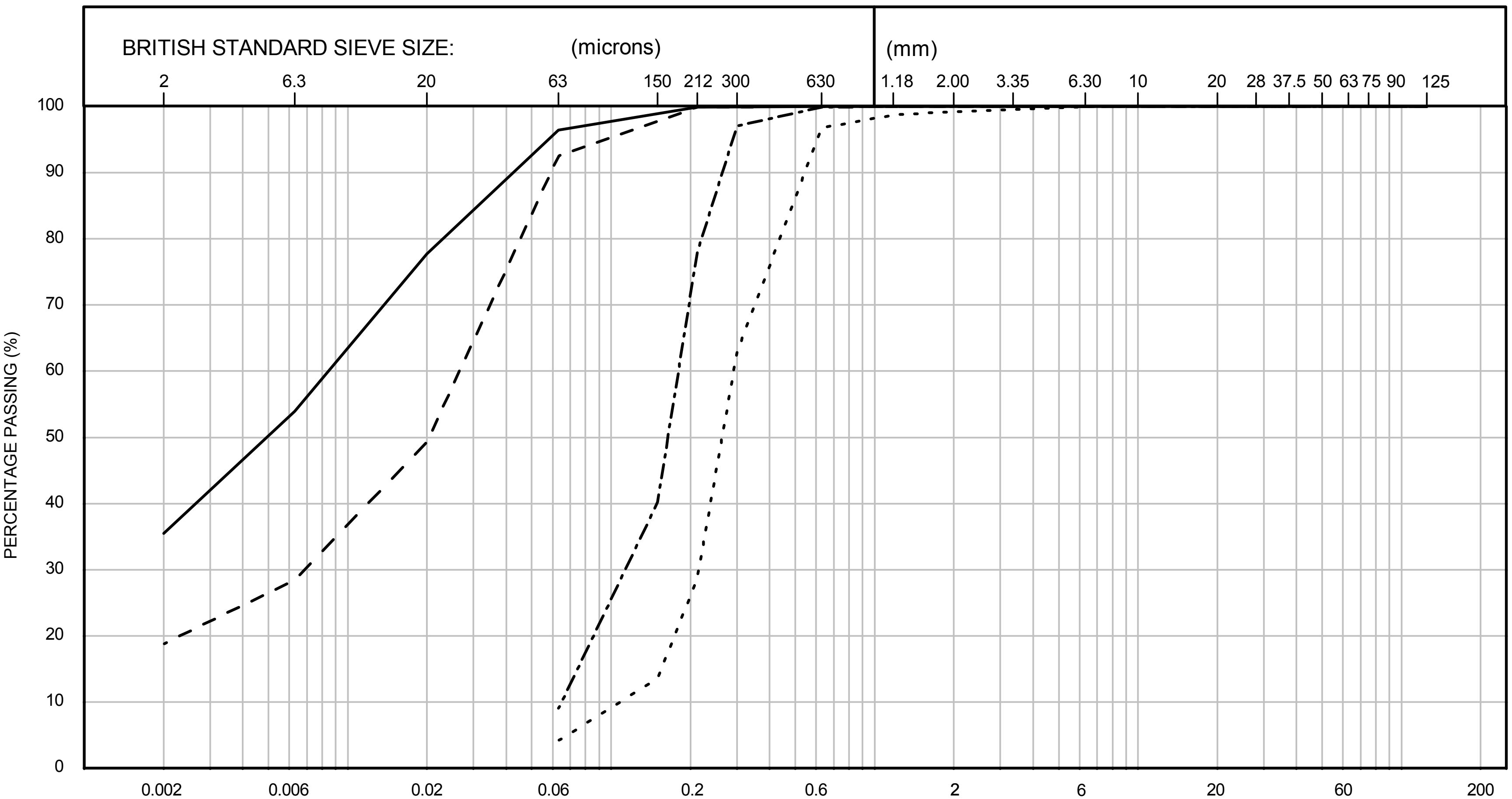
Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH06-SA	26BagB	21.40	9.2/9.4	N/A	7	27	66	0	0
├ ─ ─┤	HKZ1-BH06-SA	29BagB	24.10	9.4	N/A	12	48	40	0	0
├···┤	HKZ1-BH06-SA	35BagB	30.05	9.2/9.4	N/A	8	26	66	0	0
├─·─┤	HKZ1-BH06-SA	39BagB	34.30	9.2	N/A	0	8	92	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH06-SA	44BagB	37.70	9.4	N/A	35	59	6	0	0
├ ─ ─┤	HKZ1-BH06-SA	46BagB	39.70	9.4	N/A	19	70	11	0	0
├ · · ·┤	HKZ1-BH06-SA	59BagA	59.00	9.2	N/A	0	4	96	0	0
├ ─·─┤	HKZ1-BH06-SA	60BagB	64.55	9.2	N/A	0	8	92	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

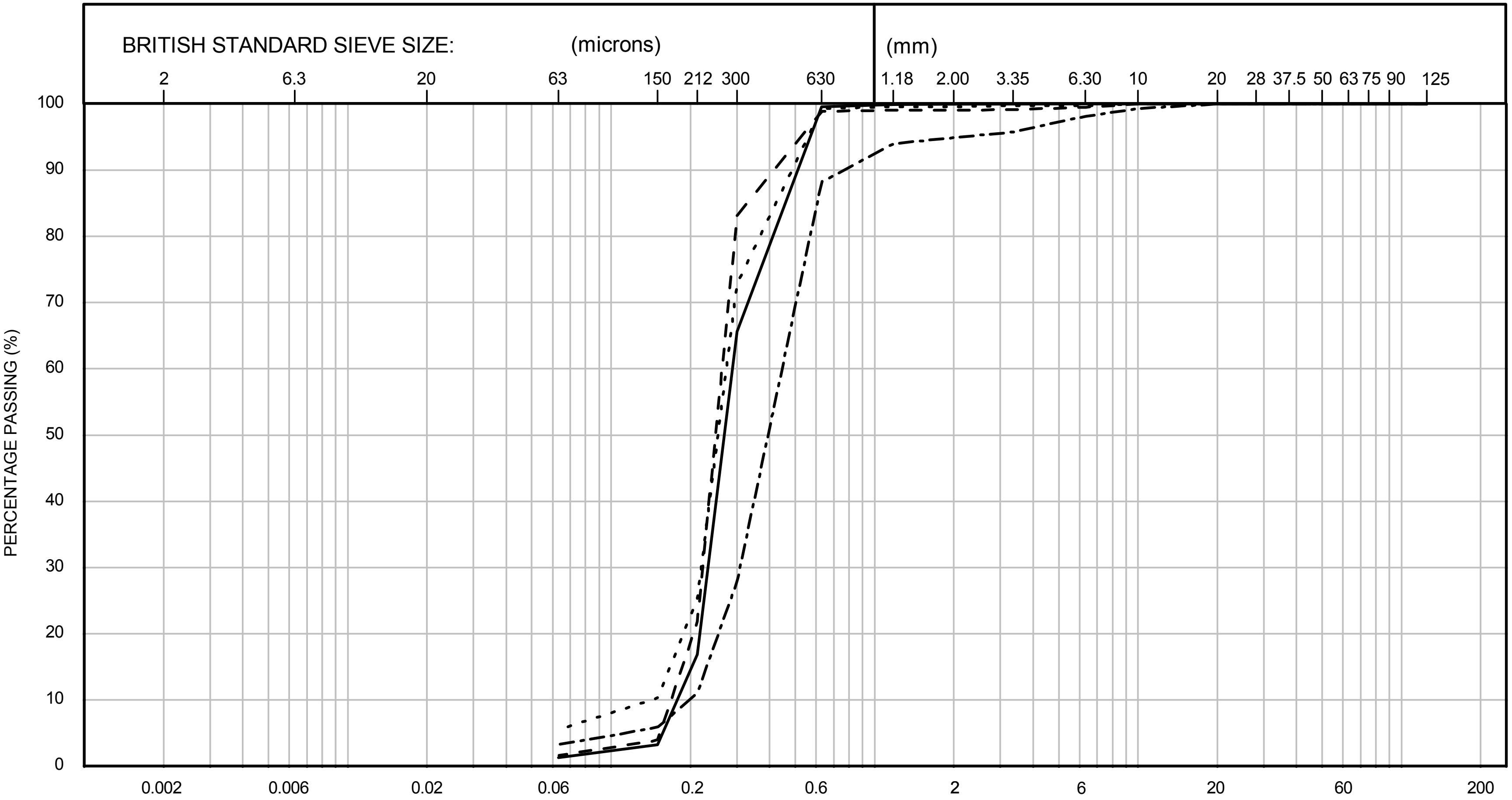
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 20/09/2016 Template Issue: 5:0 Drawn by: ALB Date: 12/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH07-SA_01BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH07-SA	01BagA	0.00	9.2	N/A	0	1	99	0	0
├ ─ ─┤	HKZ1-BH07-SA	04BagA	3.00	9.2	N/A	0	1	99	0	0
├···┤	HKZ1-BH07-SA	07BagA	5.50	9.2	N/A	0	5	95	0	0
├─·─┤	HKZ1-BH07-SA	14BagA	9.50	9.2	N/A	0	3	92	5	0

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

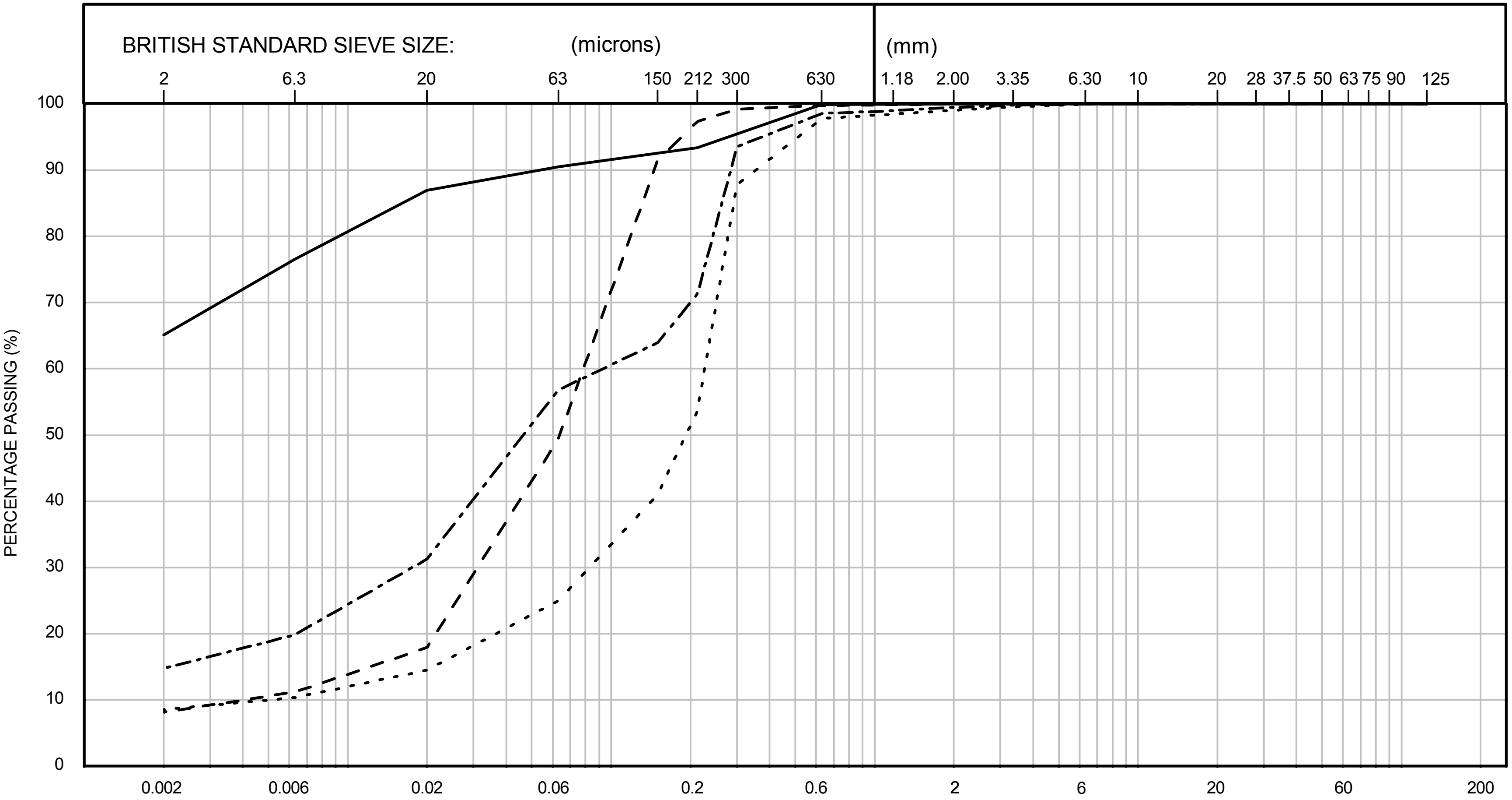
9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

FUGRO

Checked by:	PH	Date: 31/08/2016	Template Issue: 5:0	Drawn by: MSR	Date: 22/08/2016
Approved by:	PH	Date: 20/09/2016	Filename: J11335 \ CLASS \ HKZ1-BH07-SA_20WaxB_ps.OPJ		

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH07-SA	20WaxB	13.05	9.4	N/A	65	25	10	0	0
├ ─ ─┤	HKZ1-BH07-SA	24BagA	17.00	9.2/9.4	N/A	8	39	53	0	0
├···┤	HKZ1-BH07-SA	27BagA	20.00	9.2/9.4	N/A	9	15	76	0	0
├─·─┤	HKZ1-BH07-SA	32BagA	25.00	9.2/9.4	N/A	15	40	45	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

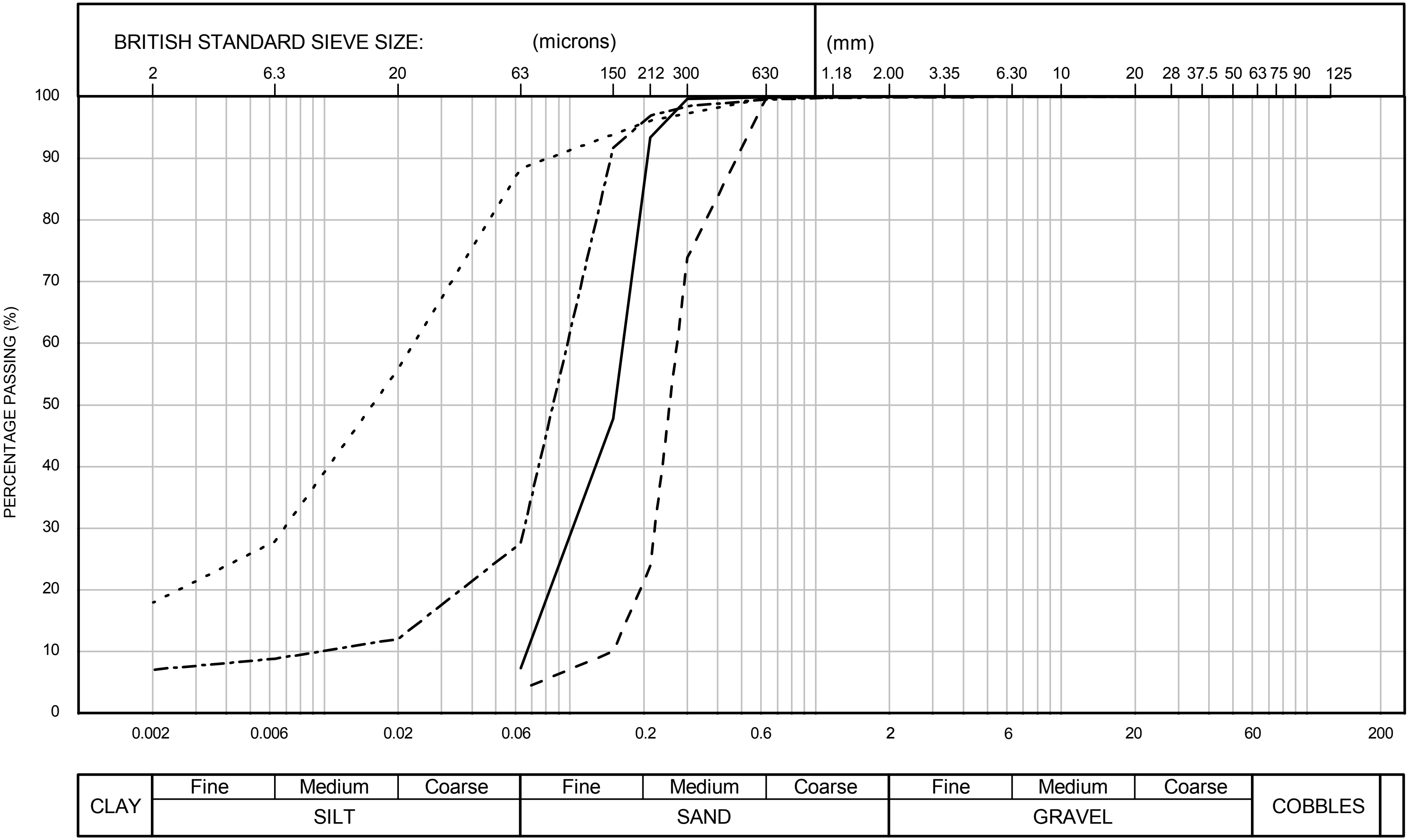
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by:	PH	Date:	31/08/2016	Template Issue: 5:0	Drawn by: MSR Date: 15/08/2016
Approved by:	PH	Date:	27/09/2016	Filename: J11335 \ CLASS \ HKZ1-BH07-SA_38BagA_ps.OPJ	

Fugro Report No. N6196/01 (3)

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH07-SA	38BagA	31.00	9.2	N/A	0	7	93	0	0
├ ─ ─┤	HKZ1-BH07-SA	44BagA	36.00	9.2	N/A	0	3	97	0	0
├ · · ·┤	HKZ1-BH07-SA	52BagC	42.50	9.4	N/A	18	68	14	0	0
├ ─·─┤	HKZ1-BH07-SA	54BagB	44.25	9.2/9.4	N/A	7	19	74	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

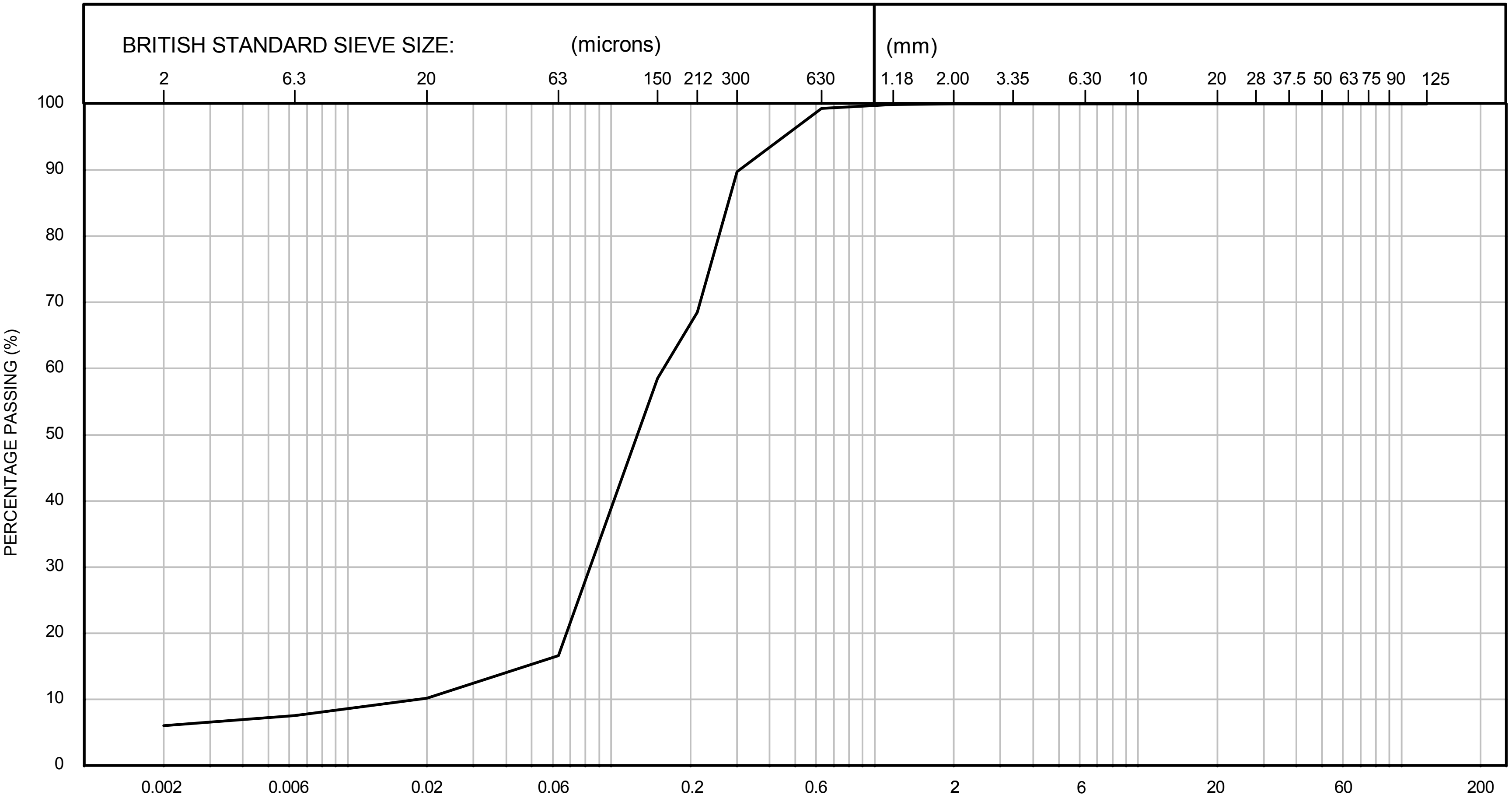
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

FUGRO

Plate C2.2-33

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

PARTICLE SIZE DISTRIBUTION TEST RESULTS



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH07-SA	58BagB	48.30	9.2/9.4	N/A	6	10	84	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

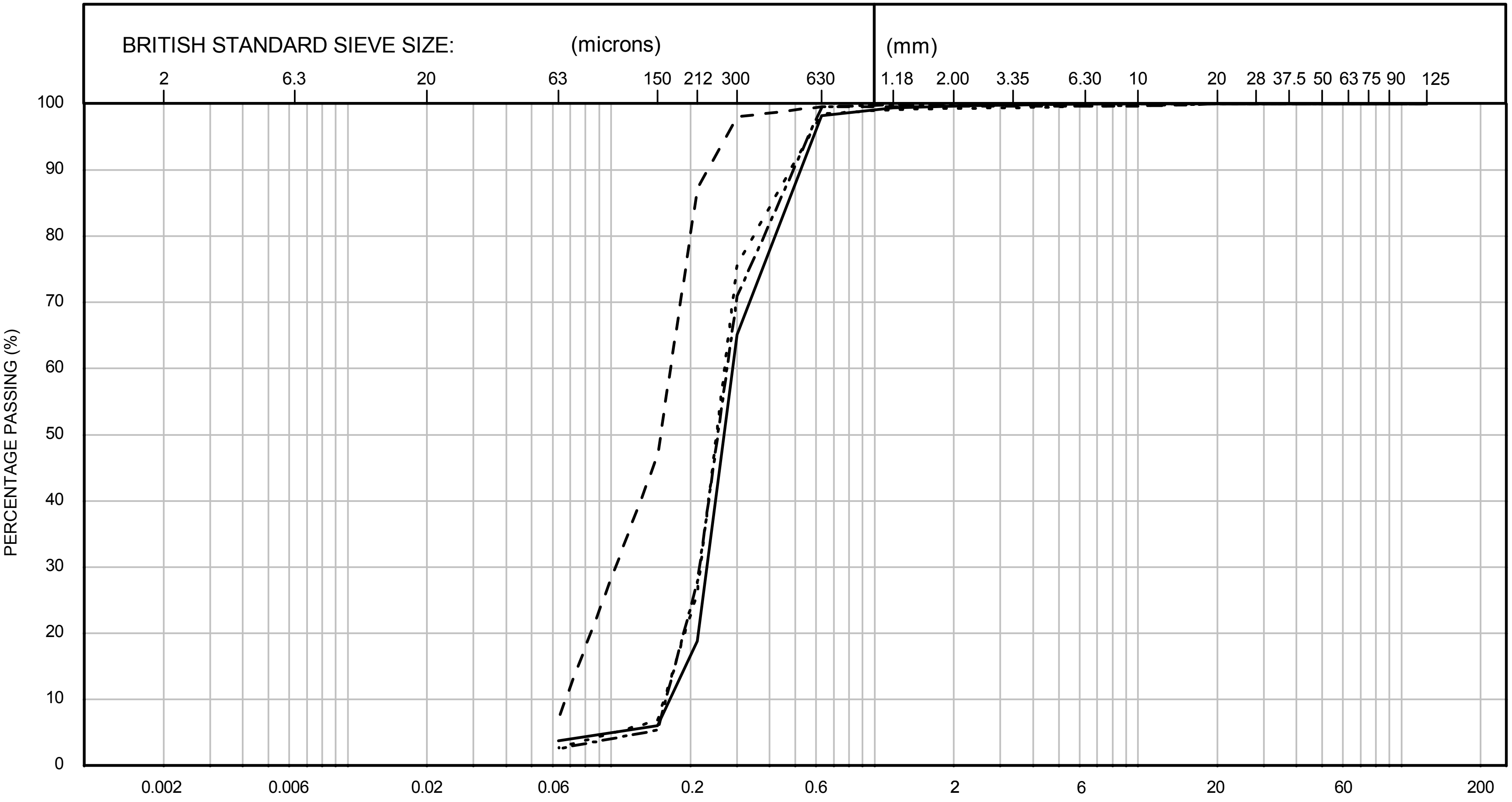
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: ALB Date: 12/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH08-SA_01BagA_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH08-SA	01BagA	0.00	9.2	N/A	0	3	97	0	0
├ ─ ─┤	HKZ1-BH08-SA	03BagA	2.00	9.2	N/A	0	7	93	0	0
├ · · ·┤	HKZ1-BH08-SA	07BagA	5.50	9.2	N/A	0	2	98	0	0
├ ─·─┤	HKZ1-BH08-SA	12BagA	10.00	9.2	N/A	0	2	98	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

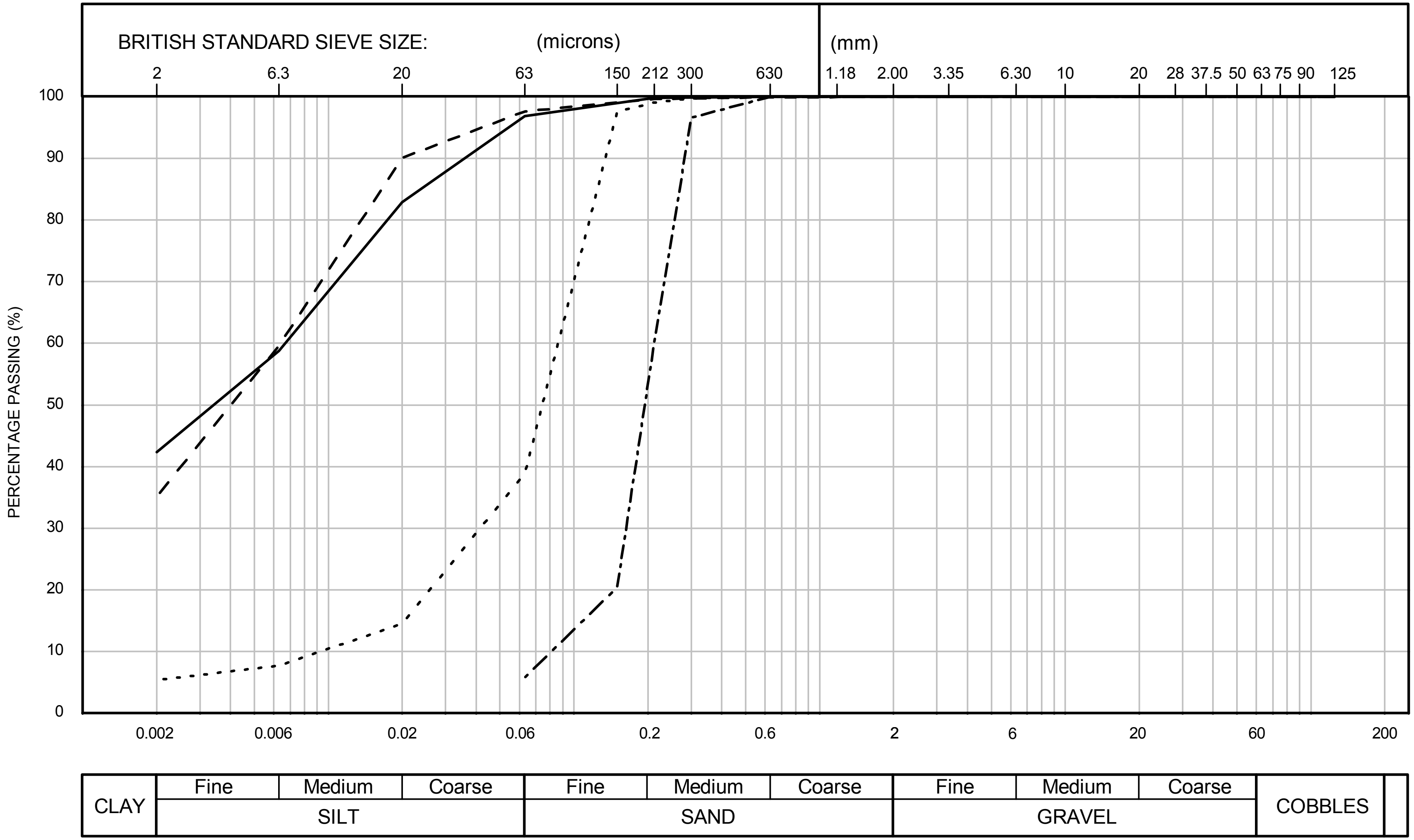
Plate C2.2-35

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 09/08/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH08-SA_13BagD_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types Clay	Silt†	Sand	Gravel	Cobbles
——	HKZ1-BH08-SA	13BagD	11.65	9.4	N/A	42	53	5	0	0
– –	HKZ1-BH08-SA	15WaxC	13.40	9.4	N/A	35	62	3	0	0
· · ·	HKZ1-BH08-SA	18BagB	15.70	9.2/9.4	N/A	5	31	64	0	0
–·–	HKZ1-BH08-SA	23BagA	20.50	9.2	N/A	0	5	95	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

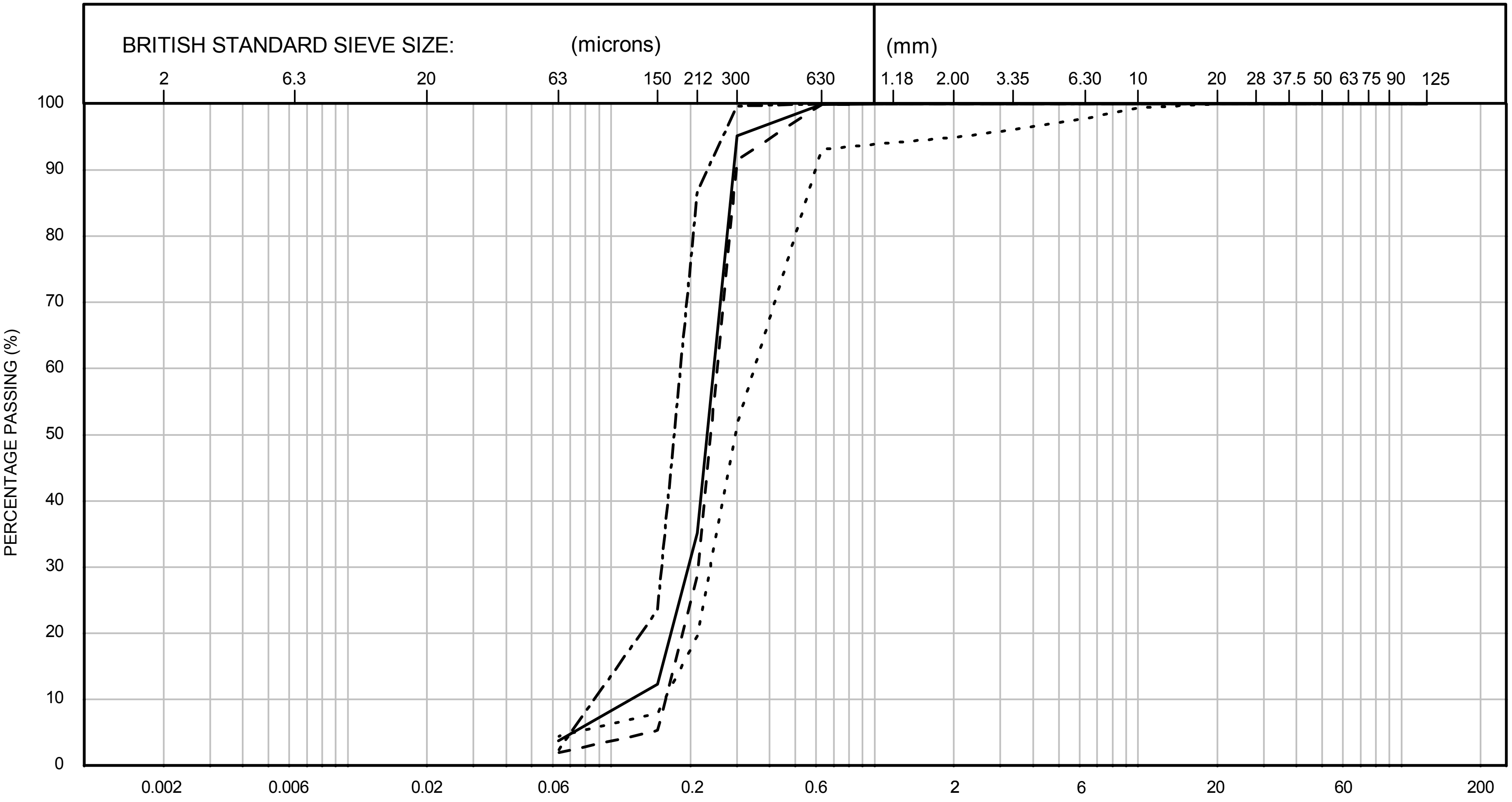
Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 09/08/2016

Approved by: PH Date: 12/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH08-SA_13BagD_ps.OPJ

Fugro Report No. N6196/01 (3)

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types				
						Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH08-SA	27BagB	24.80	9.2	N/A	0	3	97	0	0
├ ─ ─┤	HKZ1-BH08-SA	30BagA	27.50	9.2	N/A	0	1	99	0	0
├ · · ·┤	HKZ1-BH08-SA	33BagA	30.50	9.2	N/A	0	4	91	5	0
├─·─┤	HKZ1-BH08-SA	38BagA	35.00	9.2	N/A	0	2	98	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

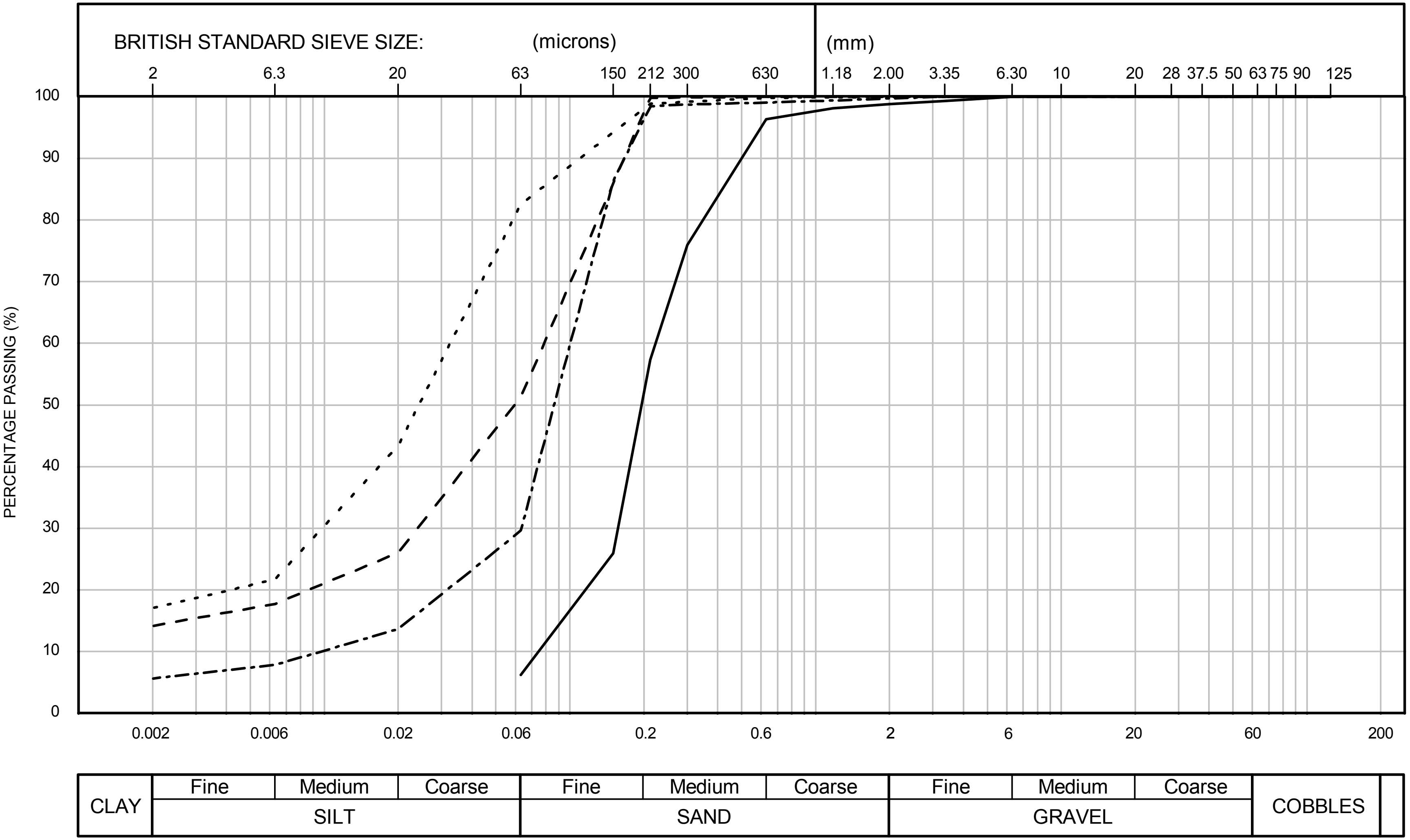
† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns

Checked by: PH Date: 31/08/2016 Template Issue: 5:0 Drawn by: MSR Date: 11/08/2016

Approved by: PH Date: 27/09/2016 Filename: J11335 \ CLASS \ HKZ1-BH08-SA_44BagA_ps.OPJ

PARTICLE SIZE DISTRIBUTION TEST RESULTS

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

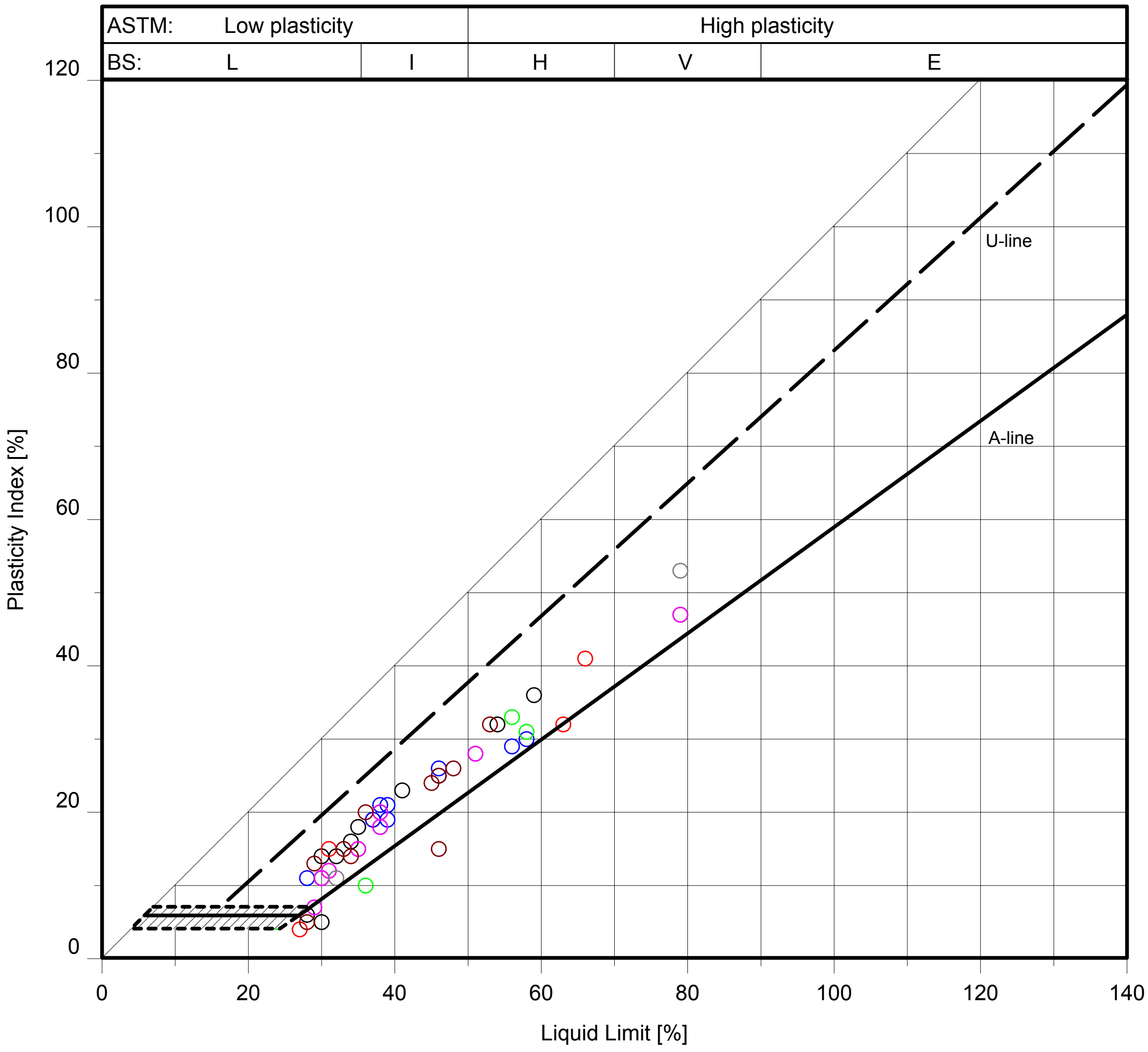


Curve	Borehole	Sample	Depth (m)	BS Test * Method	Pretreatment Method	Percentage soil types: Clay	Silt†	Sand	Gravel	Cobbles
├──┤	HKZ1-BH08-SA	44BagA	39.00	9.2	N/A	0	6	93	1	0
├ ─ ─┤	HKZ1-BH08-SA	48BagA	42.50	9.4	N/A	14	35	51	0	0
├ · · ·┤	HKZ1-BH08-SA	51BagA	45.00	9.4	N/A	17	62	21	0	0
├─·─·┤	HKZ1-BH08-SA	54BagA	48.00	9.2/9.4	N/A	6	22	72	0	0

* Tested in accordance with the following clauses of BS 1377: Part 2: 1990:

9.2	Wet sieve
9.3	Dry sieve
9.4	Sedimentation by pipette
9.5	Sedimentation by hydrometer

† Note: Where a sedimentation test was not carried out, this figure represents total fines, i.e., particles of diameter less than 63 microns



○	Atterberg limits
▨	ASTM CL-ML zone
L	Low plasticity
I	Intermediate plasticity
H	High plasticity
V	Very high plasticity
E	Extremely high plasticity
BS	British Standard 5930: 1999
ASTM	ASTM D2487-11

Location(s):
HKZ1-BH01-SA
HKZ1-BH02-SA
HKZ1-BH03-SA
HKZ1-BH04-SA
HKZ1-BH05-SA
HKZ1-BH06-SA
HKZ1-BH07-SA
HKZ1-BH08-SA

GeODin/Plasticity Chart.GLO/2016-10-06 17:42

PLASTICITY CHART

Location	Sample No.	Depth [m BSF]	w_L [%]	w_P [%]	I_P [%]
HKZ1-BH01-SA	W18	15.50	35	17	18
	W21	18.50	41	18	23
	W24	21.60	59	23	36
	W24	22.15	54	22	32
	W28	25.50	28	22	6
	W44	41.00	32	18	14
	W46	43.00	30	25	5
	W49	46.00	30	16	14
	W53	53.00	34	18	16
HKZ1-BH02-SA	W14	11.95	37	18	19
	W17	14.50	63	31	32
	W18	15.50	66	25	41
	W25	22.50	31	16	15
	W27	25.05	27	23	4
HKZ1-BH03-SA	W22	13.20	46	20	26
	W24	15.20	56	27	29
	W26	17.10	58	28	30
	W35	26.40	30	19	11
	W40	31.00	37	18	19
	W48	39.25	39	18	21
	W50	41.45	38	17	21
	W52	43.45	39	20	19
	W60	59.15	46	21	25
	W61	62.50	28	17	11
HKZ1-BH04-SA	W18	14.50	33	26	7
	W19	16.00	32	15	17
	W25	21.65	38	18	20
	W28	24.65	30	21	9
	W30	26.50	28	21	7
	W32	28.80	39	17	22
	W36	32.50	34	18	16
HKZ1-BH05-SA	W19	15.00	31	19	12
	W21	17.35	38	20	18
	W22	18.00	29	22	7
	W23	19.40	51	23	28
	W24	20.50	30	19	11
	W26	22.00	35	20	15
	W29	25.10	38	18	20
	W48	43.60	79	32	47
HKZ1-BH06-SA	W20	15.70	46	31	15
	W24	19.00	53	21	32
	W29	24.10	28	23	5
	W30	25.20	36	16	20
	W32	27.60	34	20	14
	W46	39.50	33	18	15
	W48	41.95	-	-	-

w_P = Plastic limit
w_L = Liquid limit
I_P = Plasticity index

SUMMARY OF ATTERBERG LIMITS

Location	Sample No.	Depth [m BSF]	w_L [%]	w_P [%]	I_P [%]
	W50	43.70	46	21	25
	W53	46.70	48	22	26
	W56	50.00	45	21	24
	W57	54.10	29	16	13
HKZ1-BH07-SA	W20	13.05	79	26	53
	W52	42.50	32	21	11
HKZ1-BH08-SA	W13	11.65	58	27	31
	W15	13.40	56	23	33
	W48	42.50	24	19	5
	W51	45.00	36	26	10

w_P = Plastic limit
w_L = Liquid limit
I_P = Plasticity index

GeODin/Summary of Atterberg Limits.GLO/2016-11-09 10:35

SUMMARY OF ATTERBERG LIMITS

SECTION C3: SAMPLE PHOTOGRAPHS

LIST OF PLATES IN SECTION C3:

Location : HKZ1-BH01-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.25

Location : HKZ1-BH01-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.55

Location : HKZ1-BH01-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.60

Location : HKZ1-BH01-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.50

Location : HKZ1-BH01-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.45

Location : HKZ1-BH01-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.00

Location : HKZ1-BH01-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.10

Location : HKZ1-BH01-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 6.95

Location : HKZ1-BH01-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 6.95
Note(s) : split

SAMPLE PHOTOGRAPHS

Location	:	HKZ1-BH01-SA
Sample	:	WIP09
Depth [m BSF]	:	7.00 to 7.55

Location	:	HKZ1-BH01-SA
Sample	:	WIP09
Depth [m BSF]	:	7.00 to 7.55
Note(s)	:	split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.65

Location : HKZ1-BH01-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.65
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.50

Location : HKZ1-BH01-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP12
Depth [m BSF] : 10.00 to 10.60

Location : HKZ1-BH01-SA
Sample : WIP12
Depth [m BSF] : 10.00 to 10.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.50

Location : HKZ1-BH01-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP14
Depth [m BSF] : 12.00 to 12.60

Location : HKZ1-BH01-SA
Sample : WIP14
Depth [m BSF] : 12.00 to 12.60
Note(s) : split

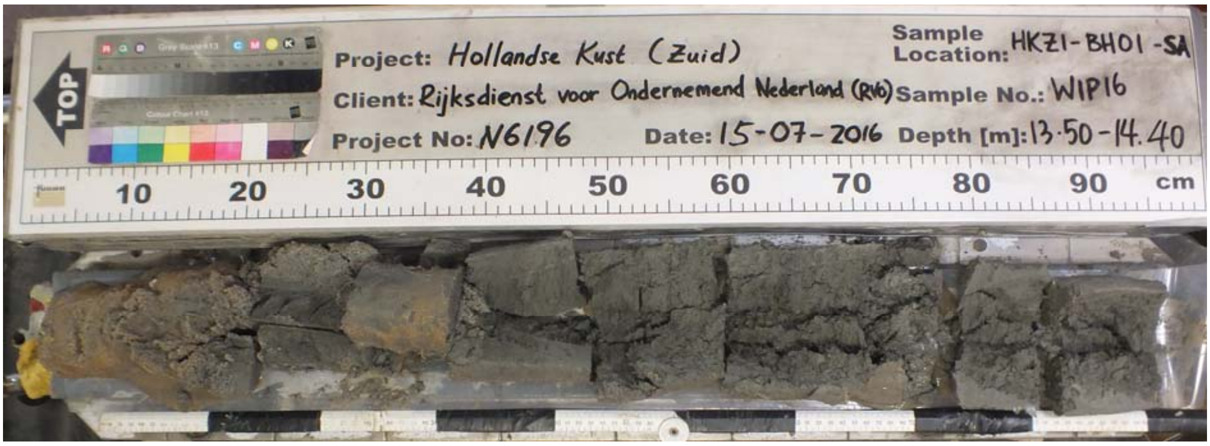
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP15
Depth [m BSF] : 13.00 to 13.40

Location : HKZ1-BH01-SA
Sample : WIP15
Depth [m BSF] : 13.00 to 13.40
Note(s) : split

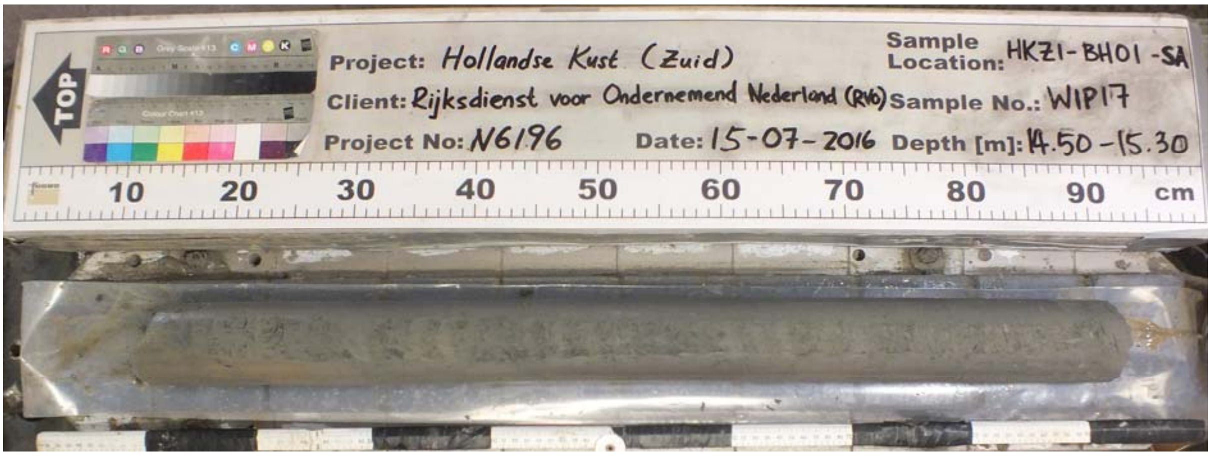
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP16
Depth [m BSF] : 13.50 to 14.40

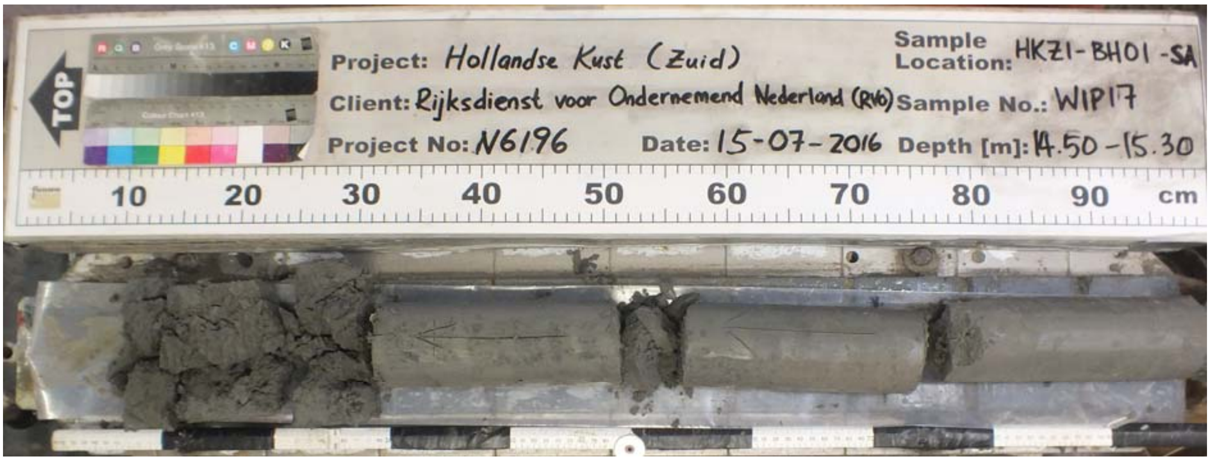


Location : HKZ1-BH01-SA
Sample : WIP16
Depth [m BSF] : 13.50 to 14.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH01-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.30



Location : HKZ1-BH01-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.25

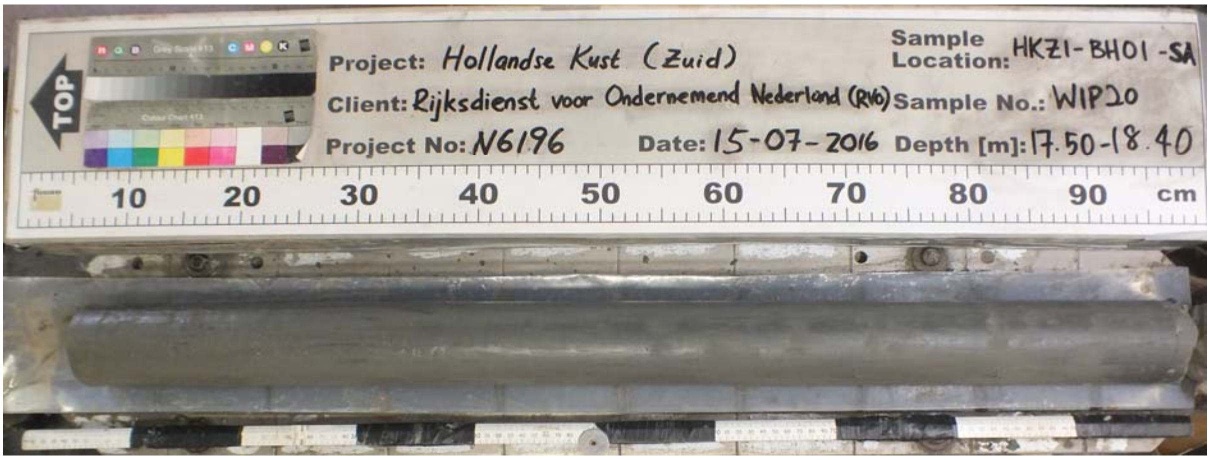
Location : HKZ1-BH01-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.25
Note(s) : split

SAMPLE PHOTOGRAPHS

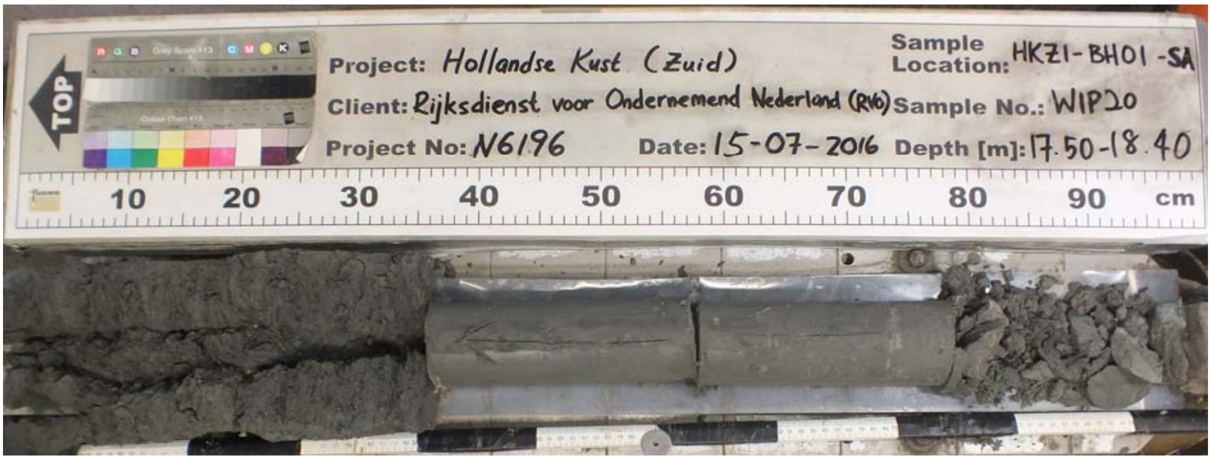
Location : HKZ1-BH01-SA
Sample : LINER19
Depth [m BSF] : 16.50 to 17.35
Note(s) : no photograph taken (sample preserved in liner)

Location : HKZ1-BH01-SA
Sample : LINER19
Depth [m BSF] : 16.50 to 17.35
Note(s) : no photograph taken (sample preserved in liner)

SAMPLE PHOTOGRAPHS

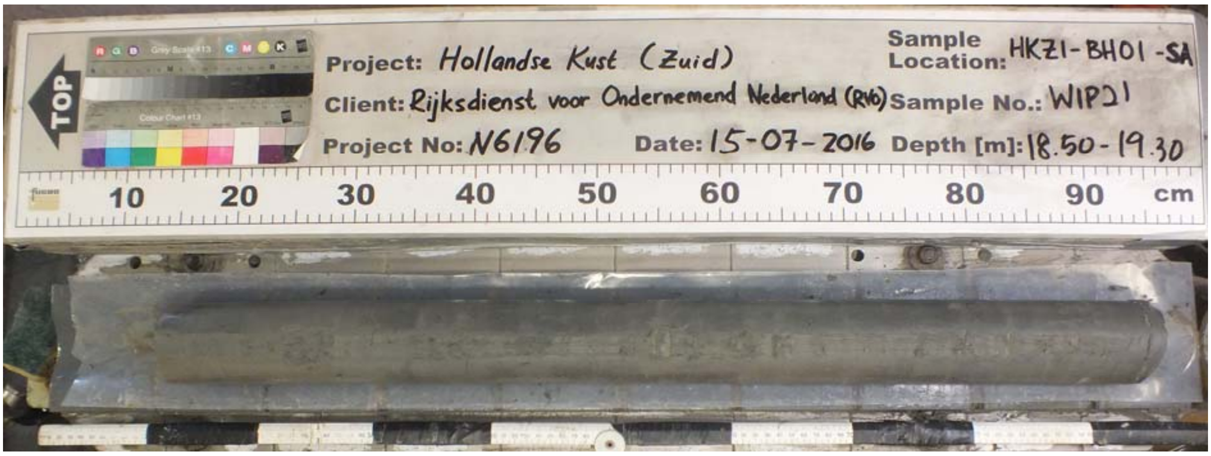


Location : HKZ1-BH01-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.40

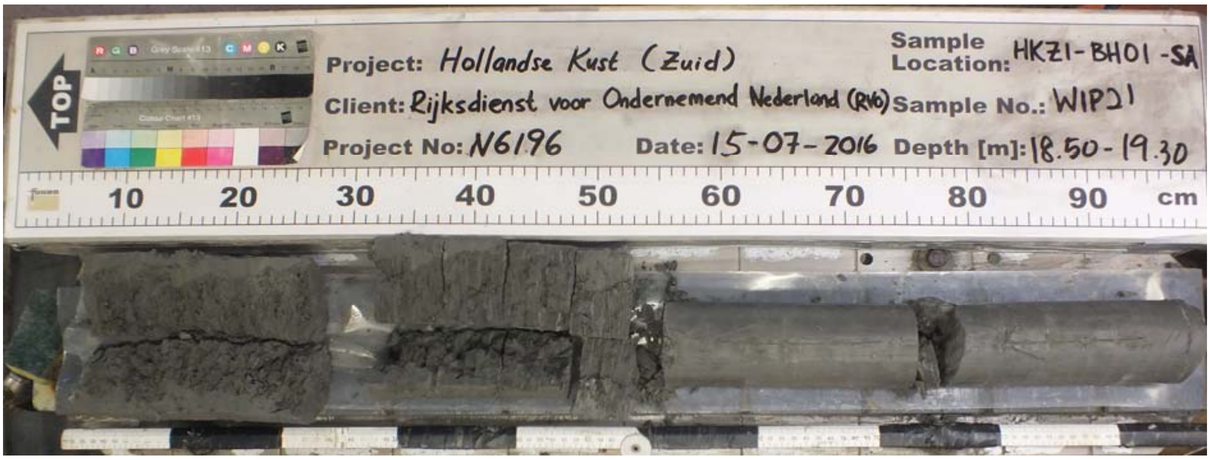


Location : HKZ1-BH01-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location	:	HKZ1-BH01-SA
Sample	:	WIP21
Depth [m BSF]	:	18.50 to 19.30



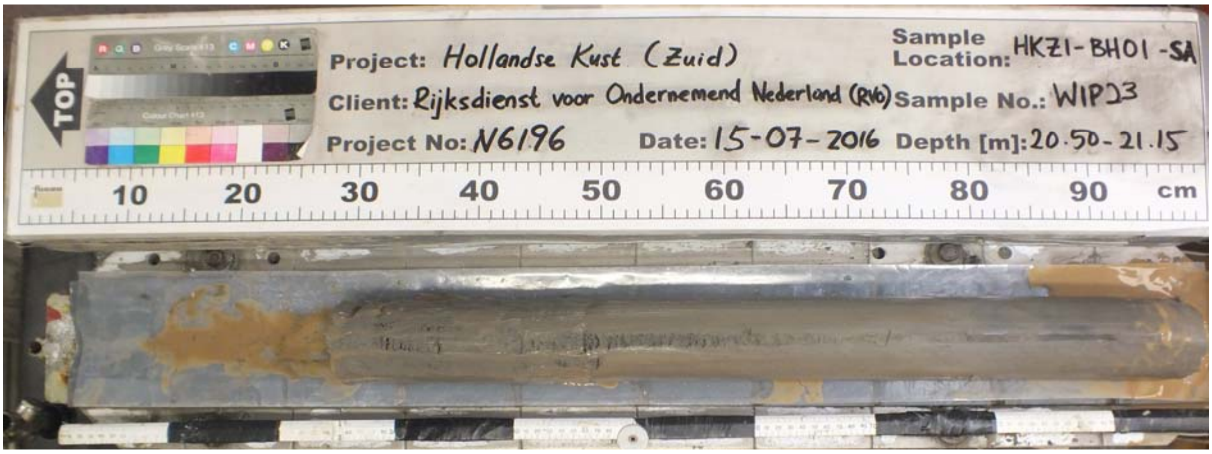
Location	:	HKZ1-BH01-SA
Sample	:	WIP21
Depth [m BSF]	:	18.50 to 19.30
Note(s)	:	split

SAMPLE PHOTOGRAPHS

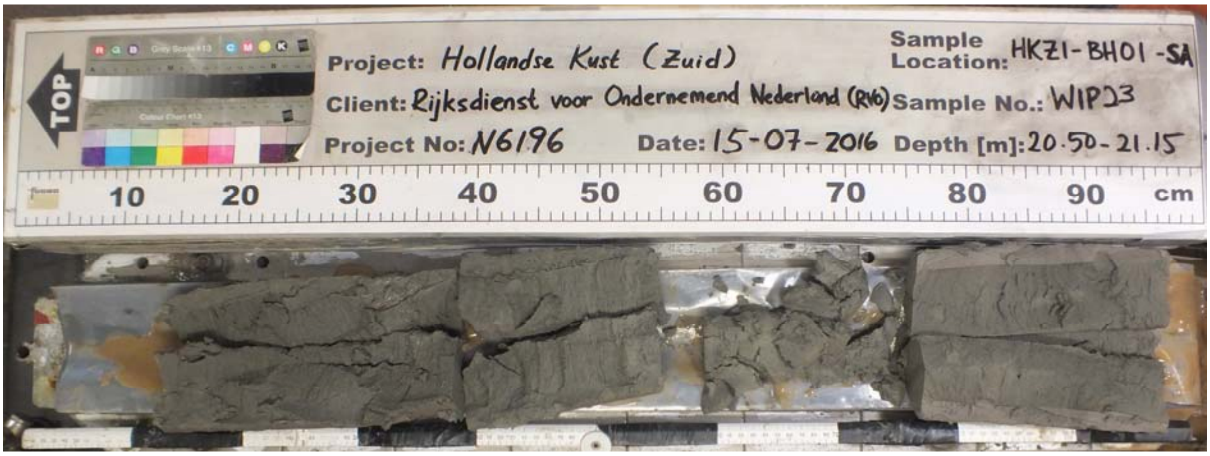
Location : HKZ1-BH01-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.05

Location : HKZ1-BH01-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.05
Note(s) : split

SAMPLE PHOTOGRAPHS



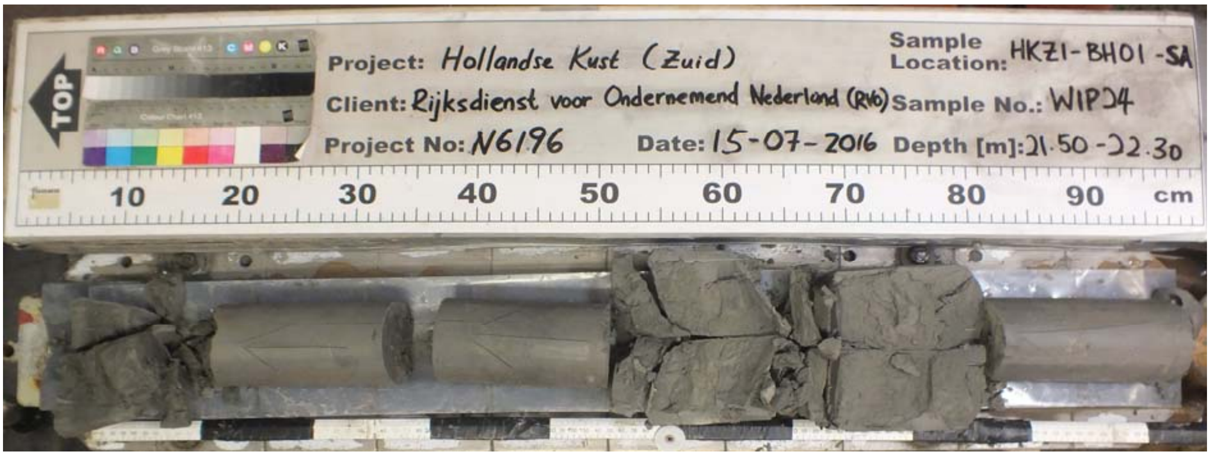
Location : HKZ1-BH01-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.15



Location : HKZ1-BH01-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.30



Location : HKZ1-BH01-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.30
Note(s) : split

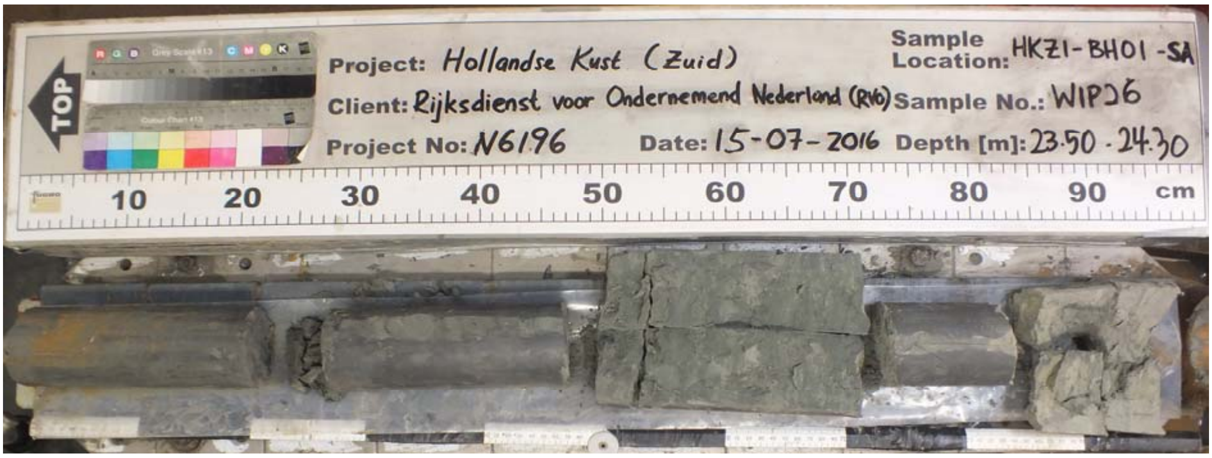
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 22.90

Location : HKZ1-BH01-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 22.90
Note(s) : split

SAMPLE PHOTOGRAPHS

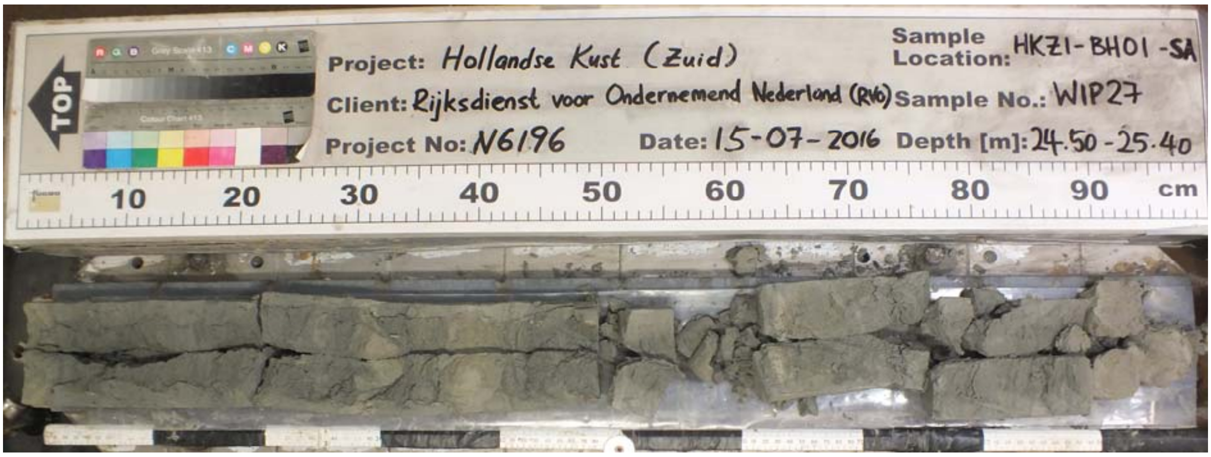
Location : HKZ1-BH01-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.30



Location : HKZ1-BH01-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.40



Location : HKZ1-BH01-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.40
Note(s) : split

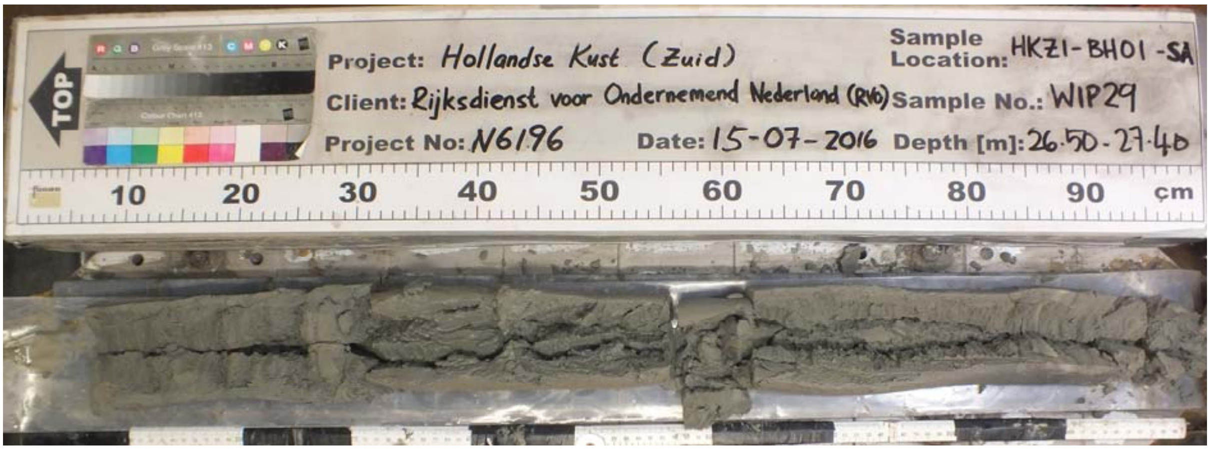
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 26.30

Location : HKZ1-BH01-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 26.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP29
Depth [m BSF] : 26.50 to 27.40



Location : HKZ1-BH01-SA
Sample : WIP29
Depth [m BSF] : 26.50 to 27.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP30
Depth [m BSF] : 27.50 to 28.20

Location : HKZ1-BH01-SA
Sample : WIP30
Depth [m BSF] : 27.50 to 28.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP31
Depth [m BSF] : 28.50 to 29.25

Location : HKZ1-BH01-SA
Sample : WIP31
Depth [m BSF] : 28.50 to 29.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP32
Depth [m BSF] : 29.50 to 30.30

Location : HKZ1-BH01-SA
Sample : WIP32
Depth [m BSF] : 29.50 to 30.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP33
Depth [m BSF] : 30.50 to 31.35

Location : HKZ1-BH01-SA
Sample : WIP33
Depth [m BSF] : 30.50 to 31.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP34
Depth [m BSF] : 31.50 to 32.30

Location : HKZ1-BH01-SA
Sample : WIP34
Depth [m BSF] : 31.50 to 32.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP35
Depth [m BSF] : 32.50 to 33.05

Location : HKZ1-BH01-SA
Sample : WIP35
Depth [m BSF] : 32.50 to 33.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP36
Depth [m BSF] : 33.50 to 34.00

Location : HKZ1-BH01-SA
Sample : WIP36
Depth [m BSF] : 33.50 to 34.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP37
Depth [m BSF] : 34.50 to 34.85

Location : HKZ1-BH01-SA
Sample : WIP37
Depth [m BSF] : 34.50 to 34.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP38
Depth [m BSF] : 35.00 to 35.55

Location : HKZ1-BH01-SA
Sample : WIP38
Depth [m BSF] : 35.00 to 35.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP39
Depth [m BSF] : 36.00 to 36.75

Location : HKZ1-BH01-SA
Sample : WIP39
Depth [m BSF] : 36.00 to 36.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP40
Depth [m BSF] : 37.00 to 37.70

Location : HKZ1-BH01-SA
Sample : WIP40
Depth [m BSF] : 37.00 to 37.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP41
Depth [m BSF] : 38.00 to 38.60

Location : HKZ1-BH01-SA
Sample : WIP41
Depth [m BSF] : 38.00 to 38.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP42
Depth [m BSF] : 39.00 to 39.70

Location : HKZ1-BH01-SA
Sample : WIP42
Depth [m BSF] : 39.00 to 39.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP43
Depth [m BSF] : 40.00 to 40.85

Location : HKZ1-BH01-SA
Sample : WIP43
Depth [m BSF] : 40.00 to 40.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP44
Depth [m BSF] : 41.00 to 41.65

Location : HKZ1-BH01-SA
Sample : WIP44
Depth [m BSF] : 41.00 to 41.65
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP45
Depth [m BSF] : 42.00 to 42.80

Location : HKZ1-BH01-SA
Sample : WIP45
Depth [m BSF] : 42.00 to 42.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP46
Depth [m BSF] : 43.00 to 43.60

Location : HKZ1-BH01-SA
Sample : WIP46
Depth [m BSF] : 43.00 to 43.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP47
Depth [m BSF] : 44.00 to 44.70

Location : HKZ1-BH01-SA
Sample : WIP47
Depth [m BSF] : 44.00 to 44.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP48
Depth [m BSF] : 45.00 to 45.60

Location : HKZ1-BH01-SA
Sample : WIP48
Depth [m BSF] : 45.00 to 45.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP49
Depth [m BSF] : 46.00 to 46.70

Location : HKZ1-BH01-SA
Sample : WIP49
Depth [m BSF] : 46.00 to 46.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP50
Depth [m BSF] : 47.00 to 47.70

Location : HKZ1-BH01-SA
Sample : WIP50
Depth [m BSF] : 47.00 to 47.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP51
Depth [m BSF] : 48.00 to 48.70

Location : HKZ1-BH01-SA
Sample : WIP51
Depth [m BSF] : 48.00 to 48.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP52
Depth [m BSF] : 49.00 to 49.60

Location : HKZ1-BH01-SA
Sample : WIP52
Depth [m BSF] : 49.00 to 49.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP53
Depth [m BSF] : 53.00 to 53.85

Location : HKZ1-BH01-SA
Sample : WIP53
Depth [m BSF] : 53.00 to 53.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP54
Depth [m BSF] : 57.00 to 57.55

Location : HKZ1-BH01-SA
Sample : WIP54
Depth [m BSF] : 57.00 to 57.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SA
Sample : WIP55
Depth [m BSF] : 61.00 to 61.65

Location : HKZ1-BH01-SA
Sample : WIP55
Depth [m BSF] : 61.00 to 61.65
Note(s) : split

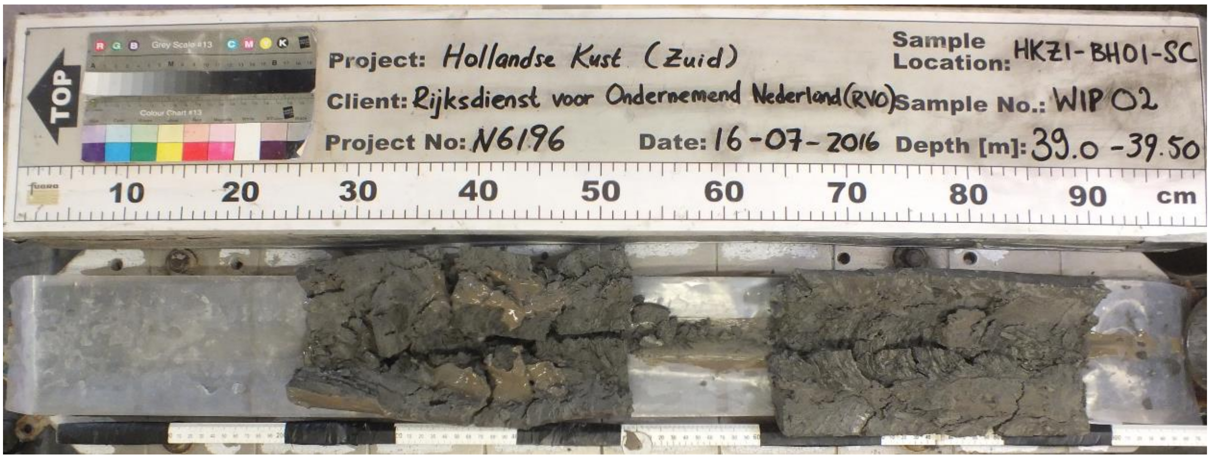
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SC
Sample : WIP01
Depth [m BSF] : 19.00 to 19.75

Location : HKZ1-BH01-SC
Sample : WIP01
Depth [m BSF] : 19.00 to 19.75
Note(s) : split

SAMPLE PHOTOGRAPHS

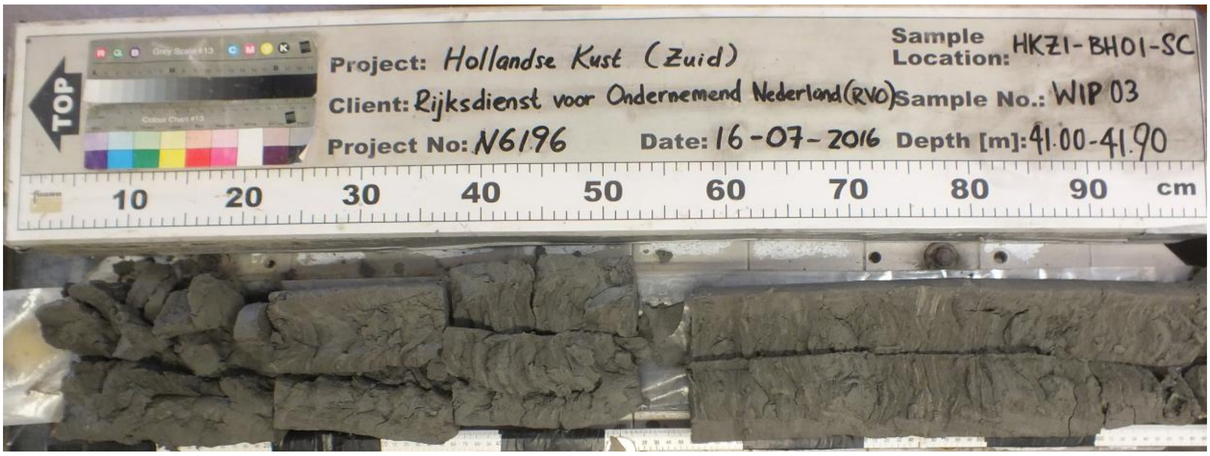
Location : HKZ1-BH01-SC
Sample : WIP02
Depth [m BSF] : 39.00 to 39.50



Location : HKZ1-BH01-SC
Sample : WIP02
Depth [m BSF] : 39.00 to 39.50
Note(s) : split

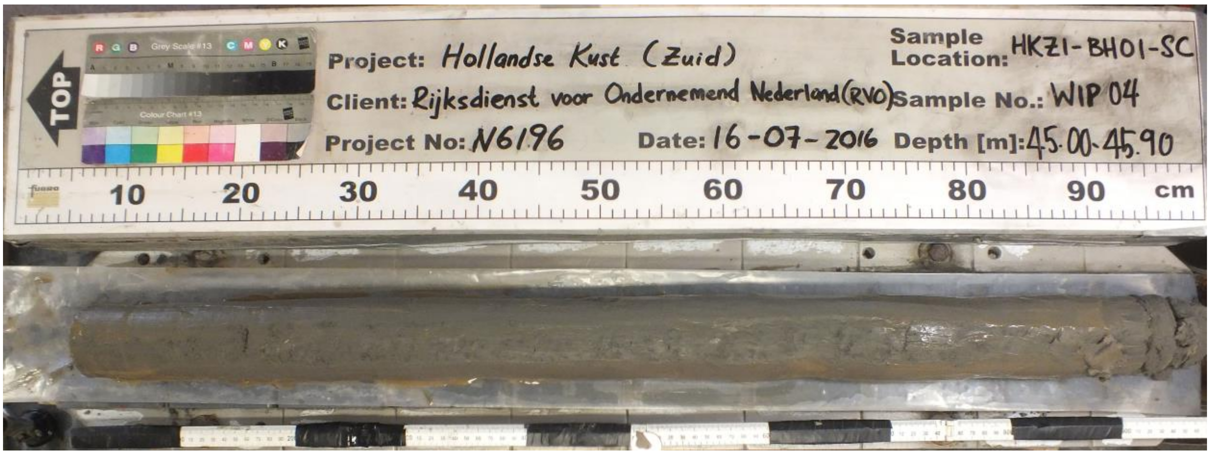
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH01-SC
Sample : WIP03
Depth [m BSF] : 41.00 to 41.90



Location : HKZ1-BH01-SC
Sample : WIP03
Depth [m BSF] : 41.00 to 41.90
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH01-SC
Sample : WIP04
Depth [m BSF] : 45.00 to 45.90

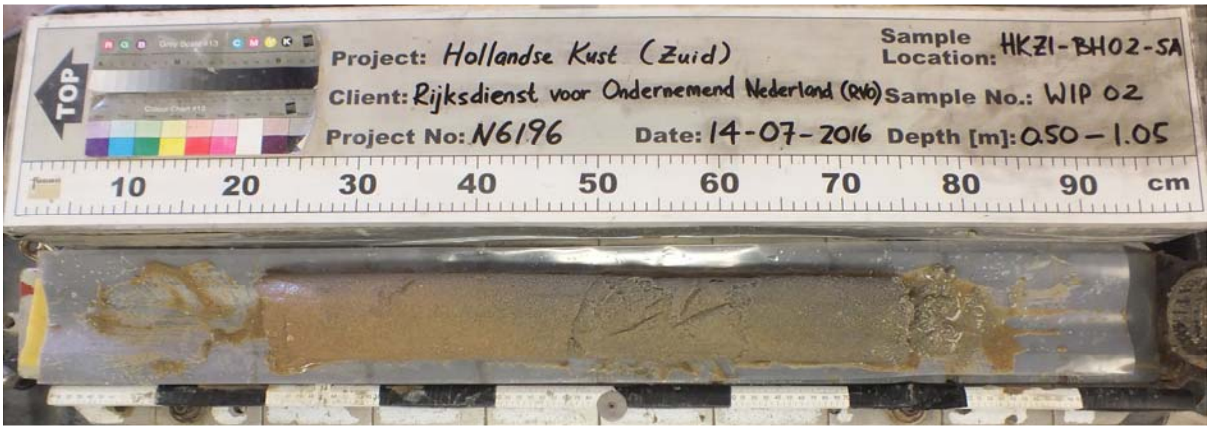
Location : HKZ1-BH01-SC
Sample : WIP04
Depth [m BSF] : 45.00 to 45.90
Note(s) : split

SAMPLE PHOTOGRAPHS

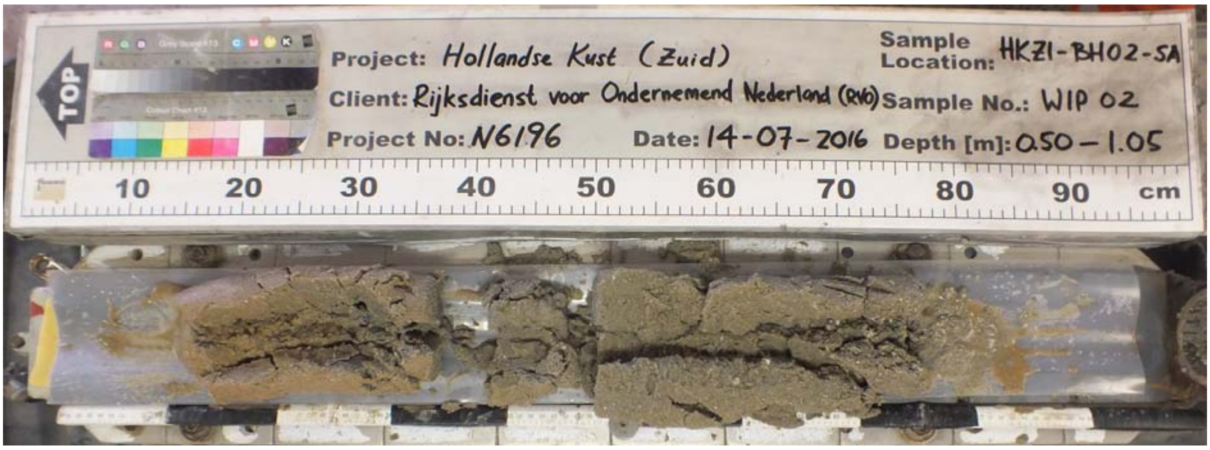
Location : HKZ1-BH02-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.45

Location : HKZ1-BH02-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.45
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH02-SA
Sample : WIP02
Depth [m BSF] : 0.50 to 1.05



Location : HKZ1-BH02-SA
Sample : WIP02
Depth [m BSF] : 0.50 to 1.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP03
Depth [m BSF] : 1.50 to 2.00

Location : HKZ1-BH02-SA
Sample : WIP03
Depth [m BSF] : 1.50 to 2.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP04
Depth [m BSF] : 2.50 to 3.05

Location : HKZ1-BH02-SA
Sample : WIP04
Depth [m BSF] : 2.50 to 3.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 4.10

Location : HKZ1-BH02-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 4.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.15

Location : HKZ1-BH02-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.15

Location : HKZ1-BH02-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 7.05

Location : HKZ1-BH02-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 7.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP09
Depth [m BSF] : 7.50 to 8.05

Location : HKZ1-BH02-SA
Sample : WIP09
Depth [m BSF] : 7.50 to 8.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP10
Depth [m BSF] : 8.50 to 8.95

Location : HKZ1-BH02-SA
Sample : WIP10
Depth [m BSF] : 8.50 to 8.95
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.45

Location : HKZ1-BH02-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP12
Depth [m BSF] : 9.50 to 10.05

Location : HKZ1-BH02-SA
Sample : WIP12
Depth [m BSF] : 9.50 to 10.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP13
Depth [m BSF] : 10.50 to 11.25

Location : HKZ1-BH02-SA
Sample : WIP13
Depth [m BSF] : 10.50 to 11.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP14
Depth [m BSF] : 11.50 to 12.40

Location : HKZ1-BH02-SA
Sample : WIP14
Depth [m BSF] : 11.50 to 12.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP15
Depth [m BSF] : 12.50 to 13.25

Location : HKZ1-BH02-SA
Sample : WIP15
Depth [m BSF] : 12.50 to 13.25
Note(s) : split

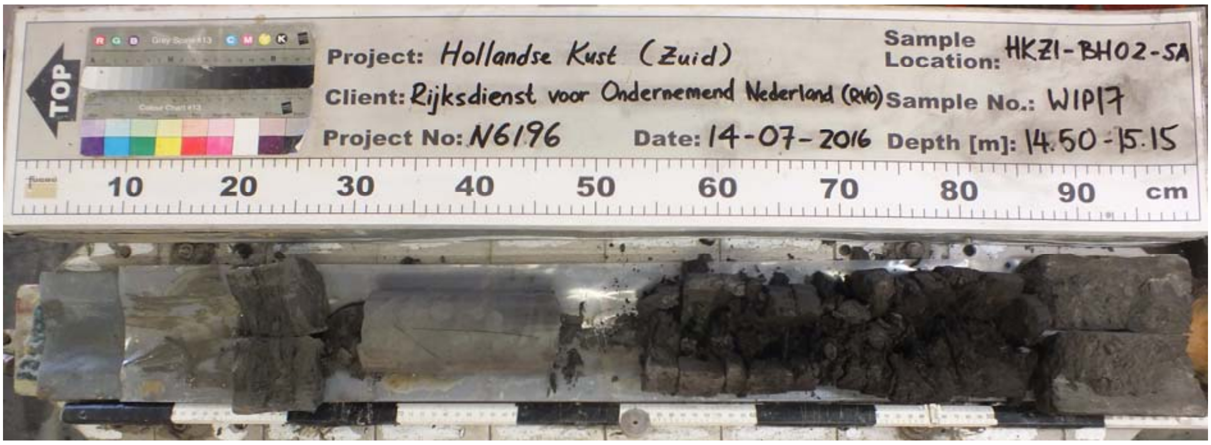
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP16
Depth [m BSF] : 13.50 to 14.30

Location : HKZ1-BH02-SA
Sample : WIP16
Depth [m BSF] : 13.50 to 14.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.15



Location : HKZ1-BH02-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.05

Location : HKZ1-BH02-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP19
Depth [m BSF] : 16.50 to 17.15

Location : HKZ1-BH02-SA
Sample : WIP19
Depth [m BSF] : 16.50 to 17.15
Note(s) : split

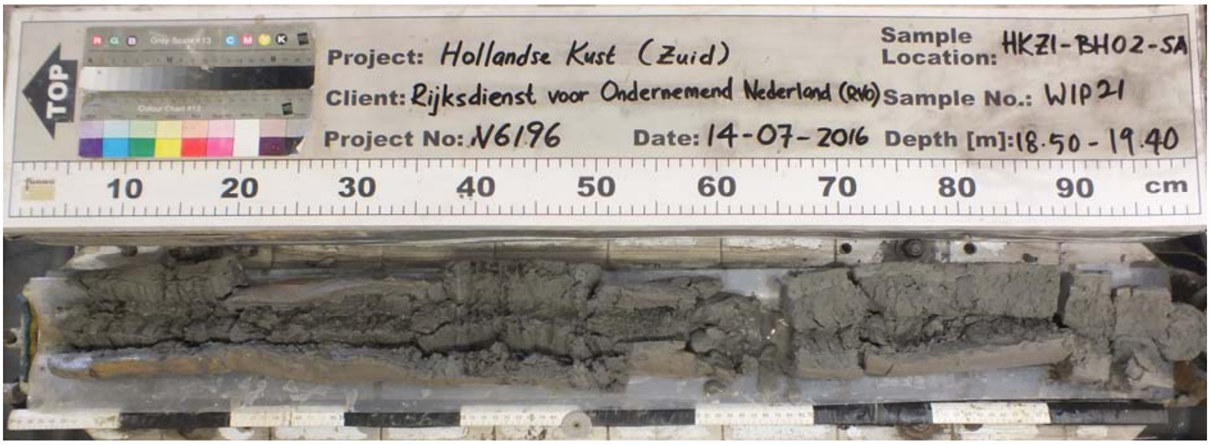
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.10

Location : HKZ1-BH02-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.10
Note(s) : split

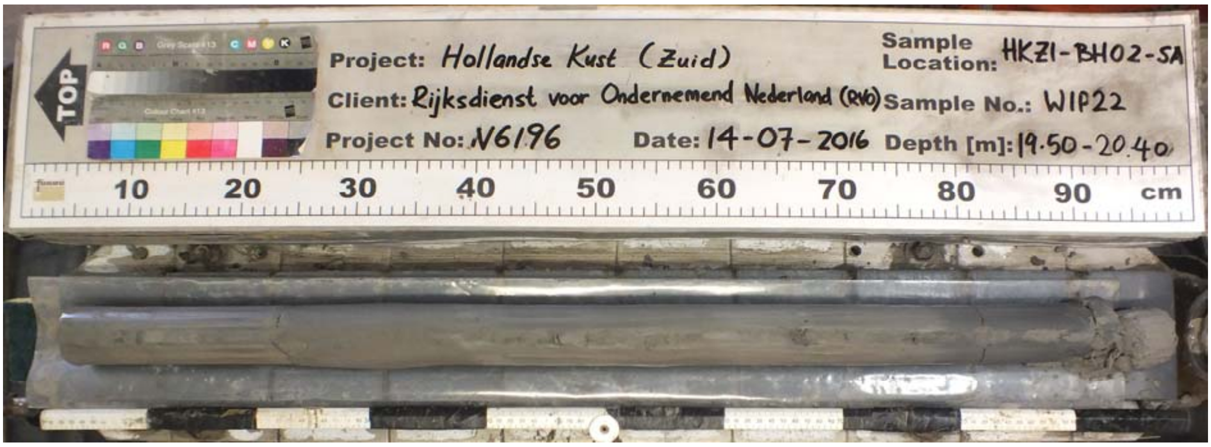
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP21
Depth [m BSF] : 18.50 to 19.40



Location : HKZ1-BH02-SA
Sample : WIP21
Depth [m BSF] : 18.50 to 19.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH02-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.40

Location : HKZ1-BH02-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.40

Location : HKZ1-BH02-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.40

Location : HKZ1-BH02-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 23.20

Location : HKZ1-BH02-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 23.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.35

Location : HKZ1-BH02-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.30

Location : HKZ1-BH02-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 25.95
Note(s) : incorrect depth presented on sample photograph

Location : HKZ1-BH02-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 25.95
Note(s) : split
: incorrect depth presented on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP29
Depth [m BSF] : 26.00 to 26.90

Location : HKZ1-BH02-SA
Sample : WIP29
Depth [m BSF] : 26.00 to 26.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP30
Depth [m BSF] : 27.00 to 27.80

Location : HKZ1-BH02-SA
Sample : WIP30
Depth [m BSF] : 27.00 to 27.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP31
Depth [m BSF] : 28.00 to 28.80

Location : HKZ1-BH02-SA
Sample : WIP31
Depth [m BSF] : 28.00 to 28.80
Note(s) : split

SAMPLE PHOTOGRAPHS


Project: Hollandse Kust (Zuid)
Sample Location: HKZ1-BH02-SA
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Sample No.: WIP 32
Project No: N6196
Date: 14-07-2016
Depth [m]: 29.00 - 29.90

Location : HKZ1-BH02-SA
Sample : WIP32
Depth [m BSF] : 29.00 to 29.90


Project: Hollandse Kust (Zuid)
Sample Location: HKZ1-BH02-SA
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Sample No.: WIP 32
Project No: N6196
Date: 14-07-2016
Depth [m]: 29.00 - 29.90

Location : HKZ1-BH02-SA
Sample : WIP32
Depth [m BSF] : 29.00 to 29.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP33
Depth [m BSF] : 30.00 to 30.80

Location : HKZ1-BH02-SA
Sample : WIP33
Depth [m BSF] : 30.00 to 30.80
Note(s) : split

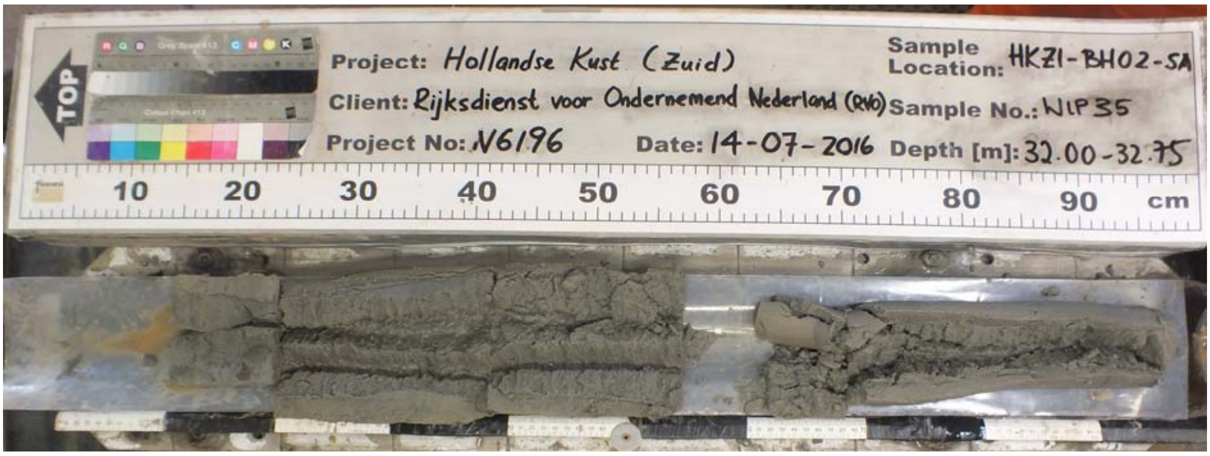
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP34
Depth [m BSF] : 31.00 to 31.85

Location : HKZ1-BH02-SA
Sample : WIP34
Depth [m BSF] : 31.00 to 31.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP35
Depth [m BSF] : 32.00 to 32.75



Location : HKZ1-BH02-SA
Sample : WIP35
Depth [m BSF] : 32.00 to 32.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP36
Depth [m BSF] : 33.00 to 33.80

Location : HKZ1-BH02-SA
Sample : WIP36
Depth [m BSF] : 33.00 to 33.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP37
Depth [m BSF] : 34.00 to 34.75

Location : HKZ1-BH02-SA
Sample : WIP37
Depth [m BSF] : 34.00 to 34.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : LINER38
Depth [m BSF] : 35.00 to 35.70
Note(s) : no photograph taken (sample preserved in liner)

Location : HKZ1-BH02-SA
Sample : LINER38
Depth [m BSF] : 35.00 to 35.70
Note(s) : no photograph taken (sample preserved in liner)

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP39
Depth [m BSF] : 36.00 to 36.90

Location : HKZ1-BH02-SA
Sample : WIP39
Depth [m BSF] : 36.00 to 36.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP40
Depth [m BSF] : 37.00 to 37.50

Location : HKZ1-BH02-SA
Sample : WIP40
Depth [m BSF] : 37.00 to 37.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP41
Depth [m BSF] : 38.00 to 38.55

Location : HKZ1-BH02-SA
Sample : WIP41
Depth [m BSF] : 38.00 to 38.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP42
Depth [m BSF] : 39.00 to 39.80

Location : HKZ1-BH02-SA
Sample : WIP42
Depth [m BSF] : 39.00 to 39.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP43
Depth [m BSF] : 40.00 to 40.65

Location : HKZ1-BH02-SA
Sample : WIP43
Depth [m BSF] : 40.00 to 40.65
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP44
Depth [m BSF] : 41.00 to 41.50

Location : HKZ1-BH02-SA
Sample : WIP44
Depth [m BSF] : 41.00 to 41.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP45
Depth [m BSF] : 42.00 to 42.45

Location : HKZ1-BH02-SA
Sample : WIP45
Depth [m BSF] : 42.00 to 42.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP46
Depth [m BSF] : 42.50 to 43.05

Location : HKZ1-BH02-SA
Sample : WIP46
Depth [m BSF] : 42.50 to 43.05
Note(s) : split

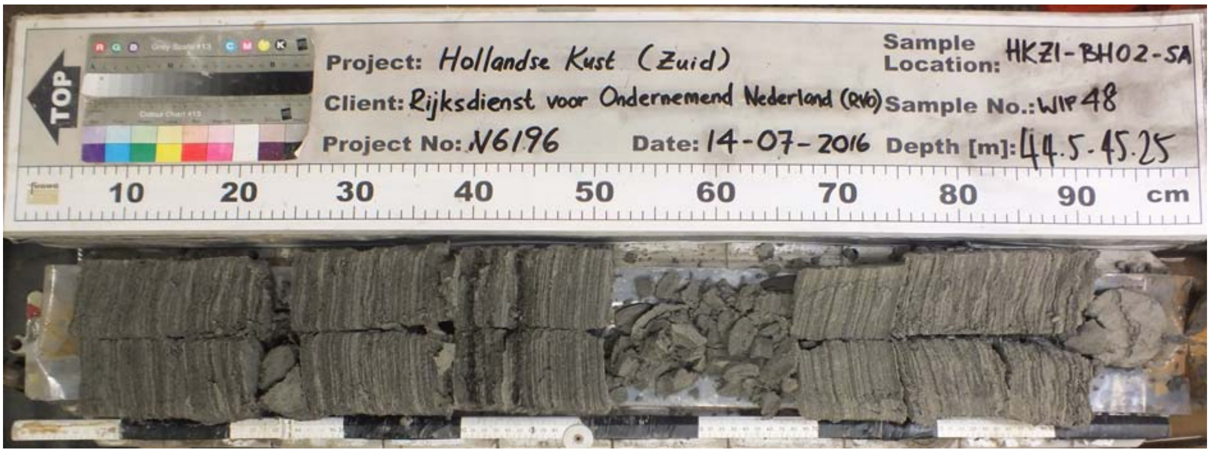
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP47
Depth [m BSF] : 43.50 to 44.25

Location : HKZ1-BH02-SA
Sample : WIP47
Depth [m BSF] : 43.50 to 44.25
Note(s) : split

SAMPLE PHOTOGRAPHS

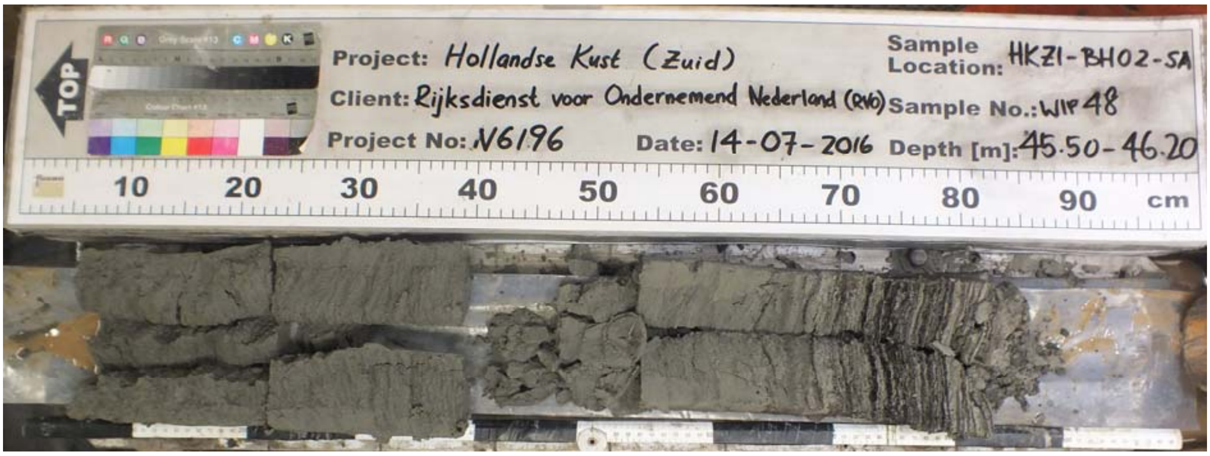
Location : HKZ1-BH02-SA
Sample : WIP48
Depth [m BSF] : 44.50 to 45.25



Location : HKZ1-BH02-SA
Sample : WIP48
Depth [m BSF] : 44.50 to 45.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP49
Depth [m BSF] : 45.50 to 46.20
Note(s) : incorrect sample number on sample photograph



Location : HKZ1-BH02-SA
Sample : WIP49
Depth [m BSF] : 45.50 to 46.20
Note(s) : split
: incorrect sample number on sample photograph

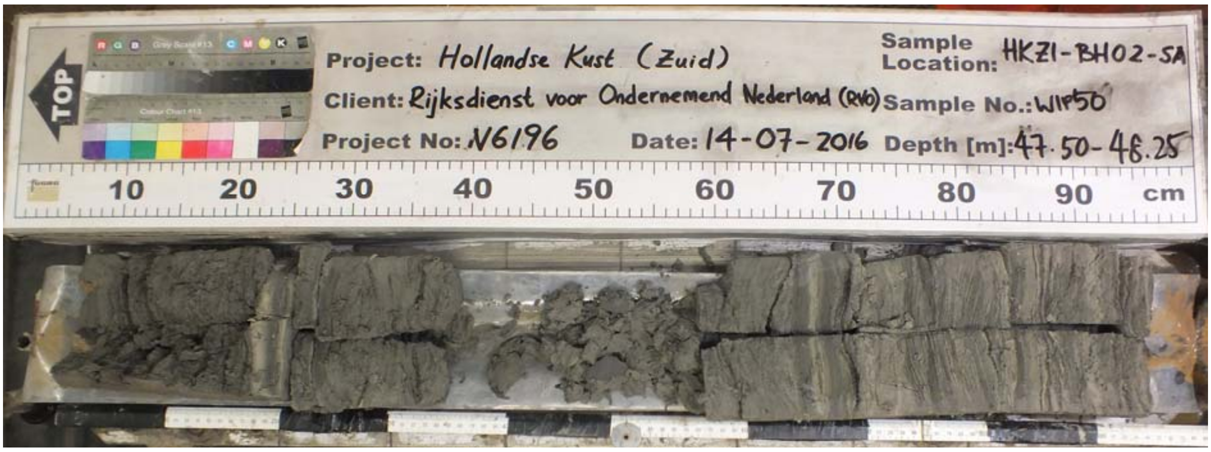
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP50
Depth [m BSF] : 46.50 to 47.40
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH02-SA
Sample : WIP50
Depth [m BSF] : 46.50 to 47.40
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

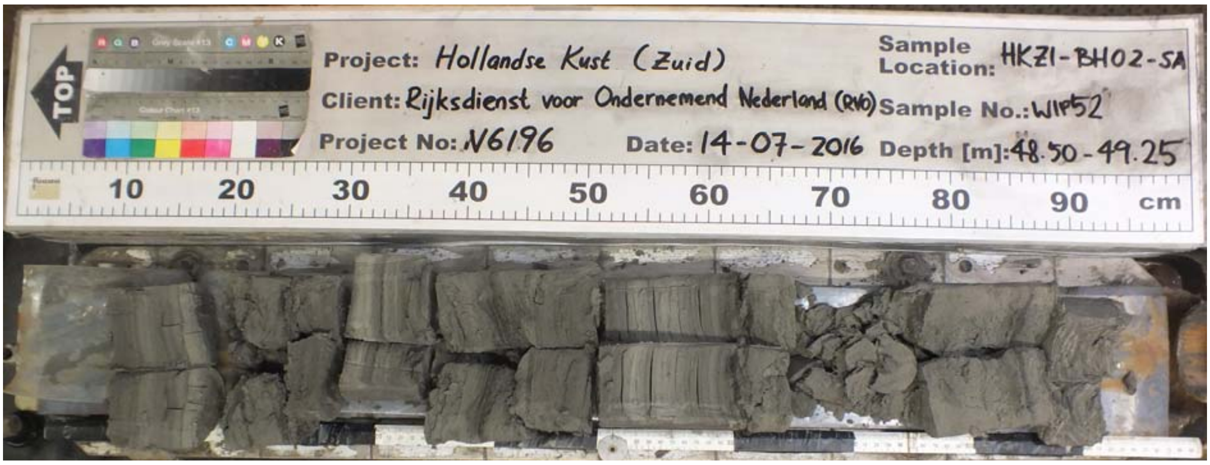
Location : HKZ1-BH02-SA
Sample : WIP51
Depth [m BSF] : 47.50 to 48.25
Note(s) : incorrect sample number on sample photograph



Location : HKZ1-BH02-SA
Sample : WIP51
Depth [m BSF] : 47.50 to 48.25
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

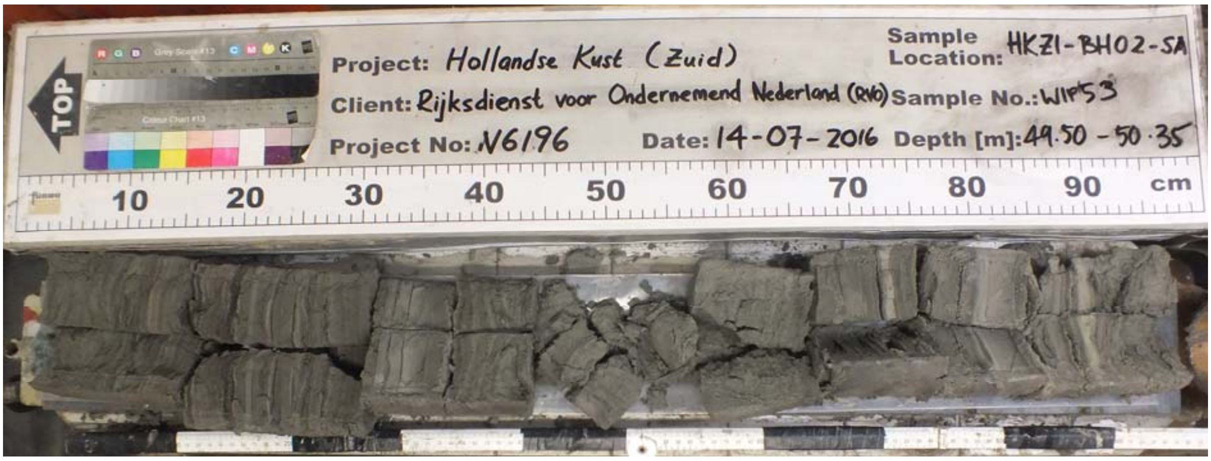
Location : HKZ1-BH02-SA
Sample : WIP52
Depth [m BSF] : 48.50 to 49.25



Location : HKZ1-BH02-SA
Sample : WIP52
Depth [m BSF] : 48.50 to 49.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH02-SA
Sample : WIP53
Depth [m BSF] : 49.50 to 50.35



Location : HKZ1-BH02-SA
Sample : WIP53
Depth [m BSF] : 49.50 to 50.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.30

Location : HKZ1-BH03-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.30
Note(s) : split

SAMPLE PHOTOGRAPHS

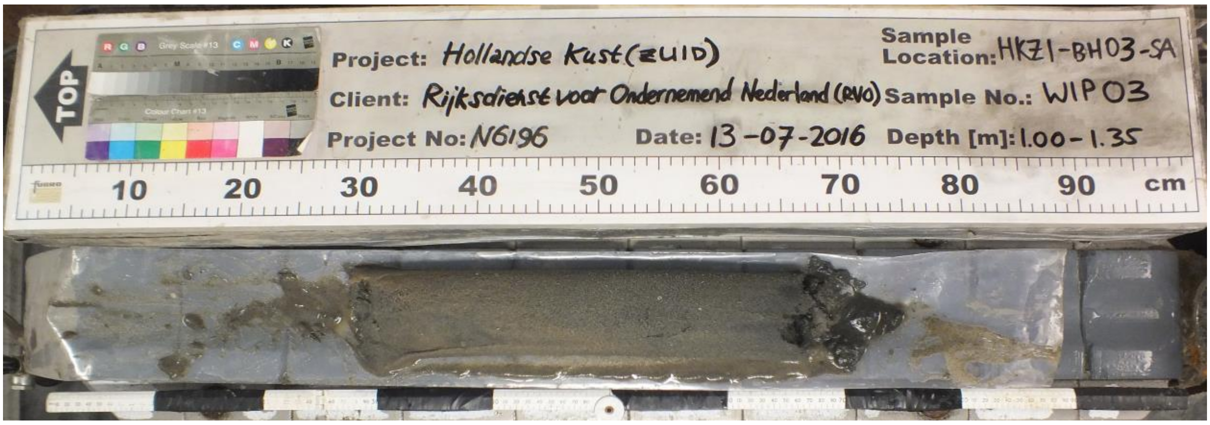
Project: Hollandse Kust (ZUID)
Sample Location: HKZ1-BH03-SA
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Sample No.: WIP02
Project No: N6196
Date: 13-07-2016
Depth [m]: 0.50 - 0.90

Location : HKZ1-BH03-SA
Sample : WIP02
Depth [m BSF] : 0.50 to 0.90

Project: Hollandse Kust (ZUID)
Sample Location: HKZ1-BH03-SA
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Sample No.: WIP02
Project No: N6196
Date: 13-07-2016
Depth [m]: 0.50 - 0.90

Location : HKZ1-BH03-SA
Sample : WIP02
Depth [m BSF] : 0.50 to 0.90
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP03
Depth [m BSF] : 1.00 to 1.35

Location : HKZ1-BH03-SA
Sample : WIP03
Depth [m BSF] : 1.00 to 1.35
Note(s) : split

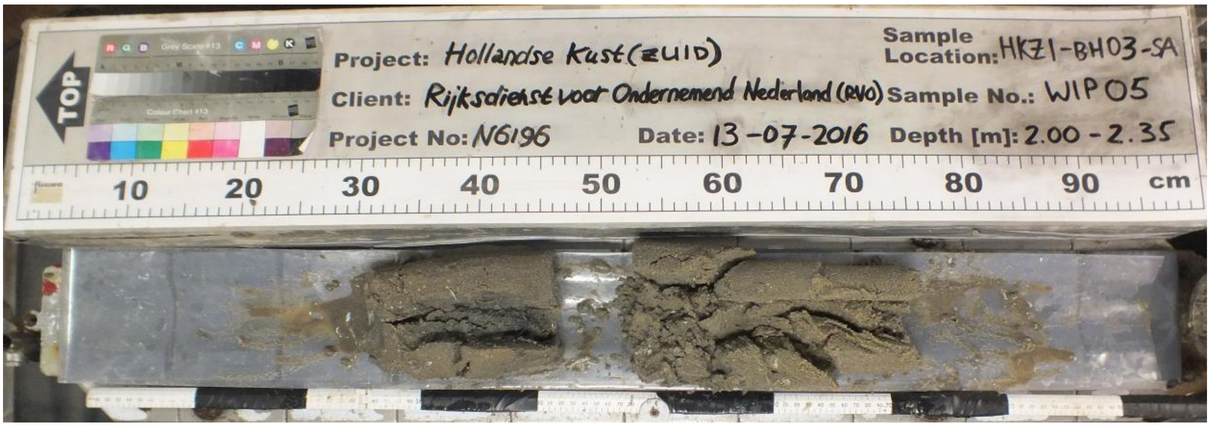
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP04
Depth [m BSF] : 1.50 to 1.95

Location : HKZ1-BH03-SA
Sample : WIP04
Depth [m BSF] : 1.50 to 1.95
Note(s) : split

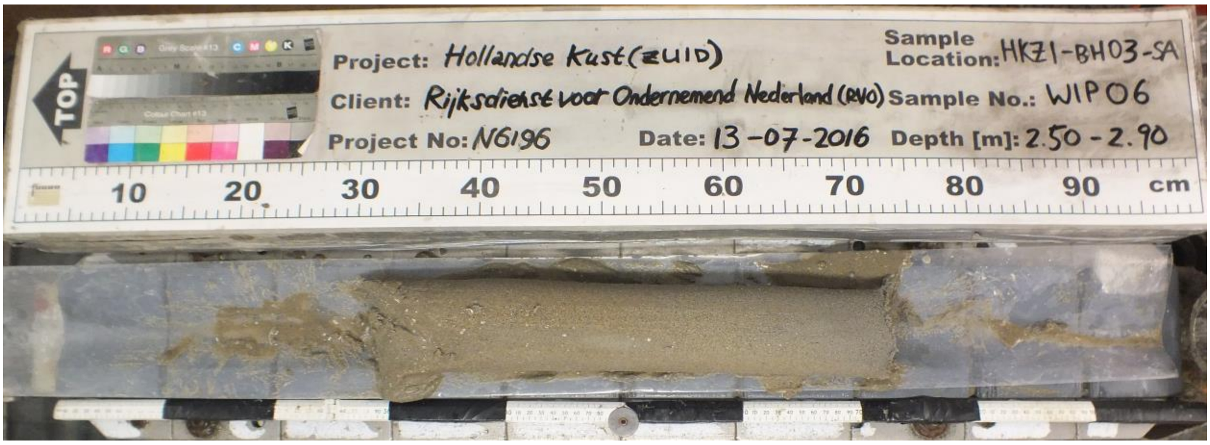
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP05
Depth [m BSF] : 2.00 to 2.35



Location : HKZ1-BH03-SA
Sample : WIP05
Depth [m BSF] : 2.00 to 2.35
Note(s) : split

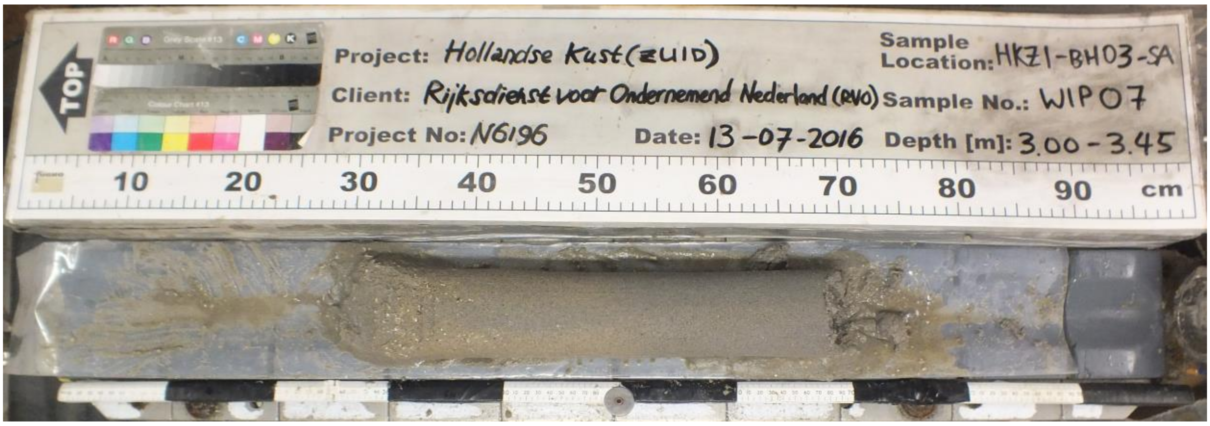
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP06
Depth [m BSF] : 2.50 to 2.90

Location : HKZ1-BH03-SA
Sample : WIP06
Depth [m BSF] : 2.50 to 2.90
Note(s) : split

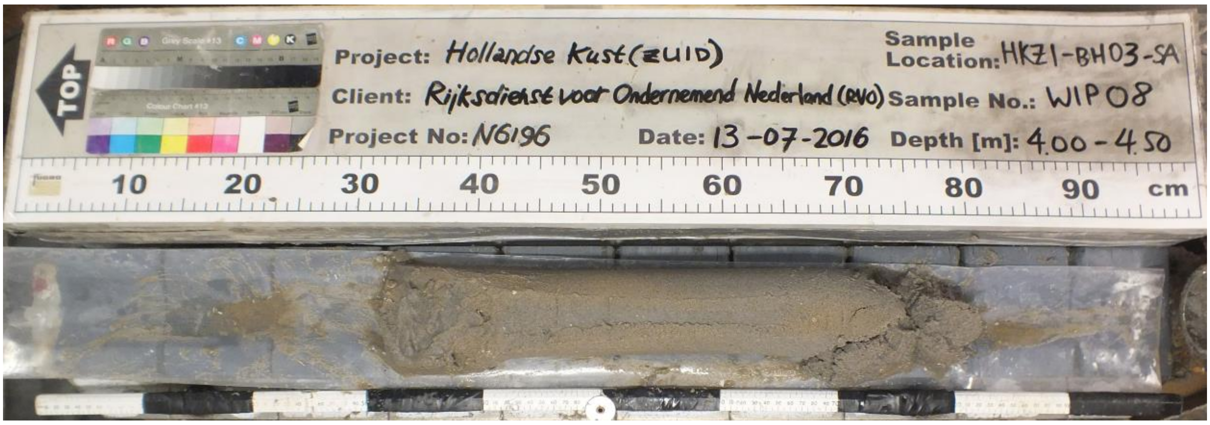
SAMPLE PHOTOGRAPHS



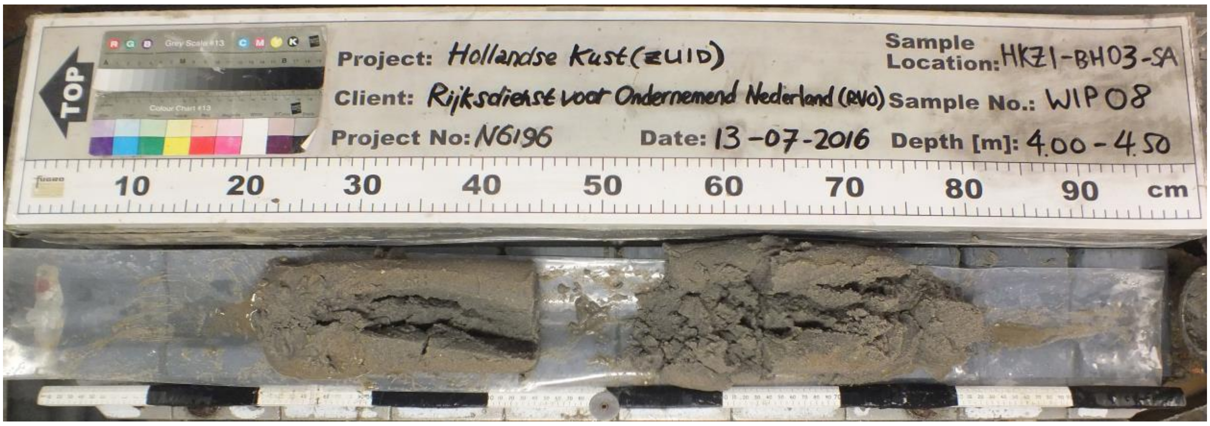
Location : HKZ1-BH03-SA
Sample : WIP07
Depth [m BSF] : 3.00 to 3.45

Location : HKZ1-BH03-SA
Sample : WIP07
Depth [m BSF] : 3.00 to 3.45
Note(s) : split

SAMPLE PHOTOGRAPHS

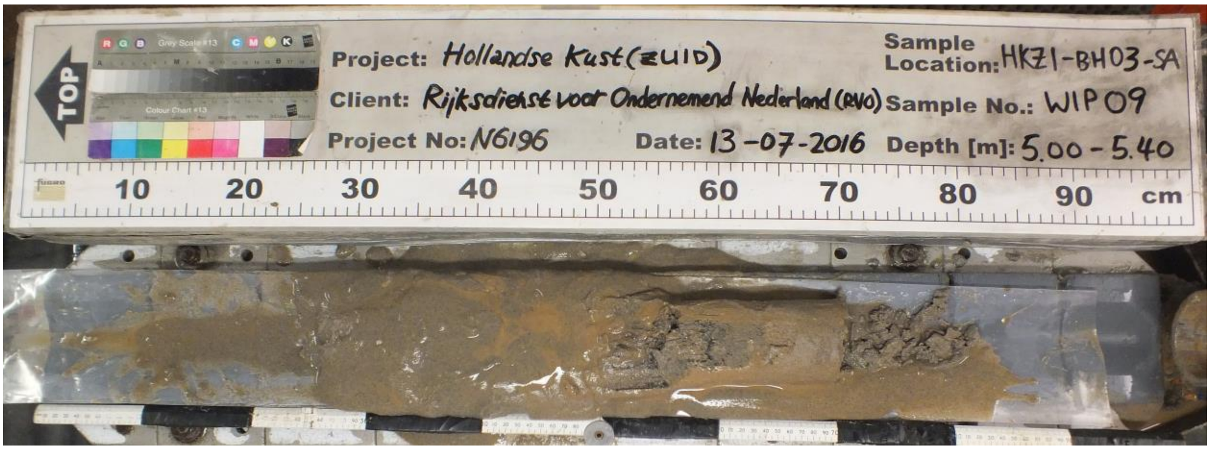


Location : HKZ1-BH03-SA
Sample : WIP08
Depth [m BSF] : 4.00 to 4.50



Location : HKZ1-BH03-SA
Sample : WIP08
Depth [m BSF] : 4.00 to 4.50
Note(s) : split

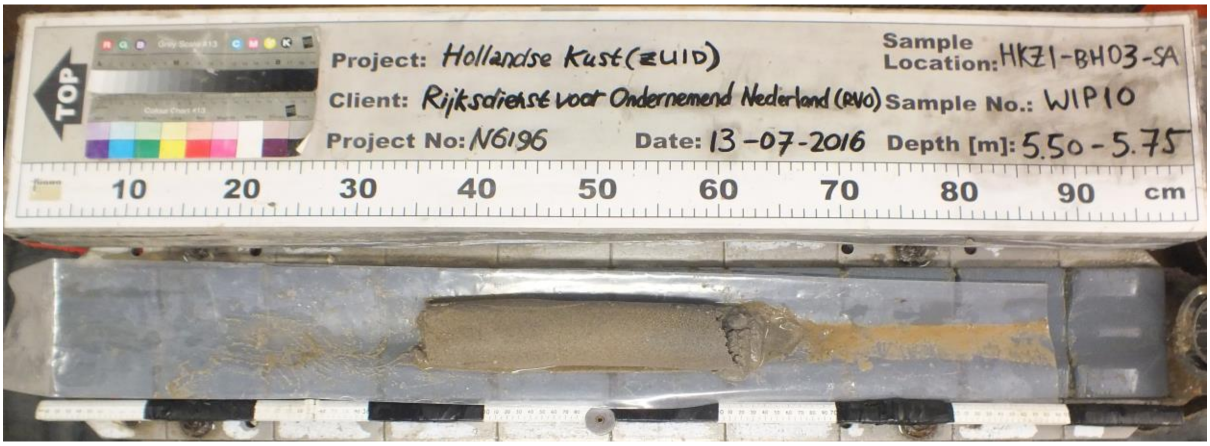
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP09
Depth [m BSF] : 5.00 to 5.40

Location : HKZ1-BH03-SA
Sample : WIP09
Depth [m BSF] : 5.00 to 5.40
Note(s) : split

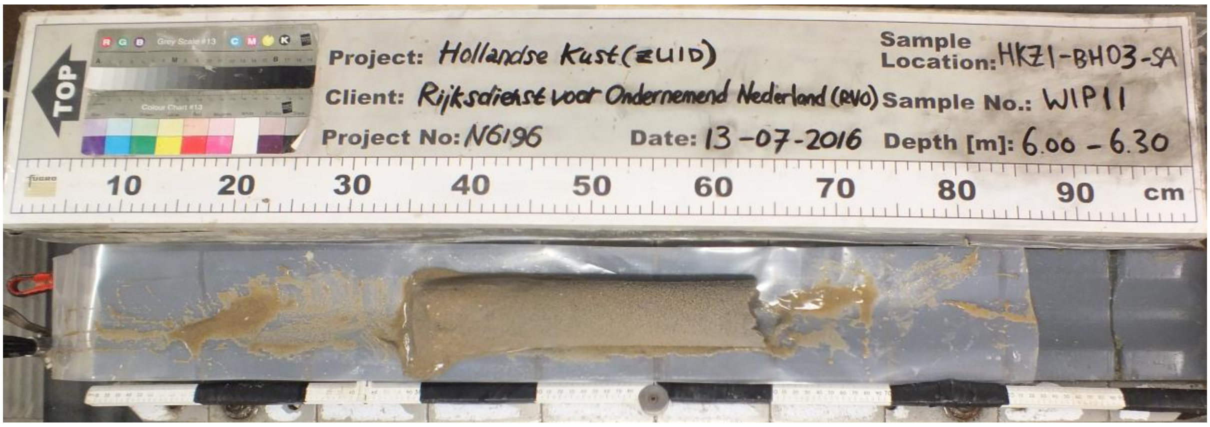
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP10
Depth [m BSF] : 5.50 to 5.75

Location : HKZ1-BH03-SA
Sample : WIP10
Depth [m BSF] : 5.50 to 5.75
Note(s) : split

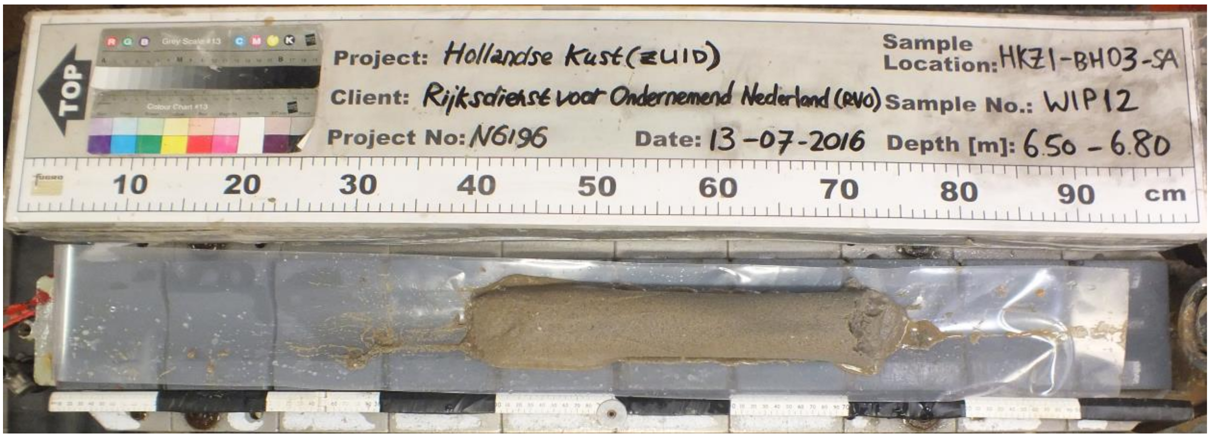
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP11
Depth [m BSF] : 6.00 to 6.30

Location : HKZ1-BH03-SA
Sample : WIP11
Depth [m BSF] : 6.00 to 6.30
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP12
Depth [m BSF] : 6.50 to 6.80

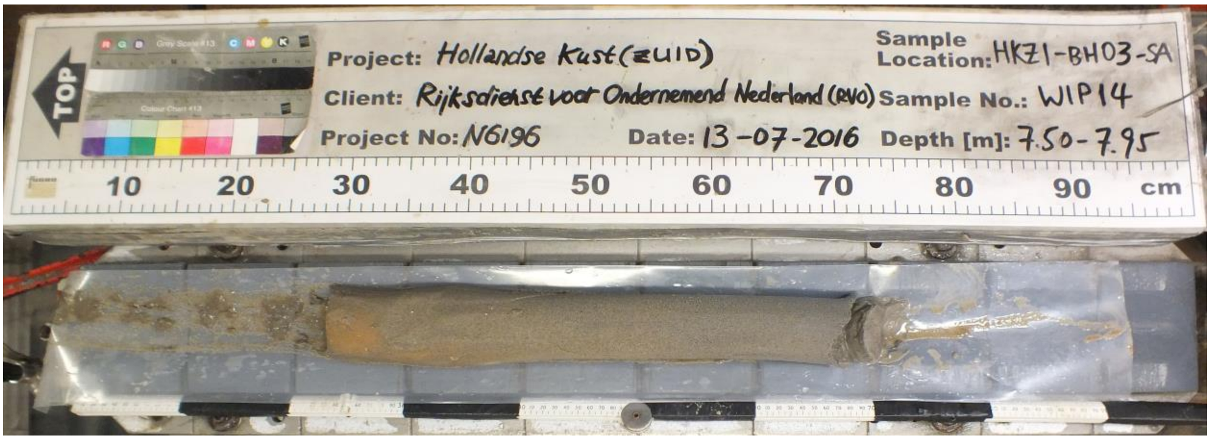
Location : HKZ1-BH03-SA
Sample : WIP12
Depth [m BSF] : 6.50 to 6.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP13
Depth [m BSF] : 7.00 to 7.30

Location : HKZ1-BH03-SA
Sample : WIP13
Depth [m BSF] : 7.00 to 7.30
Note(s) : split

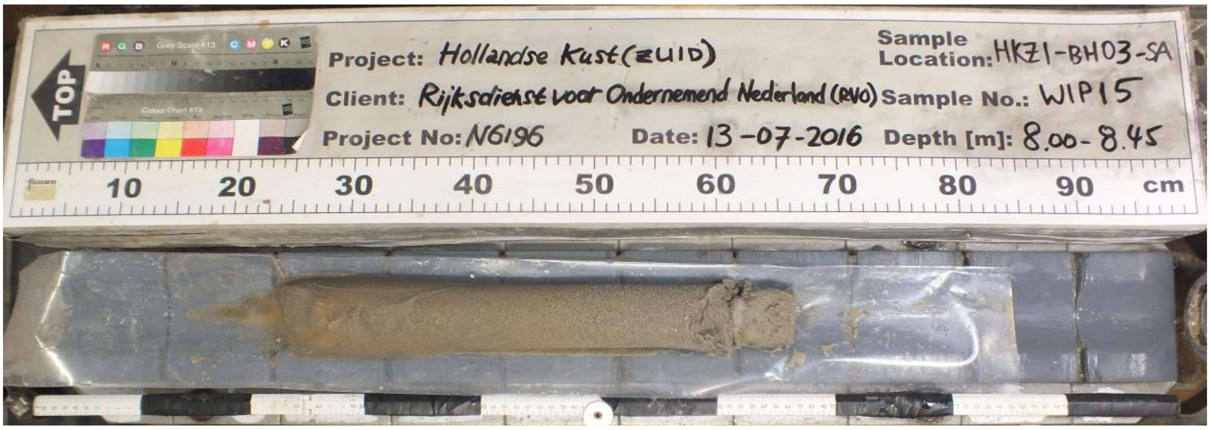
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP14
Depth [m BSF] : 7.50 to 7.95

Location : HKZ1-BH03-SA
Sample : WIP14
Depth [m BSF] : 7.50 to 7.95
Note(s) : split

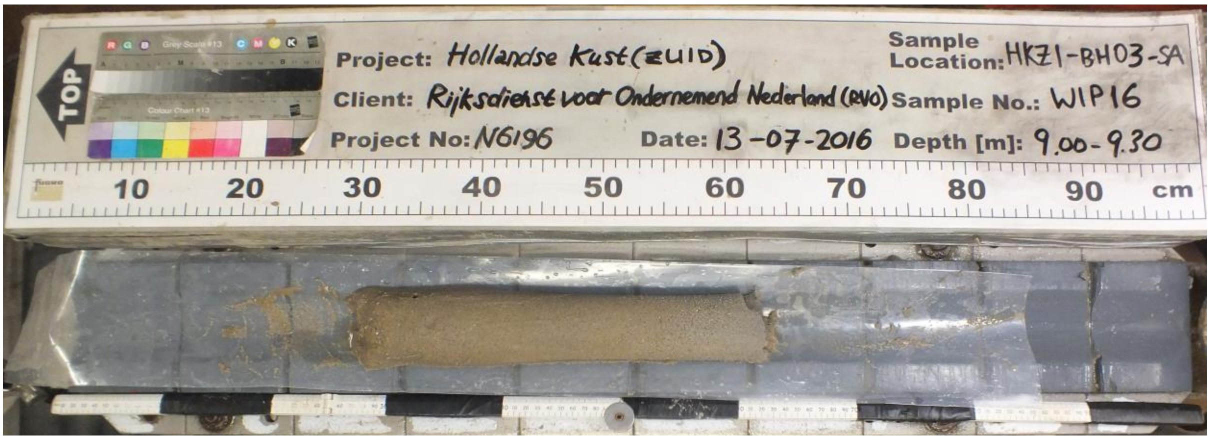
SAMPLE PHOTOGRAPHS



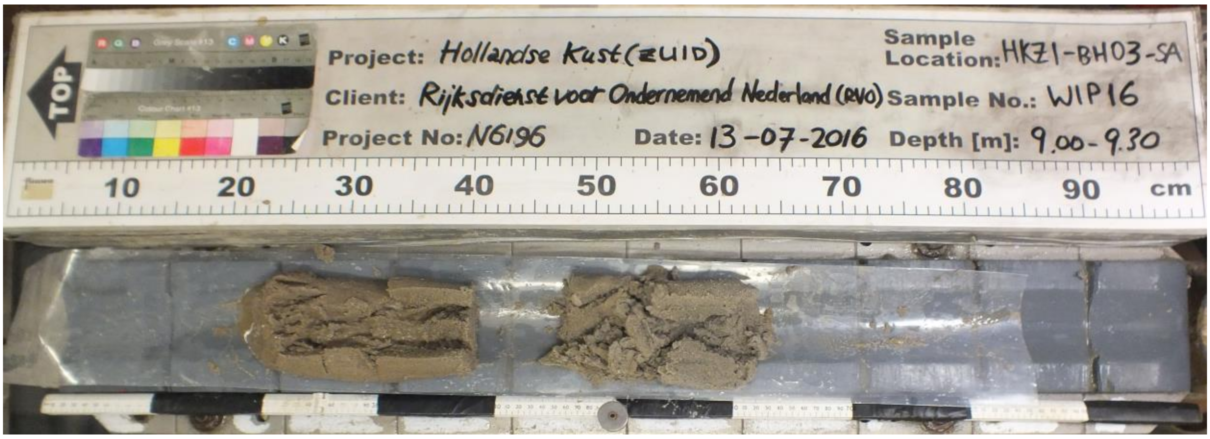
Location : HKZ1-BH03-SA
Sample : WIP15
Depth [m BSF] : 8.00 to 8.45

Location : HKZ1-BH03-SA
Sample : WIP15
Depth [m BSF] : 8.00 to 8.45
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP16
Depth [m BSF] : 9.00 to 9.30



Location : HKZ1-BH03-SA
Sample : WIP16
Depth [m BSF] : 9.00 to 9.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP17
Depth [m BSF] : 9.50 to 9.70

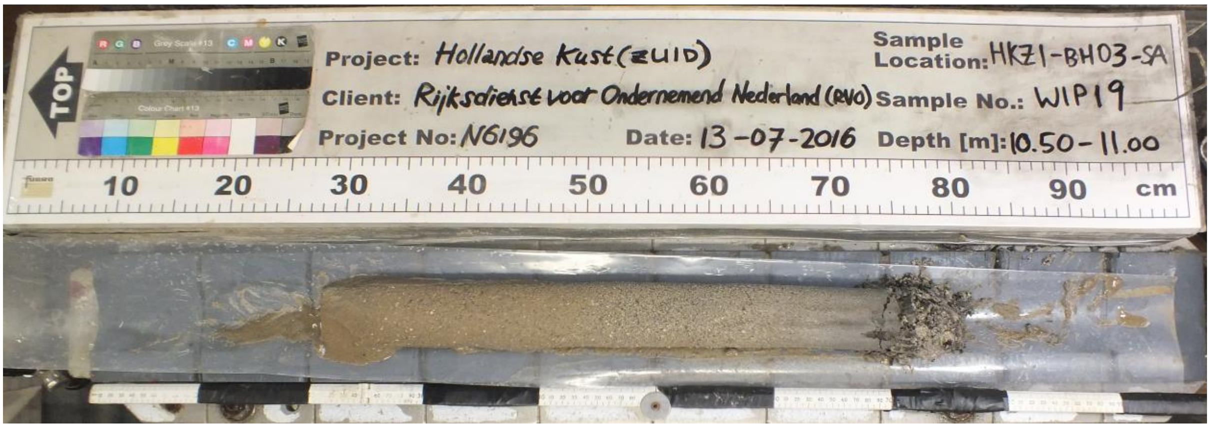
Location : HKZ1-BH03-SA
Sample : WIP17
Depth [m BSF] : 9.50 to 9.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP18
Depth [m BSF] : 10.00 to 10.30

Location : HKZ1-BH03-SA
Sample : WIP18
Depth [m BSF] : 10.00 to 10.30
Note(s) : split

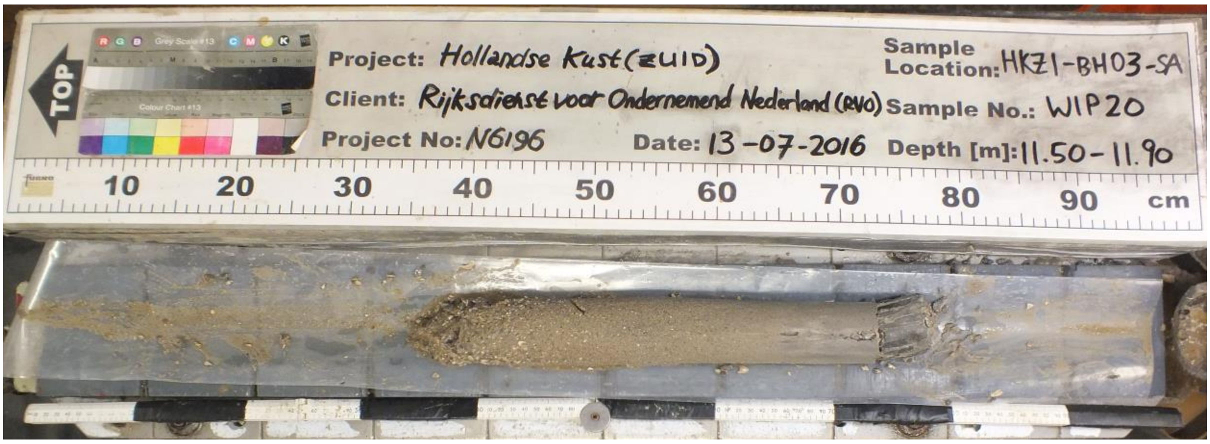
SAMPLE PHOTOGRAPHS



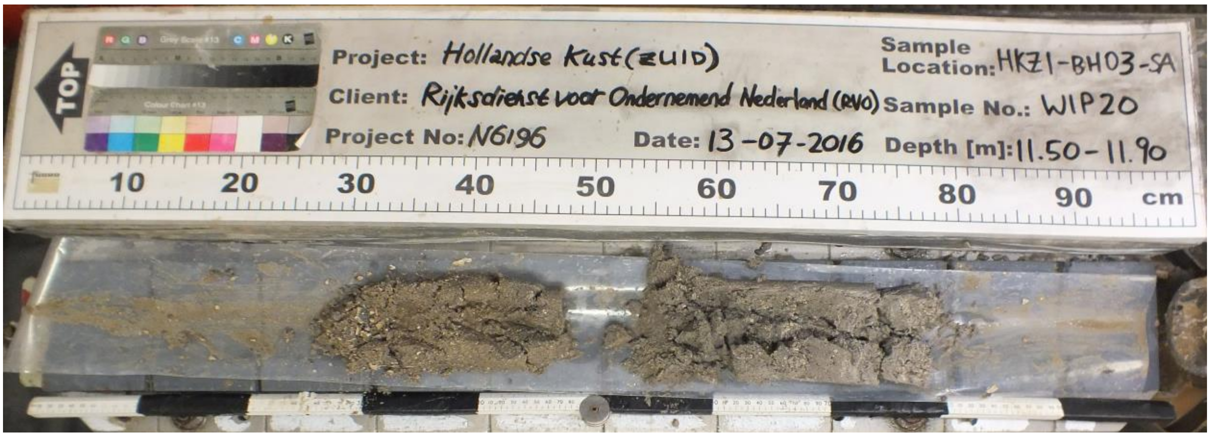
Location : HKZ1-BH03-SA
Sample : WIP19
Depth [m BSF] : 10.50 to 11.00

Location : HKZ1-BH03-SA
Sample : WIP19
Depth [m BSF] : 10.50 to 11.00
Note(s) : split

SAMPLE PHOTOGRAPHS

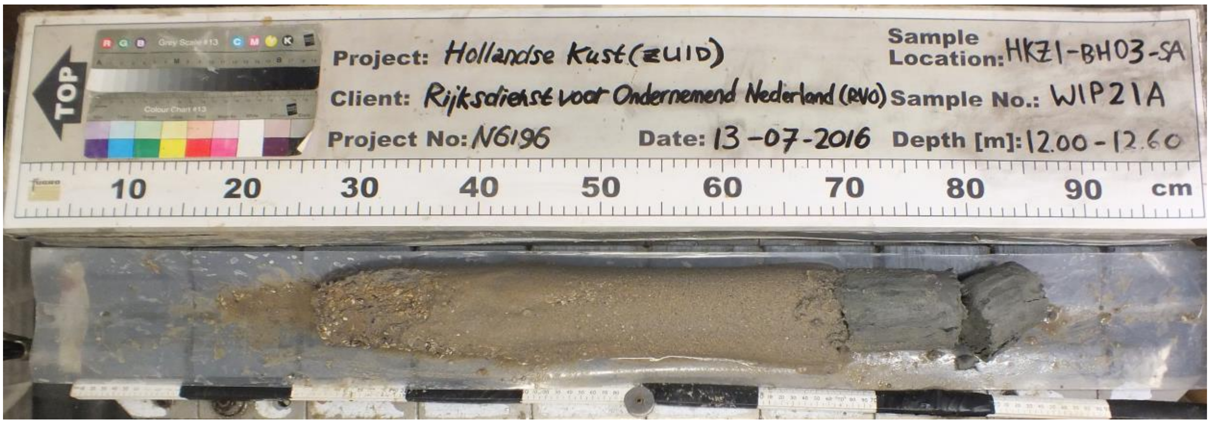


Location : HKZ1-BH03-SA
Sample : WIP20
Depth [m BSF] : 11.50 to 11.90



Location : HKZ1-BH03-SA
Sample : WIP20
Depth [m BSF] : 11.50 to 11.90
Note(s) : split

SAMPLE PHOTOGRAPHS

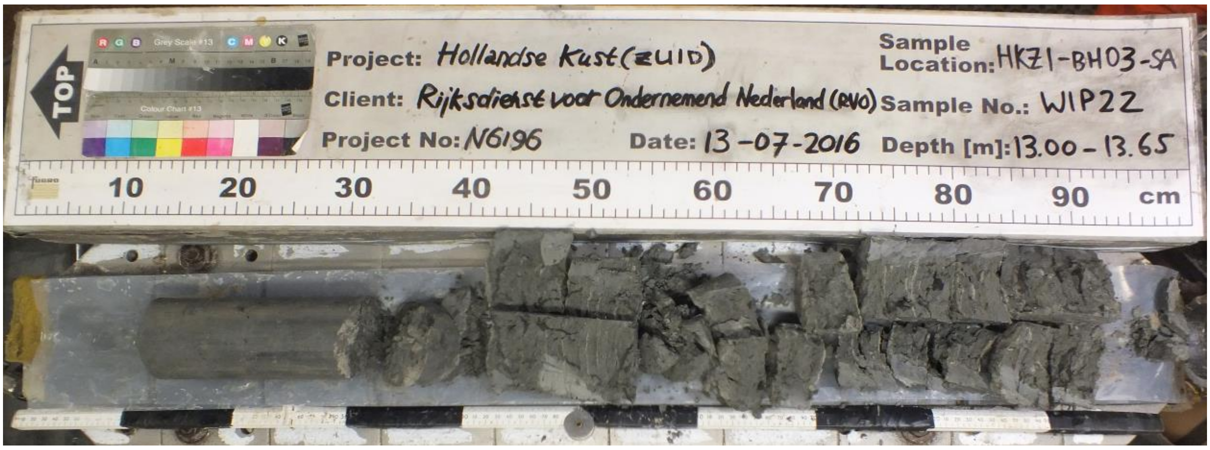


Location : HKZ1-BH03-SA
Sample : WIP21A
Depth [m BSF] : 12.00 to 12.60

Location : HKZ1-BH03-SA
Sample : WIP21A
Depth [m BSF] : 12.00 to 12.60
Note(s) : split

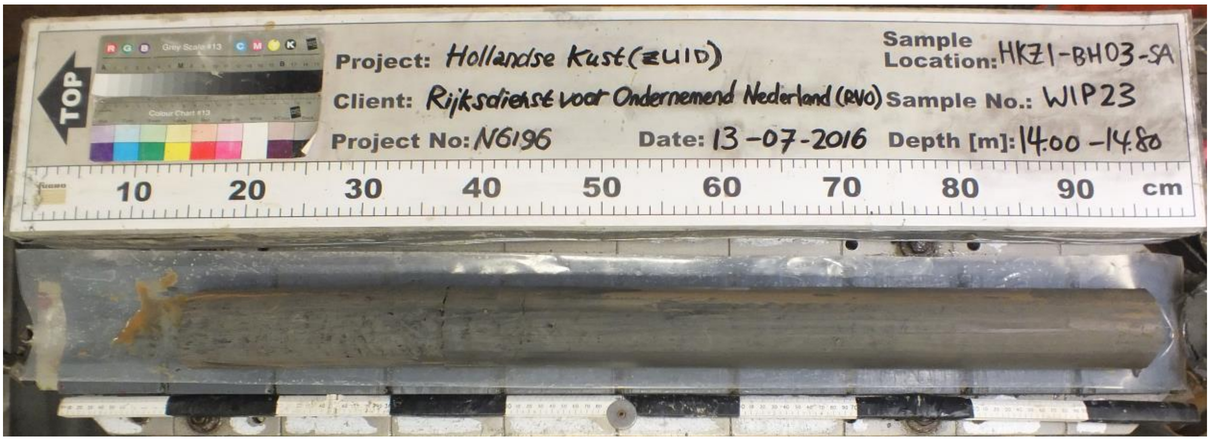
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP22
Depth [m BSF] : 13.00 to 13.65



Location : HKZ1-BH03-SA
Sample : WIP22
Depth [m BSF] : 13.00 to 13.65
Note(s) : split

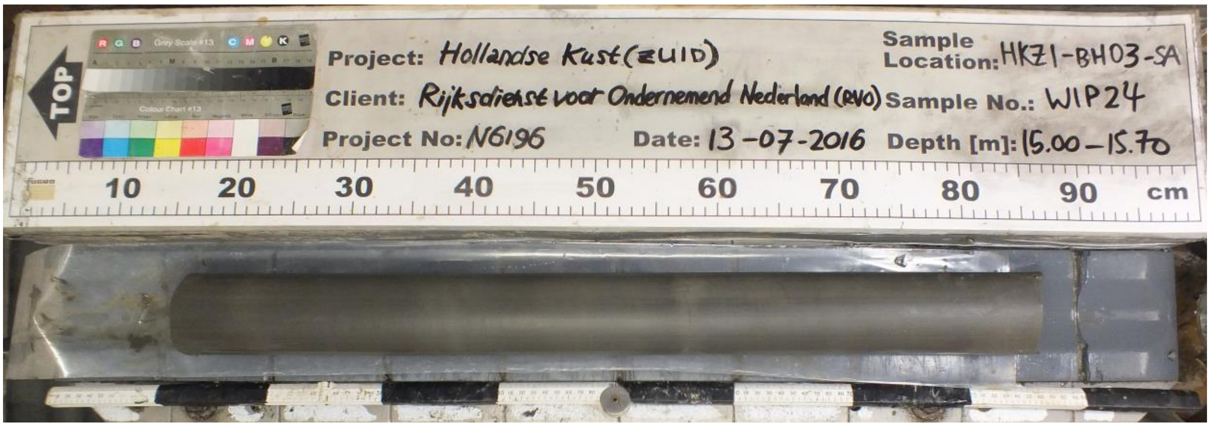
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP23
Depth [m BSF] : 14.00 to 14.80

Location : HKZ1-BH03-SA
Sample : WIP23
Depth [m BSF] : 14.00 to 14.80
Note(s) : split

SAMPLE PHOTOGRAPHS

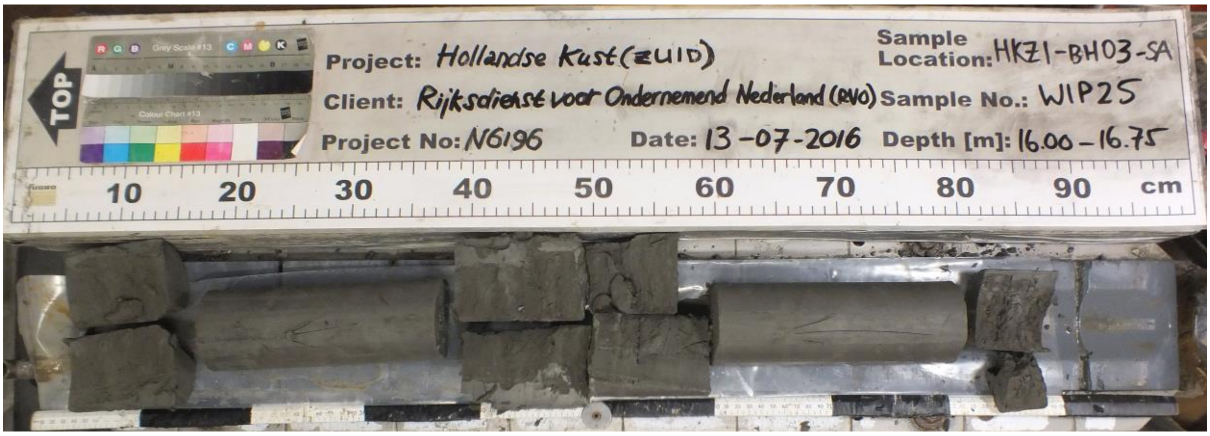


Location : HKZ1-BH03-SA
Sample : WIP24
Depth [m BSF] : 15.00 to 15.70

Location : HKZ1-BH03-SA
Sample : WIP24
Depth [m BSF] : 15.00 to 15.70
Note(s) : split

SAMPLE PHOTOGRAPHS

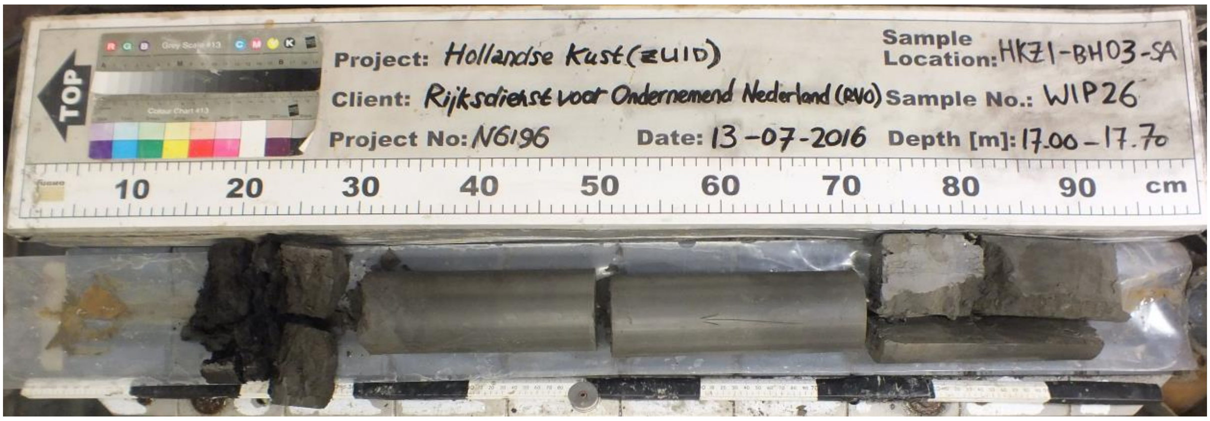
Location : HKZ1-BH03-SA
Sample : WIP25
Depth [m BSF] : 16.00 to 16.75



Location : HKZ1-BH03-SA
Sample : WIP25
Depth [m BSF] : 16.00 to 16.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP26
Depth [m BSF] : 17.00 to 17.70



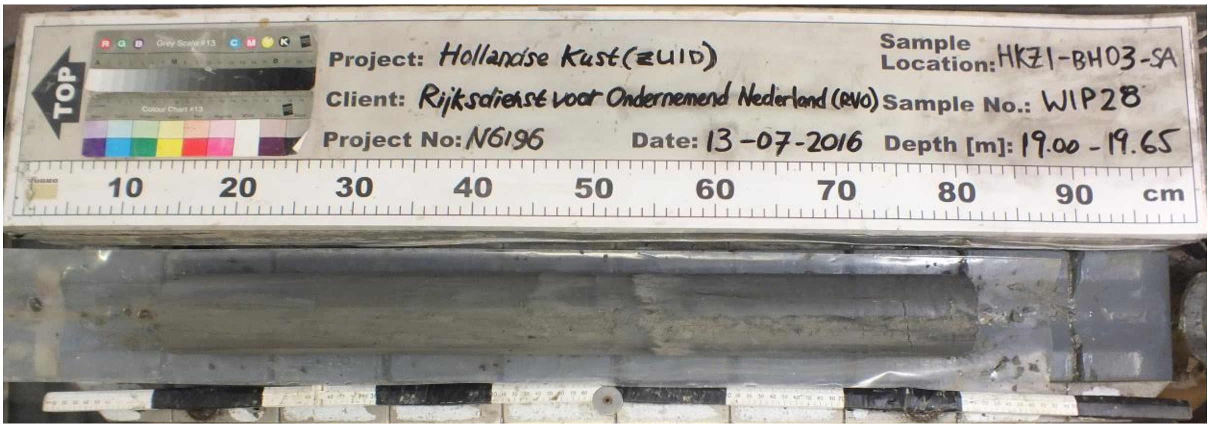
Location : HKZ1-BH03-SA
Sample : WIP26
Depth [m BSF] : 17.00 to 17.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP27
Depth [m BSF] : 18.00 to 18.70

Location : HKZ1-BH03-SA
Sample : WIP27
Depth [m BSF] : 18.00 to 18.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP28
Depth [m BSF] : 19.00 to 19.65

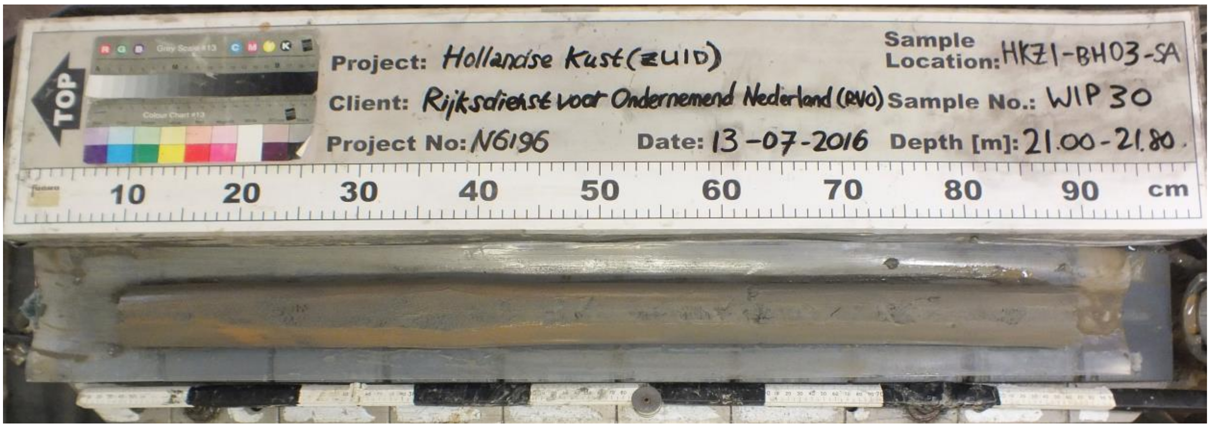
Location : HKZ1-BH03-SA
Sample : WIP28
Depth [m BSF] : 19.00 to 19.65
Note(s) : split

SAMPLE PHOTOGRAPHS

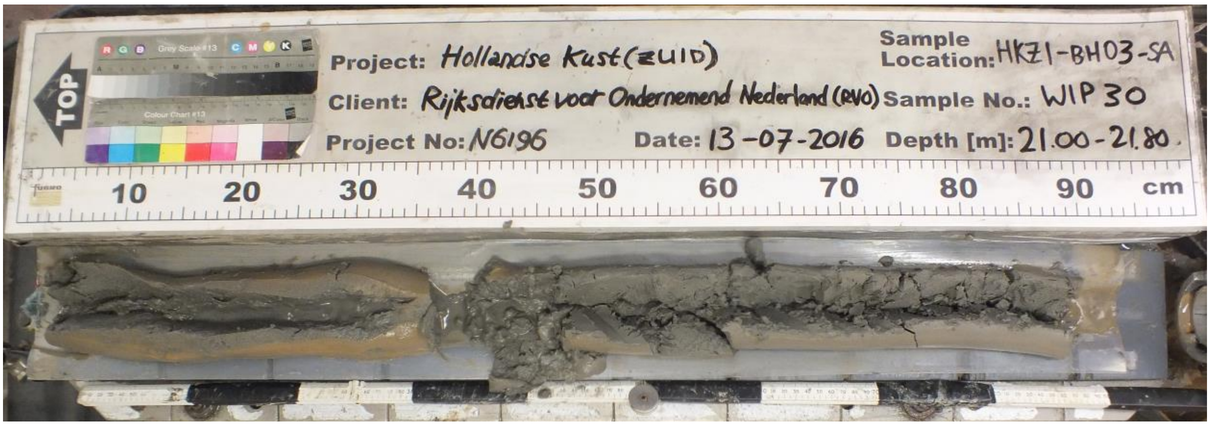
Location : HKZ1-BH03-SA
Sample : WIP29
Depth [m BSF] : 20.00 to 20.75

Location : HKZ1-BH03-SA
Sample : WIP29
Depth [m BSF] : 20.00 to 20.75
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP30
Depth [m BSF] : 21.00 to 21.80



Location : HKZ1-BH03-SA
Sample : WIP30
Depth [m BSF] : 21.00 to 21.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP31
Depth [m BSF] : 22.00 to 22.80

Location : HKZ1-BH03-SA
Sample : WIP31
Depth [m BSF] : 22.00 to 22.80
Note(s) : split

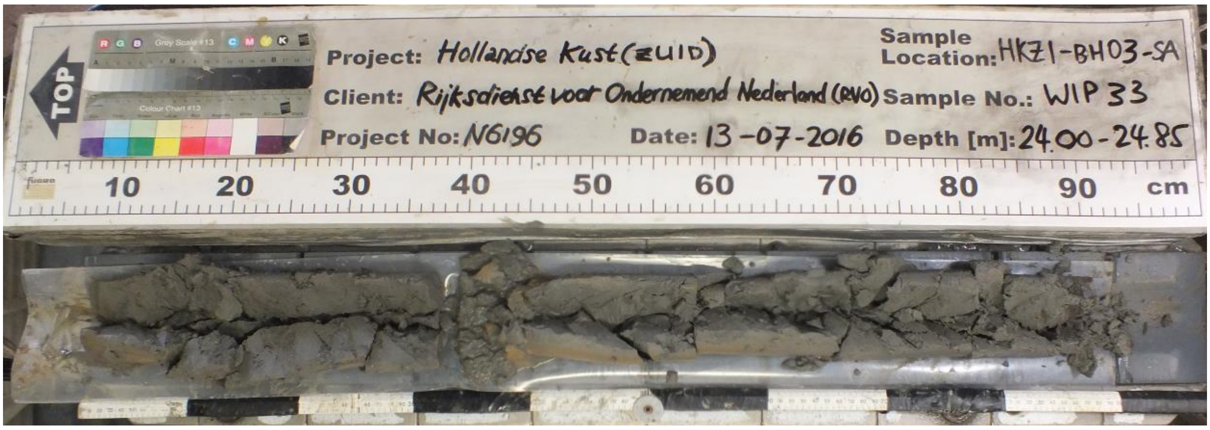
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP32
Depth [m BSF] : 23.00 to 23.75

Location : HKZ1-BH03-SA
Sample : WIP32
Depth [m BSF] : 23.00 to 23.75
Note(s) : split

SAMPLE PHOTOGRAPHS

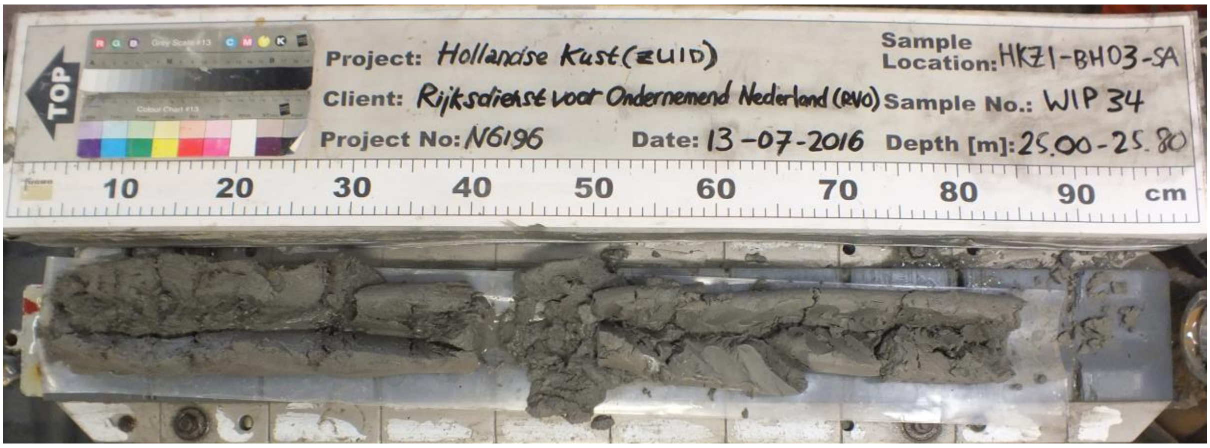
Location : HKZ1-BH03-SA
Sample : WIP33
Depth [m BSF] : 24.00 to 24.85



Location : HKZ1-BH03-SA
Sample : WIP33
Depth [m BSF] : 24.00 to 24.85
Note(s) : split

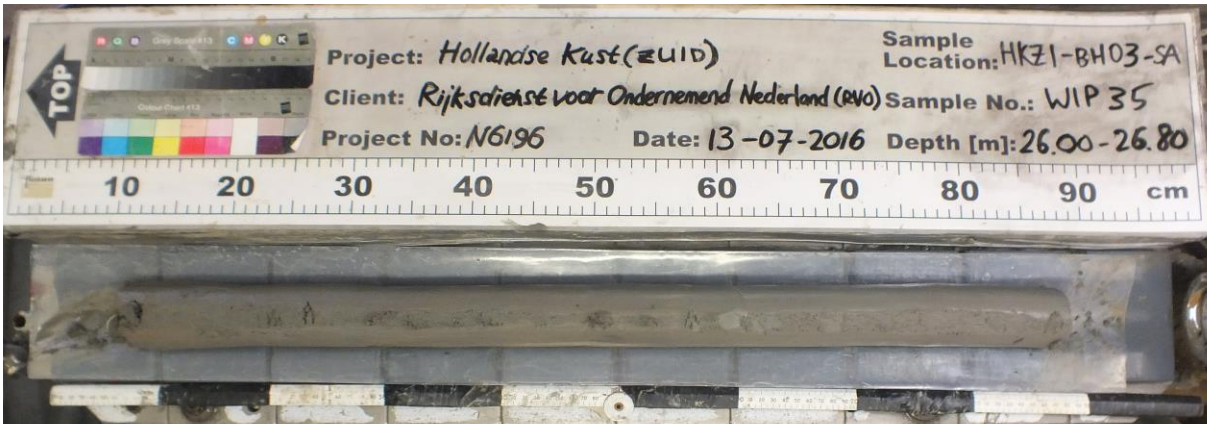
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP34
Depth [m BSF] : 25.00 to 25.80

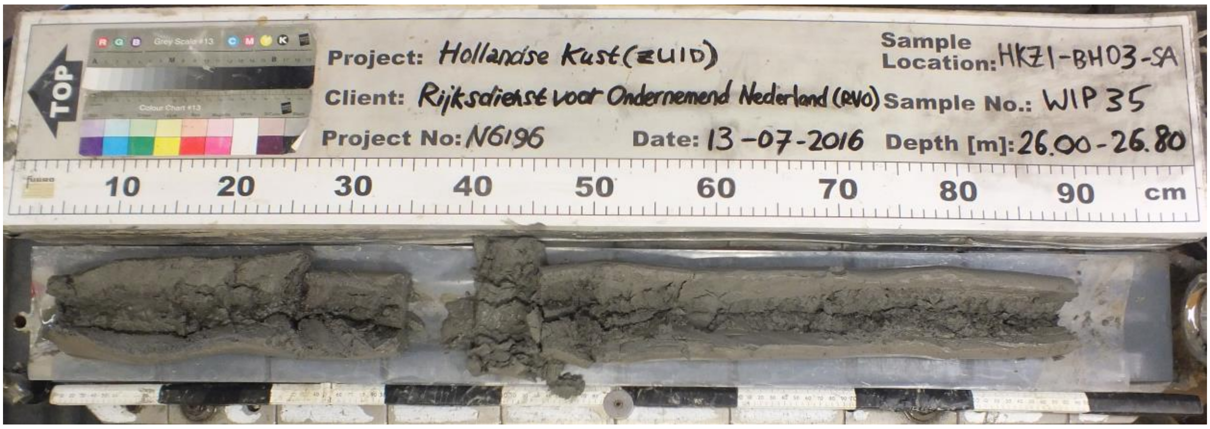


Location : HKZ1-BH03-SA
Sample : WIP34
Depth [m BSF] : 25.00 to 25.80
Note(s) : split

SAMPLE PHOTOGRAPHS



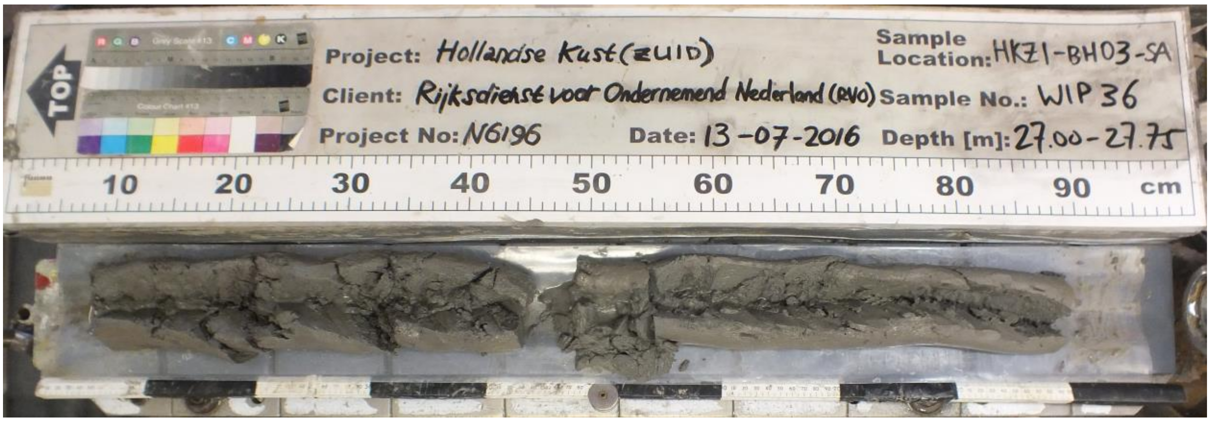
Location : HKZ1-BH03-SA
Sample : WIP35
Depth [m BSF] : 26.00 to 26.80



Location : HKZ1-BH03-SA
Sample : WIP35
Depth [m BSF] : 26.00 to 26.80
Note(s) : split

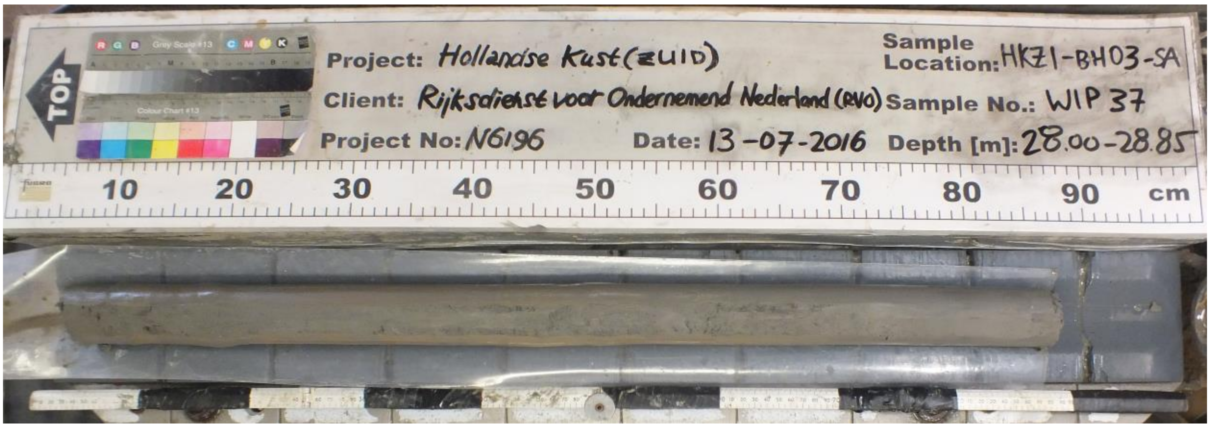
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP36
Depth [m BSF] : 27.00 to 27.75

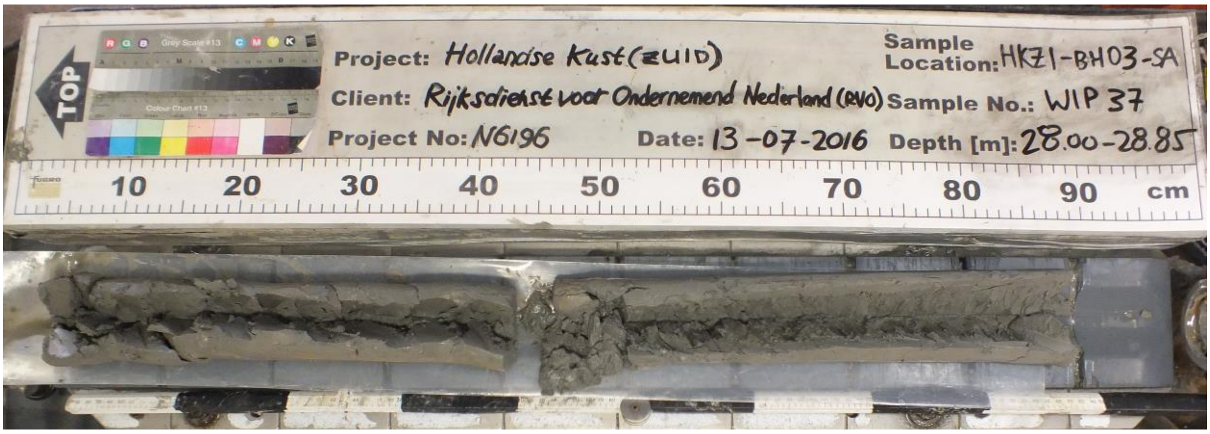


Location : HKZ1-BH03-SA
Sample : WIP36
Depth [m BSF] : 27.00 to 27.75
Note(s) : split

SAMPLE PHOTOGRAPHS



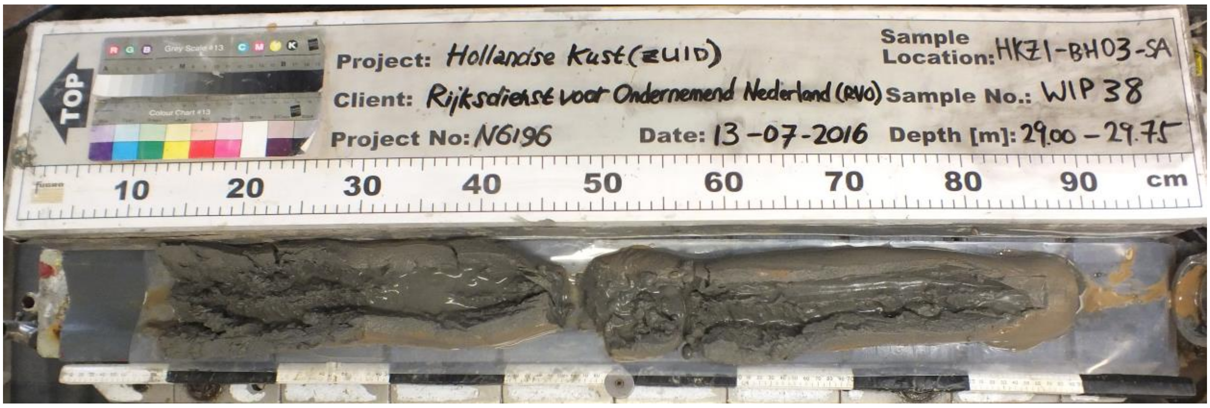
Location : HKZ1-BH03-SA
Sample : WIP37
Depth [m BSF] : 28.00 to 28.85



Location : HKZ1-BH03-SA
Sample : WIP37
Depth [m BSF] : 28.00 to 28.85
Note(s) : split

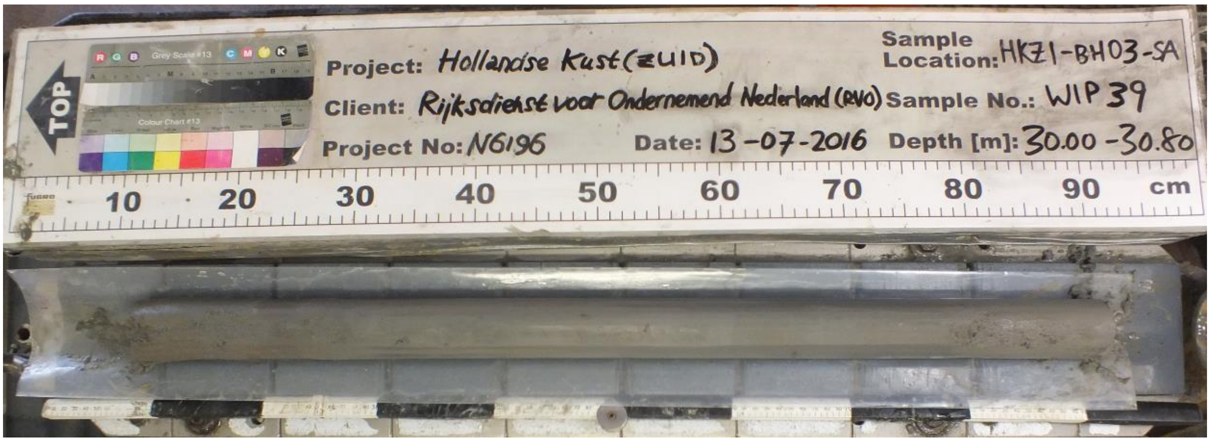
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP38
Depth [m BSF] : 29.00 to 29.75

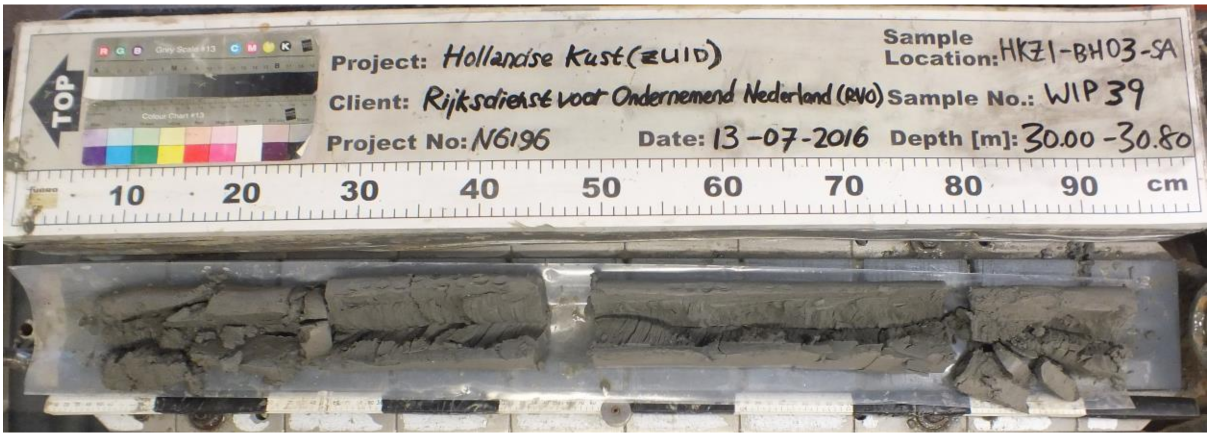


Location : HKZ1-BH03-SA
Sample : WIP38
Depth [m BSF] : 29.00 to 29.75
Note(s) : split

SAMPLE PHOTOGRAPHS

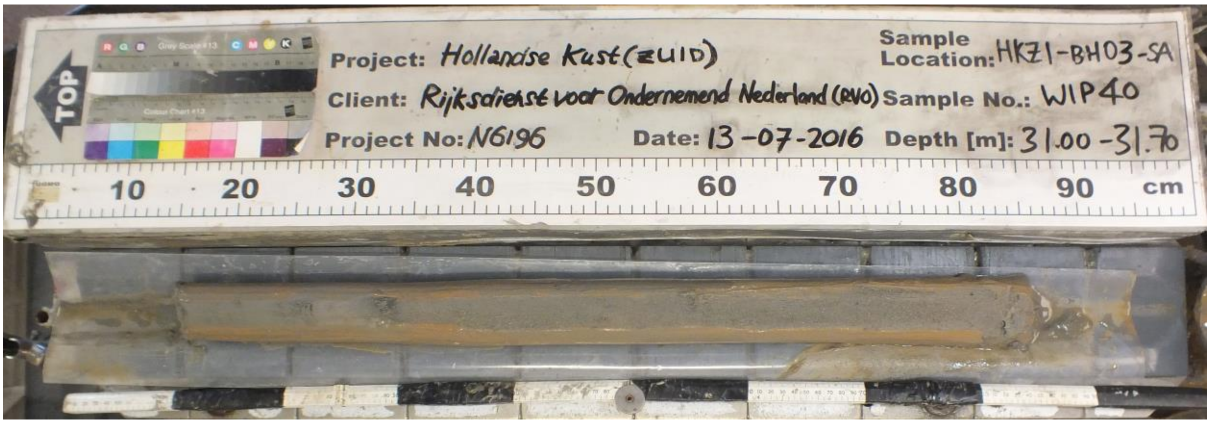


Location : HKZ1-BH03-SA
Sample : WIP39
Depth [m BSF] : 30.00 to 30.80

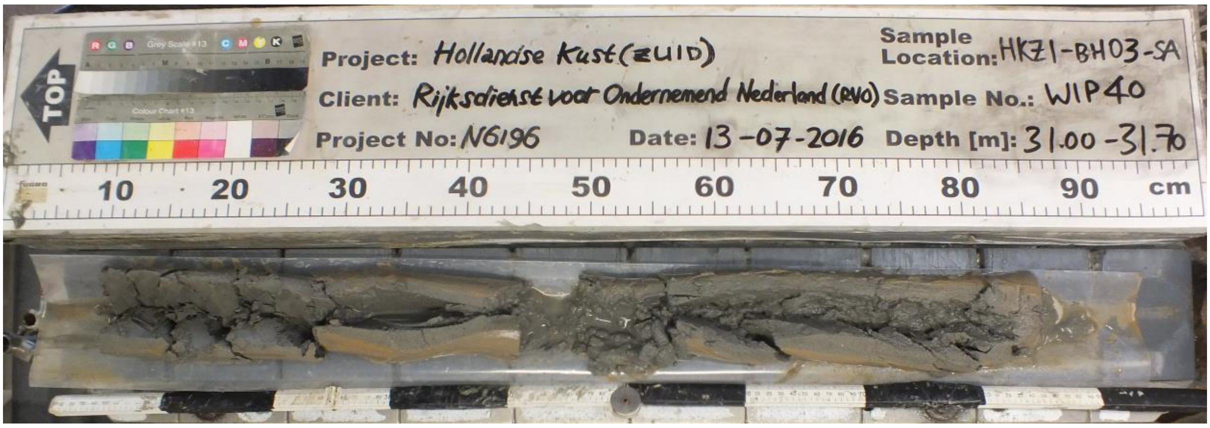


Location : HKZ1-BH03-SA
Sample : WIP39
Depth [m BSF] : 30.00 to 30.80
Note(s) : split

SAMPLE PHOTOGRAPHS

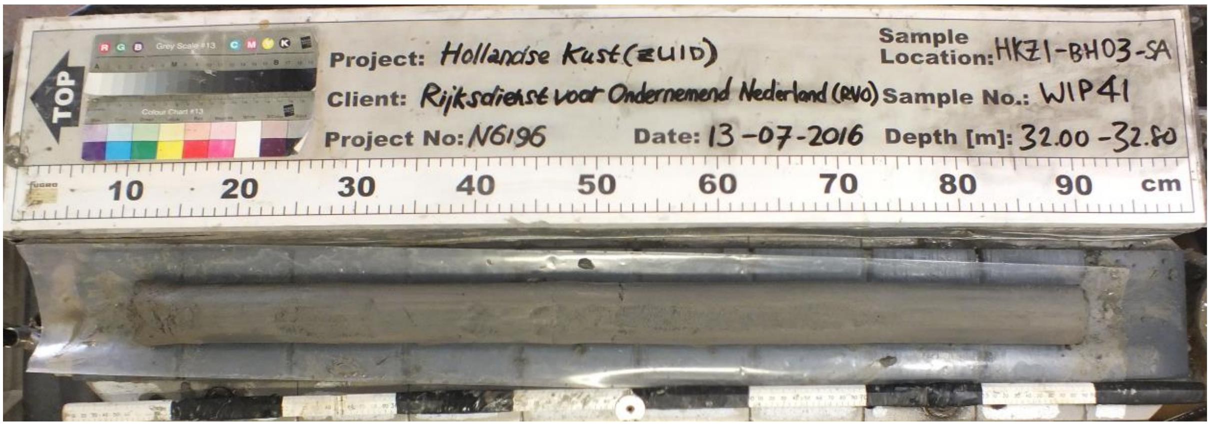


Location : HKZ1-BH03-SA
Sample : WIP40
Depth [m BSF] : 31.00 to 31.70



Location : HKZ1-BH03-SA
Sample : WIP40
Depth [m BSF] : 31.00 to 31.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP41
Depth [m BSF] : 32.00 to 32.80

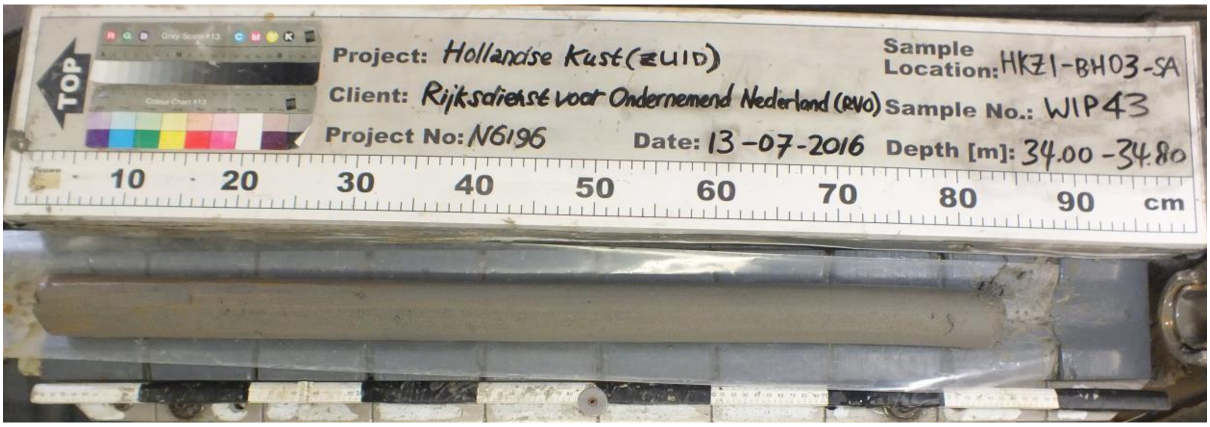
Location : HKZ1-BH03-SA
Sample : WIP41
Depth [m BSF] : 32.00 to 32.80
Note(s) : split

SAMPLE PHOTOGRAPHS

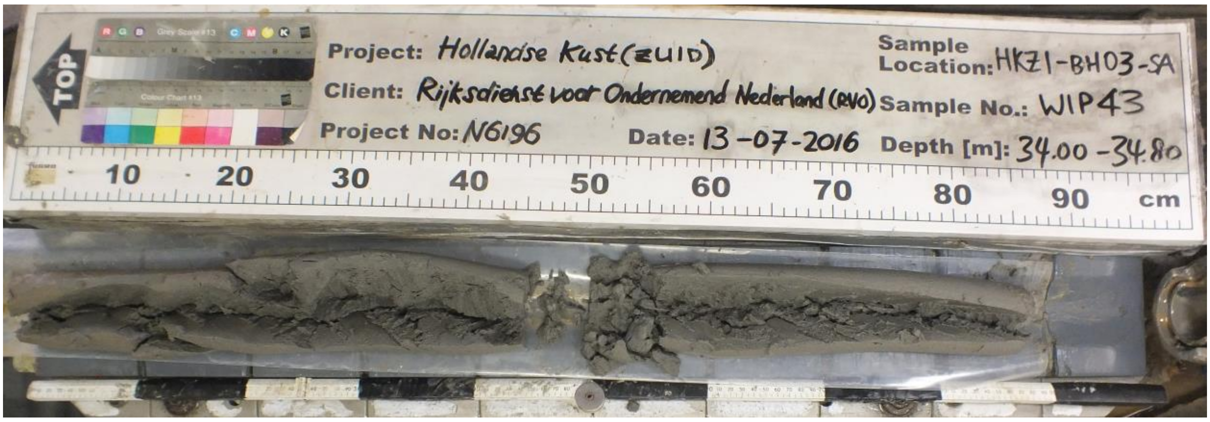
Location : HKZ1-BH03-SA
Sample : WIP42
Depth [m BSF] : 33.00 to 33.75

Location : HKZ1-BH03-SA
Sample : WIP42
Depth [m BSF] : 33.00 to 33.75
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP43
Depth [m BSF] : 34.00 to 34.80



Location : HKZ1-BH03-SA
Sample : WIP43
Depth [m BSF] : 34.00 to 34.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP44
Depth [m BSF] : 35.00 to 35.70

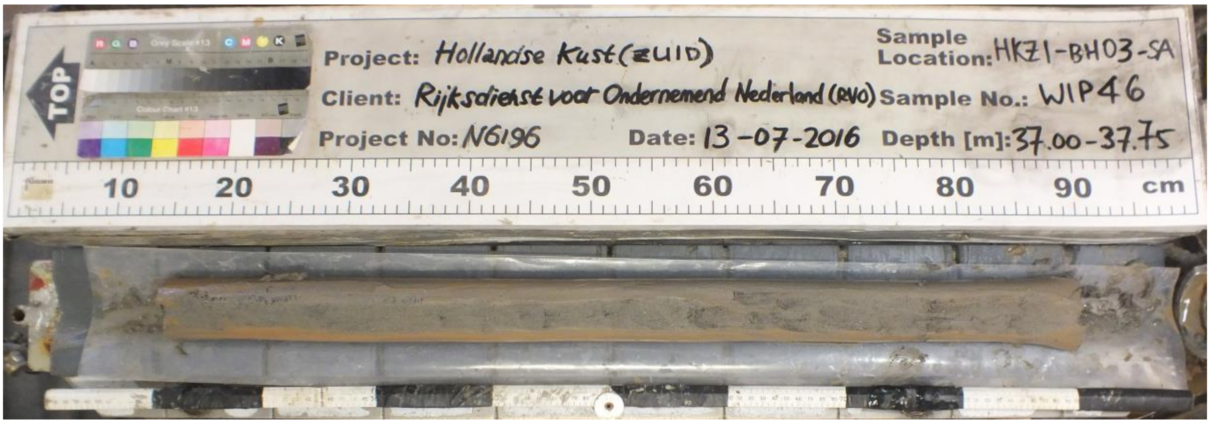
Location : HKZ1-BH03-SA
Sample : WIP44
Depth [m BSF] : 35.00 to 35.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP45
Depth [m BSF] : 36.00 to 36.75

Location : HKZ1-BH03-SA
Sample : WIP45
Depth [m BSF] : 36.00 to 36.75
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP46
Depth [m BSF] : 37.00 to 37.75

Location : HKZ1-BH03-SA
Sample : WIP46
Depth [m BSF] : 37.00 to 37.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP47
Depth [m BSF] : 38.00 to 38.75

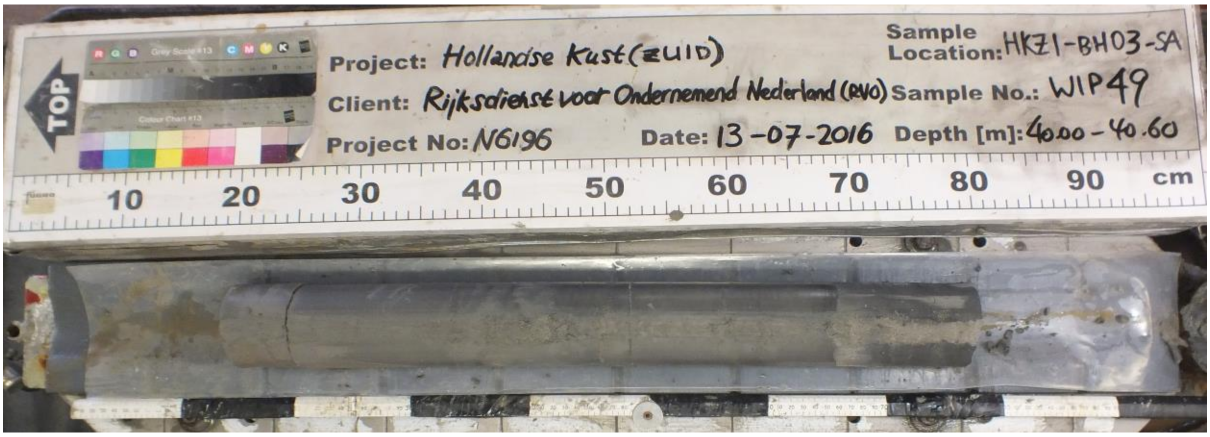
Location : HKZ1-BH03-SA
Sample : WIP47
Depth [m BSF] : 38.00 to 38.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP48
Depth [m BSF] : 39.00 to 39.75

Location : HKZ1-BH03-SA
Sample : WIP48
Depth [m BSF] : 39.00 to 39.75
Note(s) : split

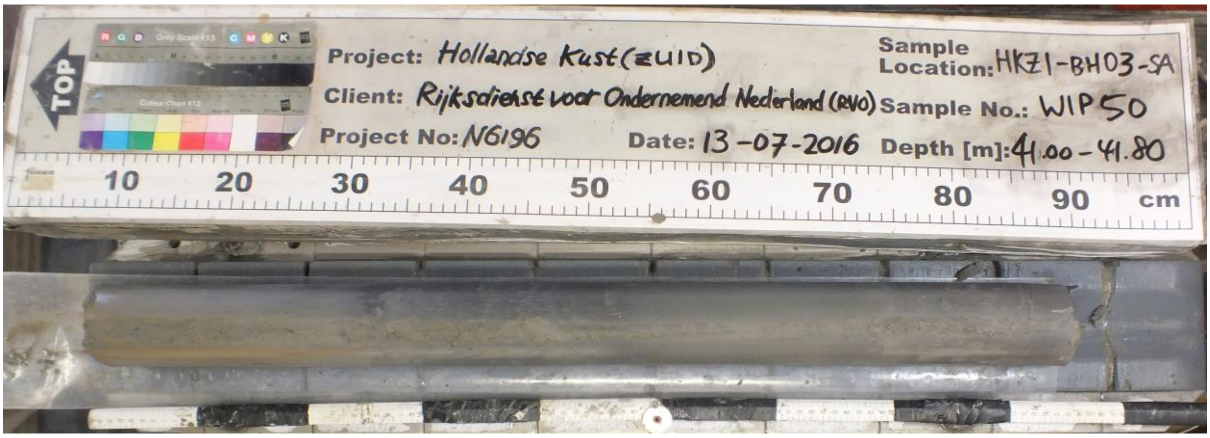
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP49
Depth [m BSF] : 40.00 to 40.60

Location : HKZ1-BH03-SA
Sample : WIP49
Depth [m BSF] : 40.00 to 40.60
Note(s) : split

SAMPLE PHOTOGRAPHS

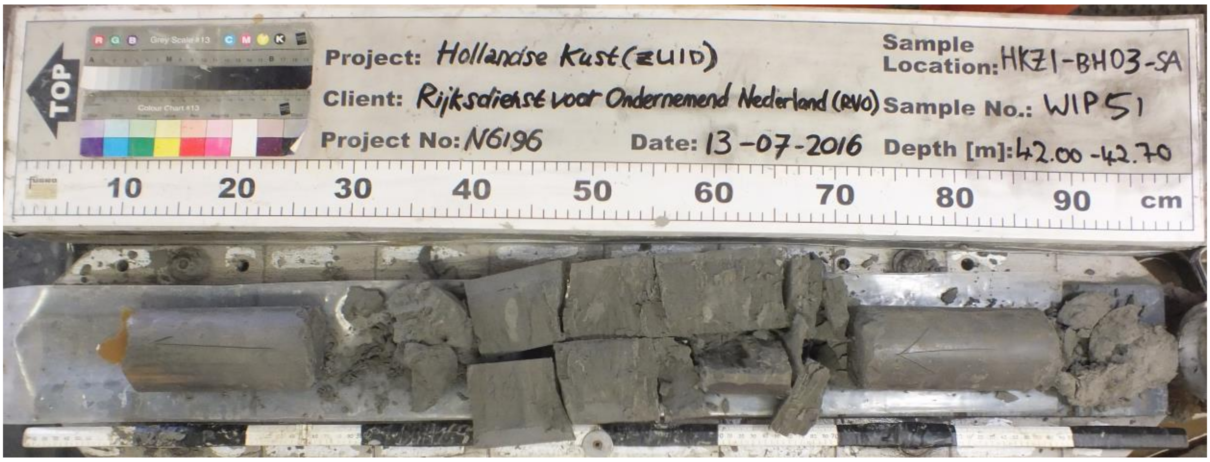


Location : HKZ1-BH03-SA
Sample : WIP50
Depth [m BSF] : 41.00 to 41.80

Location : HKZ1-BH03-SA
Sample : WIP50
Depth [m BSF] : 41.00 to 41.80
Note(s) : split

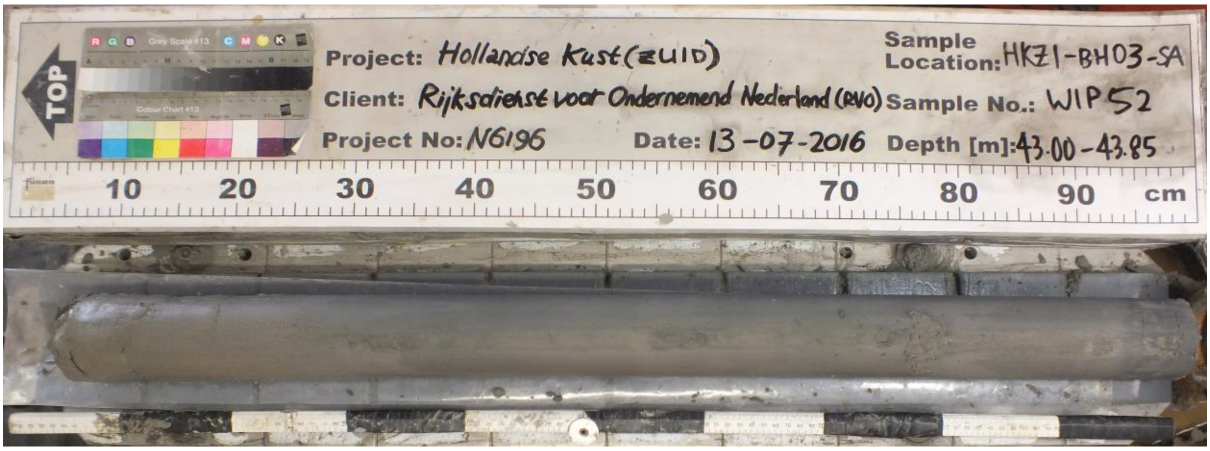
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP51
Depth [m BSF] : 42.00 to 42.70



Location : HKZ1-BH03-SA
Sample : WIP51
Depth [m BSF] : 42.00 to 42.70
Note(s) : split

SAMPLE PHOTOGRAPHS

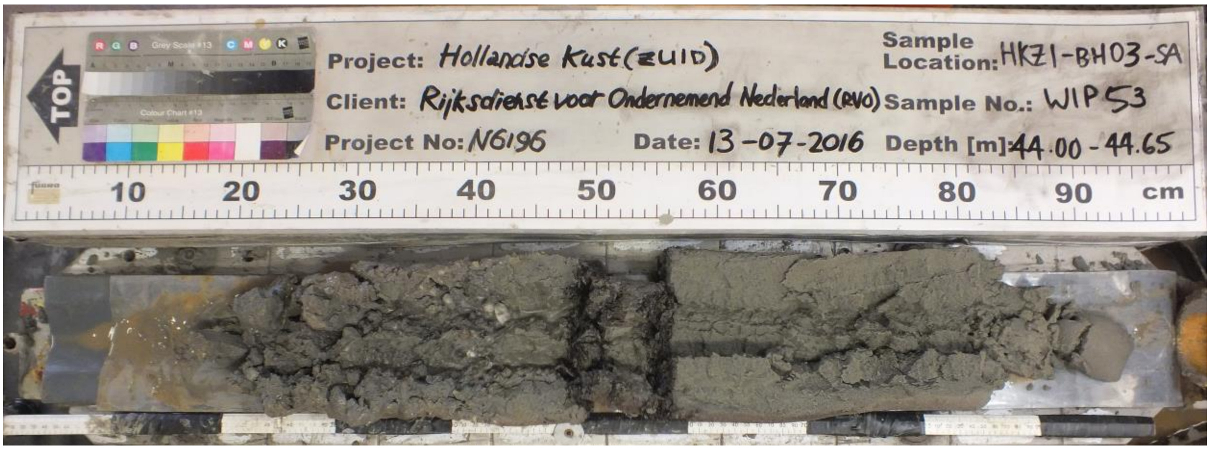


Location : HKZ1-BH03-SA
Sample : WIP52
Depth [m BSF] : 43.00 to 43.85

Location : HKZ1-BH03-SA
Sample : WIP52
Depth [m BSF] : 43.00 to 43.85
Note(s) : split

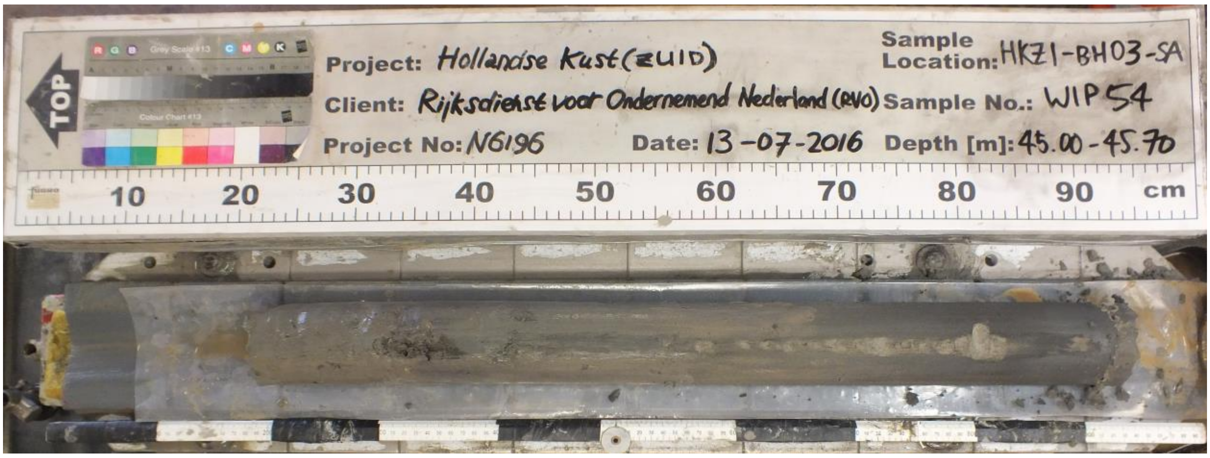
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP53
Depth [m BSF] : 44.00 to 44.65



Location : HKZ1-BH03-SA
Sample : WIP53
Depth [m BSF] : 44.00 to 44.65
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP54
Depth [m BSF] : 45.00 to 45.70

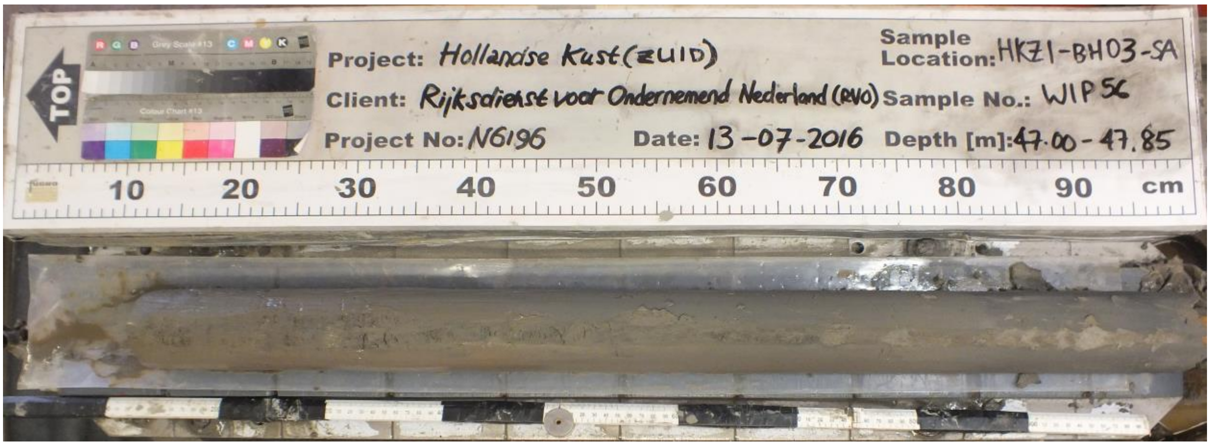
Location : HKZ1-BH03-SA
Sample : WIP54
Depth [m BSF] : 45.00 to 45.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP55
Depth [m BSF] : 46.00 to 46.85

Location : HKZ1-BH03-SA
Sample : WIP55
Depth [m BSF] : 46.00 to 46.85
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SA
Sample : WIP56
Depth [m BSF] : 47.00 to 47.85

Location : HKZ1-BH03-SA
Sample : WIP56
Depth [m BSF] : 47.00 to 47.85
Note(s) : split

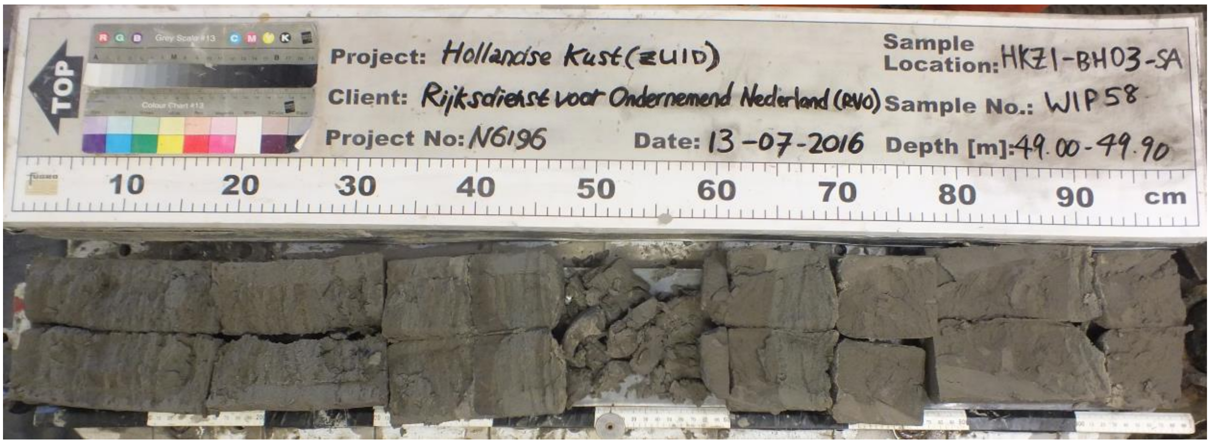
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP57
Depth [m BSF] : 48.00 to 48.90

Location : HKZ1-BH03-SA
Sample : WIP57
Depth [m BSF] : 48.00 to 48.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP58
Depth [m BSF] : 49.00 to 49.90



Location : HKZ1-BH03-SA
Sample : WIP58
Depth [m BSF] : 49.00 to 49.90
Note(s) : split

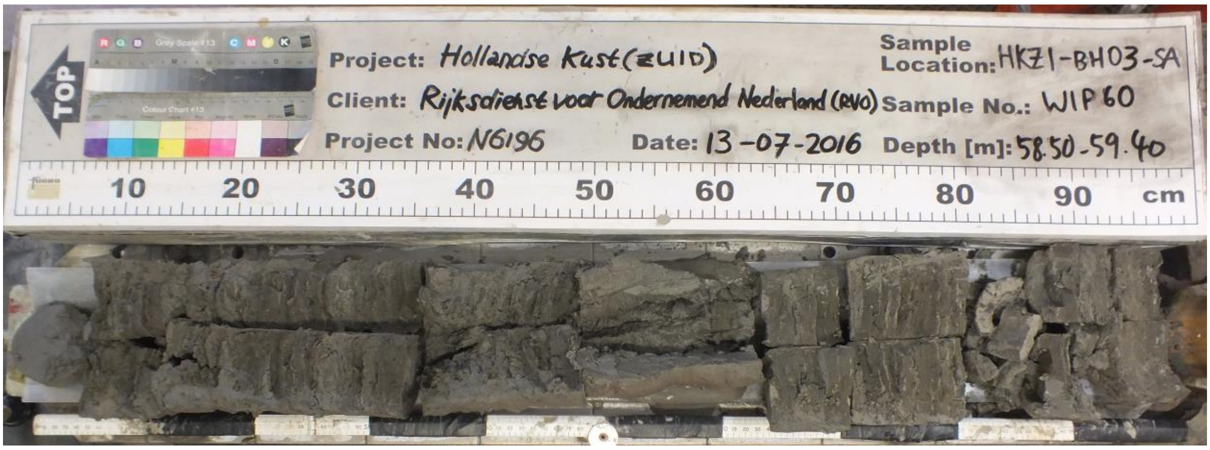
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP59
Depth [m BSF] : 54.50 to 55.30

Location : HKZ1-BH03-SA
Sample : WIP59
Depth [m BSF] : 54.50 to 55.30
Note(s) : split

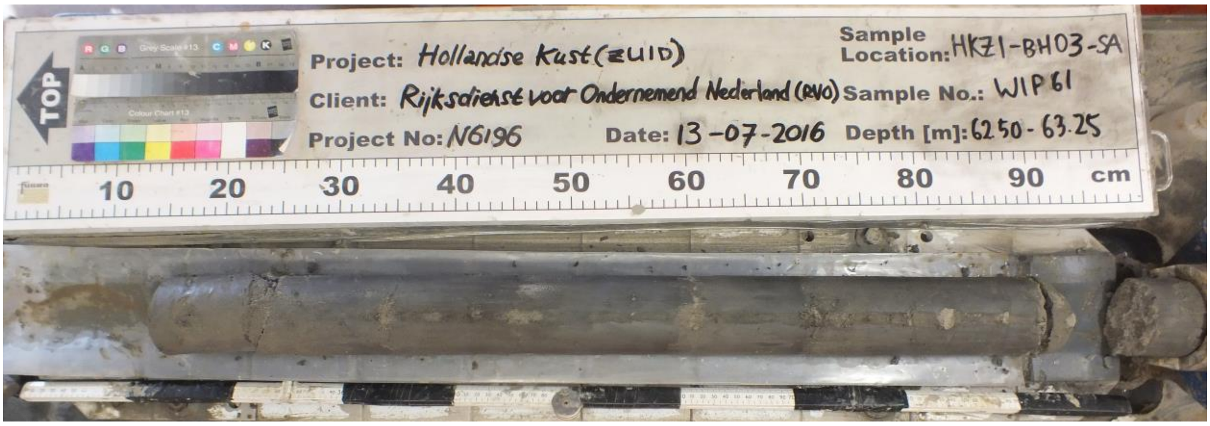
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SA
Sample : WIP60
Depth [m BSF] : 58.50 to 59.40

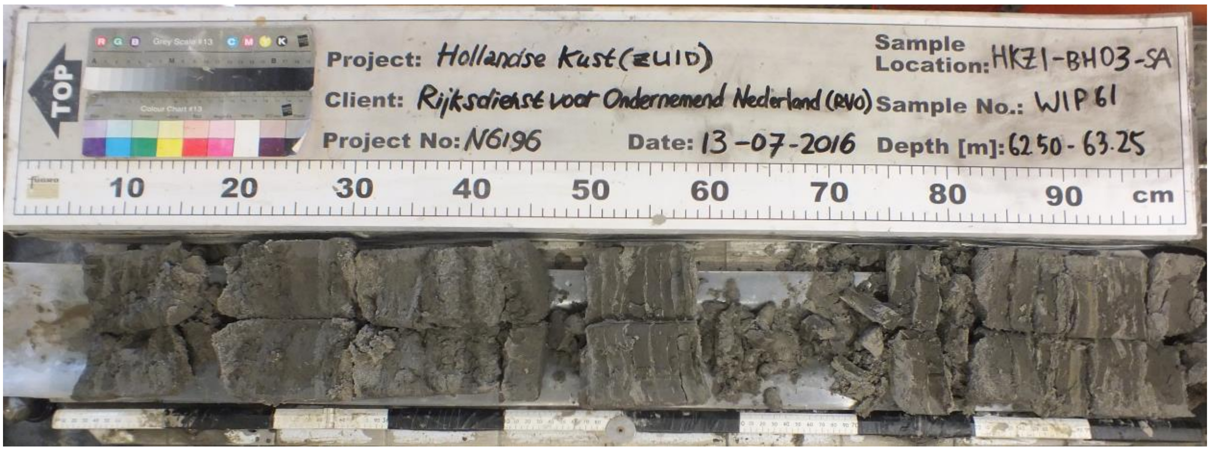


Location : HKZ1-BH03-SA
Sample : WIP60
Depth [m BSF] : 58.50 to 59.40
Note(s) : split

SAMPLE PHOTOGRAPHS

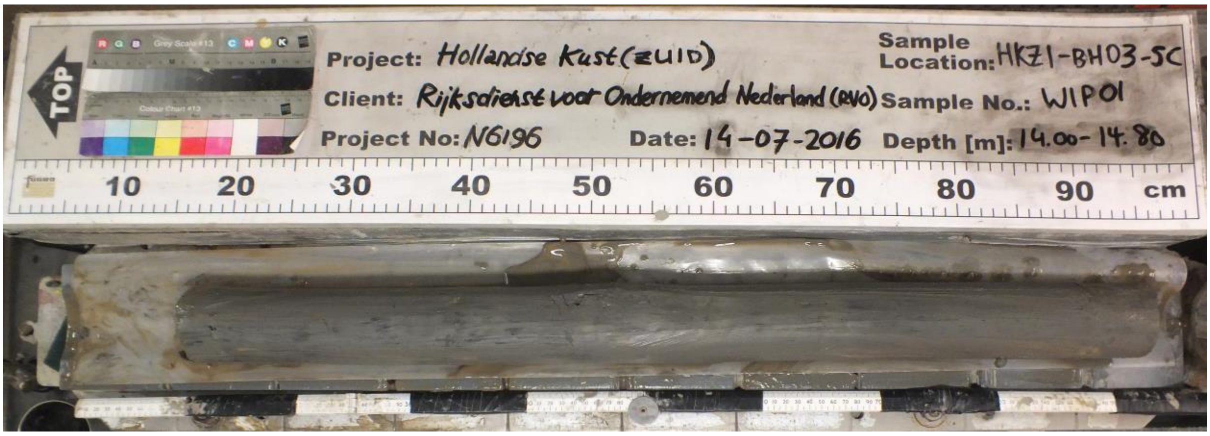


Location : HKZ1-BH03-SA
Sample : WIP61
Depth [m BSF] : 62.50 to 63.25



Location : HKZ1-BH03-SA
Sample : WIP61
Depth [m BSF] : 62.50 to 63.25
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH03-SC
Sample : WIP01
Depth [m BSF] : 14.00 to 14.80

Location : HKZ1-BH03-SC
Sample : WIP01
Depth [m BSF] : 14.00 to 14.80
Note(s) : split

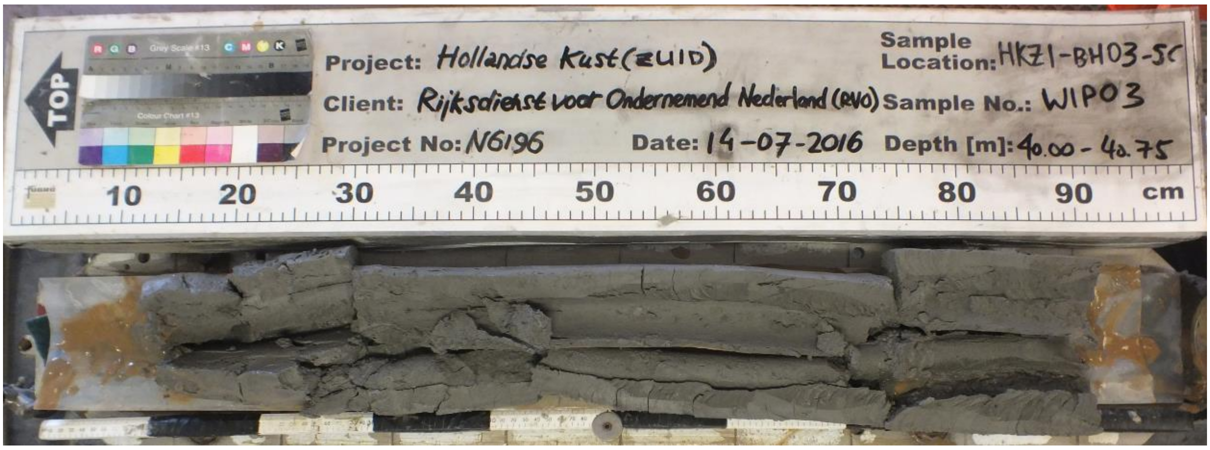
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SC
Sample : WIP02
Depth [m BSF] : 33.00 to 33.70

Location : HKZ1-BH03-SC
Sample : WIP02
Depth [m BSF] : 33.00 to 33.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SC
Sample : WIP03
Depth [m BSF] : 40.00 to 40.75



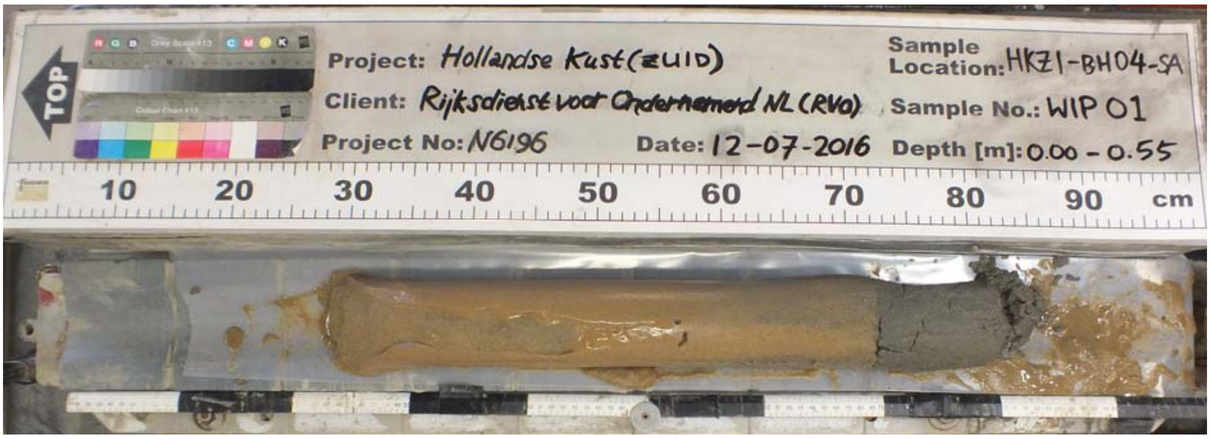
Location : HKZ1-BH03-SC
Sample : WIP03
Depth [m BSF] : 40.00 to 40.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH03-SC
Sample : WIP04
Depth [m BSF] : 47.00 to 47.85

Location : HKZ1-BH03-SC
Sample : WIP04
Depth [m BSF] : 47.00 to 47.85
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.55

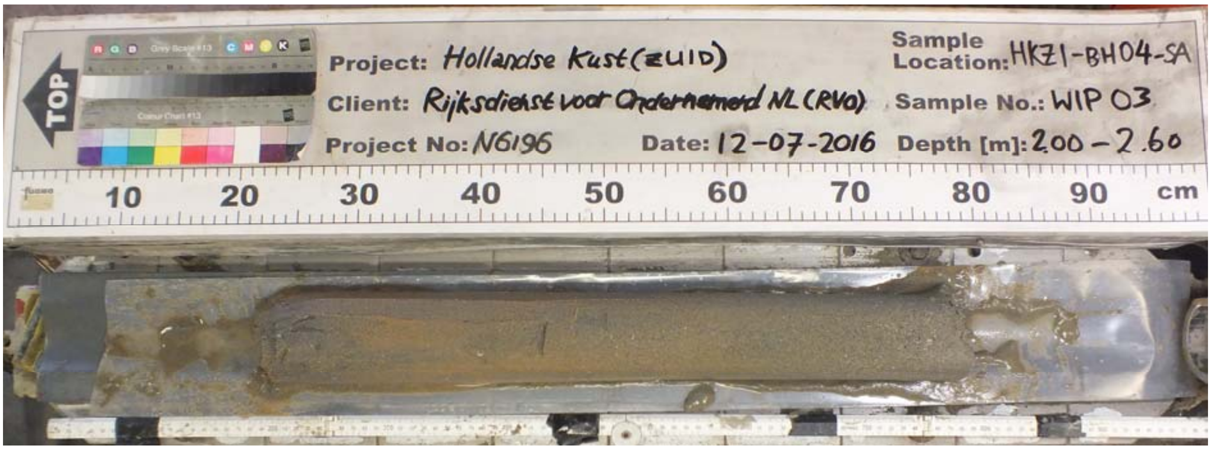
Location : HKZ1-BH04-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.55

Location : HKZ1-BH04-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.55
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.60

Location : HKZ1-BH04-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.40

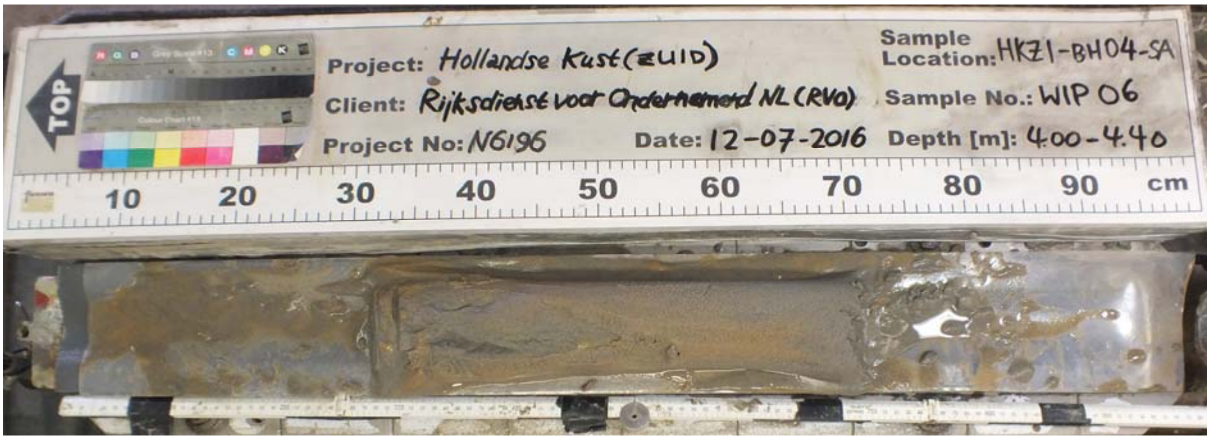
Location : HKZ1-BH04-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 3.95

Location : HKZ1-BH04-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 3.95
Note(s) : split

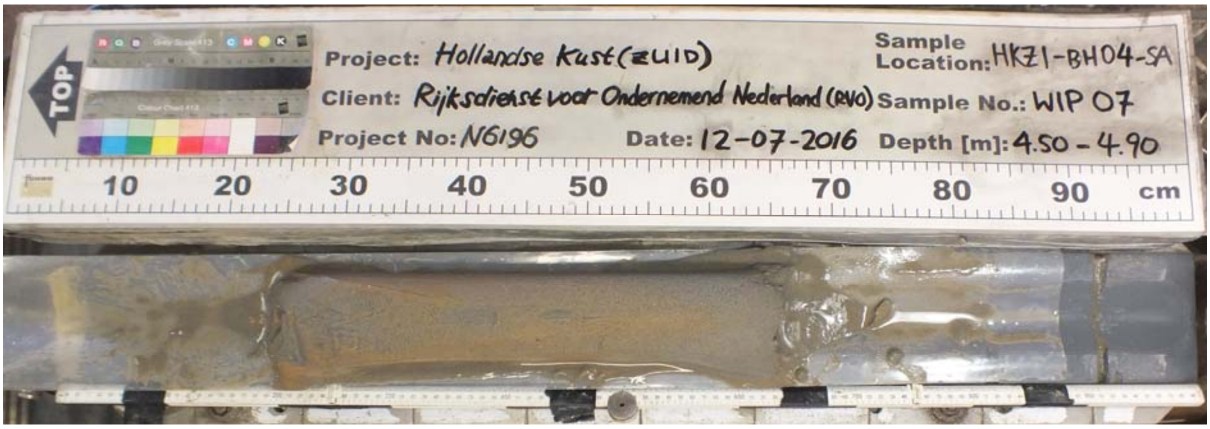
SAMPLE PHOTOGRAPHS



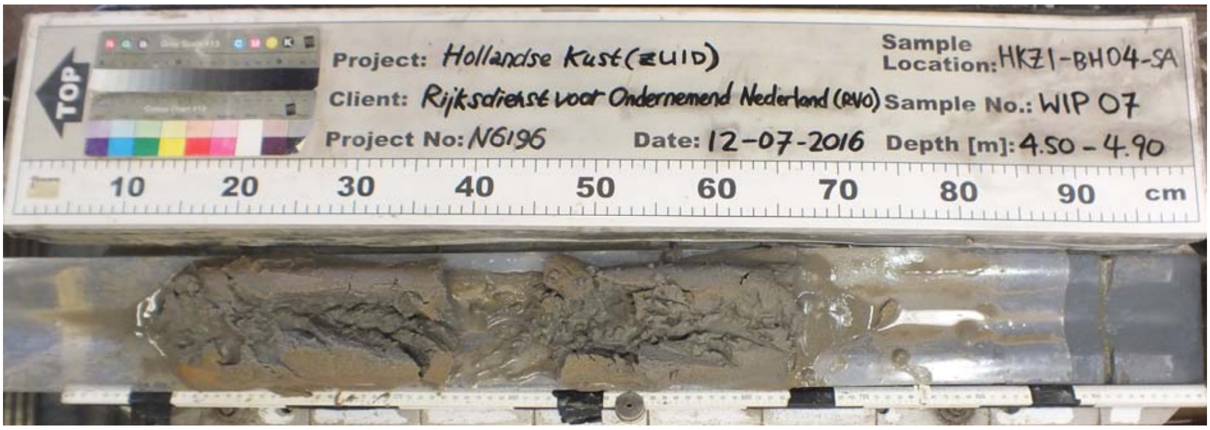
Location : HKZ1-BH04-SA
Sample : WIP06
Depth [m BSF] : 4.00 to 4.40

Location : HKZ1-BH04-SA
Sample : WIP06
Depth [m BSF] : 4.00 to 4.40
Note(s) : split

SAMPLE PHOTOGRAPHS

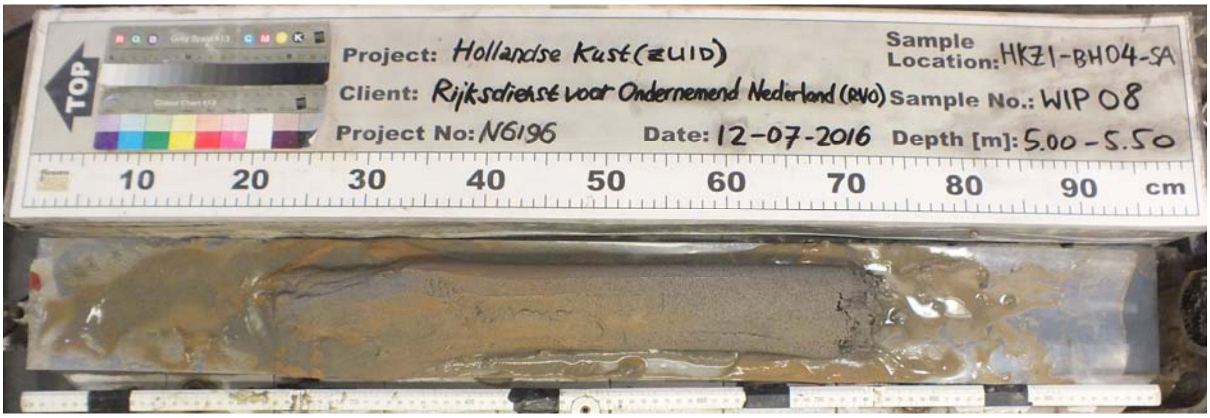


Location : HKZ1-BH04-SA
Sample : WIP07
Depth [m BSF] : 4.50 to 4.90



Location : HKZ1-BH04-SA
Sample : WIP07
Depth [m BSF] : 4.50 to 4.90
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP08
Depth [m BSF] : 5.00 to 5.50

Location : HKZ1-BH04-SA
Sample : WIP08
Depth [m BSF] : 5.00 to 5.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP09
Depth [m BSF] : 6.00 to 6.60

Location : HKZ1-BH04-SA
Sample : WIP09
Depth [m BSF] : 6.00 to 6.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP10
Depth [m BSF] : 7.00 to 7.60

Location : HKZ1-BH04-SA
Sample : WIP10
Depth [m BSF] : 7.00 to 7.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP11
Depth [m BSF] : 8.00 to 8.55

Location : HKZ1-BH04-SA
Sample : WIP11
Depth [m BSF] : 8.00 to 8.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP12
Depth [m BSF] : 9.00 to 9.55

Location : HKZ1-BH04-SA
Sample : WIP12
Depth [m BSF] : 9.00 to 9.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP13
Depth [m BSF] : 10.00 to 10.60

Location : HKZ1-BH04-SA
Sample : WIP13
Depth [m BSF] : 10.00 to 10.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP14
Depth [m BSF] : 11.00 to 11.60

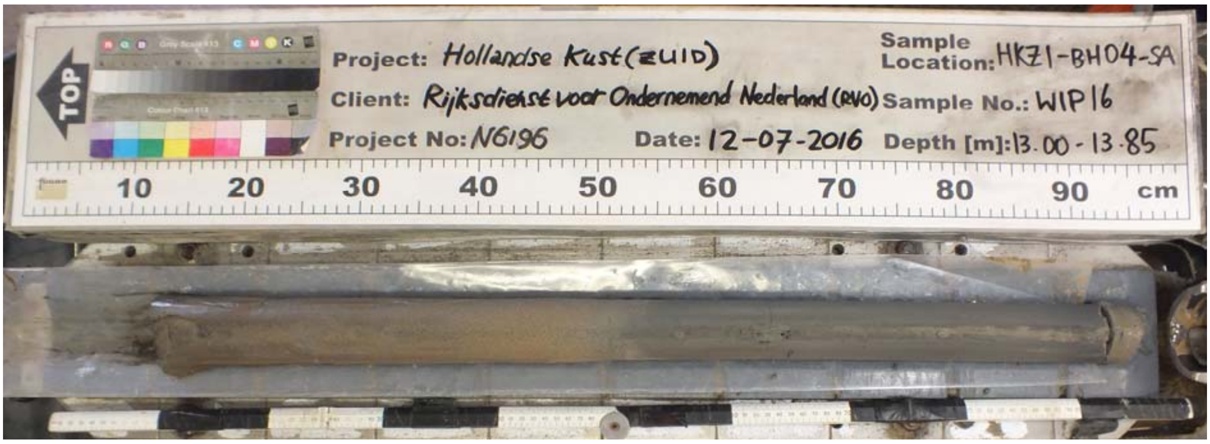
Location : HKZ1-BH04-SA
Sample : WIP14
Depth [m BSF] : 11.00 to 11.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP15
Depth [m BSF] : 12.00 to 12.70

Location : HKZ1-BH04-SA
Sample : WIP15
Depth [m BSF] : 12.00 to 12.70
Note(s) : split

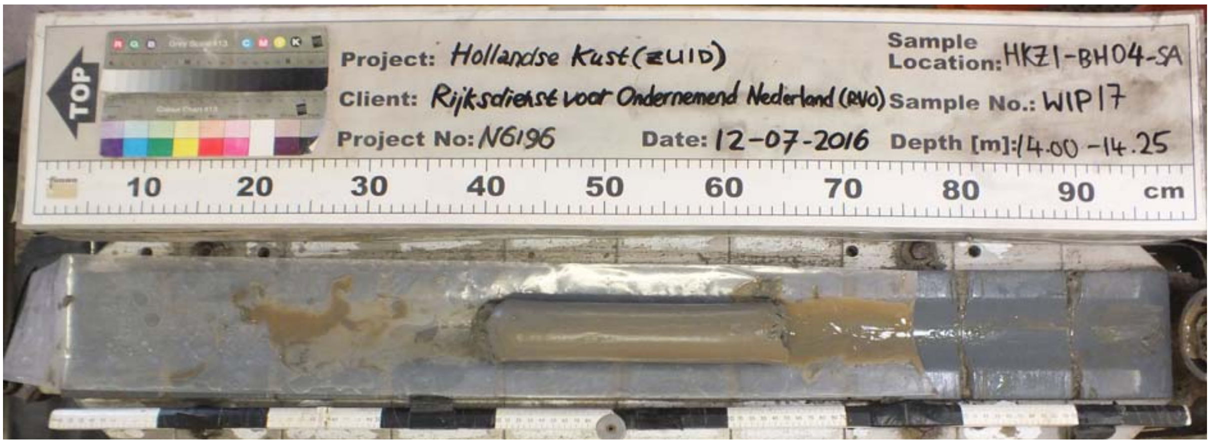
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP16
Depth [m BSF] : 13.00 to 13.85

Location : HKZ1-BH04-SA
Sample : WIP16
Depth [m BSF] : 13.00 to 13.85
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP17
Depth [m BSF] : 14.00 to 14.25

Location : HKZ1-BH04-SA
Sample : WIP17
Depth [m BSF] : 14.00 to 14.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP18
Depth [m BSF] : 14.50 to 14.95

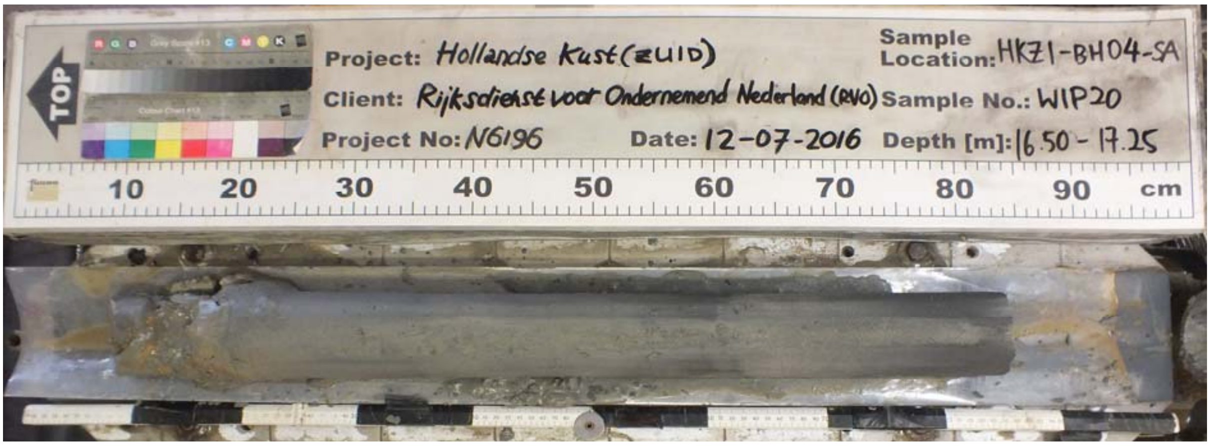
Location : HKZ1-BH04-SA
Sample : WIP18
Depth [m BSF] : 14.50 to 14.95
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP19
Depth [m BSF] : 15.50 to 16.30

Location : HKZ1-BH04-SA
Sample : WIP19
Depth [m BSF] : 15.50 to 16.30
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP20
Depth [m BSF] : 16.50 to 17.25

Location : HKZ1-BH04-SA
Sample : WIP20
Depth [m BSF] : 16.50 to 17.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP21
Depth [m BSF] : 17.50 to 18.10

Location : HKZ1-BH04-SA
Sample : WIP21
Depth [m BSF] : 17.50 to 18.10
Note(s) : split

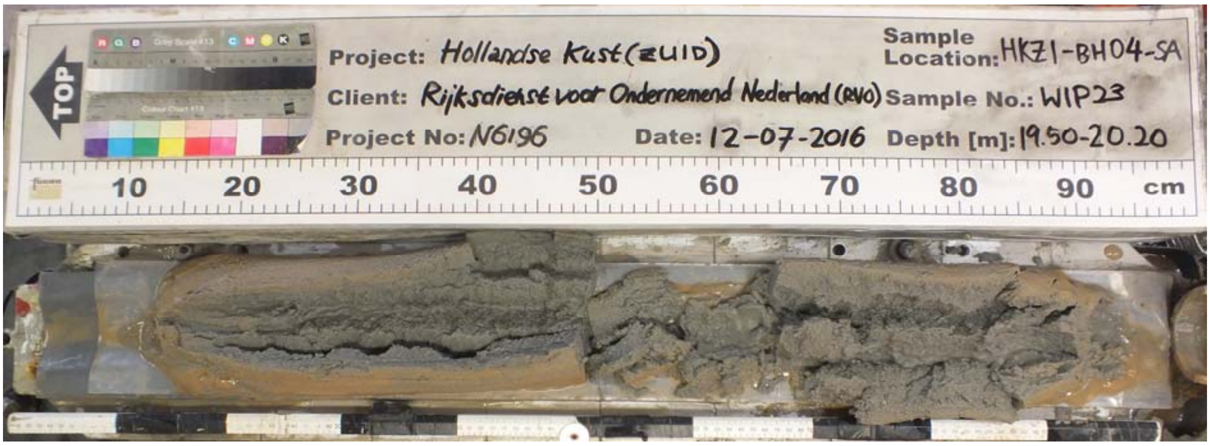
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP22
Depth [m BSF] : 18.50 to 19.30

Location : HKZ1-BH04-SA
Sample : WIP22
Depth [m BSF] : 18.50 to 19.30
Note(s) : split

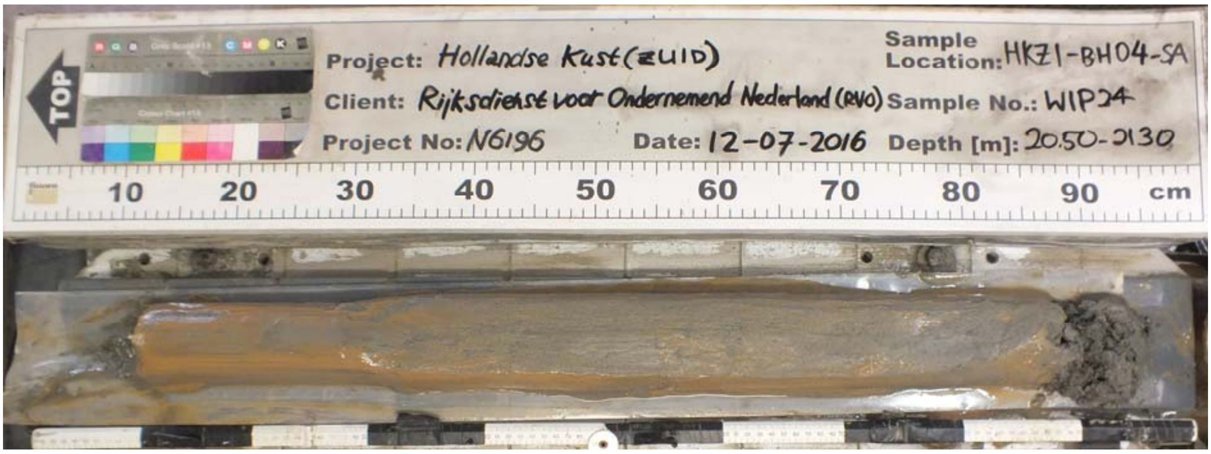
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP23
Depth [m BSF] : 19.50 to 20.20



Location : HKZ1-BH04-SA
Sample : WIP23
Depth [m BSF] : 19.50 to 20.20
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP24
Depth [m BSF] : 20.50 to 21.30

Location : HKZ1-BH04-SA
Sample : WIP24
Depth [m BSF] : 20.50 to 21.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP25
Depth [m BSF] : 21.50 to 22.40

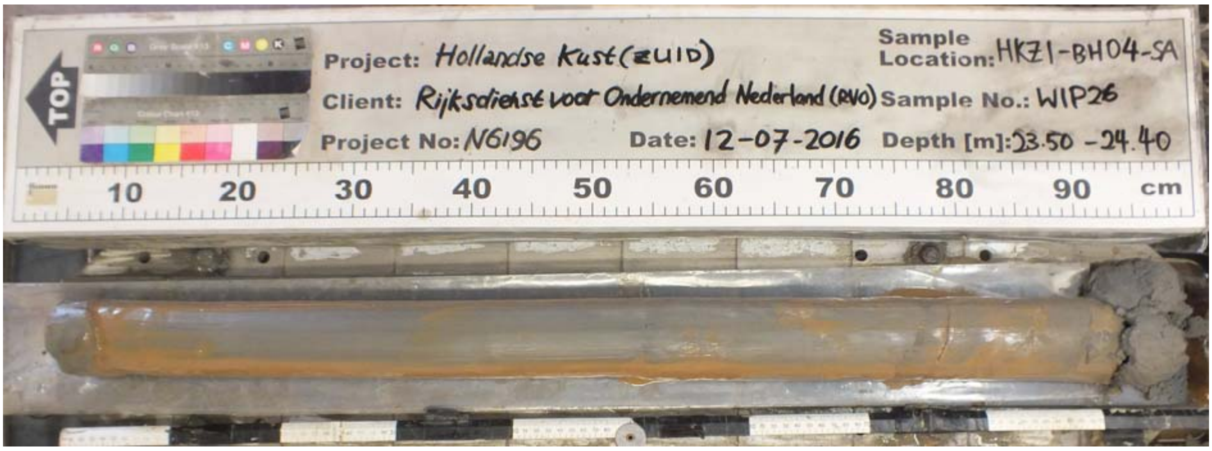
Location : HKZ1-BH04-SA
Sample : WIP25
Depth [m BSF] : 21.50 to 22.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP26
Depth [m BSF] : 22.50 to 23.35
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP26
Depth [m BSF] : 22.50 to 23.35
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP27
Depth [m BSF] : 23.50 to 24.40
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP27
Depth [m BSF] : 23.50 to 24.40
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP28
Depth [m BSF] : 24.50 to 25.40
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP28
Depth [m BSF] : 24.50 to 25.40
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP29
Depth [m BSF] : 25.50 to 26.25
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP29
Depth [m BSF] : 25.50 to 26.25
Note(s) : split

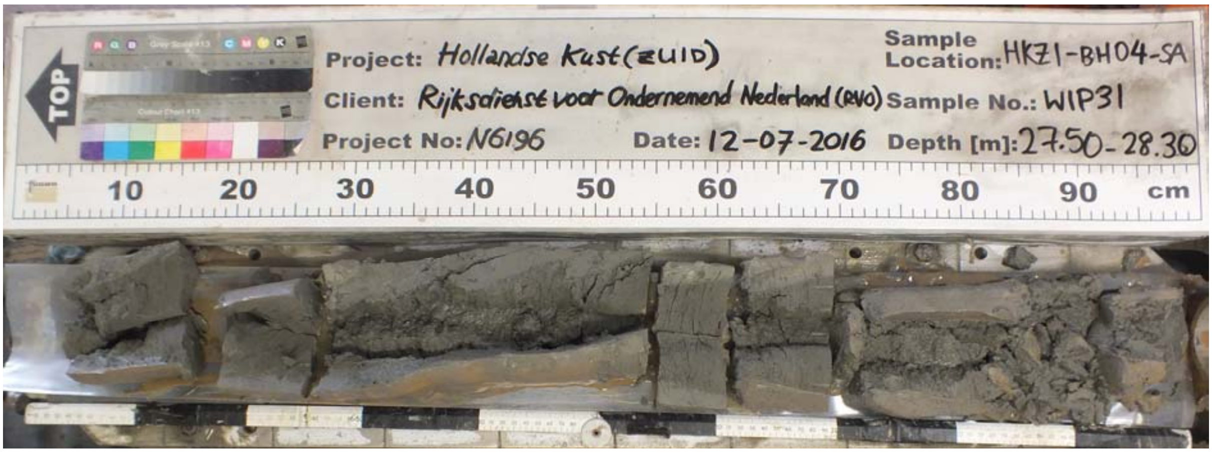
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP30
Depth [m BSF] : 26.50 to 27.35

Location : HKZ1-BH04-SA
Sample : WIP30
Depth [m BSF] : 26.50 to 27.35
Note(s) : split

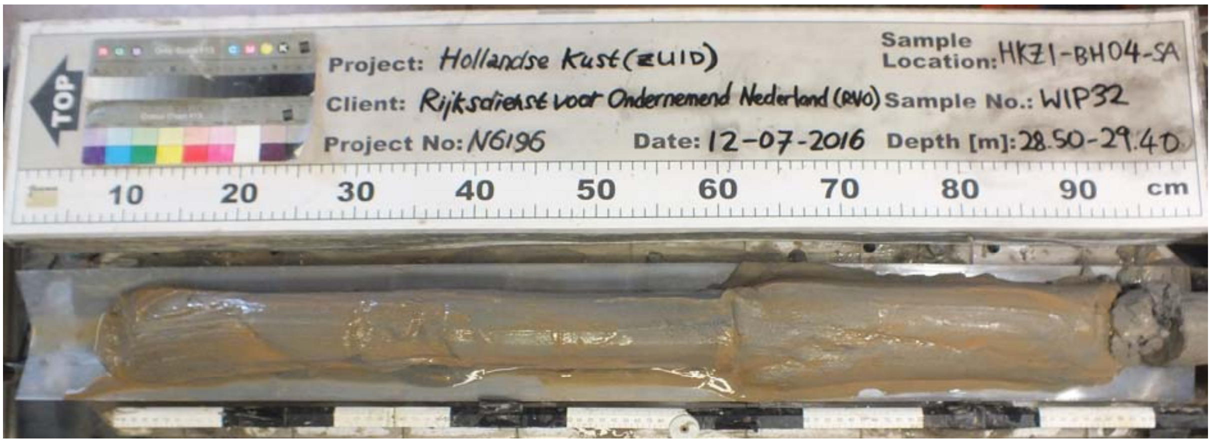
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP31
Depth [m BSF] : 27.50 to 28.30



Location : HKZ1-BH04-SA
Sample : WIP31
Depth [m BSF] : 27.50 to 28.30
Note(s) : split

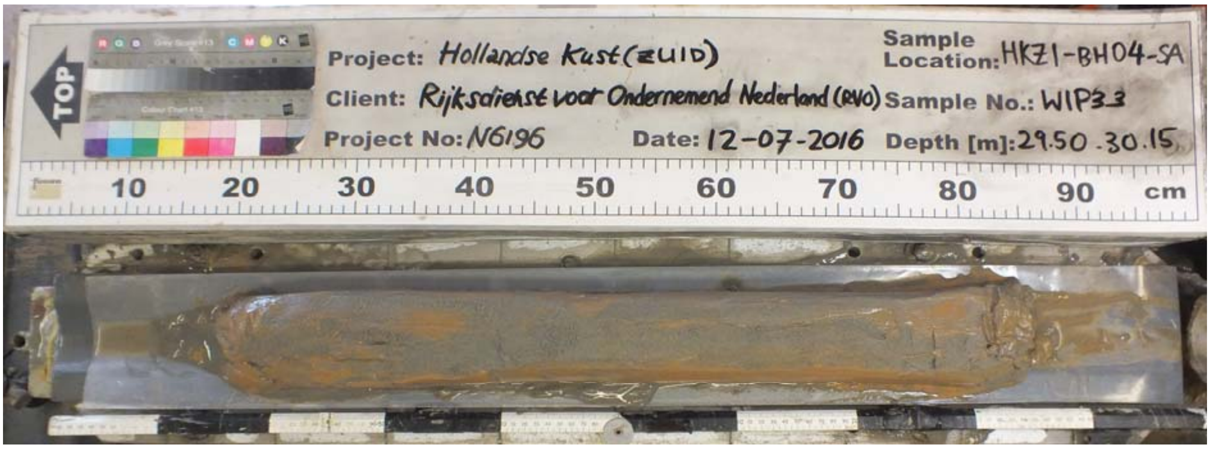
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP32
Depth [m BSF] : 28.50 to 29.40

Location : HKZ1-BH04-SA
Sample : WIP32
Depth [m BSF] : 28.50 to 29.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP33
Depth [m BSF] : 29.50 to 30.15

Location : HKZ1-BH04-SA
Sample : WIP33
Depth [m BSF] : 29.50 to 30.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP34
Depth [m BSF] : 30.50 to 31.10

Location : HKZ1-BH04-SA
Sample : WIP34
Depth [m BSF] : 30.50 to 31.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP35
Depth [m BSF] : 31.50 to 32.25

Location : HKZ1-BH04-SA
Sample : WIP35
Depth [m BSF] : 31.50 to 32.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP36
Depth [m BSF] : 32.50 to 33.15

Location : HKZ1-BH04-SA
Sample : WIP36
Depth [m BSF] : 32.50 to 33.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP37
Depth [m BSF] : 33.50 to 34.00

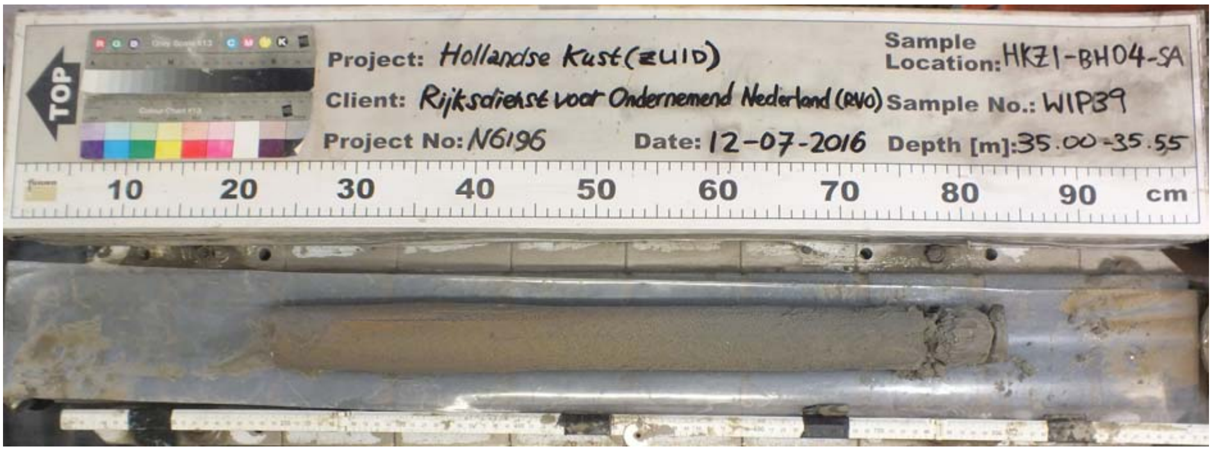
Location : HKZ1-BH04-SA
Sample : WIP37
Depth [m BSF] : 33.50 to 34.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP38
Depth [m BSF] : 34.50 to 34.90

Location : HKZ1-BH04-SA
Sample : WIP38
Depth [m BSF] : 34.50 to 34.90
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP39
Depth [m BSF] : 35.00 to 35.55

Location : HKZ1-BH04-SA
Sample : WIP39
Depth [m BSF] : 35.00 to 35.55
Note(s) : split

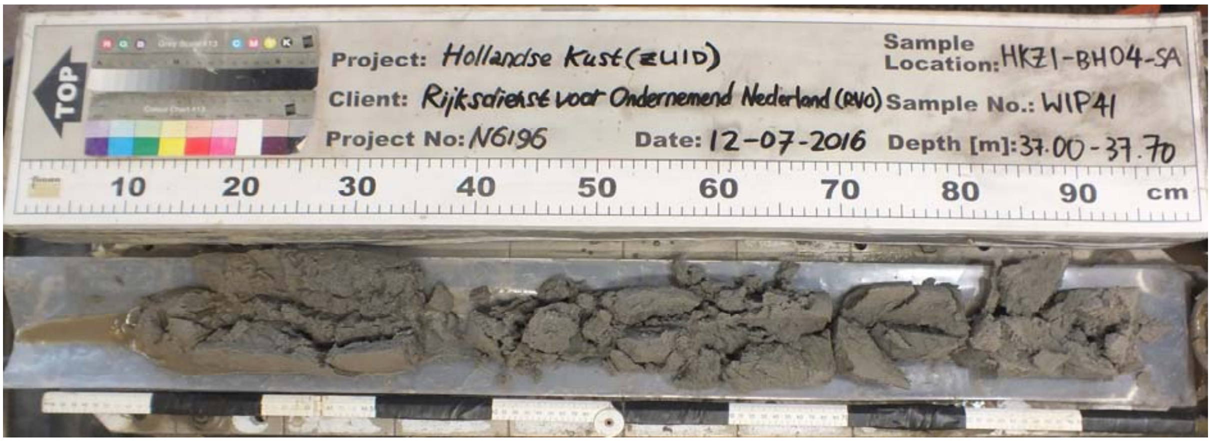
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP40
Depth [m BSF] : 36.00 to 36.50

Location : HKZ1-BH04-SA
Sample : WIP40
Depth [m BSF] : 36.00 to 36.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP41
Depth [m BSF] : 37.00 to 37.70



Location : HKZ1-BH04-SA
Sample : WIP41
Depth [m BSF] : 37.00 to 37.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP42
Depth [m BSF] : 38.00 to 38.50

Location : HKZ1-BH04-SA
Sample : WIP42
Depth [m BSF] : 38.00 to 38.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP43
Depth [m BSF] : 39.00 to 39.55

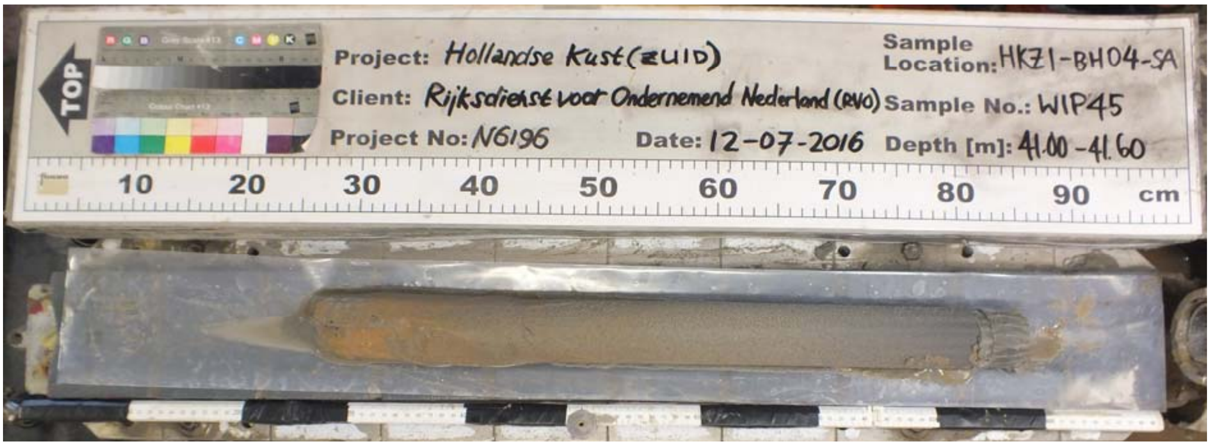
Location : HKZ1-BH04-SA
Sample : WIP43
Depth [m BSF] : 39.00 to 39.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP44
Depth [m BSF] : 40.00 to 40.45

Location : HKZ1-BH04-SA
Sample : WIP44
Depth [m BSF] : 40.00 to 40.45
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP45
Depth [m BSF] : 40.50 to 41.10
Note(s) : incorrect depth presented on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP45
Depth [m BSF] : 40.50 to 41.10
Note(s) : split
: incorrect depth presented on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP46
Depth [m BSF] : 41.50 to 42.00

Location : HKZ1-BH04-SA
Sample : WIP46
Depth [m BSF] : 41.50 to 42.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP47
Depth [m BSF] : 42.50 to 43.05

Location : HKZ1-BH04-SA
Sample : WIP47
Depth [m BSF] : 42.50 to 43.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP48
Depth [m BSF] : 43.50 to 44.00

Location : HKZ1-BH04-SA
Sample : WIP48
Depth [m BSF] : 43.50 to 44.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP49
Depth [m BSF] : 44.50 to 44.90

Location : HKZ1-BH04-SA
Sample : WIP49
Depth [m BSF] : 44.50 to 44.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP50
Depth [m BSF] : 45.00 to 45.45

Location : HKZ1-BH04-SA
Sample : WIP50
Depth [m BSF] : 45.00 to 45.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP51
Depth [m BSF] : 45.50 to 45.85

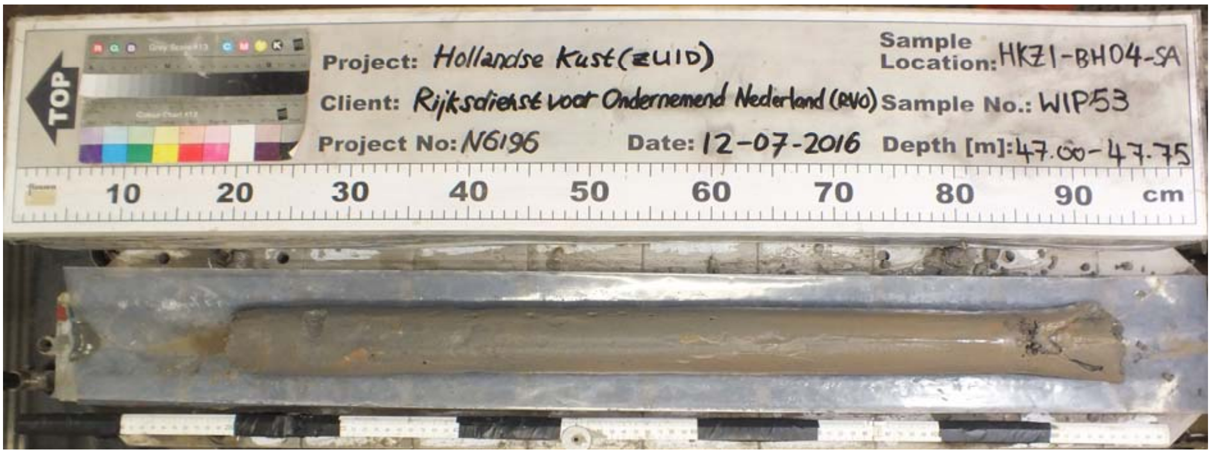
Location : HKZ1-BH04-SA
Sample : WIP51
Depth [m BSF] : 45.50 to 45.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP52
Depth [m BSF] : 46.00 to 46.85

Location : HKZ1-BH04-SA
Sample : WIP52
Depth [m BSF] : 46.00 to 46.85
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH04-SA
Sample : WIP53
Depth [m BSF] : 47.00 to 47.75

Location : HKZ1-BH04-SA
Sample : WIP53
Depth [m BSF] : 47.00 to 47.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP54
Depth [m BSF] : 48.00 to 48.60
Note(s) : incorrect depth presented on sample photograph

Location : HKZ1-BH04-SA
Sample : WIP54
Depth [m BSF] : 48.00 to 48.60
Note(s) : split

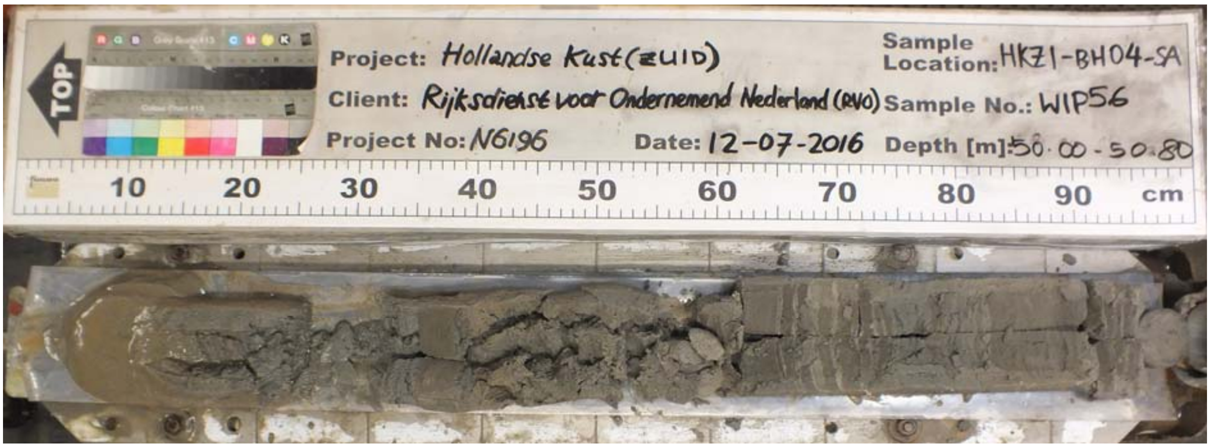
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP55
Depth [m BSF] : 49.00 to 49.55

Location : HKZ1-BH04-SA
Sample : WIP55
Depth [m BSF] : 49.00 to 49.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH04-SA
Sample : WIP56
Depth [m BSF] : 50.00 to 50.80



Location : HKZ1-BH04-SA
Sample : WIP56
Depth [m BSF] : 50.00 to 50.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.55

Location : HKZ1-BH05-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.60

Location : HKZ1-BH05-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.70

Location : HKZ1-BH05-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.70

Location : HKZ1-BH05-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.60

Location : HKZ1-BH05-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.55

Location : HKZ1-BH05-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP07
Depth [m BSF] : 6.00 to 6.60

Location : HKZ1-BH05-SA
Sample : WIP07
Depth [m BSF] : 6.00 to 6.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP08
Depth [m BSF] : 7.00 to 7.55

Location : HKZ1-BH05-SA
Sample : WIP08
Depth [m BSF] : 7.00 to 7.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP09
Depth [m BSF] : 8.00 to 8.60

Location : HKZ1-BH05-SA
Sample : WIP09
Depth [m BSF] : 8.00 to 8.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP10
Depth [m BSF] : 9.00 to 9.50

Location : HKZ1-BH05-SA
Sample : WIP10
Depth [m BSF] : 9.00 to 9.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP11
Depth [m BSF] : 10.00 to 10.30

Location : HKZ1-BH05-SA
Sample : WIP11
Depth [m BSF] : 10.00 to 10.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP12
Depth [m BSF] : 10.50 to 10.80

Location : HKZ1-BH05-SA
Sample : WIP12
Depth [m BSF] : 10.50 to 10.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.30
Note(s) : incorrect depth presented on sample photograph
: incorrect sample number on sample photograph

Location : HKZ1-BH05-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.30
Note(s) : split
: incorrect depth presented on sample photograph
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP14
Depth [m BSF] : 11.50 to 11.75

Location : HKZ1-BH05-SA
Sample : WIP14
Depth [m BSF] : 11.50 to 11.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP15
Depth [m BSF] : 12.00 to 12.40

Location : HKZ1-BH05-SA
Sample : WIP15
Depth [m BSF] : 12.00 to 12.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP16
Depth [m BSF] : 12.50 to 12.80

Location : HKZ1-BH05-SA
Sample : WIP16
Depth [m BSF] : 12.50 to 12.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP17
Depth [m BSF] : 13.00 to 13.70

Location : HKZ1-BH05-SA
Sample : WIP17
Depth [m BSF] : 13.00 to 13.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP18
Depth [m BSF] : 14.00 to 14.85

Location : HKZ1-BH05-SA
Sample : WIP18
Depth [m BSF] : 14.00 to 14.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP19
Depth [m BSF] : 15.00 to 15.85

Location : HKZ1-BH05-SA
Sample : WIP19
Depth [m BSF] : 15.00 to 15.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP20
Depth [m BSF] : 16.00 to 16.55

Location : HKZ1-BH05-SA
Sample : WIP20
Depth [m BSF] : 16.00 to 16.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP21
Depth [m BSF] : 17.00 to 17.75

Location : HKZ1-BH05-SA
Sample : WIP21
Depth [m BSF] : 17.00 to 17.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP22
Depth [m BSF] : 18.00 to 18.50

Location : HKZ1-BH05-SA
Sample : WIP22
Depth [m BSF] : 18.00 to 18.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP23
Depth [m BSF] : 19.00 to 19.90

Location : HKZ1-BH05-SA
Sample : WIP23
Depth [m BSF] : 19.00 to 19.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP24
Depth [m BSF] : 20.00 to 20.75

Location : HKZ1-BH05-SA
Sample : WIP24
Depth [m BSF] : 20.00 to 20.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP25
Depth [m BSF] : 21.00 to 21.15

Location : HKZ1-BH05-SA
Sample : WIP25
Depth [m BSF] : 21.00 to 21.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP26
Depth [m BSF] : 22.00 to 22.80

Location : HKZ1-BH05-SA
Sample : WIP26
Depth [m BSF] : 22.00 to 22.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP27
Depth [m BSF] : 23.00 to 23.40
Note(s) : incorrect depth presented on sample photograph

Location : HKZ1-BH05-SA
Sample : WIP27
Depth [m BSF] : 23.00 to 23.40
Note(s) : split
: incorrect depth presented on sample photograph

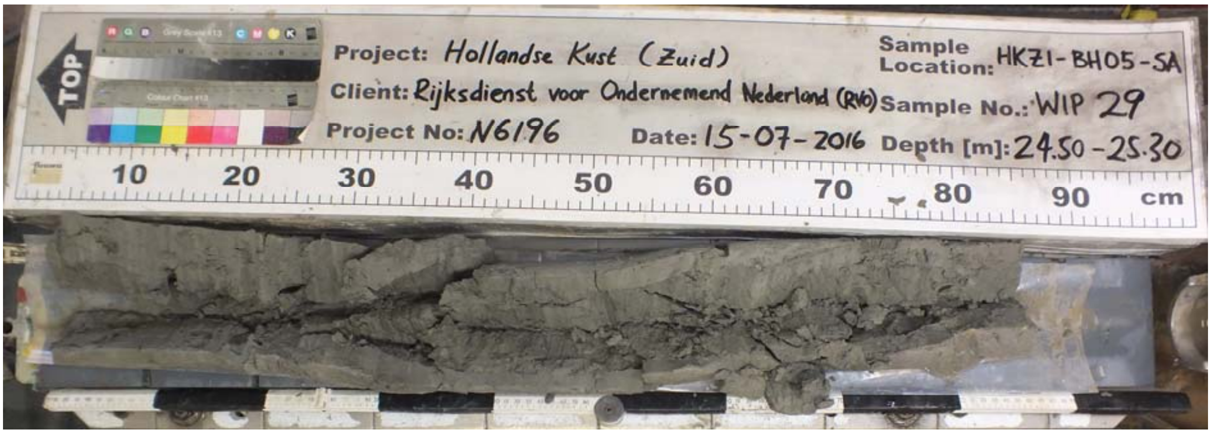
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP28
Depth [m BSF] : 23.50 to 24.20

Location : HKZ1-BH05-SA
Sample : WIP28
Depth [m BSF] : 23.50 to 24.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP29
Depth [m BSF] : 24.50 to 25.30



Location : HKZ1-BH05-SA
Sample : WIP29
Depth [m BSF] : 24.50 to 25.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP30
Depth [m BSF] : 25.50 to 26.30

Location : HKZ1-BH05-SA
Sample : WIP30
Depth [m BSF] : 25.50 to 26.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP31
Depth [m BSF] : 26.50 to 27.40

Location : HKZ1-BH05-SA
Sample : WIP31
Depth [m BSF] : 26.50 to 27.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP32
Depth [m BSF] : 27.50 to 28.30

Location : HKZ1-BH05-SA
Sample : WIP32
Depth [m BSF] : 27.50 to 28.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP33
Depth [m BSF] : 28.50 to 29.10

Location : HKZ1-BH05-SA
Sample : WIP33
Depth [m BSF] : 28.50 to 29.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP34
Depth [m BSF] : 29.50 to 30.20

Location : HKZ1-BH05-SA
Sample : WIP34
Depth [m BSF] : 29.50 to 30.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP35
Depth [m BSF] : 30.50 to 31.30

Location : HKZ1-BH05-SA
Sample : WIP35
Depth [m BSF] : 30.50 to 31.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP36
Depth [m BSF] : 31.50 to 32.10

Location : HKZ1-BH05-SA
Sample : WIP36
Depth [m BSF] : 31.50 to 32.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP37
Depth [m BSF] : 32.50 to 33.05

Location : HKZ1-BH05-SA
Sample : WIP37
Depth [m BSF] : 32.50 to 33.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP38
Depth [m BSF] : 33.50 to 34.05

Location : HKZ1-BH05-SA
Sample : WIP38
Depth [m BSF] : 33.50 to 34.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP39
Depth [m BSF] : 34.50 to 35.10

Location : HKZ1-BH05-SA
Sample : WIP39
Depth [m BSF] : 34.50 to 35.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP40
Depth [m BSF] : 35.50 to 36.35

Location : HKZ1-BH05-SA
Sample : WIP40
Depth [m BSF] : 35.50 to 36.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP41
Depth [m BSF] : 36.50 to 37.35

Location : HKZ1-BH05-SA
Sample : WIP41
Depth [m BSF] : 36.50 to 37.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP42
Depth [m BSF] : 37.50 to 38.25

Location : HKZ1-BH05-SA
Sample : WIP42
Depth [m BSF] : 37.50 to 38.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP43
Depth [m BSF] : 38.50 to 39.25

Location : HKZ1-BH05-SA
Sample : WIP43
Depth [m BSF] : 38.50 to 39.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP44
Depth [m BSF] : 39.50 to 40.30
Note(s) : incorrect depth presented on sample photograph
: incorrect sample number on sample photograph

Location : HKZ1-BH05-SA
Sample : WIP44
Depth [m BSF] : 39.50 to 40.30
Note(s) : split
: incorrect depth presented on sample photograph
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP45
Depth [m BSF] : 40.50 to 41.25

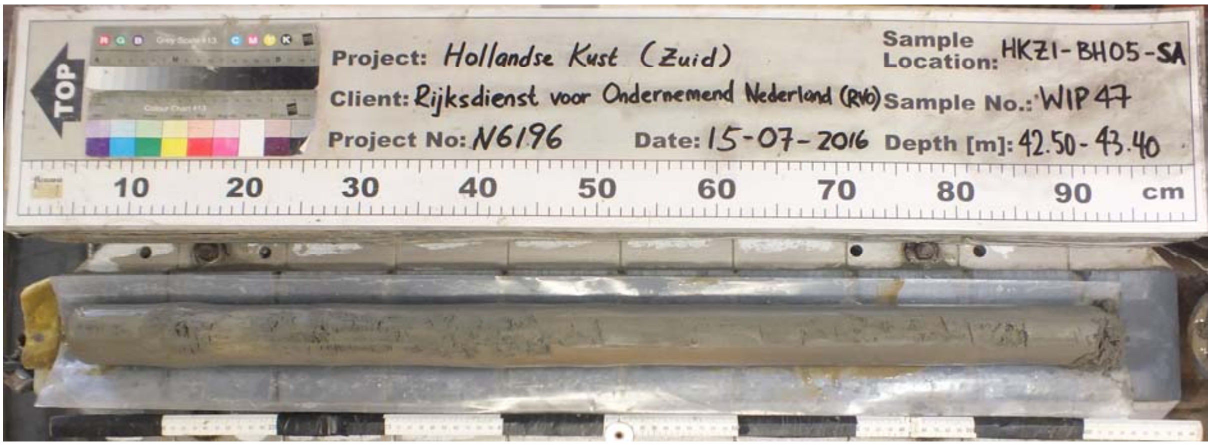
Location : HKZ1-BH05-SA
Sample : WIP45
Depth [m BSF] : 40.50 to 41.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP46
Depth [m BSF] : 41.50 to 42.25

Location : HKZ1-BH05-SA
Sample : WIP47
Depth [m BSF] : 42.50 to 43.25
Note(s) : split

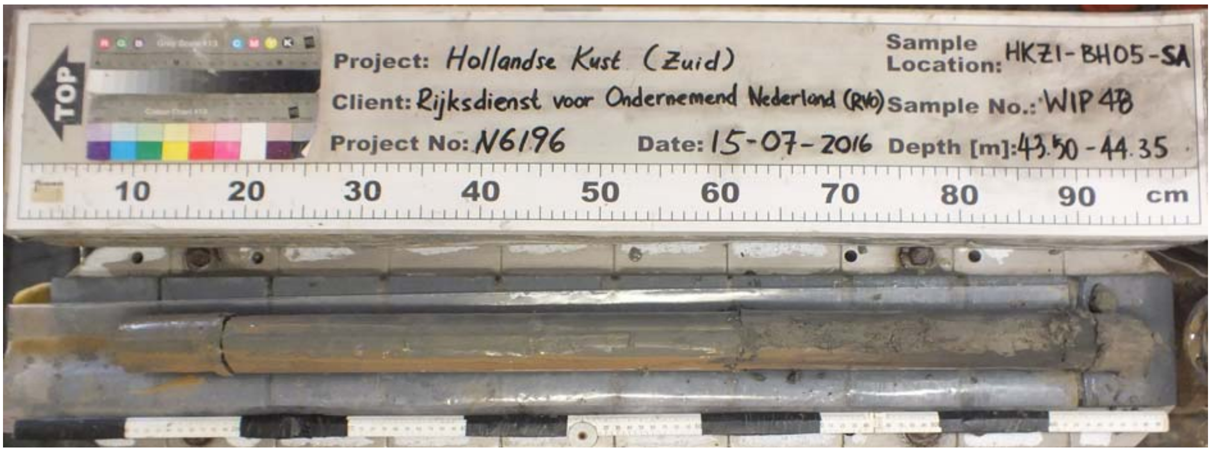
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH05-SA
Sample : WIP47
Depth [m BSF] : 42.50 to 43.40

Location : HKZ1-BH05-SA
Sample : WIP47
Depth [m BSF] : 42.50 to 43.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH05-SA
Sample : WIP48
Depth [m BSF] : 43.50 to 44.35

Location : HKZ1-BH05-SA
Sample : WIP48
Depth [m BSF] : 43.50 to 44.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP49
Depth [m BSF] : 44.50 to 45.25

Location : HKZ1-BH05-SA
Sample : WIP49
Depth [m BSF] : 44.50 to 45.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP50
Depth [m BSF] : 45.50 to 46.25

Location : HKZ1-BH05-SA
Sample : WIP50
Depth [m BSF] : 45.50 to 46.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP51
Depth [m BSF] : 46.50 to 47.30

Location : HKZ1-BH05-SA
Sample : WIP51
Depth [m BSF] : 46.50 to 47.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP52
Depth [m BSF] : 47.50 to 48.25

Location : HKZ1-BH05-SA
Sample : WIP52
Depth [m BSF] : 47.50 to 48.25
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP53
Depth [m BSF] : 48.50 to 49.40

Location : HKZ1-BH05-SA
Sample : WIP53
Depth [m BSF] : 48.50 to 49.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH05-SA
Sample : WIP54
Depth [m BSF] : 49.50 to 50.35

Location : HKZ1-BH05-SA
Sample : WIP54
Depth [m BSF] : 49.50 to 50.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.65

Location : HKZ1-BH06-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.65
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.60

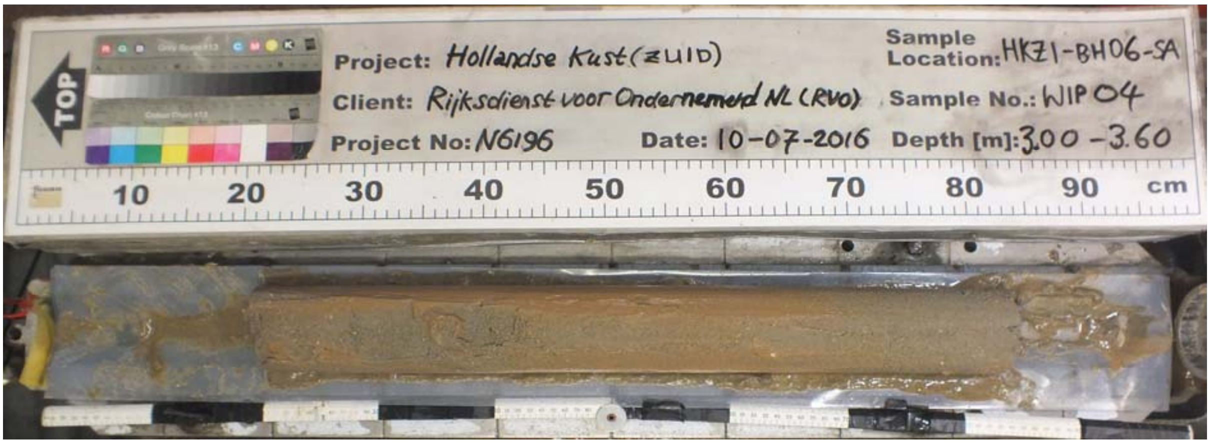
Location : HKZ1-BH06-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.65

Location : HKZ1-BH06-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.65
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.60

Location : HKZ1-BH06-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.55

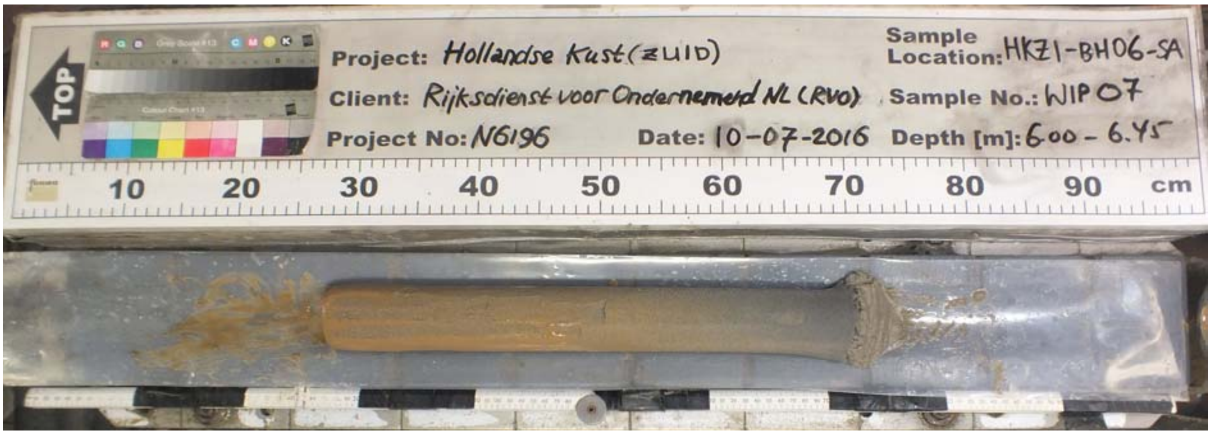
Location : HKZ1-BH06-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.55
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.50

Location : HKZ1-BH06-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.50
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP07
Depth [m BSF] : 6.00 to 6.45

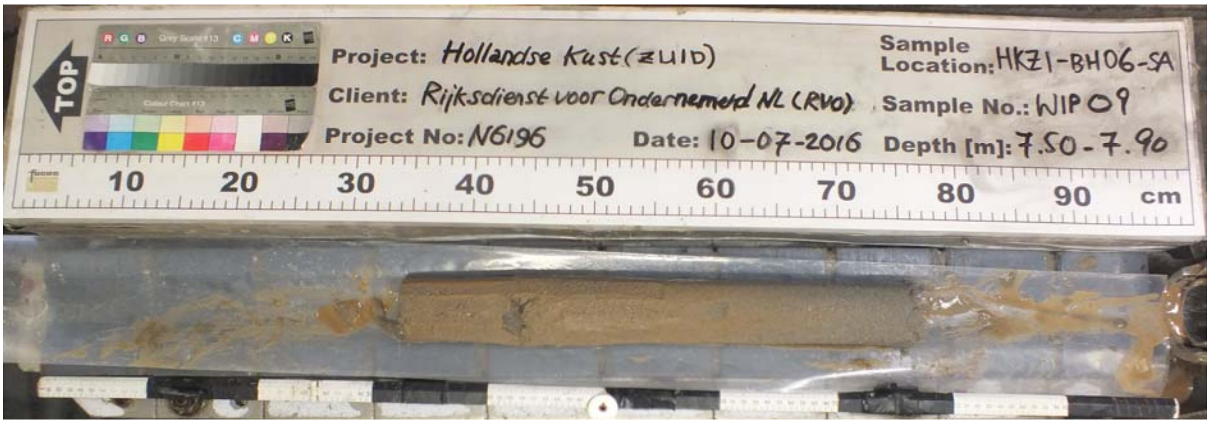
Location : HKZ1-BH06-SA
Sample : WIP07
Depth [m BSF] : 6.00 to 6.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 7.00
Note(s) : incorrect depth presented on sample photograph

Location : HKZ1-BH06-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 7.00
Note(s) : split
: incorrect depth presented on sample photograph

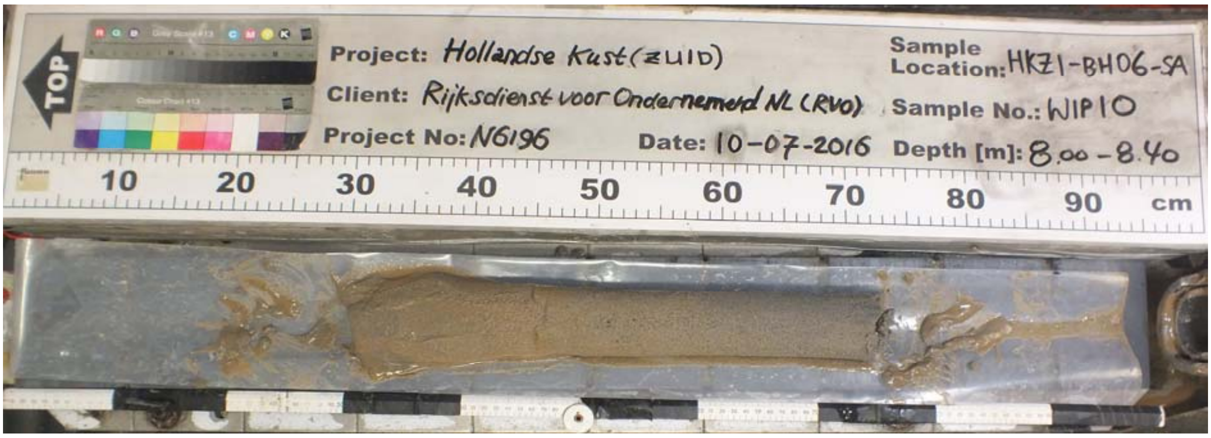
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP09
Depth [m BSF] : 7.50 to 7.90

Location : HKZ1-BH06-SA
Sample : WIP09
Depth [m BSF] : 7.50 to 7.90
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.40

Location : HKZ1-BH06-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.40
Note(s) : split

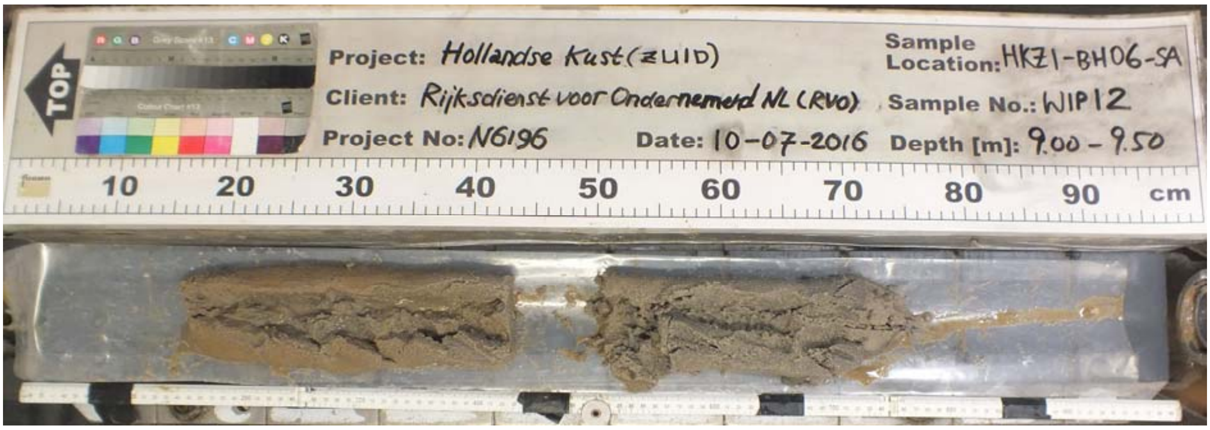
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP11
Depth [m BSF] : 8.50 to 8.85

Location : HKZ1-BH06-SA
Sample : WIP11
Depth [m BSF] : 8.50 to 8.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP12
Depth [m BSF] : 9.00 to 9.50



Location : HKZ1-BH06-SA
Sample : WIP12
Depth [m BSF] : 9.00 to 9.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP13
Depth [m BSF] : 10.00 to 10.35

Location : HKZ1-BH06-SA
Sample : WIP13
Depth [m BSF] : 10.00 to 10.35
Note(s) : split

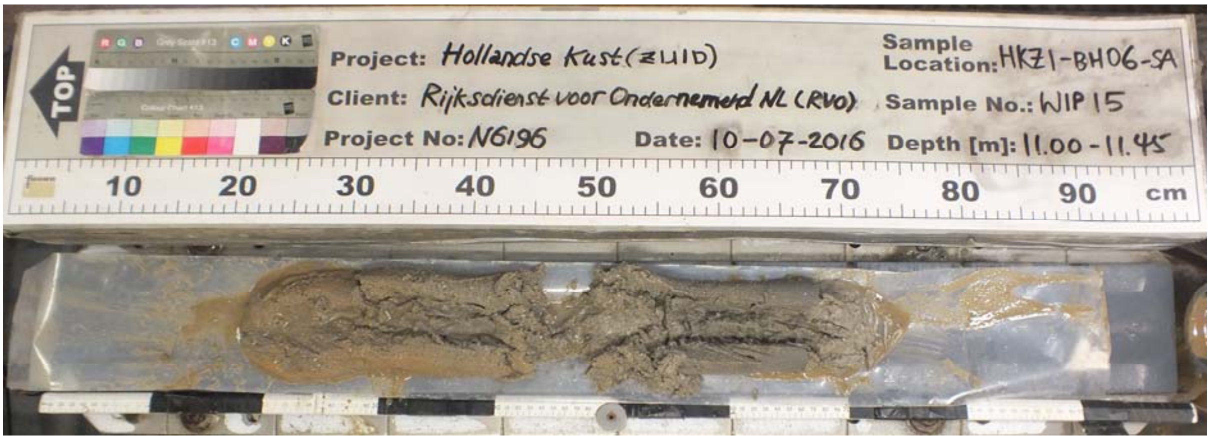
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP14
Depth [m BSF] : 10.50 to 10.90

Location : HKZ1-BH06-SA
Sample : WIP14
Depth [m BSF] : 10.50 to 10.90
Note(s) : split

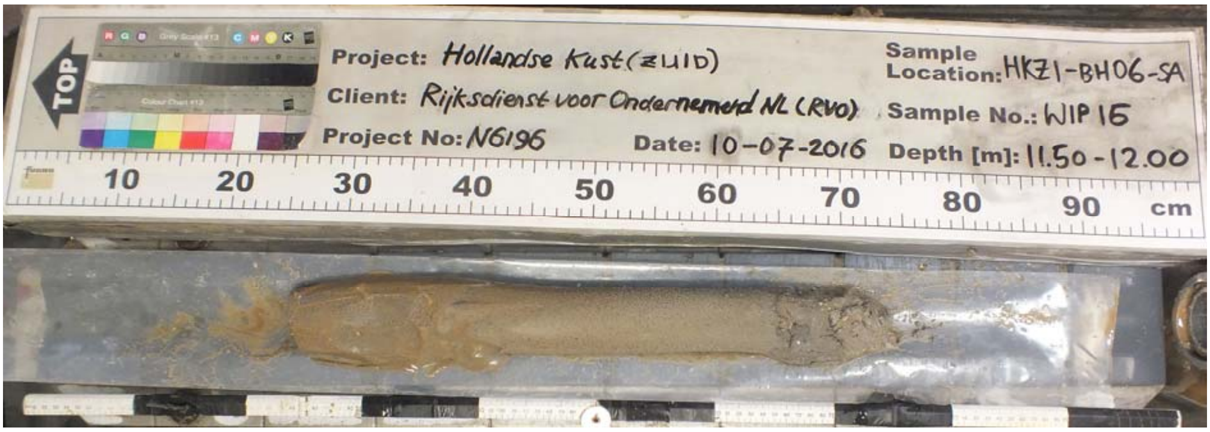
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP15
Depth [m BSF] : 11.00 to 11.45



Location : HKZ1-BH06-SA
Sample : WIP15
Depth [m BSF] : 11.00 to 11.45
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP16
Depth [m BSF] : 11.50 to 12.00

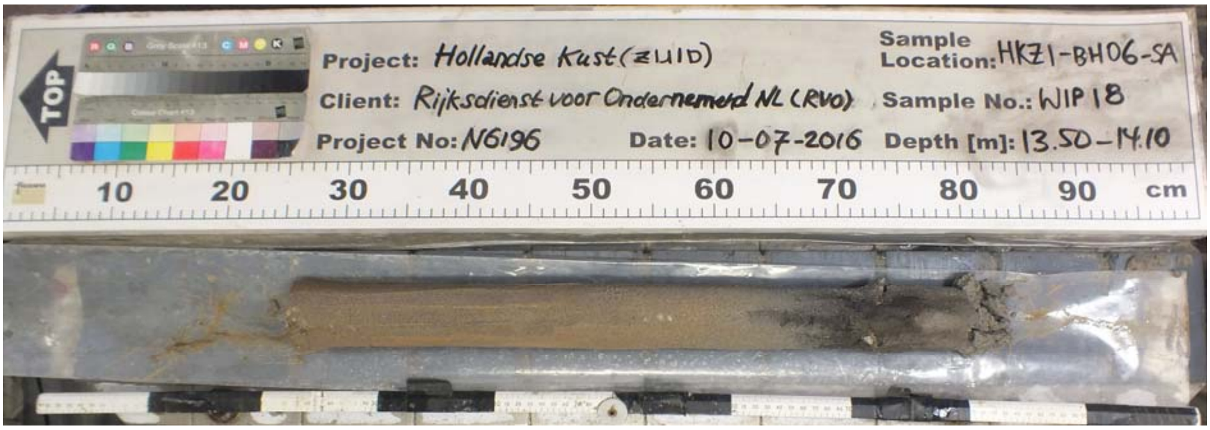
Location : HKZ1-BH06-SA
Sample : WIP16
Depth [m BSF] : 11.50 to 12.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP17
Depth [m BSF] : 12.50 to 13.00

Location : HKZ1-BH06-SA
Sample : WIP17
Depth [m BSF] : 12.50 to 13.00
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP18
Depth [m BSF] : 13.50 to 14.10

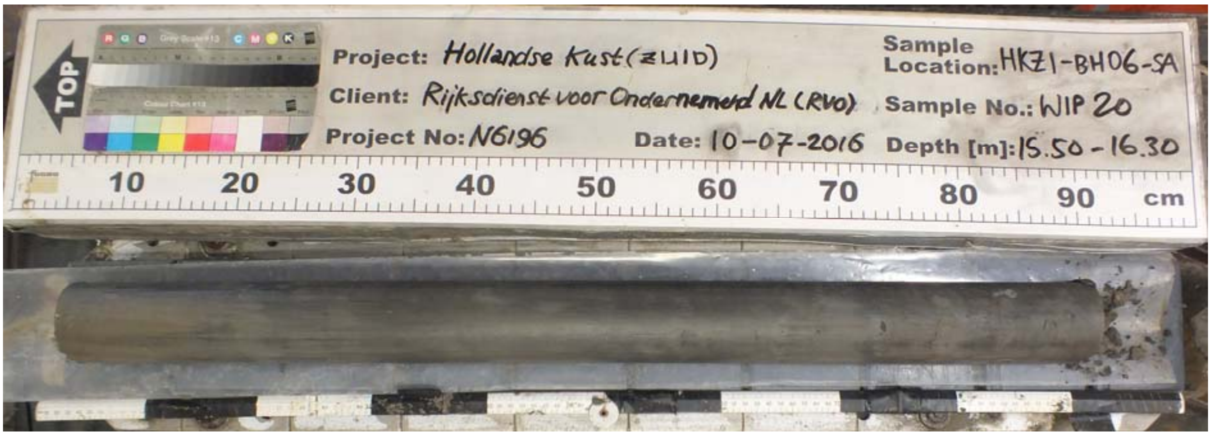
Location : HKZ1-BH06-SA
Sample : WIP18
Depth [m BSF] : 13.50 to 14.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP19
Depth [m BSF] : 14.50 to 15.20

Location : HKZ1-BH06-SA
Sample : WIP19
Depth [m BSF] : 14.50 to 15.20
Note(s) : split

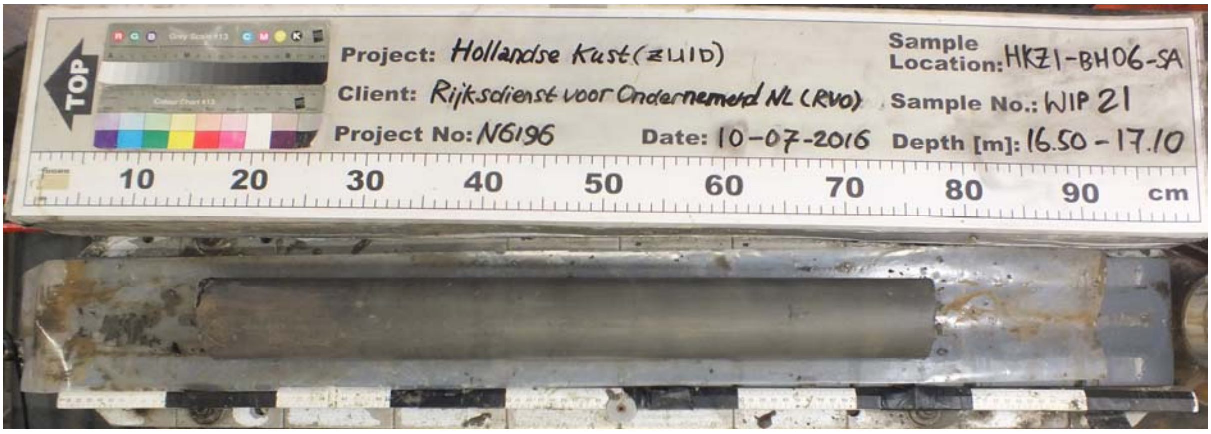
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP20
Depth [m BSF] : 15.50 to 16.30

Location : HKZ1-BH06-SA
Sample : WIP20
Depth [m BSF] : 15.50 to 16.30
Note(s) : sample photograph is missing

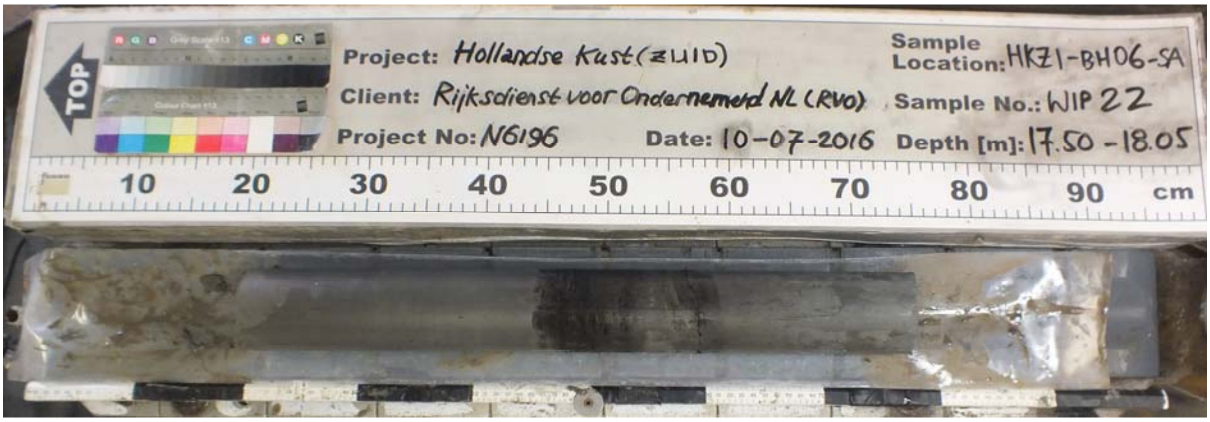
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP21
Depth [m BSF] : 16.50 to 17.10

Location : HKZ1-BH06-SA
Sample : WIP21
Depth [m BSF] : 16.50 to 17.10
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP22
Depth [m BSF] : 17.50 to 18.05

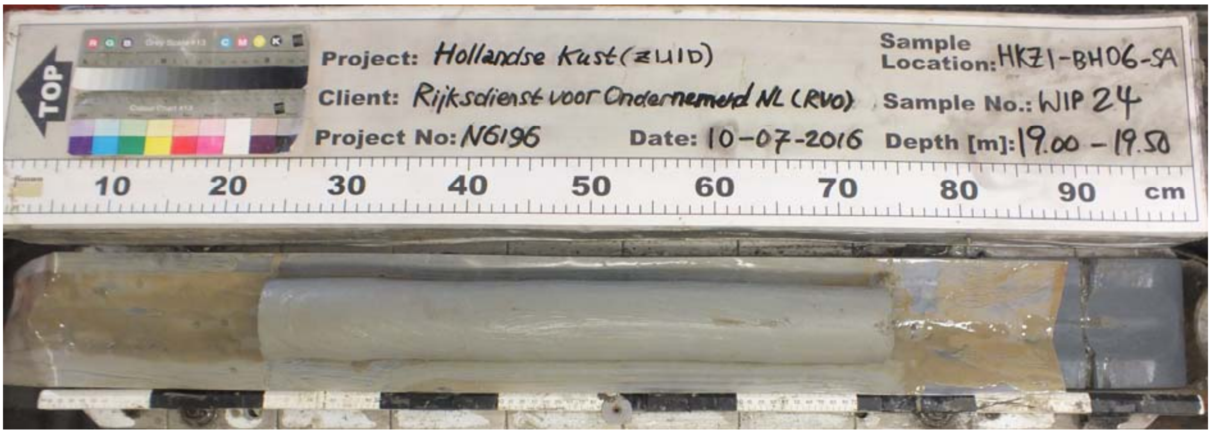
Location : HKZ1-BH06-SA
Sample : WIP22
Depth [m BSF] : 17.50 to 18.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP23
Depth [m BSF] : 18.50 to 18.75

Location : HKZ1-BH06-SA
Sample : WIP23
Depth [m BSF] : 18.50 to 18.75
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP24
Depth [m BSF] : 19.00 to 19.50

Location : HKZ1-BH06-SA
Sample : WIP24
Depth [m BSF] : 19.00 to 19.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP25
Depth [m BSF] : 20.00 to 20.70

Location : HKZ1-BH06-SA
Sample : WIP25
Depth [m BSF] : 20.00 to 20.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP26
Depth [m BSF] : 21.00 to 21.80

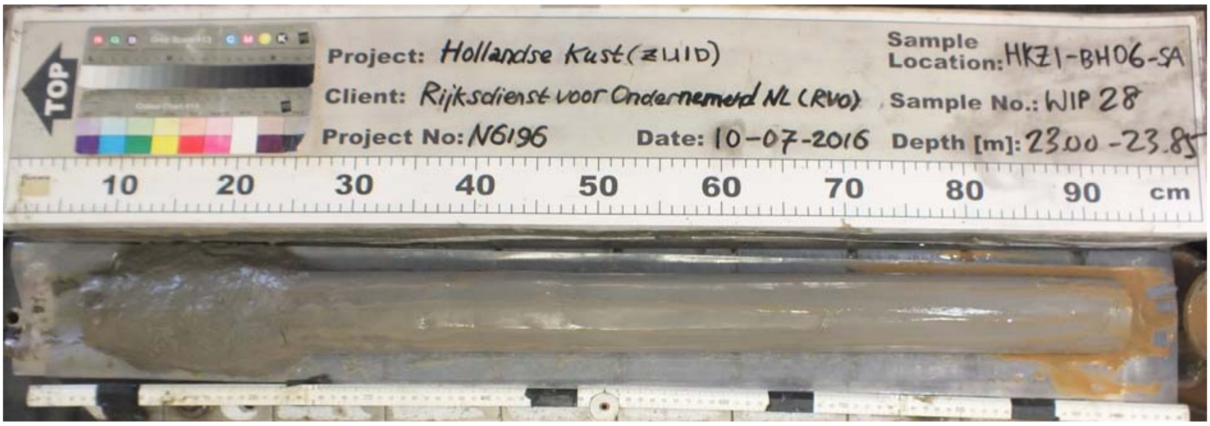
Location : HKZ1-BH06-SA
Sample : WIP26
Depth [m BSF] : 21.00 to 21.80
Note(s) : split

SAMPLE PHOTOGRAPHS

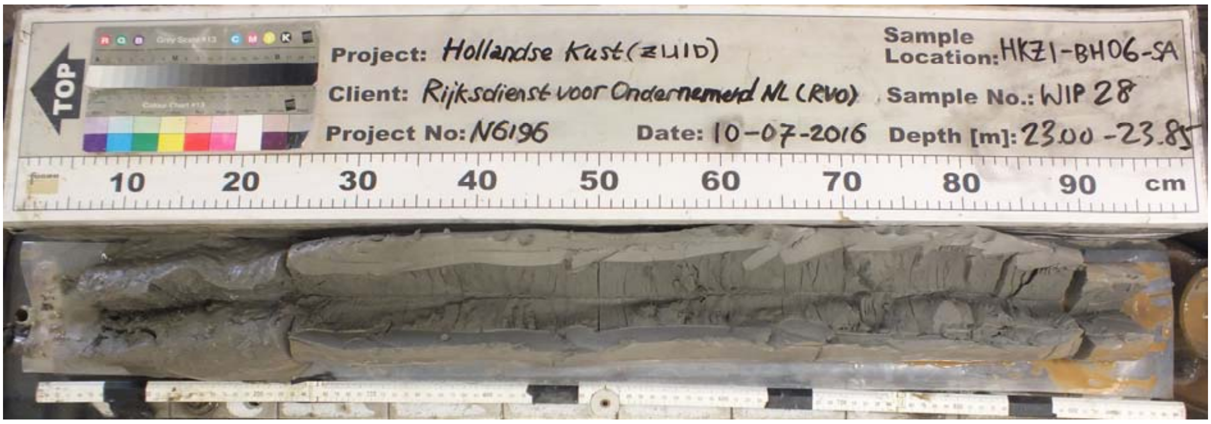
Location : HKZ1-BH06-SA
Sample : WIP27
Depth [m BSF] : 22.00 to 22.70

Location : HKZ1-BH06-SA
Sample : WIP27
Depth [m BSF] : 22.00 to 22.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP28
Depth [m BSF] : 23.00 to 23.85



Location : HKZ1-BH06-SA
Sample : WIP28
Depth [m BSF] : 23.00 to 23.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP29
Depth [m BSF] : 24.00 to 24.55

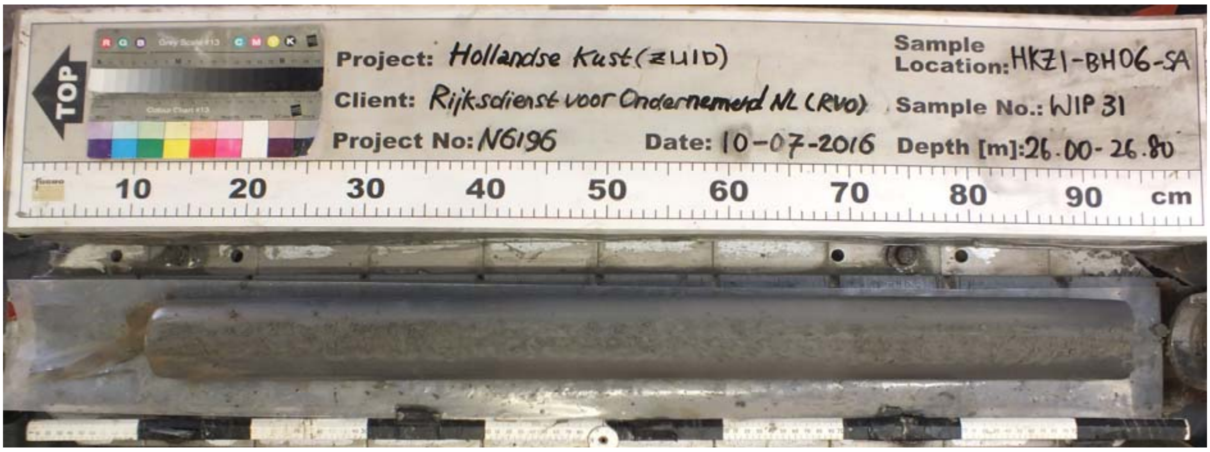
Location : HKZ1-BH06-SA
Sample : WIP29
Depth [m BSF] : 24.00 to 24.55
Note(s) : split

SAMPLE PHOTOGRAPHS

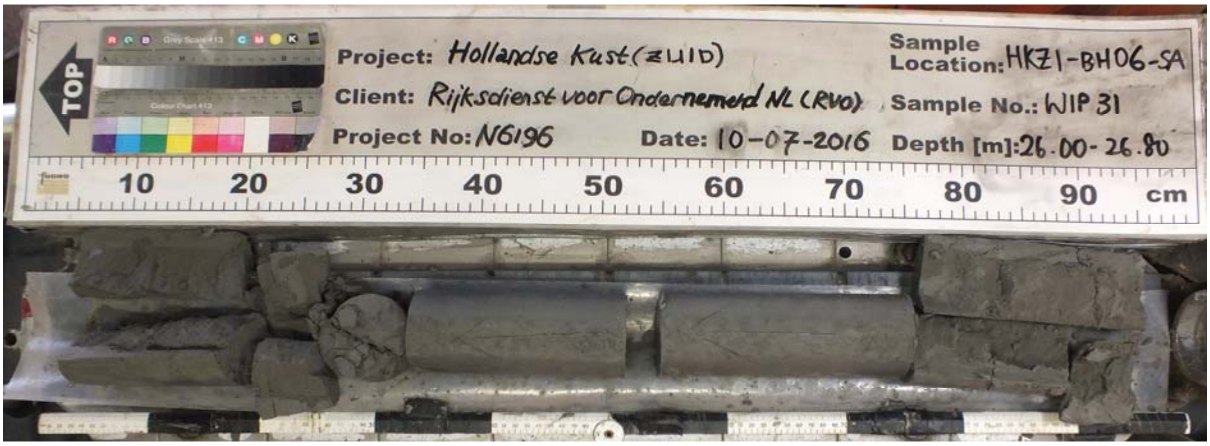
Location : HKZ1-BH06-SA
Sample : WIP30
Depth [m BSF] : 25.00 to 25.95

Location : HKZ1-BH06-SA
Sample : WIP30
Depth [m BSF] : 25.00 to 25.95
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP31
Depth [m BSF] : 26.00 to 26.80



Location : HKZ1-BH06-SA
Sample : WIP31
Depth [m BSF] : 26.00 to 26.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP32
Depth [m BSF] : 27.00 to 27.90

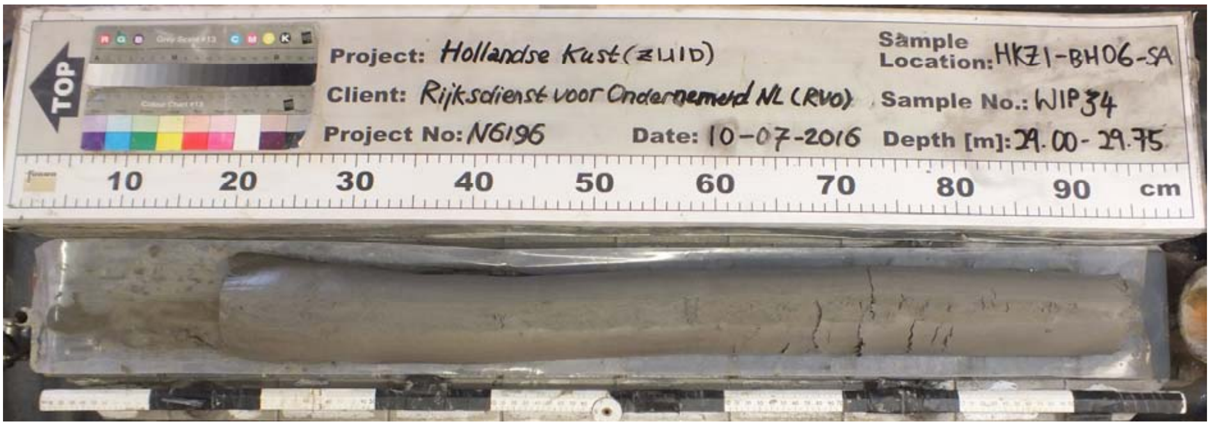
Location : HKZ1-BH06-SA
Sample : WIP32
Depth [m BSF] : 27.00 to 27.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP33
Depth [m BSF] : 28.00 to 28.70

Location : HKZ1-BH06-SA
Sample : WIP33
Depth [m BSF] : 28.00 to 28.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP34
Depth [m BSF] : 29.00 to 29.75

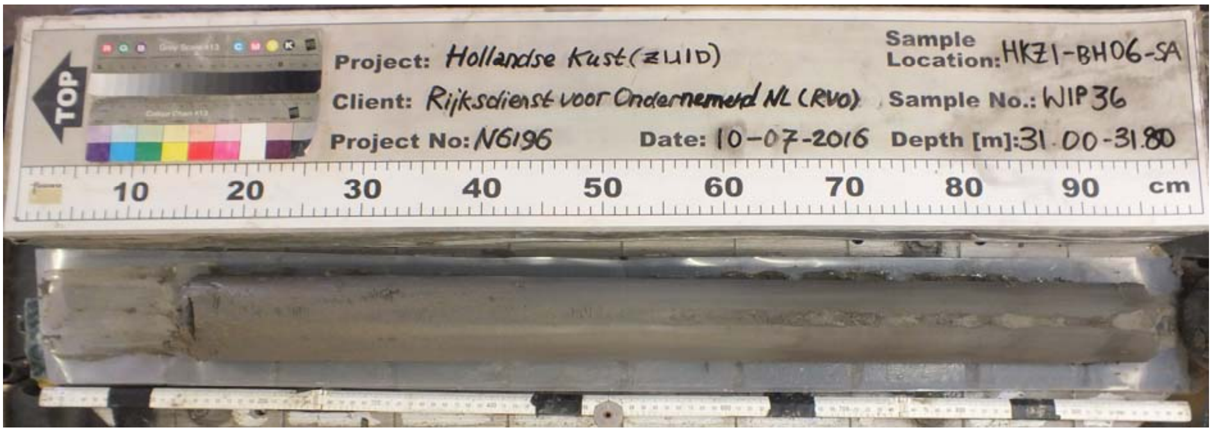
Location : HKZ1-BH06-SA
Sample : WIP34
Depth [m BSF] : 29.00 to 29.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP35
Depth [m BSF] : 30.00 to 30.75

Location : HKZ1-BH06-SA
Sample : WIP35
Depth [m BSF] : 30.00 to 30.75
Note(s) : split

SAMPLE PHOTOGRAPHS

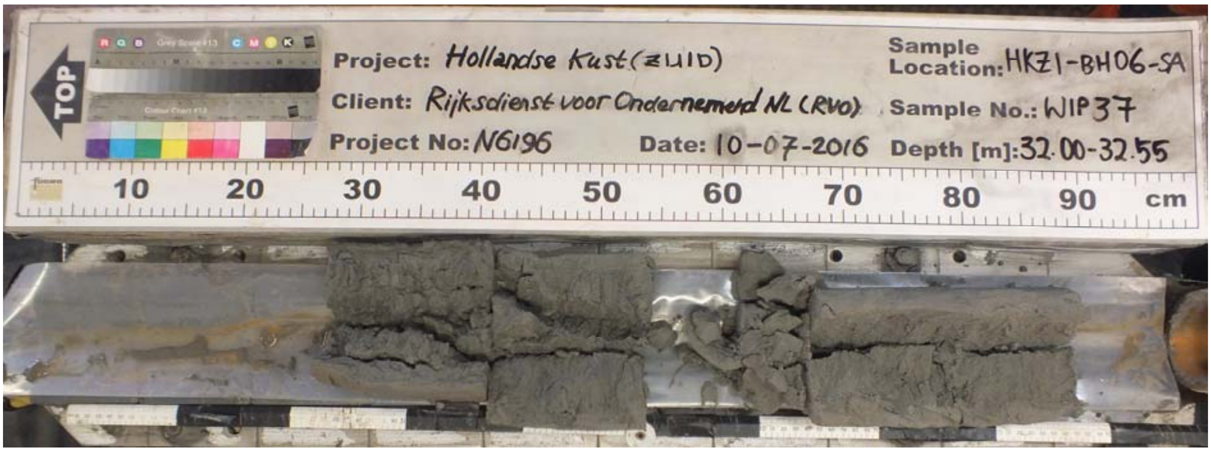


Location : HKZ1-BH06-SA
Sample : WIP36
Depth [m BSF] : 31.00 to 31.80

Location : HKZ1-BH06-SA
Sample : WIP36
Depth [m BSF] : 31.00 to 31.80
Note(s) : split

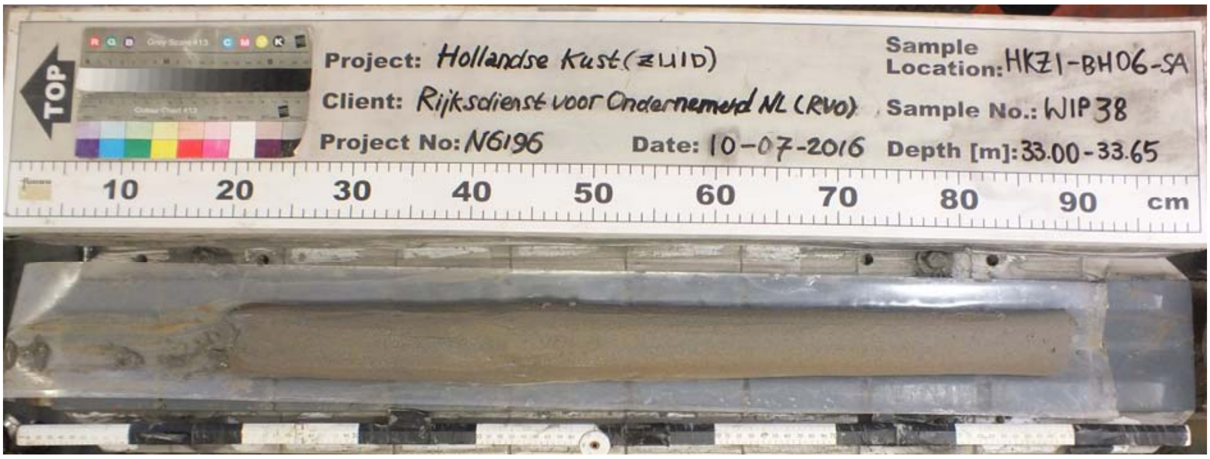
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP37
Depth [m BSF] : 32.00 to 32.55

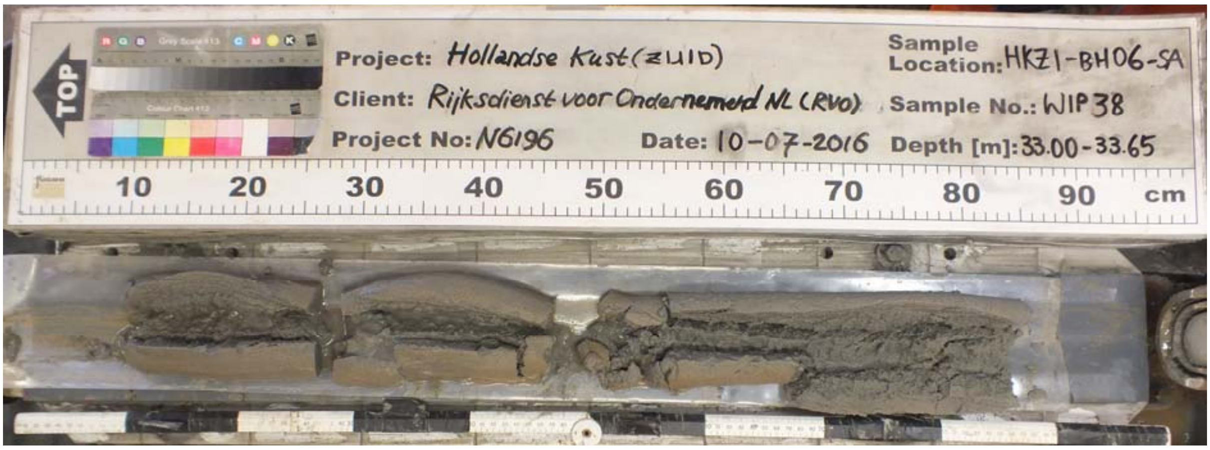


Location : HKZ1-BH06-SA
Sample : WIP37
Depth [m BSF] : 32.00 to 32.55
Note(s) : split

SAMPLE PHOTOGRAPHS

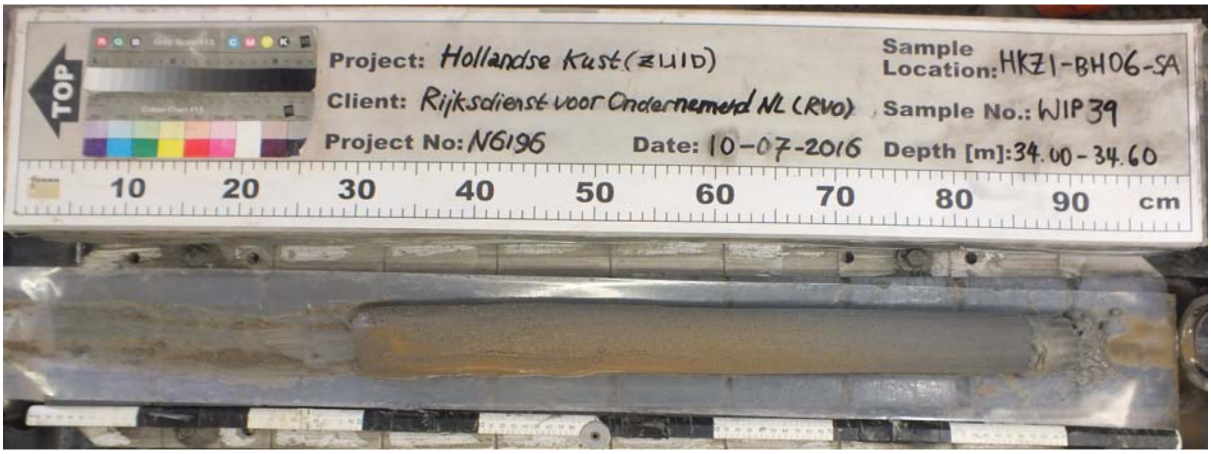


Location : HKZ1-BH06-SA
Sample : WIP38
Depth [m BSF] : 33.00 to 33.65



Location : HKZ1-BH06-SA
Sample : WIP38
Depth [m BSF] : 33.00 to 33.65
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP39
Depth [m BSF] : 34.00 to 34.60

Location : HKZ1-BH06-SA
Sample : WIP39
Depth [m BSF] : 34.00 to 34.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP40
Depth [m BSF] : 35.00 to 35.45

Location : HKZ1-BH06-SA
Sample : WIP40
Depth [m BSF] : 35.00 to 35.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP41
Depth [m BSF] : 35.50 to 35.95

Location : HKZ1-BH06-SA
Sample : WIP41
Depth [m BSF] : 35.50 to 35.95
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP42
Depth [m BSF] : 36.00 to 36.30

Location : HKZ1-BH06-SA
Sample : WIP42
Depth [m BSF] : 36.00 to 36.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP43
Depth [m BSF] : 36.50 to 37.10
Note(s) : sample photograph is missing

Location : HKZ1-BH06-SA
Sample : WIP43
Depth [m BSF] : 36.50 to 37.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP44
Depth [m BSF] : 37.50 to 38.15

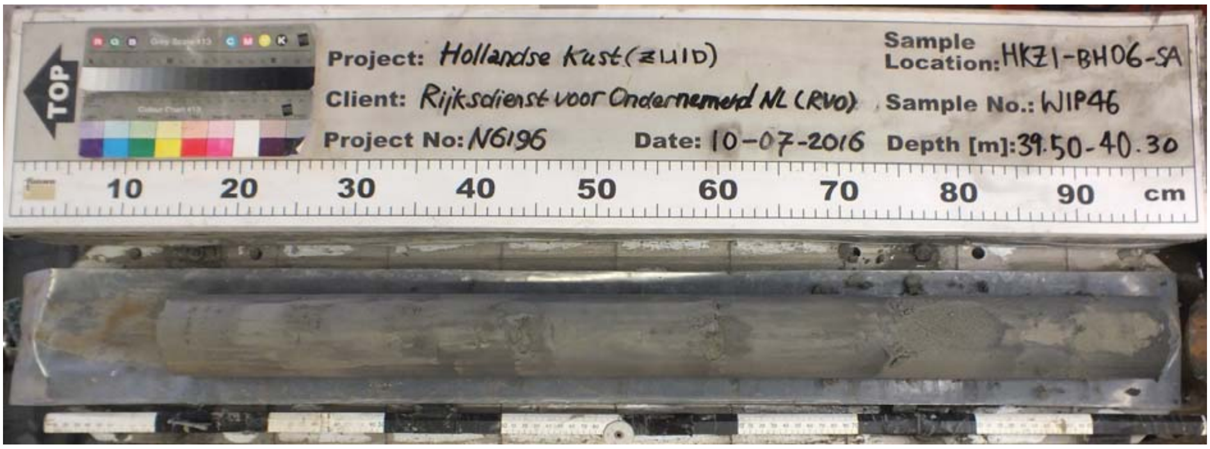
Location : HKZ1-BH06-SA
Sample : WIP44
Depth [m BSF] : 37.50 to 38.15
Note(s) : split

SAMPLE PHOTOGRAPHS

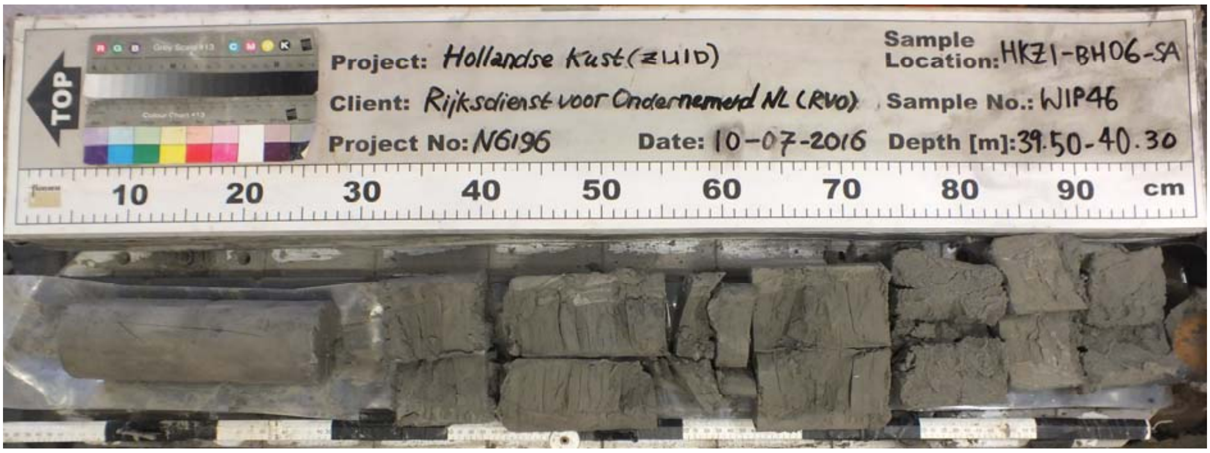
Location : HKZ1-BH06-SA
Sample : WIP45
Depth [m BSF] : 38.50 to 39.35

Location : HKZ1-BH06-SA
Sample : WIP45
Depth [m BSF] : 38.50 to 39.35
Note(s) : split

SAMPLE PHOTOGRAPHS



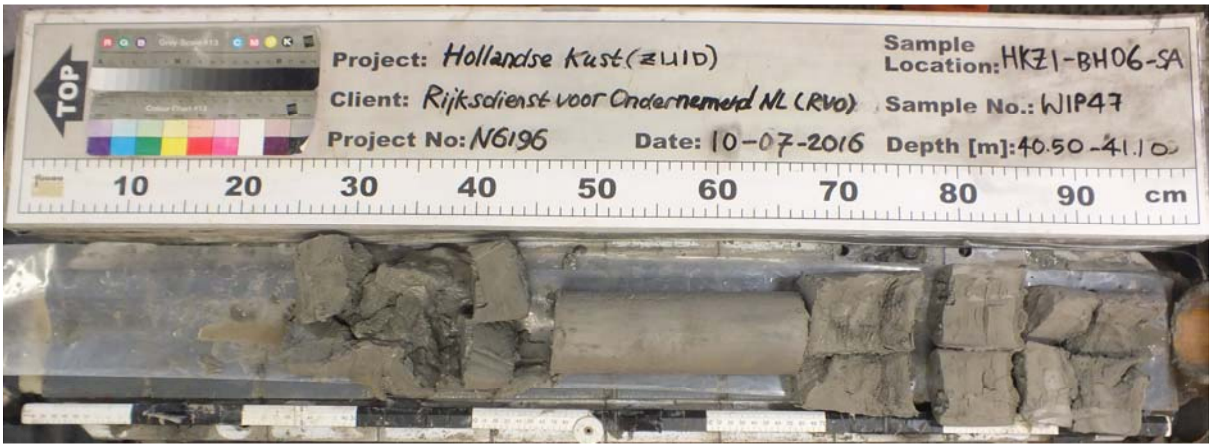
Location : HKZ1-BH06-SA
Sample : WIP46
Depth [m BSF] : 39.50 to 40.30



Location : HKZ1-BH06-SA
Sample : WIP46
Depth [m BSF] : 39.50 to 40.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP47
Depth [m BSF] : 40.50 to 41.10



Location : HKZ1-BH06-SA
Sample : WIP47
Depth [m BSF] : 40.50 to 41.10
Note(s) : split

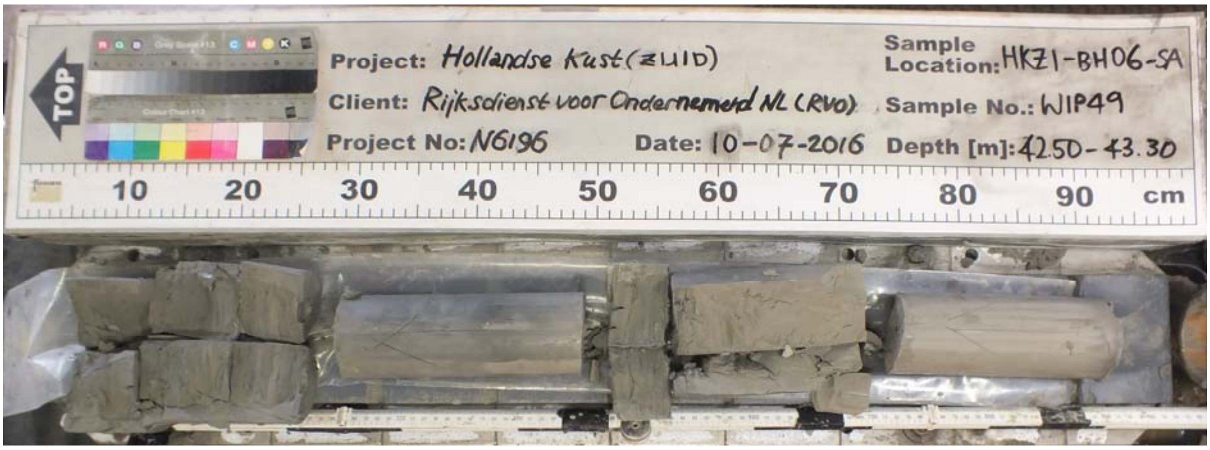
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP48
Depth [m BSF] : 41.50 to 42.30

Location : HKZ1-BH06-SA
Sample : WIP48
Depth [m BSF] : 41.50 to 42.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP49
Depth [m BSF] : 42.50 to 43.30



Location : HKZ1-BH06-SA
Sample : WIP49
Depth [m BSF] : 42.50 to 43.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP50
Depth [m BSF] : 43.50 to 44.30

Location : HKZ1-BH06-SA
Sample : WIP50
Depth [m BSF] : 43.50 to 44.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP51
Depth [m BSF] : 44.50 to 45.35

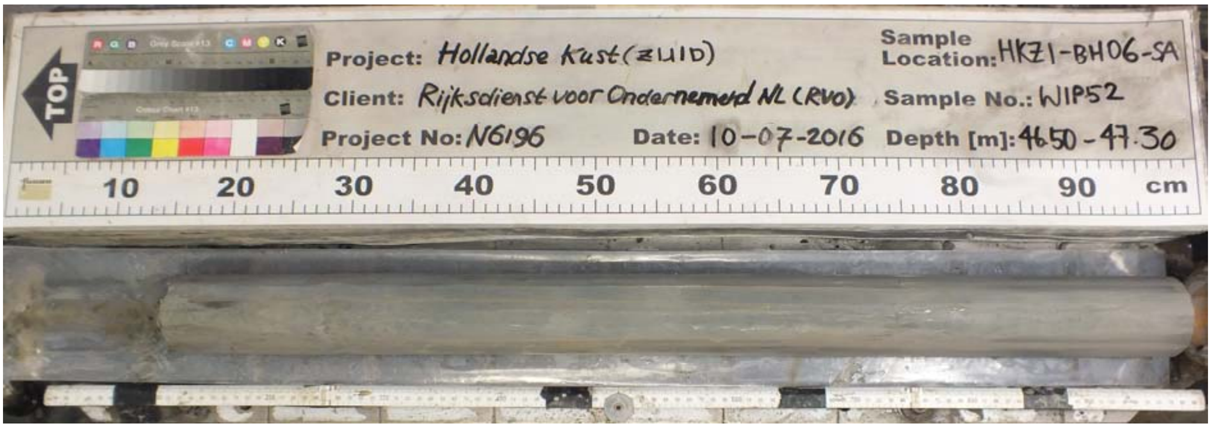
Location : HKZ1-BH06-SA
Sample : WIP51
Depth [m BSF] : 44.50 to 45.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP52
Depth [m BSF] : 45.50 to 46.25
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH06-SA
Sample : WIP52
Depth [m BSF] : 45.50 to 46.25
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS



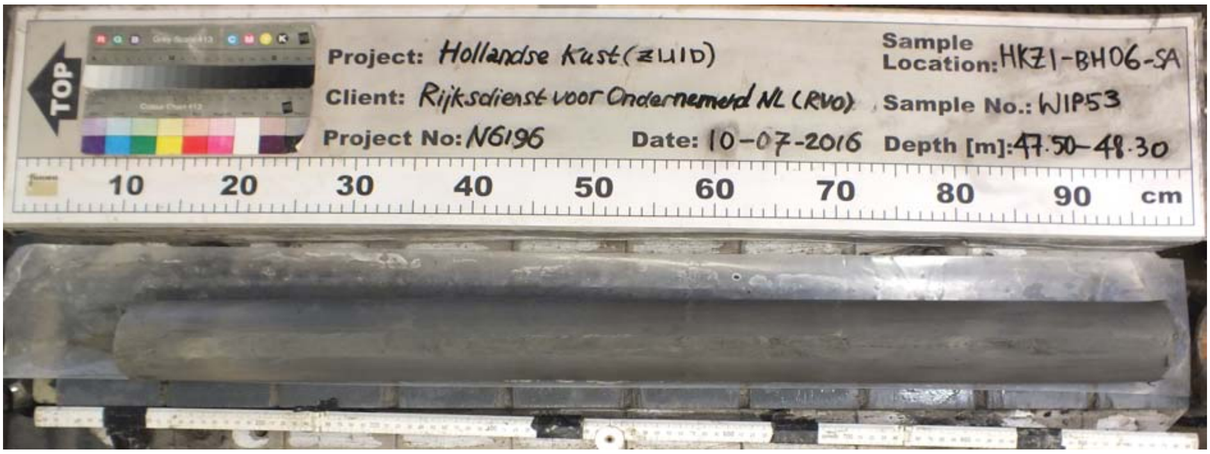
Project: Hollandse kust (zuid)
Sample Location: HKZ1-BH06-SA
Client: Rijksdienst voor Ondernemend NL (RVO)
Sample No.: WIP52
Project No: N6196
Date: 10-07-2016
Depth [m]: 46.50 - 47.30

Location : HKZ1-BH06-SA
Sample : WIP53
Depth [m BSF] : 46.50 to 47.30
Note(s) : incorrect sample number on sample photograph

Project: Hollandse kust (zuid)
Sample Location: HKZ1-BH06-SA
Client: Rijksdienst voor Ondernemend NL (RVO)
Sample No.: WIP52
Project No: N6196
Date: 10-07-2016
Depth [m]: 46.50 - 47.30

Location : HKZ1-BH06-SA
Sample : WIP53
Depth [m BSF] : 46.50 to 47.30
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH06-SA
Sample : WIP54
Depth [m BSF] : 47.50 to 48.30
Note(s) : incorrect sample number on sample photograph

Location : HKZ1-BH06-SA
Sample : WIP54
Depth [m BSF] : 47.50 to 48.30
Note(s) : split
: incorrect sample number on sample photograph

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP55
Depth [m BSF] : 48.50 to 49.20

Location : HKZ1-BH06-SA
Sample : WIP55
Depth [m BSF] : 48.50 to 49.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP56
Depth [m BSF] : 49.50 to 50.35

Location : HKZ1-BH06-SA
Sample : WIP56
Depth [m BSF] : 49.50 to 50.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP57
Depth [m BSF] : 53.50 to 54.40

Location : HKZ1-BH06-SA
Sample : WIP57
Depth [m BSF] : 53.50 to 54.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP58
Depth [m BSF] : 54.50 to 55.05

Location : HKZ1-BH06-SA
Sample : WIP58
Depth [m BSF] : 54.50 to 55.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP59
Depth [m BSF] : 59.00 to 59.35

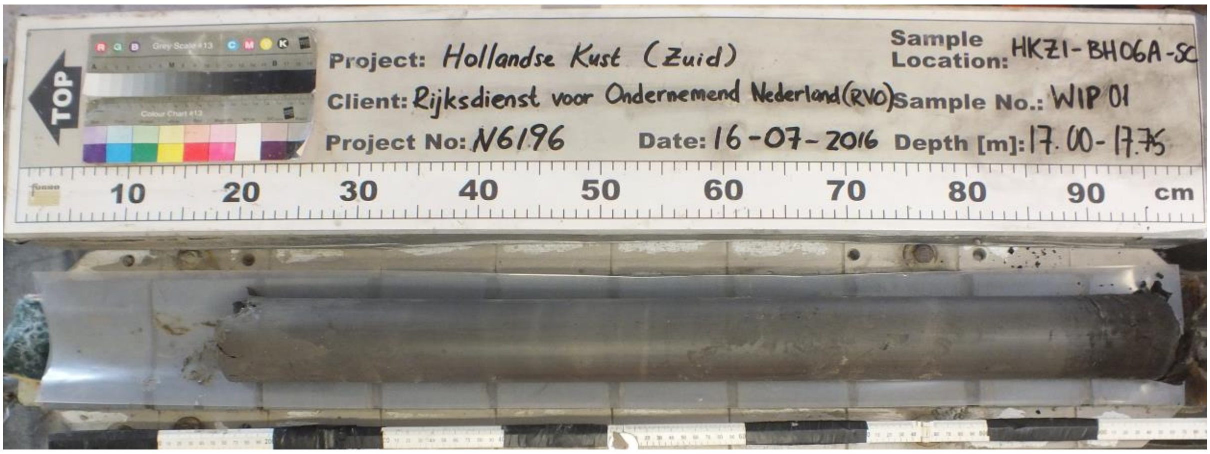
Location : HKZ1-BH06-SA
Sample : WIP59
Depth [m BSF] : 59.00 to 59.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06-SA
Sample : WIP60
Depth [m BSF] : 64.50 to 65.05

Location : HKZ1-BH06-SA
Sample : WIP60
Depth [m BSF] : 64.50 to 65.05
Note(s) : split

SAMPLE PHOTOGRAPHS

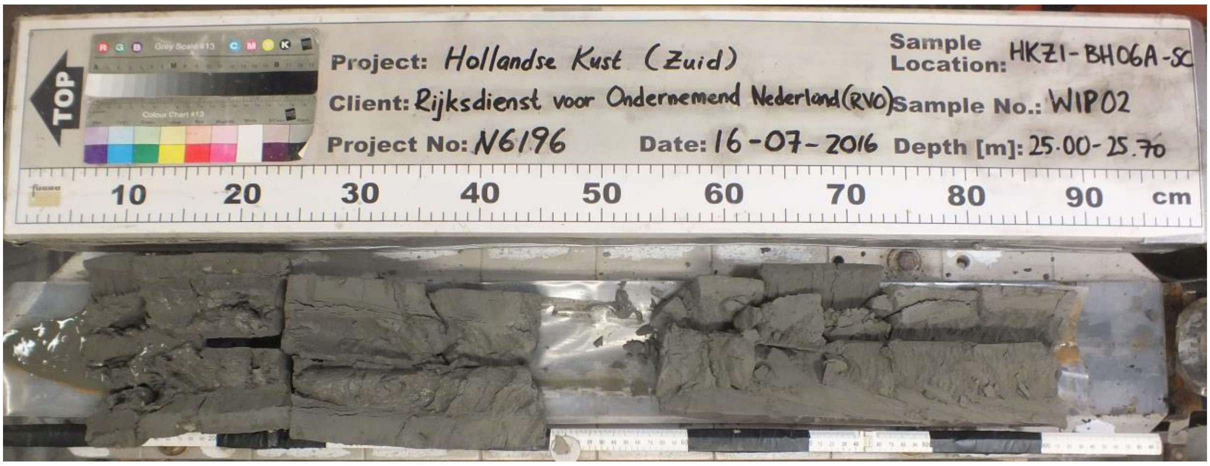


Location : HKZ1-BH06A-SC
Sample : WIP01
Depth [m BSF] : 17.00 to 17.75

Location : HKZ1-BH06A-SC
Sample : WIP01
Depth [m BSF] : 17.00 to 17.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06A-SC
Sample : WIP02
Depth [m BSF] : 25.00 to 25.70



Location : HKZ1-BH06A-SC
Sample : WIP02
Depth [m BSF] : 25.00 to 25.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH06A-SC
Sample : WIP03
Depth [m BSF] : 39.00 to 39.90

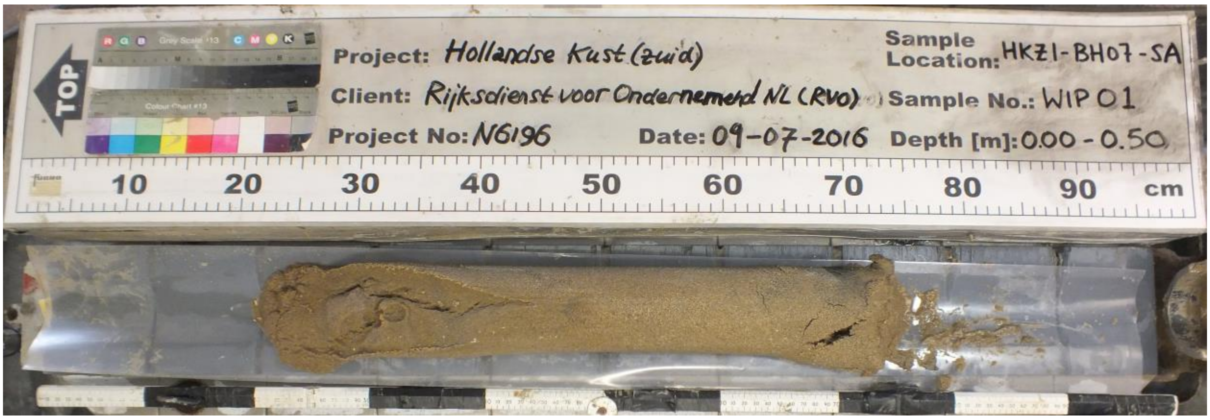
Location : HKZ1-BH06A-SC
Sample : WIP03
Depth [m BSF] : 39.00 to 39.90
Note(s) : split

SAMPLE PHOTOGRAPHS

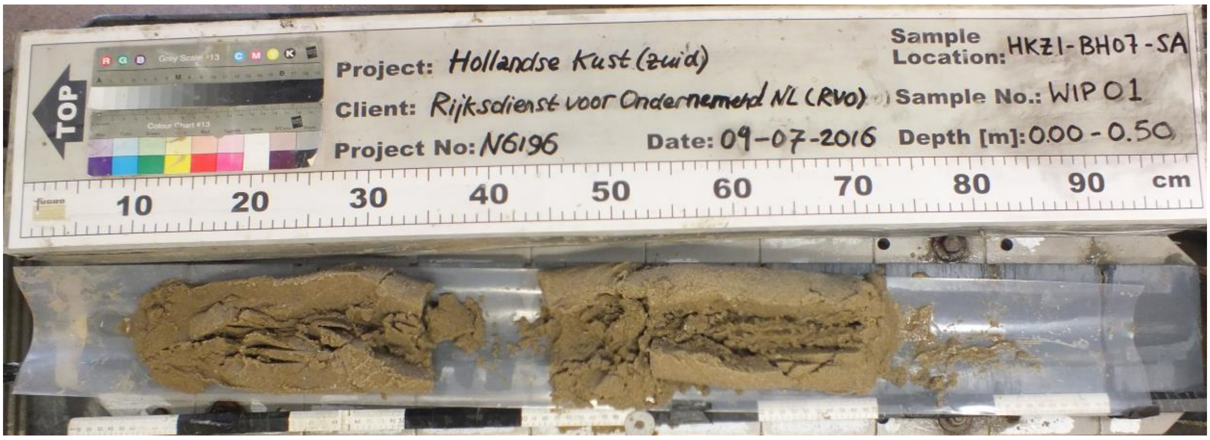
Location : HKZ1-BH06A-SC
Sample : WIP04
Depth [m BSF] : 43.00 to 43.80

Location : HKZ1-BH06A-SC
Sample : WIP04
Depth [m BSF] : 43.00 to 43.80
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.50



Location : HKZ1-BH07-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.50

Location : HKZ1-BH07-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.50

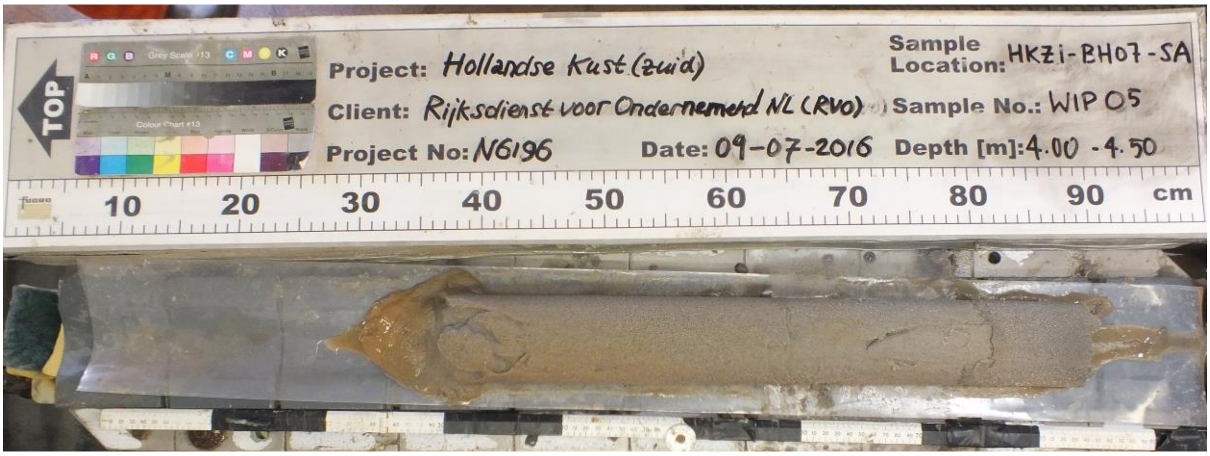
Location : HKZ1-BH07-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.60

Location : HKZ1-BH07-SA
Sample : WIP04
Depth [m BSF] : 3.00 to 3.60
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.50

Location : HKZ1-BH07-SA
Sample : WIP05
Depth [m BSF] : 4.00 to 4.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.45

Location : HKZ1-BH07-SA
Sample : WIP06
Depth [m BSF] : 5.00 to 5.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 5.90

Location : HKZ1-BH07-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 5.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP08
Depth [m BSF] : 6.00 to 6.45

Location : HKZ1-BH07-SA
Sample : WIP08
Depth [m BSF] : 6.00 to 6.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP09
Depth [m BSF] : 6.50 to 7.00

Location : HKZ1-BH07-SA
Sample : WIP09
Depth [m BSF] : 6.50 to 7.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP10
Depth [m BSF] : 7.50 to 7.90

Location : HKZ1-BH07-SA
Sample : WIP10
Depth [m BSF] : 7.50 to 7.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP11
Depth [m BSF] : 8.00 to 8.40

Location : HKZ1-BH07-SA
Sample : WIP11
Depth [m BSF] : 8.00 to 8.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP12
Depth [m BSF] : 8.50 to 8.80

Location : HKZ1-BH07-SA
Sample : WIP12
Depth [m BSF] : 8.50 to 8.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP13
Depth [m BSF] : 9.00 to 9.40

Location : HKZ1-BH07-SA
Sample : WIP13
Depth [m BSF] : 9.00 to 9.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP14
Depth [m BSF] : 9.50 to 9.95

Location : HKZ1-BH07-SA
Sample : WIP14
Depth [m BSF] : 9.50 to 9.95
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP15
Depth [m BSF] : 10.00 to 10.45

Location : HKZ1-BH07-SA
Sample : WIP15
Depth [m BSF] : 10.00 to 10.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP16
Depth [m BSF] : 10.50 to 11.05

Location : HKZ1-BH07-SA
Sample : WIP16
Depth [m BSF] : 10.50 to 11.05
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP17
Depth [m BSF] : 11.50 to 11.85

Location : HKZ1-BH07-SA
Sample : WIP17
Depth [m BSF] : 11.50 to 11.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP18
Depth [m BSF] : 12.00 to 12.35

Location : HKZ1-BH07-SA
Sample : WIP18
Depth [m BSF] : 12.00 to 12.35
Note(s) : split

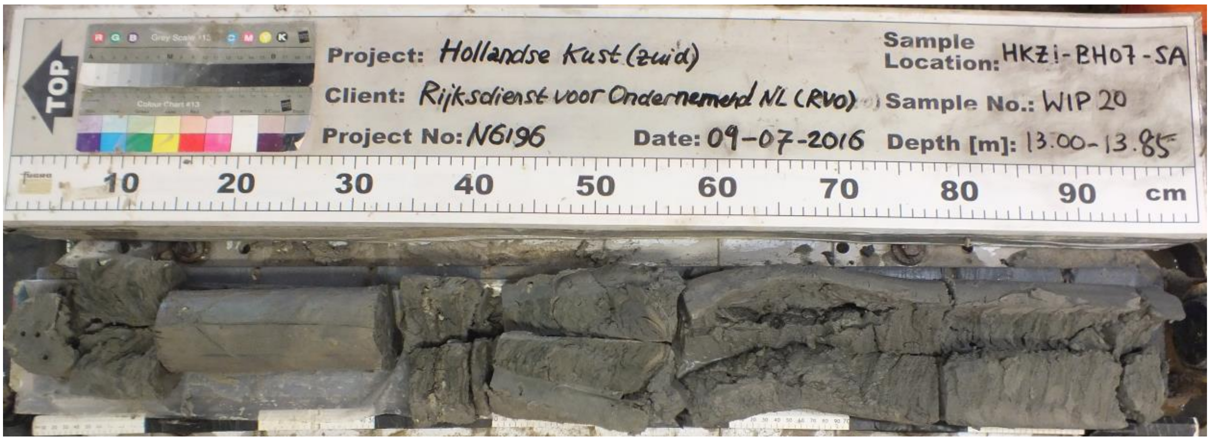
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP19
Depth [m BSF] : 12.50 to 12.90

Location : HKZ1-BH07-SA
Sample : WIP19
Depth [m BSF] : 12.50 to 12.90
Note(s) : split

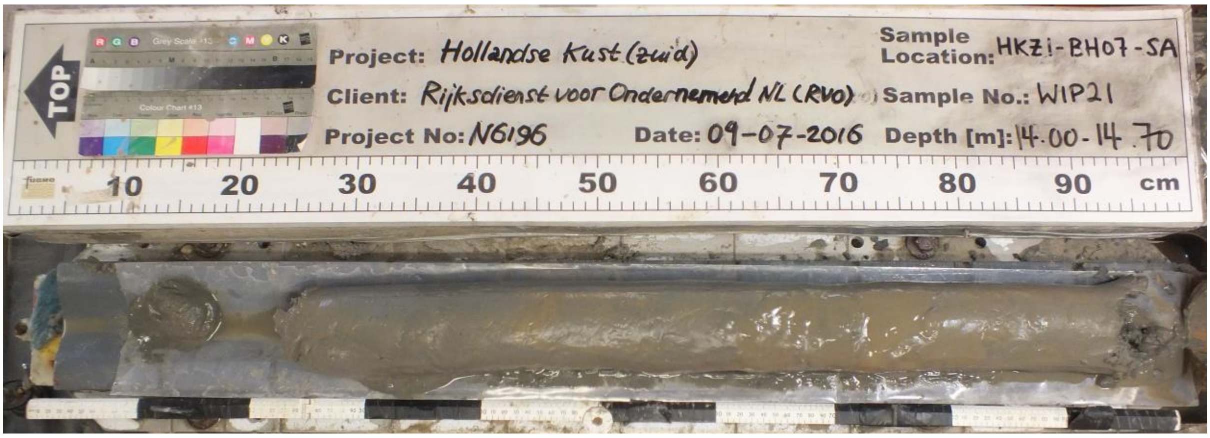
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP20
Depth [m BSF] : 13.00 to 13.85



Location : HKZ1-BH07-SA
Sample : WIP20
Depth [m BSF] : 13.00 to 13.85
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP21
Depth [m BSF] : 14.00 to 14.70

Location : HKZ1-BH07-SA
Sample : WIP21
Depth [m BSF] : 14.00 to 14.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location	:	HKZ1-BH07-SA
Sample	:	WIP22
Depth [m BSF]	:	15.00 to 15.70

Location	:	HKZ1-BH07-SA
Sample	:	WIP22
Depth [m BSF]	:	15.00 to 15.70
Note(s)	:	split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP23
Depth [m BSF] : 16.00 to 16.30

Location : HKZ1-BH07-SA
Sample : WIP23
Depth [m BSF] : 16.00 to 16.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP24
Depth [m BSF] : 17.00 to 17.75

Location : HKZ1-BH07-SA
Sample : WIP24
Depth [m BSF] : 17.00 to 17.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP25
Depth [m BSF] : 18.00 to 18.70

Location : HKZ1-BH07-SA
Sample : WIP25
Depth [m BSF] : 18.00 to 18.70
Note(s) : split

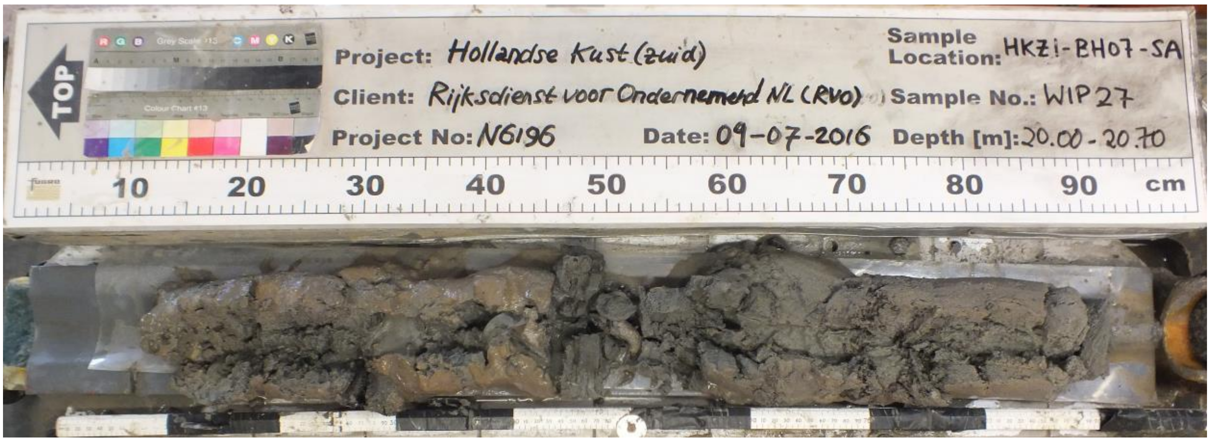
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP26
Depth [m BSF] : 19.00 to 19.70

Location : HKZ1-BH07-SA
Sample : WIP26
Depth [m BSF] : 19.00 to 19.70
Note(s) : split

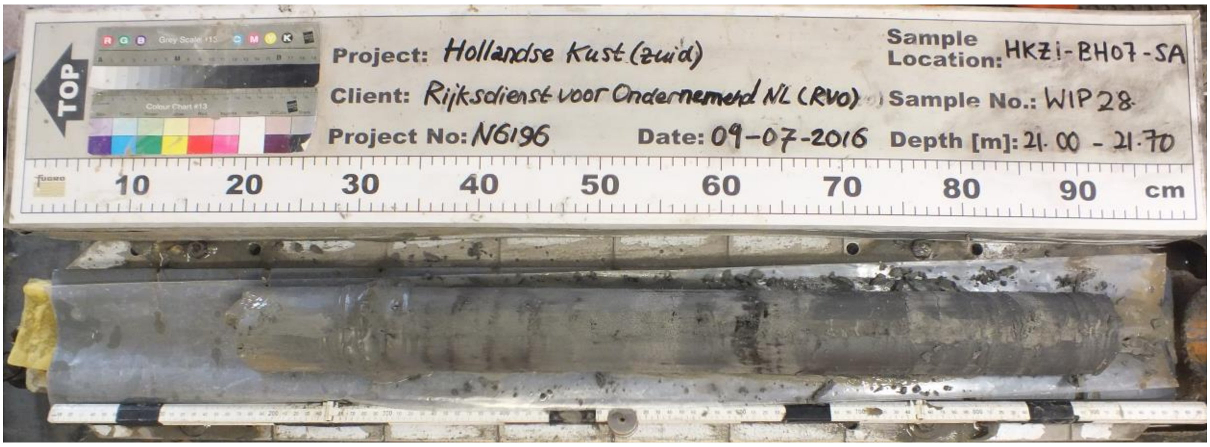
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP27
Depth [m BSF] : 20.00 to 20.70

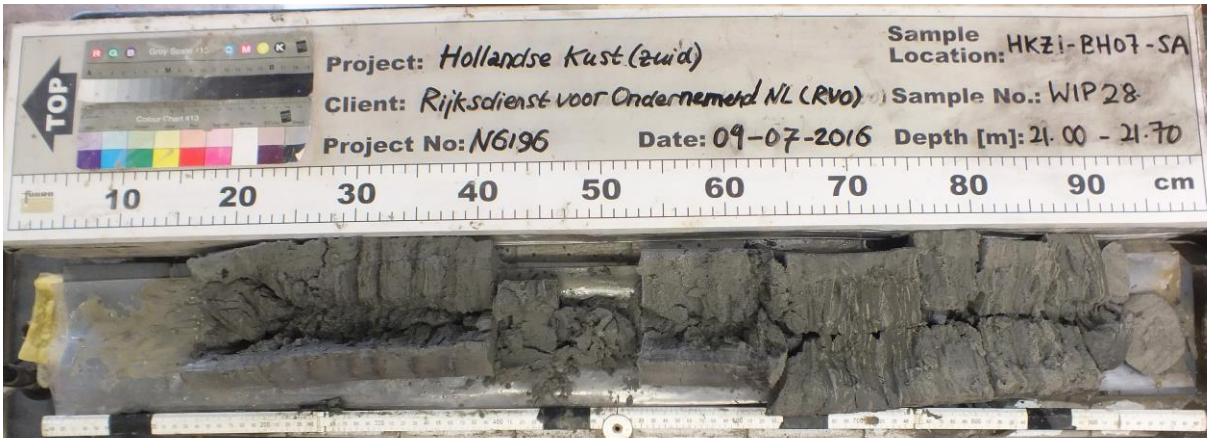


Location : HKZ1-BH07-SA
Sample : WIP27
Depth [m BSF] : 20.00 to 20.70
Note(s) : split

SAMPLE PHOTOGRAPHS

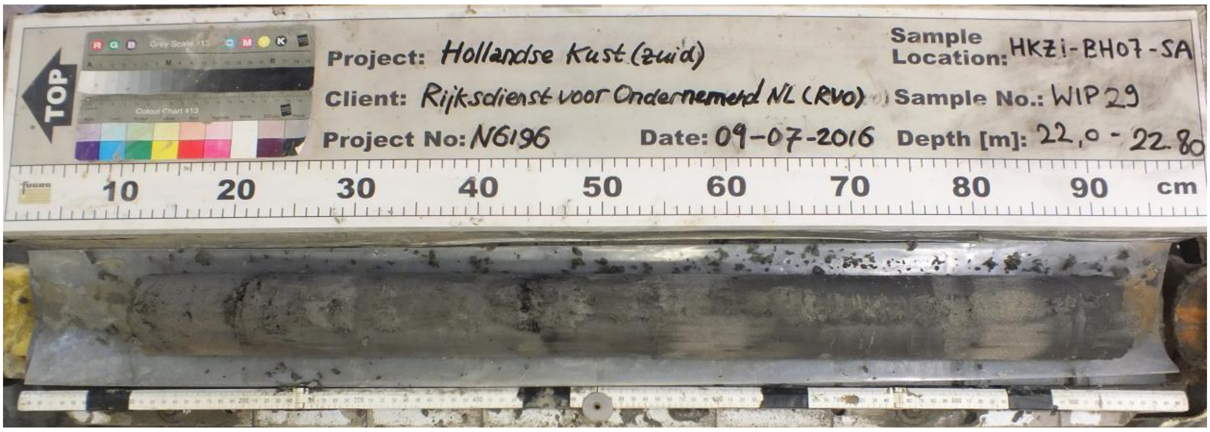


Location : HKZ1-BH07-SA
Sample : WIP28
Depth [m BSF] : 21.00 to 21.70



Location : HKZ1-BH07-SA
Sample : WIP28
Depth [m BSF] : 21.00 to 21.70
Note(s) : split

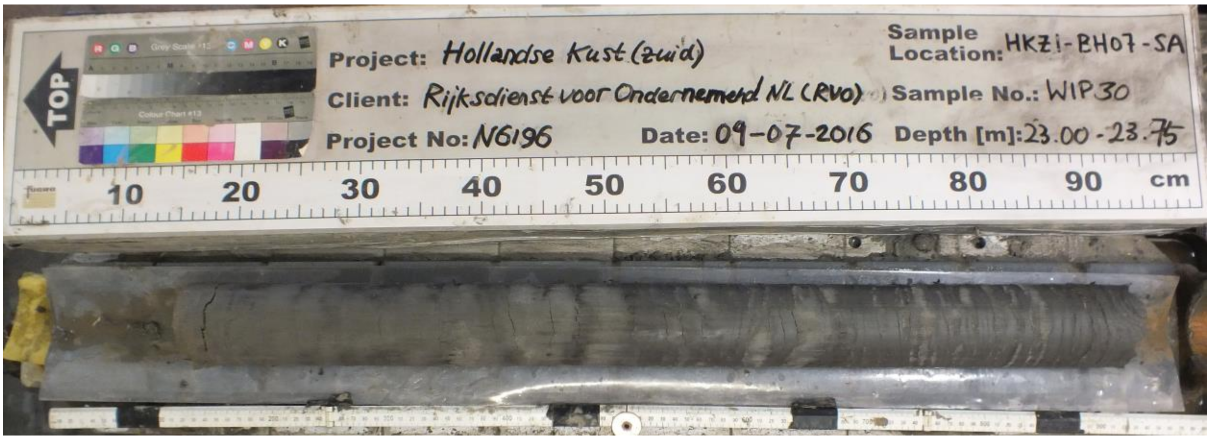
SAMPLE PHOTOGRAPHS



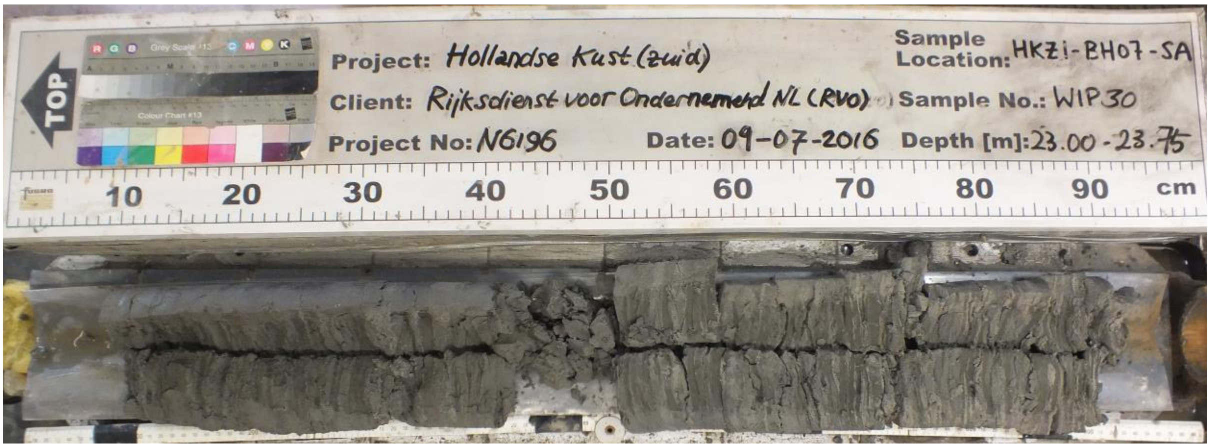
Location : HKZ1-BH07-SA
Sample : WIP29
Depth [m BSF] : 22.00 to 22.80

Location : HKZ1-BH07-SA
Sample : WIP29
Depth [m BSF] : 22.00 to 22.80
Note(s) : split

SAMPLE PHOTOGRAPHS

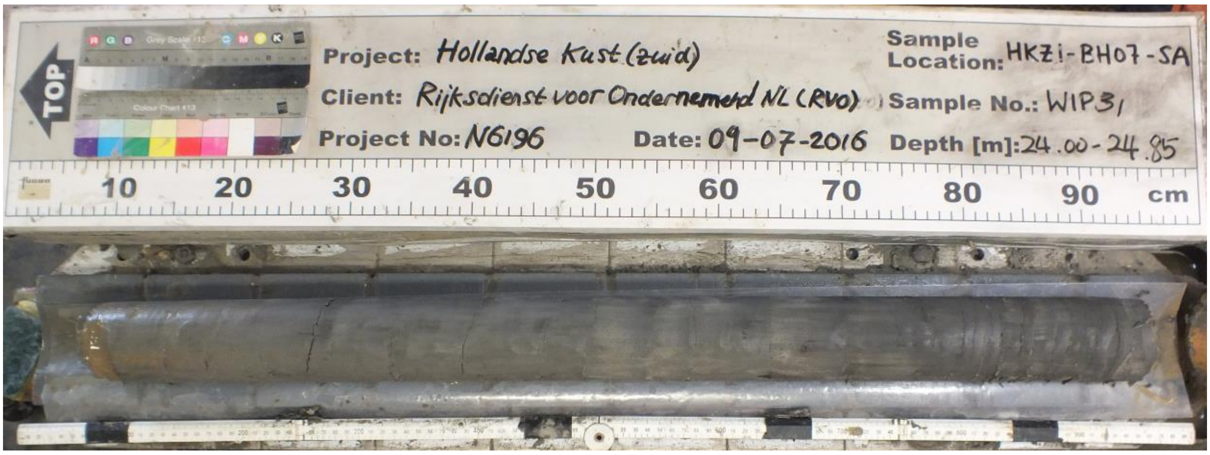


Location : HKZ1-BH07-SA
Sample : WIP30
Depth [m BSF] : 23.00 to 23.75



Location : HKZ1-BH07-SA
Sample : WIP30
Depth [m BSF] : 23.00 to 23.75
Note(s) : split

SAMPLE PHOTOGRAPHS

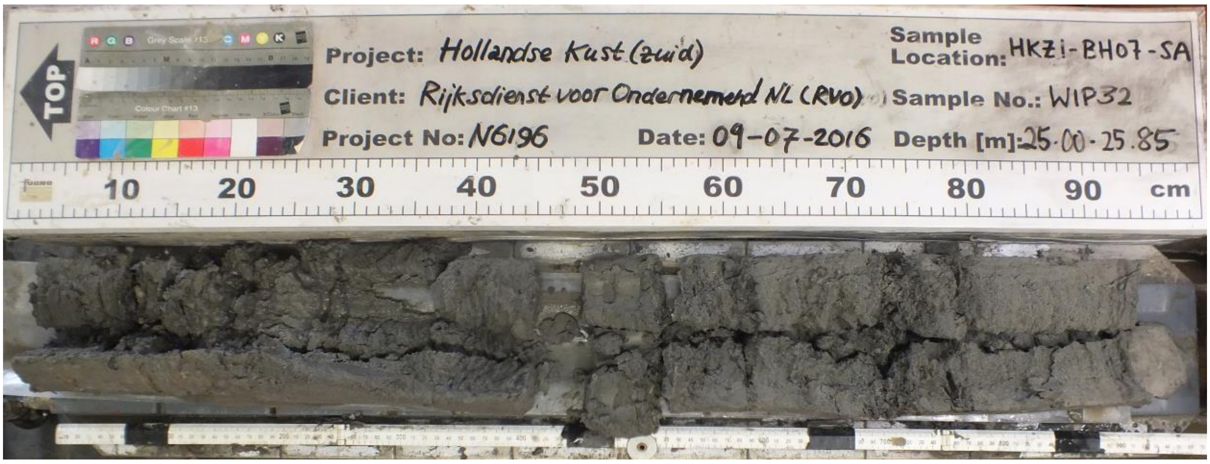


Location : HKZ1-BH07-SA
Sample : WIP31
Depth [m BSF] : 24.00 to 24.85

Location : HKZ1-BH07-SA
Sample : WIP31
Depth [m BSF] : 24.00 to 24.85
Note(s) : split

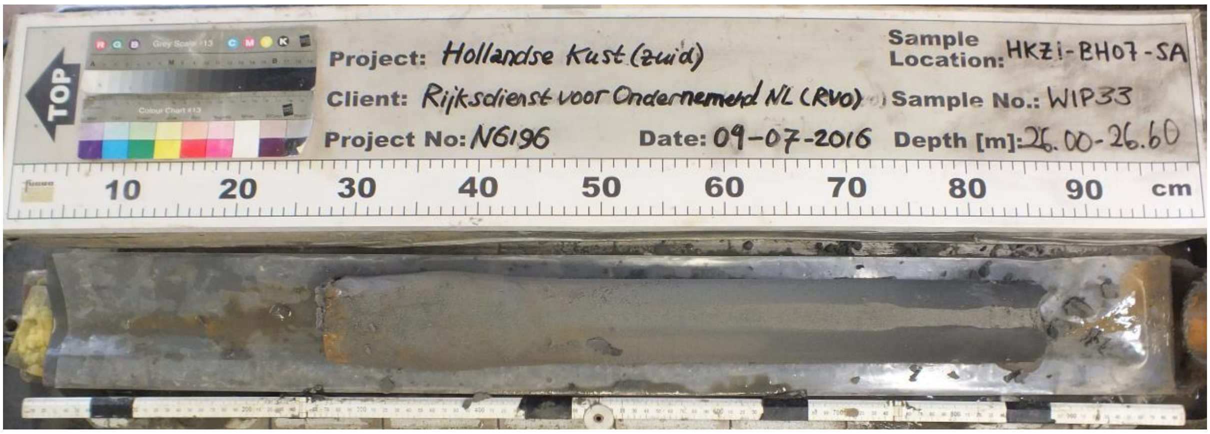
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP32
Depth [m BSF] : 25.00 to 25.85



Location : HKZ1-BH07-SA
Sample : WIP32
Depth [m BSF] : 25.00 to 25.85
Note(s) : split

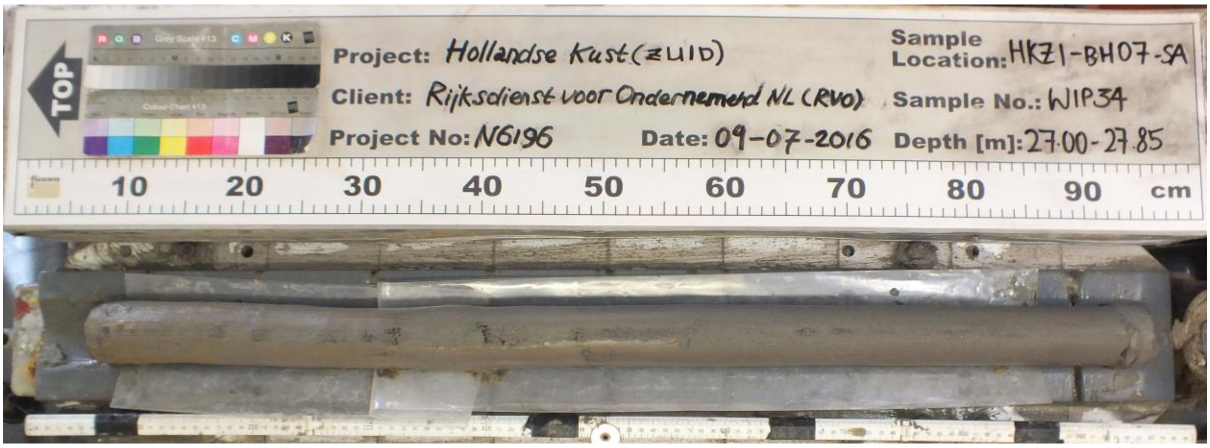
SAMPLE PHOTOGRAPHS



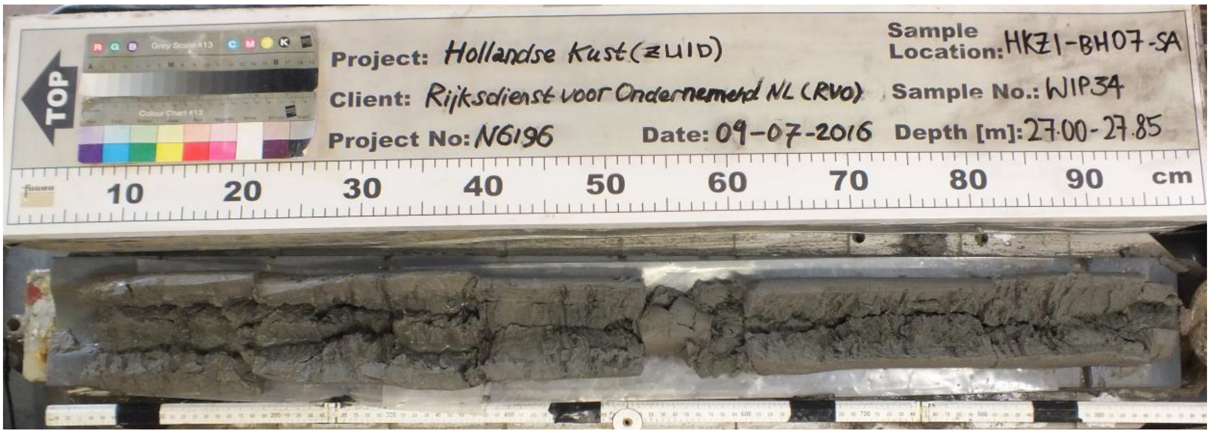
Location : HKZ1-BH07-SA
Sample : WIP33
Depth [m BSF] : 26.00 to 26.60

Location : HKZ1-BH07-SA
Sample : WIP33
Depth [m BSF] : 26.00 to 26.60
Note(s) : split

SAMPLE PHOTOGRAPHS



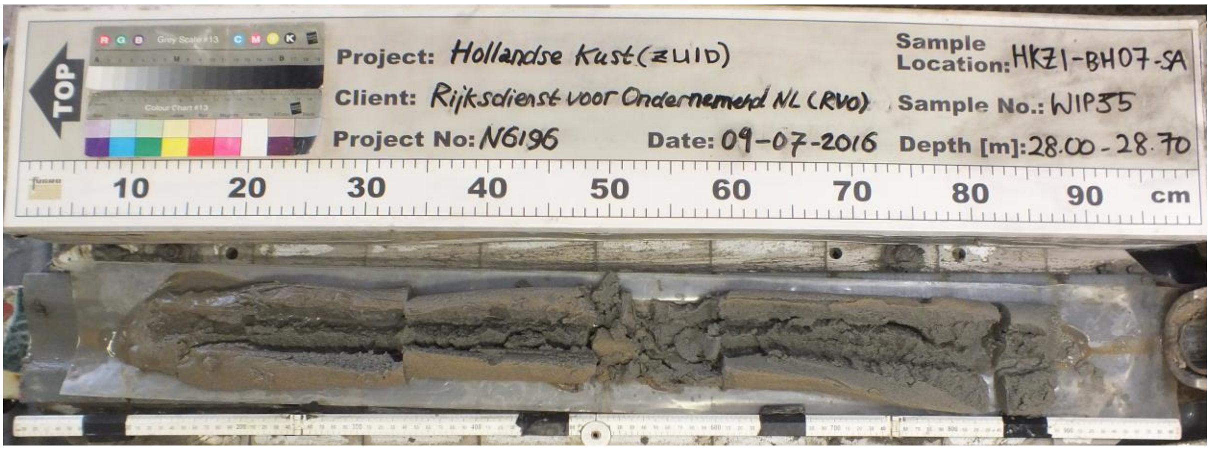
Location : HKZ1-BH07-SA
Sample : WIP34
Depth [m BSF] : 27.00 to 27.85



Location : HKZ1-BH07-SA
Sample : WIP34
Depth [m BSF] : 27.00 to 27.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP35
Depth [m BSF] : 28.00 to 28.70



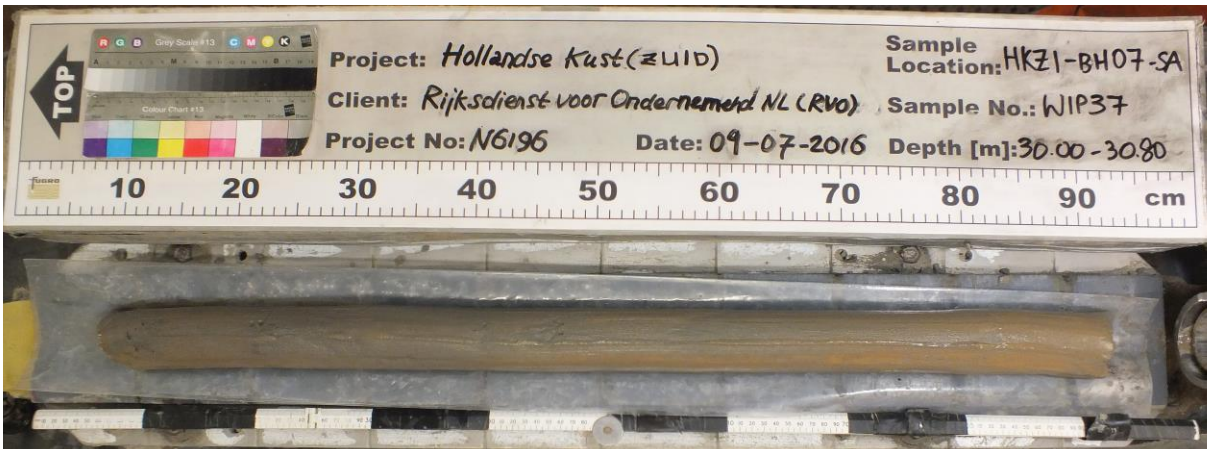
Location : HKZ1-BH07-SA
Sample : WIP35
Depth [m BSF] : 28.00 to 28.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP36
Depth [m BSF] : 29.00 to 29.55

Location : HKZ1-BH07-SA
Sample : WIP36
Depth [m BSF] : 29.00 to 29.55
Note(s) : split

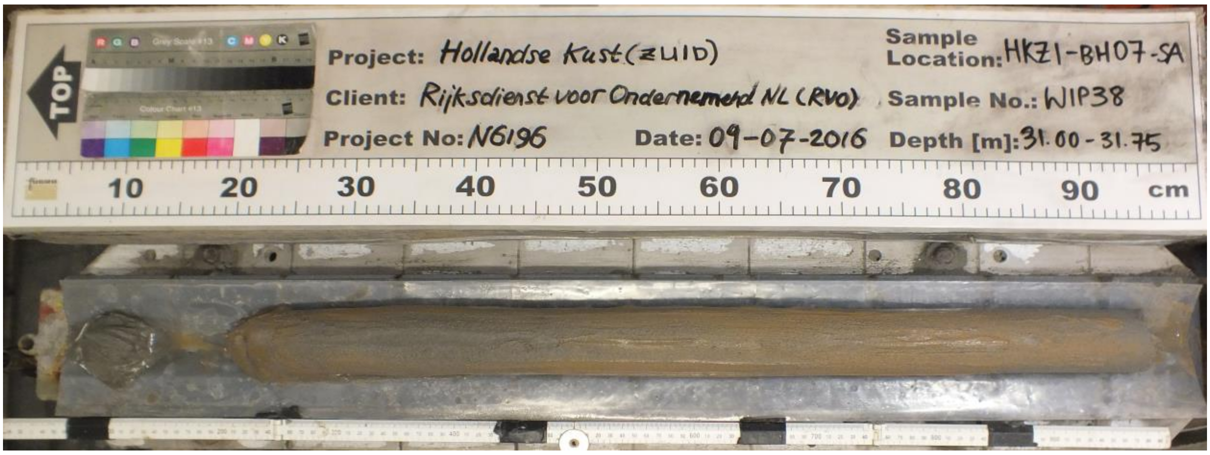
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP37
Depth [m BSF] : 30.00 to 30.80

Location : HKZ1-BH07-SA
Sample : WIP37
Depth [m BSF] : 30.00 to 30.80
Note(s) : split

SAMPLE PHOTOGRAPHS



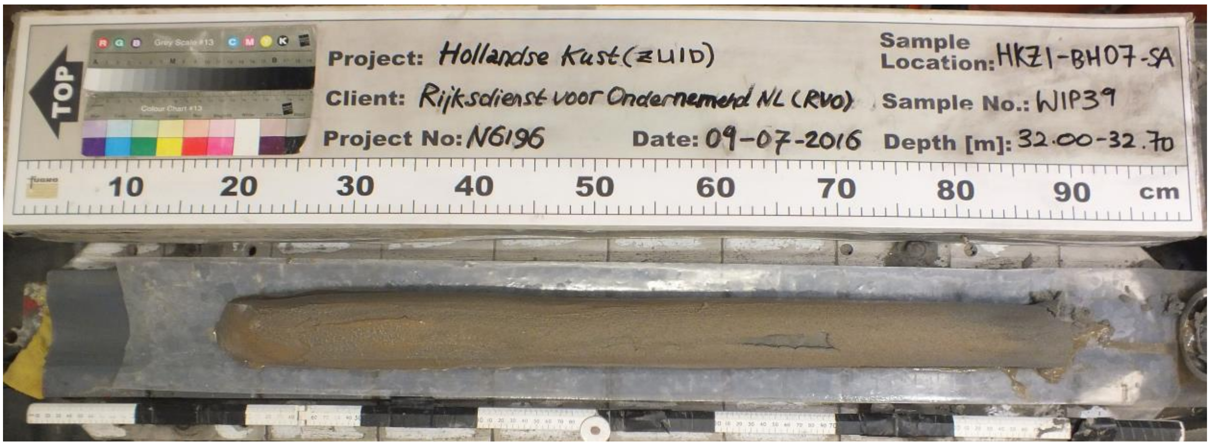
Project: Hollandse Kust (zuid)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 09-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP38
Depth [m]: 31.00 - 31.75

Location : HKZ1-BH07-SA
Sample : WIP38
Depth [m BSF] : 31.00 to 31.75

Project: Hollandse Kust (zuid)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 09-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP38
Depth [m]: 31.00 - 31.75

Location : HKZ1-BH07-SA
Sample : WIP38
Depth [m BSF] : 31.00 to 31.75
Note(s) : split

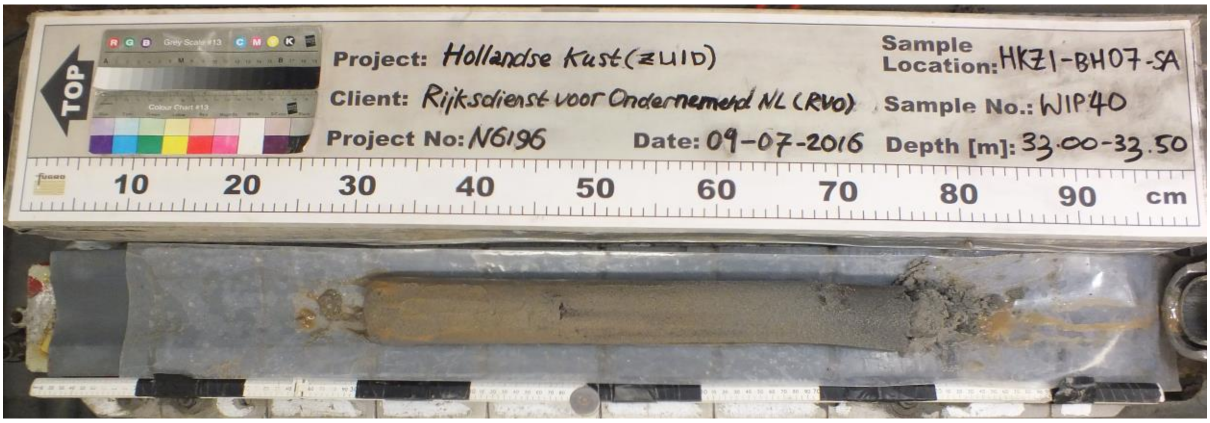
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP39
Depth [m BSF] : 32.00 to 32.70

Location : HKZ1-BH07-SA
Sample : WIP39
Depth [m BSF] : 32.00 to 32.70
Note(s) : split

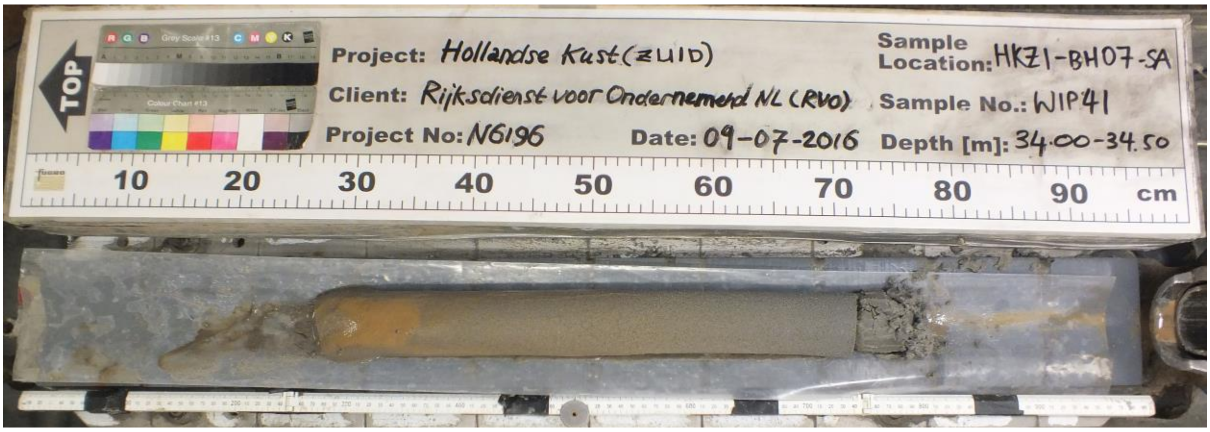
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP40
Depth [m BSF] : 33.00 to 33.50

Location : HKZ1-BH07-SA
Sample : WIP40
Depth [m BSF] : 33.00 to 33.50
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP41
Depth [m BSF] : 34.00 to 34.50

Location : HKZ1-BH07-SA
Sample : WIP41
Depth [m BSF] : 34.00 to 34.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP42
Depth [m BSF] : 35.00 to 35.40

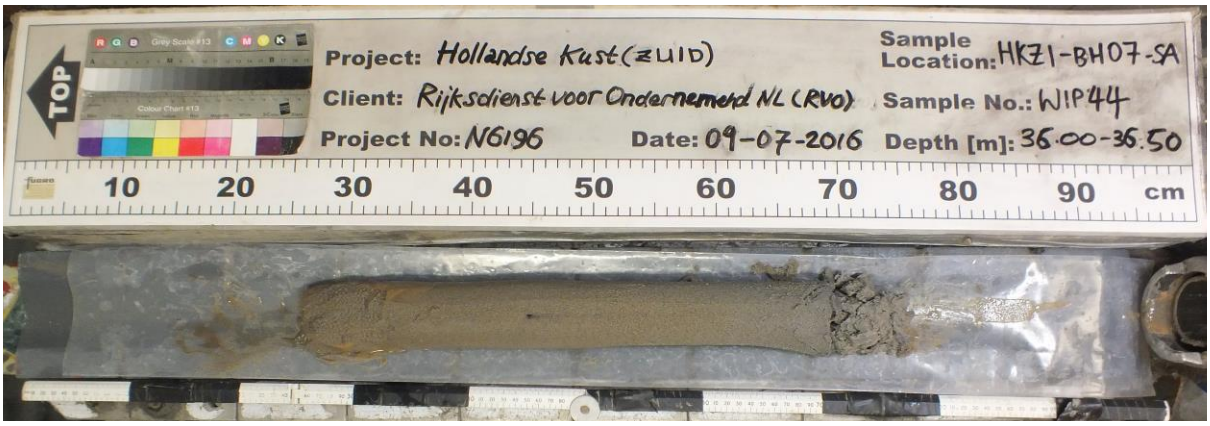
Location : HKZ1-BH07-SA
Sample : WIP42
Depth [m BSF] : 35.00 to 35.40
Note(s) : split

SAMPLE PHOTOGRAPHS

Location	:	HKZ1-BH07-SA
Sample	:	WIP43
Depth [m BSF]	:	35.50 to 35.90
Note(s)	:	incorrect depth presented on sample photograph

Location	:	HKZ1-BH07-SA
Sample	:	WIP43
Depth [m BSF]	:	35.50 to 35.90
Note(s)	:	split
	:	incorrect depth presented on sample photograph

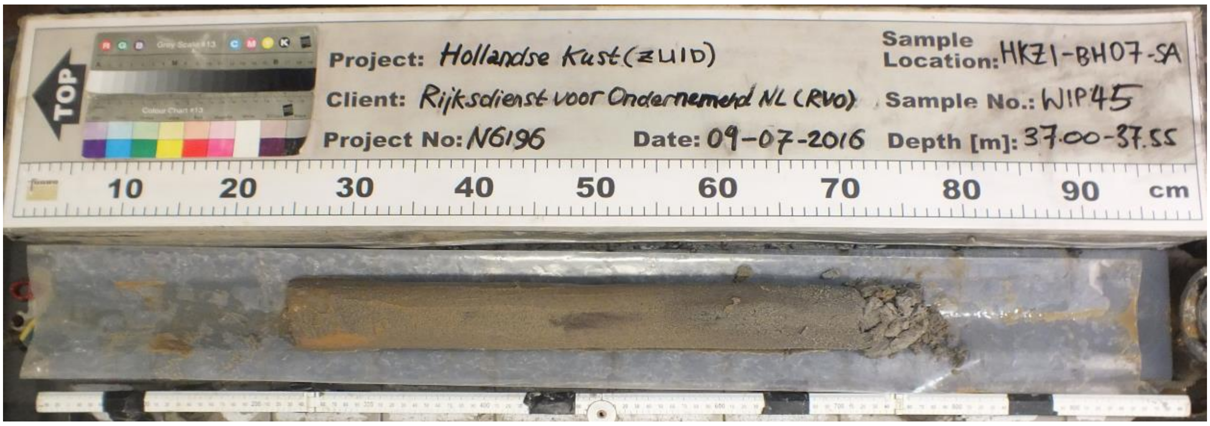
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP44
Depth [m BSF] : 36.00 to 36.50

Location : HKZ1-BH07-SA
Sample : WIP44
Depth [m BSF] : 36.00 to 36.50
Note(s) : split

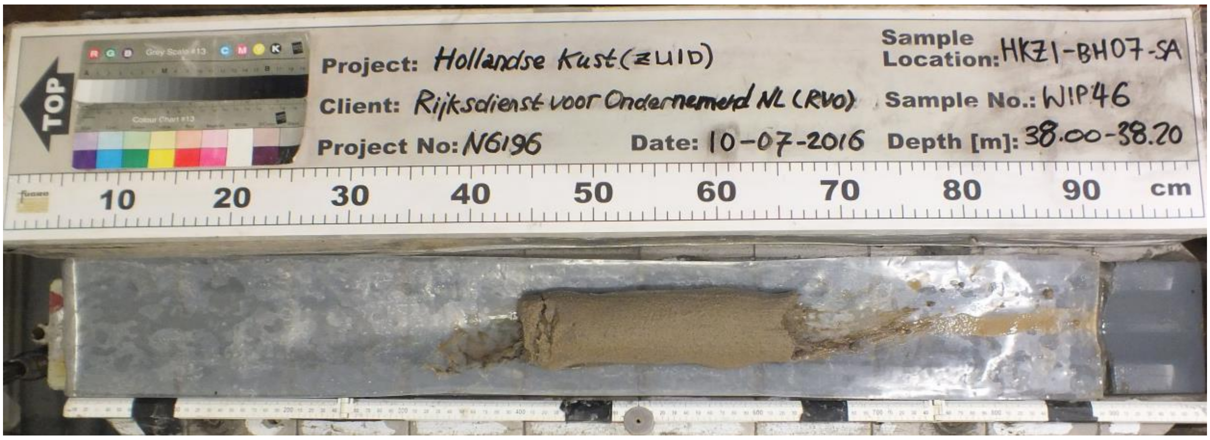
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP45
Depth [m BSF] : 37.00 to 37.55

Location : HKZ1-BH07-SA
Sample : WIP45
Depth [m BSF] : 37.00 to 37.55
Note(s) : split

SAMPLE PHOTOGRAPHS

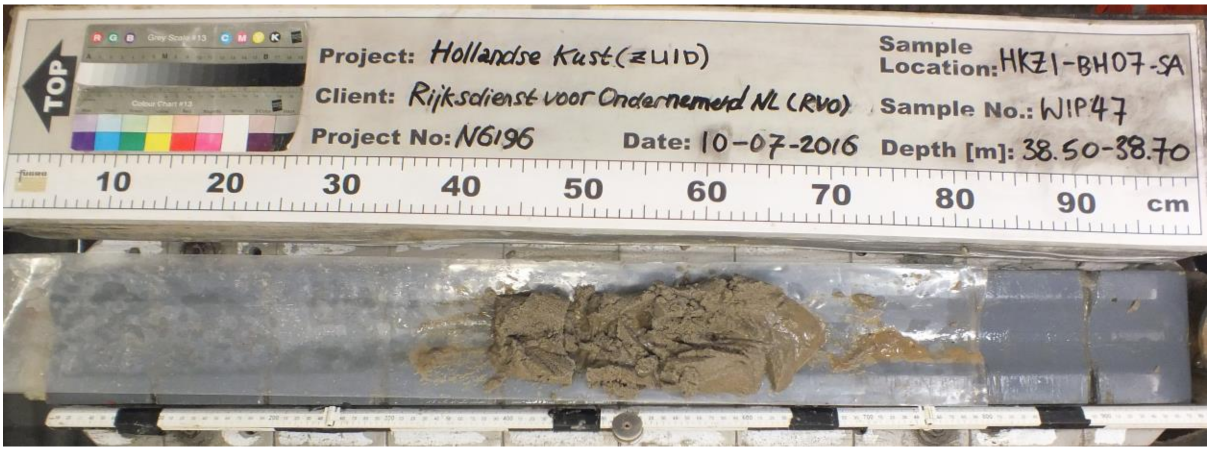


Location : HKZ1-BH07-SA
Sample : WIP46
Depth [m BSF] : 38.00 to 38.20

Location : HKZ1-BH07-SA
Sample : WIP46
Depth [m BSF] : 38.00 to 38.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP47
Depth [m BSF] : 38.50 to 38.70



Location : HKZ1-BH07-SA
Sample : WIP47
Depth [m BSF] : 38.50 to 38.70
Note(s) : split

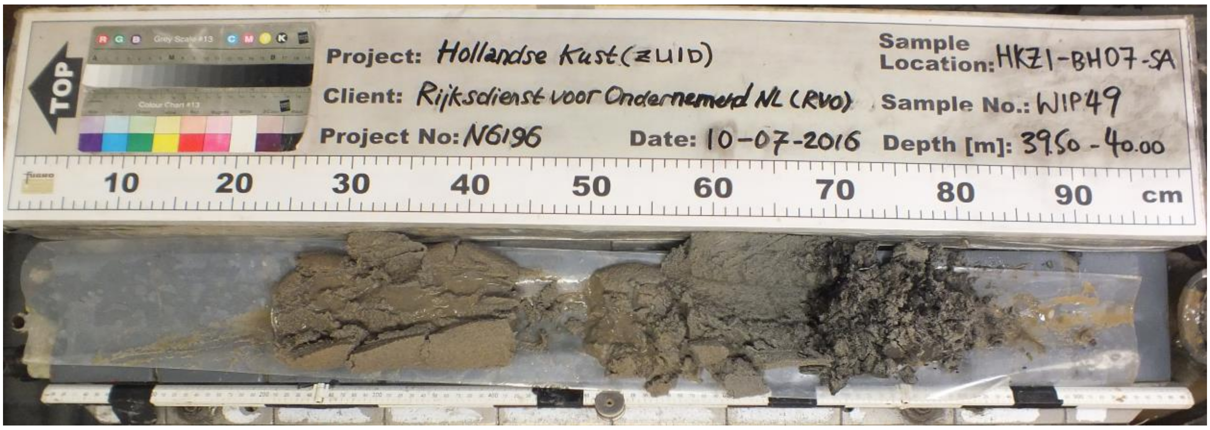
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP48
Depth [m BSF] : 39.00 to 39.25

Location : HKZ1-BH07-SA
Sample : WIP48
Depth [m BSF] : 39.00 to 39.25
Note(s) : split

SAMPLE PHOTOGRAPHS

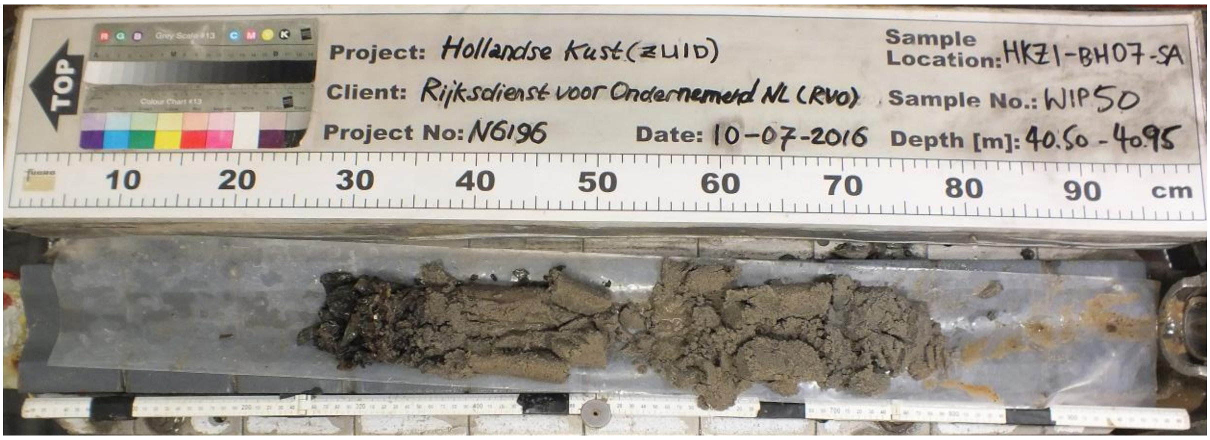
Location : HKZ1-BH07-SA
Sample : WIP49
Depth [m BSF] : 39.50 to 40.00



Location : HKZ1-BH07-SA
Sample : WIP49
Depth [m BSF] : 39.50 to 40.00
Note(s) : split

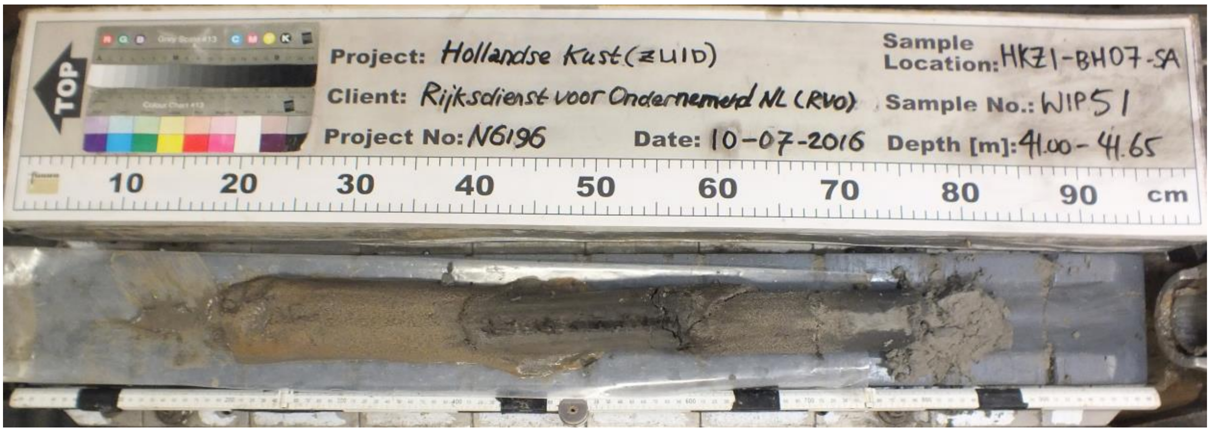
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP50
Depth [m BSF] : 40.50 to 40.95



Location : HKZ1-BH07-SA
Sample : WIP50
Depth [m BSF] : 40.50 to 40.95
Note(s) : split

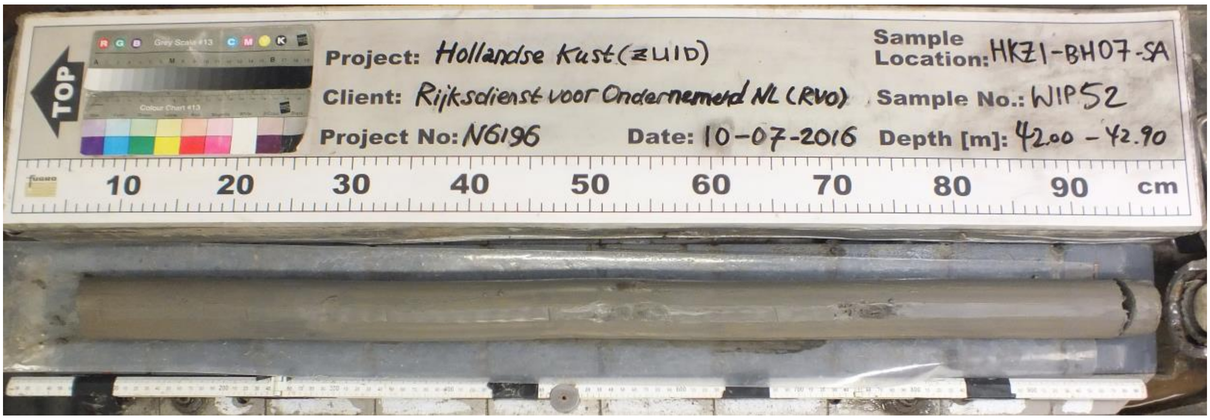
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP51
Depth [m BSF] : 41.00 to 41.65

Location : HKZ1-BH07-SA
Sample : WIP51
Depth [m BSF] : 41.00 to 41.65
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP52
Depth [m BSF] : 42.00 to 42.90

Location : HKZ1-BH07-SA
Sample : WIP52
Depth [m BSF] : 42.00 to 42.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Project: Hollandse Kust (ZUID)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 10-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP53
Depth [m]: 43.00 - 43.85

Location : HKZ1-BH07-SA
Sample : WIP53
Depth [m BSF] : 43.00 to 43.85

Project: Hollandse Kust (ZUID)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 10-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP53
Depth [m]: 43.00 - 43.85

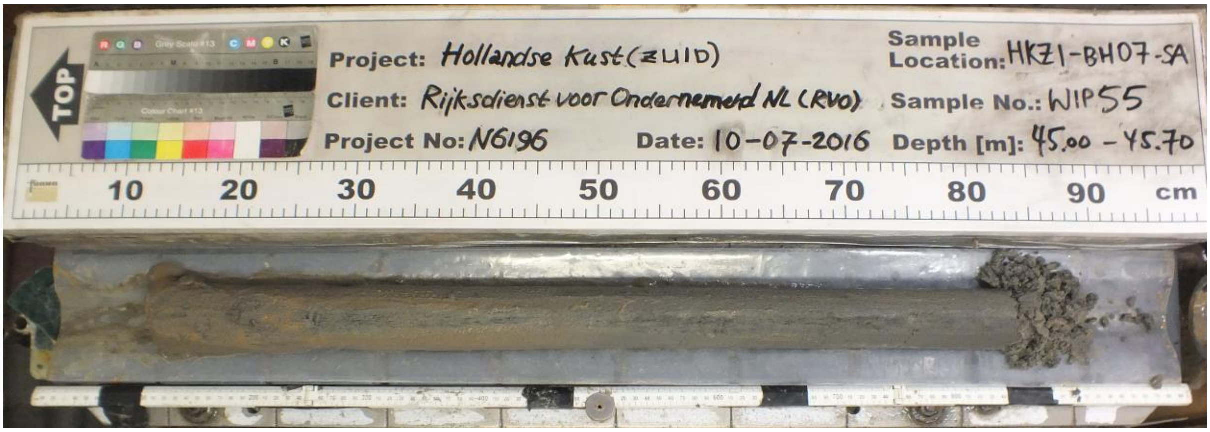
Location : HKZ1-BH07-SA
Sample : WIP53
Depth [m BSF] : 43.00 to 43.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP54
Depth [m BSF] : 44.00 to 44.65

Location : HKZ1-BH07-SA
Sample : WIP54
Depth [m BSF] : 44.00 to 44.65
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP55
Depth [m BSF] : 45.00 to 45.70

Location : HKZ1-BH07-SA
Sample : WIP55
Depth [m BSF] : 45.00 to 45.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Project: Hollandse Kust (ZUID)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 10-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP56
Depth [m]: 46.00 - 46.70

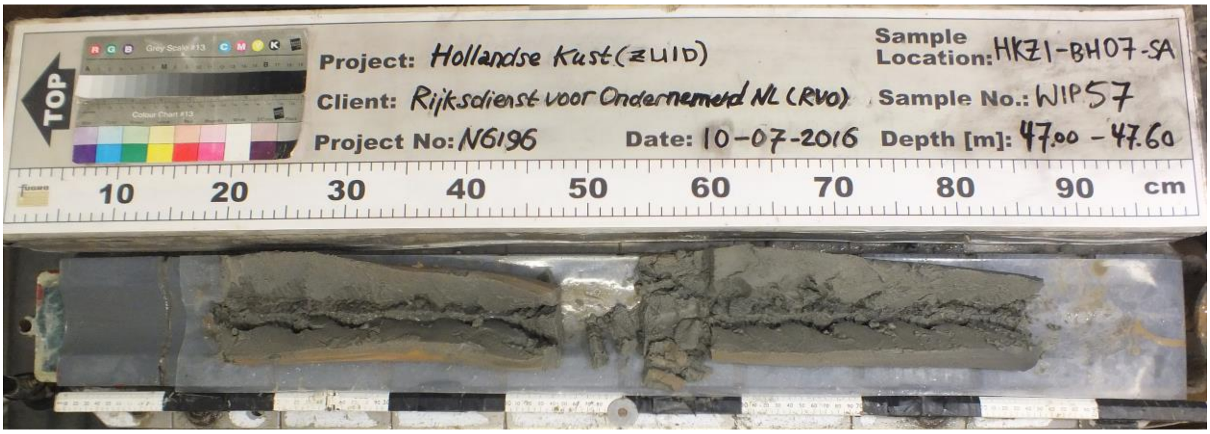
Location : HKZ1-BH07-SA
Sample : WIP56
Depth [m BSF] : 46.00 to 46.70

Project: Hollandse Kust (ZUID)
Client: Rijksdienst voor Ondernemend NL (RVO)
Project No: N6196
Date: 10-07-2016
Sample Location: HKZ1-BH07-SA
Sample No.: WIP56
Depth [m]: 46.00 - 46.70

Location : HKZ1-BH07-SA
Sample : WIP56
Depth [m BSF] : 46.00 to 46.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP57
Depth [m BSF] : 47.00 to 47.60



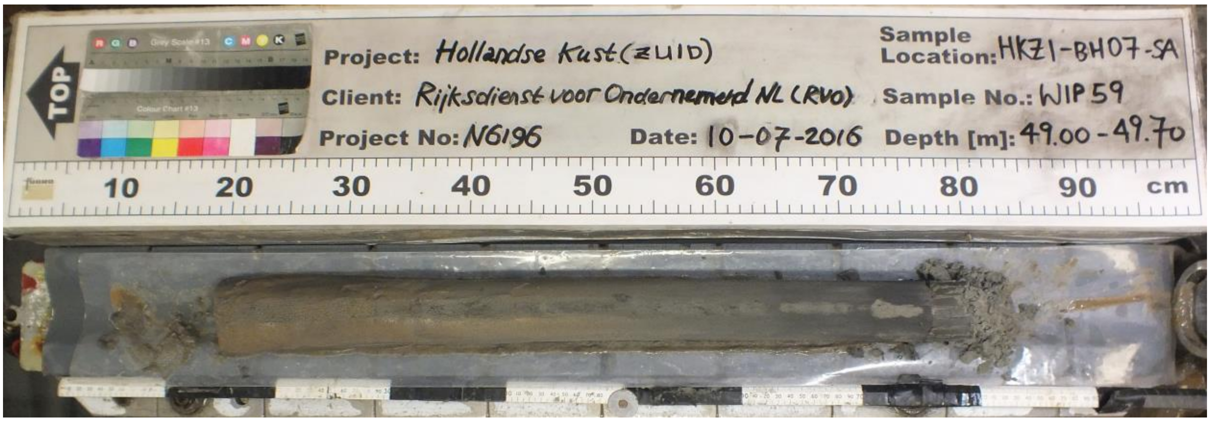
Location : HKZ1-BH07-SA
Sample : WIP57
Depth [m BSF] : 47.00 to 47.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP58
Depth [m BSF] : 48.00 to 48.60

Location : HKZ1-BH07-SA
Sample : WIP58
Depth [m BSF] : 48.00 to 48.60
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH07-SA
Sample : WIP59
Depth [m BSF] : 49.00 to 49.70

Location : HKZ1-BH07-SA
Sample : WIP59
Depth [m BSF] : 49.00 to 49.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH07-SA
Sample : WIP60
Depth [m BSF] : 50.00 to 50.70

Location : HKZ1-BH07-SA
Sample : WIP60
Depth [m BSF] : 50.00 to 50.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.50

Location : HKZ1-BH08-SA
Sample : WIP01
Depth [m BSF] : 0.00 to 0.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.65

Location : HKZ1-BH08-SA
Sample : WIP02
Depth [m BSF] : 1.00 to 1.65
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.45

Location : HKZ1-BH08-SA
Sample : WIP03
Depth [m BSF] : 2.00 to 2.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP04
Depth [m BSF] : 2.50 to 3.00

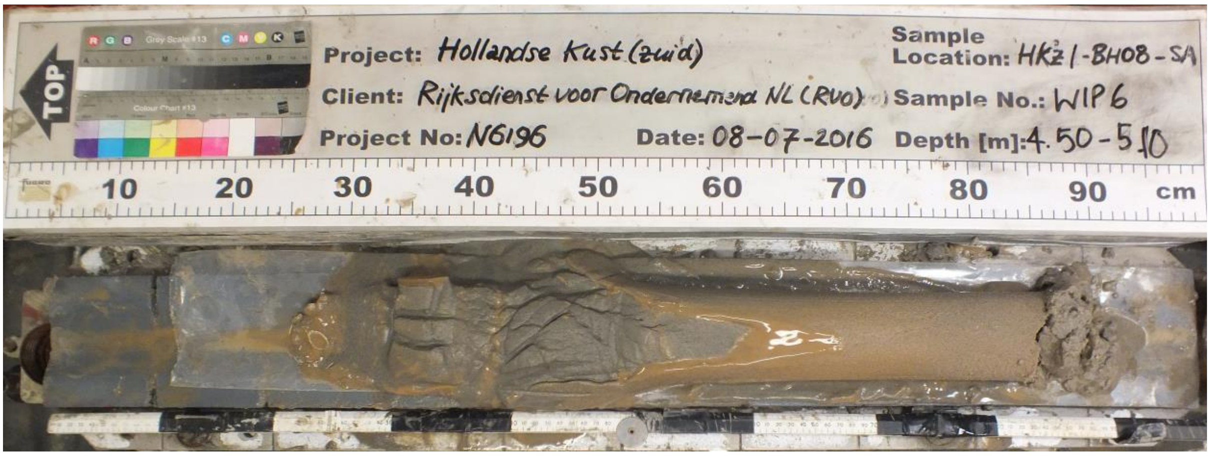
Location : HKZ1-BH08-SA
Sample : WIP04
Depth [m BSF] : 2.50 to 3.00
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 4.05

Location : HKZ1-BH08-SA
Sample : WIP05
Depth [m BSF] : 3.50 to 4.05
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.10

Location : HKZ1-BH08-SA
Sample : WIP06
Depth [m BSF] : 4.50 to 5.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.10

Location : HKZ1-BH08-SA
Sample : WIP07
Depth [m BSF] : 5.50 to 6.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 6.90

Location : HKZ1-BH08-SA
Sample : WIP08
Depth [m BSF] : 6.50 to 6.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP09
Depth [m BSF] : 7.00 to 7.50

Location : HKZ1-BH08-SA
Sample : WIP09
Depth [m BSF] : 7.00 to 7.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.50

Location : HKZ1-BH08-SA
Sample : WIP10
Depth [m BSF] : 8.00 to 8.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.50

Location : HKZ1-BH08-SA
Sample : WIP11
Depth [m BSF] : 9.00 to 9.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP12
Depth [m BSF] : 10.00 to 10.50

Location : HKZ1-BH08-SA
Sample : WIP12
Depth [m BSF] : 10.00 to 10.50
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.70

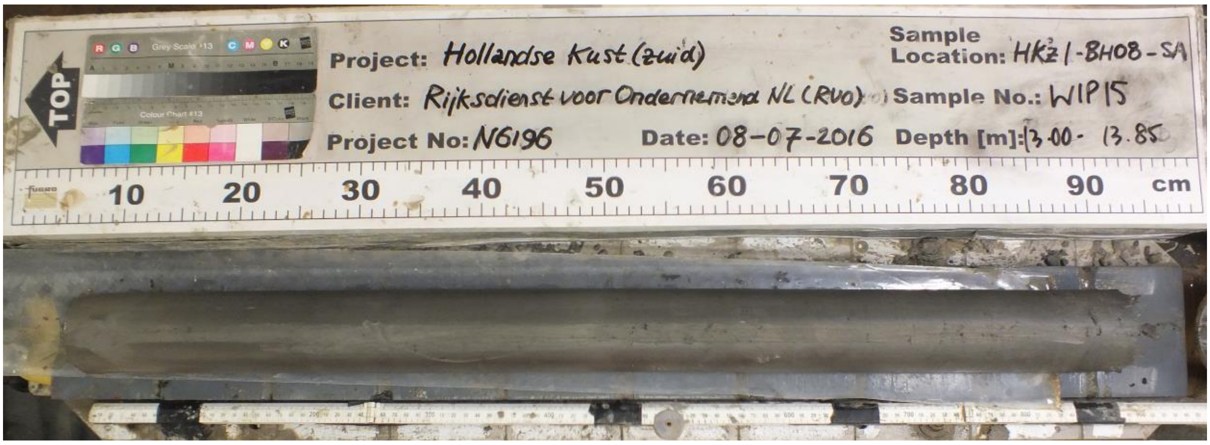
Location : HKZ1-BH08-SA
Sample : WIP13
Depth [m BSF] : 11.00 to 11.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP14
Depth [m BSF] : 12.00 to 12.70

Location : HKZ1-BH08-SA
Sample : WIP14
Depth [m BSF] : 12.00 to 12.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP15
Depth [m BSF] : 13.00 to 13.85

Location : HKZ1-BH08-SA
Sample : WIP15
Depth [m BSF] : 13.00 to 13.85
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP16
Depth [m BSF] : 14.00 to 14.45

Location : HKZ1-BH08-SA
Sample : WIP16
Depth [m BSF] : 14.00 to 14.45
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.10

Location : HKZ1-BH08-SA
Sample : WIP17
Depth [m BSF] : 14.50 to 15.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.20

Location : HKZ1-BH08-SA
Sample : WIP18
Depth [m BSF] : 15.50 to 16.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP19
Depth [m BSF] : 16.50 to 17.20

Location : HKZ1-BH08-SA
Sample : WIP19
Depth [m BSF] : 16.50 to 17.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.10

Location : HKZ1-BH08-SA
Sample : WIP20
Depth [m BSF] : 17.50 to 18.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP21
Depth [m BSF] : 18.50 to 19.10

Location : HKZ1-BH08-SA
Sample : WIP21
Depth [m BSF] : 18.50 to 19.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.10

Location : HKZ1-BH08-SA
Sample : WIP22
Depth [m BSF] : 19.50 to 20.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.20

Location : HKZ1-BH08-SA
Sample : WIP23
Depth [m BSF] : 20.50 to 21.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.15

Location : HKZ1-BH08-SA
Sample : WIP24
Depth [m BSF] : 21.50 to 22.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 23.10

Location : HKZ1-BH08-SA
Sample : WIP25
Depth [m BSF] : 22.50 to 23.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.10

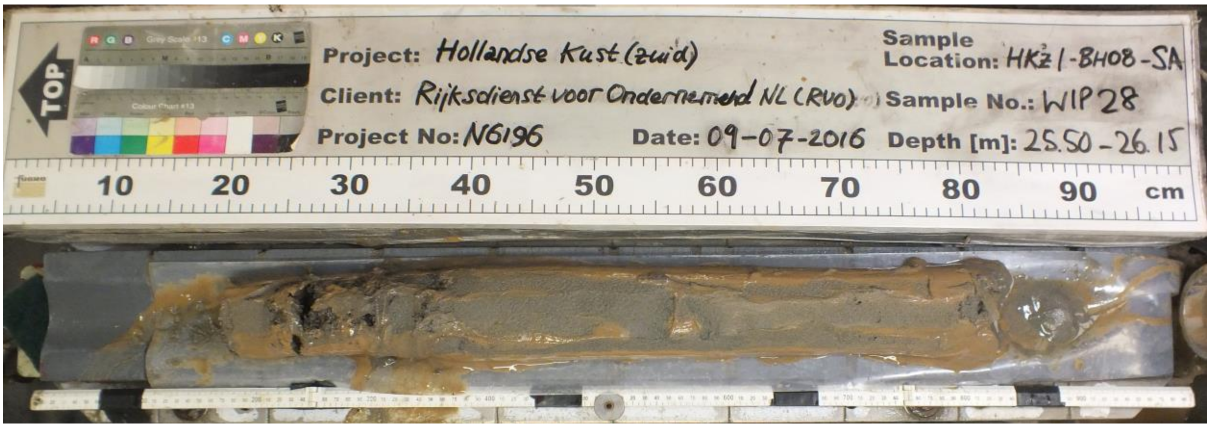
Location : HKZ1-BH08-SA
Sample : WIP26
Depth [m BSF] : 23.50 to 24.10
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.10

Location : HKZ1-BH08-SA
Sample : WIP27
Depth [m BSF] : 24.50 to 25.10
Note(s) : split

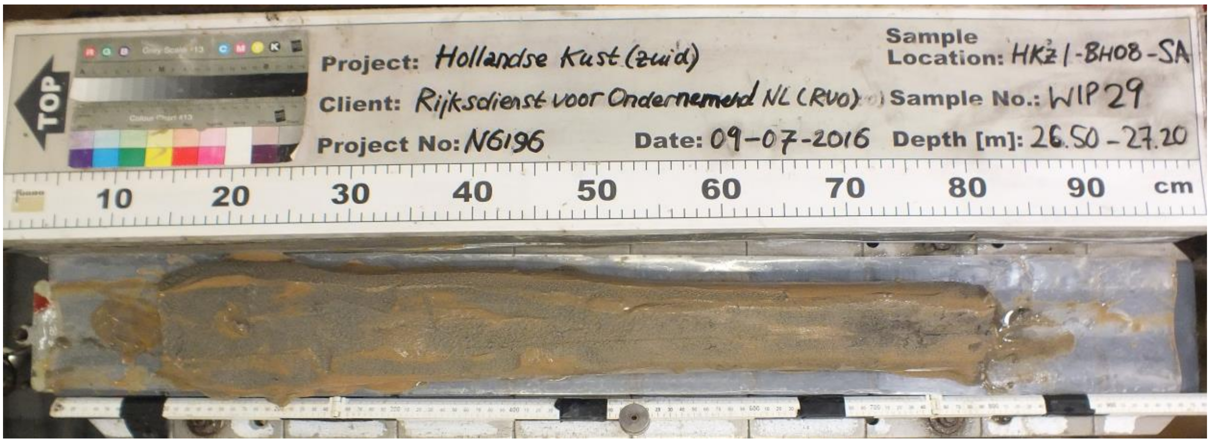
SAMPLE PHOTOGRAPHS



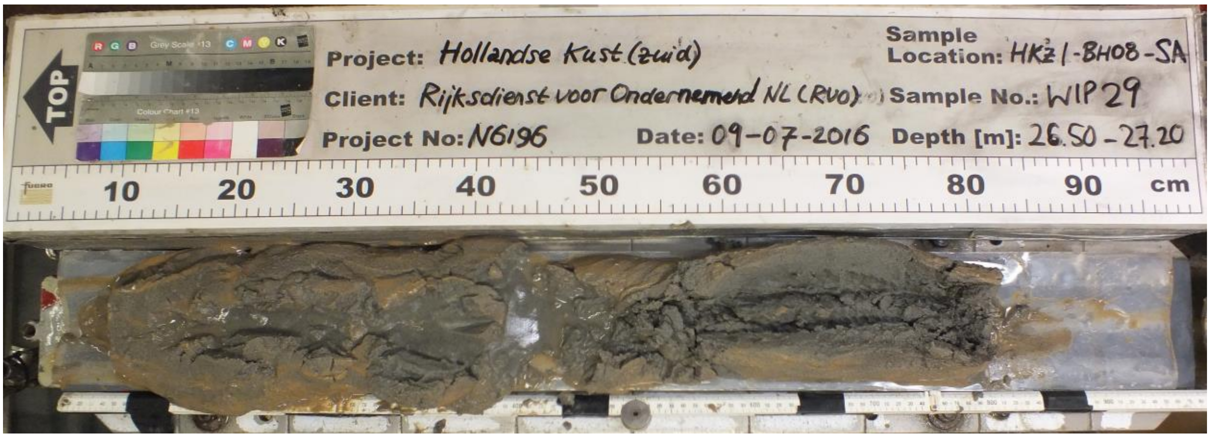
Location : HKZ1-BH08-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 26.15

Location : HKZ1-BH08-SA
Sample : WIP28
Depth [m BSF] : 25.50 to 26.15
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP29
Depth [m BSF] : 26.50 to 27.20



Location : HKZ1-BH08-SA
Sample : WIP29
Depth [m BSF] : 26.50 to 27.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP30
Depth [m BSF] : 27.50 to 28.20

Location : HKZ1-BH08-SA
Sample : WIP30
Depth [m BSF] : 27.50 to 28.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP31
Depth [m BSF] : 28.50 to 29.20

Location : HKZ1-BH08-SA
Sample : WIP31
Depth [m BSF] : 28.50 to 29.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP32
Depth [m BSF] : 29.50 to 30.15

Location : HKZ1-BH08-SA
Sample : WIP32
Depth [m BSF] : 29.50 to 30.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP33
Depth [m BSF] : 30.50 to 31.15

Location : HKZ1-BH08-SA
Sample : WIP33
Depth [m BSF] : 30.50 to 31.15
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP34
Depth [m BSF] : 31.50 to 32.20

Location : HKZ1-BH08-SA
Sample : WIP34
Depth [m BSF] : 31.50 to 32.20
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP35
Depth [m BSF] : 32.50 to 32.90

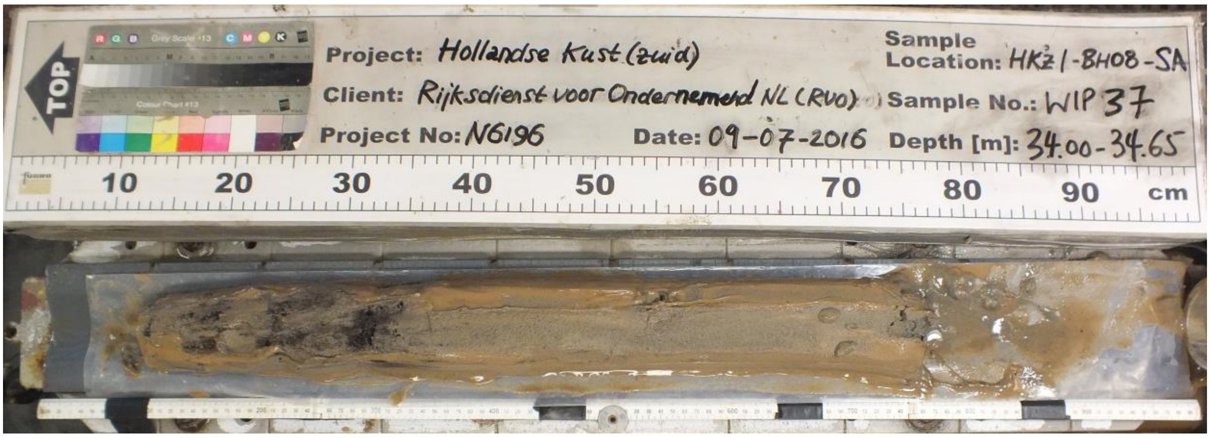
Location : HKZ1-BH08-SA
Sample : WIP35
Depth [m BSF] : 32.50 to 32.90
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP36
Depth [m BSF] : 33.00 to 33.65

Location : HKZ1-BH08-SA
Sample : WIP36
Depth [m BSF] : 33.00 to 33.65
Note(s) : split

SAMPLE PHOTOGRAPHS

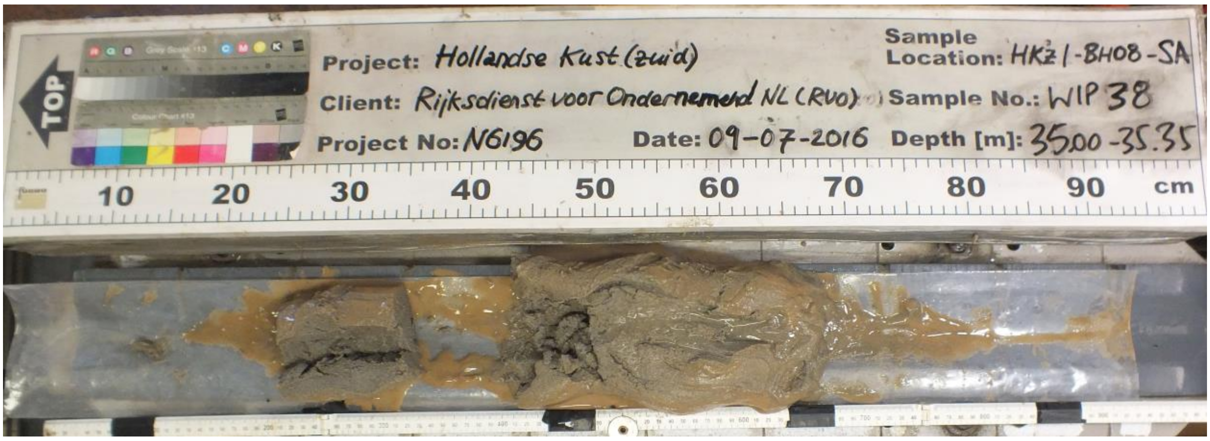


Location : HKZ1-BH08-SA
Sample : WIP37
Depth [m BSF] : 34.00 to 34.65

Location : HKZ1-BH08-SA
Sample : WIP37
Depth [m BSF] : 34.00 to 34.65
Note(s) : split

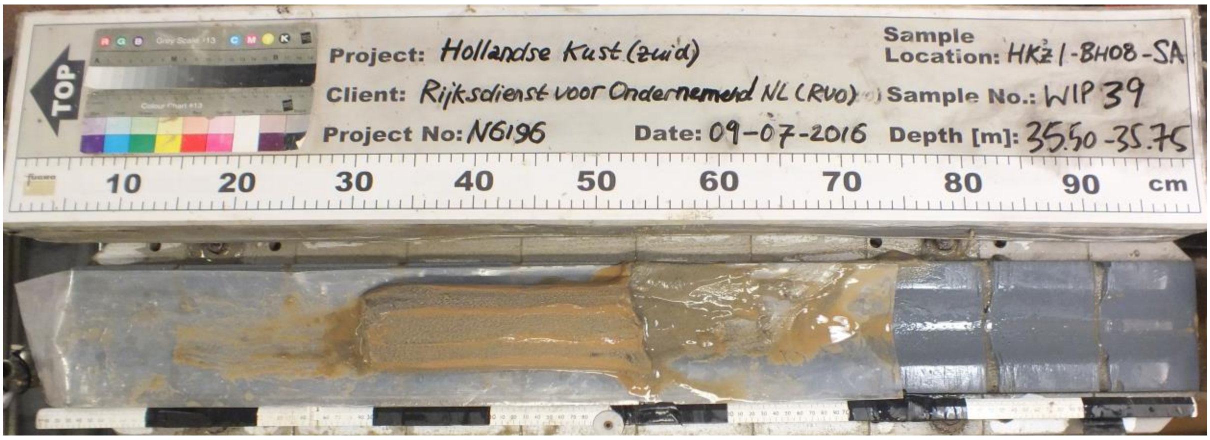
SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP38
Depth [m BSF] : 35.00 to 35.35



Location : HKZ1-BH08-SA
Sample : WIP38
Depth [m BSF] : 35.00 to 35.35
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP39
Depth [m BSF] : 35.50 to 35.75

Location : HKZ1-BH08-SA
Sample : WIP39
Depth [m BSF] : 35.50 to 35.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP40
Depth [m BSF] : 36.00 to 36.35

Location : HKZ1-BH08-SA
Sample : WIP40
Depth [m BSF] : 36.00 to 36.35
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP41
Depth [m BSF] : 36.50 to 36.75

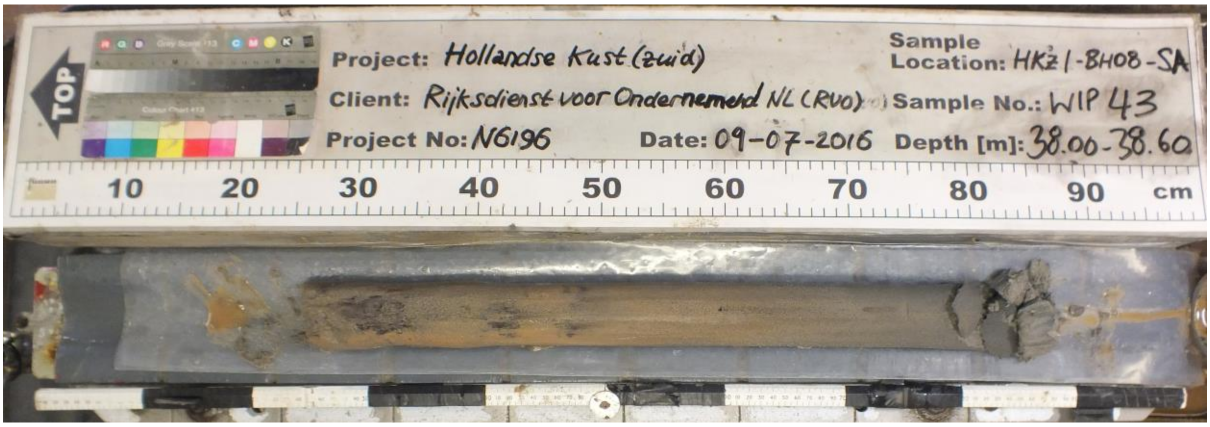
Location : HKZ1-BH08-SA
Sample : WIP41
Depth [m BSF] : 36.50 to 36.75
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP42
Depth [m BSF] : 37.00 to 37.65

Location : HKZ1-BH08-SA
Sample : WIP42
Depth [m BSF] : 37.00 to 37.65
Note(s) : split

SAMPLE PHOTOGRAPHS

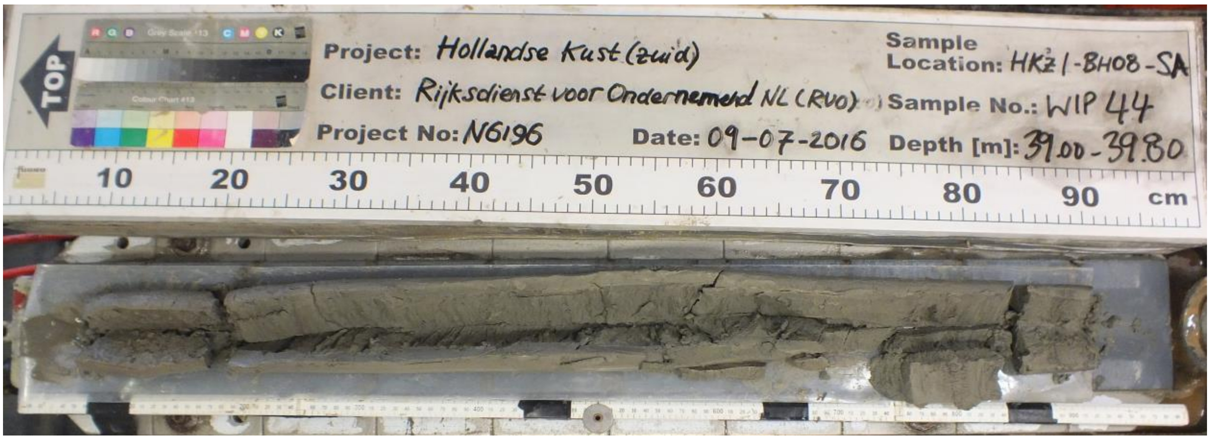


Location : HKZ1-BH08-SA
Sample : WIP43
Depth [m BSF] : 38.00 to 38.60

Location : HKZ1-BH08-SA
Sample : WIP43
Depth [m BSF] : 38.00 to 38.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP44
Depth [m BSF] : 39.00 to 39.80



Location : HKZ1-BH08-SA
Sample : WIP44
Depth [m BSF] : 39.00 to 39.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP45
Depth [m BSF] : 40.00 to 40.80

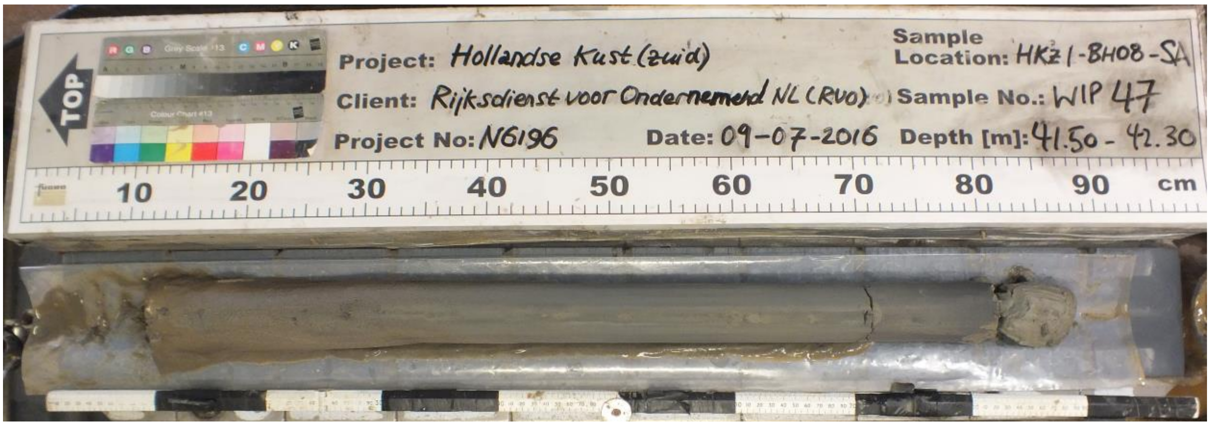
Location : HKZ1-BH08-SA
Sample : WIP45
Depth [m BSF] : 40.00 to 40.80
Note(s) : split

SAMPLE PHOTOGRAPHS

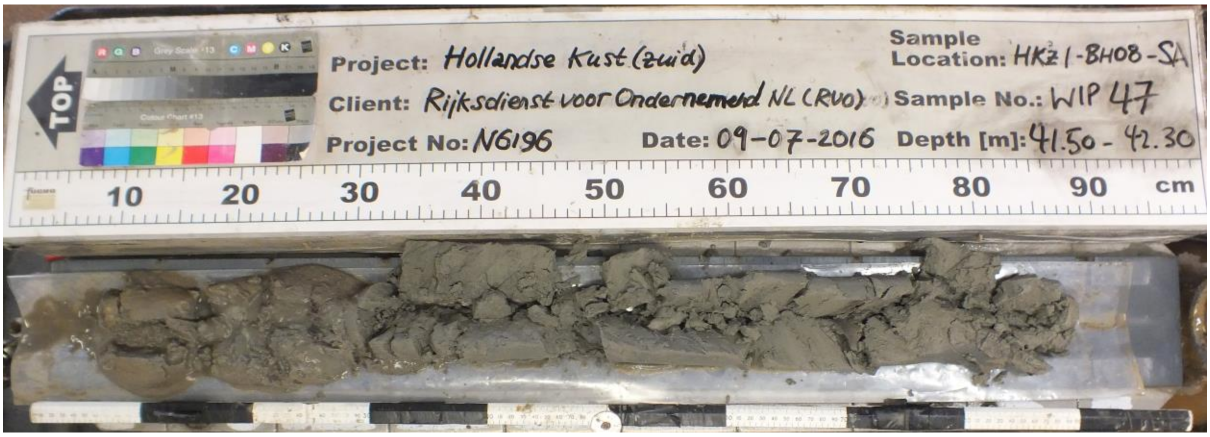
Location : HKZ1-BH08-SA
Sample : WIP46
Depth [m BSF] : 41.00 to 41.40

Location : HKZ1-BH08-SA
Sample : WIP46
Depth [m BSF] : 41.00 to 41.40
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP47
Depth [m BSF] : 41.50 to 42.30



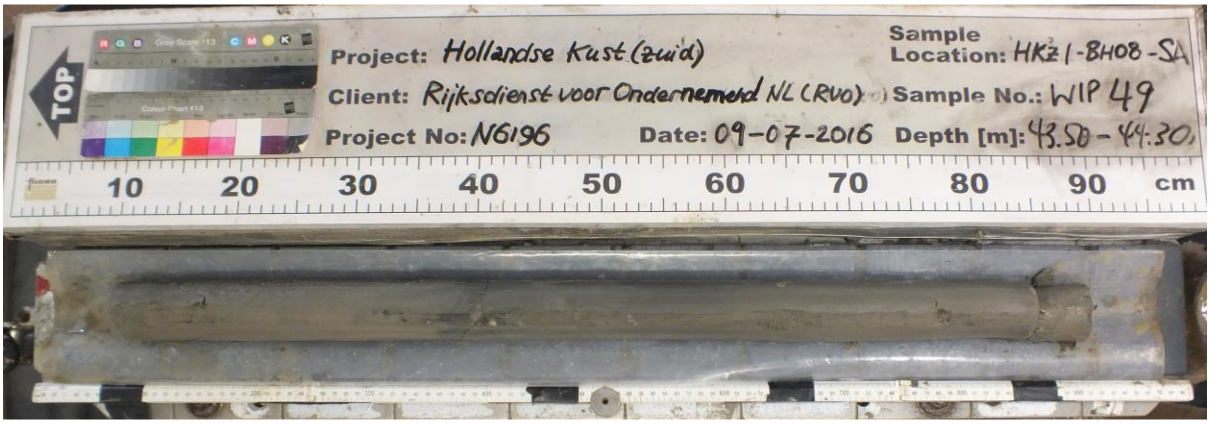
Location : HKZ1-BH08-SA
Sample : WIP47
Depth [m BSF] : 41.50 to 42.30
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP48
Depth [m BSF] : 42.50 to 43.30

Location : HKZ1-BH08-SA
Sample : WIP48
Depth [m BSF] : 42.50 to 43.30
Note(s) : split

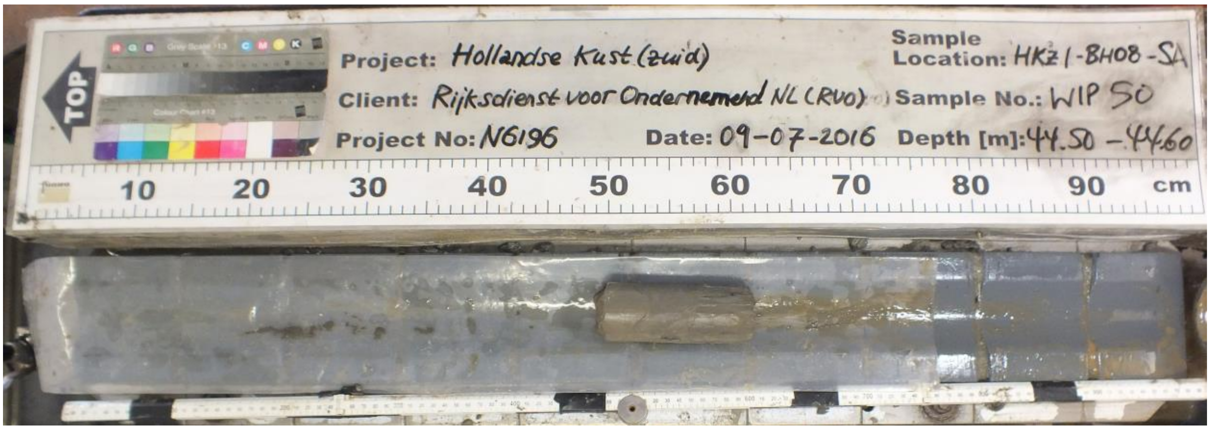
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP49
Depth [m BSF] : 43.50 to 44.30

Location : HKZ1-BH08-SA
Sample : WIP49
Depth [m BSF] : 43.50 to 44.30
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP50
Depth [m BSF] : 44.50 to 45.60

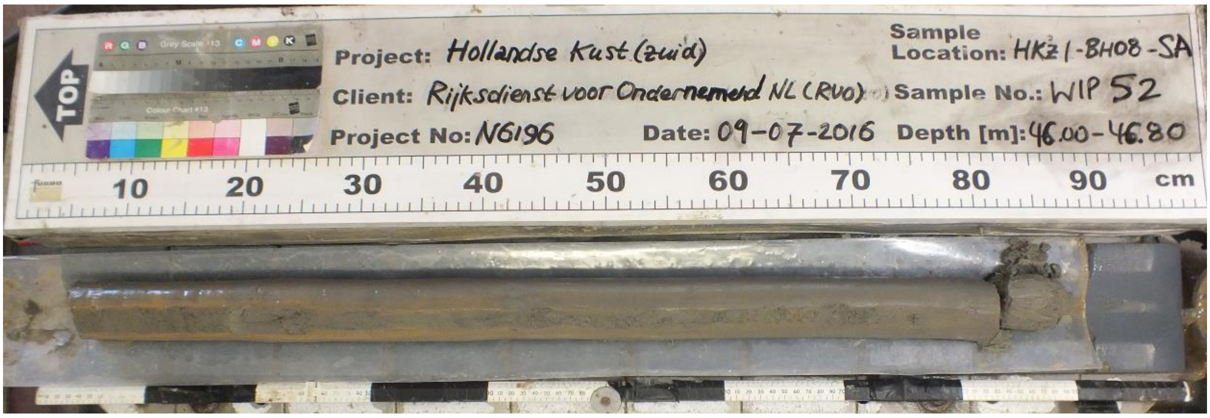
Location : HKZ1-BH08-SA
Sample : WIP50
Depth [m BSF] : 44.50 to 45.60
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP51
Depth [m BSF] : 45.00 to 45.80

Location : HKZ1-BH08-SA
Sample : WIP51
Depth [m BSF] : 45.00 to 45.80
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP52
Depth [m BSF] : 46.00 to 46.80

Location : HKZ1-BH08-SA
Sample : WIP52
Depth [m BSF] : 46.00 to 46.80
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP53
Depth [m BSF] : 47.00 to 47.70

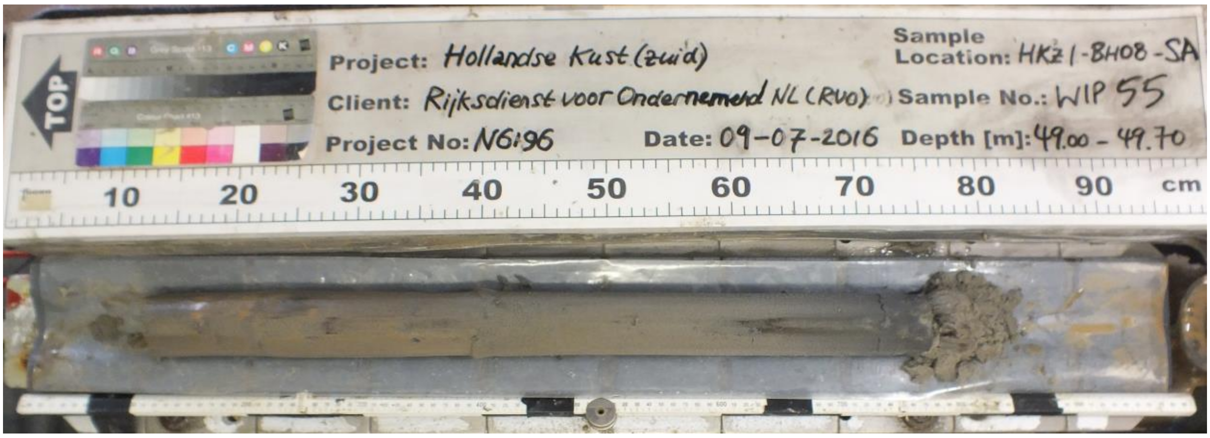
Location : HKZ1-BH08-SA
Sample : WIP53
Depth [m BSF] : 47.00 to 47.70
Note(s) : split

SAMPLE PHOTOGRAPHS

Location : HKZ1-BH08-SA
Sample : WIP54
Depth [m BSF] : 48.00 to 48.70

Location : HKZ1-BH08-SA
Sample : WIP54
Depth [m BSF] : 48.00 to 48.70
Note(s) : split

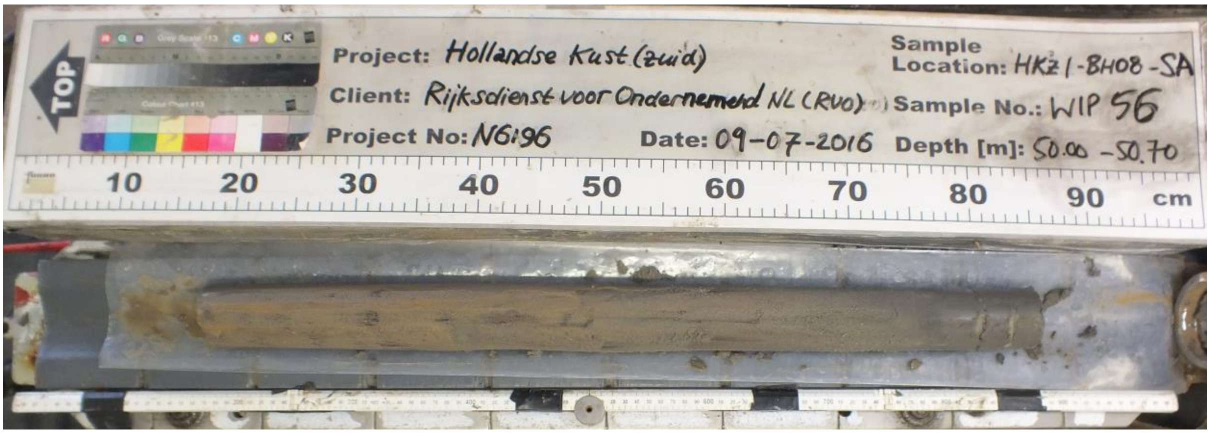
SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP55
Depth [m BSF] : 49.00 to 49.70

Location : HKZ1-BH08-SA
Sample : WIP55
Depth [m BSF] : 49.00 to 49.70
Note(s) : split

SAMPLE PHOTOGRAPHS



Location : HKZ1-BH08-SA
Sample : WIP56
Depth [m BSF] : 50.00 to 50.70

Location : HKZ1-BH08-SA
Sample : WIP56
Depth [m BSF] : 50.00 to 50.70
Note(s) : split

SAMPLE PHOTOGRAPHS

SECTION C4: TRIAXIAL TESTS

LIST OF PLATES IN SECTION C4:

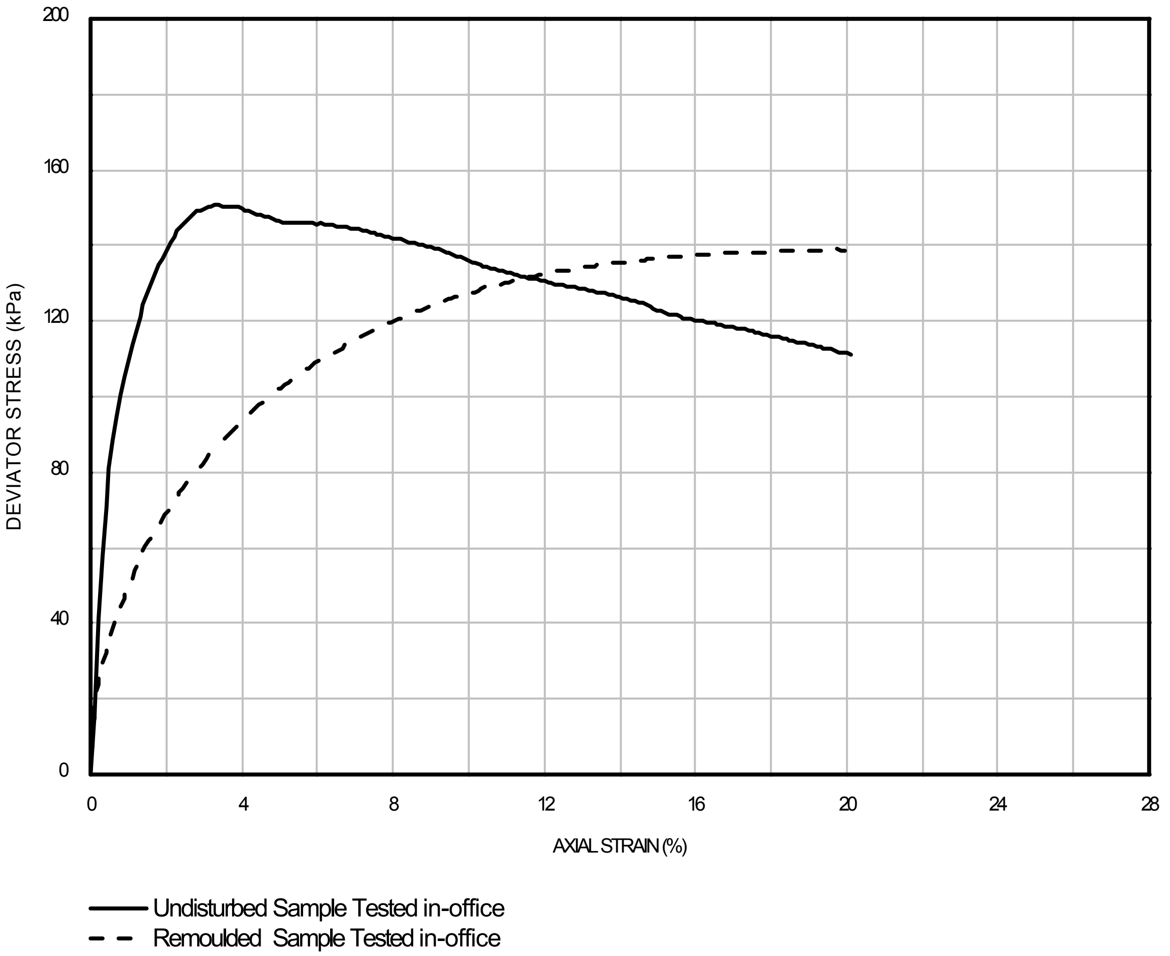
Drawn by: ALB Date: 24/08/2016

Template Issue: 3:4

Filename: J11335 \ Labdata \ Triaxial \ HKZ1-BH01-SA_24WaxE_uu.OPJ

Checked by: MSR Date : 19/08/2016

Approved by: Date :



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	3
Corrected deviator stress	(kPa)	151	139
Strain at failure	(%)	3.3	19.7
Undrained shear strength	(kPa)	75	69

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	139.2	100.8
Sample diameter	(mm)	71.7	49.2
Membrane thickness	(mm)	0.62	0.38
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.96	1.96
Dry density	(Mg/m^3)	1.57	1.50
Water content	(%)	24.4	30.2

Borehole : HKZ1-BH01-SA

Sample : 24WaxE

Depth (m) : 22.15

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 24/08/2016

Template Issue: 3:4

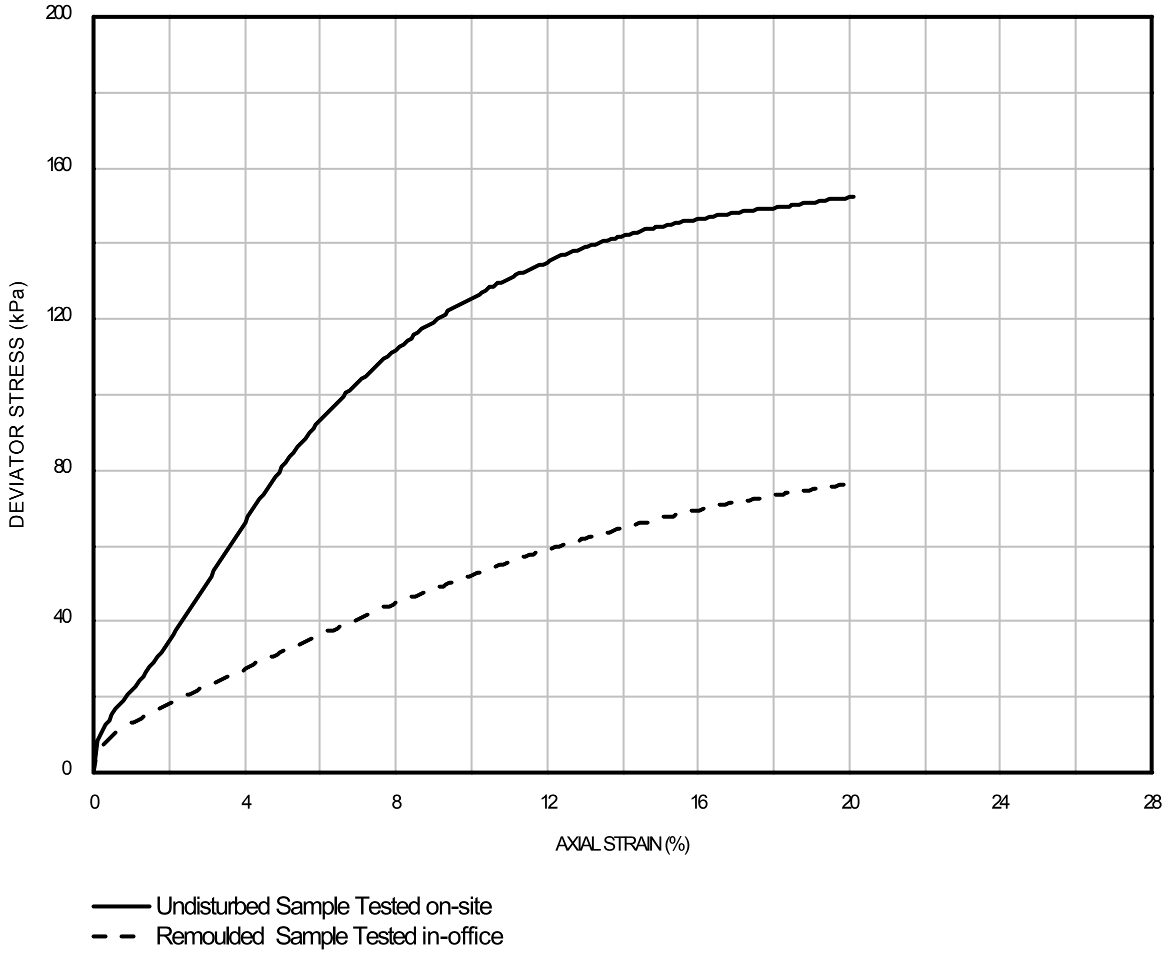
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH02-SA_14BagUUC_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	3
Corrected deviator stress	(kPa)	152	76
Strain at failure	(%)	20.0	20.0
Undrained shear strength	(kPa)	76	38

Undisturbed

Compound failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	137.8	99.3
Sample diameter	(mm)	71.6	49.4
Membrane thickness	(mm)	0.32	0.34
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.98	2.00
Dry density	(Mg/m^3)	1.53	1.56
Water content	(%)	29.1	28.4

Borehole : HKZ1-BH02-SA

Sample : 14UUC

Depth (m) : 11.95

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

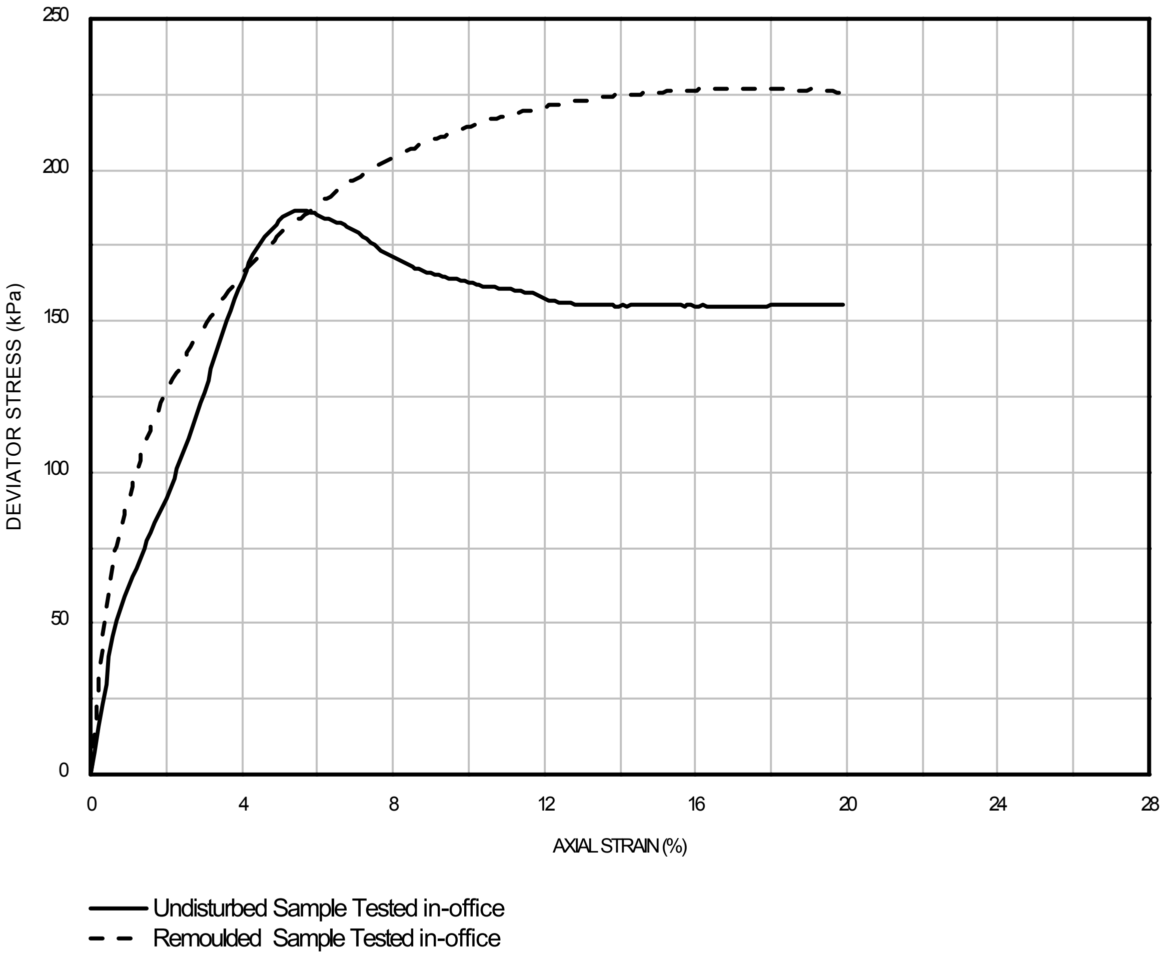
Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

Filename: J11335 \ Labdata \ Triaxial \ HKZ1-BH02-SA_17WaxB_uu.OPJ

Checked by: MSR Date : 19/08/2016

Approved by: Date :



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	3
Corrected deviator stress	(kPa)	187	227
Strain at failure	(%)	5.5	17.0
Undrained shear strength	(kPa)	93	114

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	138.8	100.7
Sample diameter	(mm)	71.8	49.2
Membrane thickness	(mm)	0.38	0.48
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.83	1.84
Dry density	(Mg/m^3)	1.32	1.34
Water content	(%)	38.5	36.6

Borehole : HKZ1-BH02-SA

Sample : 17WaxB

Depth (m) : 14.60

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

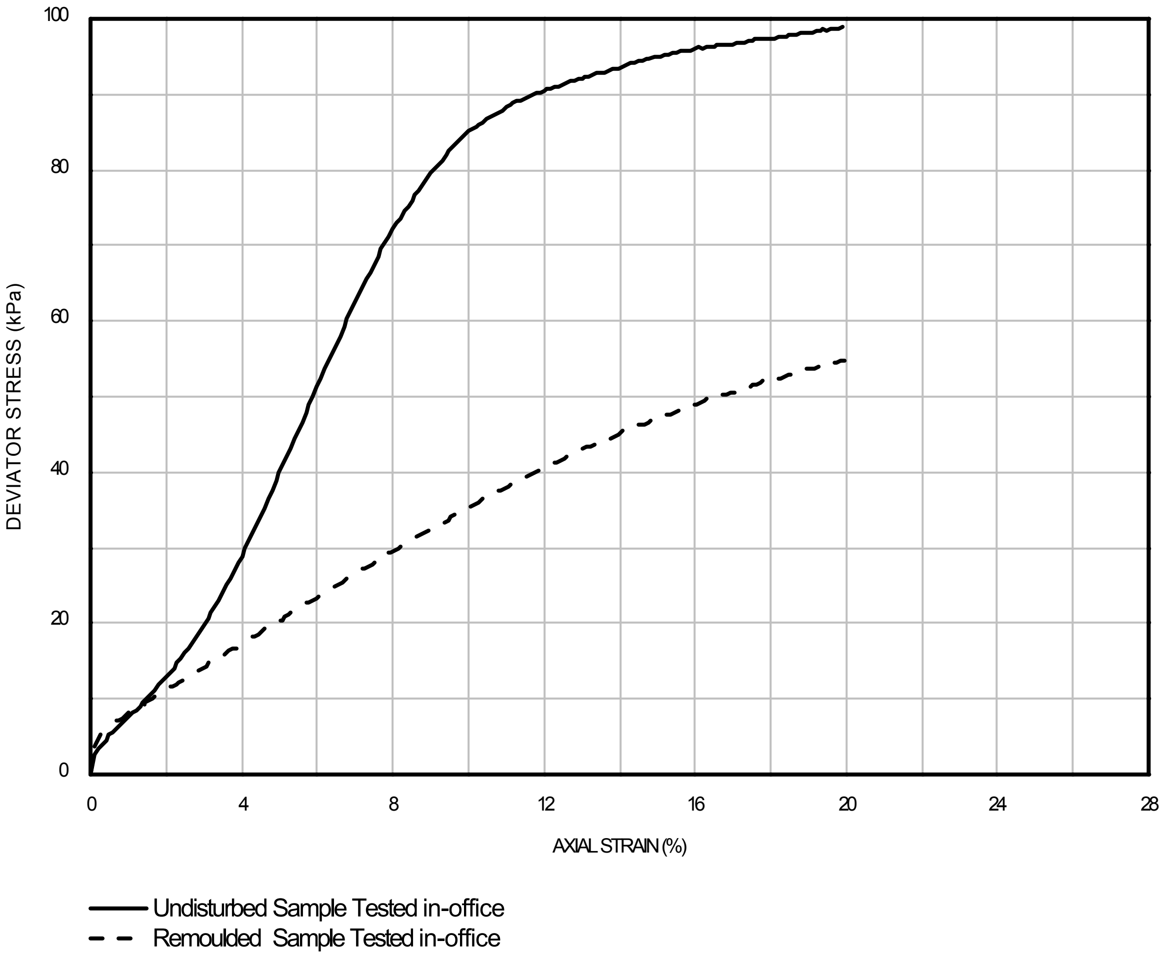
Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH02-SA_22WaxA_uu.OPJ

Checked by: MSR Date : 19/08/2016

Approved by: Date :



Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	3	4
Corrected deviator stress	(kPa)	99	55
Strain at failure	(%)	19.9	20.0
Undrained shear strength	(kPa)	49	27

Failure Shapes:

Undisturbed

Barrel failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	98.3	98.6
Sample diameter	(mm)	51.3	49.6
Membrane thickness	(mm)	0.41	0.54
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.98	1.98
Dry density	(Mg/m^3)	1.52	1.57
Water content	(%)	30.2	26.4

Borehole : HKZ1-BH02-SA

Sample : 22WaxA

Depth (m) : 19.50

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

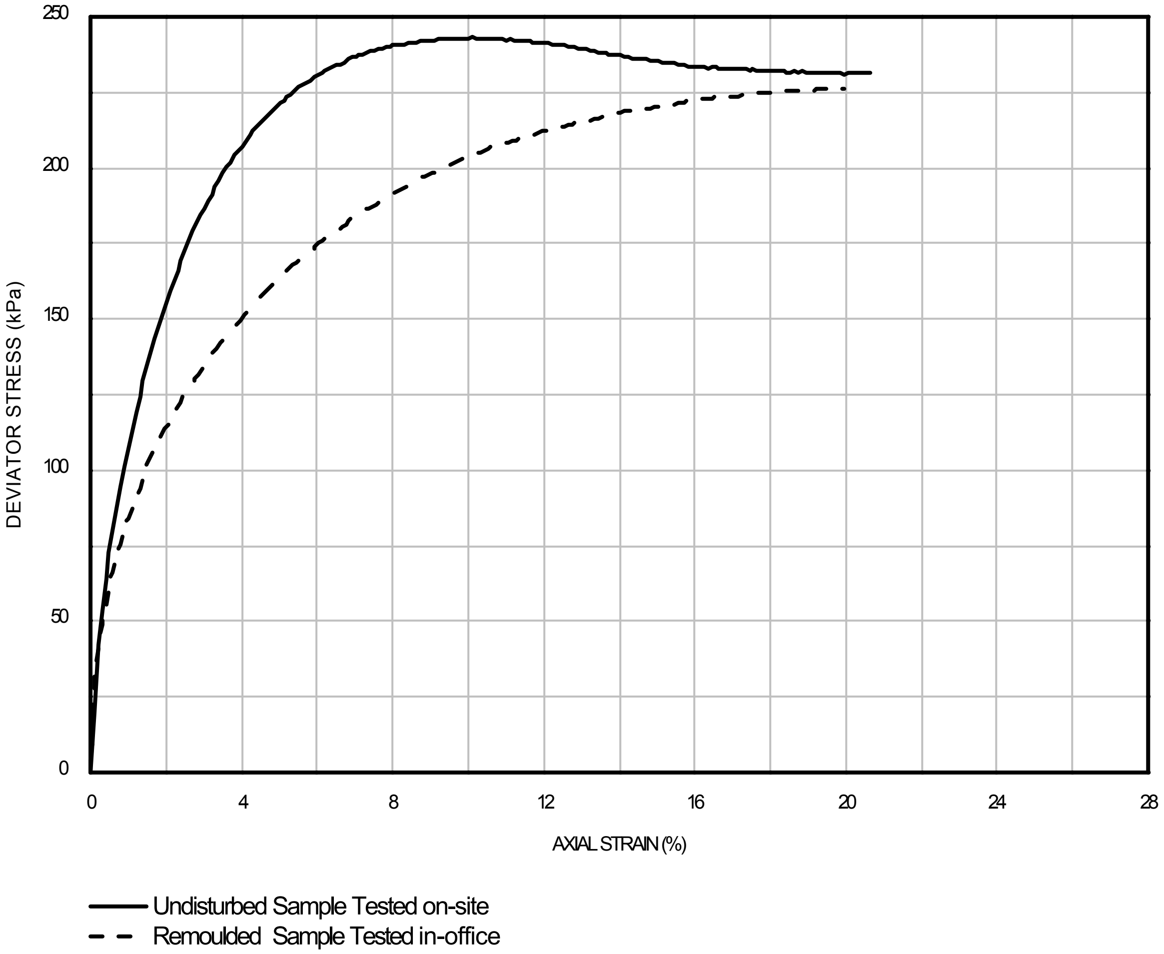
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH03-SA_22BagUUA_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	3
Corrected deviator stress	(kPa)	243	227
Strain at failure	(%)	10.1	20.0
Undrained shear strength	(kPa)	122	113

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	145.6	101.5
Sample diameter	(mm)	71.3	49.2
Membrane thickness	(mm)	0.32	0.42
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.05	2.03
Dry density	(Mg/m^3)	1.60	1.61
Water content	(%)	27.6	26.0

Borehole : HKZ1-BH03-SA

Sample : 22UUC

Depth (m) : 13.00

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 26/08/2016

Template Issue: 3:4

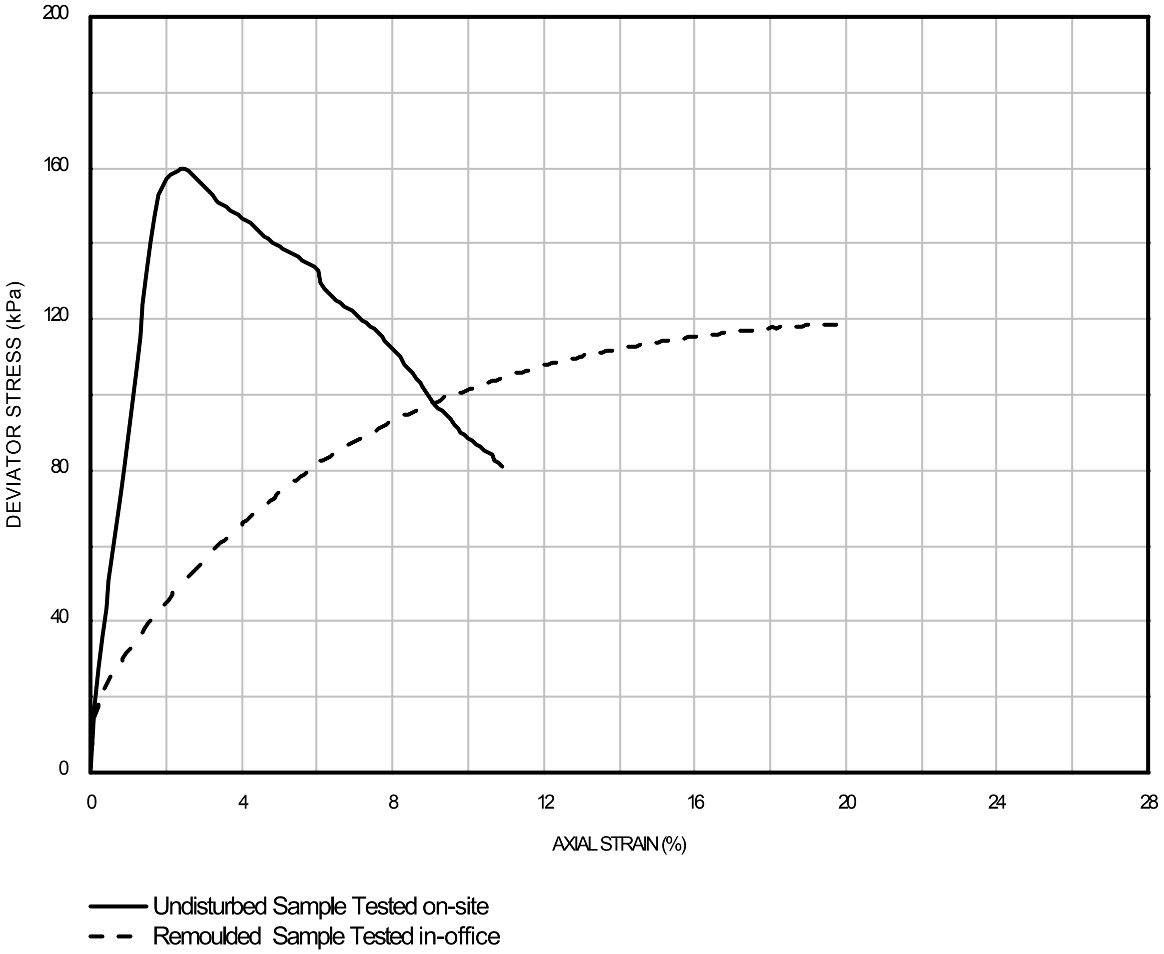
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH03-SA_24BagUUB_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	0	2
Corrected deviator stress	(kPa)	160	119
Strain at failure	(%)	2.5	20.0
Undrained shear strength	(kPa)	80	60

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	144.8	101.8
Sample diameter	(mm)	71.5	49.3
Membrane thickness	(mm)	0.32	0.30
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.91	1.89
Dry density	(Mg/m^3)	1.39	1.40
Water content	(%)	36.8	35.2

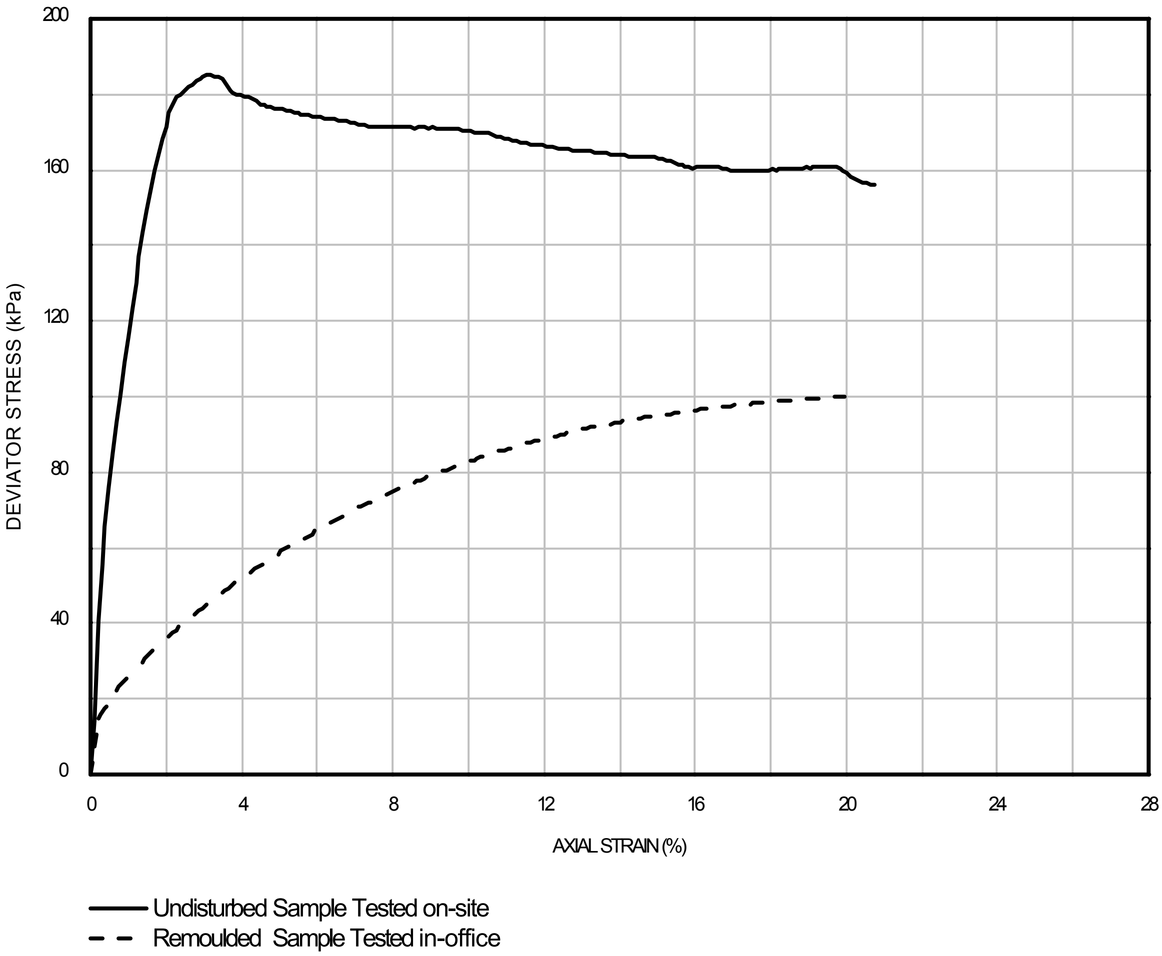
Borehole : HKZ1-BH03-SA

Sample : 24UUB

Depth (m) : 15.20

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	0	2
Corrected deviator stress	(kPa)	185	100
Strain at failure	(%)	3.2	20.0
Undrained shear strength	(kPa)	93	50

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	146.5	100.3
Sample diameter	(mm)	71.6	49.5
Membrane thickness	(mm)	0.32	0.28
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.88	1.87
Dry density	(Mg/m^3)	1.37	1.37
Water content	(%)	36.4	36.5

Borehole : HKZ1-BH03-SA
Sample : 26UUB
Depth (m) : 17.10

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 24/08/2016
Template Issue: 3:4
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH03-SA_26BagUUB_uu.OPJ
Checked by: 0 Date : 00/01/1900
Approved by: Date :

Drawn by: ALB Date: 26/08/2016

Template Issue: 3:4

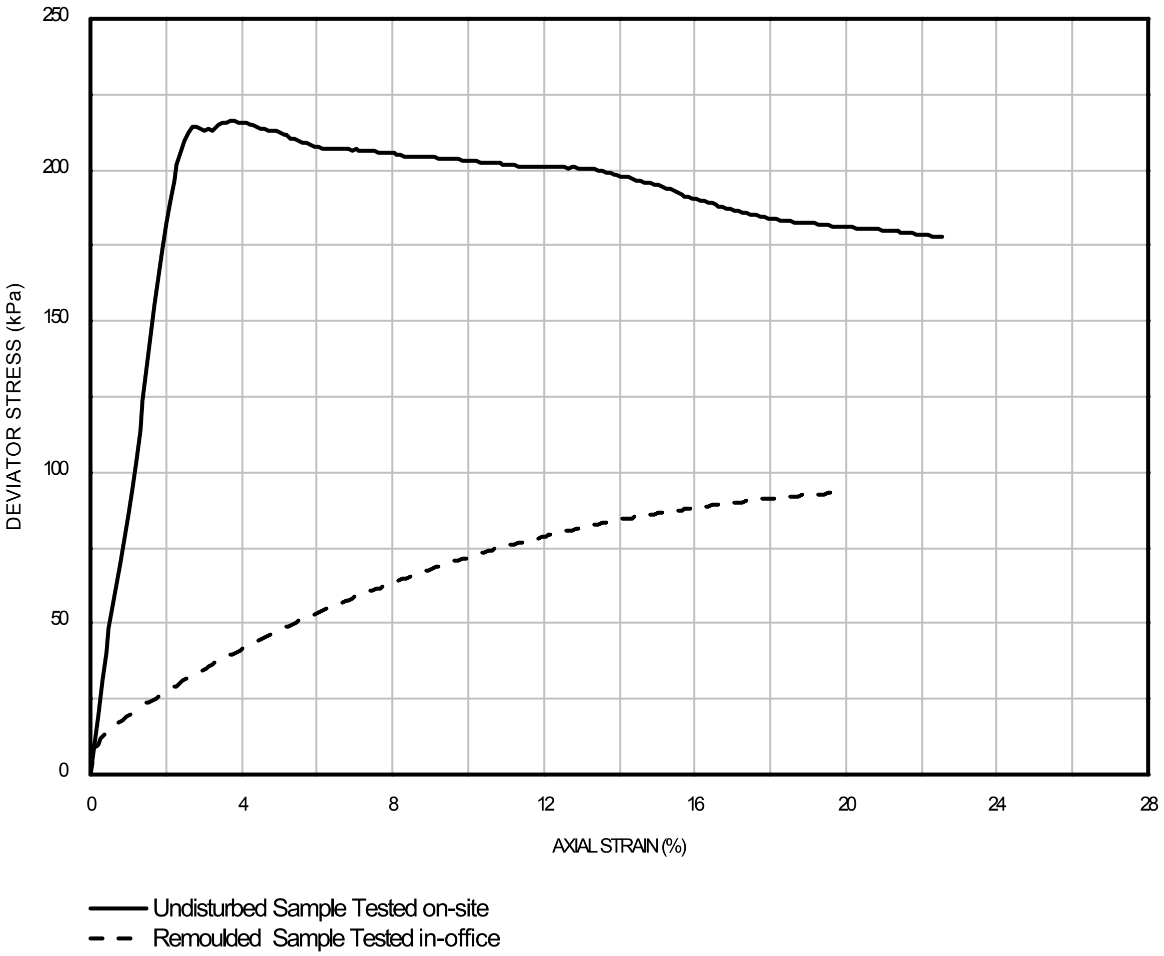
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH03-SA_27BagUUC_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	0	3
Corrected deviator stress	(kPa)	216	93
Strain at failure	(%)	3.7	20.0
Undrained shear strength	(kPa)	108	47

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	139.6	100.9
Sample diameter	(mm)	72.0	48.9
Membrane thickness	(mm)	0.32	0.42
Rate of strain	(%/min)	2.0	1.0
Bulk density	(Mg/m^3)	1.96	1.97
Dry density	(Mg/m^3)	1.52	1.53
Water content	(%)	28.2	28.5

Borehole : HKZ1-BH03-SA

Sample : 27UUC

Depth (m) : 18.30

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

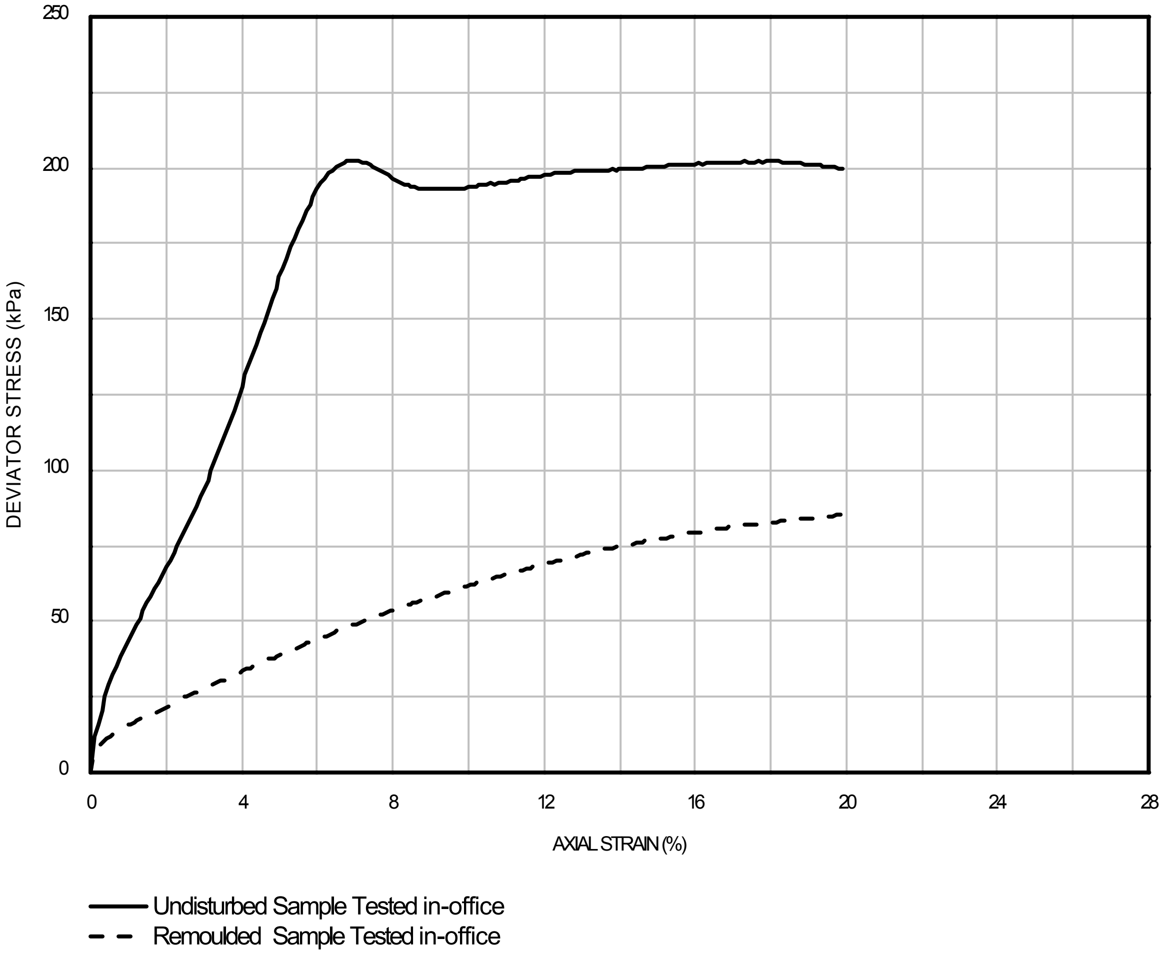
Drawn by: ALB Date: 17/08/2016

Template Issue: 3:4

Filename: J11335 \ Labdata \ Triaxial \ HKZ1-BH03-SA_48WaxC_uu.OPJ

Checked by: MSR Date : 16/08/2016

Approved by: Date :



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	4
Corrected deviator stress	(kPa)	203	85
Strain at failure	(%)	6.8	19.9
Undrained shear strength	(kPa)	101	43

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	138.3	99.9
Sample diameter	(mm)	72.5	49.2
Membrane thickness	(mm)	0.49	0.52
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.02	2.01
Dry density	(Mg/m^3)	1.58	1.59
Water content	(%)	27.3	25.9

Borehole : HKZ1-BH03-SA

Sample : 48WaxC

Depth (m) : 39.25

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: MSR Date: 22/08/2016

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH04-SA_27BagUUC_uu.OPJ

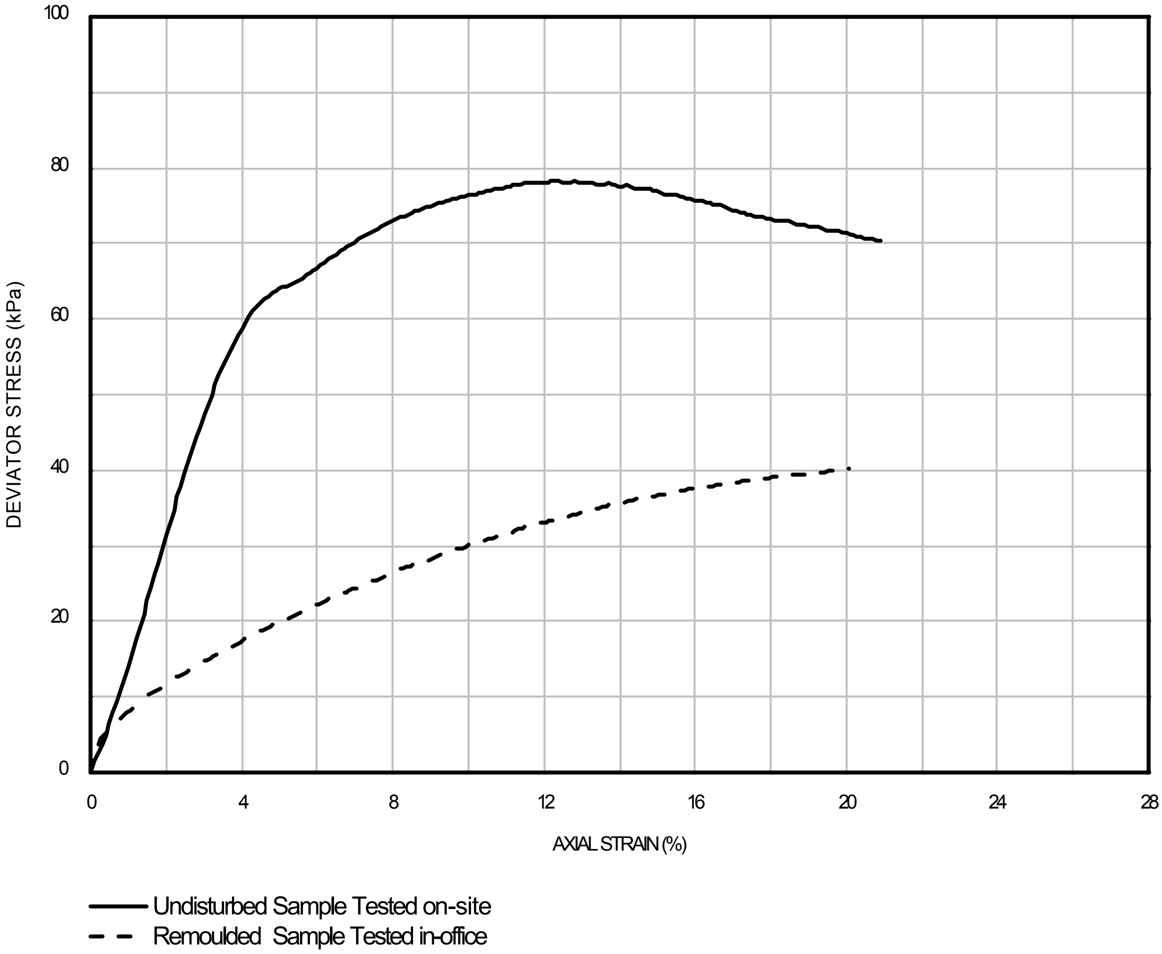
Template Issue: 3:4

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	3
Corrected deviator stress	(kPa)	78	40
Strain at failure	(%)	12.8	20.0
Undrained shear strength	(kPa)	39	20

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	147.1	98.6
Sample diameter	(mm)	66.7	49.7
Membrane thickness	(mm)	0.32	0.40
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.05	2.03
Dry density	(Mg/m^3)	1.60	1.58
Water content	(%)	28.2	28.8

Borehole : HKZ1-BH04-SA

Sample : 27UUC

Depth (m) : 23.75

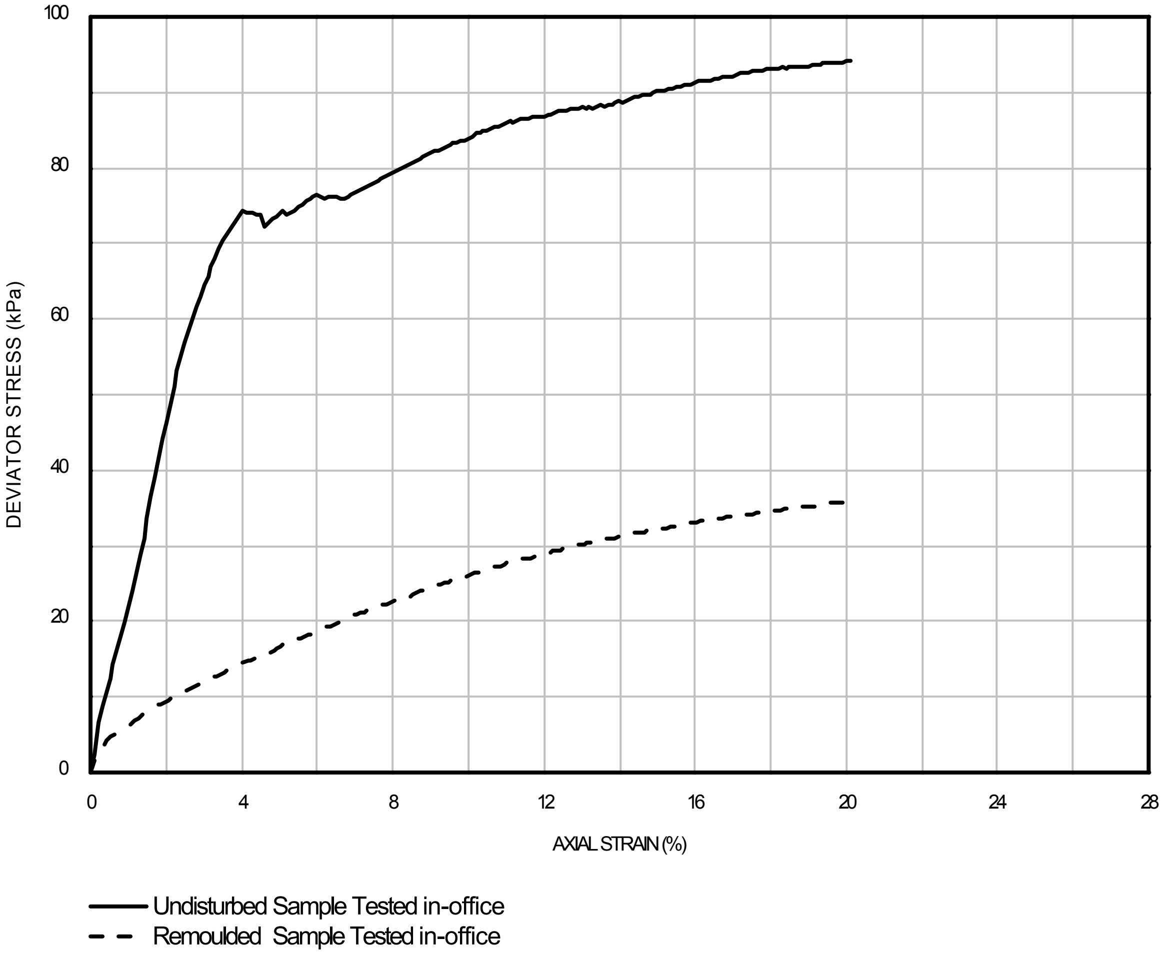
Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 15/08/2016

Template Issue: 3:4

Filename: J11335 \ Labdata \ Triaxial \ HKZ1-BH04-SA_28WaxA_uu.OPJ



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	4
Corrected deviator stress	(kPa)	94	36
Strain at failure	(%)	20.0	20.0
Undrained shear strength	(kPa)	47	18

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	98.5	101.2
Sample diameter	(mm)	51.8	49.2
Membrane thickness	(mm)	0.29	0.49
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.97	1.96
Dry density	(Mg/m^3)	1.54	1.52
Water content	(%)	27.5	29.0

Borehole : HKZ1-BH04-SA

Sample : 28WaxA

Depth (m) : 24.50

Checked by: ALB Date : 12/08/2016

Approved by: Date :

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

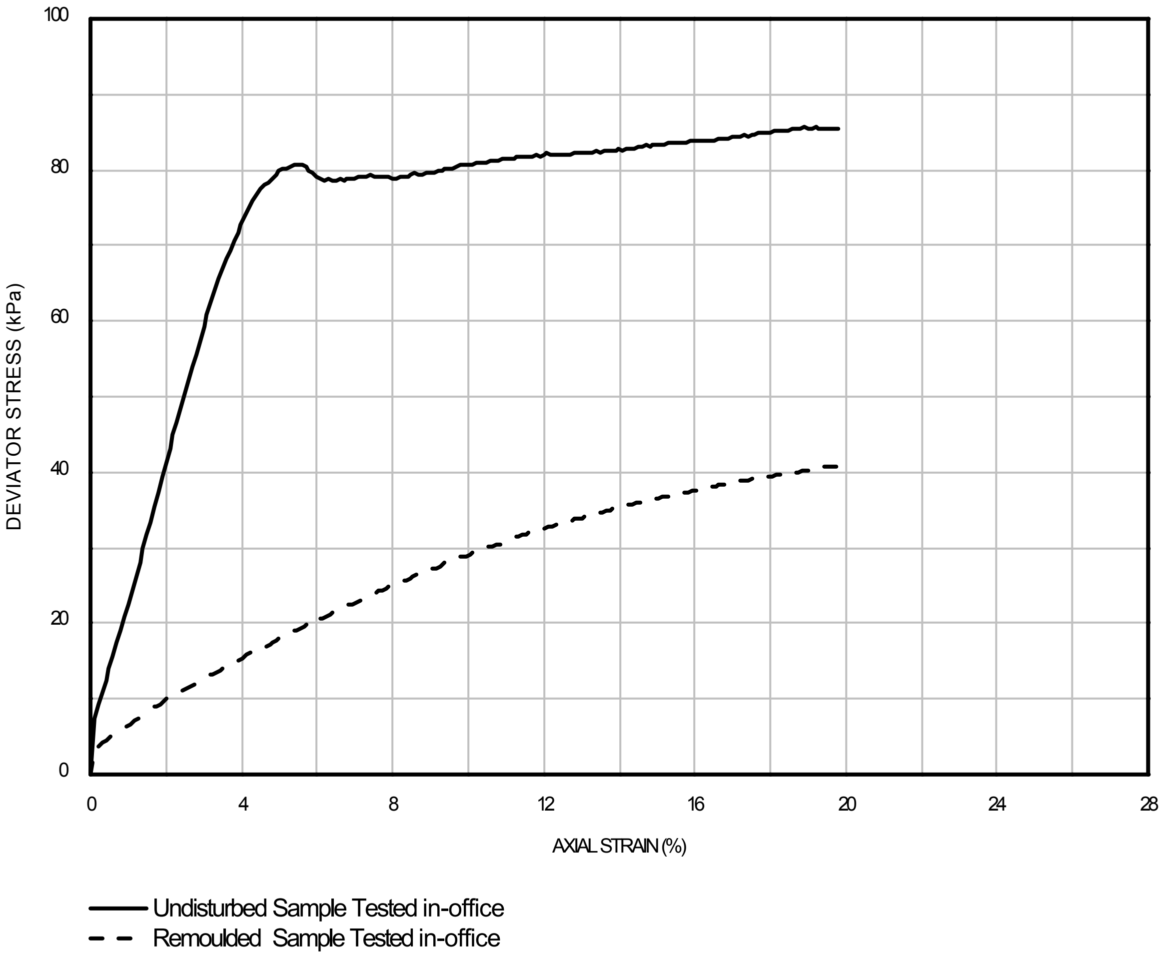
Drawn by: ALB Date: 17/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH04-SA_36WaxA_uu.OPJ

Checked by: ALB Date : 12/08/2016

Approved by: Date :



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	4
Corrected deviator stress	(kPa)	86	41
Strain at failure	(%)	19.2	19.9
Undrained shear strength	(kPa)	43	21

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	140.8	98.2
Sample diameter	(mm)	68.2	49.6
Membrane thickness	(mm)	0.42	0.52
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.98	1.99
Dry density	(Mg/m^3)	1.57	1.58
Water content	(%)	26.0	26.3

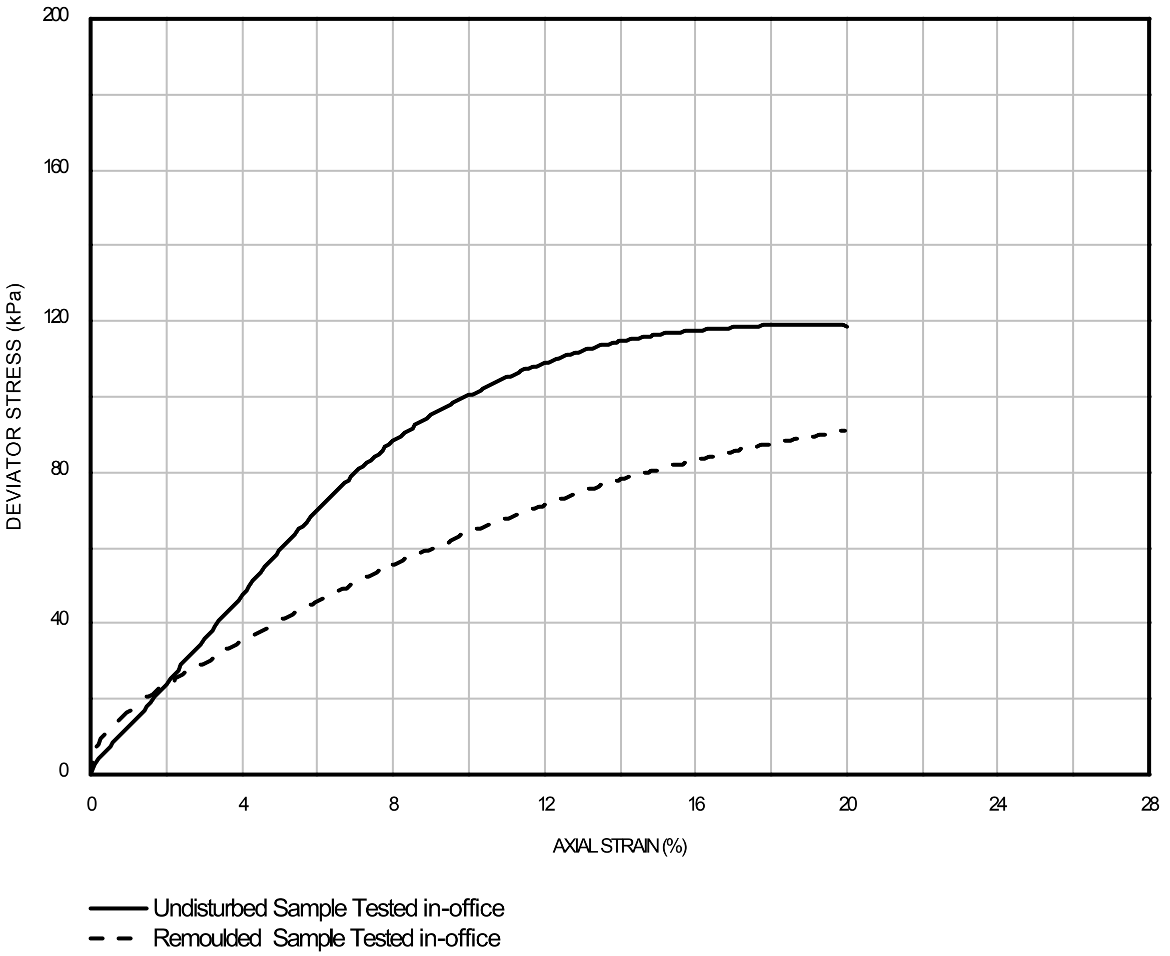
Borehole : HKZ1-BH04-SA

Sample : 36WaxA

Depth (m) : 32.50

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS



Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	3
Corrected deviator stress	(kPa)	119	91
Strain at failure	(%)	18.6	20.0
Undrained shear strength	(kPa)	60	46

Failure Shapes:

Undisturbed

Barrel failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	137.2	99.4
Sample diameter	(mm)	72.5	49.4
Membrane thickness	(mm)	0.40	0.42
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.06	2.07
Dry density	(Mg/m^3)	1.66	1.68
Water content	(%)	23.8	23.7

Borehole : HKZ1-BH05-SA

Sample : 21WaxC

Depth (m) : 17.35

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 24/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH05-SA_21WaxC_uu.OPJ

Checked by: MSR Date : 19/08/2016

Approved by: Date :

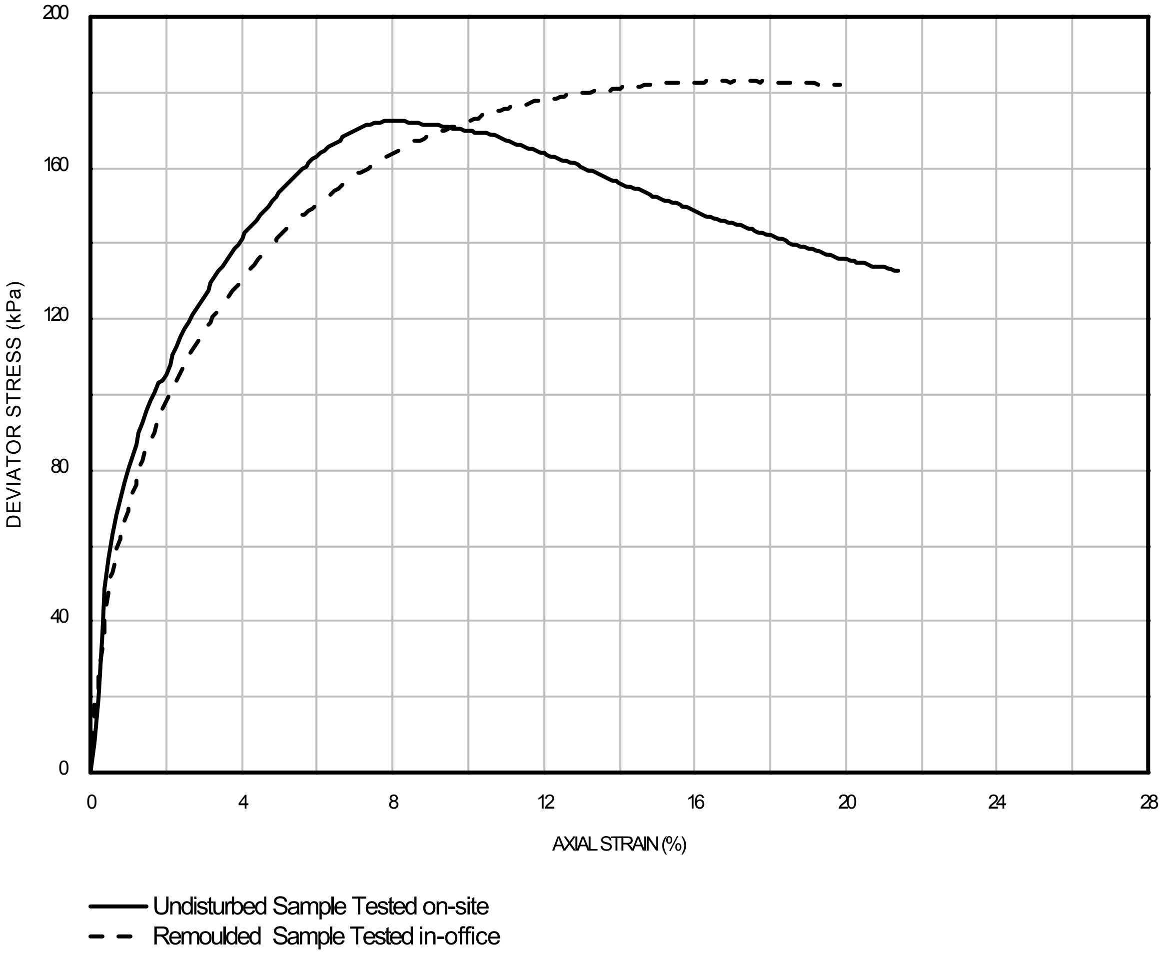
Drawn by: ALB Date: 26/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH05-SA_23BagUUC_uu.OPJ

Checked by: 0 Date : 00/01/1900

Approved by: Date :



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	2
Corrected deviator stress	(kPa)	172	183
Strain at failure	(%)	7.8	17.2
Undrained shear strength	(kPa)	86	92

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	145.9	100.8
Sample diameter	(mm)	67.7	49.3
Membrane thickness	(mm)	0.32	0.28
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.06	2.04
Dry density	(Mg/m^3)	1.59	1.58
Water content	(%)	30.2	29.4

Borehole : HKZ1-BH05-SA

Sample : 23UUC

Depth (m) : 19.40

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

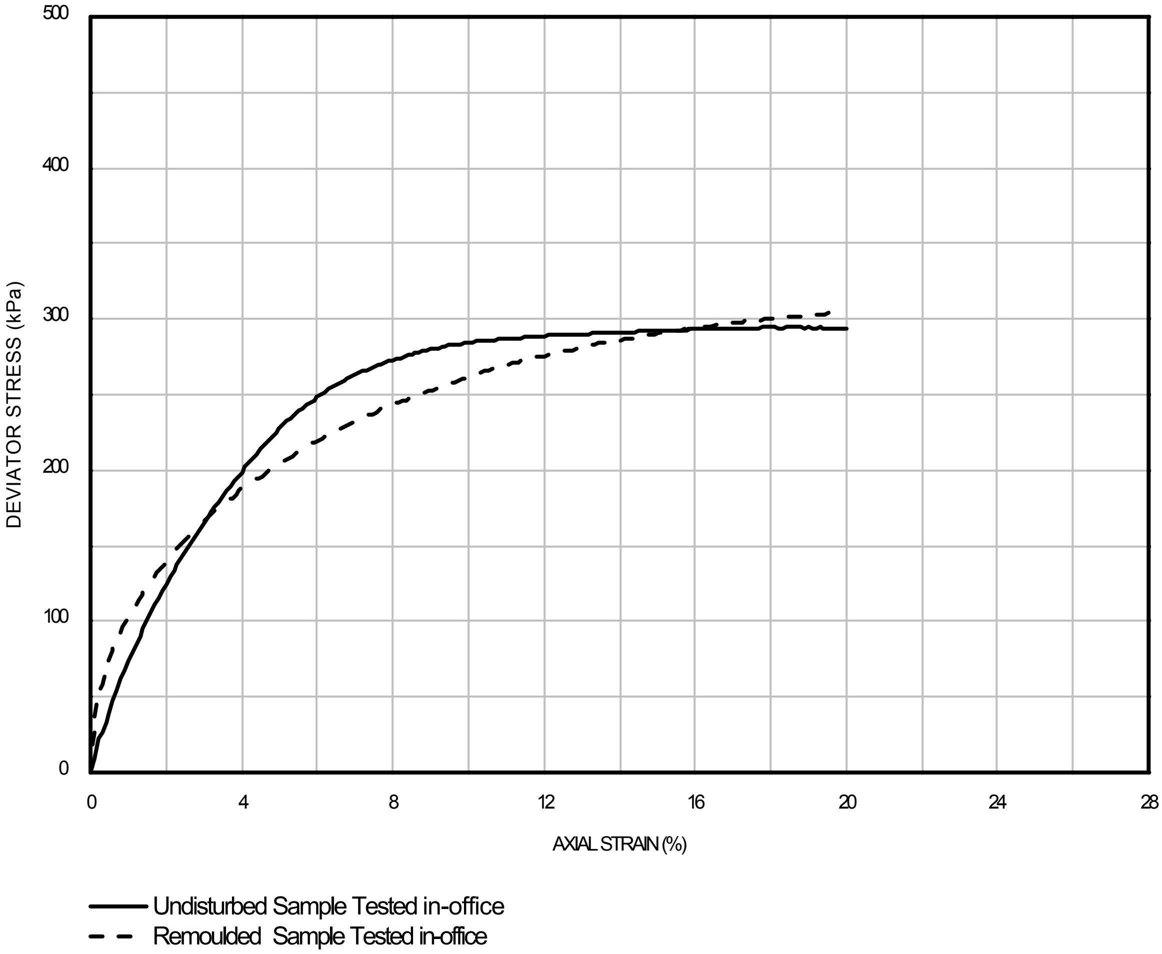
Drawn by: ALB Date: 26/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH05-SA_26WaxD_uu.OPJ

Checked by: MSR Date : 19/08/2016

Approved by: Date :



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	3	2
Corrected deviator stress	(kPa)	295	304
Strain at failure	(%)	18.5	19.8
Undrained shear strength	(kPa)	147	152

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	139.0	100.8
Sample diameter	(mm)	68.0	49.4
Membrane thickness	(mm)	0.51	0.28
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.08	2.05
Dry density	(Mg/m^3)	1.69	1.66
Water content	(%)	22.8	23.7

Borehole : HKZ1-BH05-SA

Sample : 26WaxD

Depth (m) : 22.55

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

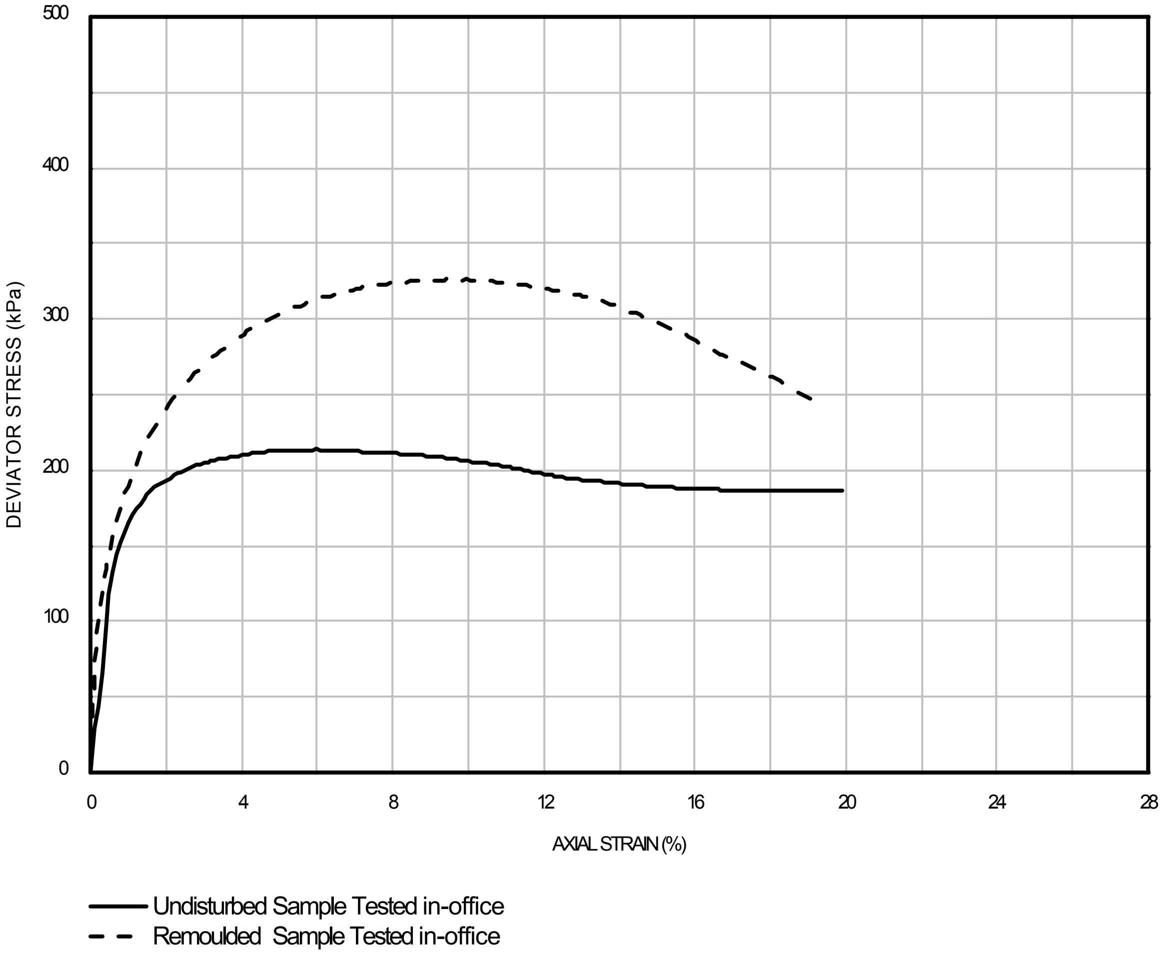
Drawn by: ALB Date: 24/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH05-SA_48WaxB_uu.OPJ

Checked by: PH Date : 02/09/2016

Approved by: Date :



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Shear failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	2
Corrected deviator stress	(kPa)	214	326
Strain at failure	(%)	6.0	9.4
Undrained shear strength	(kPa)	107	163

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	99.9	101.0
Sample diameter	(mm)	51.6	49.2
Membrane thickness	(mm)	0.58	0.49
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.83	1.84
Dry density	(Mg/m^3)	1.34	1.35
Water content	(%)	36.3	36.5

Borehole : HKZ1-BH05-SA

Sample : 48WaxB

Depth (m) : 43.60

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

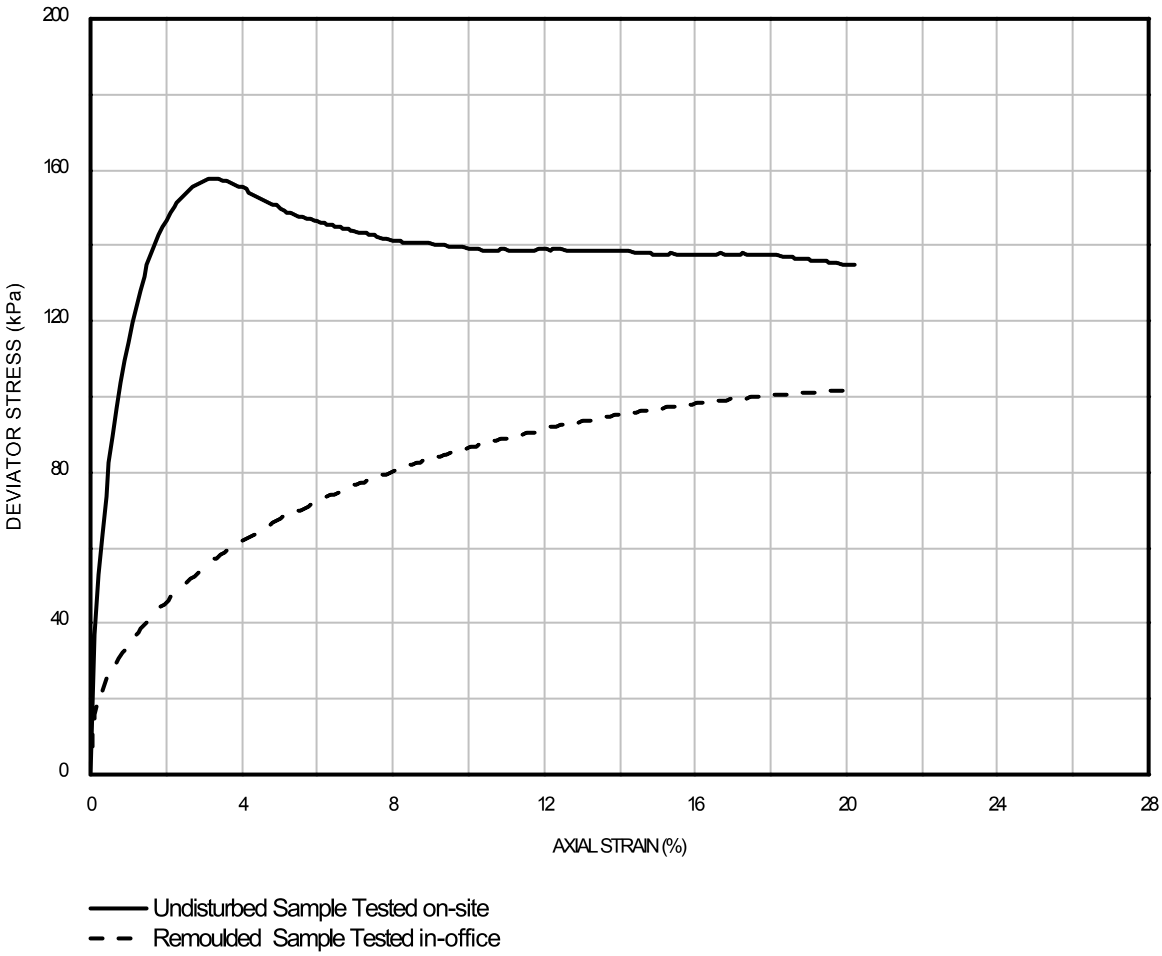
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_21BagUUB_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	0	4
Corrected deviator stress	(kPa)	158	102
Strain at failure	(%)	3.3	19.8
Undrained shear strength	(kPa)	79	51

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	145.2	100.3
Sample diameter	(mm)	72.9	49.1
Membrane thickness	(mm)	0.32	0.48
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.80	1.83
Dry density	(Mg/m^3)	1.32	1.35
Water content	(%)	35.8	35.1

Borehole : HKZ1-BH06-SA

Sample : 21UUB

Depth (m) : 16.70

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

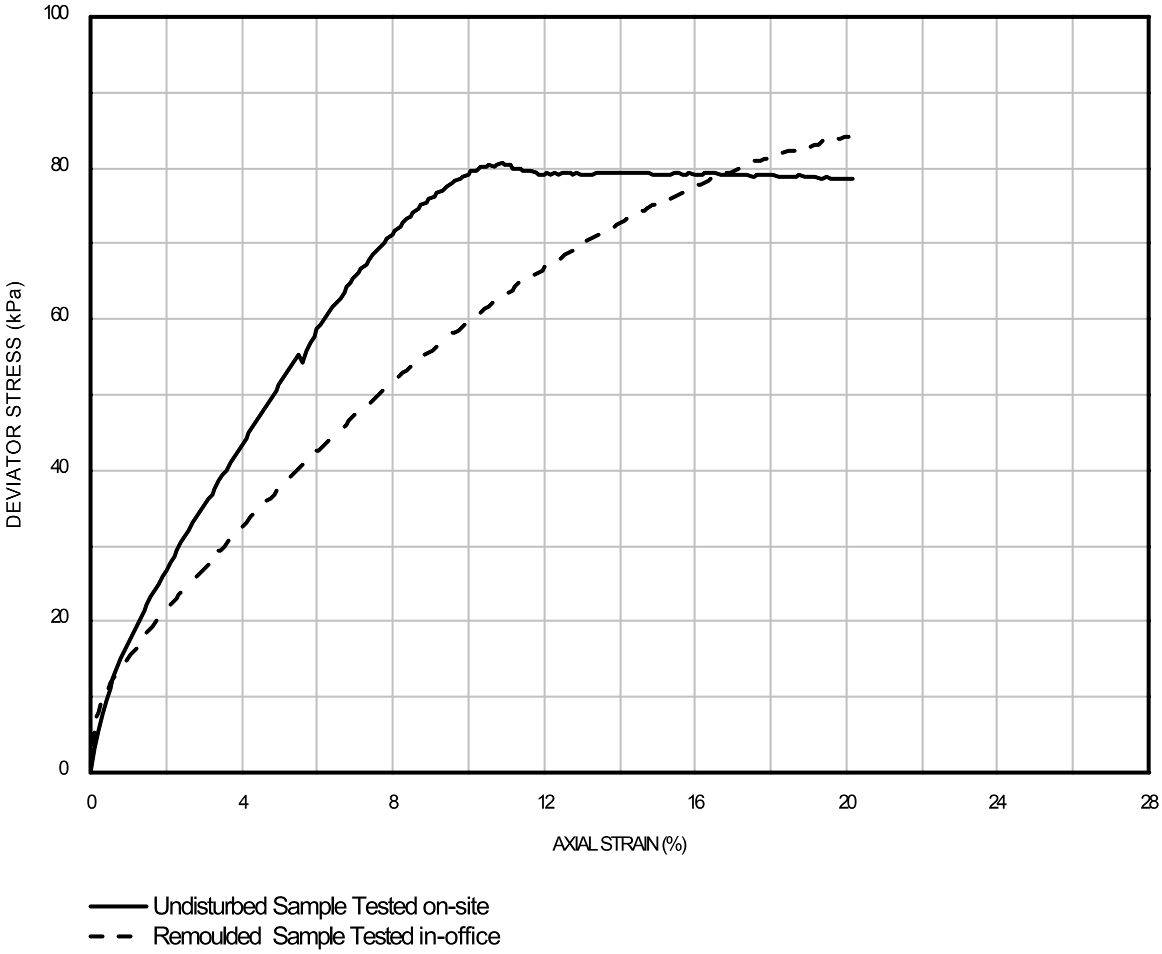
Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_30BagUUD_uu.OPJ

Checked by: 0 Date : 00/01/1900

Approved by: Date :



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	3
Corrected deviator stress	(kPa)	81	84
Strain at failure	(%)	10.9	20.1
Undrained shear strength	(kPa)	40	42

Undisturbed

Barrel failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	145.1	99.4
Sample diameter	(mm)	71.2	49.2
Membrane thickness	(mm)	0.32	0.34
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.98	2.01
Dry density	(Mg/m^3)	1.58	1.59
Water content	(%)	25.7	26.1

Borehole : HKZ1-BH06-SA

Sample : 30UUD

Depth (m) : 25.60

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

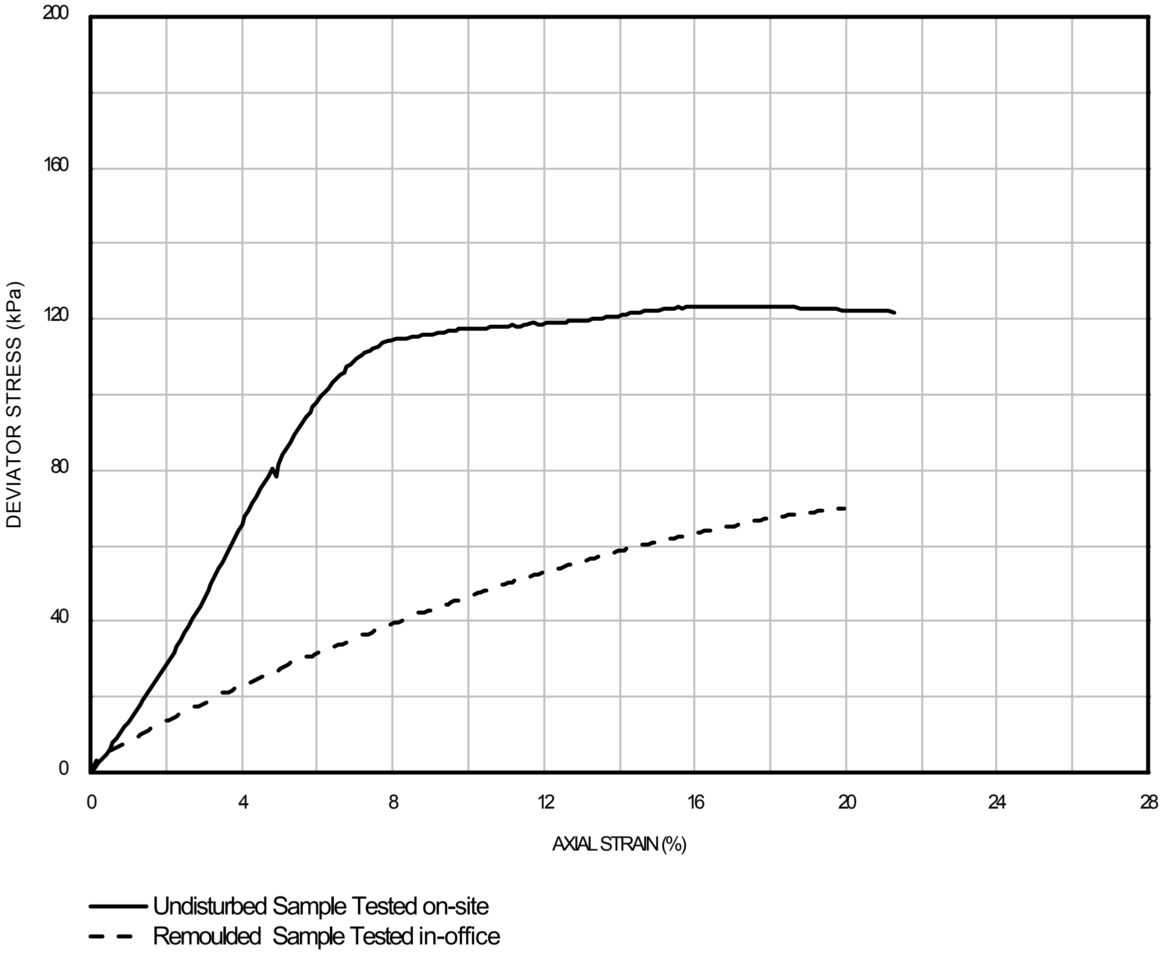
Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_32BagUUC_uu.OPJ

Checked by: 0 Date : 00/01/1900

Approved by: Date :



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	3
Corrected deviator stress	(kPa)	124	70
Strain at failure	(%)	17.5	20.0
Undrained shear strength	(kPa)	62	35

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	144.8	98.5
Sample diameter	(mm)	71.5	50.1
Membrane thickness	(mm)	0.32	0.34
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.08	2.06
Dry density	(Mg/m^3)	1.64	1.58
Water content	(%)	26.8	29.9

Borehole : HKZ1-BH06-SA

Sample : 32UUC

Depth (m) : 27.40

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

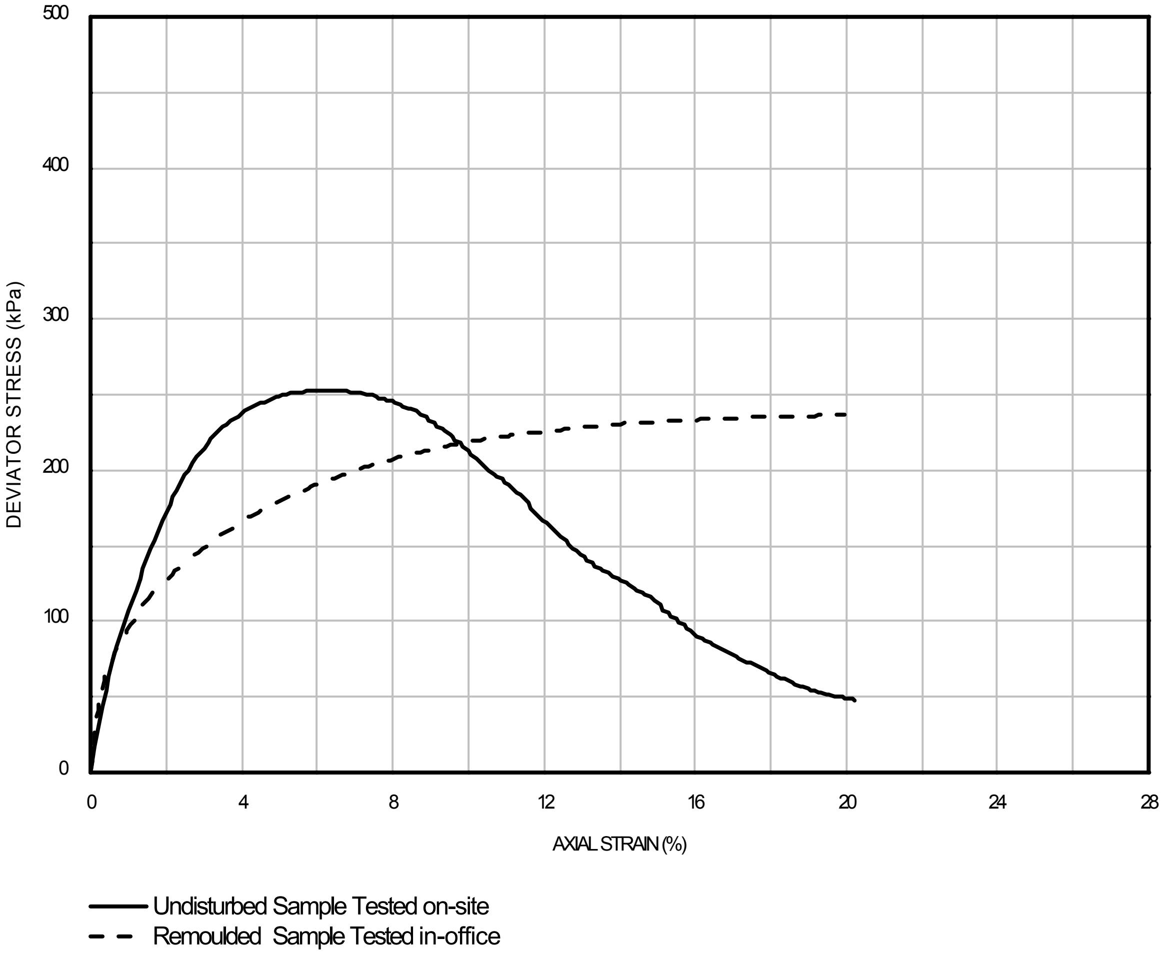
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_51BagUUC_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	1	2
Corrected deviator stress	(kPa)	253	237
Strain at failure	(%)	6.4	20.0
Undrained shear strength	(kPa)	126	118

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	145.3	101.0
Sample diameter	(mm)	71.9	49.3
Membrane thickness	(mm)	0.32	0.29
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.86	1.85
Dry density	(Mg/m^3)	1.39	1.36
Water content	(%)	33.6	35.8

Borehole : HKZ1-BH06-SA

Sample : 51UUC

Depth (m) : 44.90

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 25/08/2016

Template Issue: 3:4

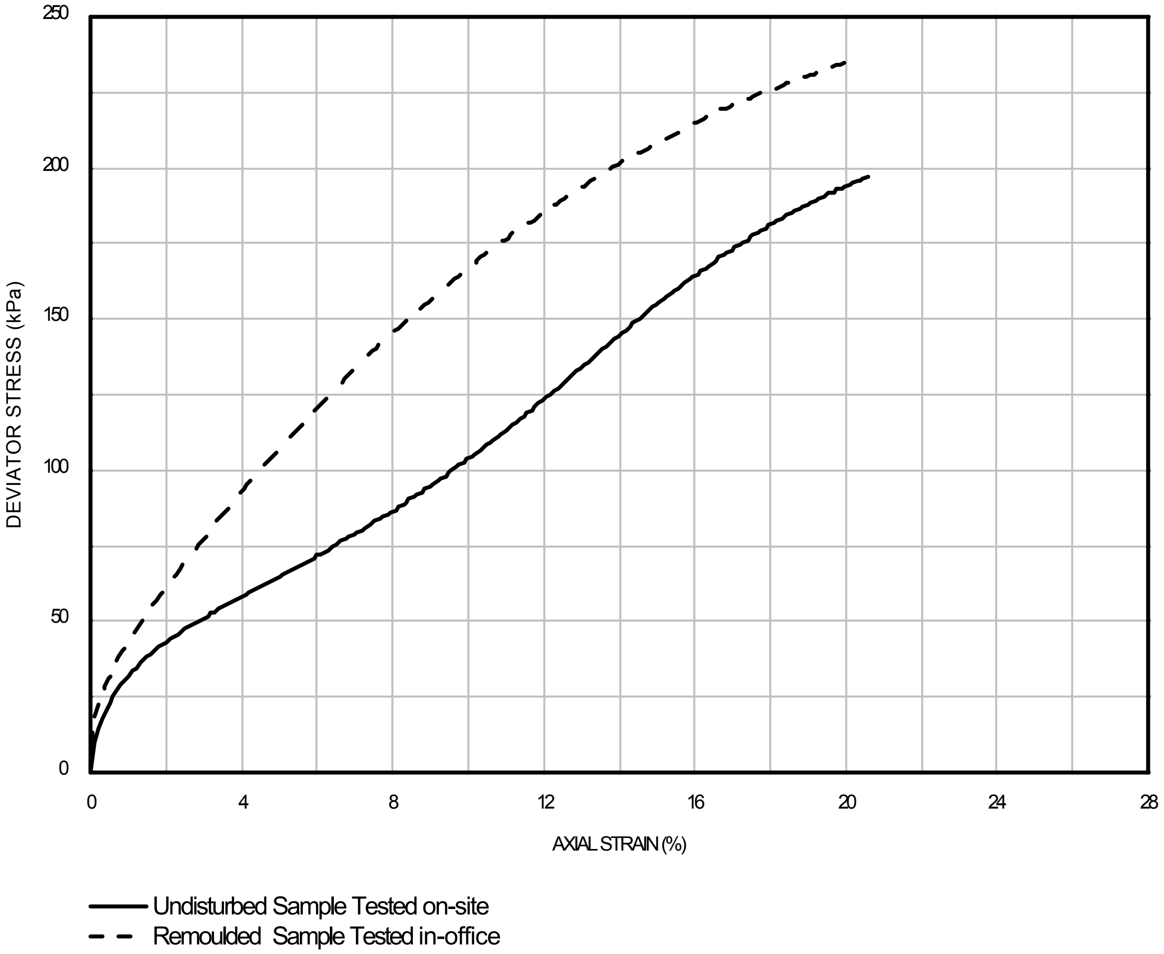
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_53BagUUC_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Undisturbed

Shear failure

Remoulded

Barrel failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	2
Corrected deviator stress	(kPa)	194	235
Strain at failure	(%)	20.0	20.0
Undrained shear strength	(kPa)	97	118

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	144.9	100.3
Sample diameter	(mm)	71.2	49.3
Membrane thickness	(mm)	0.32	0.28
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	2.14	2.13
Dry density	(Mg/m^3)	1.78	1.75
Water content	(%)	20.4	21.5

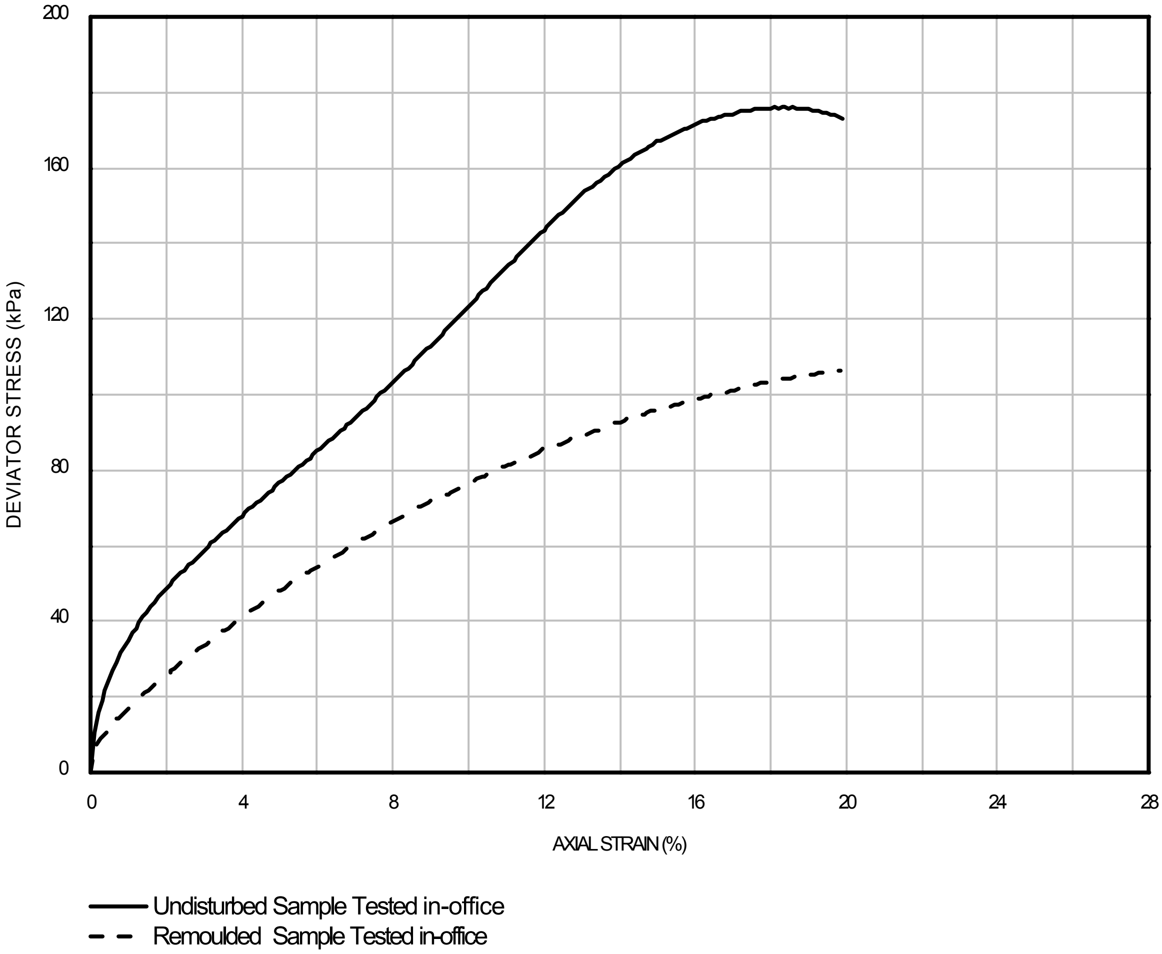
Borehole : HKZ1-BH06-SA

Sample : 53UUC

Depth (m) : 46.90

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS



Failure Shapes:

Undisturbed

Barrel failure

Remoulded

Shear failure

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	4
Corrected deviator stress	(kPa)	176	107
Strain at failure	(%)	18.3	19.9
Undrained shear strength	(kPa)	88	53

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	138.7	100.2
Sample diameter	(mm)	72.5	49.4
Membrane thickness	(mm)	0.44	0.49
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.96	1.96
Dry density	(Mg/m^3)	1.51	1.50
Water content	(%)	29.9	30.8

Borehole : HKZ1-BH06-SA
Sample : 56WaxC
Depth (m) : 50.00

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 17/08/2016
Template Issue: 3:4
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH06-SA_56WaxC_uu.OPJ
Checked by: MSR Date : 16/08/2016
Approved by: Date :

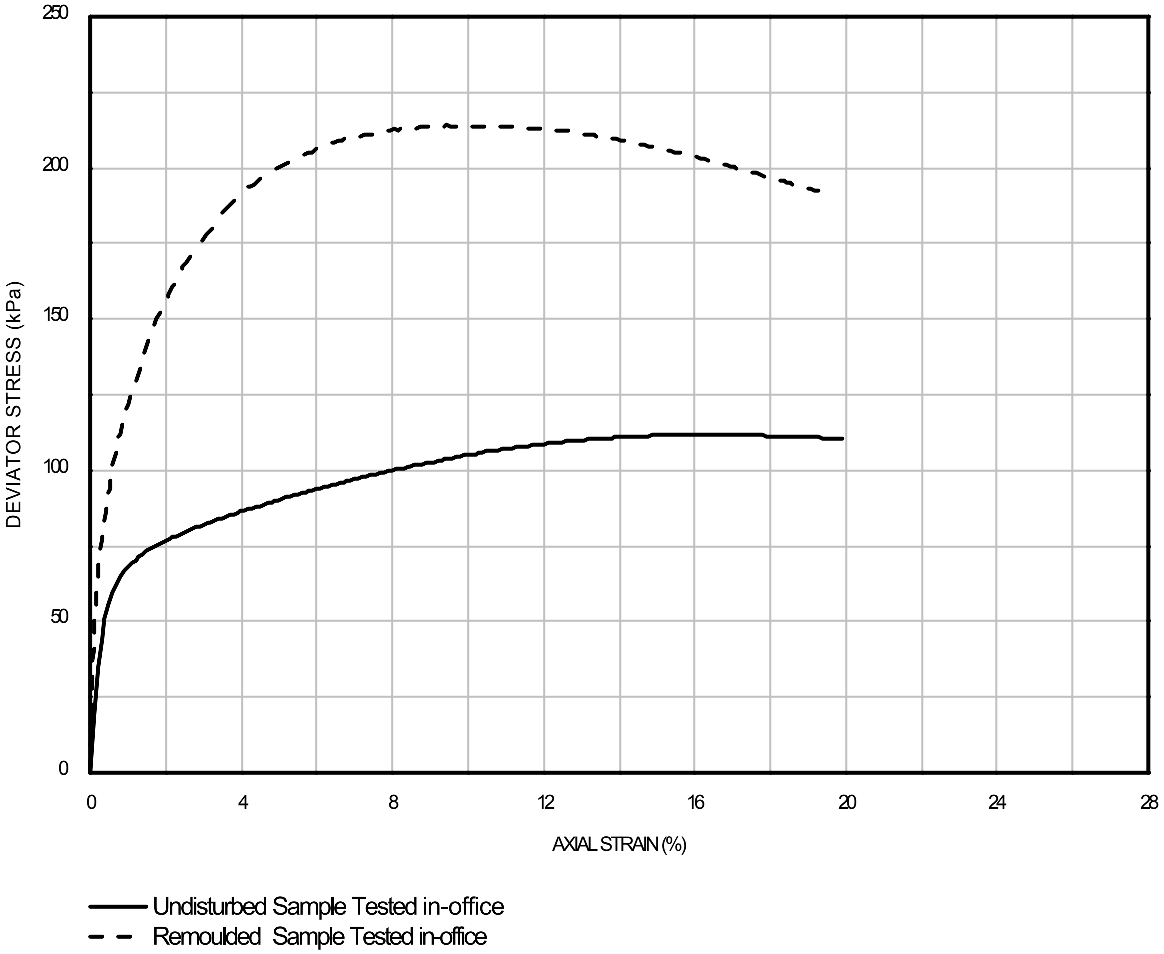
Drawn by: ALB Date: 17/08/2016

Template Issue: 3:4

Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH04-SA_20WaxB_uu.OPJ

Checked by: MSR Date : 16/08/2016

Approved by: Date :



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	2	3
Corrected deviator stress	(kPa)	112	214
Strain at failure	(%)	16.7	9.8
Undrained shear strength	(kPa)	56	107

Undisturbed

Shear failure

Remoulded

Shear failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	139.1	101.0
Sample diameter	(mm)	71.9	49.3
Membrane thickness	(mm)	0.41	0.56
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.90	1.89
Dry density	(Mg/m^3)	1.39	1.48
Water content	(%)	35.9	27.4

Borehole : HKZ1-BH07-SA

Sample : 20WaxB

Depth (m) : 13.05

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Drawn by: ALB Date: 24/08/2016

Template Issue: 3:4

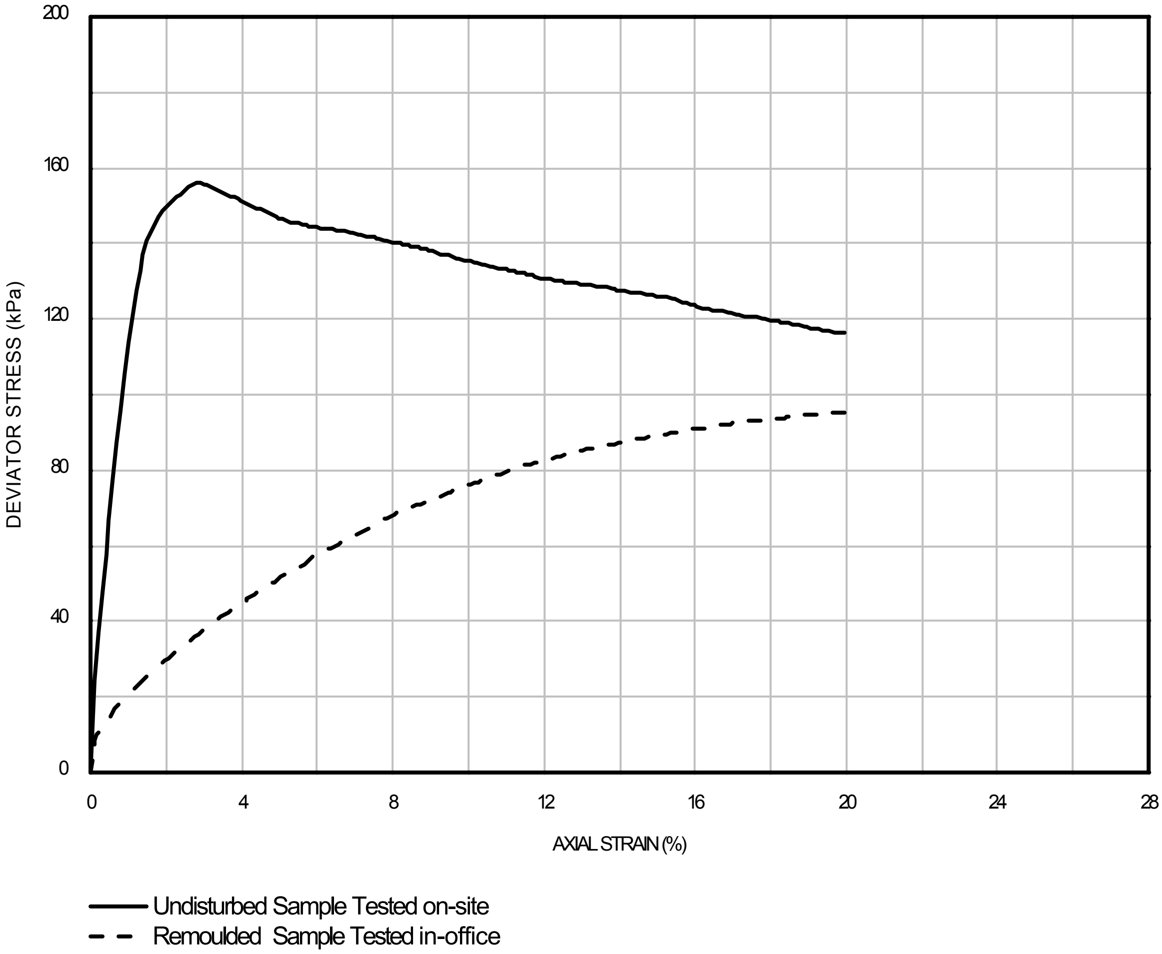
Filename: N6196 \ Labdata \ Triaxial \ HKZ1-BH08-SA_14BagUUC_uu.OPJ

Date : 00/01/1900

Date :

Checked by: 0

Approved by:



Failure Shapes:

Failure Conditions		Undisturbed	Remoulded
Cell pressure	(kPa)	1000	1000
Membrane correction	(kPa)	0	3
Corrected deviator stress	(kPa)	156	95
Strain at failure	(%)	2.8	20.0
Undrained shear strength	(kPa)	78	48

Undisturbed

Shear failure

Remoulded

Barrel failure

Initial Conditions		Undisturbed	Remoulded
Sample length	(mm)	146.0	100.6
Sample diameter	(mm)	71.9	49.4
Membrane thickness	(mm)	0.32	0.44
Rate of strain	(%/min)	1.0	1.0
Bulk density	(Mg/m^3)	1.92	1.90
Dry density	(Mg/m^3)	1.47	1.43
Water content	(%)	30.4	33.1

Borehole : HKZ1-BH08-SA

Sample : 14UUC

Depth (m) : 12.30

Tested in accordance with BS 1377: Part 7: 1990: Clause 8 (Offshore tests not UKAS accredited)

UNCONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST
UNDISTURBED AND REMOULDED SPECIMENS

Date: 18/10/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Checked by: PH Date: 20/10/2016
Approved by: PH Date: 20/10/2016

VISUAL DESCRIPTION
High strength dark grey CLAY with laminations and layers of light grey silt and sand

GENERAL	
Date test started	11/10/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	[mm]	71.6
Length	[mm]	139.6
Water content	[%]	29.1
Bulk density	[Mg/m³]	1.94
Dry density	[Mg/m³]	1.50
Void ratio		0.776
Degree of saturation	[%]	100

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	N/A
Pore pressure on completion	[kPa]	453
Cell pressure on completion	[kPa]	570
B value achieved		0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA
Sample	18WaxC
Depth [m]	15.94

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	570
Back pressure	[kPa]	400
Effective cell pressure	[kPa]	170
Pore pressure on completion	[kPa]	400
Pore pressure dissipation	[%]	100
Water content	[%]	28.6
Bulk density	[Mg/m³]	1.95
Dry density	[Mg/m³]	1.51
Void ratio		0.763
Degree of saturation	[%]	100
Volumetric strain	[%]	0.73
Axial strain	[%]	0.24

Borehole	HKZ1-BH01-SA
Sample	18WaxC
Depth [m]	15.94

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 18/10/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Date: 20/10/2016
Checked by: PH
Date: 20/10/2016
Approved by: PH

BENDER ELEMENT DETERMINATIONS - POST SATURATION

Bulk density	$[Mg/m^3]$	1.94
Dry density	$[Mg/m^3]$	1.50
Void ratio	[-]	0.776
Distance	[mm]	136.7
Effective radial pressure	[kPa]	117
Effective axial pressure	[kPa]	117

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.7980	7.98	171.25	56.9
0.12	0.8080	6.73	169.13	55.5
0.14	0.8145	5.82	167.78	54.6
0.16	0.8285	5.18	164.95	52.8
0.18	0.8315	4.62	164.35	52.4
0.20	0.8285	4.14	164.95	52.8
0.22	0.8330	3.79	164.06	52.2
0.24	0.8320	3.47	164.25	52.4
0.26	0.8340	3.21	163.86	52.1
0.28	0.8380	2.99	163.08	51.6

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION

Bulk density	$[Mg/m^3]$	1.95
Dry density	$[Mg/m^3]$	1.51
Void ratio	[-]	0.763
Distance	[mm]	136.32
Effective radial pressure	[kPa]	170
Effective axial pressure	[kPa]	170

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.7065	7.07	192.95	72.5
0.12	0.7175	5.98	189.99	70.3
0.14	0.7265	5.19	187.64	68.6
0.16	0.7270	4.54	187.51	68.5
0.18	0.7270	4.04	187.51	68.5
0.20	0.7305	3.65	186.61	67.8
0.22	0.7325	3.33	186.10	67.5
0.24	0.7315	3.05	186.36	67.6

Borehole	HKZ1-BH01-SA
Sample	18WaxC
Depth [m]	15.94

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SHEARING		
Initial pore pressure	[kPa]	400
Initial effective cell pressure	[kPa]	170
Rate of strain	[%/hour]	0.48
At peak deviator stress		
Corrected deviator stress	[kPa]	246
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
Axial strain	[%]	10.75
Excess pore pressure	[kPa]	117
Major principal effective stress	[kPa]	299
Minor principal effective stress	[kPa]	53
Principal effective stress ratio		5.65
Epsilon 50 [ε 50]	[%]	0.58
Secant modulus [E50] at ε 50	[kPa]	21167
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	246
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
Axial strain	[%]	11.25
Excess pore pressure	[kPa]	118
Major principal effective stress	[kPa]	298
Minor principal effective stress	[kPa]	52
Principal effective stress ratio		5.72
At 15% axial strain		
Corrected deviator stress	[kPa]	235
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	115
Major principal effective stress	[kPa]	289
Minor principal effective stress	[kPa]	55
Principal effective stress ratio		5.29

FINAL CONDITIONS		
Water content	[%]	28.6
Bulk density	[Mg/m³]	1.95
Dry density	[Mg/m³]	1.51

Borehole	HKZ1-BH01-SA
Sample	18WaxC
Depth [m]	15.94

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 18/10/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Date: 20/10/2016
Checked by: PH
Date: 20/10/2016
Approved by: PH

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH01-SA
Sample	18WaxC
Depth [m]	15.94

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 18/10/2016

Drawn by: ALB

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_18WaxC_ca.OPJ

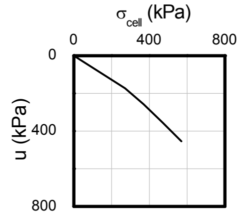
Date : 20/10/2016

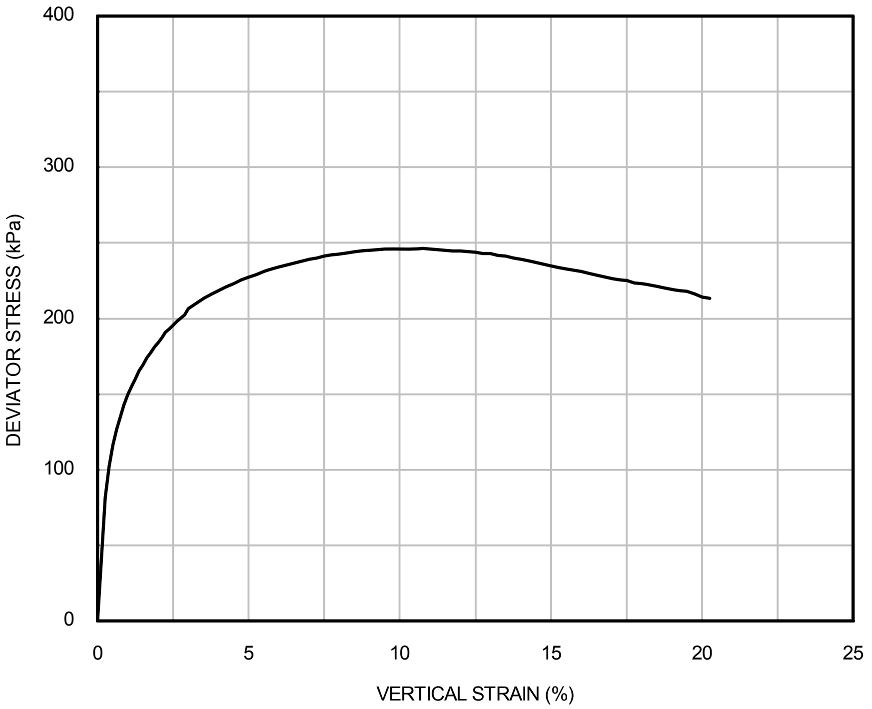
Date : 20/10/2016

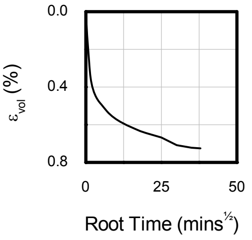
Checked by: PH

Approved by: PH

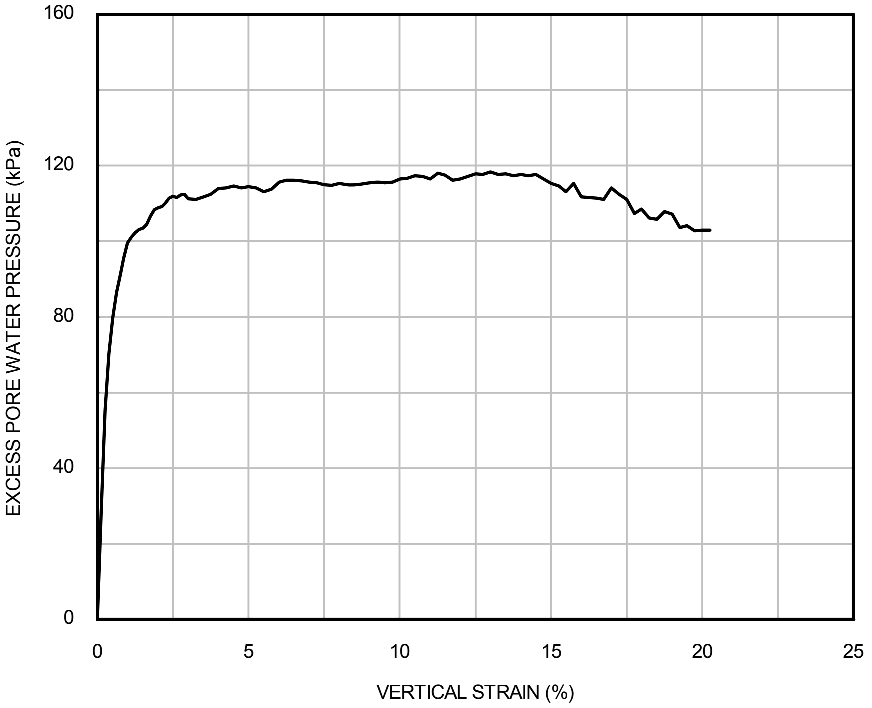
Saturation







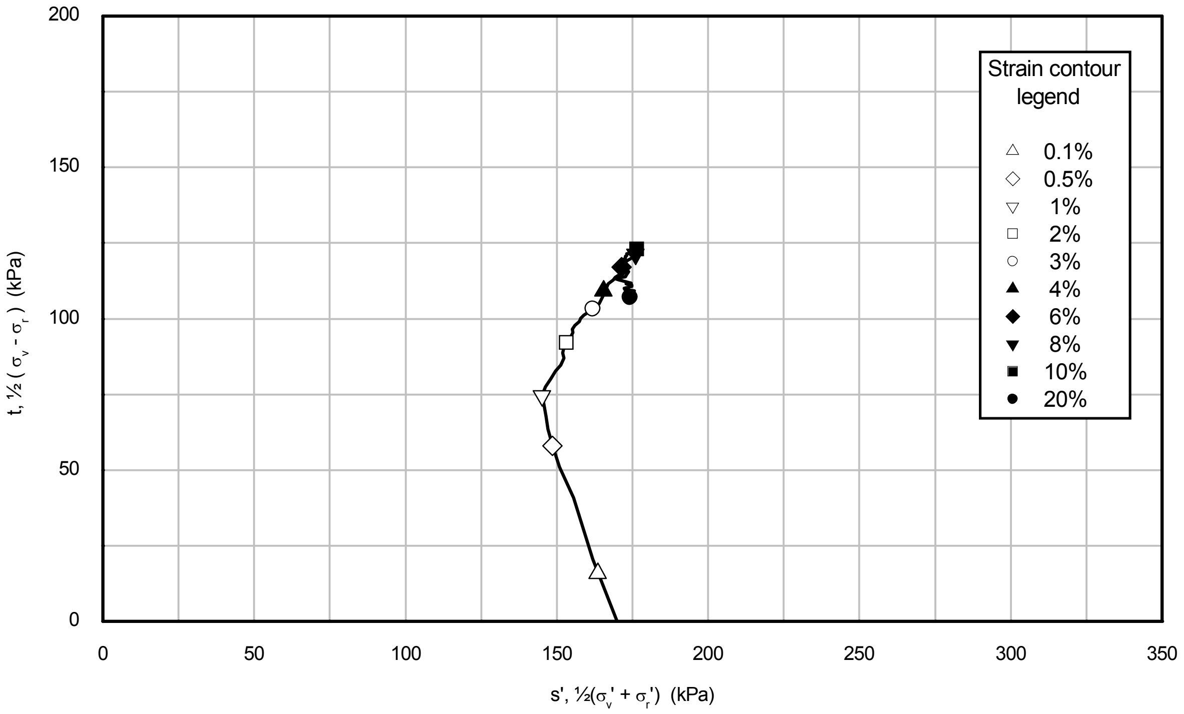
Consolidation

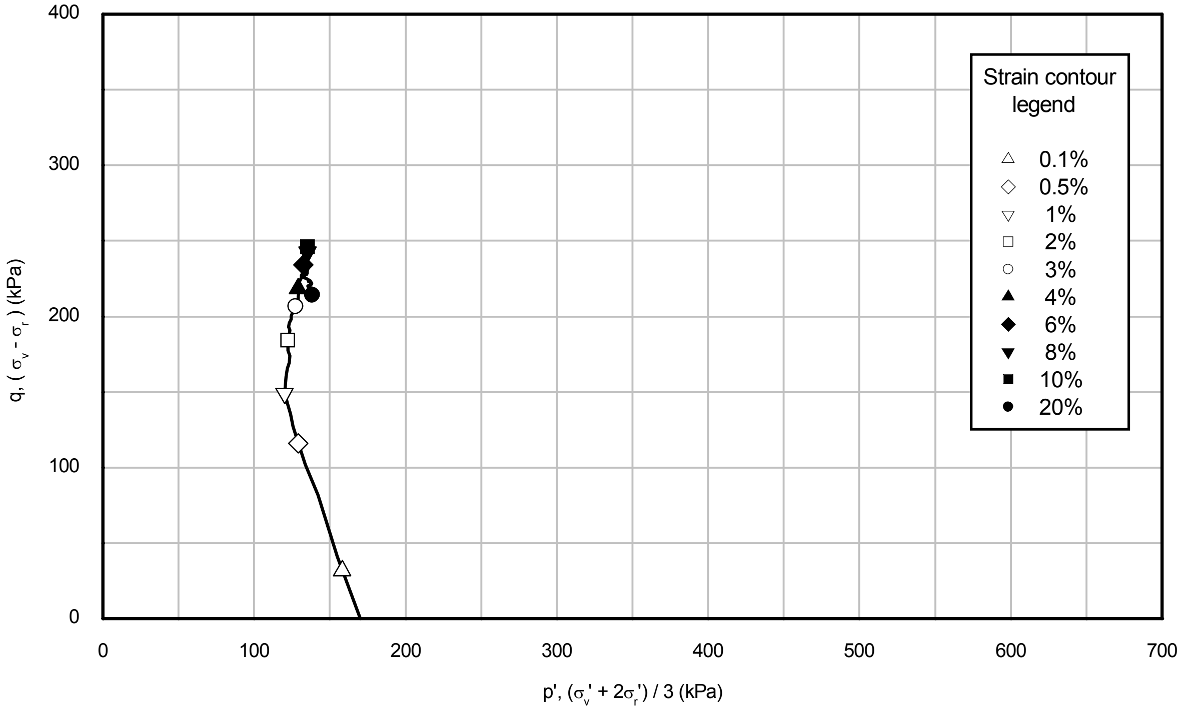


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	170	170	HKZ1-BH01-SA	18WaxC	15.94

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

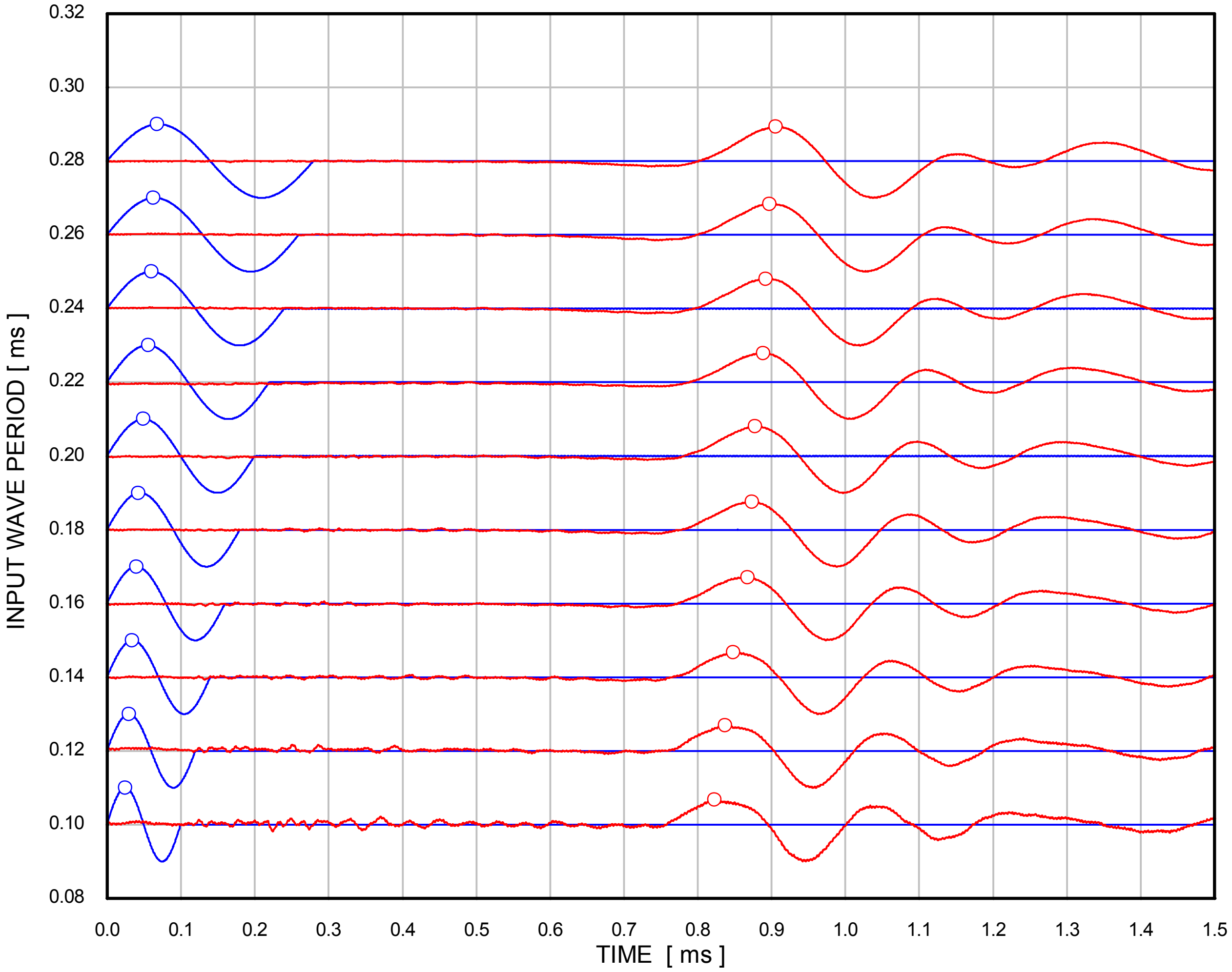
Date: 18/10/2016
Drawn by: ALB
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_18WaxC_ca.OPJ
Date : 20/10/2016
Date : 20/10/2016
Checked by: PH
Approved by: PH

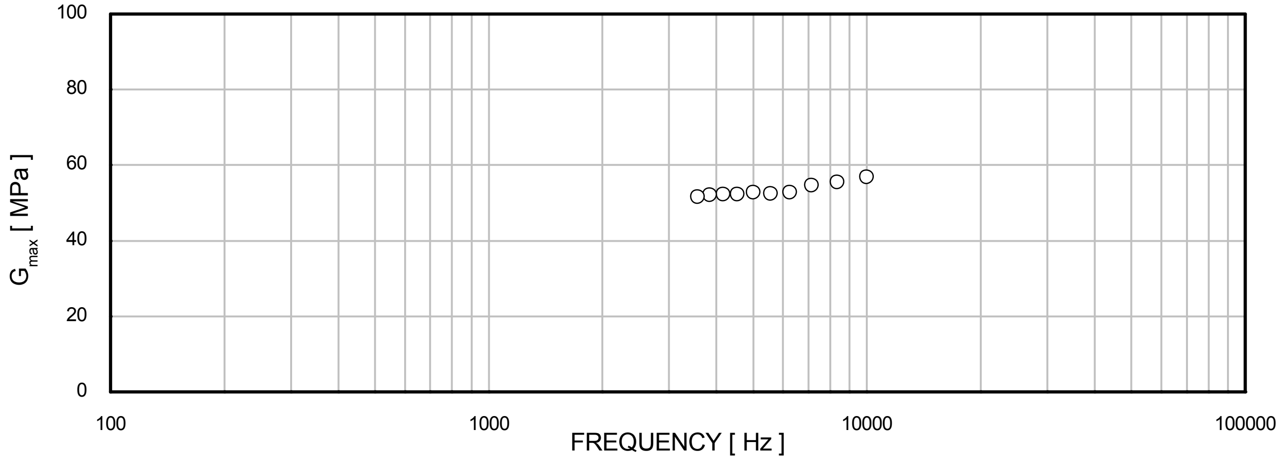




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	170	170	HKZ1-BH01 -SA	18WaxC	15.94

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





σ'_{rc} : 117 kPa

σ'_{ac} : 117 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

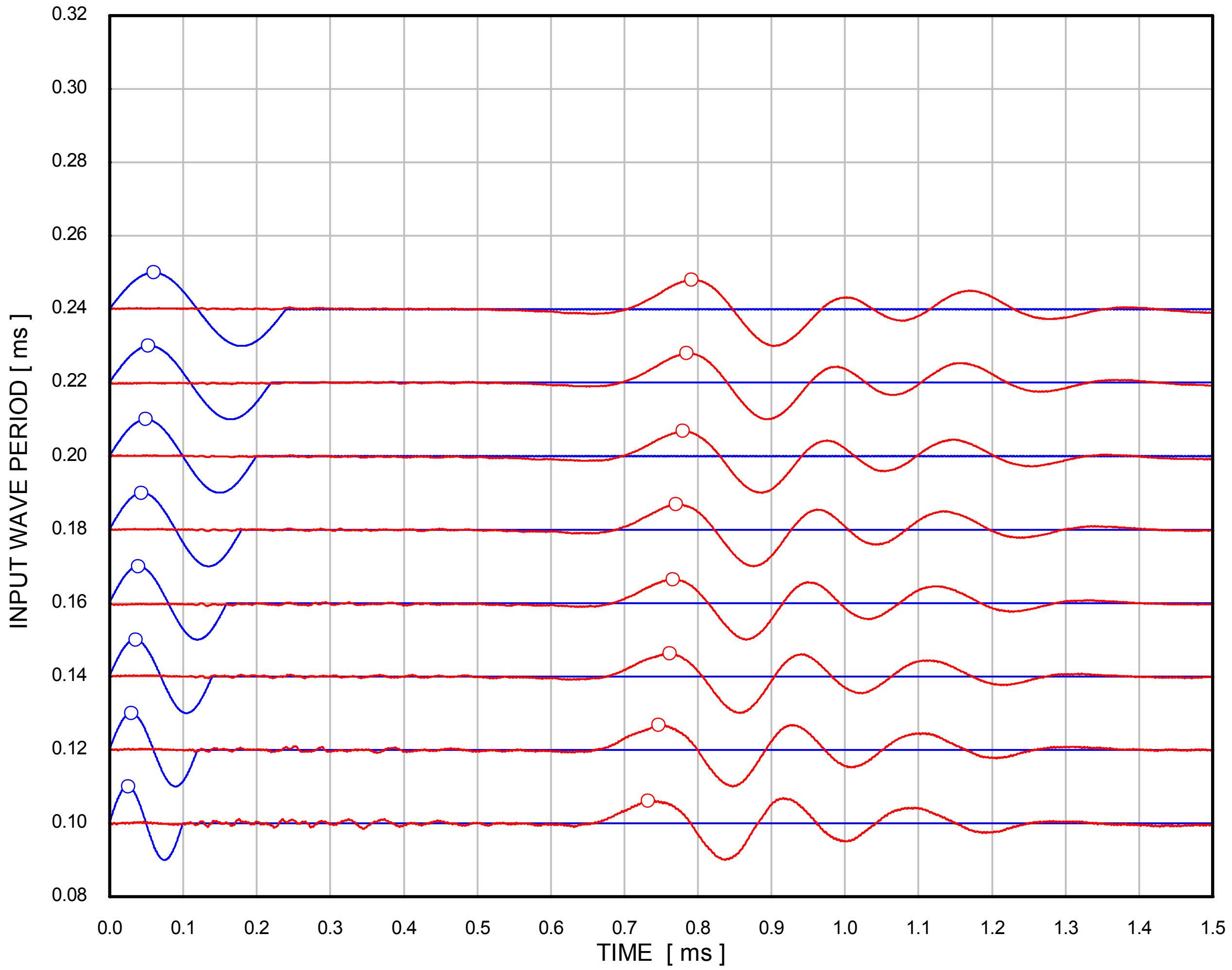
Borehole : HKZ1-BH01-SA

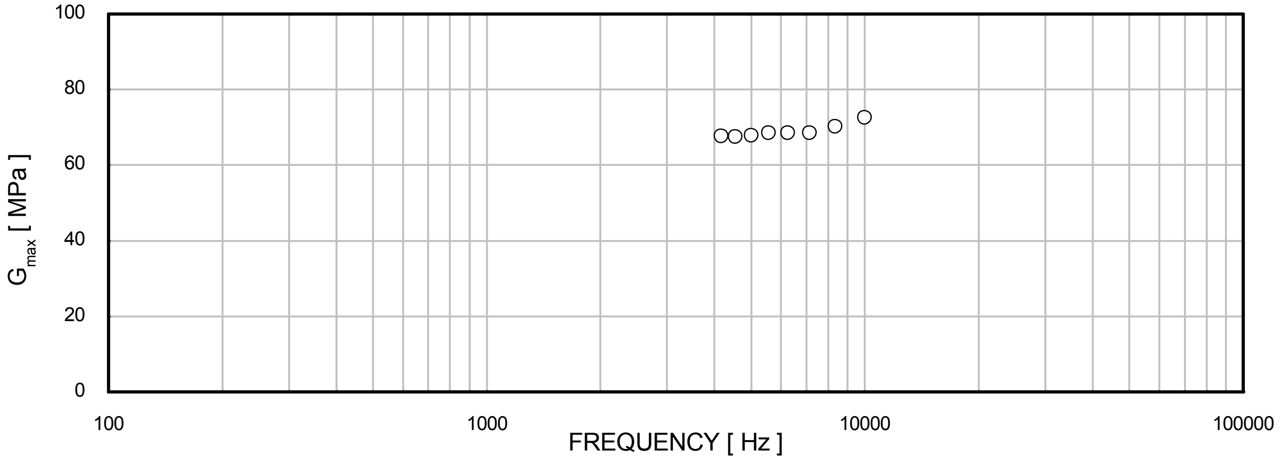
Sample : 18WaxC

Depth [m] : 15.94

Test No. : 125

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 170 kPa		Borehole	: HKZ1-BH01-SA
σ'_{ac}	: 170 kPa		Sample	: 18WaxC
▬	Source signal		Depth [m]	: 15.94
▬	Received signal			
○ / ○	Selected peak values		Test No.	: 125

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
High strength dark grey CLAY with traces of silt

GENERAL	
Date test started	28/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	49.9
Length	(mm)	99.7
Water content	(%)	30.9
Bulk density	(Mg/m³)	1.94
Dry density	(Mg/m³)	1.48
Void ratio		0.819
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	538
Cell pressure on completion	(kPa)	610
B value achieved		0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA
Sample	24WaxC
Depth (m)	21.75

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	610
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	210
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	29.6
Bulk density	(Mg/m³)	1.96
Dry density	(Mg/m³)	1.51
Void ratio		0.785
Degree of saturation	(%)	100
Volumetric strain	(%)	1.85

Mode of failure: Brittle failure

Borehole	HKZ1-BH01-SA
Sample	24WaxC
Depth (m)	21.75

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 02/09/2016 Drawn by: ALB Template Issue: 2

Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_24WaxC_CU.XLS

Date: 02/09/2016 Checked by: MSR

Date: 05/09/2016 Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	210
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	215
Membrane correction applied	(kPa)	0.5
Drain correction applied	(kPa)	0
Axial strain	(%)	3.50
Excess pore pressure	(kPa)	107
Major principal effective stress	(kPa)	318
Minor principal effective stress	(kPa)	103
Principal effective stress ratio		3.09
Epsilon 50 (ε 50)	(%)	0.24
Secant modulus (E50) at ε 50	(kPa)	45701
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	215
Membrane correction applied	(kPa)	0.5
Drain correction applied	(kPa)	0
Axial strain	(%)	3.00
Excess pore pressure	(kPa)	108
Major principal effective stress	(kPa)	316
Minor principal effective stress	(kPa)	102
Principal effective stress ratio		3.11
At 15% axial strain		
Corrected deviator stress	(kPa)	175
Membrane correction applied	(kPa)	1.8
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	100
Major principal effective stress	(kPa)	285
Minor principal effective stress	(kPa)	110
Principal effective stress ratio		2.58

FINAL CONDITIONS		
Water content	(%)	29.6
Bulk density	(Mg/m^3)	1.96
Dry density	(Mg/m^3)	1.51

Borehole	HKZ1-BH01-SA
Sample	24WaxC
Depth (m)	21.75

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Drawn by: ALB Date: 02/09/2016

Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_24WaxC_CU.XLS

Checked by: MSR Date: 02/09/2016

Approved by: PH Date: 05/09/2016

SPECIMEN PHOTOGRAPHS

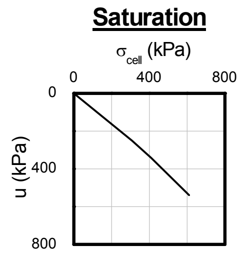
Borehole	HKZ1-BH01-SA
Sample	24WaxC
Depth (m)	21.75

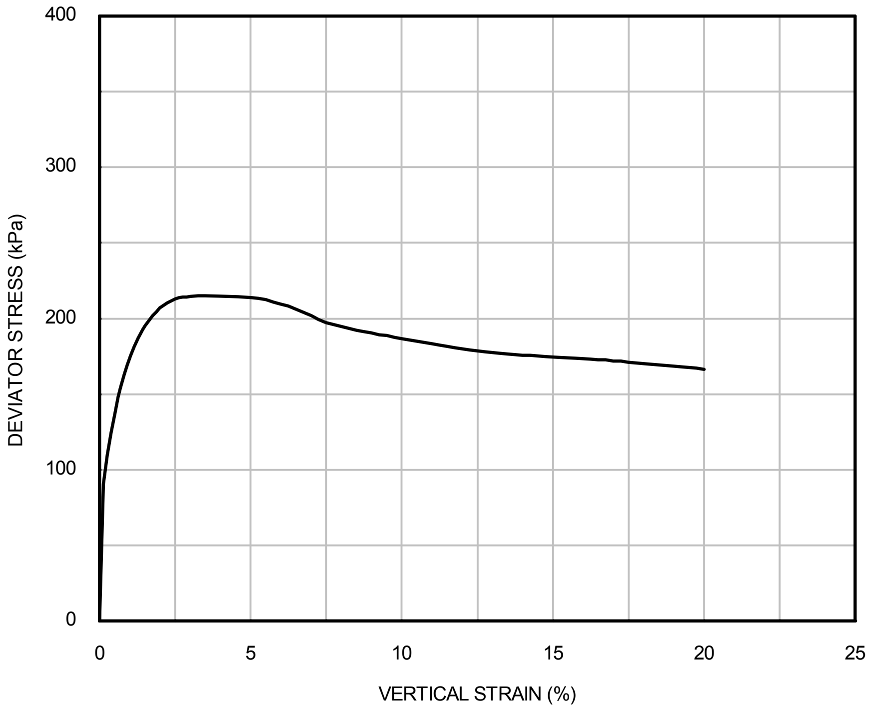
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

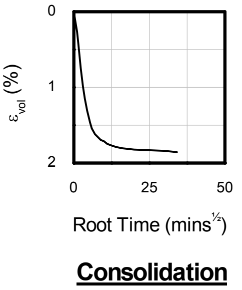
Drawn by: ALB Date: 02/09/2016

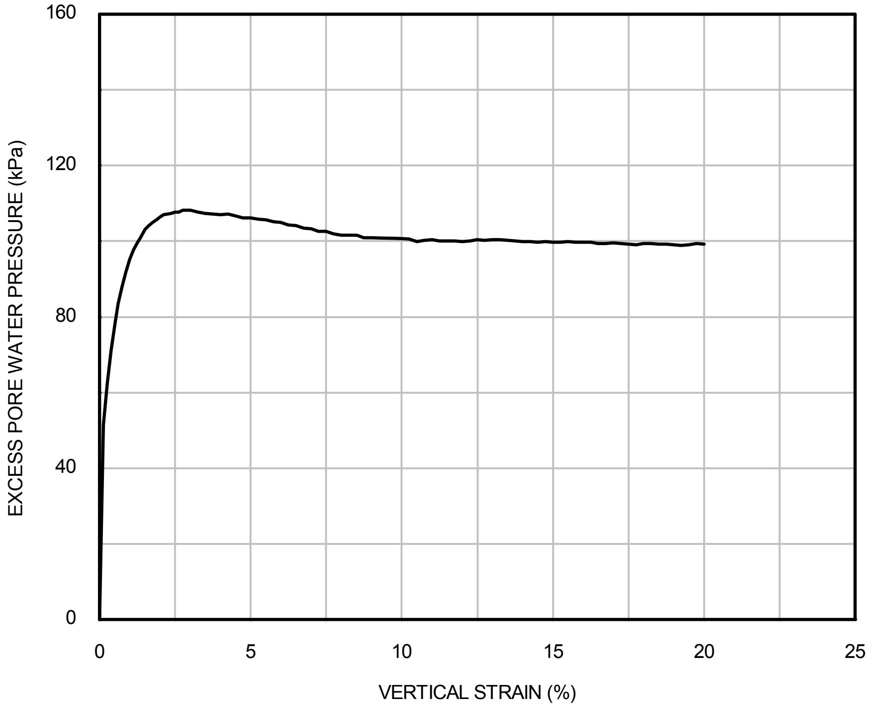
Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_24WaxC_CU.OPJ







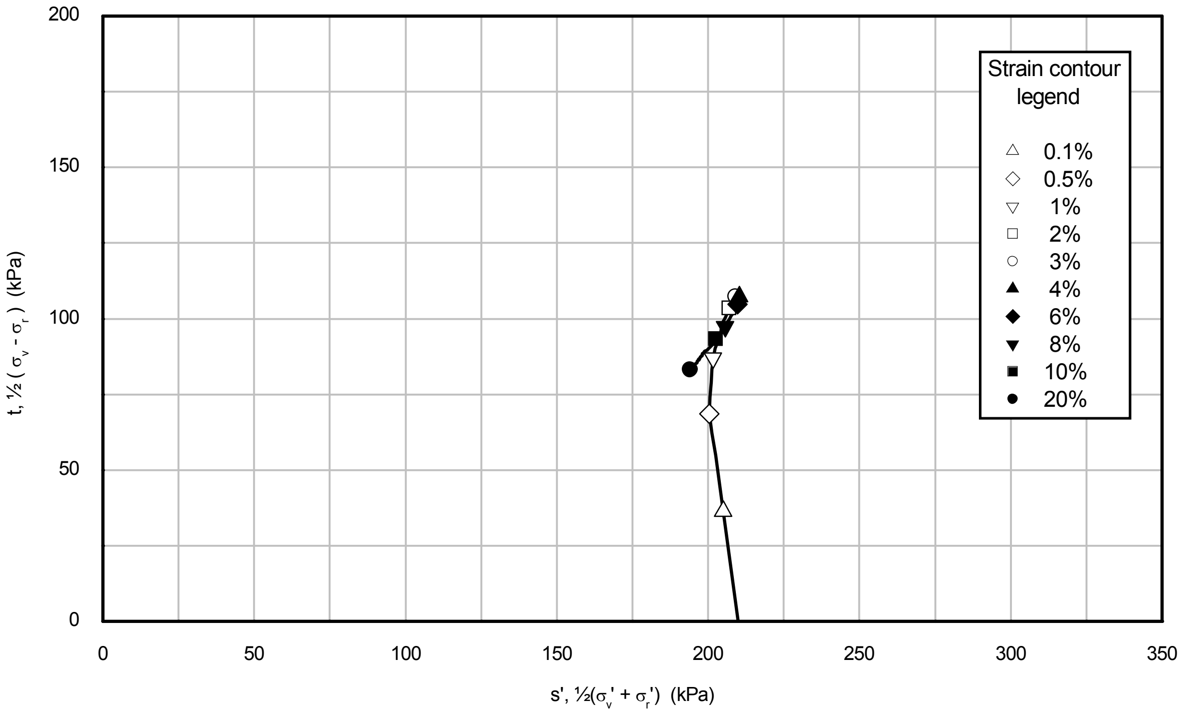


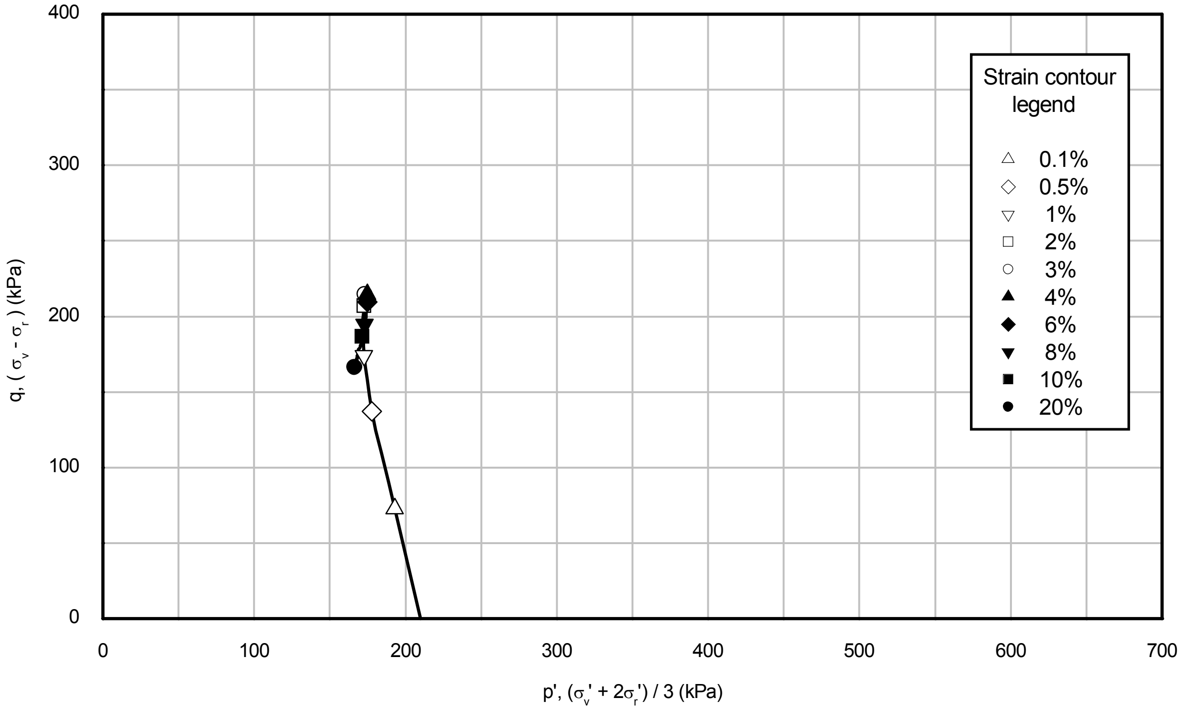
Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	210	210	HKZ1-BH01 -SA	24WaxC	21.75

Date : 02/09/2016 Checked by: MSR

Date : 05/09/2016 Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ$_{rc}$' (kPa)	σ$_{vc}$' (kPa)	Borehole	Sample	Depth (m)
———	1	210	210	HKZ1-BH01 -SA	24WaxC	21.75

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 02/09/2016
Drawn by: ALB
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_24WaxC_CU.OPJ
Date : 02/09/2016
Date : 05/09/2016
Checked by: MSR
Approved by: PH

Date: 14/10/2016 Drawn by: ALB
Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Date: 14/10/2016 Checked by: PH
Date: 14/10/2016 Approved by: PH

VISUAL DESCRIPTION
Brown fine SAND

GENERAL	
Date test started	10/10/2016
Type of sample	Compacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	[mm]	71.7
Length	[mm]	135.0
Water content	[%]	10.2
Bulk density	[Mg/m³]	1.71
Dry density	[Mg/m³]	1.55
Void ratio		0.728
Degree of saturation	[%]	38

SATURATION		
Pressure increments applied	[kPa]	50
Differential pressure used	[kPa]	10
Pore pressure on completion	[kPa]	528
Cell pressure on completion	[kPa]	540
B value achieved		0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA
Sample	28BagA&B
Depth [m]	25.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 14/10/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Checked by: PH Date: 14/10/2016
Approved by: PH Date: 14/10/2016

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	540
Back pressure	[kPa]	300
Effective cell pressure	[kPa]	240
Pore pressure on completion	[kPa]	300
Pore pressure dissipation	[%]	100
Water content	[%]	25.0
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.61
Void ratio		0.669
Degree of saturation	[%]	100
Volumetric strain	[%]	3.37
Axial strain	[%]	1.12

Borehole	HKZ1-BH01-SA
Sample	28BagA&B
Depth [m]	25.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 14/10/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH01-
Date: 14/10/2016 Checked by: PH
Date: 14/10/2016 Approved by: PH

BENDER ELEMENT DETERMINATIONS - POST SATURATION

Bulk density	[Mg/m^3]	1.97
Dry density	[Mg/m^3]	1.55
Void ratio	[-]	0.728
Distance	[mm]	132.1
Effective radial pressure	[kPa]	14
Effective axial pressure	[kPa]	14

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	1.5020	15.02	87.98	15.3
0.12	1.5020	12.52	87.98	15.3
0.14	1.5110	10.79	87.45	15.1
0.16	1.5150	9.47	87.22	15.0
0.18	1.5180	8.43	87.05	14.9
0.20	1.5215	7.61	86.85	14.9
0.22	1.5245	6.93	86.68	14.8
0.24	1.5245	6.35	86.68	14.8
0.26	1.5325	5.89	86.23	14.7
0.28	1.5315	5.47	86.28	14.7

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION

Bulk density	[Mg/m^3]	2.01
Dry density	[Mg/m^3]	1.61
Void ratio	[-]	0.669
Distance	[mm]	130.59
Effective radial pressure	[kPa]	240
Effective axial pressure	[kPa]	240

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6525	6.53	200.14	80.4
0.12	0.6525	5.44	200.14	80.4
0.14	0.6520	4.66	200.29	80.5
0.16	0.6535	4.08	199.83	80.1
0.18	0.6505	3.61	200.75	80.9
0.20	0.6490	3.25	201.22	81.2

Borehole	HKZ1-BH01-SA
Sample	28BagA&B
Depth [m]	25.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SHEARING		
Initial pore pressure	[kPa]	300
Initial effective cell pressure	[kPa]	240
Rate of strain	[%/hour]	0.00
At peak deviator stress		
Corrected deviator stress	[kPa]	122
Membrane correction applied	[kPa]	1.8
Drain correction applied	[kPa]	0
Axial strain	[%]	20.01
Excess pore pressure	[kPa]	190
Major principal effective stress	[kPa]	172
Minor principal effective stress	[kPa]	50
Principal effective stress ratio		3.42
Epsilon 50 [ε 50]	[%]	0.11
Secant modulus [E50] at ε 50	[kPa]	53990
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	107
Membrane correction applied	[kPa]	1.5
Drain correction applied	[kPa]	0
Axial strain	[%]	15.50
Excess pore pressure	[kPa]	198
Major principal effective stress	[kPa]	150
Minor principal effective stress	[kPa]	42
Principal effective stress ratio		3.52
At 15% axial strain		
Corrected deviator stress	[kPa]	105
Membrane correction applied	[kPa]	1.5
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	197
Major principal effective stress	[kPa]	148
Minor principal effective stress	[kPa]	43
Principal effective stress ratio		3.45

FINAL CONDITIONS		
Water content	[%]	25.0
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.61

Borehole	HKZ1-BH01-SA
Sample	28BagA&B
Depth [m]	25.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 14/10/2016 Drawn by: ALB Template Issue: 3

Filename: J11335 / EFFECTIVE / HKZ1-BH01-

Checked by: PH Date: 14/10/2016

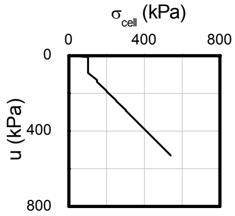
Approved by: PH Date: 14/10/2016

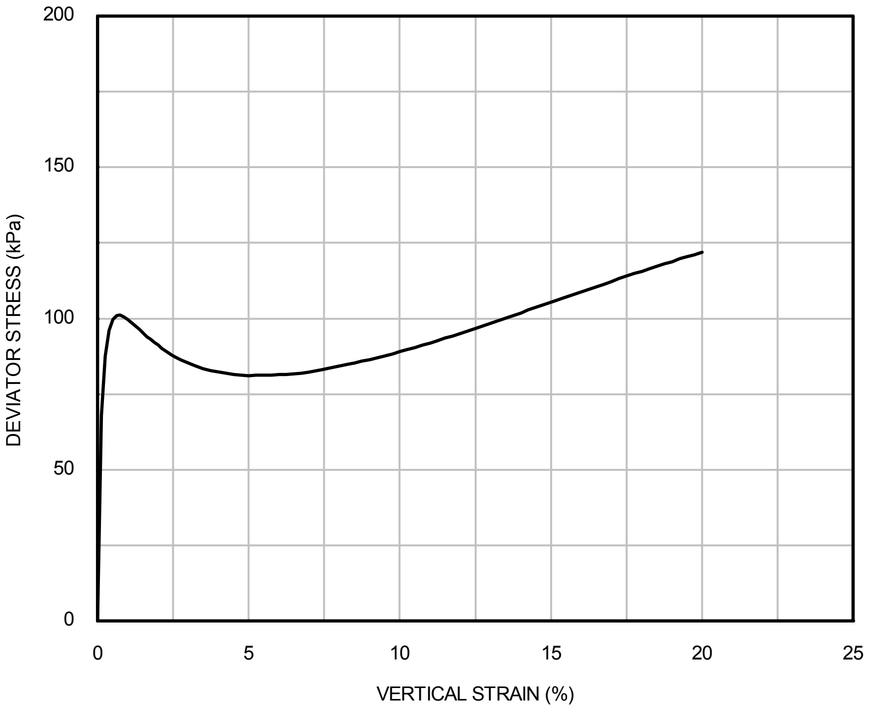
SPECIMEN PHOTOGRAPHS

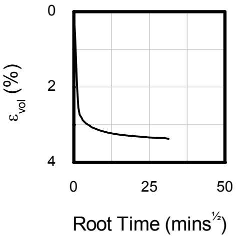
Borehole	HKZ1-BH01-SA
Sample	28BagA&B
Depth [m]	25.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

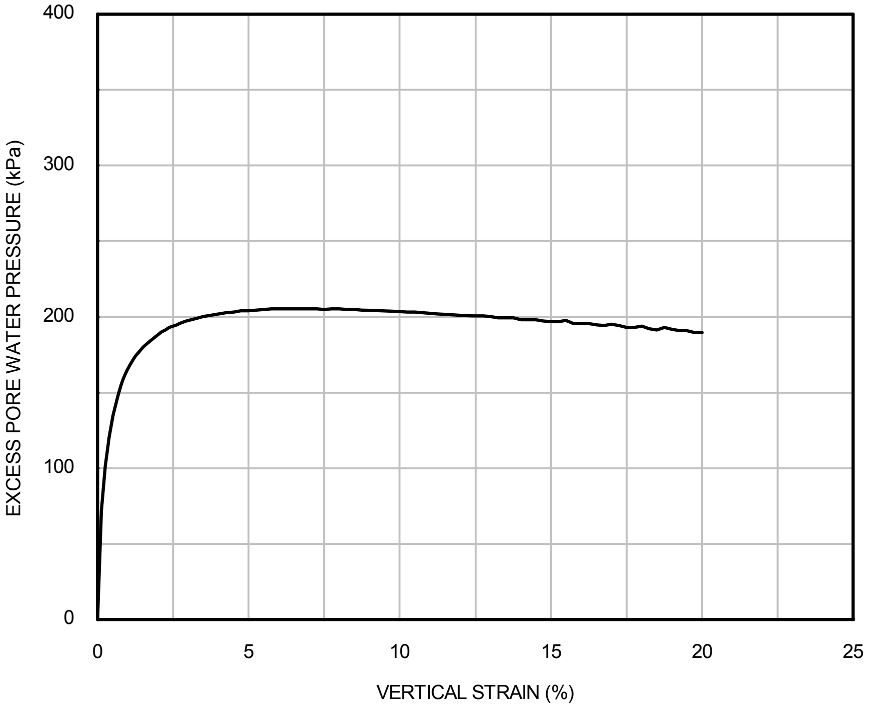
Saturation







Consolidation



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	240	240	HKZ1-BH01 -SA	28BagA&B	25.50

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 14/10/2016

Drawn by: ALB

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_28BagA&B_ca.OPJ

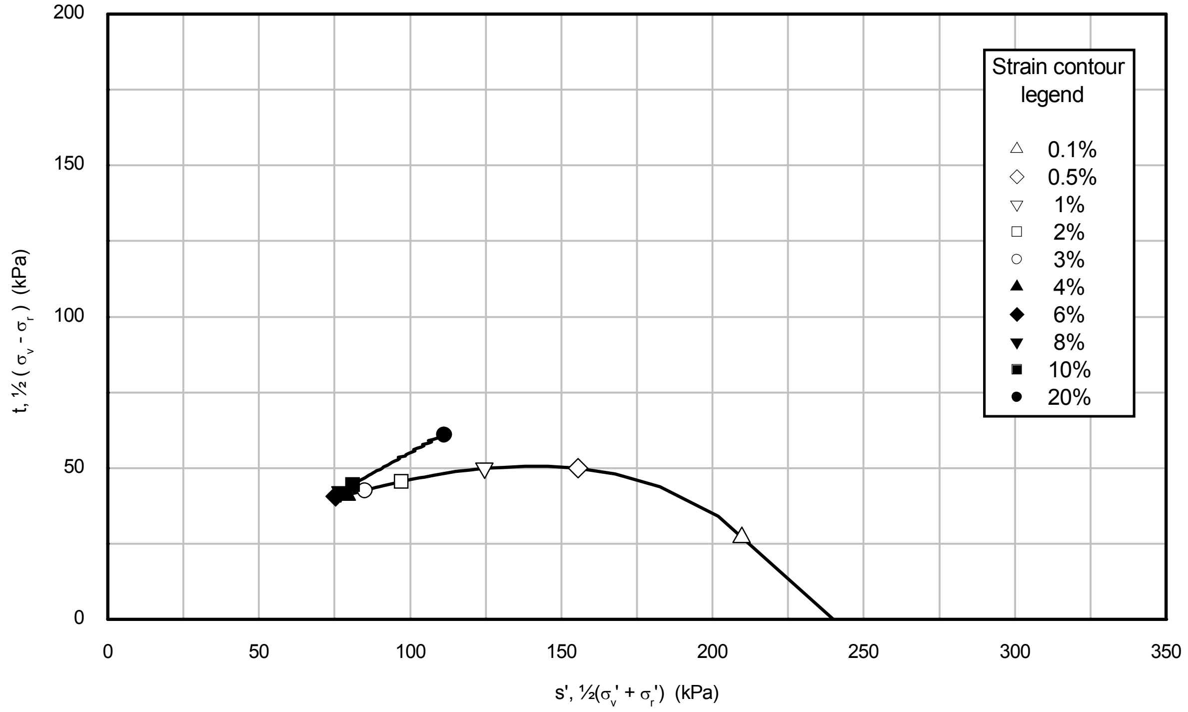
Date : 30/09/2016

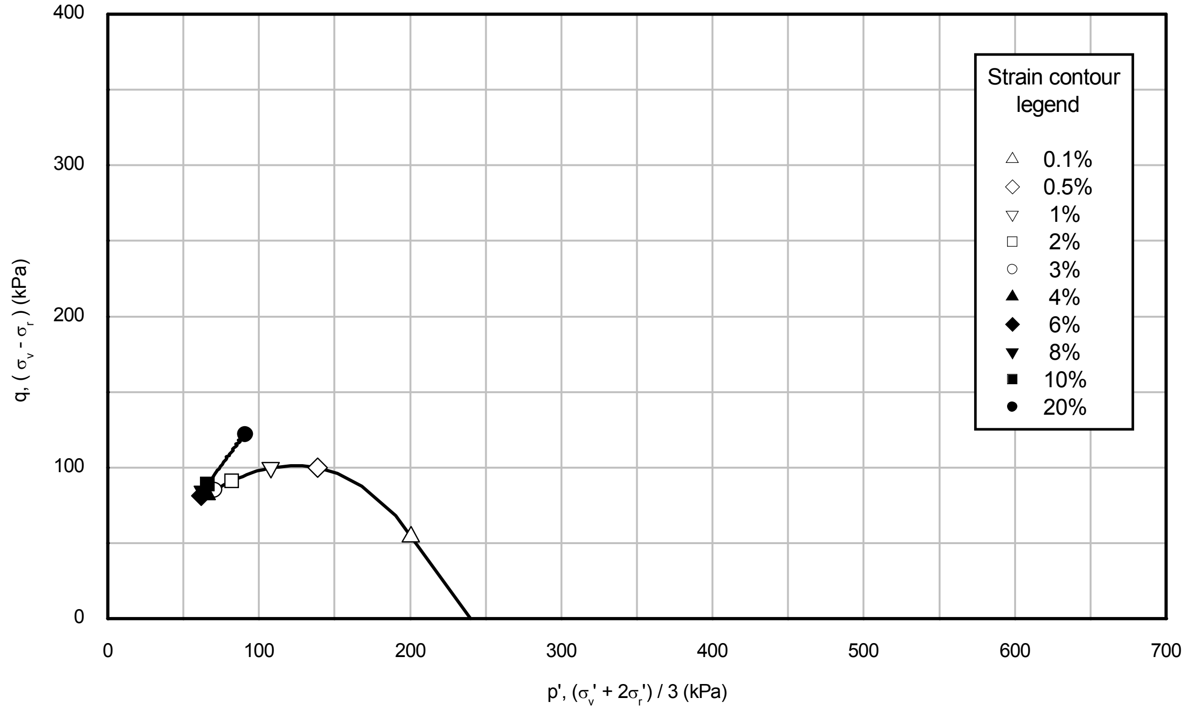
Date : 04/10/2016

Checked by: MSR

Approved by: PH

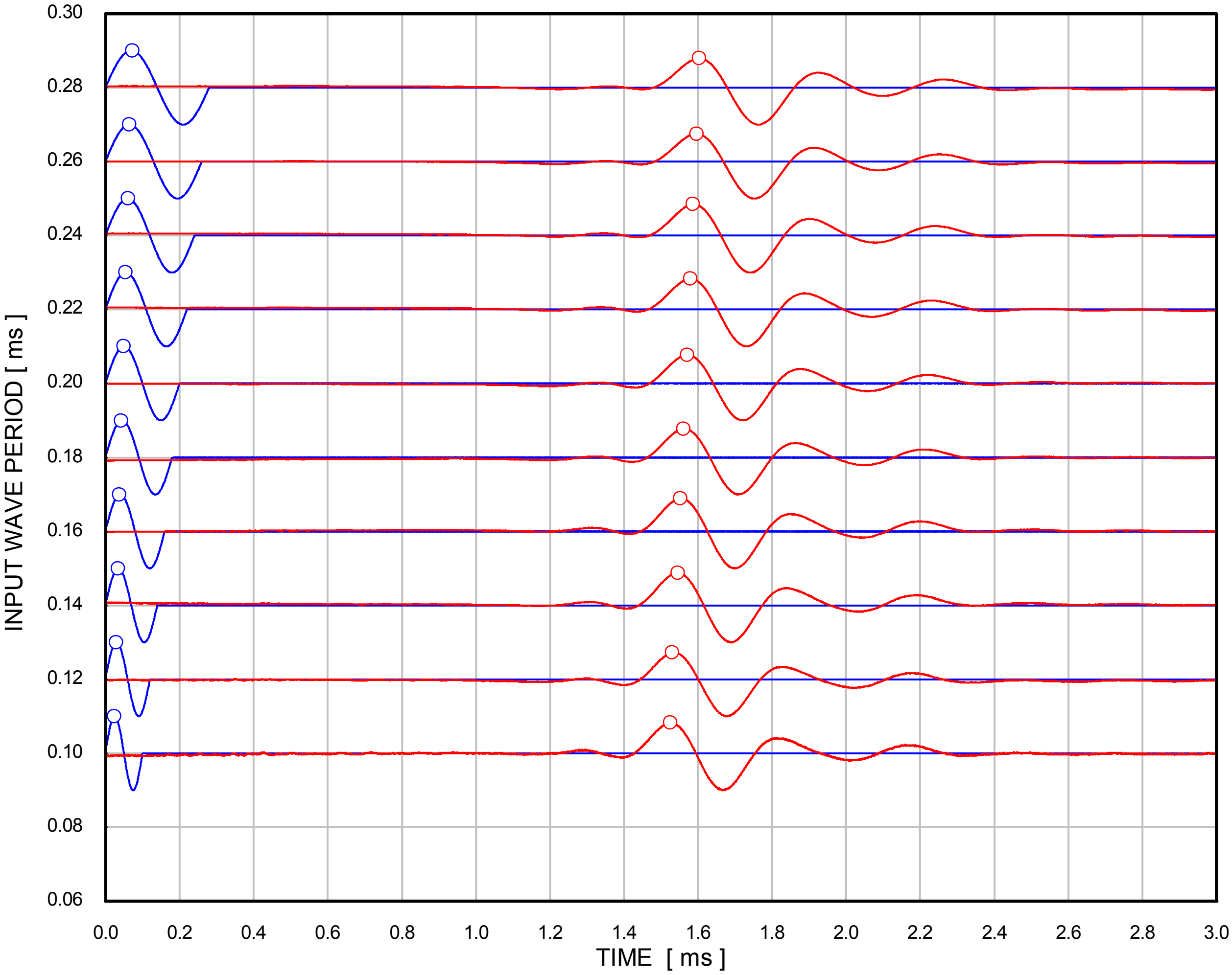
Date: 14/10/2016
Drawn by: ALB
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_28BagA&B_ca.OPJ
Date : 30/09/2016
Date : 04/10/2016
Checked by: MSR
Approved by: PH

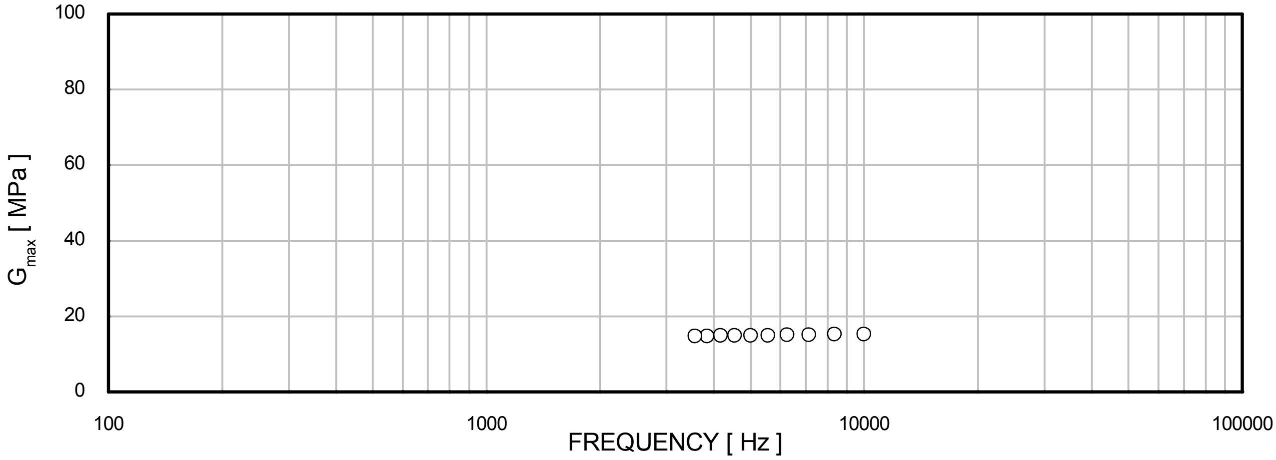




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	240	240	HKZ1-BH01 -SA	28BagA&B	25.50

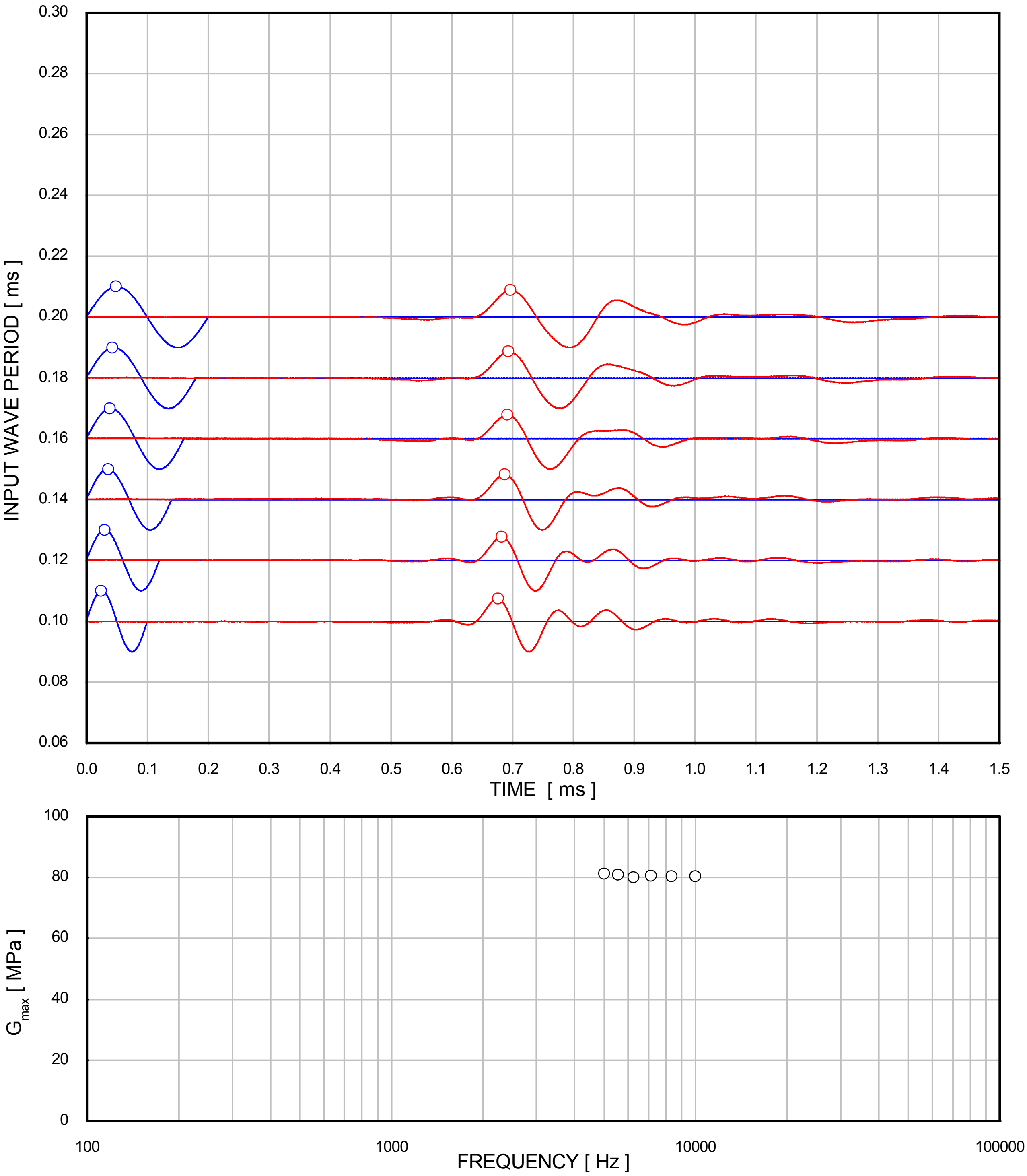
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





σ'_{rc}	: 14 kPa	Borehole	: HKZ1-BH01-SA
σ'_{ac}	: 14 kPa	Sample	: 28BagA&B
—	Source signal	Depth [m]	: 25.50
—	Received signal	Test No.	: 130
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS



σ'_{rc} : 240 kPa
σ'_{ac} : 240 kPa
— Source signal
— Received signal
○ / ○ Selected peak values

Borehole : HKZ1-BH01-SA
Sample : 28BagA&B
Depth [m] : 25.50
Test No. : 130

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
High strength dark grey CLAY with pockets of dark grey silt

GENERAL	
Date test started	29/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.5
Length	(mm)	139.9
Water content	(%)	28.3
Bulk density	(Mg/m³)	1.97
Dry density	(Mg/m³)	1.54
Void ratio		0.757
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	476
Cell pressure on completion	(kPa)	520
B value achieved		0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA
Sample	14WaxD
Depth (m)	12.17

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 09/09/2016 Drawn by: MSR Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_14WaxD_CU.XLS Checked by: PH Date: 04/10/2016 Approved by: PH Date: 04/10/2016

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	520
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	120
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	27.6
Bulk density	(Mg/m³)	1.98
Dry density	(Mg/m³)	1.55
Void ratio		0.738
Degree of saturation	(%)	100
Volumetric strain	(%)	1.08

Mode of failure: Brittle failure

Borehole	HKZ1-BH02-SA
Sample	14WaxD
Depth (m)	12.17

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	120
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	228
Membrane correction applied	(kPa)	0.3
Drain correction applied	(kPa)	0
Axial strain	(%)	2.82
Excess pore pressure	(kPa)	54
Major principal effective stress	(kPa)	293
Minor principal effective stress	(kPa)	66
Principal effective stress ratio		4.45
Epsilon 50 (ε 50)	(%)	0.66
Secant modulus (E50) at ε 50	(kPa)	17209
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	214
Membrane correction applied	(kPa)	0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	1.95
Excess pore pressure	(kPa)	63
Major principal effective stress	(kPa)	271
Minor principal effective stress	(kPa)	57
Principal effective stress ratio		4.78
At 15% axial strain		
Corrected deviator stress	(kPa)	181
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	39
Major principal effective stress	(kPa)	262
Minor principal effective stress	(kPa)	81
Principal effective stress ratio		3.22

FINAL CONDITIONS		
Water content	(%)	27.6
Bulk density	(Mg/m³)	1.98
Dry density	(Mg/m³)	1.55

Borehole	HKZ1-BH02-SA
Sample	14WaxD
Depth (m)	12.17

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Checked by: PH Date: 04/10/2016 Template Issue: 2 Drawn by: MSR Date: 09/09/2016

Approved by: PH Date: 04/10/2016 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_14WaxD_CU.XLS

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH02-SA
Sample	14WaxD
Depth (m)	12.17

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Drawn by: MSR Date: 09/09/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_14WaxD_CU.OPJ

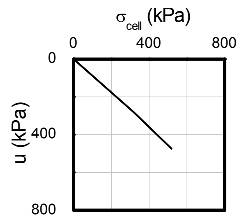
Date : 04/10/2016

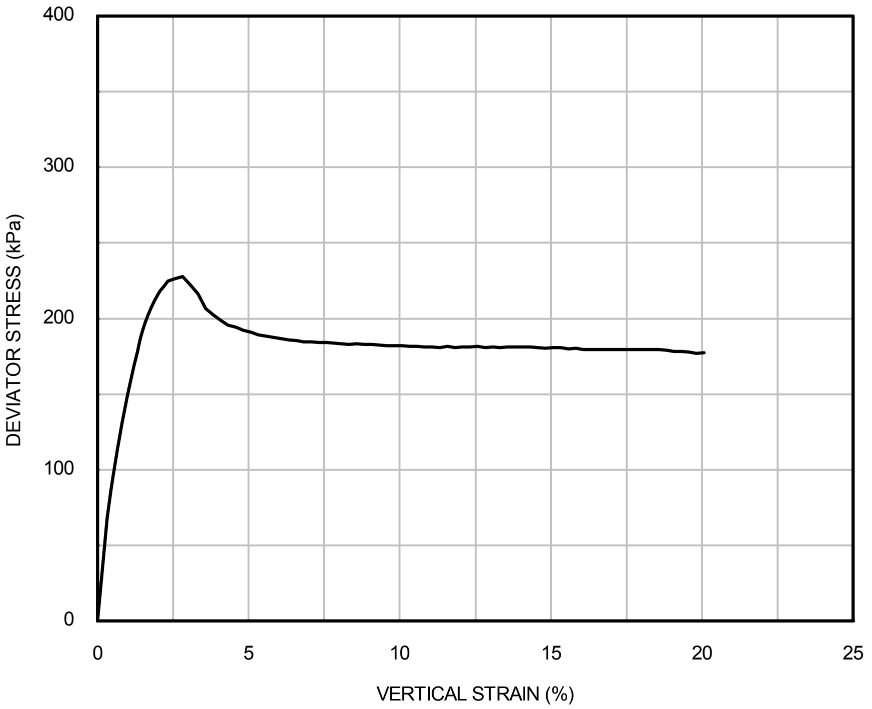
Date : 04/10/2016

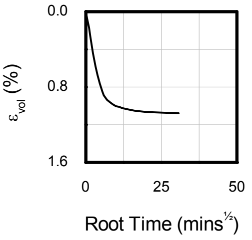
Checked by: PH

Approved by: PH

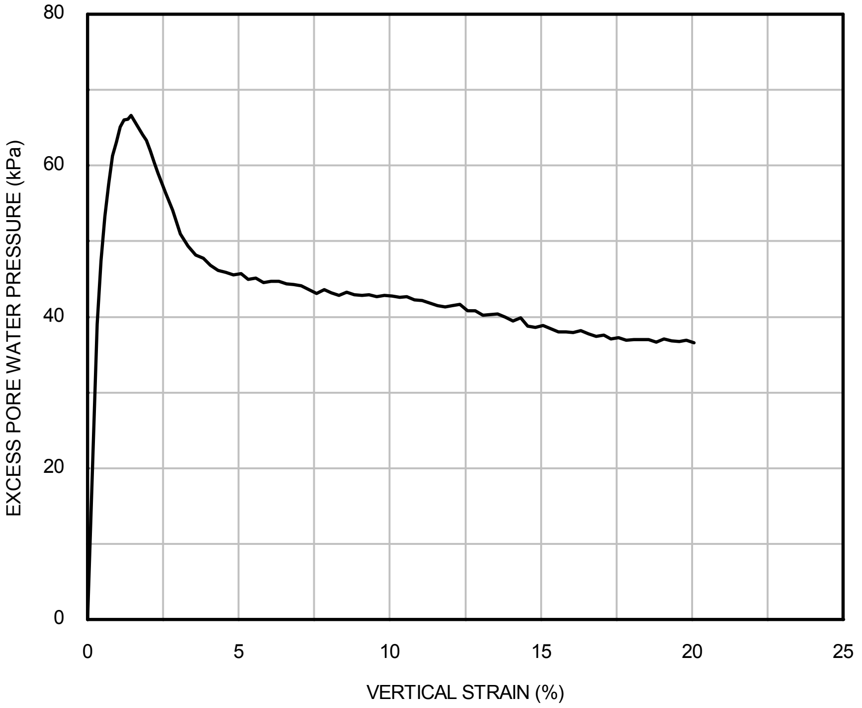
Saturation





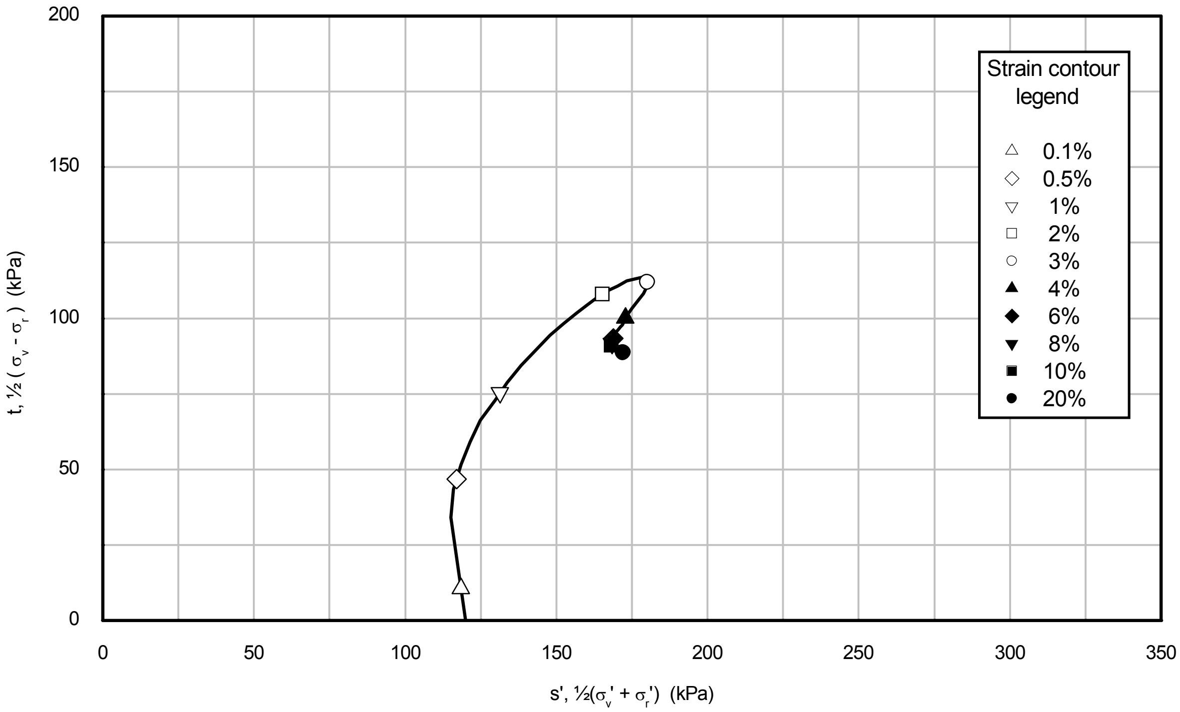


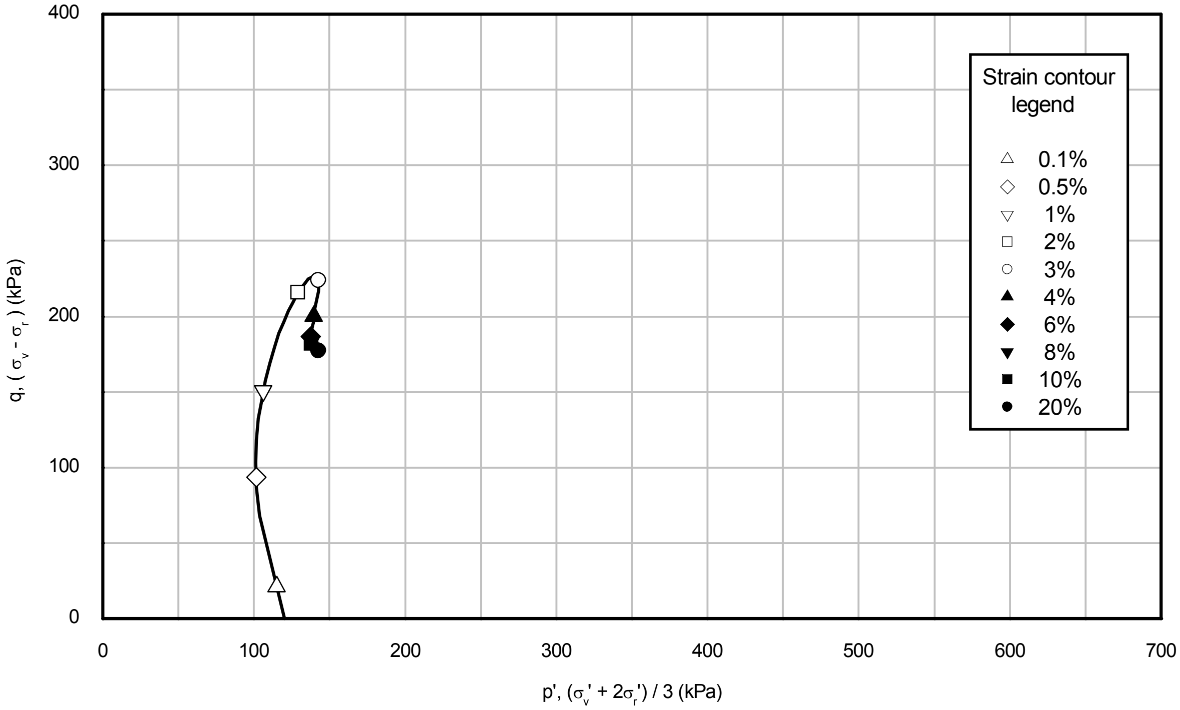
Consolidation



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	120	120	HKZ1-BH02 -SA	14WaxD	12.17

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	120	120	HKZ1-BH02 -SA	14WaxD	12.17

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Drawn by: MSR Date: 09/09/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_14WaxD_CU.OPJ

Checked by: PH Date : 04/10/2016

Approved by: PH Date : 04/10/2016

VISUAL DESCRIPTION
Extremely high strength greenish grey sandy CLAY

GENERAL		
Date test started		06/09/2016
Type of sample		Undisturbed
Specimen orientation		Vertical
Type of drains fitted		Radial & one end

INITIAL		
Diameter	(mm)	51.3
Length	(mm)	100.6
Water content	(%)	17.5
Bulk density	(Mg/m³)	2.24
Dry density	(Mg/m³)	1.90
Void ratio		0.376
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	575
Cell pressure on completion	(kPa)	585
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA
Sample	25WaxB
Depth (m)	22.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	585
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	185
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	16.1
Bulk density	(Mg/m³)	2.27
Dry density	(Mg/m³)	1.96
Void ratio		0.340
Degree of saturation	(%)	100
Volumetric strain	(%)	2.61

Mode of failure: Brittle failure

Borehole	HKZ1-BH02-SA
Sample	25WaxB
Depth (m)	22.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_25WaxB_CU.XLS
Checked by: MSR
Date: 26/09/2016
Approved by: PH
Date: 04/10/2016

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	185
Rate of strain	(%/hour)	0.50
At peak deviator stress		
Corrected deviator stress	(kPa)	859
Membrane correction applied	(kPa)	2.0
Drain correction applied	(kPa)	0
Axial strain	(%)	16.51
Excess pore pressure	(kPa)	-178
Major principal effective stress	(kPa)	1222
Minor principal effective stress	(kPa)	363
Principal effective stress ratio		3.37
Epsilon 50 (ε 50)	(%)	3.91
Secant modulus (E50) at ε 50	(kPa)	10996
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	498
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	5.01
Excess pore pressure	(kPa)	7
Major principal effective stress	(kPa)	676
Minor principal effective stress	(kPa)	178
Principal effective stress ratio		3.80
At 15% axial strain		
Corrected deviator stress	(kPa)	857
Membrane correction applied	(kPa)	1.9
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	-169
Major principal effective stress	(kPa)	1211
Minor principal effective stress	(kPa)	354
Principal effective stress ratio		3.42

FINAL CONDITIONS		
Water content	(%)	16.1
Bulk density	(Mg/m³)	2.27
Dry density	(Mg/m³)	1.96

Borehole	HKZ1-BH02-SA
Sample	25WaxB
Depth (m)	22.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

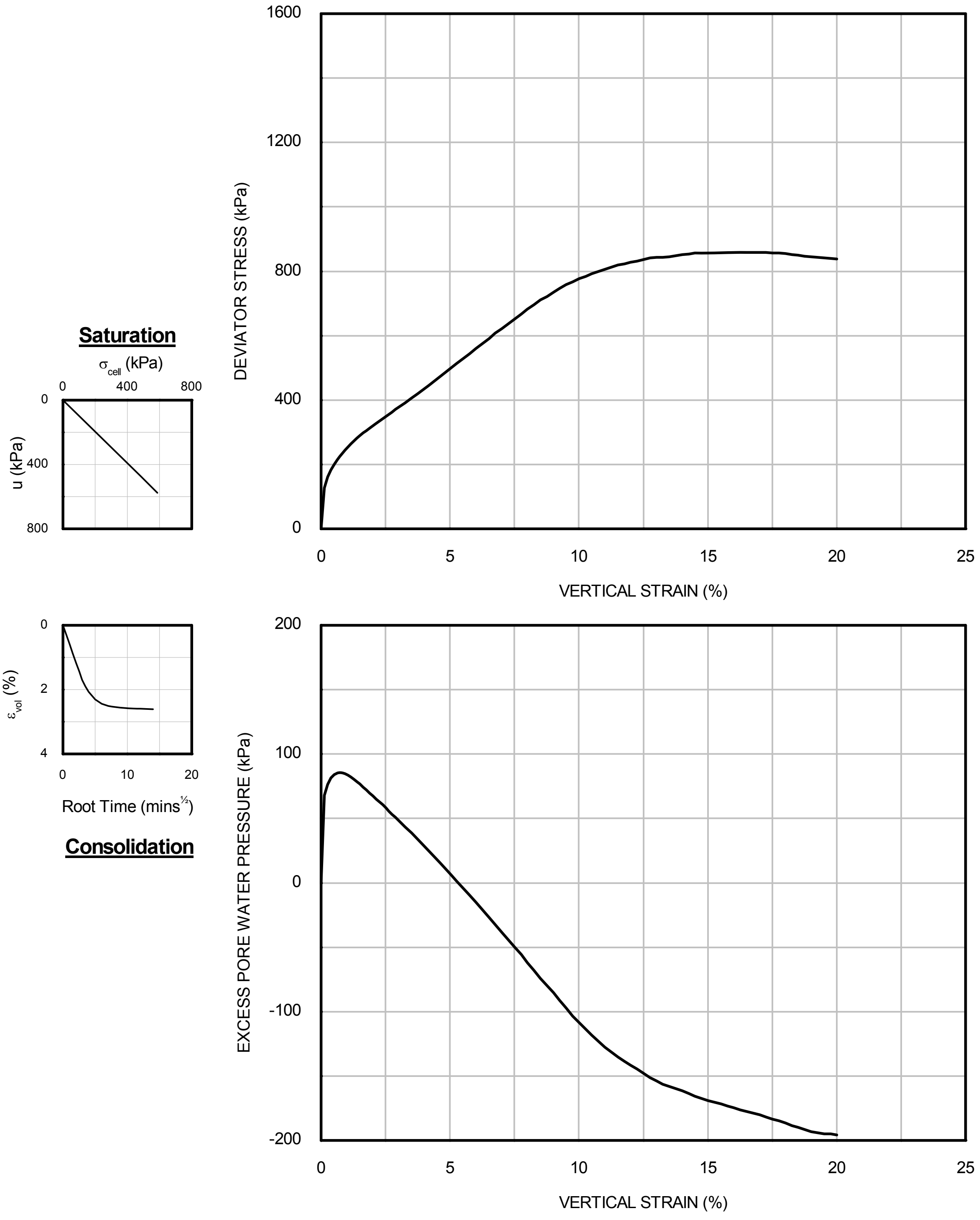
Date: 09/09/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_25WaxB_CU.XLS

Date: 26/09/2016 Checked by: MSR Date: 04/10/2016 Approved by: PH

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH02-SA
Sample	25WaxB
Depth (m)	22.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	185	185	HKZ1-BH02 -SA	25WaxB	22.70

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Drawn by: ALB Date: 09/09/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_25WaxB_CU.OPJ

Checked by: PH Date : 04/10/2016

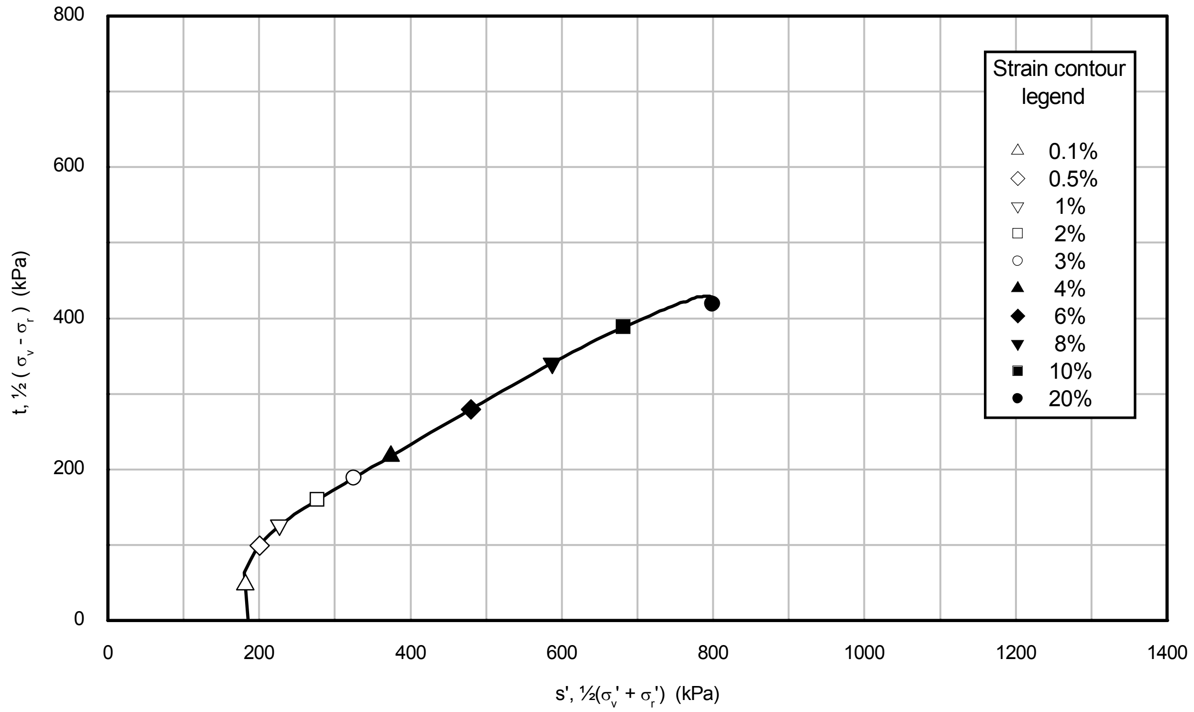
Approved by: PH Date : 04/10/2016

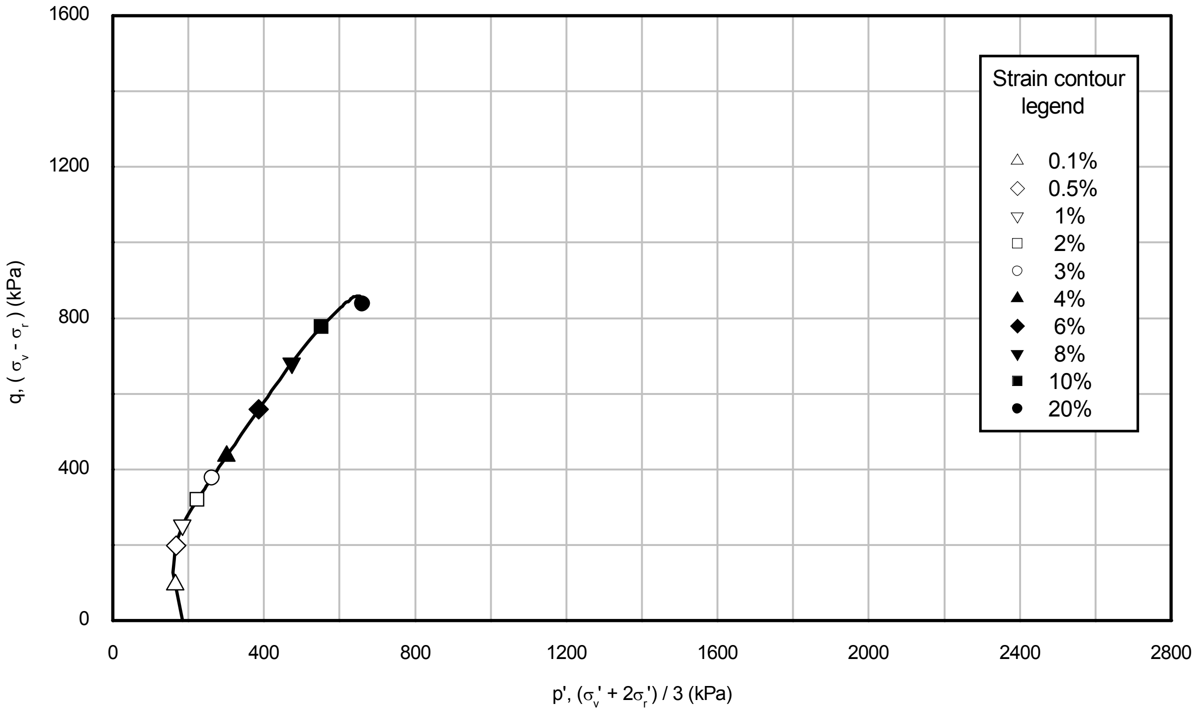
Drawn by: ALB Date: 09/09/2016

Template Issue: 4.1 Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_25WaxB_CU.OPJ

Checked by: PH Date : 04/10/2016

Approved by: PH Date : 04/10/2016





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	185	185	HKZ1-BH02 -SA	25WaxB	22.70

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 04/10/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_27BagC_CU.XLS

Checked by: MSR Date: 07/10/2016 Approved by: PH Date: 10/10/2016

VISUAL DESCRIPTION
Brown slightly silty fine SAND

GENERAL	
Date test started	01/10/2016
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.7
Length	(mm)	135.0
Water content	(%)	10.0
Bulk density	(Mg/m³)	1.76
Dry density	(Mg/m³)	1.60
Void ratio		0.657
Degree of saturation	(%)	40

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	10
Pore pressure on completion	(kPa)	510
Cell pressure on completion	(kPa)	520
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA
Sample	27BagC
Depth (m)	25.05

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	520
Back pressure	(kPa)	300
Effective cell pressure	(kPa)	220
Pore pressure on completion	(kPa)	300
Pore pressure dissipation	(%)	100
Water content	(%)	22.7
Bulk density	(Mg/m³)	2.03
Dry density	(Mg/m³)	1.65
Void ratio		0.601
Degree of saturation	(%)	100
Volumetric strain	(%)	3.37

Mode of failure: Brittle failure

Borehole	HKZ1-BH02-SA
Sample	27BagC
Depth (m)	25.05

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	300
Initial effective cell pressure	(kPa)	220
Rate of strain	(%/hour)	0.50
At peak deviator stress		
Corrected deviator stress	(kPa)	105
Membrane correction applied	(kPa)	0.1
Drain correction applied	(kPa)	0
Axial strain	(%)	0.81
Excess pore pressure	(kPa)	135
Major principal effective stress	(kPa)	190
Minor principal effective stress	(kPa)	85
Principal effective stress ratio		2.23
Epsilon 50 (ε 50)	(%)	0.14
Secant modulus (E50) at ε 50	(kPa)	37215
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	47
Membrane correction applied	(kPa)	1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	12.68
Excess pore pressure	(kPa)	201
Major principal effective stress	(kPa)	66
Minor principal effective stress	(kPa)	19
Principal effective stress ratio		3.49
At 15% axial strain		
Corrected deviator stress	(kPa)	44
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	200
Major principal effective stress	(kPa)	64
Minor principal effective stress	(kPa)	20
Principal effective stress ratio		3.28

FINAL CONDITIONS		
Water content	(%)	22.7
Bulk density	(Mg/m³)	2.03
Dry density	(Mg/m³)	1.65

Borehole	HKZ1-BH02-SA
Sample	27BagC
Depth (m)	25.05

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA

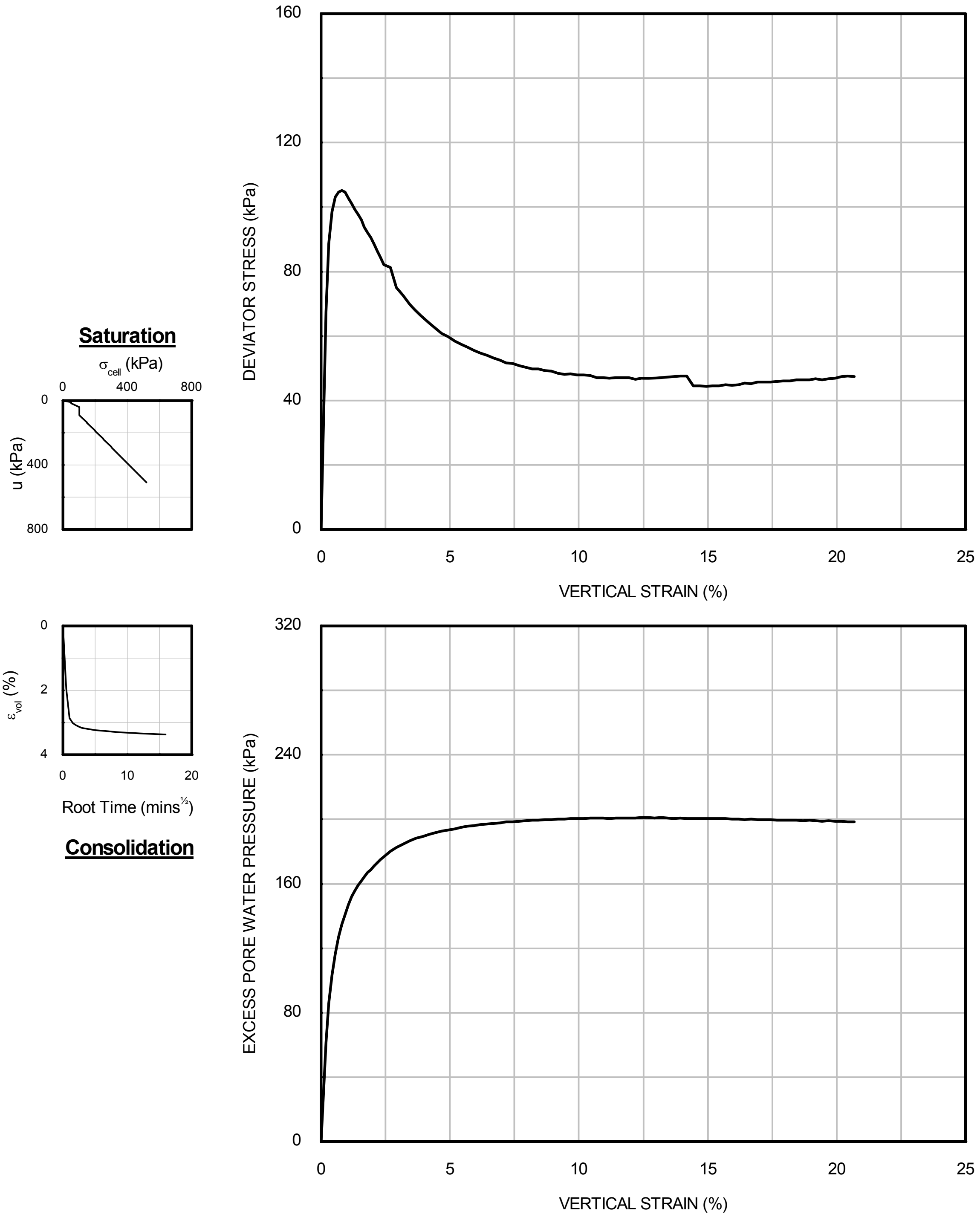
Drawn by: ALB Date: 04/10/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_27BagC_CU.OPJ

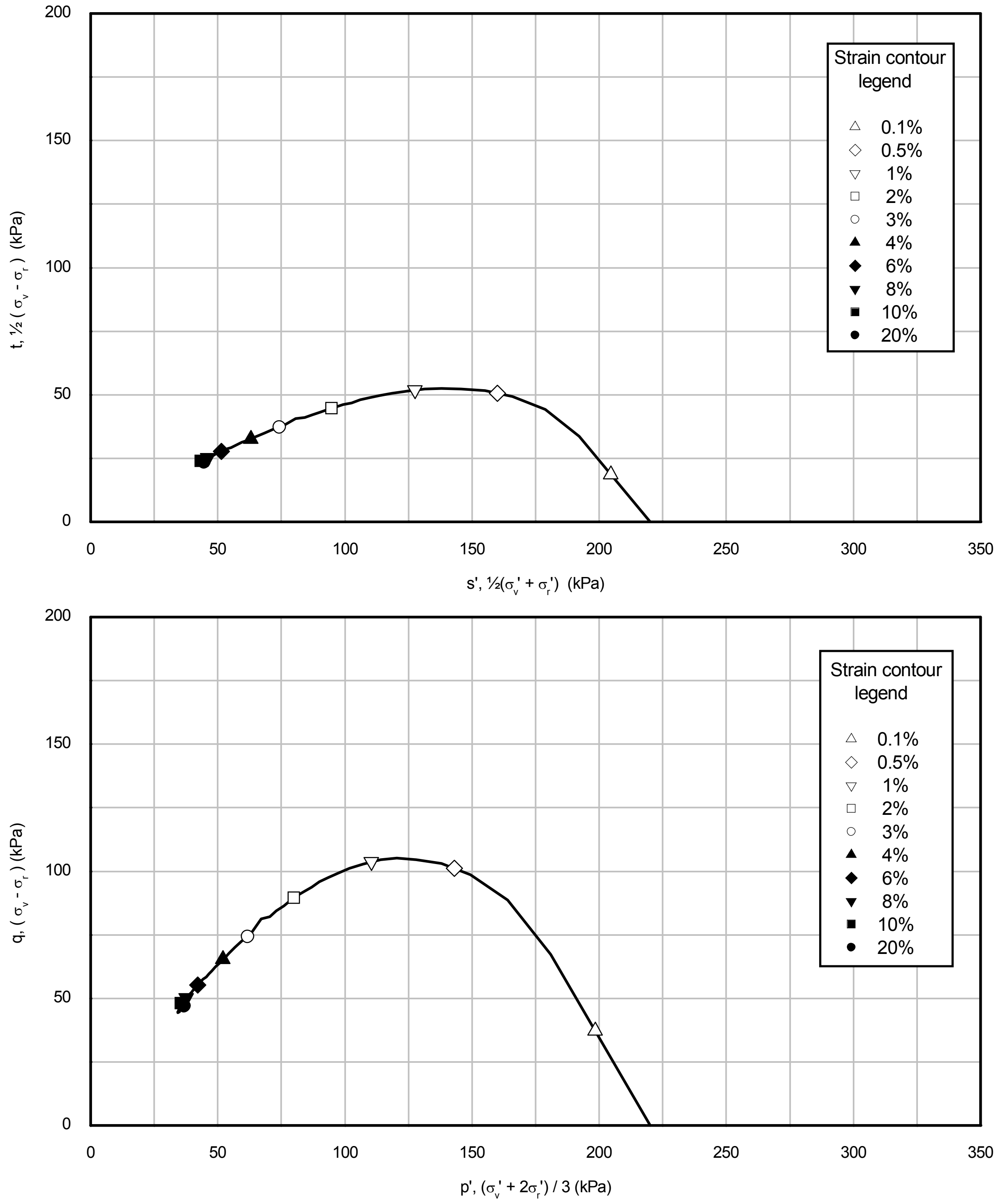
Checked by: PH Date : 10/10/2016

Approved by: PH Date : 10/10/2016



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	220	220	HKZ1-BH02-SA	27BagC	25.05

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	220	220	HKZ1- BH02-SA	27BagC	25.05

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 04/10/2016
Drawn by: ALB
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_27BagC_CU.OPJ
Date : 10/10/201
Date : 10/10/2016
Checked by: PH
Approved by: PH

VISUAL DESCRIPTION
High strength very dark grey CLAY

GENERAL	
Date test started	29/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	70.9
Length	(mm)	139.8
Water content	(%)	34.1
Bulk density	(Mg/m³)	1.91
Dry density	(Mg/m³)	1.43
Void ratio		0.892
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	505
Cell pressure on completion	(kPa)	540
B value achieved		0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA
Sample	23WaxC
Depth (m)	14.42

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	540
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	140
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	33.1
Bulk density	(Mg/m³)	1.93
Dry density	(Mg/m³)	1.45
Void ratio		0.866
Degree of saturation	(%)	100
Volumetric strain	(%)	1.41

Mode of failure: Brittle failure

Borehole	HKZ1-BH03-SA
Sample	23WaxC
Depth (m)	14.42

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Template Issue: 2 Drawn by: MSR Date: 06/09/2016

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_23WaxC_CU.XLS

Checked by: PH Date: 04/10/2016

Approved by: PH Date: 04/10/2016

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	140
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	257
Membrane correction applied	(kPa)	0.3
Drain correction applied	(kPa)	0
Axial strain	(%)	2.50
Excess pore pressure	(kPa)	68
Major principal effective stress	(kPa)	329
Minor principal effective stress	(kPa)	72
Principal effective stress ratio		4.57
Epsilon 50 (ε 50)	(%)	0.58
Secant modulus (E50) at ε 50	(kPa)	22277
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	242
Membrane correction applied	(kPa)	0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	1.88
Excess pore pressure	(kPa)	75
Major principal effective stress	(kPa)	307
Minor principal effective stress	(kPa)	65
Principal effective stress ratio		4.73
At 15% axial strain		
Corrected deviator stress	(kPa)	187
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	56
Major principal effective stress	(kPa)	271
Minor principal effective stress	(kPa)	84
Principal effective stress ratio		3.22

FINAL CONDITIONS		
Water content	(%)	33.1
Bulk density	(Mg/m³)	1.93
Dry density	(Mg/m³)	1.45

Borehole	HKZ1-BH03-SA
Sample	23WaxC
Depth (m)	14.42

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 06/09/2016
Drawn by: MSR
Template Issue: 2
Date: 04/10/2016
Checked by: PH
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_23WaxC_CU.XLS
Date: 04/10/2016
Approved by: PH

Date: 06/09/2016 Drawn by: MSR

Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_23WaxC_CU.XLS

Checked by: PH Date: 04/10/2016

Approved by: PH Date: 04/10/2016

SPECIMEN PHOTOGRAPHS


FUGRO 1/2
PROJECT No. J11335
BORE HOLE HKZ1-BH03-SA
SAMPLE 23WaxC
DEPTH (m) 14.40


FUGRO 1/2
PROJECT No. J11335
BORE HOLE HKZ1-BH03-SA
SAMPLE 23WaxC
DEPTH (m) 14.40

Borehole Sample Depth (m)	HKZ1-BH03-SA 23WaxC 14.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Drawn by: MSR Date: 06/09/2016

Template Issue: 4.1

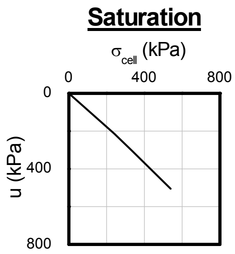
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_23WaxC_CU.OPJ

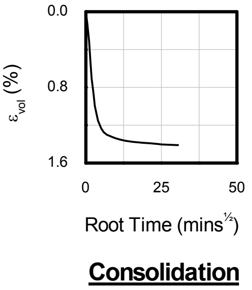
Date : 04/10/2016

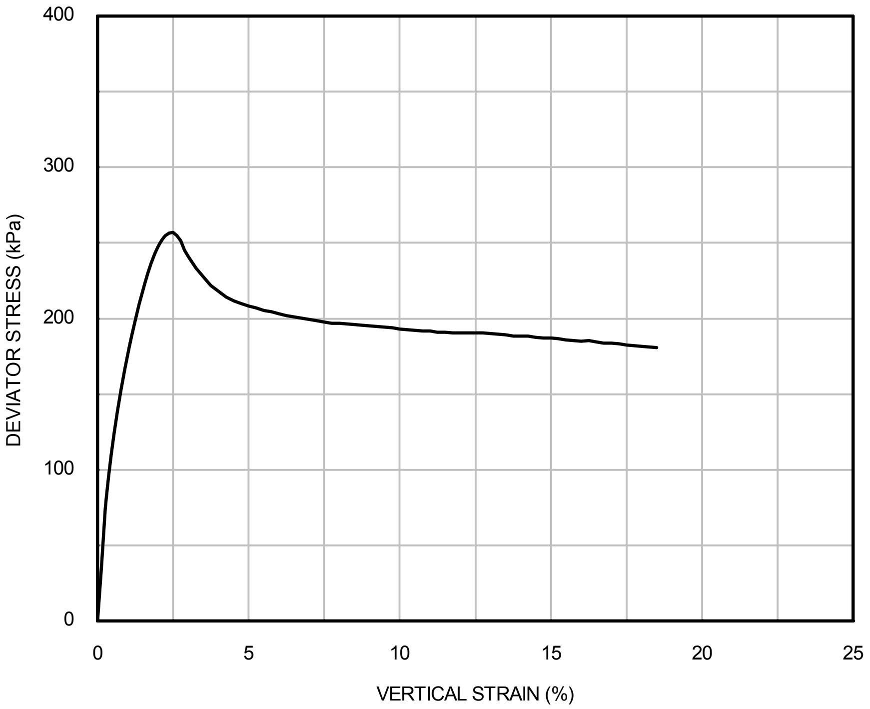
Date : 04/10/2016

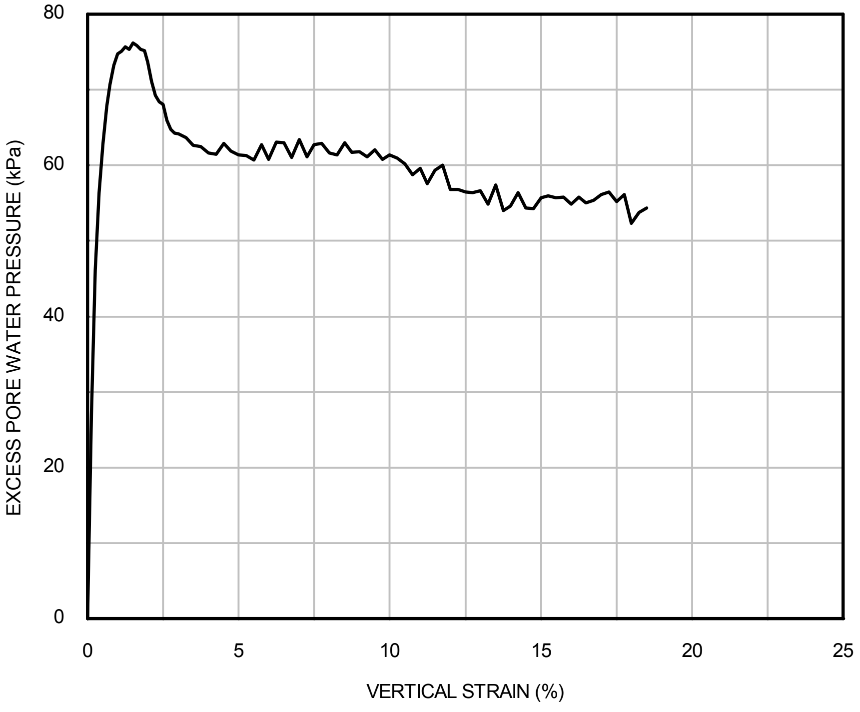
Checked by: PH

Approved by: PH









Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	140	140	HKZ1-BH03-SA	23WaxC	14.42

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

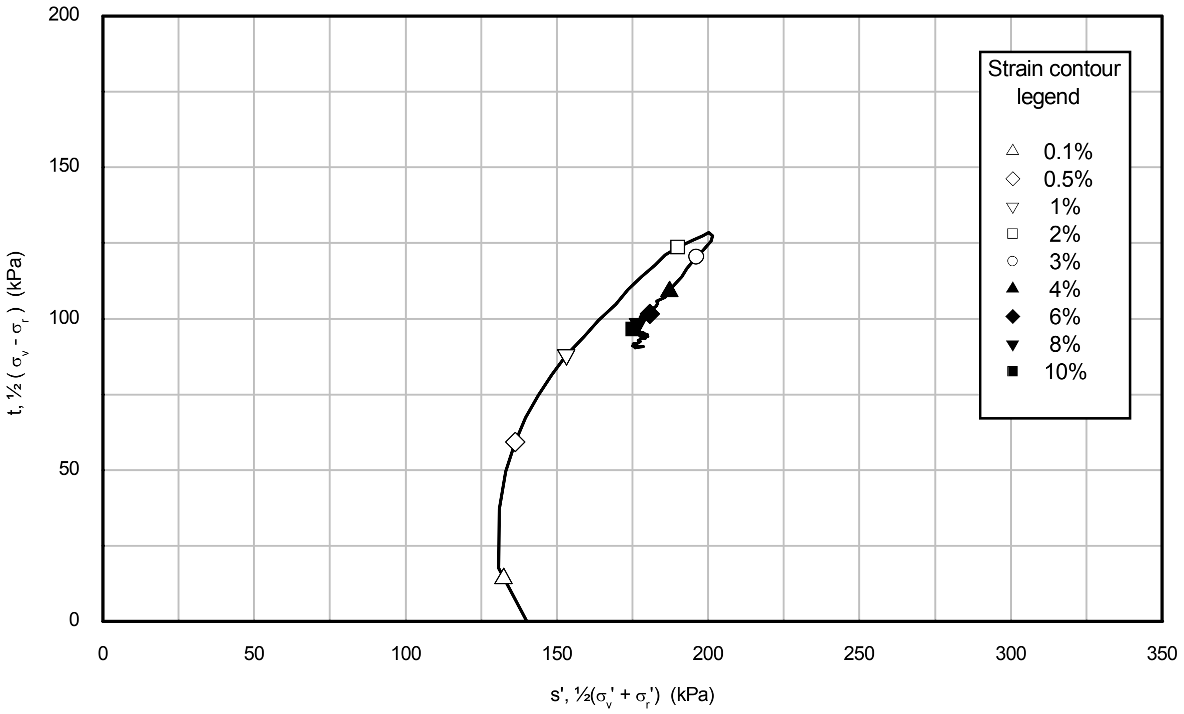
Drawn by: MSR Date: 06/09/2016

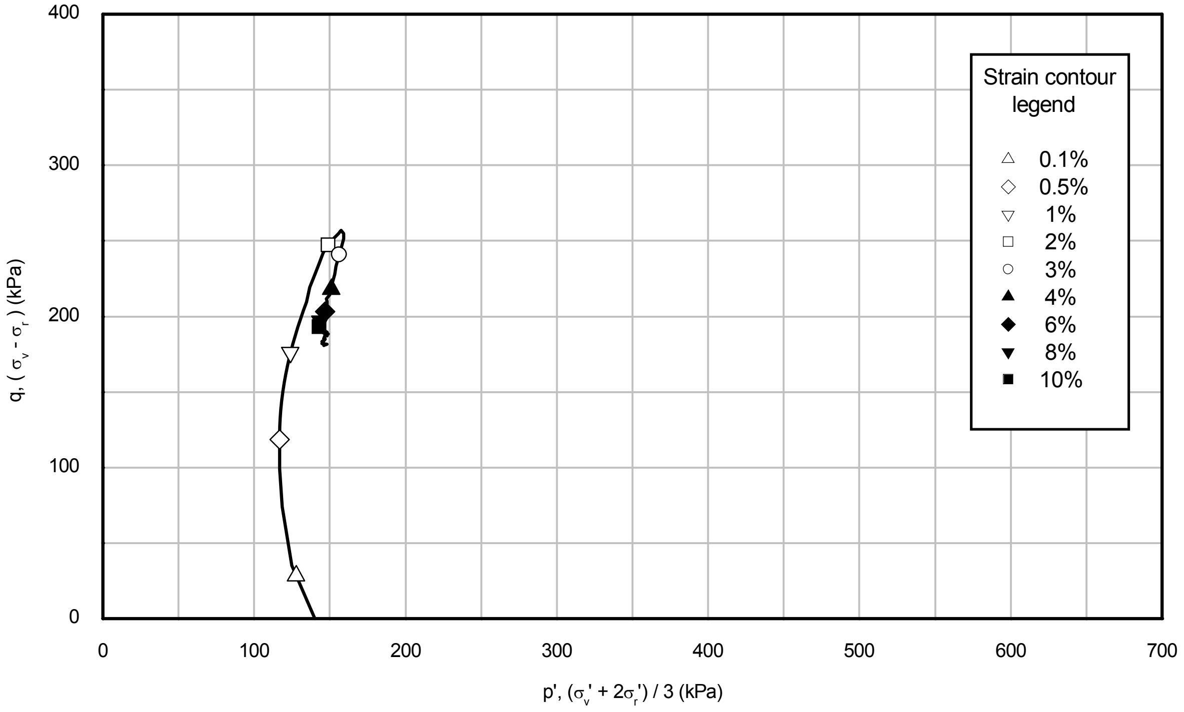
Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_23WaxC_CU.OPJ

Checked by: PH Date : 04/10/2016

Approved by: PH Date : 04/10/2016





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	140	140	HKZ1-BH03 -SA	23WaxC	14.42

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 06/09/2016
Drawn by: MSR
Template Issue: 2
Date: 07/09/2016
Checked by: ALB

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_26WaxC_CU.XLS
Date: 04/10/2016
Approved by: PH

VISUAL DESCRIPTION
High strength dark grey CLAY with pockets of silt

GENERAL	
Date test started	28/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.4
Length	(mm)	139.4
Water content	(%)	28.6
Bulk density	(Mg/m³)	1.97
Dry density	(Mg/m³)	1.53
Void ratio		0.765
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	446
Cell pressure on completion	(kPa)	565
B value achieved		0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA
Sample	26WaxC
Depth (m)	17.32

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	565
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	165
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	28.3
Bulk density	(Mg/m³)	1.97
Dry density	(Mg/m³)	1.54
Void ratio		0.757
Degree of saturation	(%)	100
Volumetric strain	(%)	0.40

Mode of failure: Brittle failure

Borehole	HKZ1-BH03-SA
Sample	26WaxC
Depth (m)	17.32

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	165
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	274
Membrane correction applied	(kPa)	0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	1.85
Excess pore pressure	(kPa)	83
Major principal effective stress	(kPa)	356
Minor principal effective stress	(kPa)	82
Principal effective stress ratio		4.33
Epsilon 50 (ε 50)	(%)	0.34
Secant modulus (E50) at ε 50	(kPa)	40248
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	271
Membrane correction applied	(kPa)	0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	1.60
Excess pore pressure	(kPa)	86
Major principal effective stress	(kPa)	350
Minor principal effective stress	(kPa)	79
Principal effective stress ratio		4.43
At 15% axial strain		
Corrected deviator stress	(kPa)	197
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	71
Major principal effective stress	(kPa)	291
Minor principal effective stress	(kPa)	94
Principal effective stress ratio		3.10

FINAL CONDITIONS		
Water content	(%)	28.3
Bulk density	(Mg/m³)	1.97
Dry density	(Mg/m³)	1.54

Borehole	HKZ1-BH03-SA
Sample	26WaxC
Depth (m)	17.32

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 06/09/2016 Drawn by: MSR Template Issue: 2

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_26WaxC_CU.XLS

Checked by: ALB Date: 07/09/2016

Approved by: PH Date: 04/10/2016

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH03-SA
Sample	26WaxC
Depth (m)	17.32

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Drawn by: MSR Date: 06/09/2016

Template Issue: 4.1

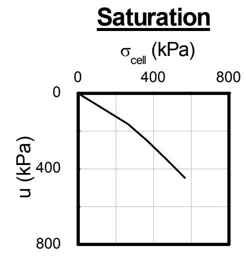
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_26WaxC_CU.OPJ

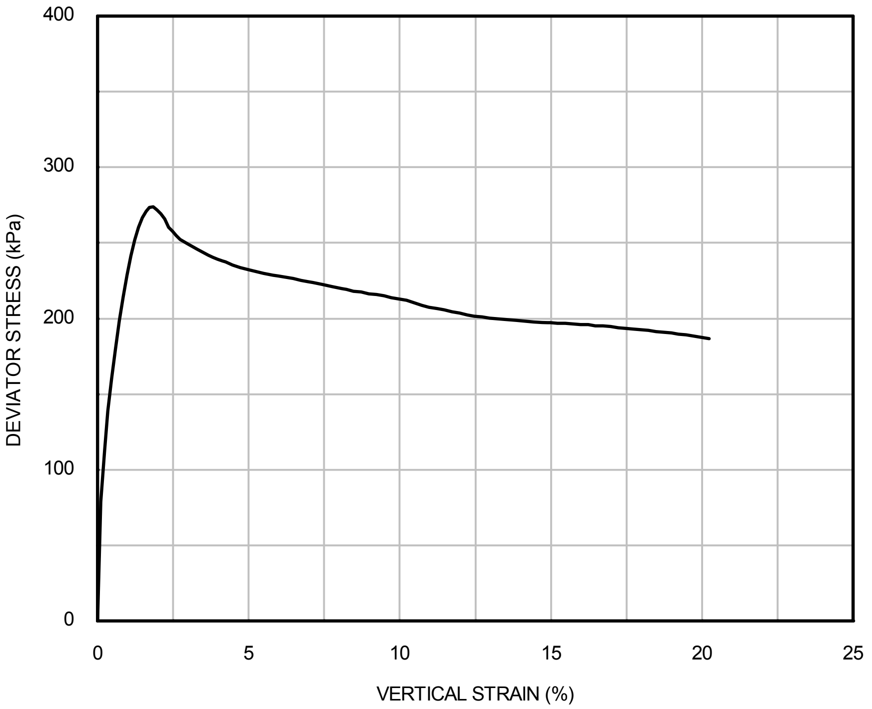
Date : 04/10/2016

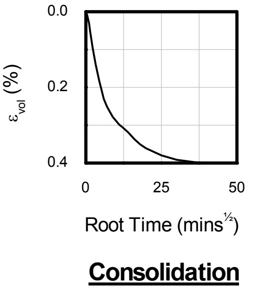
Date : 04/10/2016

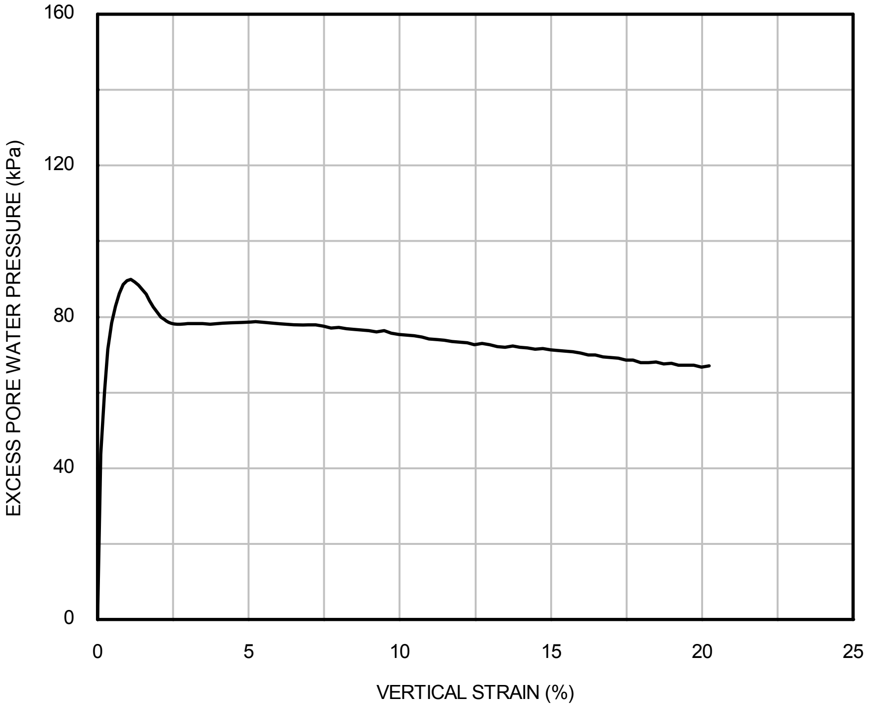
Checked by: PH

Approved by: PH



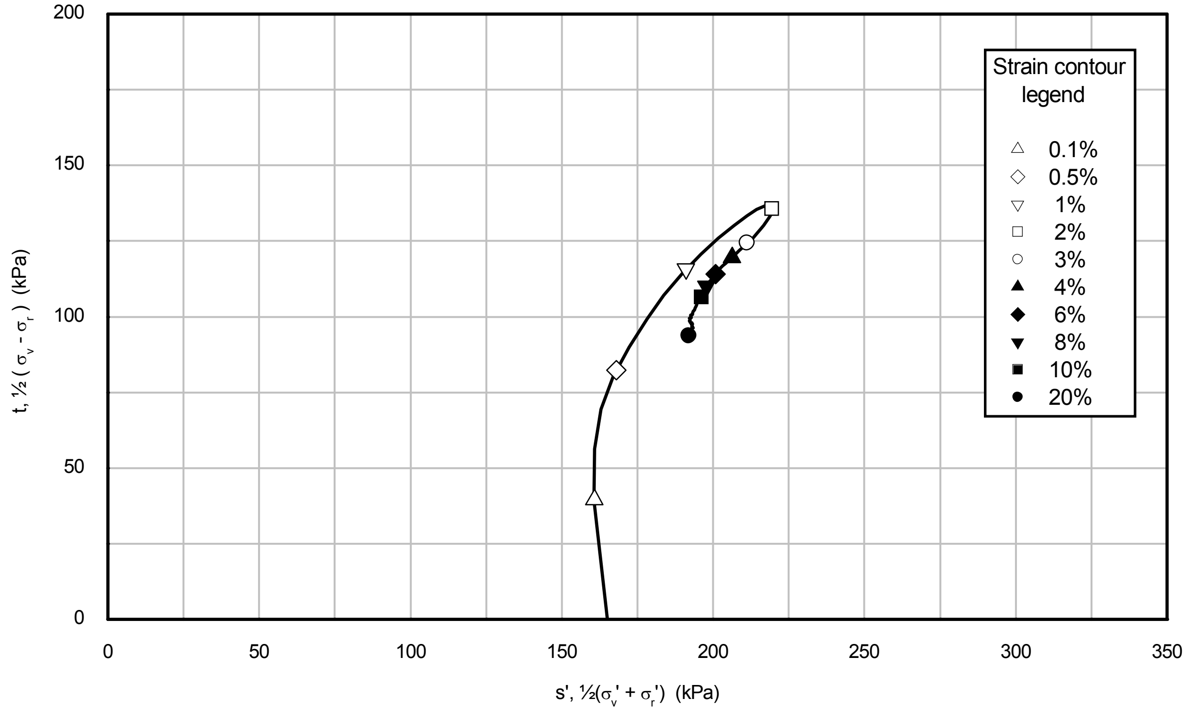


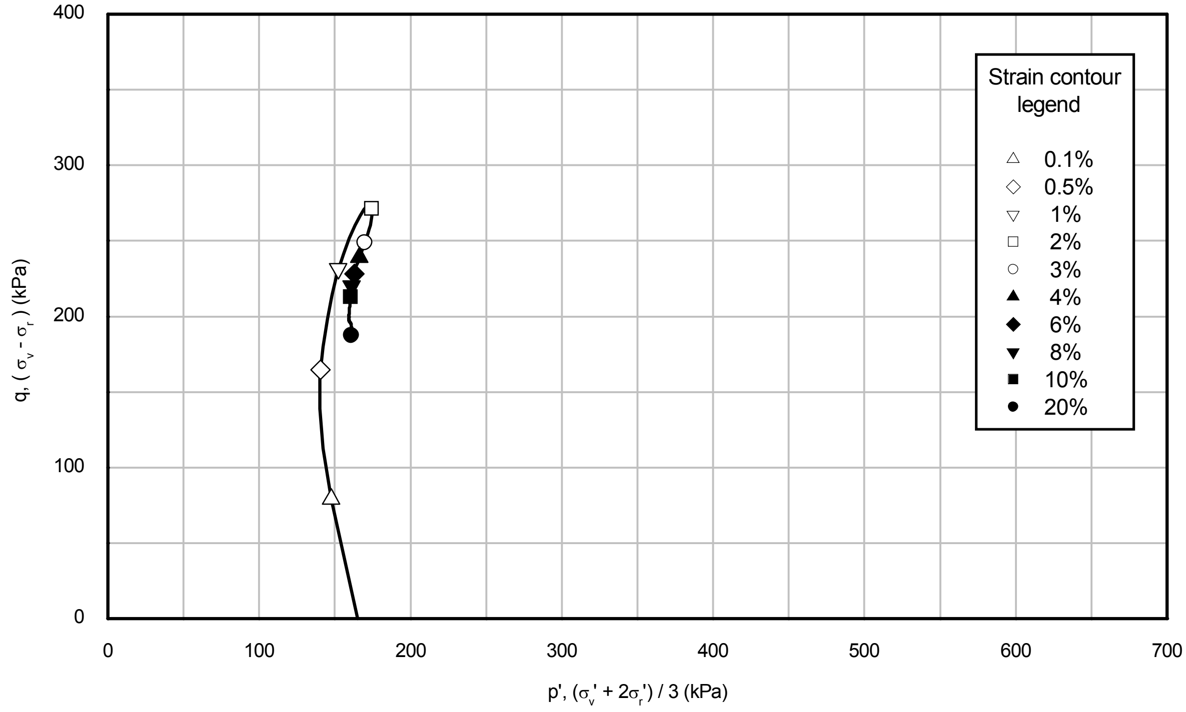




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	165	165	HKZ1-BH03 -SA	26WaxC	17.32

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	165	165	HKZ1-BH03-SA	26WaxC	17.32

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 02/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_50WaxC_CU.XLS
Checked by: MSR Date: 02/09/2016
Approved by: PH Date: 05/09/2016

VISUAL DESCRIPTION
Very high strength dark grey CLAY with pockets and laminations of light grey silt

GENERAL		
Date test started		27/08/2016
Type of sample		Undisturbed
Specimen orientation		Vertical
Type of drains fitted		Radial & one end

INITIAL		
Diameter	(mm)	71.4
Length	(mm)	139.9
Water content	(%)	23.5
Bulk density	(Mg/m³)	2.04
Dry density	(Mg/m³)	1.65
Void ratio		0.632
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	782
Cell pressure on completion	(kPa)	825
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA
Sample	50WaxC
Depth (m)	41.46

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	825
Back pressure	(kPa)	500
Effective cell pressure	(kPa)	325
Pore pressure on completion	(kPa)	500
Pore pressure dissipation	(%)	100
Water content	(%)	21.6
Bulk density	(Mg/m³)	2.08
Dry density	(Mg/m³)	1.71
Void ratio		0.581
Degree of saturation	(%)	100
Volumetric strain	(%)	3.11

Mode of failure: Brittle failure

Borehole	HKZ1-BH03-SA
Sample	50WaxC
Depth (m)	41.46

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	500
Initial effective cell pressure	(kPa)	325
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	444
Membrane correction applied	(kPa)	0.5
Drain correction applied	(kPa)	0
Axial strain	(%)	4.88
Excess pore pressure	(kPa)	155
Major principal effective stress	(kPa)	613
Minor principal effective stress	(kPa)	170
Principal effective stress ratio		3.62
Epsilon 50 (ε 50)	(%)	0.96
Secant modulus (E50) at ε 50	(kPa)	23116
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	427
Membrane correction applied	(kPa)	0.4
Drain correction applied	(kPa)	0
Axial strain	(%)	3.38
Excess pore pressure	(kPa)	168
Major principal effective stress	(kPa)	584
Minor principal effective stress	(kPa)	157
Principal effective stress ratio		3.72
At 15% axial strain		
Corrected deviator stress	(kPa)	351
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	167
Major principal effective stress	(kPa)	509
Minor principal effective stress	(kPa)	158
Principal effective stress ratio		3.22

FINAL CONDITIONS		
Water content	(%)	21.6
Bulk density	(Mg/m³)	2.08
Dry density	(Mg/m³)	1.71

Borehole	HKZ1-BH03-SA
Sample	50WaxC
Depth (m)	41.46

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 02/09/2016 Drawn by: ALB Template Issue: 2 Checked by: MSR Date: 02/09/2016

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_50WaxC_CU.XLS Approved by: PH Date: 05/09/2016

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH03-SA
Sample	50WaxC
Depth (m)	41.46

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Drawn by: ALB Date: 02/09/2016

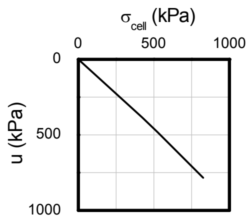
Template Issue: 4.1

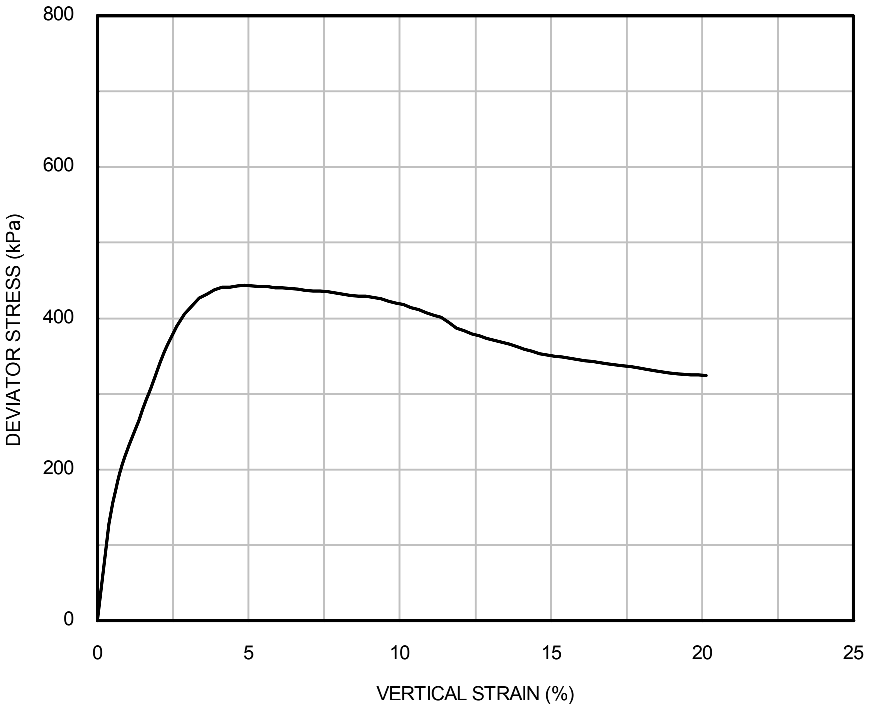
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_50WaxC_CU.OPJ

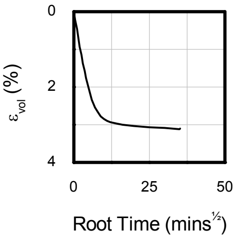
Checked by: MSR Date : 02/09/2016

Approved by: PH Date : 05/09/2016

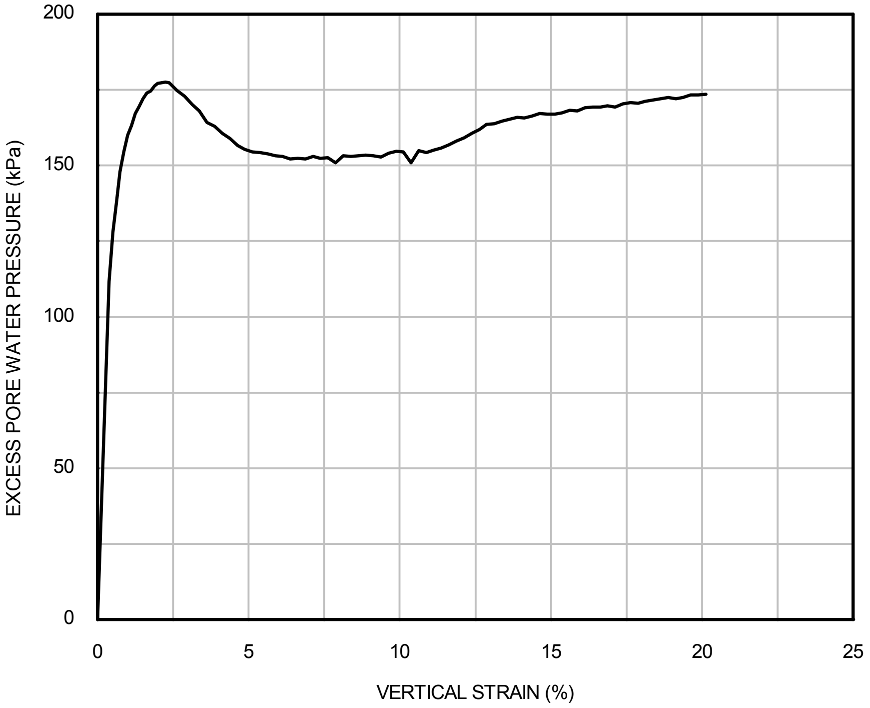
Saturation





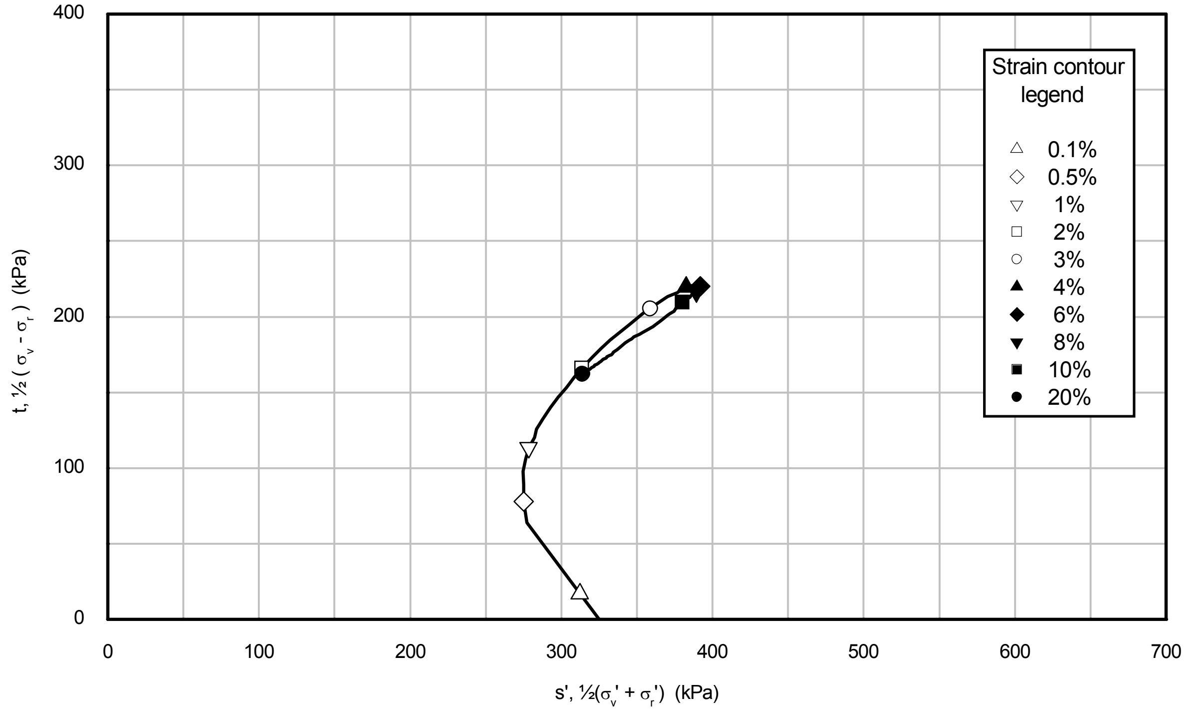


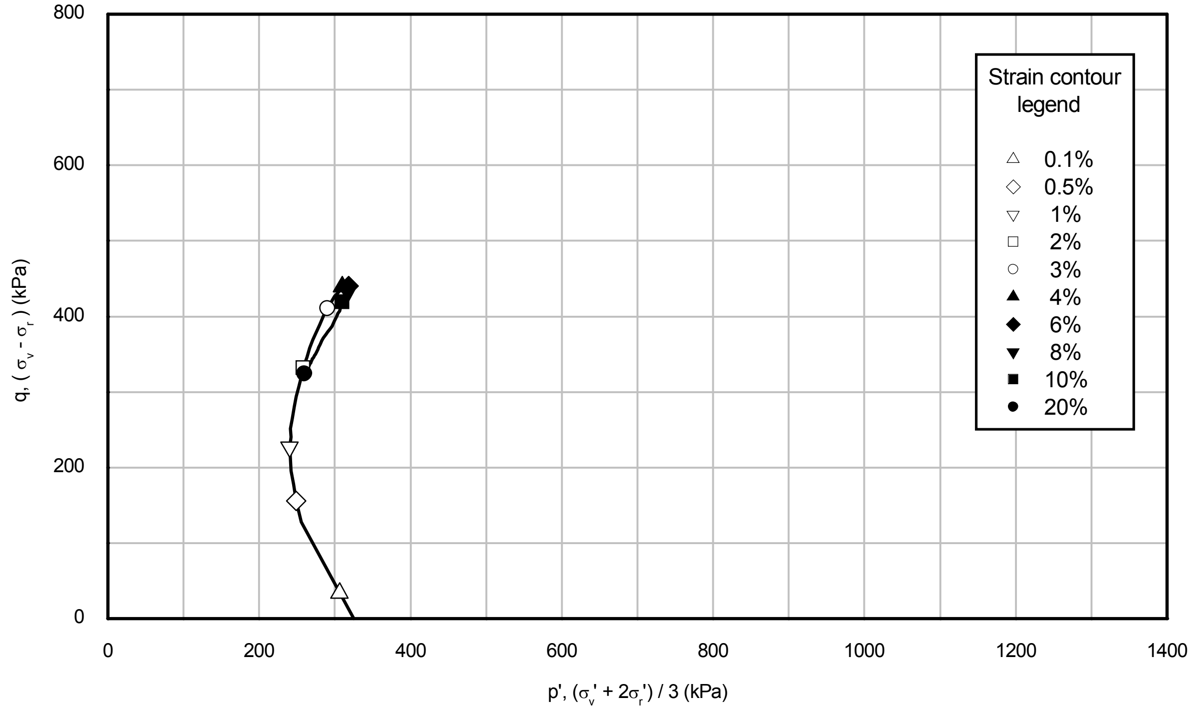
Consolidation



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	325	325	HKZ1-BH03 -SA	50WaxC	41.46

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	325	325	HKZ1-BH03 -SA	50WaxC	41.46

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 02/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_19WaxC_CU.XLS
Checked by: MSR Date: 02/09/2016
Approved by: PH Date: 05/09/2016

VISUAL DESCRIPTION
High strength dark grey CLAY with fine sand and silt pockets

GENERAL	
Date test started	28/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.6
Length	(mm)	139.9
Water content	(%)	19.8
Bulk density	(Mg/m³)	2.11
Dry density	(Mg/m³)	1.76
Void ratio		0.534
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	498
Cell pressure on completion	(kPa)	555
B value achieved		0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA
Sample	19WaxC
Depth (m)	16.02

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 02/09/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_19WaxC_CU.XLS Date: 02/09/2016 Date: 05/09/2016 Checked by: MSR Approved by: PH

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	555
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	155
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	19.1
Bulk density	(Mg/m³)	2.12
Dry density	(Mg/m³)	1.78
Void ratio		0.515
Degree of saturation	(%)	100
Volumetric strain	(%)	1.23

Mode of failure: Brittle failure

Borehole	HKZ1-BH04-SA
Sample	19WaxC
Depth (m)	16.02

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	155
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	267
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	7.25
Excess pore pressure	(kPa)	45
Major principal effective stress	(kPa)	377
Minor principal effective stress	(kPa)	110
Principal effective stress ratio		3.43
Epsilon 50 (ε 50)	(%)	0.42
Secant modulus (E50) at ε 50	(kPa)	32064
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	249
Membrane correction applied	(kPa)	0.4
Drain correction applied	(kPa)	0
Axial strain	(%)	3.25
Excess pore pressure	(kPa)	56
Major principal effective stress	(kPa)	348
Minor principal effective stress	(kPa)	99
Principal effective stress ratio		3.53
At 15% axial strain		
Corrected deviator stress	(kPa)	241
Membrane correction applied	(kPa)	1.4
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	46
Major principal effective stress	(kPa)	350
Minor principal effective stress	(kPa)	109
Principal effective stress ratio		3.20

FINAL CONDITIONS		
Water content	(%)	19.1
Bulk density	(Mg/m³)	2.12
Dry density	(Mg/m³)	1.78

Borehole	HKZ1-BH04-SA
Sample	19WaxC
Depth (m)	16.02

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 02/09/2016 Drawn by: ALB Template Issue: 2 Date: 02/09/2016 Checked by: MSR

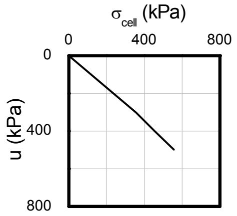
Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_19WaxC_CU.XLS Date: 05/09/2016 Approved by: PH

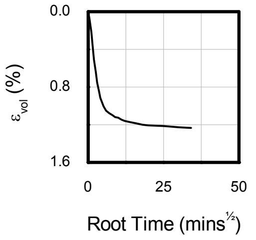
SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH04-SA
Sample	19WaxC
Depth (m)	16.02

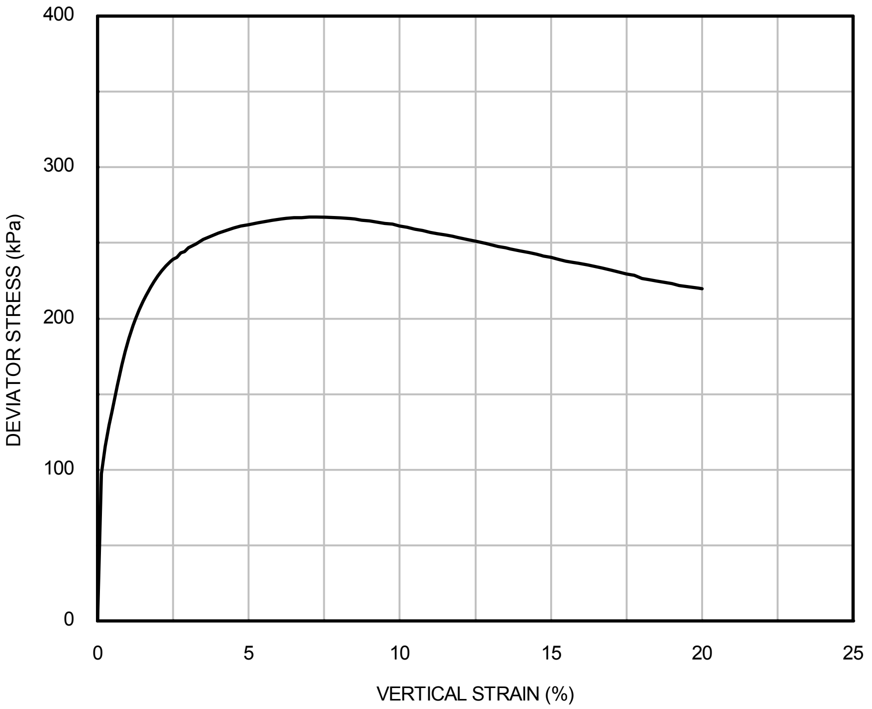
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

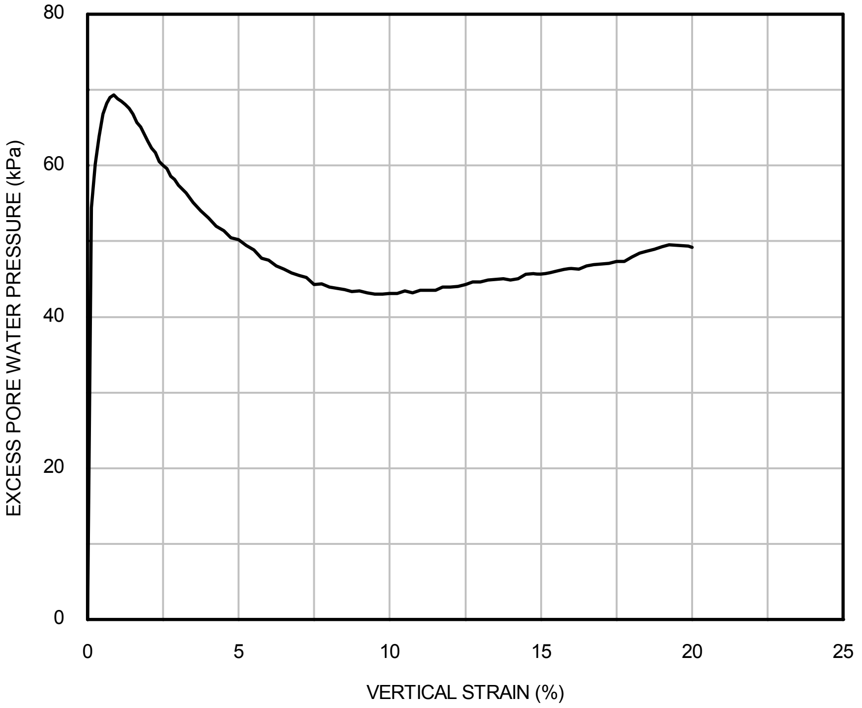
Saturation





Consolidation





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	155	155	HKZ1-BH04 -SA	19WaxC	16.02

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 02/09/2016

Drawn by: ALB

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_19WaxC_CU.OPJ

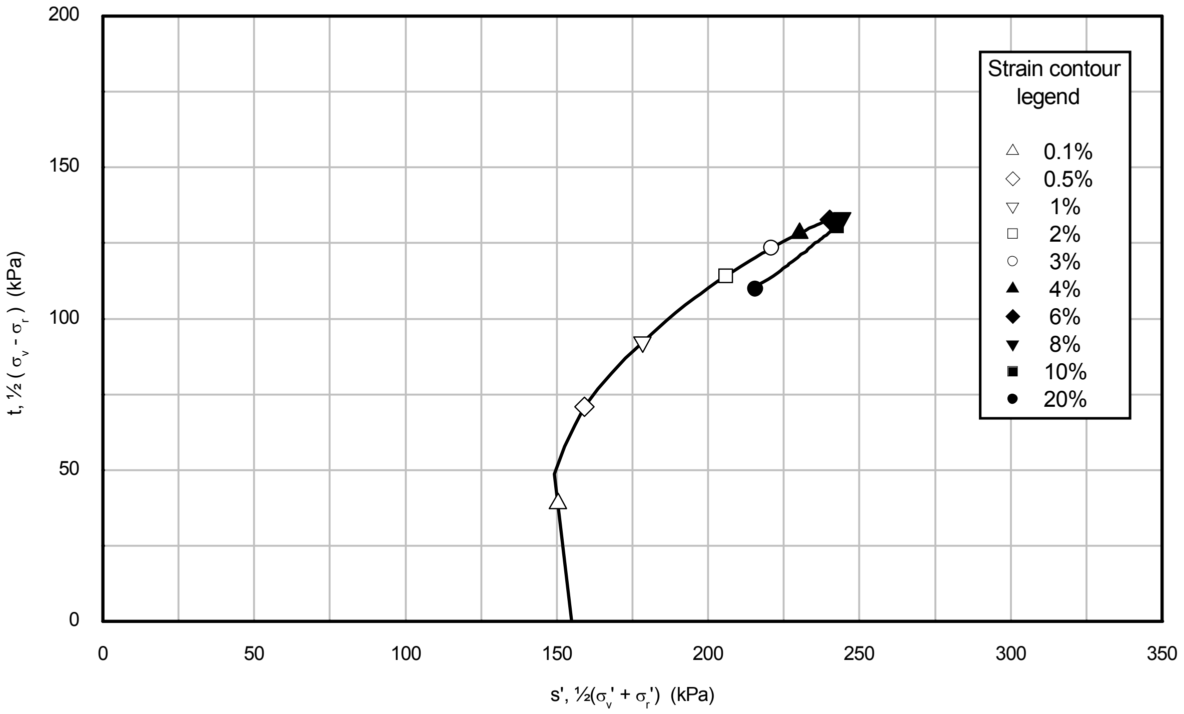
Date : 02/09/2016

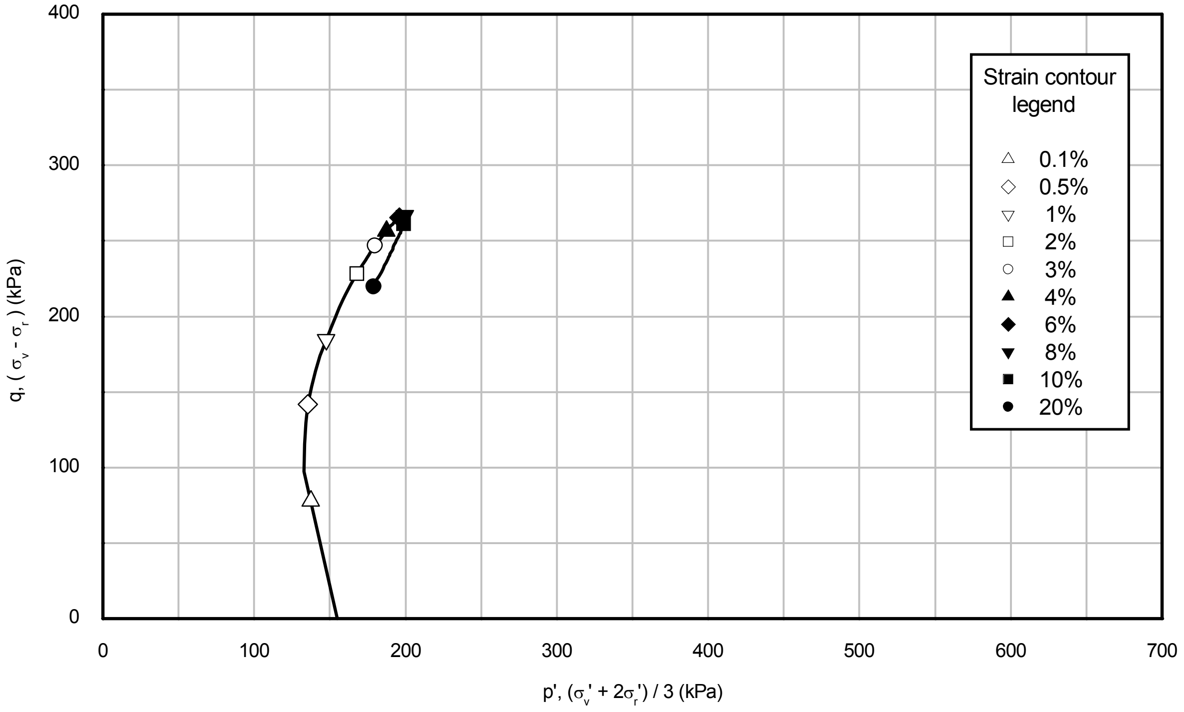
Date : 05/09/2016

Checked by: MSR

Approved by: PH

Date: 02/09/2016
Drawn by: ALB
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_19WaxC_CU.OPJ
Date : 02/09/2016
Date : 05/09/2016
Checked by: MSR
Approved by: PH





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	155	155	HKZ1-BH04-SA	19WaxC	16.02

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

VISUAL DESCRIPTION
Grey fine SAND

GENERAL	
Date test started	30/09/2016
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	[mm]	71.7
Length	[mm]	135.0
Water content	[%]	10.4
Bulk density	[Mg/m³]	1.62
Dry density	[Mg/m³]	1.46
Void ratio		0.811
Degree of saturation	[%]	34

SATURATION		
Pressure increments applied	[kPa]	50
Differential pressure used	[kPa]	10
Pore pressure on completion	[kPa]	476
Cell pressure on completion	[kPa]	490
B value achieved		0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA
Sample	25WaxB
Depth [m]	21.65

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 10/10/2016 Drawn by: MSR
Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH04-
Checked by: PH Date: 11/10/2016
Approved by: PH Date: 11/10/2016

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	490
Back pressure	[kPa]	300
Effective cell pressure	[kPa]	190
Pore pressure on completion	[kPa]	300
Pore pressure dissipation	[%]	100
Water content	[%]	25.6
Bulk density	[Mg/m³]	1.98
Dry density	[Mg/m³]	1.58
Void ratio		0.678
Degree of saturation	[%]	100
Volumetric strain	[%]	7.38
Axial strain	[%]	2.46

Borehole	HKZ1-BH04-SA
Sample	25WaxB
Depth [m]	21.65

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Bulk density	[Mg/m^3]	1.91
Dry density	[Mg/m^3]	1.46
Void ratio	[-]	0.811
Distance	[mm]	132.1
Effective radial pressure	[kPa]	14
Effective axial pressure	[kPa]	14

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.4860	7.43	88.92	15.1
0.22	1.4905	6.77	88.65	15.0
0.24	1.4915	6.22	88.60	15.0
0.26	1.4950	5.75	88.39	14.9
0.28	1.4960	5.34	88.33	14.9
0.30	1.4960	4.99	88.33	14.9
0.32	1.4960	4.68	88.33	14.9
0.34	1.5000	4.41	88.09	14.8
0.36	1.5015	4.17	88.01	14.8
0.38	1.5010	3.95	88.03	14.8

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION		
Bulk density	[Mg/m^3]	1.98
Dry density	[Mg/m^3]	1.58
Void ratio	[-]	0.678
Distance	[mm]	128.65
Effective radial pressure	[kPa]	190
Effective axial pressure	[kPa]	190

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6390	6.39	201.32	80.4
0.12	0.6390	5.32	201.32	80.4
0.14	0.6390	4.56	201.32	80.4
0.16	0.6365	3.98	202.12	81.0
0.18	0.6320	3.51	203.55	82.2
0.20	0.6305	3.15	204.04	82.6
0.22	0.6315	2.87	203.72	82.3

Borehole	HKZ1-BH04-SA
Sample	25WaxB
Depth [m]	21.65

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 10/10/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH04-
Date: 11/10/2016
Checked by: PH
Date: 11/10/2016
Approved by: PH

SHEARING		
Initial pore pressure	[kPa]	300
Initial effective cell pressure	[kPa]	190
Rate of strain	[%/hour]	1.00
At peak deviator stress		
Corrected deviator stress	[kPa]	132
Membrane correction applied	[kPa]	1.5
Drain correction applied	[kPa]	0
Axial strain	[%]	20.03
Excess pore pressure	[kPa]	133
Major principal effective stress	[kPa]	188
Minor principal effective stress	[kPa]	57
Principal effective stress ratio		3.33
Epsilon 50 [ε 50]	[%]	0.34
Secant modulus [E50] at ε 50	[kPa]	19151
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	122
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
Axial strain	[%]	11.52
Excess pore pressure	[kPa]	142
Major principal effective stress	[kPa]	171
Minor principal effective stress	[kPa]	48
Principal effective stress ratio		3.53
At 15% axial strain		
Corrected deviator stress	[kPa]	127
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	137
Major principal effective stress	[kPa]	180
Minor principal effective stress	[kPa]	53
Principal effective stress ratio		3.42

FINAL CONDITIONS		
Water content	[%]	25.6
Bulk density	[Mg/m³]	1.98
Dry density	[Mg/m³]	1.58

Borehole	HKZ1-BH04-SA
Sample	25WaxB
Depth [m]	21.65

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

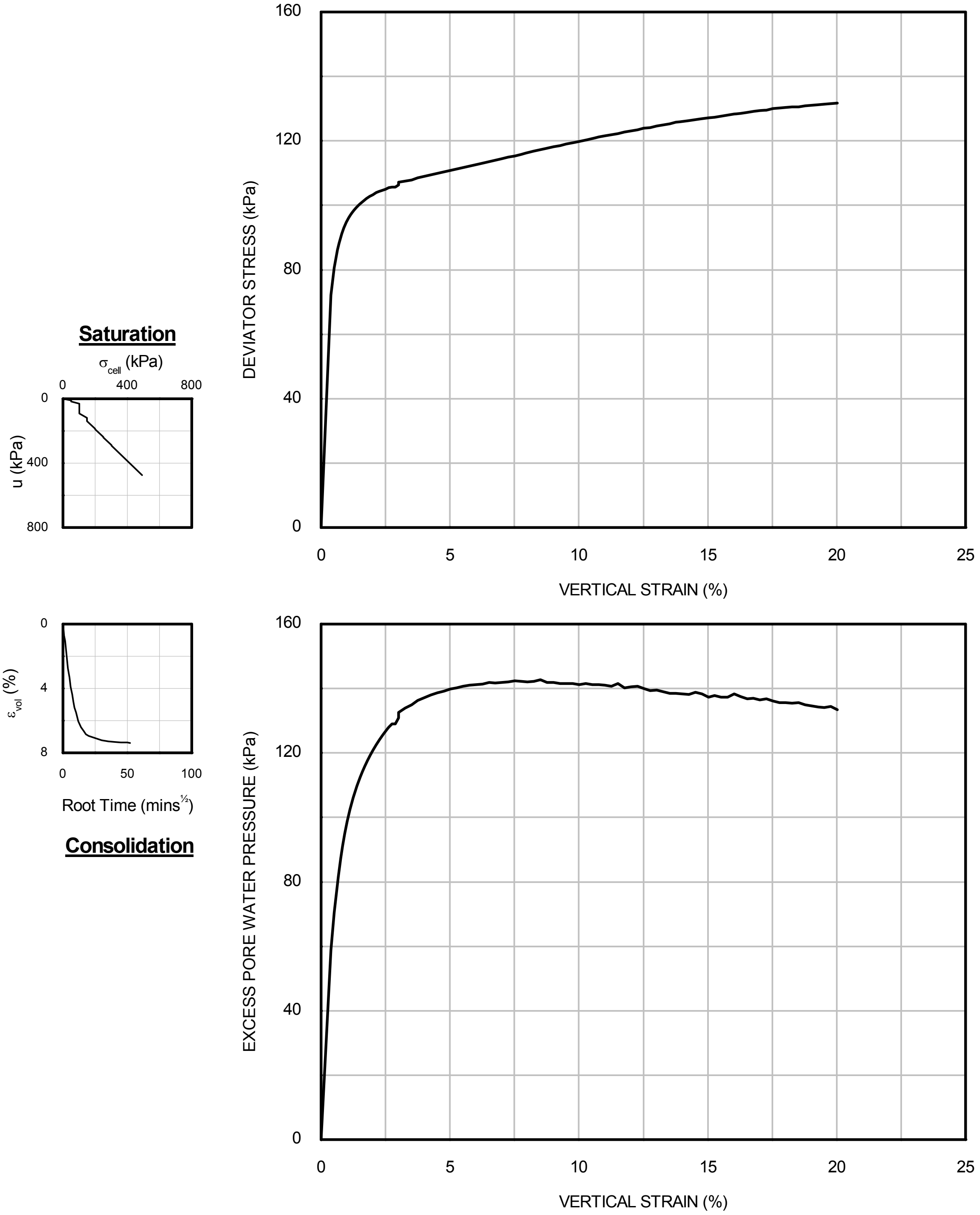
Drawn by: MSR Date: 10/10/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_25WaxB_ca.OPJ

Checked by: PH Date : 11/10/2016

Approved by: PH Date : 11/10/2016



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	190	190	HKZ1-BH04-SA	25WaxB	21.65

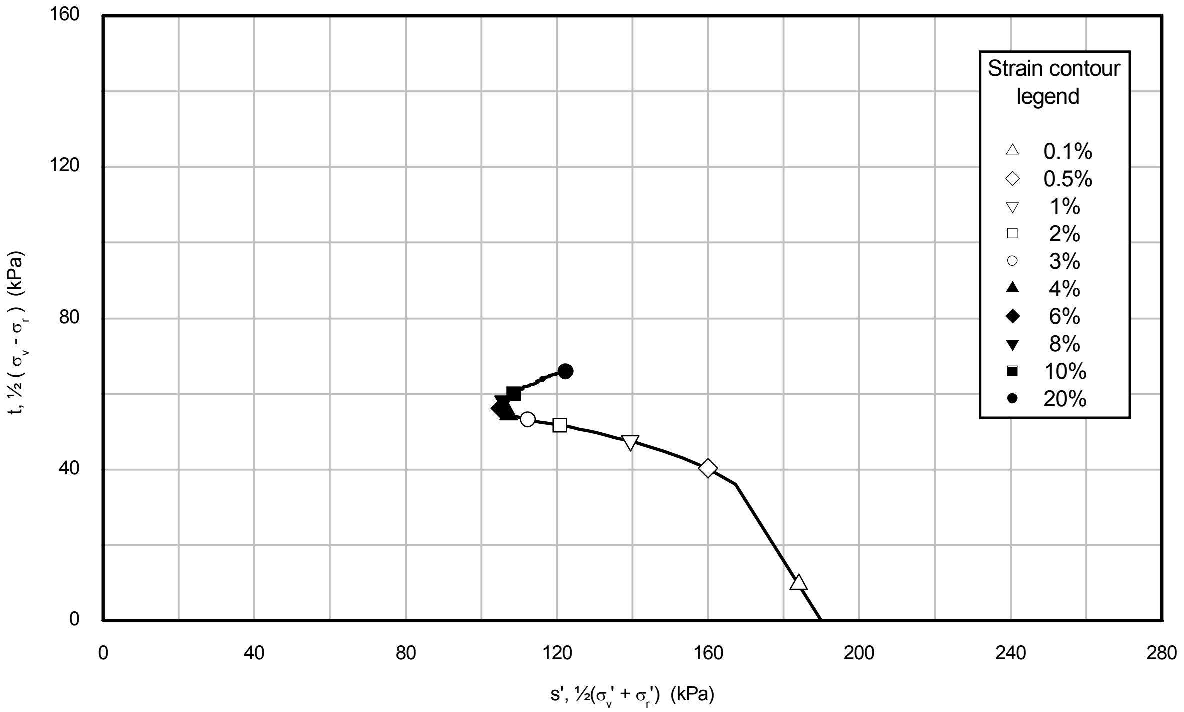
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

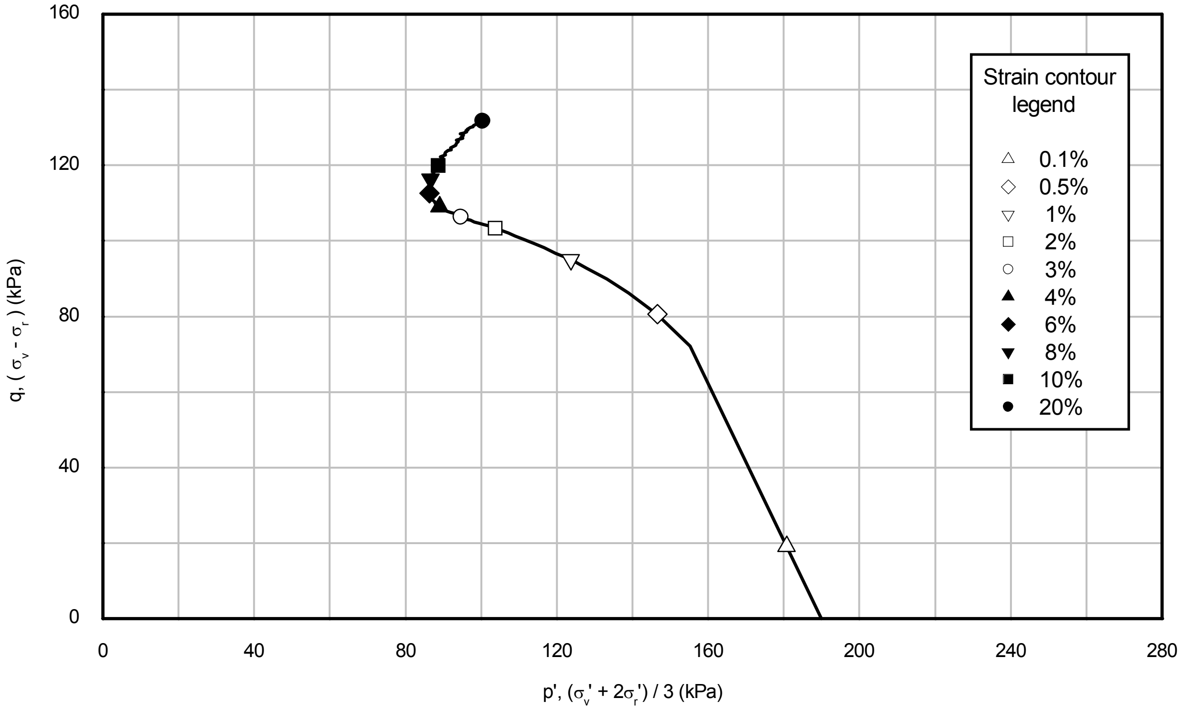
Date: 10/10/2016 Drawn by: MSR

Template Issue: 4.1 Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_25WaxB_ca.OPJ

Date : 11/10/2016 Date : 11/10/2016

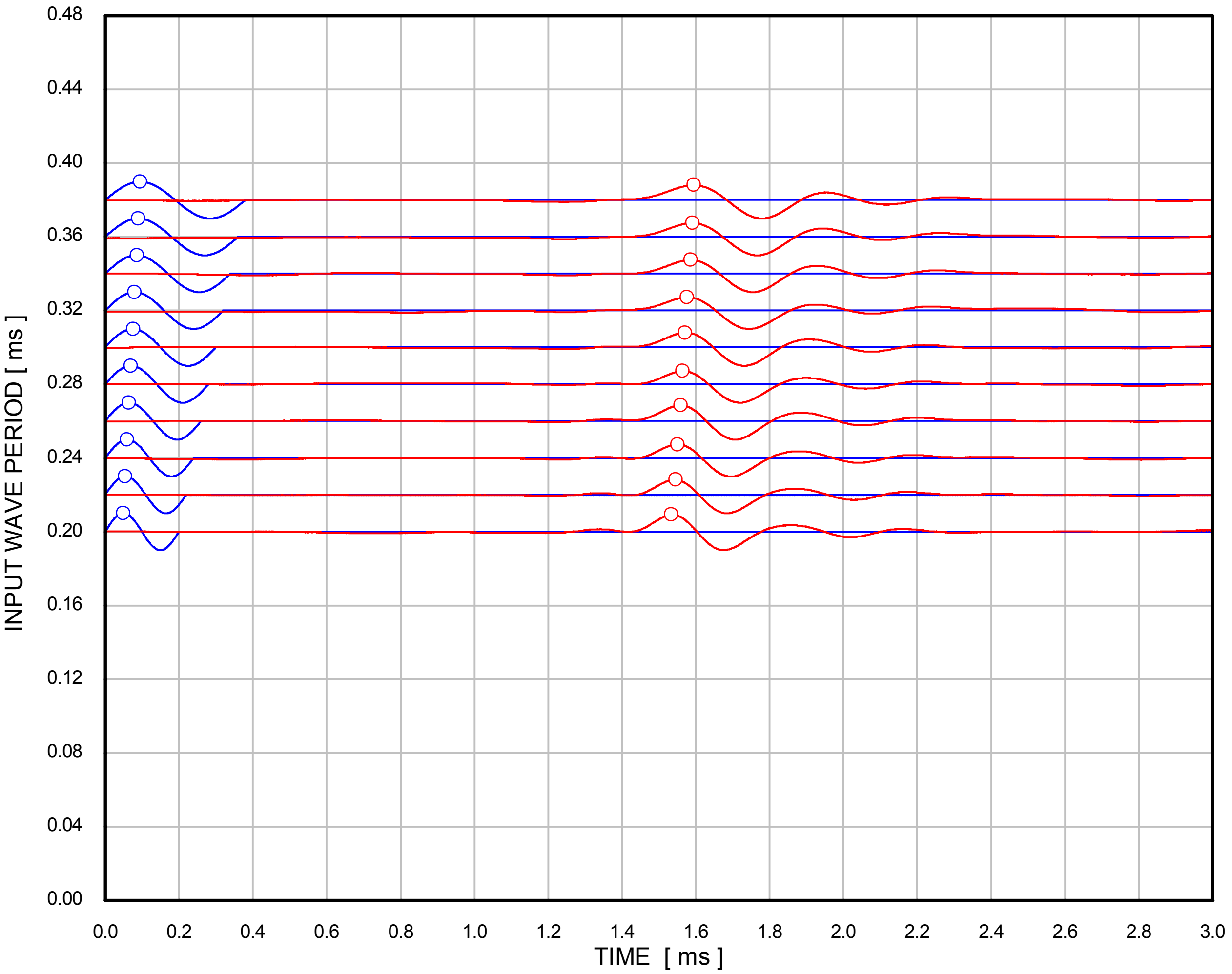
Checked by: PH Approved by: PH

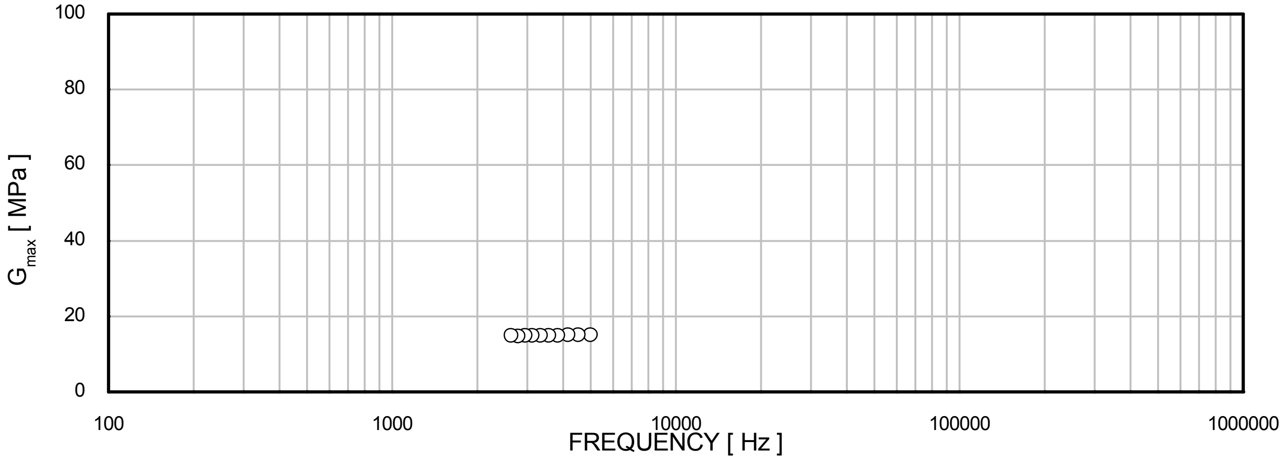




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
──	1	190	190	HKZ1-BH04-SA	25WaxB	21.65

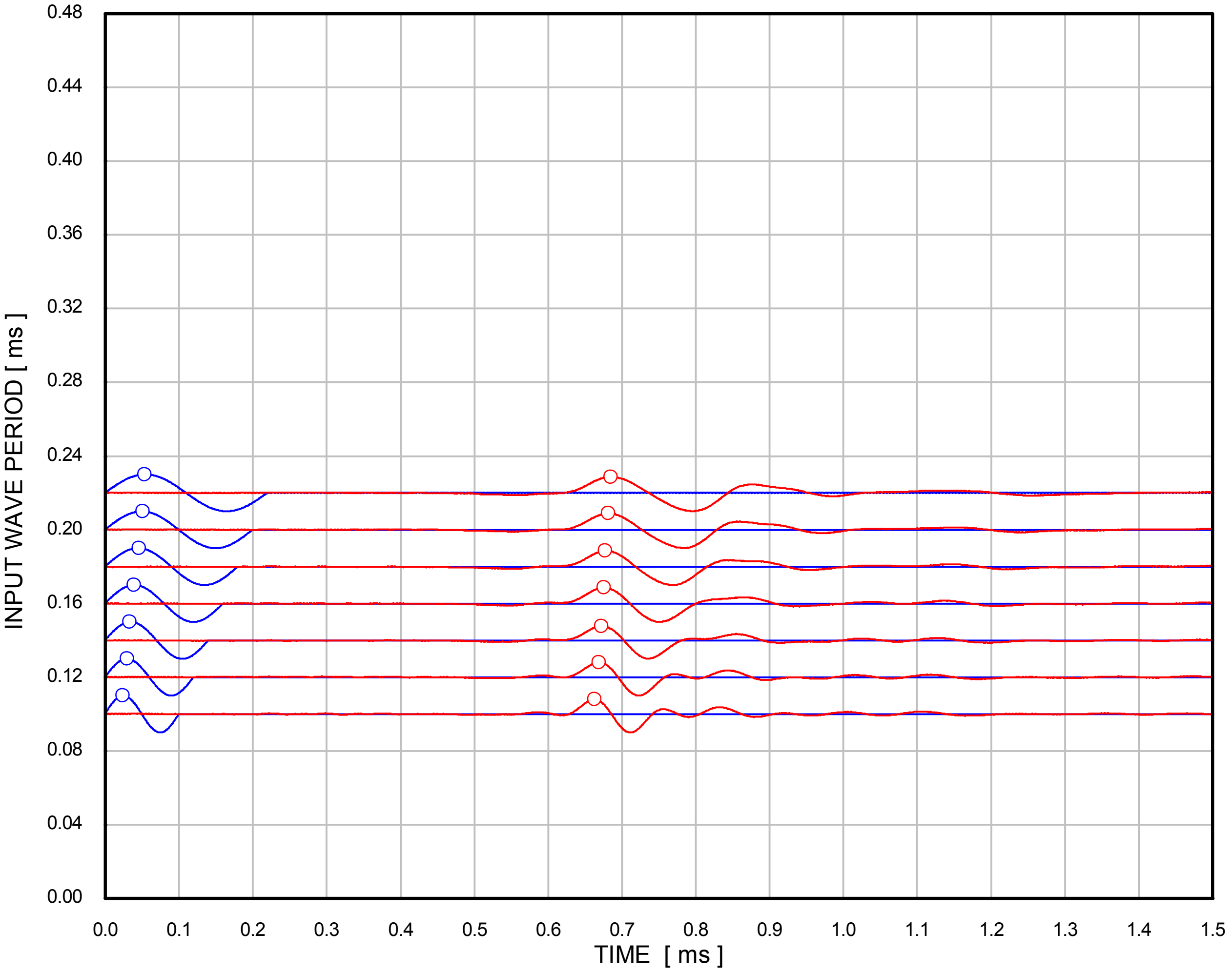
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

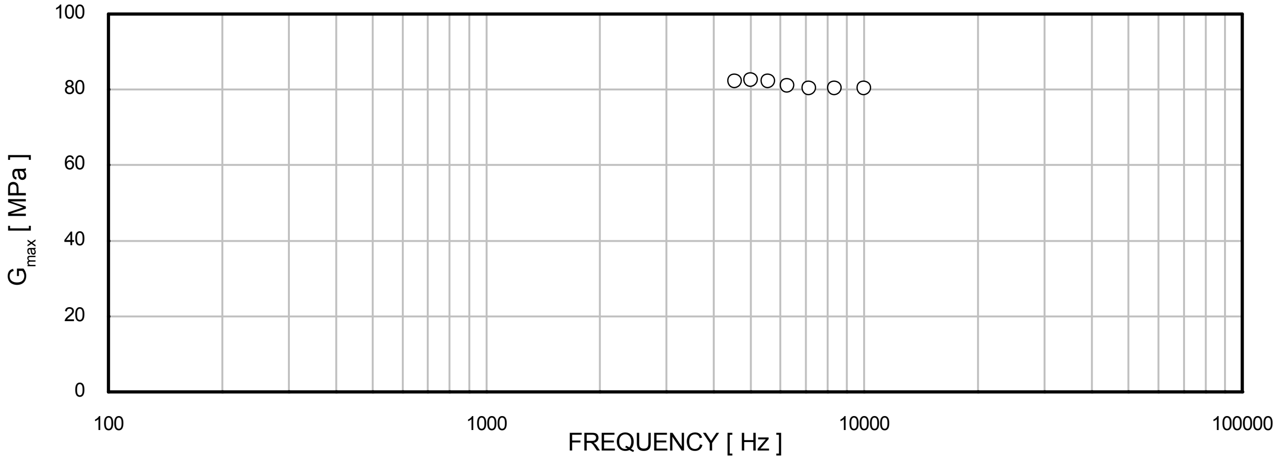




σ'_{rc}	: 14 kPa	Borehole	: HKZ1-BH04-SA
σ'_{ac}	: 14 kPa	Sample	: 25WaxB
—	Source signal	Depth [m]	: 21.65
—	Received signal	Test No.	: 131
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 190 kPa	Borehole	:	HKZ1-BH04-SA
σ'_{ac}	: 190 kPa	Sample	:	25WaxB
—	Source signal	Depth [m]	:	21.65
—	Received signal	Test No.	:	131
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Very high strength very dark grey CLAY with fine to medium sand and silt

GENERAL	
Date test started	28/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	49.6
Length	(mm)	100.0
Water content	(%)	27.7
Bulk density	(Mg/m³)	1.97
Dry density	(Mg/m³)	1.54
Void ratio		0.750
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	724
Cell pressure on completion	(kPa)	735
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA
Sample	32WaxC
Depth (m)	28.82

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	735
Back pressure	(kPa)	500
Effective cell pressure	(kPa)	235
Pore pressure on completion	(kPa)	500
Pore pressure dissipation	(%)	100
Water content	(%)	23.2
Bulk density	(Mg/m³)	2.04
Dry density	(Mg/m³)	1.66
Void ratio		0.628
Degree of saturation	(%)	100
Volumetric strain	(%)	6.93

Mode of failure: Plastic failure

Borehole	HKZ1-BH04-SA
Sample	32WaxC
Depth (m)	28.82

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	500
Initial effective cell pressure	(kPa)	235
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	323
Membrane correction applied	(kPa)	1.7
Drain correction applied	(kPa)	0
Axial strain	(%)	14.01
Excess pore pressure	(kPa)	112
Major principal effective stress	(kPa)	446
Minor principal effective stress	(kPa)	123
Principal effective stress ratio		3.63
Epsilon 50 (ε 50)	(%)	1.03
Secant modulus (E50) at ε 50	(kPa)	15610
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	292
Membrane correction applied	(kPa)	1.2
Drain correction applied	(kPa)	0
Axial strain	(%)	8.50
Excess pore pressure	(kPa)	130
Major principal effective stress	(kPa)	397
Minor principal effective stress	(kPa)	105
Principal effective stress ratio		3.80
At 15% axial strain		
Corrected deviator stress	(kPa)	321
Membrane correction applied	(kPa)	1.8
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	110
Major principal effective stress	(kPa)	446
Minor principal effective stress	(kPa)	125
Principal effective stress ratio		3.57

FINAL CONDITIONS		
Water content	(%)	23.2
Bulk density	(Mg/m³)	2.04
Dry density	(Mg/m³)	1.66

Borehole	HKZ1-BH04-SA
Sample	32WaxC
Depth (m)	28.82

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

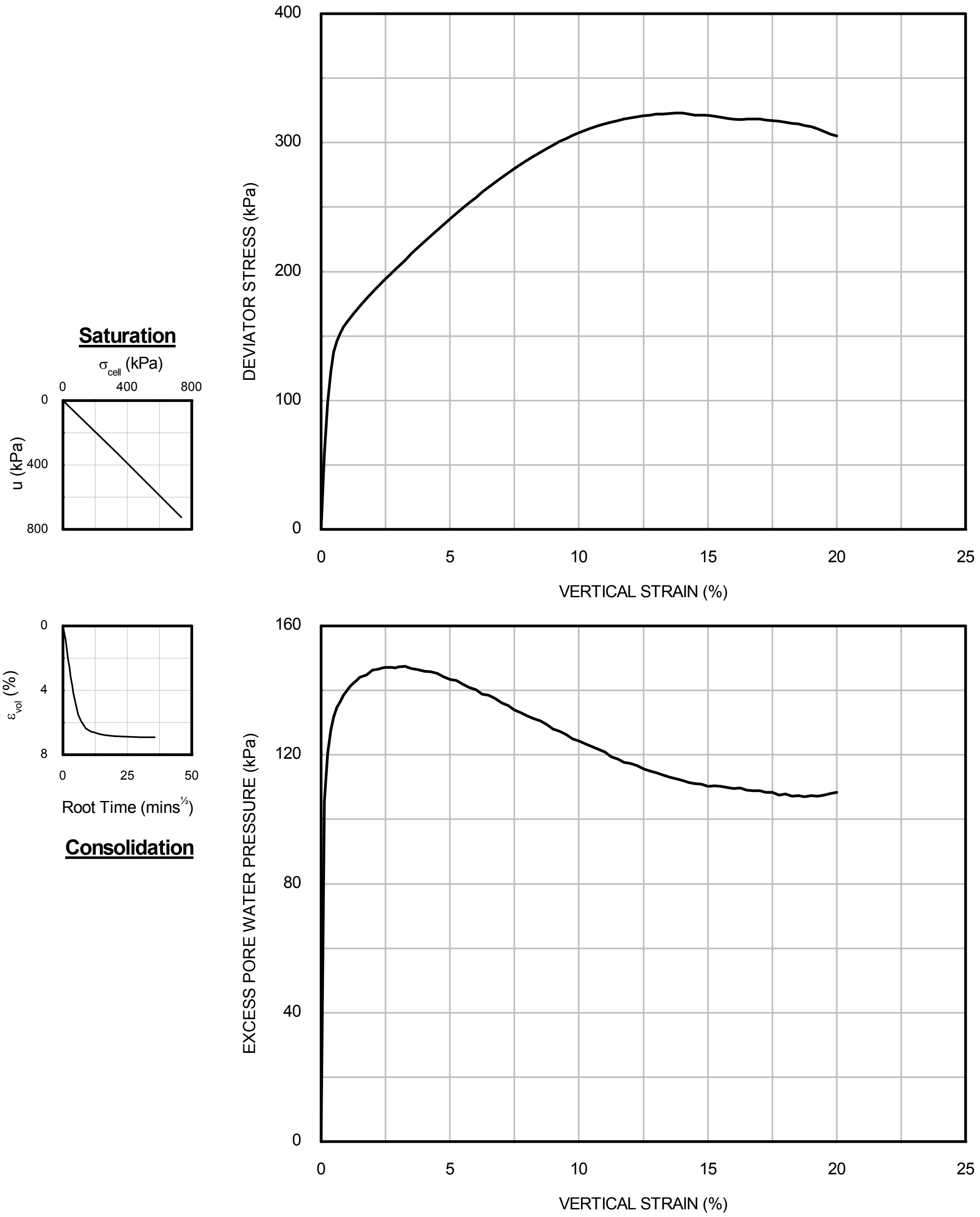
Date: 02/09/2016 Drawn by: ALB Template Issue: 2 Checked by: MSR Date: 02/09/2016

Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_32WaxC_CU.XLS Approved by: PH Date: 05/09/2016

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH04-SA
Sample	32WaxC
Depth (m)	28.82

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	235	235	HKZ1-BH04-SA	32WaxC	28.82

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Drawn by: ALB Date: 02/09/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_32WaxC_CU.OPJ

Date : 02/09/2016

Date : 05/09/2016

Checked by: MSR

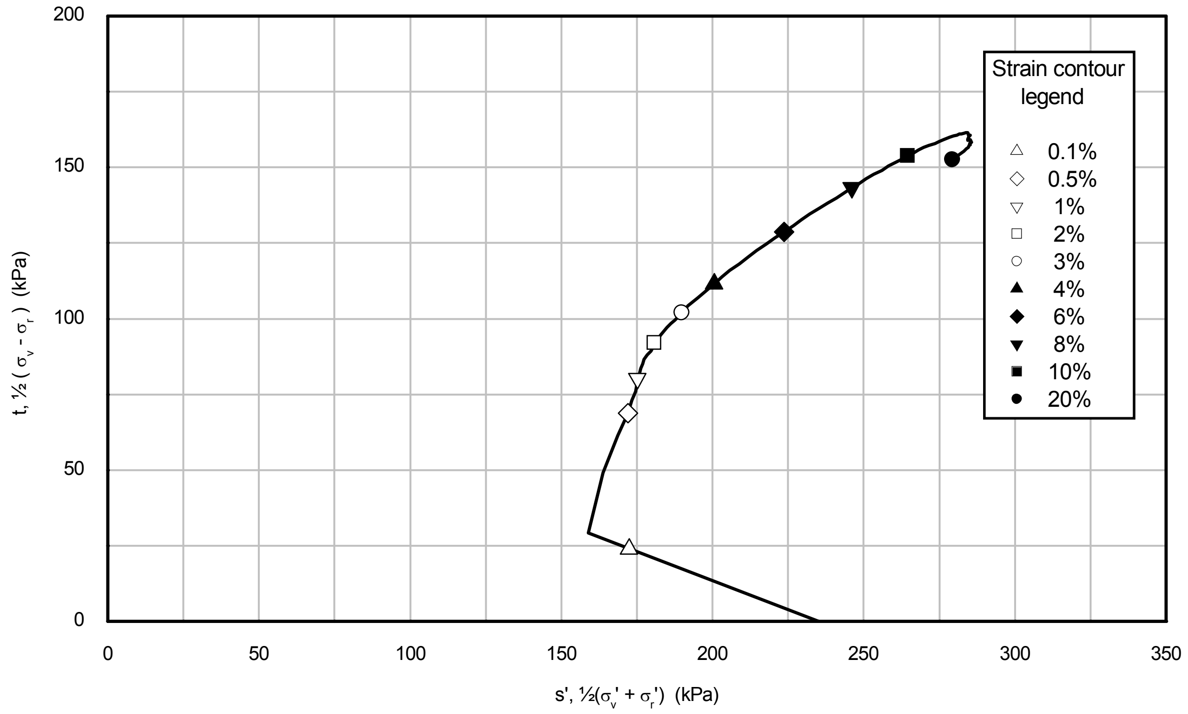
Approved by: PH

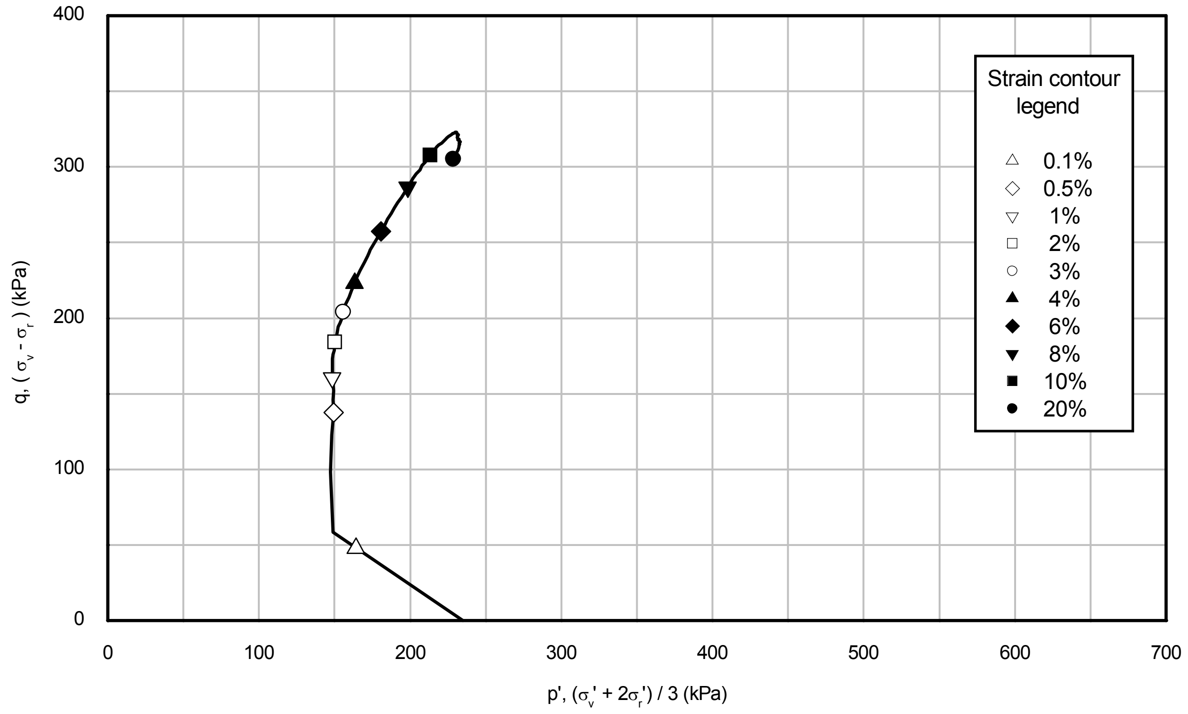
Date: 02/09/2016

Drawn by: ALB

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_32WaxC_CU.OPJ





Date : 02/09/2016

Date : 05/09/2016

Checked by: MSR

Approved by: PH

Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
――	1	235	235	HKZ1-BH04 -SA	32WaxC	28.82

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 10/10/2016 Drawn by: MSR

Template Issue: 3

Filename: J11335 / EFFECTIVE / HKZ1-BH05-

Checked by: PH Date: 11/10/2016

Approved by: PH Date: 11/10/2016

VISUAL DESCRIPTION
Grey CLAY with laminations of light brown silt

GENERAL	
Date test started	30/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	[mm]	70.7
Length	[mm]	139.9
Water content	[%]	33.5
Bulk density	[Mg/m³]	1.89
Dry density	[Mg/m³]	1.41
Void ratio		0.912
Degree of saturation	[%]	99

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	N/A
Pore pressure on completion	[kPa]	571
Cell pressure on completion	[kPa]	630
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH05-SA
Sample	23WaxB
Depth [m]	19.22

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	605
Back pressure	[kPa]	400
Effective cell pressure	[kPa]	205
Pore pressure on completion	[kPa]	400
Pore pressure dissipation	[%]	100
Water content	[%]	31.6
Bulk density	[Mg/m³]	1.91
Dry density	[Mg/m³]	1.45
Void ratio		0.861
Degree of saturation	[%]	99
Volumetric strain	[%]	2.68
Axial strain	[%]	0.89

Borehole	HKZ1-BH05-SA
Sample	23WaxB
Depth [m]	19.22

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION

Bulk density	[Mg/m^3]	1.89
Dry density	[Mg/m^3]	1.41
Void ratio	[-]	0.912
Distance	[mm]	136.9
Effective radial pressure	[kPa]	34
Effective axial pressure	[kPa]	34

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.1135	5.57	122.95	28.5
0.25	1.1200	4.48	122.23	28.2
0.30	1.1245	3.75	121.74	27.9
0.35	1.1330	3.24	120.83	27.5
0.40	1.1440	2.86	119.67	27.0

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION

Bulk density	[Mg/m^3]	1.91
Dry density	[Mg/m^3]	1.45
Void ratio	[-]	0.861
Distance	[mm]	135.63
Effective radial pressure	[kPa]	205
Effective axial pressure	[kPa]	205

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	0.7415	3.71	182.91	63.9
0.22	0.7485	3.40	181.20	62.7
0.24	0.7420	3.09	182.79	63.8
0.26	0.7485	2.88	181.20	62.7

Borehole	HKZ1-BH05-SA
Sample	23WaxB
Depth [m]	19.22

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 10/10/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH05-
Date: 11/10/2016
Date: 11/10/2016
Checked by: PH
Approved by: PH

SHEARING		
Initial pore pressure	[kPa]	400
Initial effective cell pressure	[kPa]	205
Rate of strain	[%/hour]	0.43
At peak deviator stress		
Corrected deviator stress	[kPa]	199
Membrane correction applied	[kPa]	0.6
Drain correction applied	[kPa]	0
Axial strain	[%]	6.25
Excess pore pressure	[kPa]	102
Major principal effective stress	[kPa]	303
Minor principal effective stress	[kPa]	103
Principal effective stress ratio		2.93
Epsilon 50 [ε 50]	[%]	0.96
Secant modulus [E50] at ε 50	[kPa]	10347
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	191
Membrane correction applied	[kPa]	0.5
Drain correction applied	[kPa]	0
Axial strain	[%]	5.25
Excess pore pressure	[kPa]	109
Major principal effective stress	[kPa]	287
Minor principal effective stress	[kPa]	96
Principal effective stress ratio		3.00
At 15% axial strain		
Corrected deviator stress	[kPa]	144
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	87
Major principal effective stress	[kPa]	263
Minor principal effective stress	[kPa]	118
Principal effective stress ratio		2.22

FINAL CONDITIONS		
Water content	[%]	31.6
Bulk density	[Mg/m³]	1.91
Dry density	[Mg/m³]	1.45

Borehole	HKZ1-BH05-SA
Sample	23WaxB
Depth [m]	19.22

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 10/10/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH05-
Checked by: PH Date: 11/10/2016
Approved by: PH Date: 11/10/2016

SPECIMEN PHOTOGRAPHS

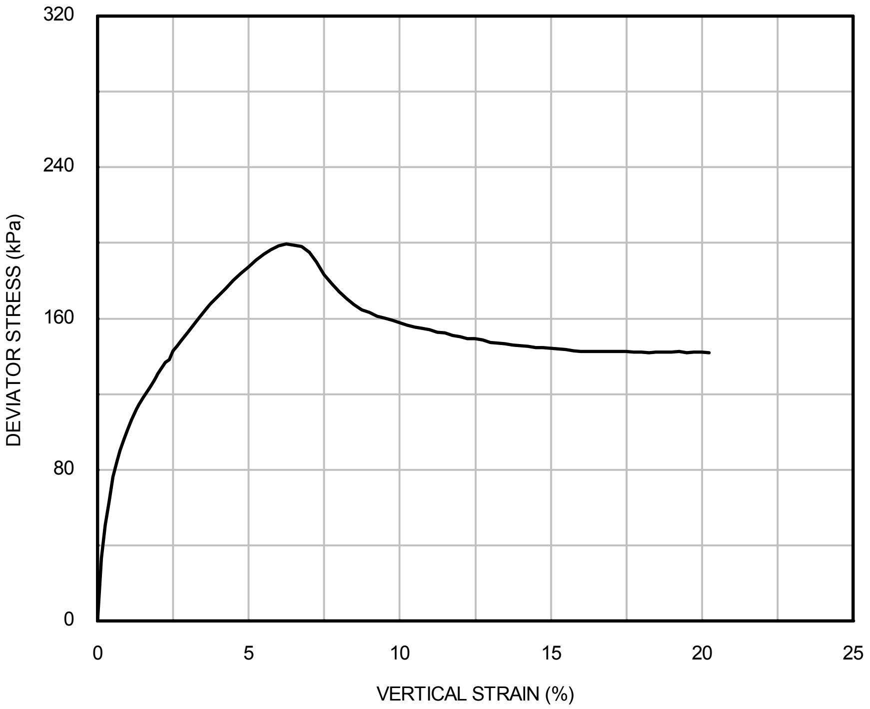
Borehole	HKZ1-BH05-SA
Sample	23WaxB
Depth [m]	19.22

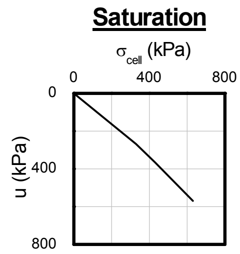
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

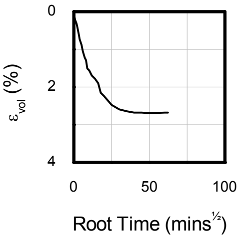
Drawn by: MSR Date: 10/10/2016

Template Issue: 4.1

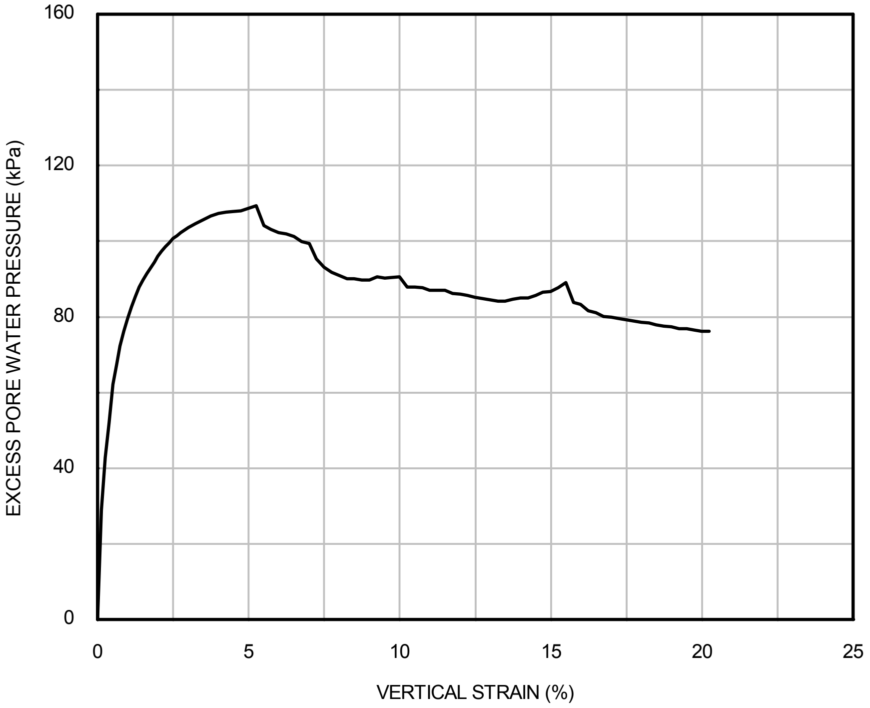
Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_23WaxB_ca.OPJ




Saturation



Consolidation



Date : 11/10/2016

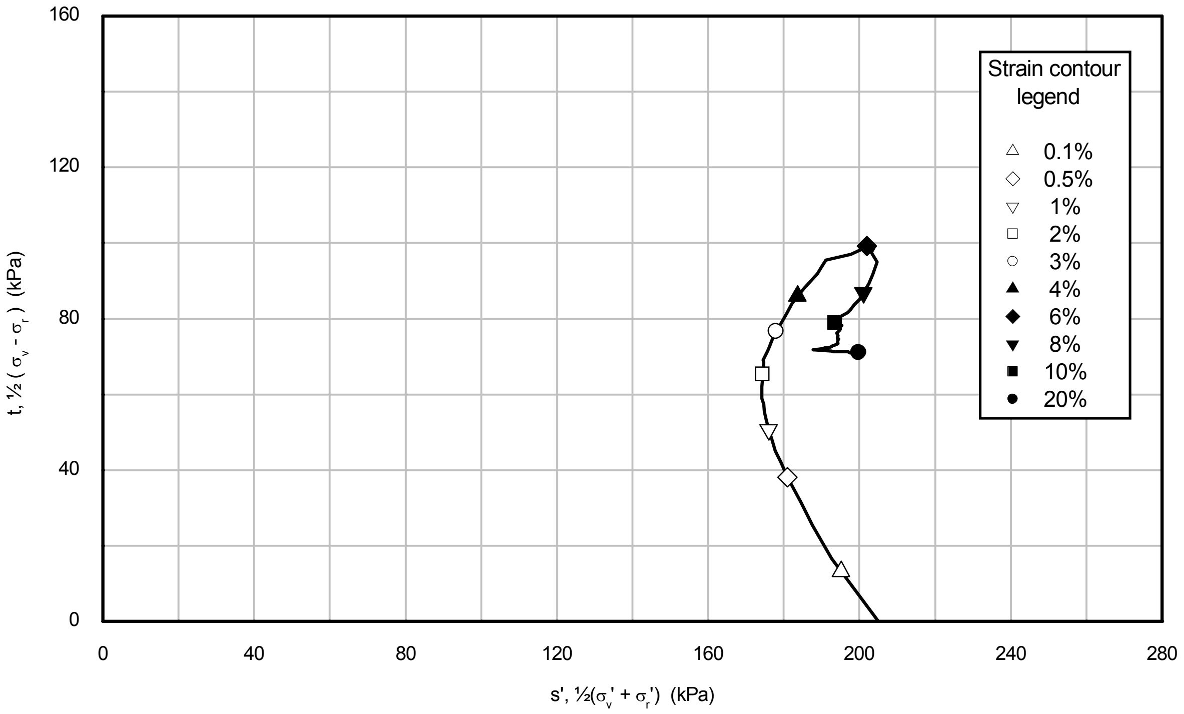
Date : 11/10/2016

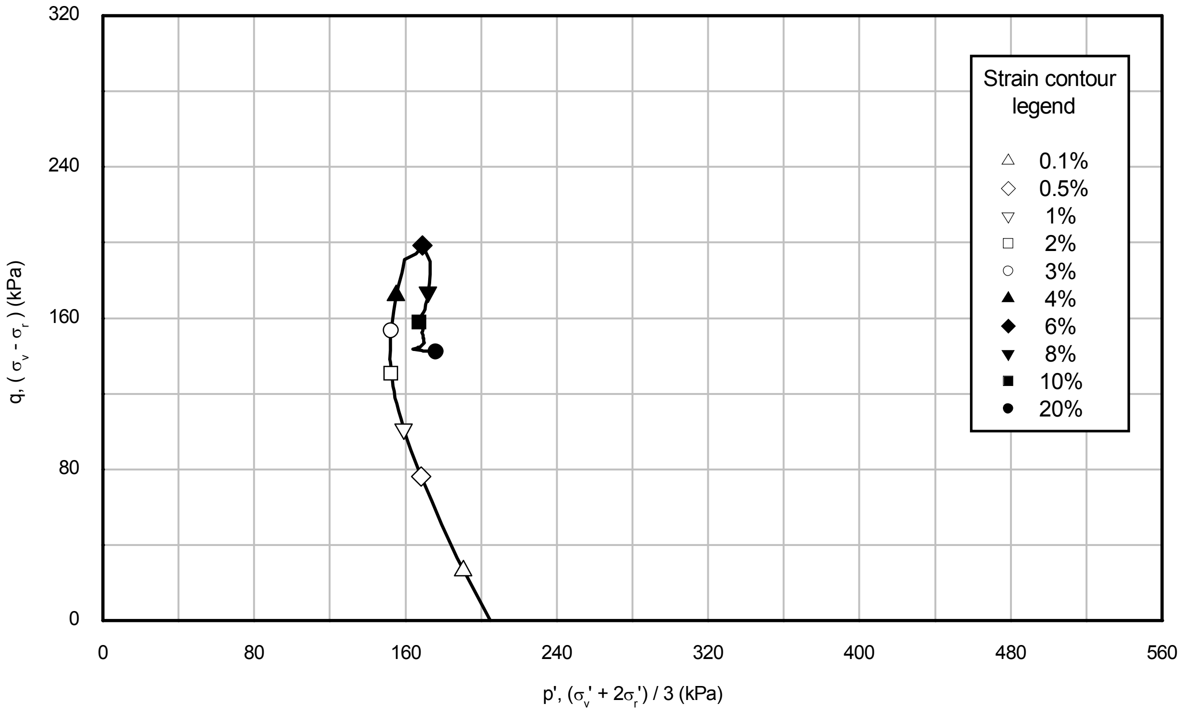
Checked by: PH

Approved by: PH

Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	205	205	HKZ1 -BH05-SA	23WaxB	19.22

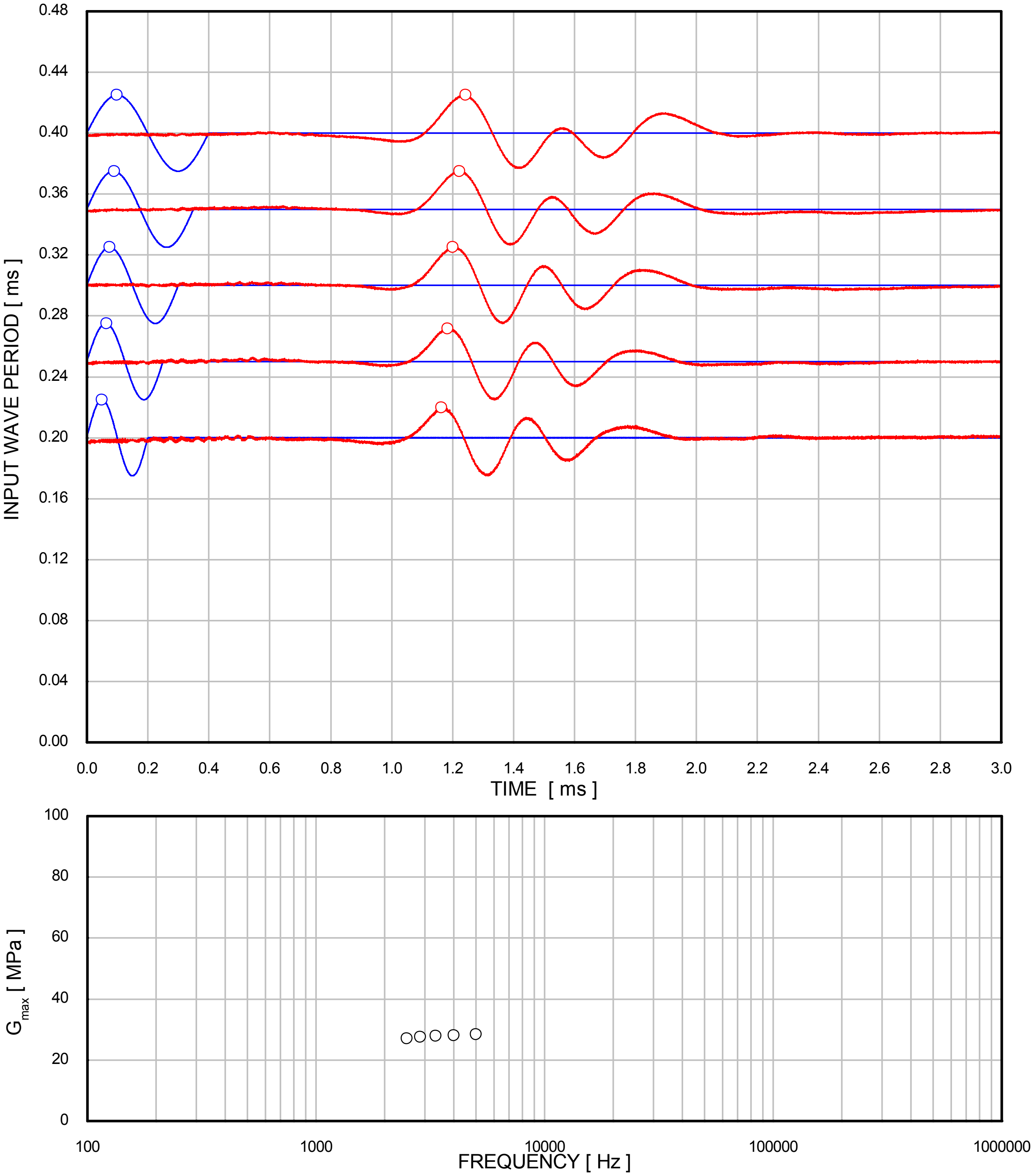
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	205	205	HKZ1 -BH05-SA	23WaxB	19.22

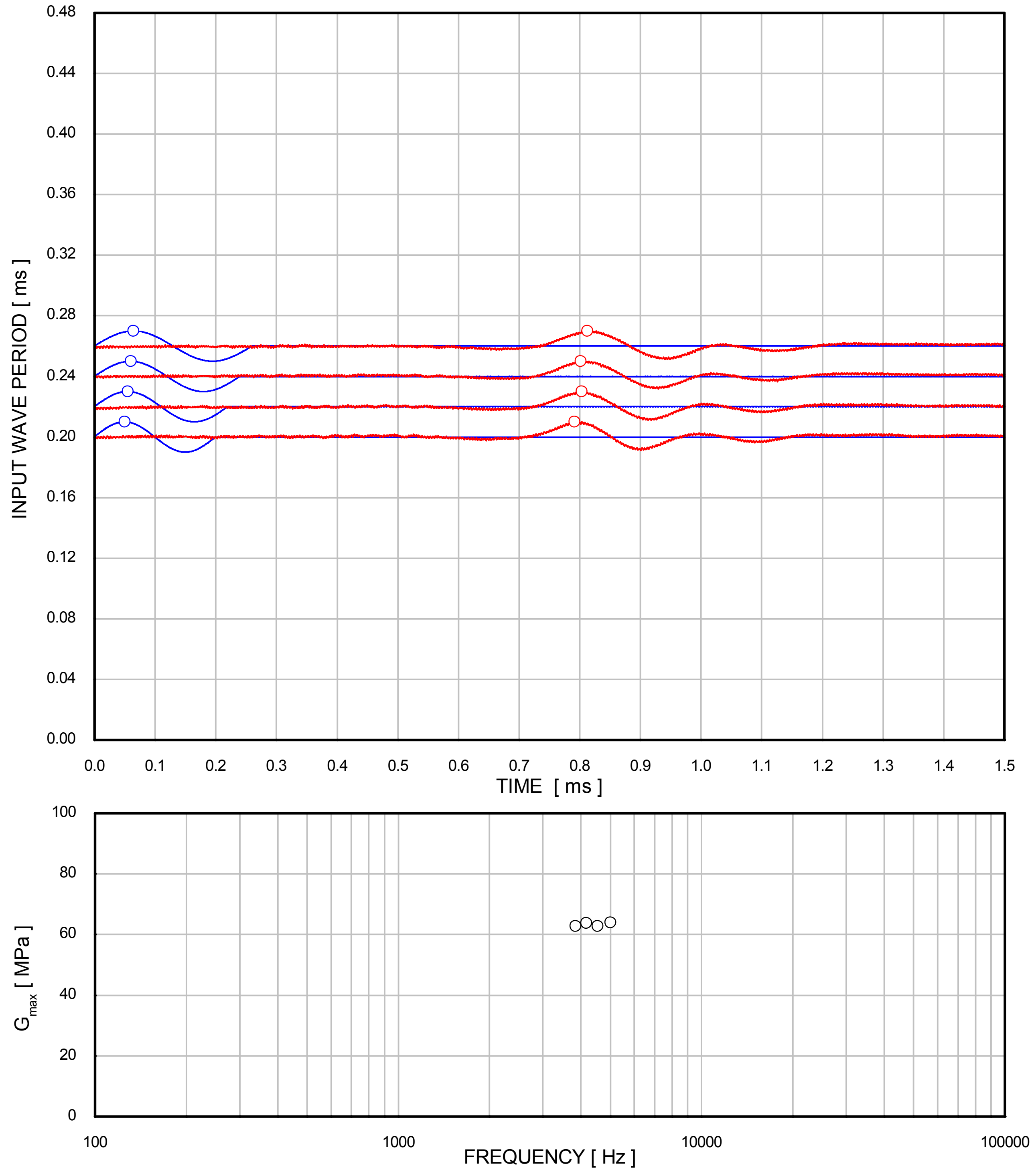
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN



σ'_{rc} : 34 kPa
σ'_{ac} : 34 kPa
— Source signal
— Received signal
○ / ○ Selected peak values

Borehole : HKZ1-BH05-SA
Sample : 23WaxB
Depth [m] : 19.22
Test No. : 126

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS



σ'_{rc} : 205 kPa

σ'_{ac} : 205 kPa

Source signal

Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH05-SA

Sample : 23WaxB

Depth [m] : 19.22

Test No. : 126

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Light brownish grey silty fine SAND

GENERAL	
Date test started	04/10/2016
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	[mm]	71.7
Length	[mm]	135.0
Water content	[%]	10.4
Bulk density	[Mg/m³]	1.67
Dry density	[Mg/m³]	1.51
Void ratio		0.763
Degree of saturation	[%]	36

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	10
Pore pressure on completion	[kPa]	644
Cell pressure on completion	[kPa]	655
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Fugro testing procedure L-T-023 Clause 5.3.6
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH05-SA
Sample	29BagC&D
Depth [m]	24.90

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 11/10/2016 Drawn by: MSR

Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH05-

Date: 11/10/2016 Checked by: PH

Date: 14/10/2016 Approved by: PH

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	655
Back pressure	[kPa]	400
Effective cell pressure	[kPa]	255
Pore pressure on completion	[kPa]	400
Pore pressure dissipation	[%]	100
Water content	[%]	24.4
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62
Void ratio		0.653
Degree of saturation	[%]	100
Volumetric strain	[%]	6.24
Axial strain	[%]	2.08

Borehole	HKZ1-BH05-SA
Sample	29BagC&D
Depth [m]	24.90

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION				
Bulk density	[Mg/m^3]	1.95		
Dry density	[Mg/m^3]	1.51		
Void ratio	[-]	0.763		
Distance	[mm]	132.1		
Effective radial pressure	[kPa]	11		
Effective axial pressure	[kPa]	11		
Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	1.5950	15.95	82.79	13.3
0.12	1.6020	13.35	82.43	13.2
0.14	1.5990	11.42	82.58	13.3
0.16	1.6120	10.08	81.92	13.1
0.18	1.6095	8.94	82.04	13.1
0.20	1.6140	8.07	81.82	13.0
0.22	1.6210	7.37	81.46	12.9
0.24	1.6200	6.75	81.51	12.9
0.26	1.6230	6.24	81.36	12.9
0.28	1.6310	5.82	80.96	12.8

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION				
Bulk density	[Mg/m^3]	2.01		
Dry density	[Mg/m^3]	1.62		
Void ratio	[-]	0.653		
Distance	[mm]	129.12		
Effective radial pressure	[kPa]	255		
Effective axial pressure	[kPa]	255		
Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.5745	5.75	224.75	101.6
0.12	0.5735	4.78	225.14	101.9
0.14	0.5745	4.10	224.75	101.6
0.16	0.5725	3.58	225.53	102.3
0.18	0.5710	3.17	226.13	102.8

Borehole	HKZ1-BH05-SA
Sample	29BagC&D
Depth [m]	24.90

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SHEARING		
Initial pore pressure	[kPa]	400
Initial effective cell pressure	[kPa]	255
Rate of strain	[%/hour]	0.45
At peak deviator stress		
Corrected deviator stress	[kPa]	203
Membrane correction applied	[kPa]	1.8
Drain correction applied	[kPa]	0
Axial strain	[%]	20.02
Excess pore pressure	[kPa]	160
Major principal effective stress	[kPa]	298
Minor principal effective stress	[kPa]	95
Principal effective stress ratio		3.14
Epsilon 50 [ε 50]	[%]	0.47
Secant modulus [E50] at ε 50	[kPa]	21491
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	178
Membrane correction applied	[kPa]	1.1
Drain correction applied	[kPa]	0
Axial strain	[%]	10.51
Excess pore pressure	[kPa]	178
Major principal effective stress	[kPa]	254
Minor principal effective stress	[kPa]	77
Principal effective stress ratio		3.32
At 15% axial strain		
Corrected deviator stress	[kPa]	192
Membrane correction applied	[kPa]	1.5
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	169
Major principal effective stress	[kPa]	279
Minor principal effective stress	[kPa]	86
Principal effective stress ratio		3.22

FINAL CONDITIONS		
Water content	[%]	24.4
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62

Borehole	HKZ1-BH05-SA
Sample	29BagC&D
Depth [m]	24.90

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 11/10/2016 Drawn by: MSR Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH05-

Checked by: PH Date: 11/10/2016 Approved by: PH Date: 14/10/2016

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH05-SA
Sample	29BagC&D
Depth [m]	24.90

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 11/10/2016

Drawn by: MSR

Template Issue: 4.1

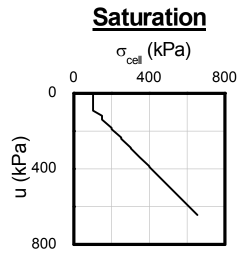
Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_29BagC&D_ca.OPJ

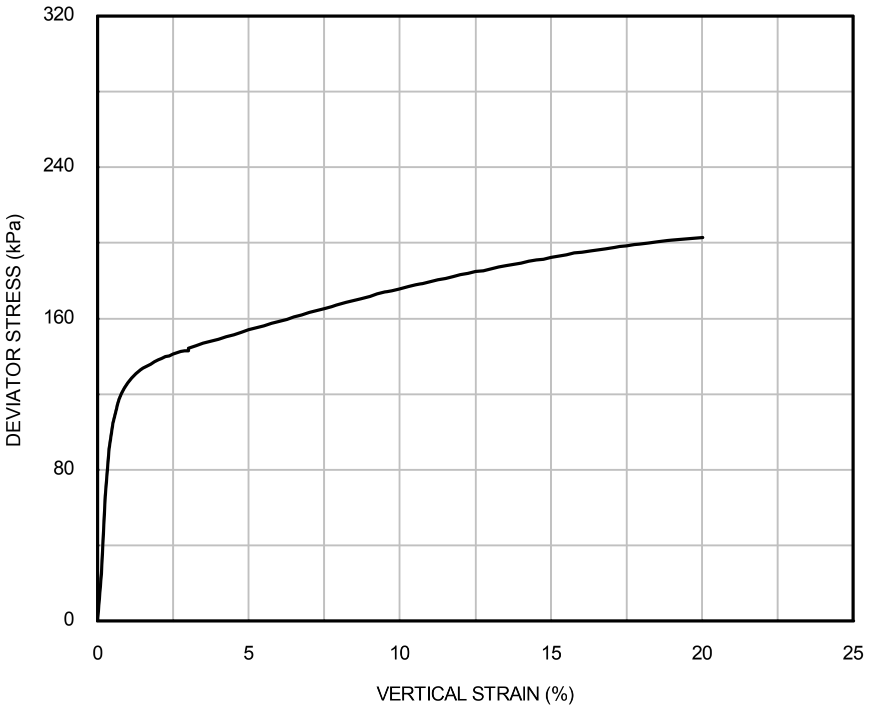
Date : 14/10/2016

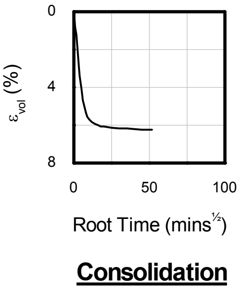
Date : 14/10/2016

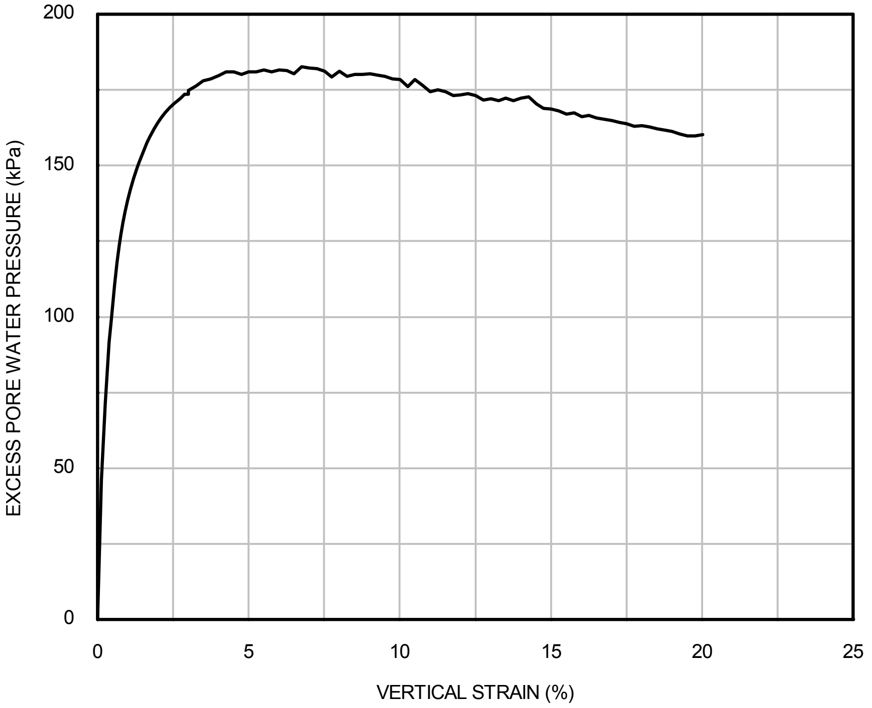
Checked by: PH

Approved by: PH



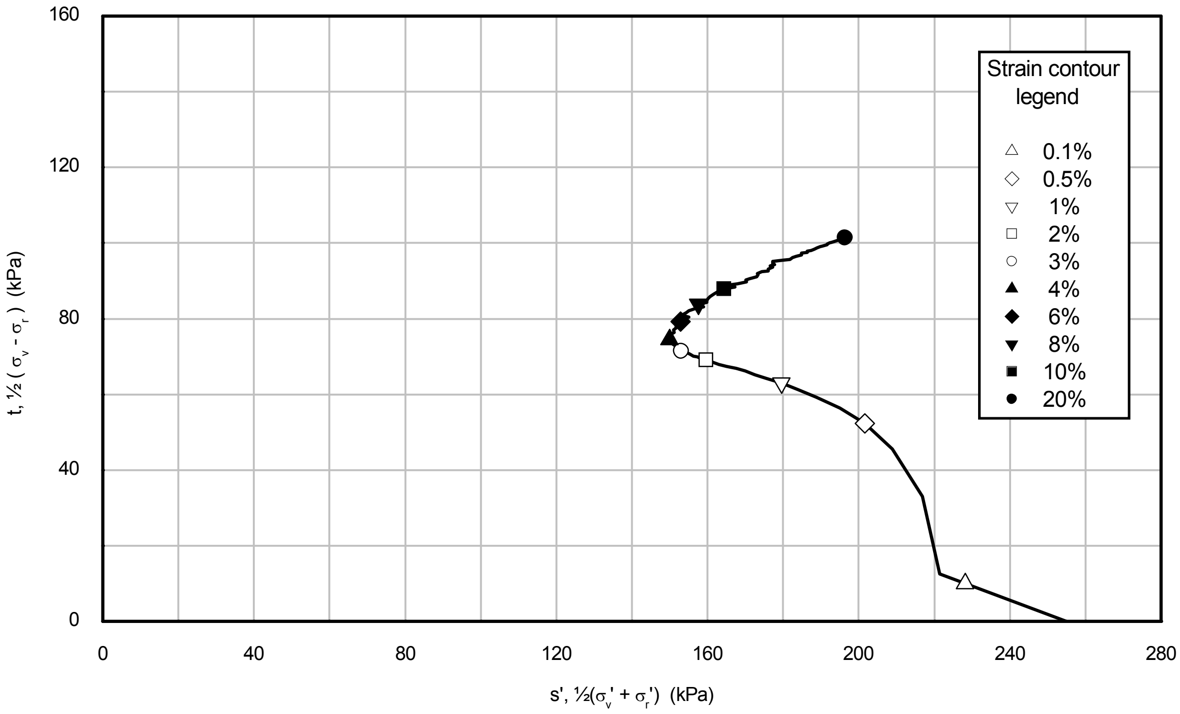


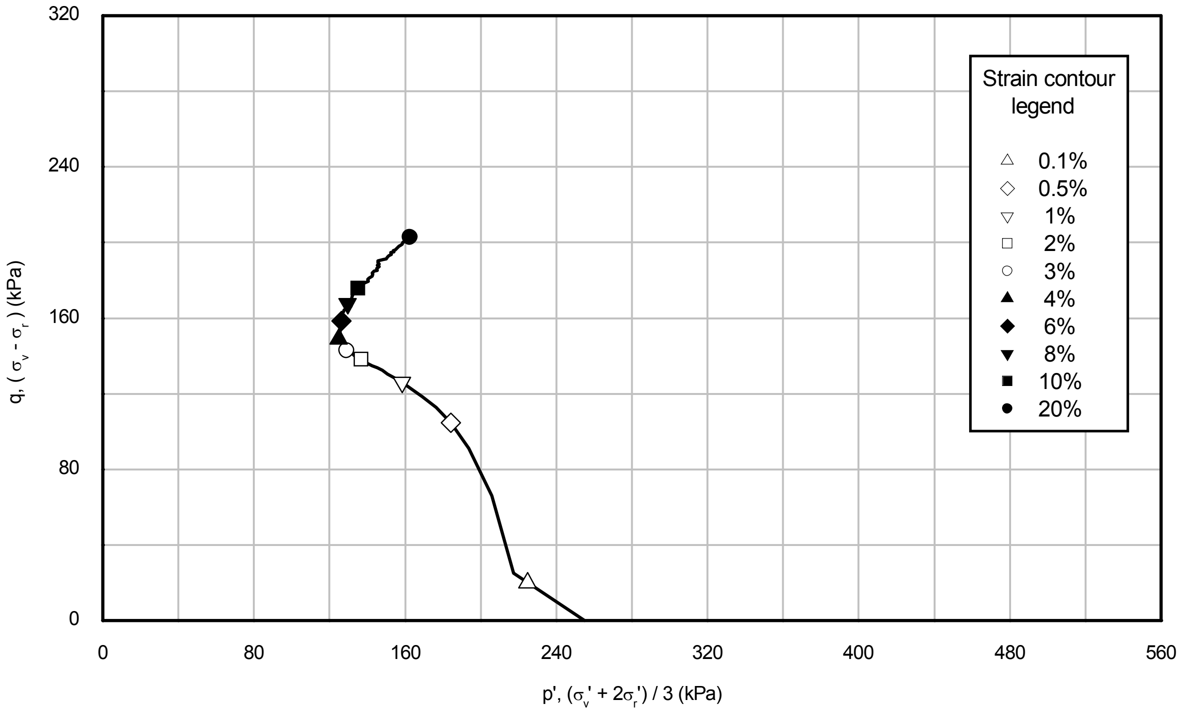




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	255	255	HKZ1 -BH05-SA	29BagC&D	24.90

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN



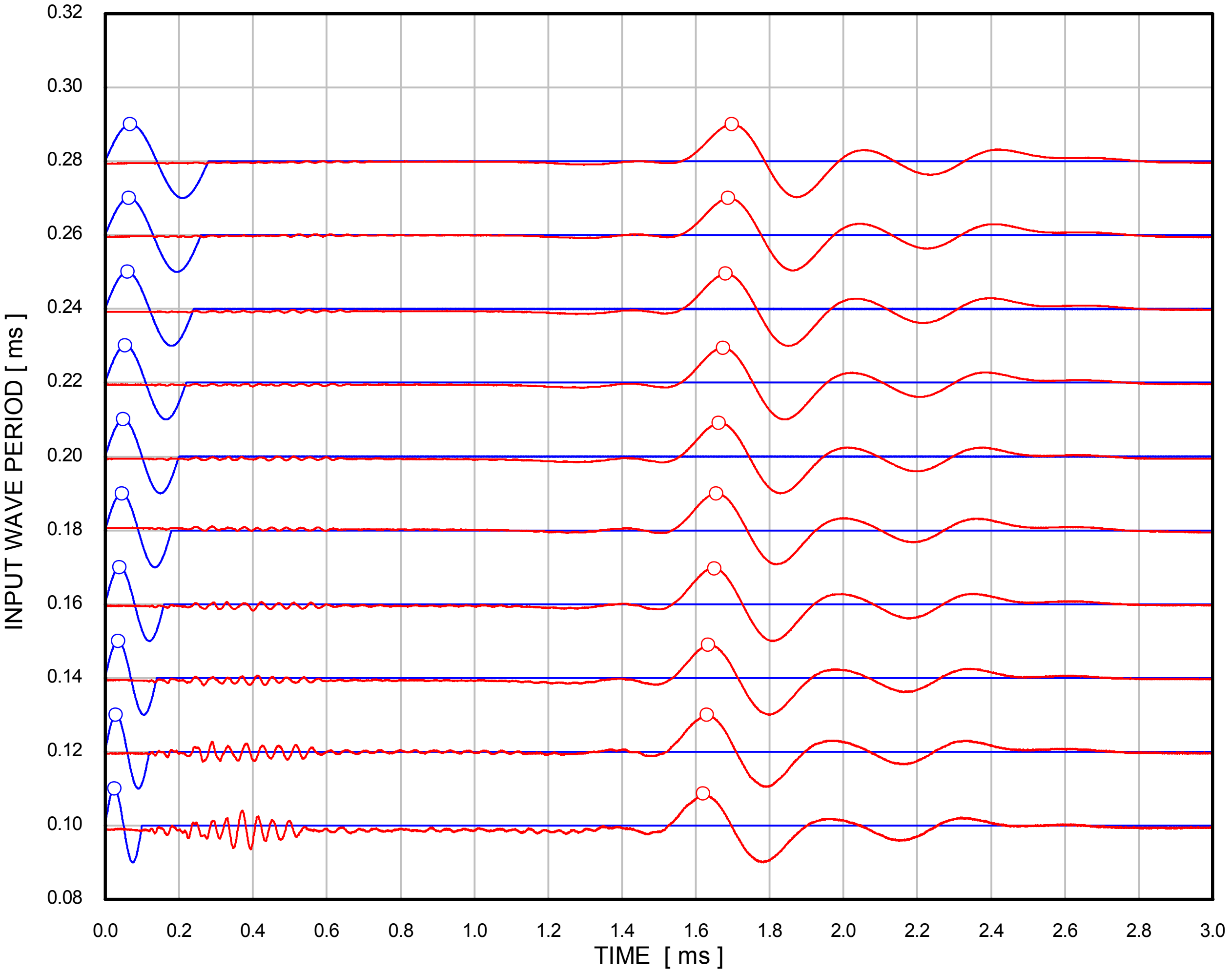


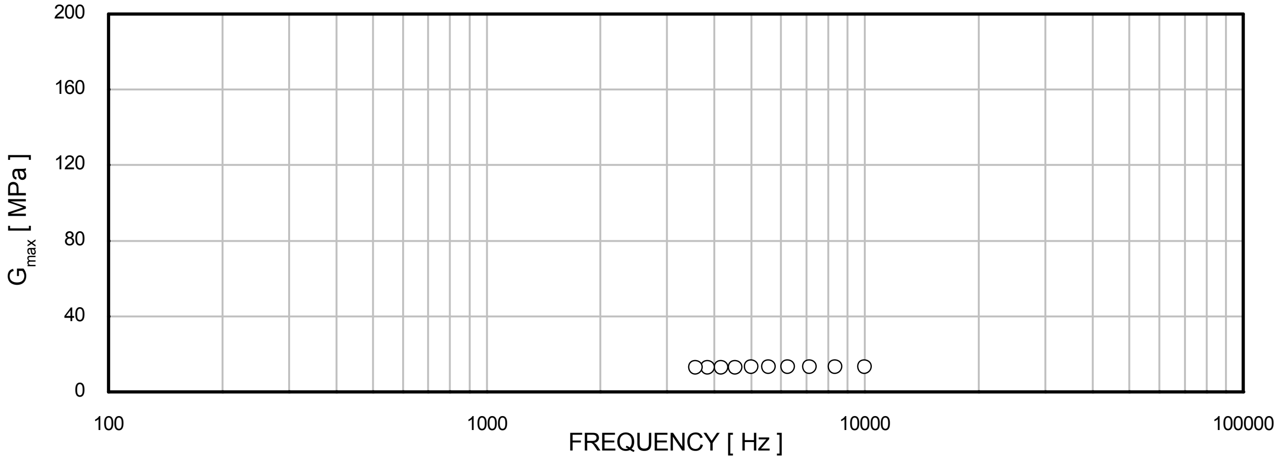
Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	255	255	HKZ1 -BH05-SA	29BagC&D	24.90

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Checked by: PH Date : 14/10/2016

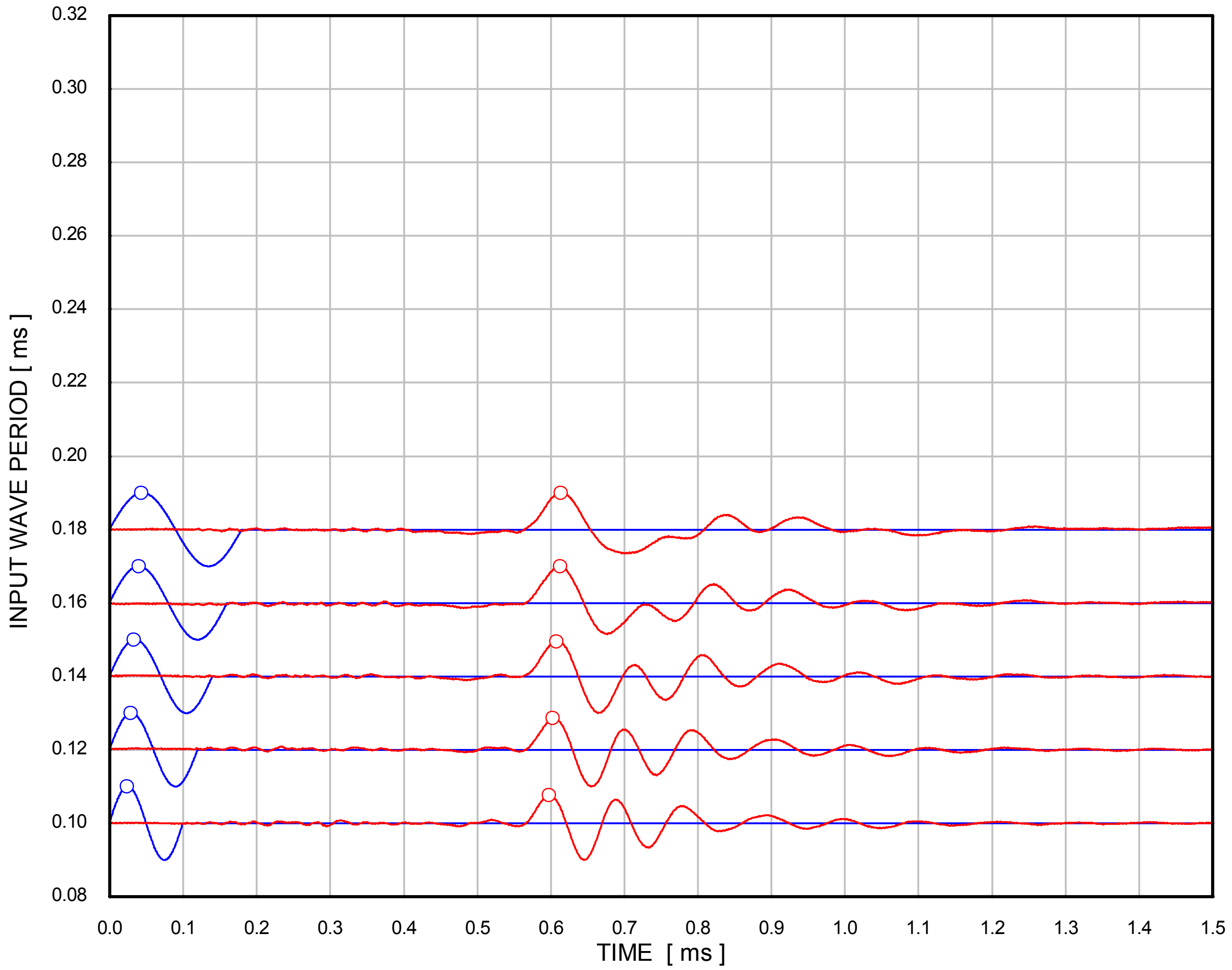
Approved by: PH Date : 14/10/2016

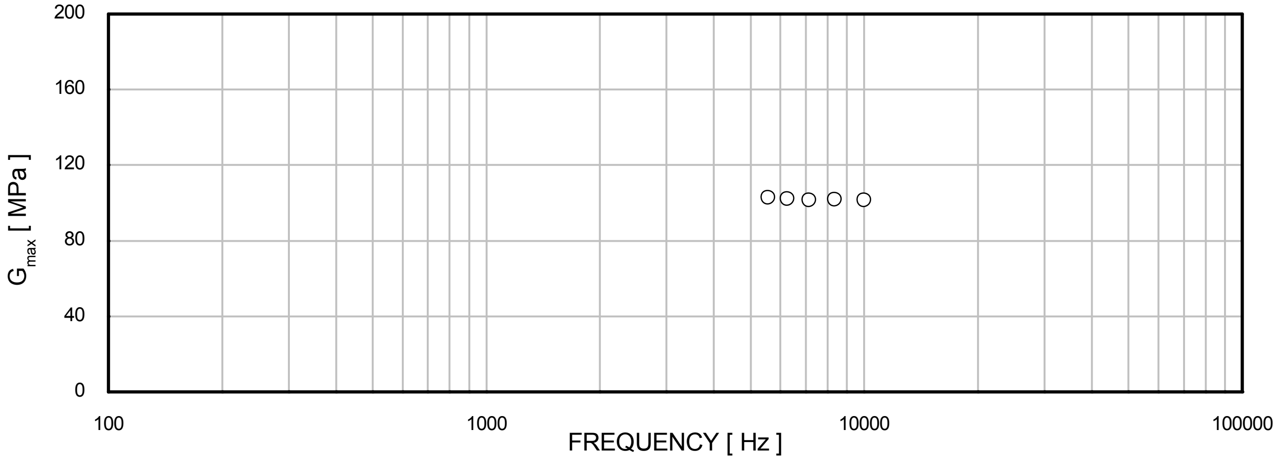




σ'_{rc}	: 11 kPa	Borehole	: HKZ1-BH05-SA
σ'_{ac}	: 11 kPa	Sample	: 29BagC&D
—	Source signal	Depth [m]	: 24.90
—	Received signal	Test No.	: 132
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc} : 255 kPa

σ'_{ac} : 255 kPa

― Source signal

― Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH05-SA

Sample : 29BagC&D

Depth [m] : 24.90

Test No. : 132

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
High strength dark grey CLAY with fine sand and silt

GENERAL		
Date test started		24/08/2016
Type of sample		Undisturbed
Specimen orientation		Vertical
Type of drains fitted		Radial & one end

INITIAL		
Diameter	(mm)	69.8
Length	(mm)	139.8
Water content	(%)	36.1
Bulk density	(Mg/m³)	1.86
Dry density	(Mg/m³)	1.37
Void ratio		0.975
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	551
Cell pressure on completion	(kPa)	560
B value achieved		0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA
Sample	20WaxC
Depth (m)	15.92

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	560
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	160
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	33.2
Bulk density	(Mg/m³)	1.90
Dry density	(Mg/m³)	1.42
Void ratio		0.897
Degree of saturation	(%)	100
Volumetric strain	(%)	3.97

Mode of failure: Plastic Failure

Borehole	HKZ1-BH06-SA
Sample	20WaxC
Depth (m)	15.92

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	160
Rate of strain	(%/hour)	0.83
At peak deviator stress		
Corrected deviator stress	(kPa)	209
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	8.51
Excess pore pressure	(kPa)	87
Major principal effective stress	(kPa)	282
Minor principal effective stress	(kPa)	73
Principal effective stress ratio		3.89
Epsilon 50 (ε 50)	(%)	0.63
Secant modulus (E50) at ε 50	(kPa)	16754
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	204
Membrane correction applied	(kPa)	0.5
Drain correction applied	(kPa)	0
Axial strain	(%)	4.26
Excess pore pressure	(kPa)	94
Major principal effective stress	(kPa)	270
Minor principal effective stress	(kPa)	66
Principal effective stress ratio		4.08
At 15% axial strain		
Corrected deviator stress	(kPa)	201
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	87
Major principal effective stress	(kPa)	274
Minor principal effective stress	(kPa)	73
Principal effective stress ratio		3.74

FINAL CONDITIONS		
Water content	(%)	33.2
Bulk density	(Mg/m³)	1.90
Dry density	(Mg/m³)	1.42

Borehole	HKZ1-BH06-SA
Sample	20WaxC
Depth (m)	15.92

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 30/08/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_20WaxC_CU.XLS
Checked by: MSR Date: 31/08/2016
Approved by: PH Date: 05/09/2016

SPECIMEN PHOTOGRAPHS

Borehole	HKZ1-BH06-SA
Sample	20WaxC
Depth (m)	15.92

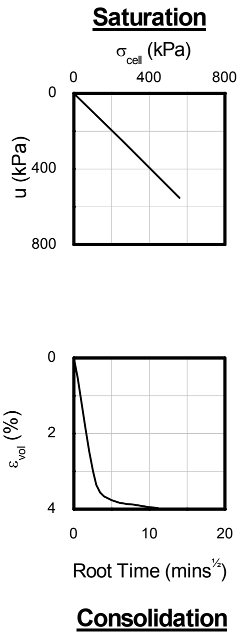
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

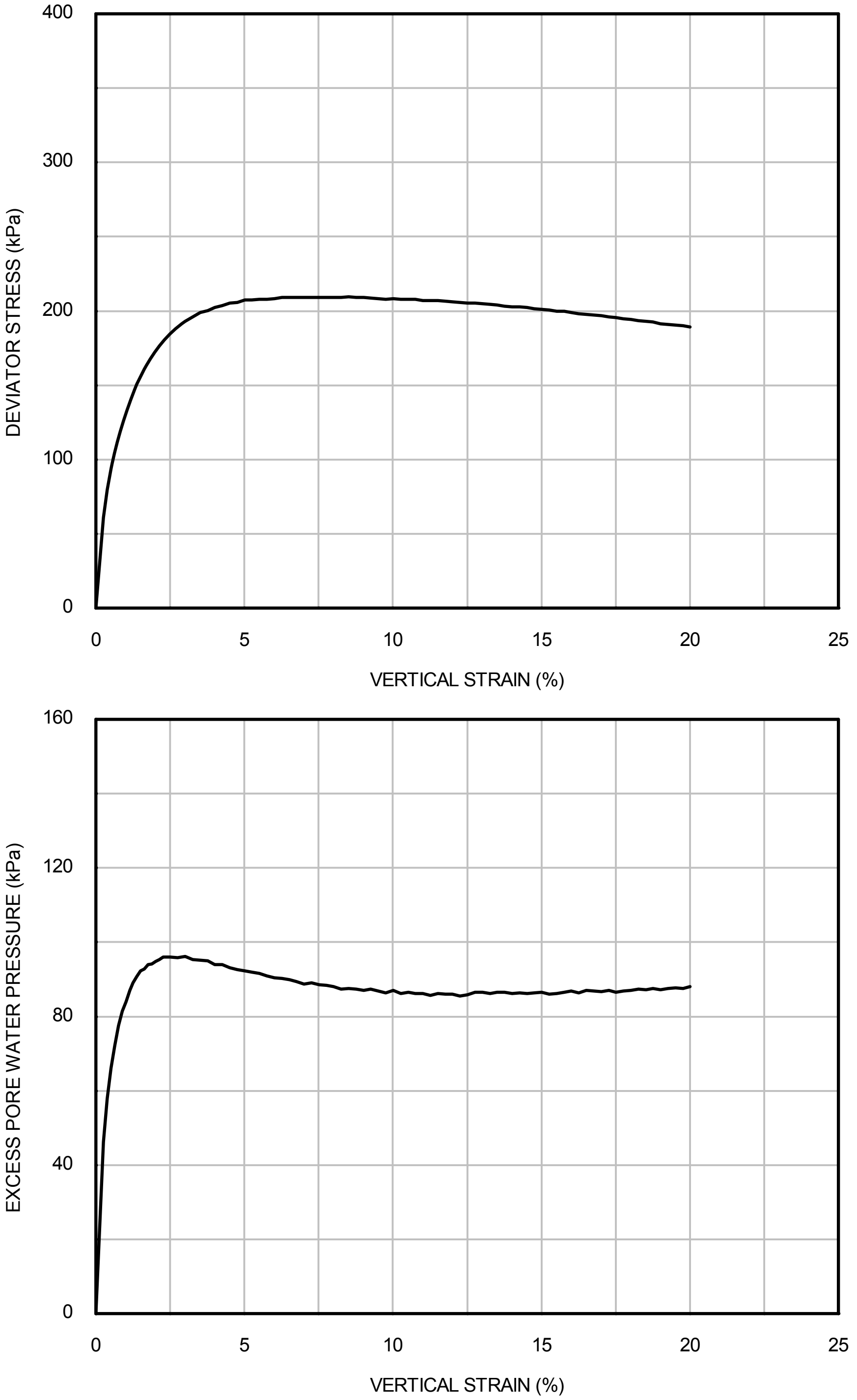
Drawn by: ALB Date: 30/08/2016

Template Issue: 4.1 Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_20WaxC_CU.OPJ

Date :31/08/2016 Date : 05/09/2016

Checked by: MSR Approved by: PH





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	160	160	HKZ1-BH06-SA	20WaxC	15.92

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

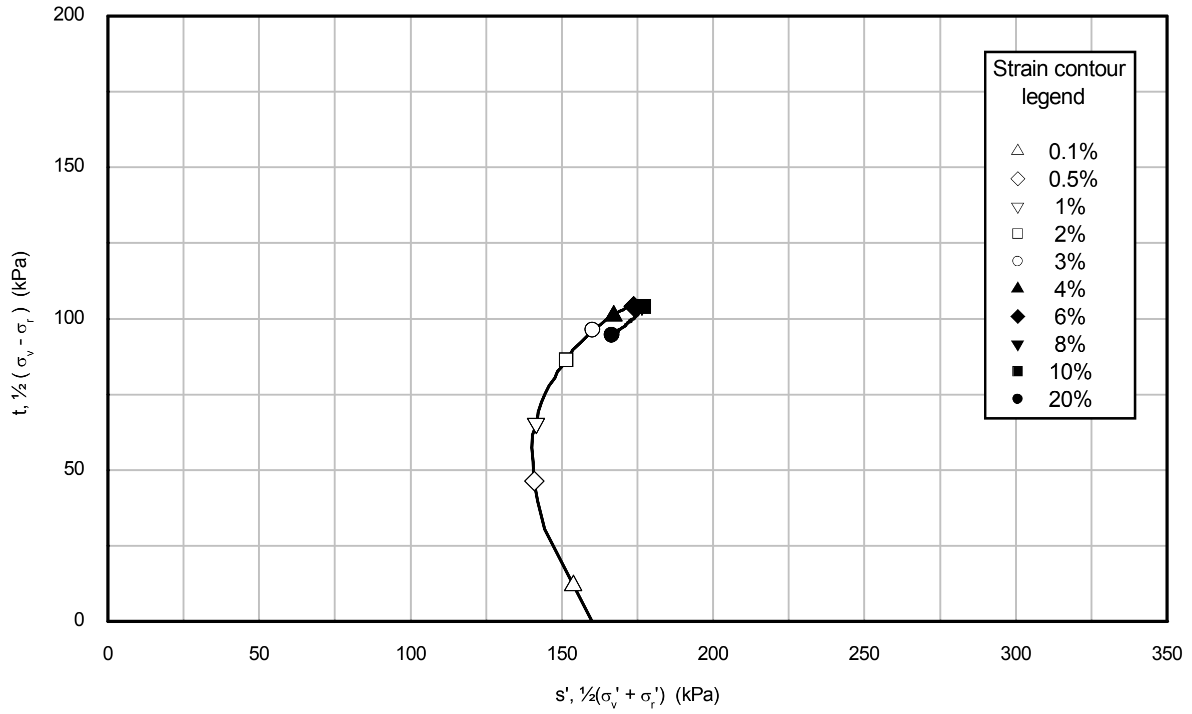
Drawn by: ALB Date: 30/08/2016

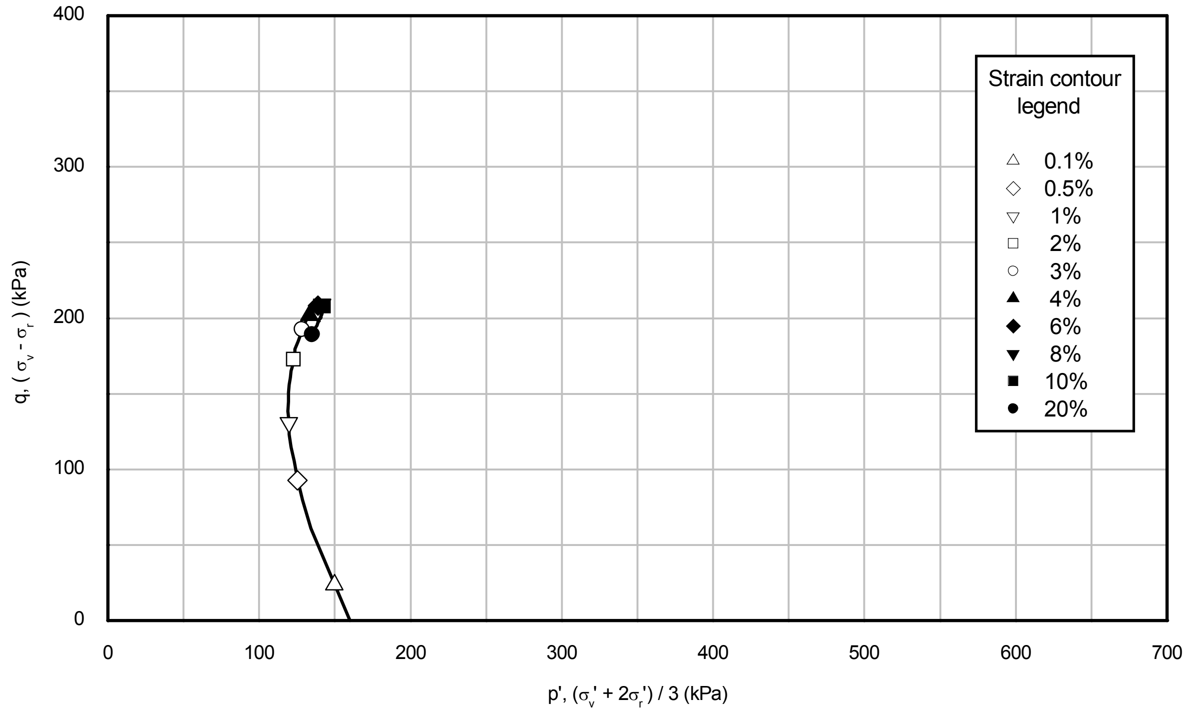
Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_20WaxC_CU.OPJ

Checked by: MSR Date : 05/09/2016

Approved by: PH Date : 05/09/2016





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	160	160	HKZ1-BH06-SA	20WaxC	15.92

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

VISUAL DESCRIPTION
Very high strength dark grey CLAY with fine sand, silt and black staining

GENERAL	
Date test started	09/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	[mm]	69.3
Length	[mm]	139.7
Water content	[%]	29.2
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.56
Void ratio		0.734
Degree of saturation	[%]	100

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	N/A
Pore pressure on completion	[kPa]	629
Cell pressure on completion	[kPa]	630
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA
Sample	30WaxB
Depth [m]	25.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 16/09/2016

Drawn by: MSR

Template Issue: 3

Filename: J11335 / EFFECTIVE / HKZ1-BH06-

Checked by: PH Date: 04/10/2016

Approved by: PH Date: 04/10/2016

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	630
Back pressure	[kPa]	400
Effective cell pressure	[kPa]	230
Pore pressure on completion	[kPa]	400
Pore pressure dissipation	[%]	100
Water content	[%]	23.7
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.70
Void ratio		0.585
Degree of saturation	[%]	100
Volumetric strain	[%]	8.56
Axial strain	[%]	2.85

Borehole	HKZ1-BH06-SA
Sample	30WaxB
Depth [m]	25.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 16/09/2016 Drawn by: MSR Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH06- Checked by: PH Date: 04/10/2016 Approved by: PH Date: 04/10/2016

BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Bulk density	[Mg/m^3]	2.01
Dry density	[Mg/m^3]	1.56
Void ratio	[-]	0.734
Distance	[mm]	136.8
Effective radial pressure	[kPa]	1
Effective axial pressure	[kPa]	1

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.50	2.9280	5.86	46.71	4.4
0.55	2.9395	5.34	46.53	4.4
0.60	2.9635	4.94	46.15	4.3
0.65	2.9685	4.57	46.08	4.3
0.70	2.9775	4.25	45.94	4.2
0.75	2.9980	4.00	45.62	4.2
0.80	3.0180	3.77	45.32	4.1
0.85	3.0275	3.56	45.18	4.1
0.90	3.0425	3.38	44.96	4.1
0.95	3.0465	3.21	44.90	4.1

Borehole	HKZ1-BH06-SA
Sample	30WaxB
Depth [m]	25.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 16/09/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH06-
Checked by: PH Date: 04/10/2016
Approved by: PH Date: 04/10/2016

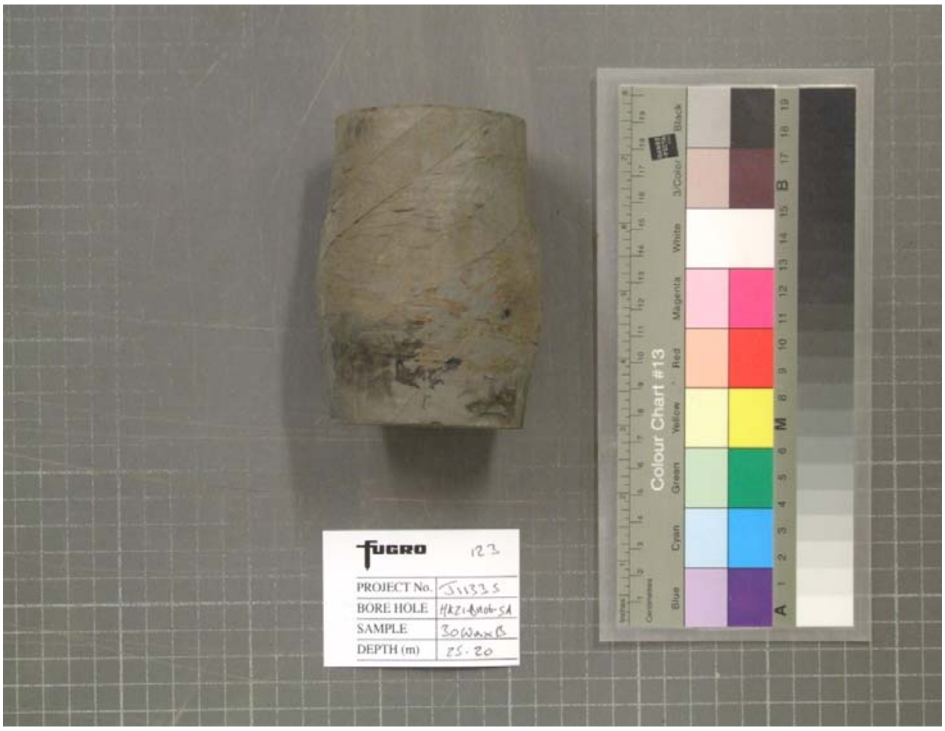
SHEARING		
Initial pore pressure	[kPa]	400
Initial effective cell pressure	[kPa]	230
Rate of strain	[%/hour]	0.43
At peak deviator stress		
Corrected deviator stress	[kPa]	315
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	17.03
Excess pore pressure	[kPa]	138
Major principal effective stress	[kPa]	407
Minor principal effective stress	[kPa]	92
Principal effective stress ratio		4.42
Epsilon 50 [ε 50]	[%]	1.02
Secant modulus [E50] at ε 50	[kPa]	15374
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	306
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
Axial strain	[%]	12.77
Excess pore pressure	[kPa]	144
Major principal effective stress	[kPa]	392
Minor principal effective stress	[kPa]	86
Principal effective stress ratio		4.56
At 15% axial strain		
Corrected deviator stress	[kPa]	312
Membrane correction applied	[kPa]	1.2
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	140
Major principal effective stress	[kPa]	402
Minor principal effective stress	[kPa]	90
Principal effective stress ratio		4.47

FINAL CONDITIONS		
Water content	[%]	23.7
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.70

Borehole	HKZ1-BH06-SA
Sample	30WaxB
Depth [m]	25.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SPECIMEN PHOTOGRAPHS



Borehole	HKZ1-BH06-SA
Sample	30WaxB
Depth [m]	25.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 16/09/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ1-BH06-
Checked by: PH Date: 04/10/2016
Approved by: PH Date: 04/10/2016

Drawn by: MSR Date: 16/09/2016

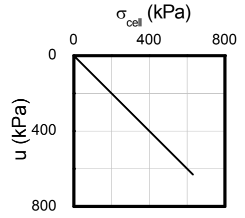
Template Issue: 4.1

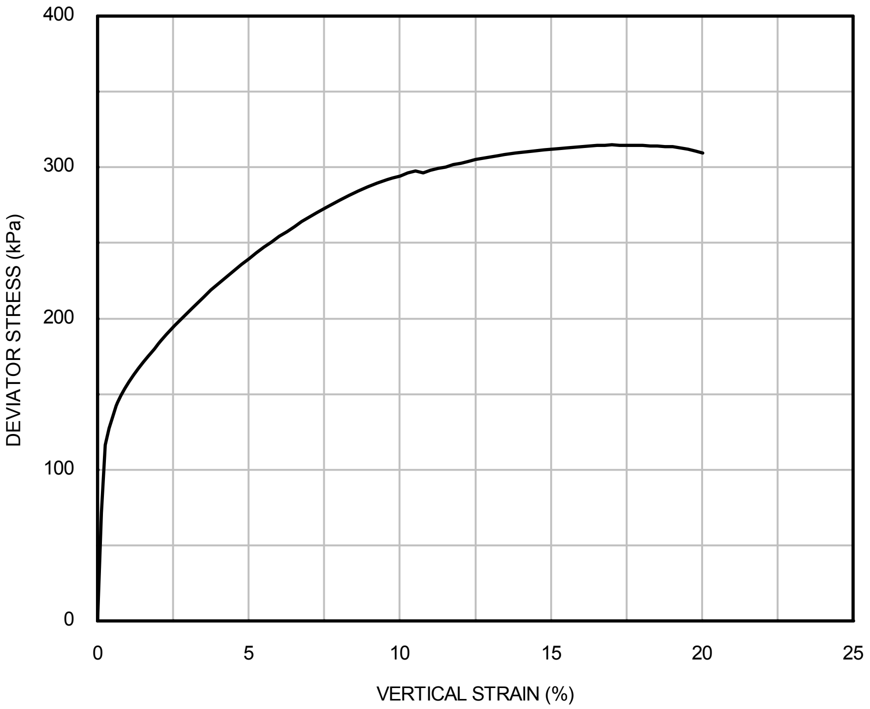
Filename: J11335 \ EFFECTIV \ HKZ2-BH21-SA_30WaxB_ca.OPJ

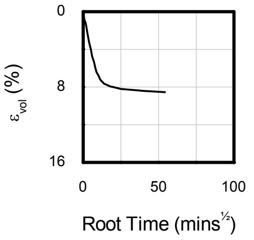
Checked by: PH Date : 15/09/2016

Approved by: PH Date : 15/09/2016

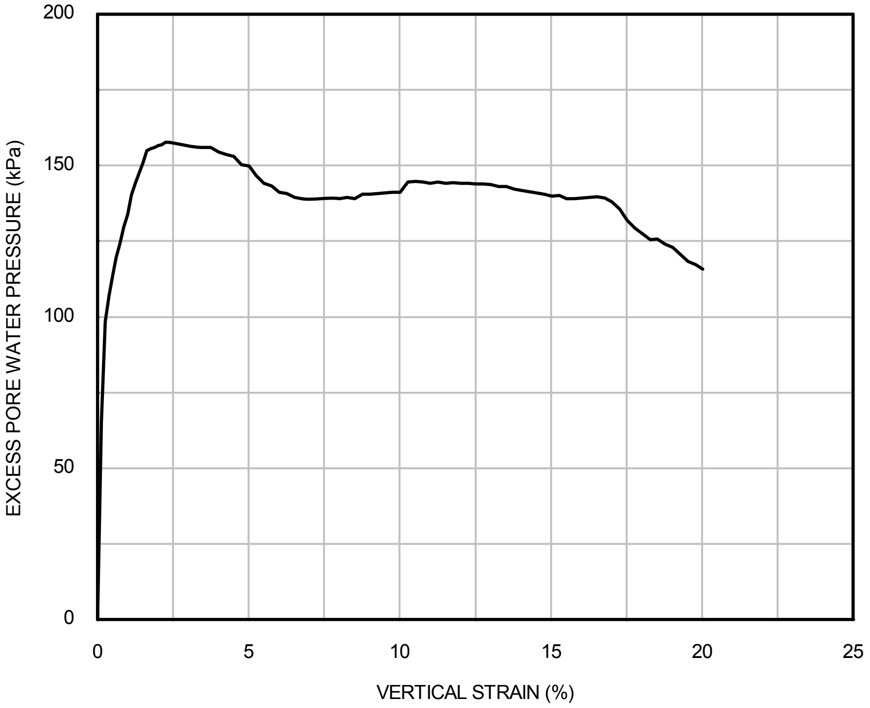
Saturation







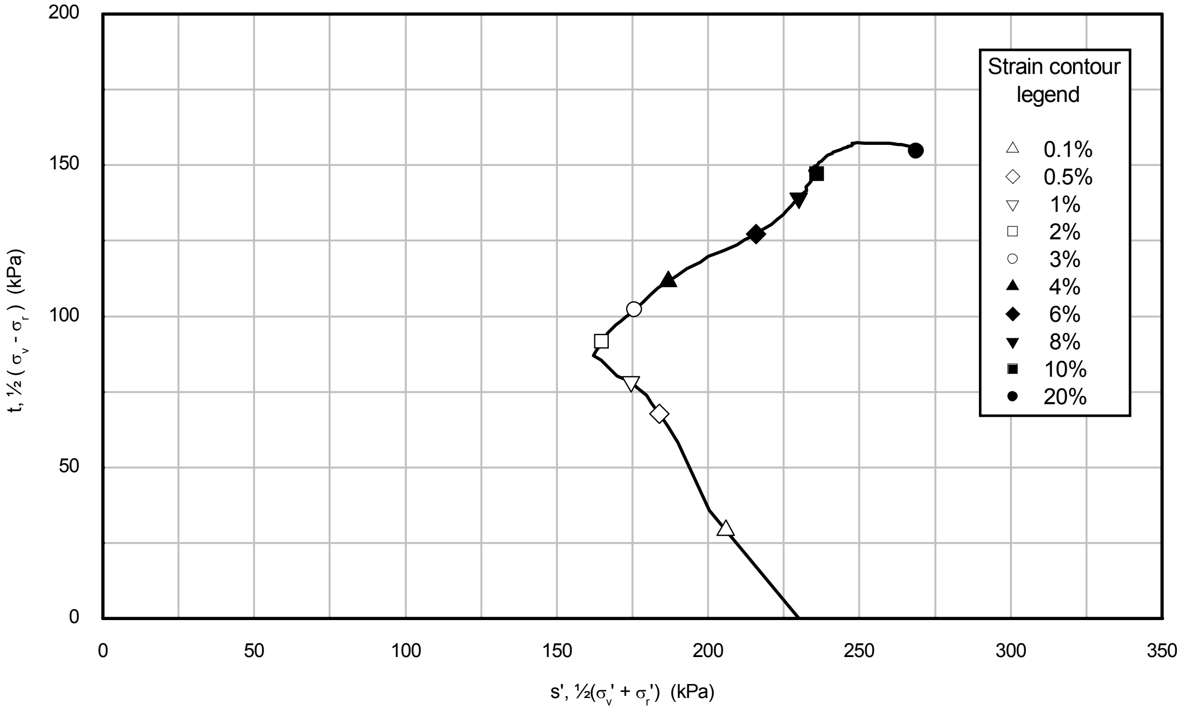
Consolidation

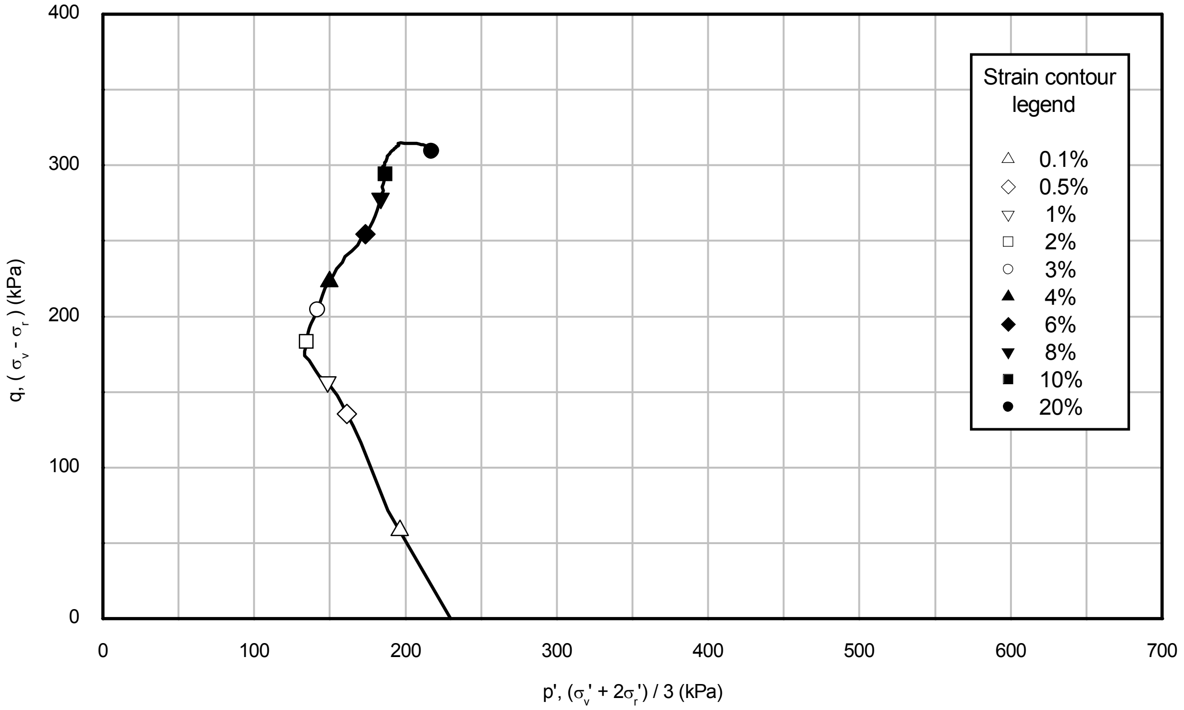


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
──	1	230	230	HKZ1-BH06 -SA	30WaxB	25.25

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 16/09/2016
Drawn by: MSR
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ2-BH21-SA_30WaxB_ca.OPJ
Date : 05/09/2016
Date : 05/09/2016
Checked by: PH
Approved by: PH

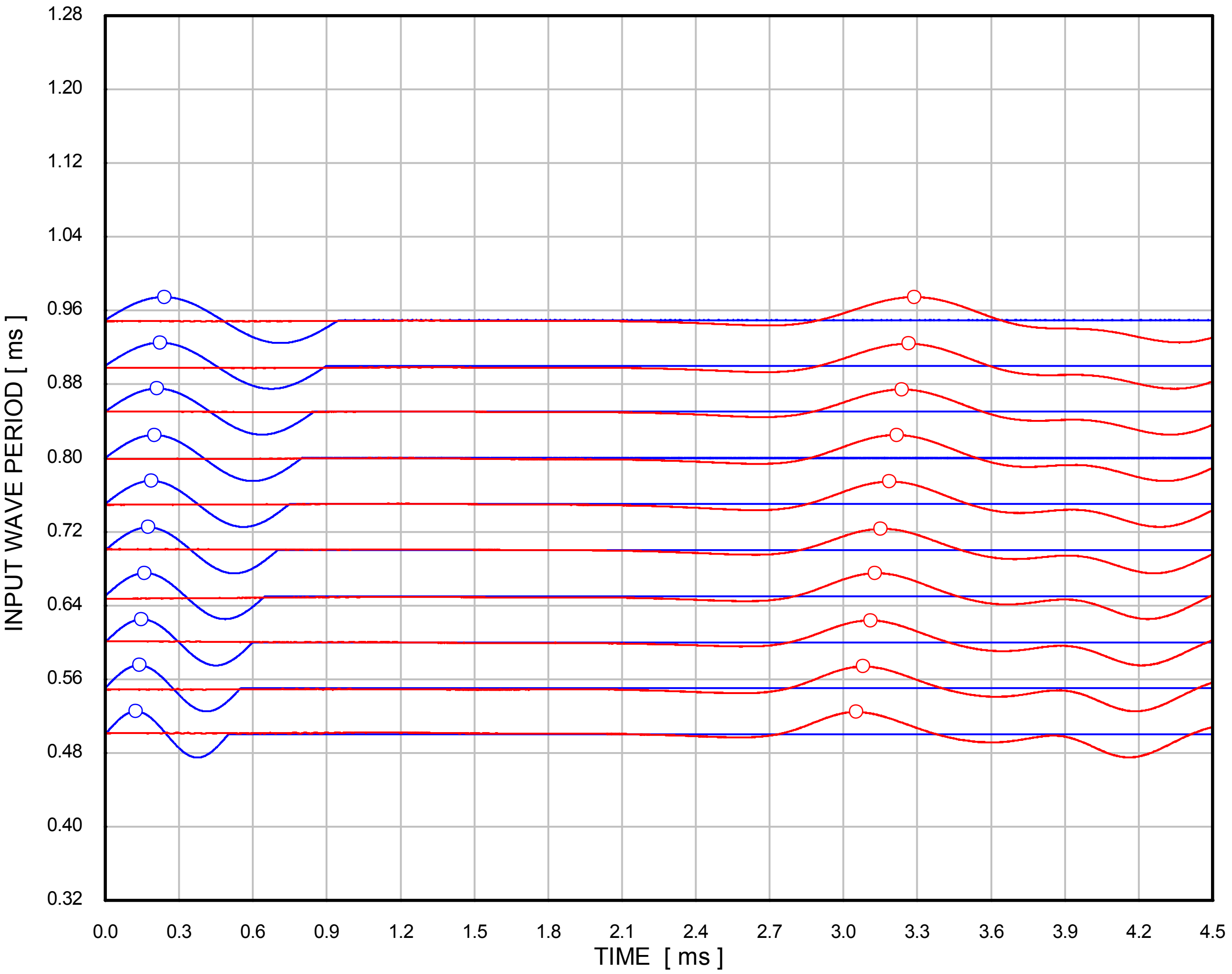


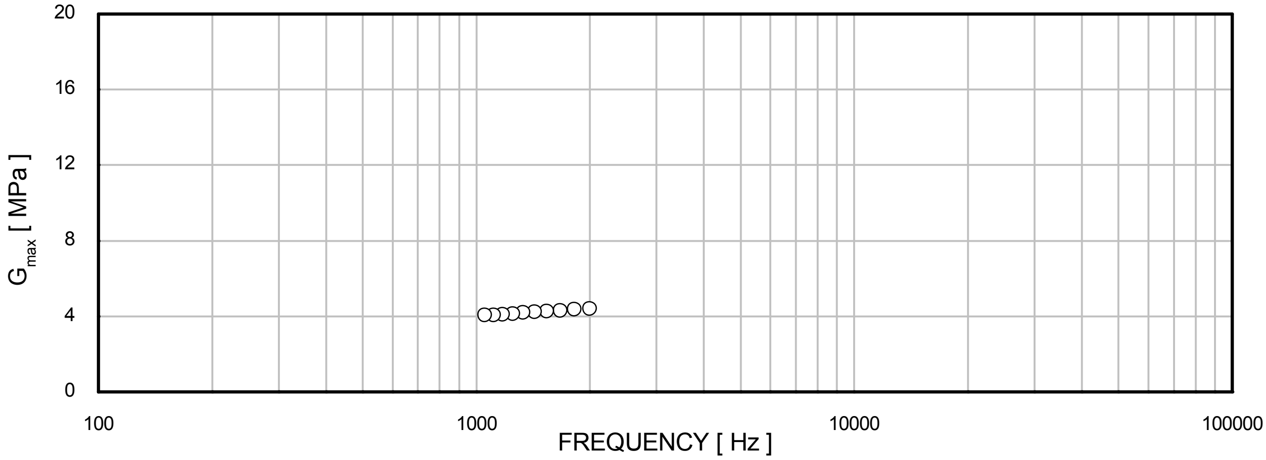


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	230	230	HKZ1-BH06 -SA	30WaxB	25.25

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

HOLLANDSE KUST (ZUID) WFZ, WFS I – DUTCH SECTOR, NORTH SEA





σ'_{rc}	: 1 kPa	Borehole	:	HKZ1-BH06-SA
σ'_{ac}	: 1 kPa	Sample	:	30WaxB
—	Source signal	Depth [m]	:	25.25
—	Received signal	Test No.	:	123
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Very high strength grey CLAY

GENERAL	
Date test started	20/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	[mm]	72.4
Length	[mm]	137.1
Water content	[%]	23.6
Bulk density	[Mg/m³]	2.05
Dry density	[Mg/m³]	1.66
Void ratio		0.628
Degree of saturation	[%]	100

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	N/A
Pore pressure on completion	[kPa]	819
Cell pressure on completion	[kPa]	835
B value achieved		0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Fugro testing procedure L-T-023 Clause 5.3.6
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA
Sample	46WaxA
Depth [m]	39.51

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 29/09/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ2-BH01-
Checked by: MSR Date: 30/09/2016
Approved by: PH Date: 04/10/2016

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	835
Back pressure	[kPa]	500
Effective cell pressure	[kPa]	335
Pore pressure on completion	[kPa]	500
Pore pressure dissipation	[%]	100
Water content	[%]	20.3
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.76
Void ratio		0.538
Degree of saturation	[%]	100
Volumetric strain	[%]	5.49
Axial strain	[%]	1.83

Borehole	HKZ1-BH06-SA
Sample	46WaxA
Depth [m]	39.51

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION

Bulk density	[Mg/m^3]	2.05
Dry density	[Mg/m^3]	1.66
Void ratio	[-]	0.628
Distance	[mm]	134.17
Effective radial pressure	[kPa]	16
Effective axial pressure	[kPa]	16

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.40	1.6610	4.15	80.78	13.4
0.45	1.6780	3.73	79.96	13.1
0.50	1.6875	3.38	79.51	13.0
0.55	1.7030	3.10	78.78	12.7

Borehole	HKZ1-BH06-SA
Sample	46WaxA
Depth [m]	39.51

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 29/09/2016
Drawn by: ALB
Template Issue: 3
Filename: J11335 / EFFECTIVE / HKZ2-BH01-
Date: 30/09/2016
Checked by: MSR
Date: 04/10/2016
Approved by: PH

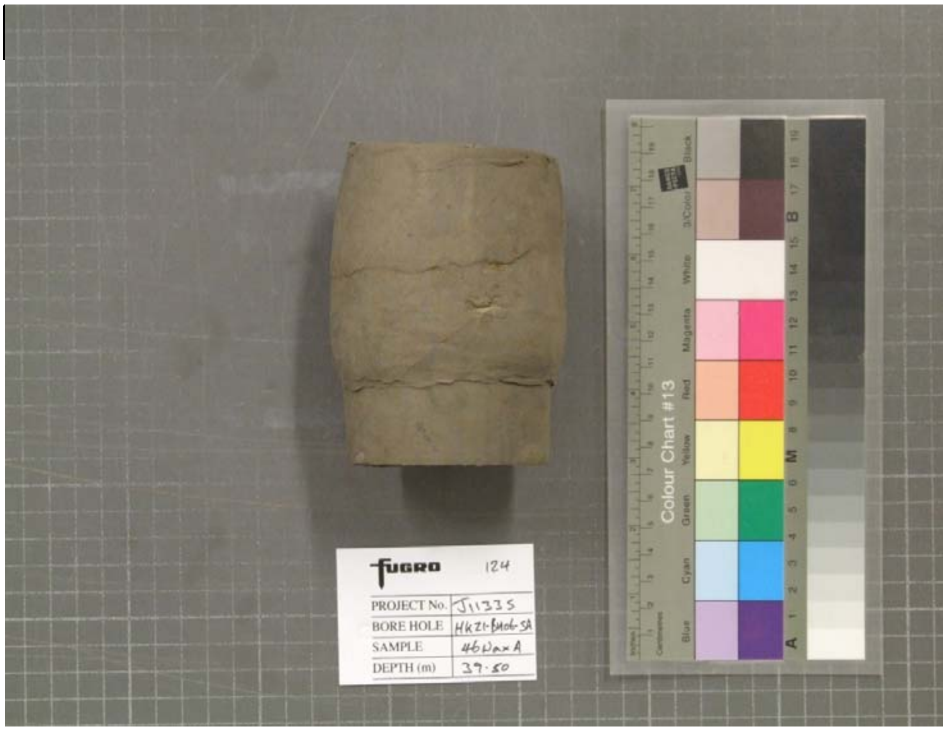
SHEARING		
Initial pore pressure	[kPa]	500
Initial effective cell pressure	[kPa]	335
Rate of strain	[%/hour]	0.50
At peak deviator stress		
Corrected deviator stress	[kPa]	444
Membrane correction applied	[kPa]	0.8
Drain correction applied	[kPa]	0
Axial strain	[%]	9.01
Excess pore pressure	[kPa]	141
Major principal effective stress	[kPa]	638
Minor principal effective stress	[kPa]	194
Principal effective stress ratio		3.29
Epsilon 50 [ε 50]	[%]	1.20
Secant modulus [E50] at ε 50	[kPa]	18576
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	429
Membrane correction applied	[kPa]	0.7
Drain correction applied	[kPa]	0
Axial strain	[%]	7.01
Excess pore pressure	[kPa]	168
Major principal effective stress	[kPa]	596
Minor principal effective stress	[kPa]	167
Principal effective stress ratio		3.56
At 15% axial strain		
Corrected deviator stress	[kPa]	419
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	119
Major principal effective stress	[kPa]	635
Minor principal effective stress	[kPa]	216
Principal effective stress ratio		2.94

FINAL CONDITIONS		
Water content	[%]	20.3
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.76

Borehole	HKZ1-BH06-SA
Sample	46WaxA
Depth [m]	39.51

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SPECIMEN PHOTOGRAPHS



Borehole	HKZ1-BH06-SA
Sample	46WaxA
Depth [m]	39.51

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Drawn by: ALB Date: 29/09/2016

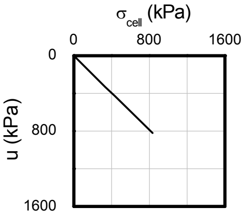
Template Issue: 4.1

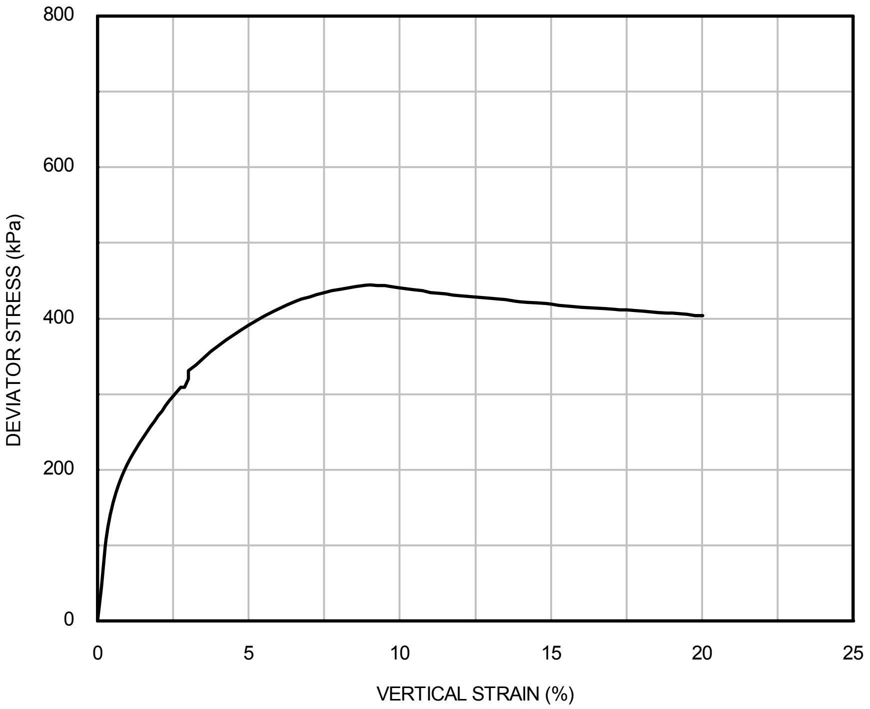
Filename: J11335 \ EFFECTIV \ HKZ2-BH01-SA_46WaxA_ca.OPJ

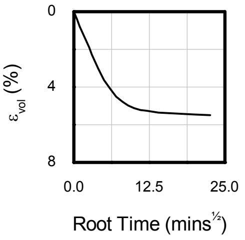
Checked by: PH Date : 04/10/2016

Approved by: PH Date : 04/10/2016

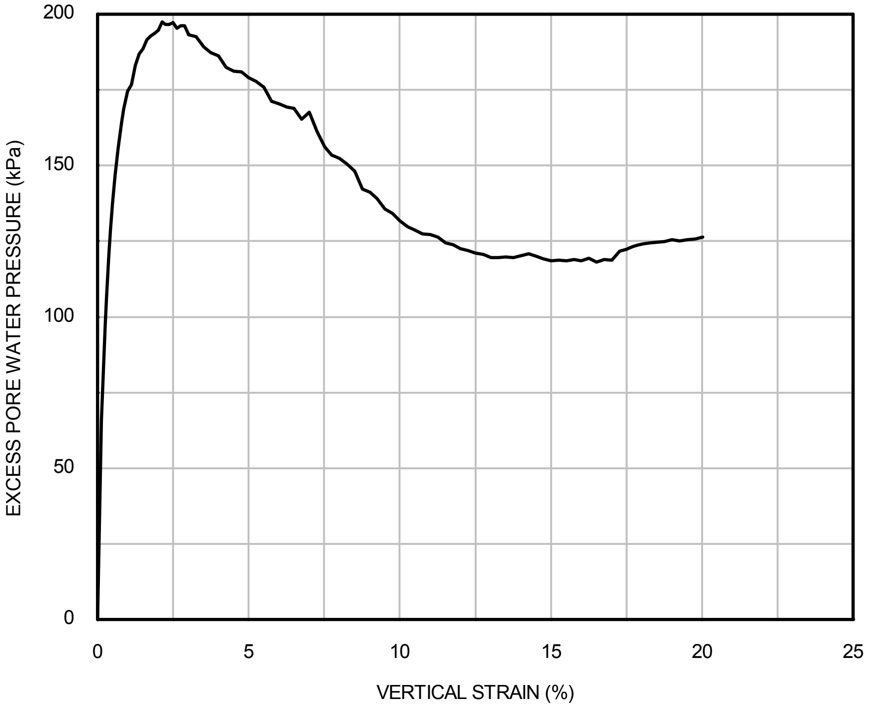
Saturation







Consolidation



Curve	Specimen	σ$_{rc}$' (kPa)	σ$_{vc}$' (kPa)	Borehole	Sample	Depth (m)
—	1	335	335	HKZ1-BH06-SA	46WaxA	39.51

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Drawn by: ALB Date: 29/09/2016

Template Issue: 4.1

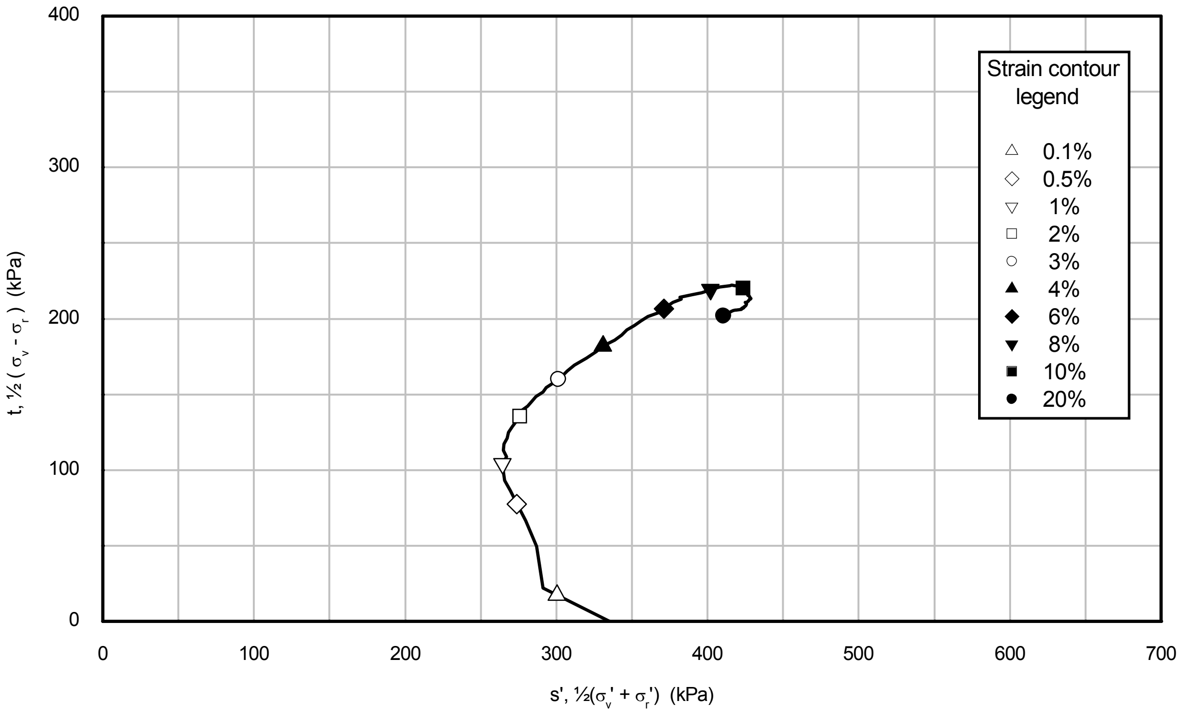
Filename: J11335 \ EFFECTIV \ HKZ2-BH01-SA_46WaxA_ca.OPJ

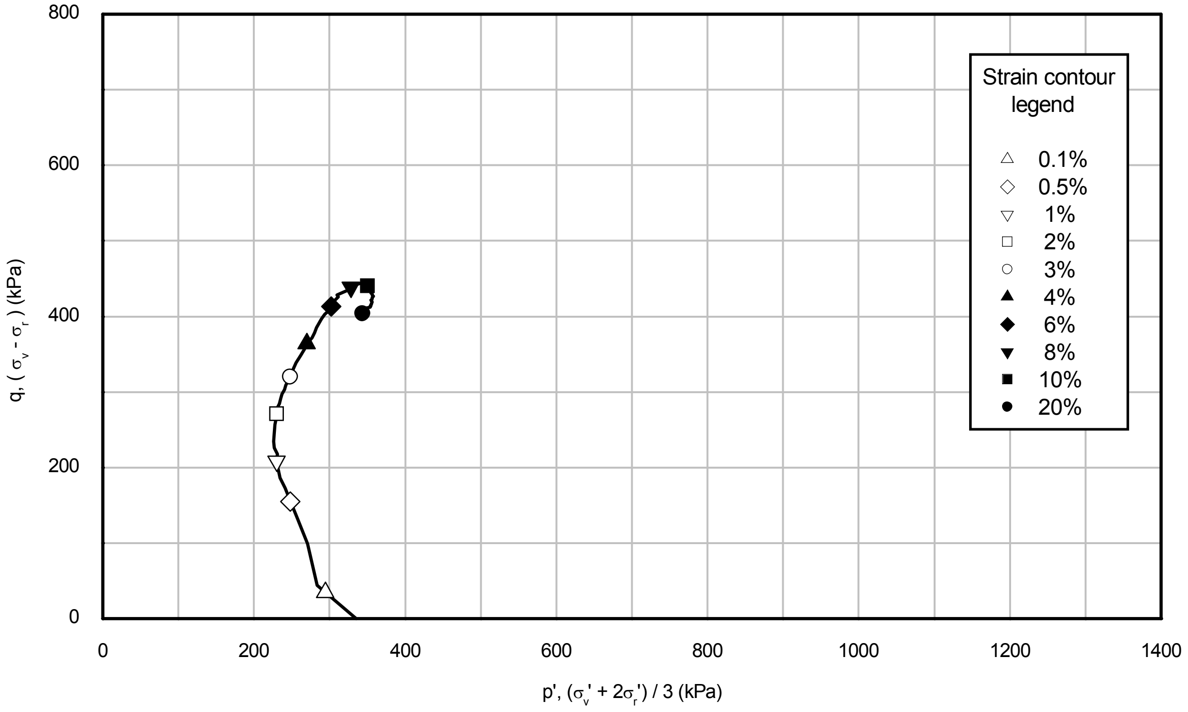
Date : 04/10/2016

Date : 04/10/2016

Checked by: PH

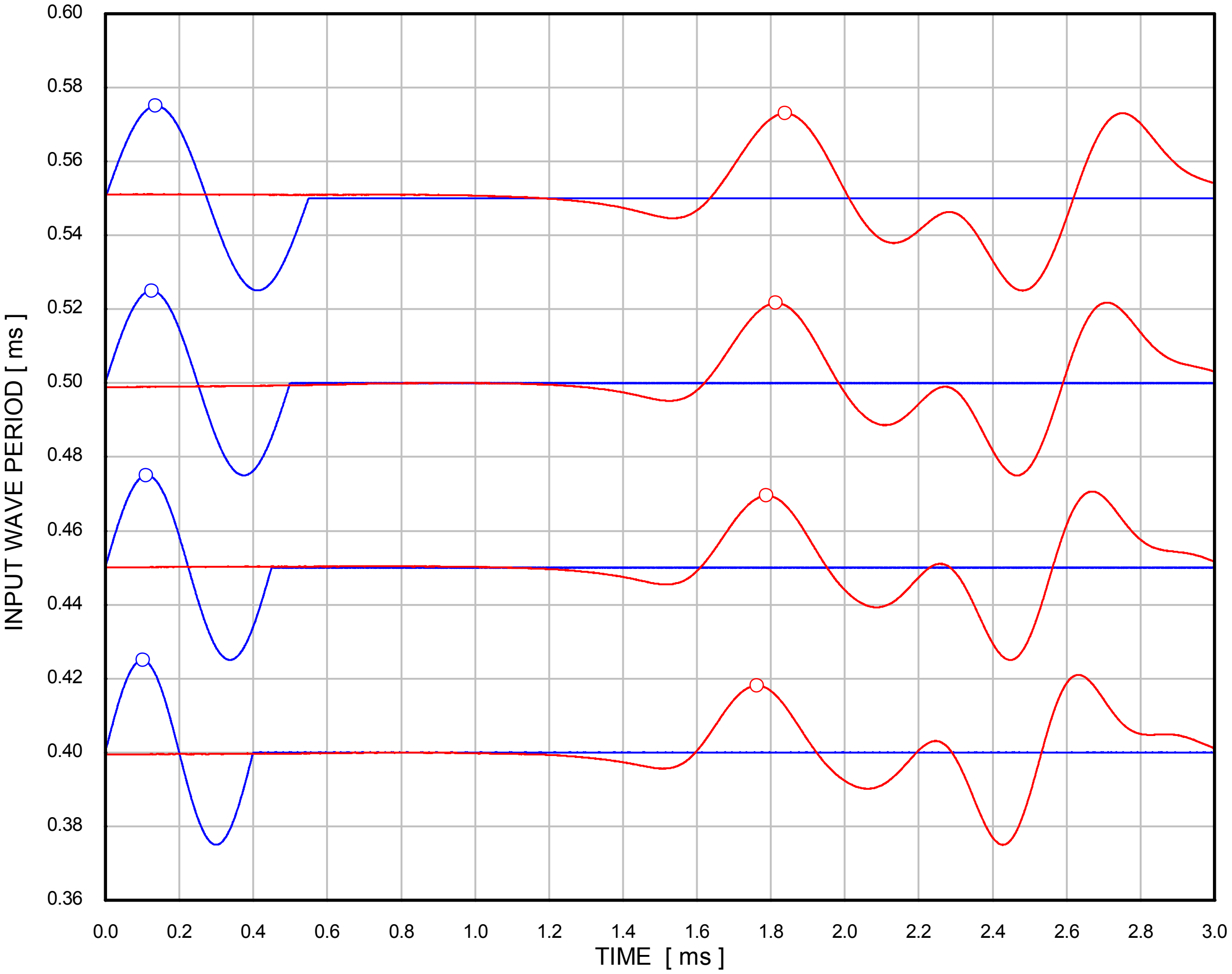
Approved by: PH

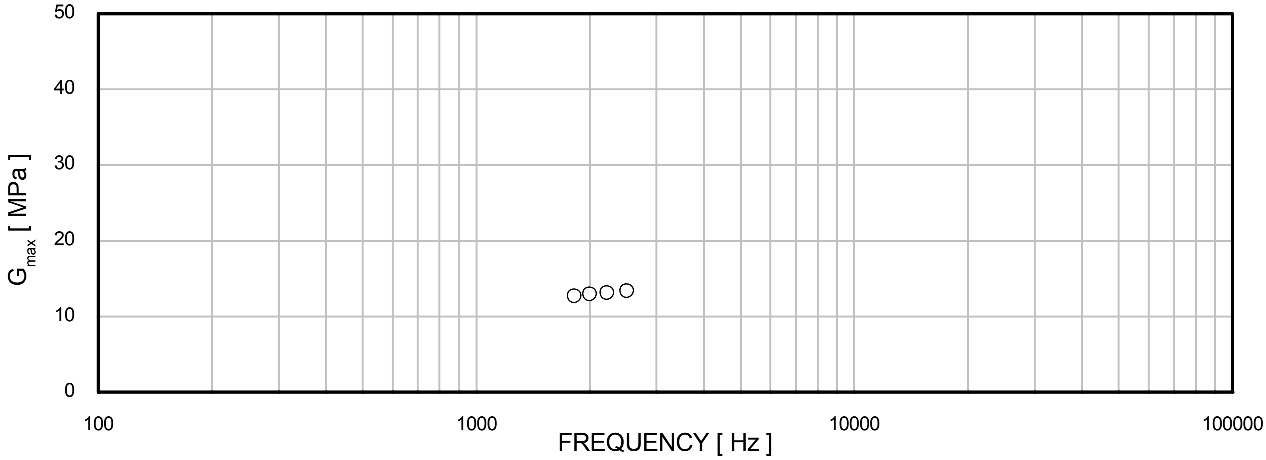




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	335	335	HKZ1-BH06 -SA	46WaxA	39.51

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





σ'$_{rc}$: 16 kPa

σ'$_{ac}$: 16 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH06-SA

Sample : 46WaxA

Depth [m] : 39.51

Test No. : 124

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 01/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_57WaxD_CU.XLS
Checked by: MSR Date: 02/09/2016
Approved by: PH Date: 05/09/2016

VISUAL DESCRIPTION
Extremely high strength dark grey fine silty SAND

GENERAL	
Date test started	25/08/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.4
Length	(mm)	139.2
Water content	(%)	25.5
Bulk density	(Mg/m³)	2.03
Dry density	(Mg/m³)	1.62
Void ratio		0.638
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	843
Cell pressure on completion	(kPa)	845
B value achieved		0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.4
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA
Sample	57WaxD
Depth (m)	54.13

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 01/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_57WaxD_CU.XLS
Date: 02/09/2016
Checked by: MSR
Date: 05/09/2016
Approved by: PH

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	845
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	445
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Water content	(%)	21.2
Bulk density	(Mg/m³)	2.11
Dry density	(Mg/m³)	1.74
Void ratio		0.524
Degree of saturation	(%)	100
Volumetric strain	(%)	6.96

Mode of failure: Plastic failure

Borehole	HKZ1-BH06-SA
Sample	57WaxD
Depth (m)	54.13

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 01/09/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_57WaxD_CU.XLS Date: 02/09/2016 Checked by: MSR Date: 05/09/2016 Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	445
Rate of strain	(%/hour)	0.48
At peak deviator stress		
Corrected deviator stress	(kPa)	708
Membrane correction applied	(kPa)	1.7
Drain correction applied	(kPa)	0
Axial strain	(%)	19.50
Excess pore pressure	(kPa)	189
Major principal effective stress	(kPa)	963
Minor principal effective stress	(kPa)	256
Principal effective stress ratio		3.76
Epsilon 50 (ε 50)	(%)	1.81
Secant modulus (E50) at ε 50	(kPa)	19545
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	549
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	7.49
Excess pore pressure	(kPa)	269
Major principal effective stress	(kPa)	725
Minor principal effective stress	(kPa)	176
Principal effective stress ratio		4.11
At 15% axial strain		
Corrected deviator stress	(kPa)	676
Membrane correction applied	(kPa)	1.4
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	214
Major principal effective stress	(kPa)	907
Minor principal effective stress	(kPa)	231
Principal effective stress ratio		3.92

FINAL CONDITIONS		
Water content	(%)	21.2
Bulk density	(Mg/m³)	2.11
Dry density	(Mg/m³)	1.74

Borehole	HKZ1-BH06-SA
Sample	57WaxD
Depth (m)	54.13

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 01/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_57WaxD_CU.XLS
Checked by: MSR Date: 02/09/2016
Approved by: PH Date: 05/09/2016

SPECIMEN PHOTOGRAPHS

Borehole Sample Depth (m)	HKZ1-BH06-SA 57WaxD 54.13

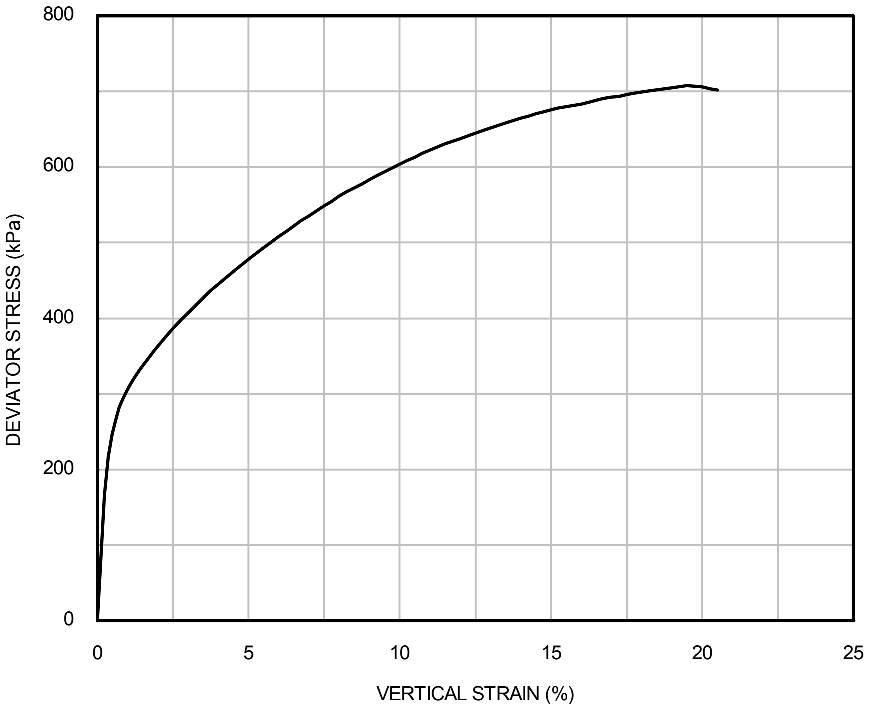
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 01/09/2016
Drawn by: ALB

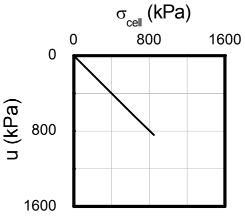
Template Issue: 4.1
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_57WaxD_CU.OPJ

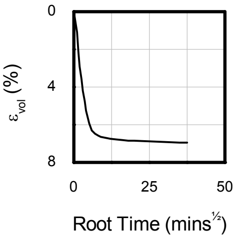
Date : 02/09/2016
Date : 05/09/2016

Checked by: MSR
Approved by: PH

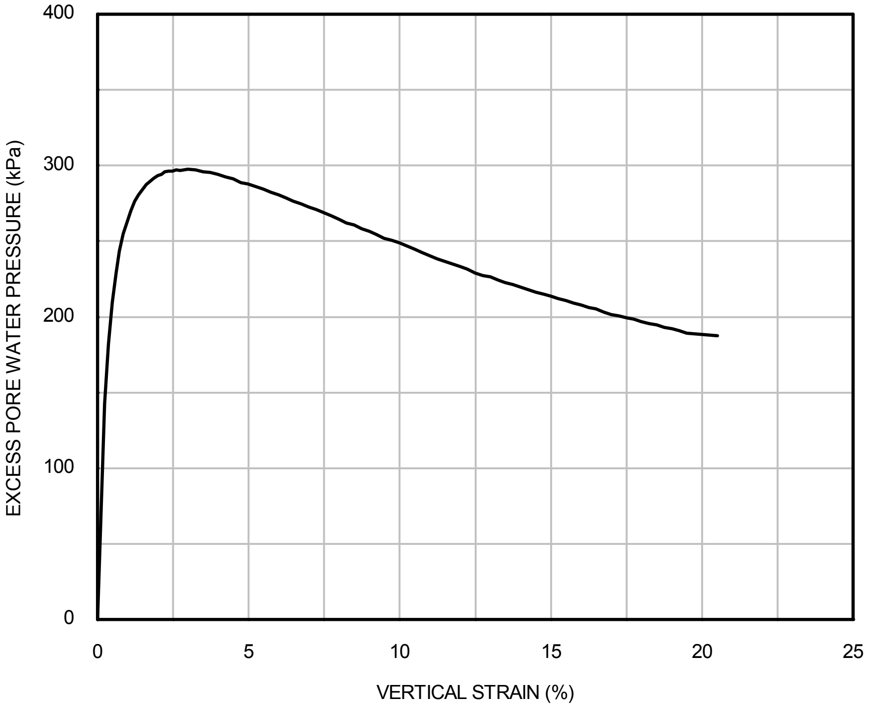


Saturation





Consolidation



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	445	445	HKZ1-BH06-SA	57WaxD	54.13

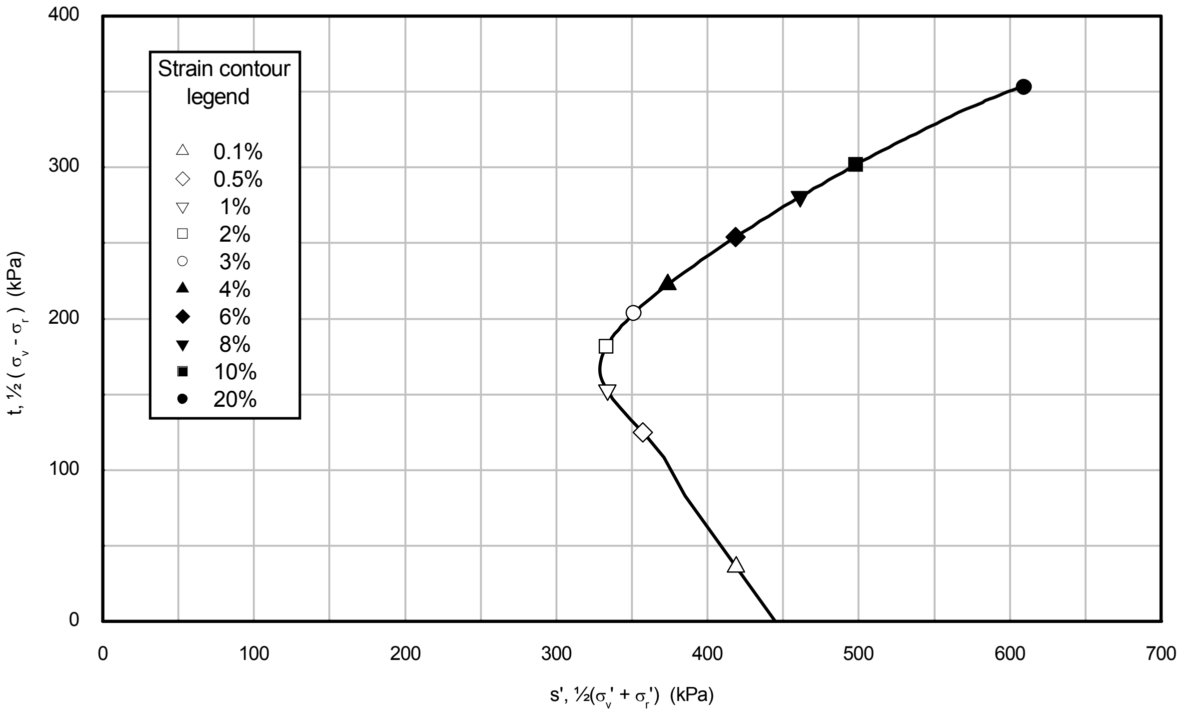
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

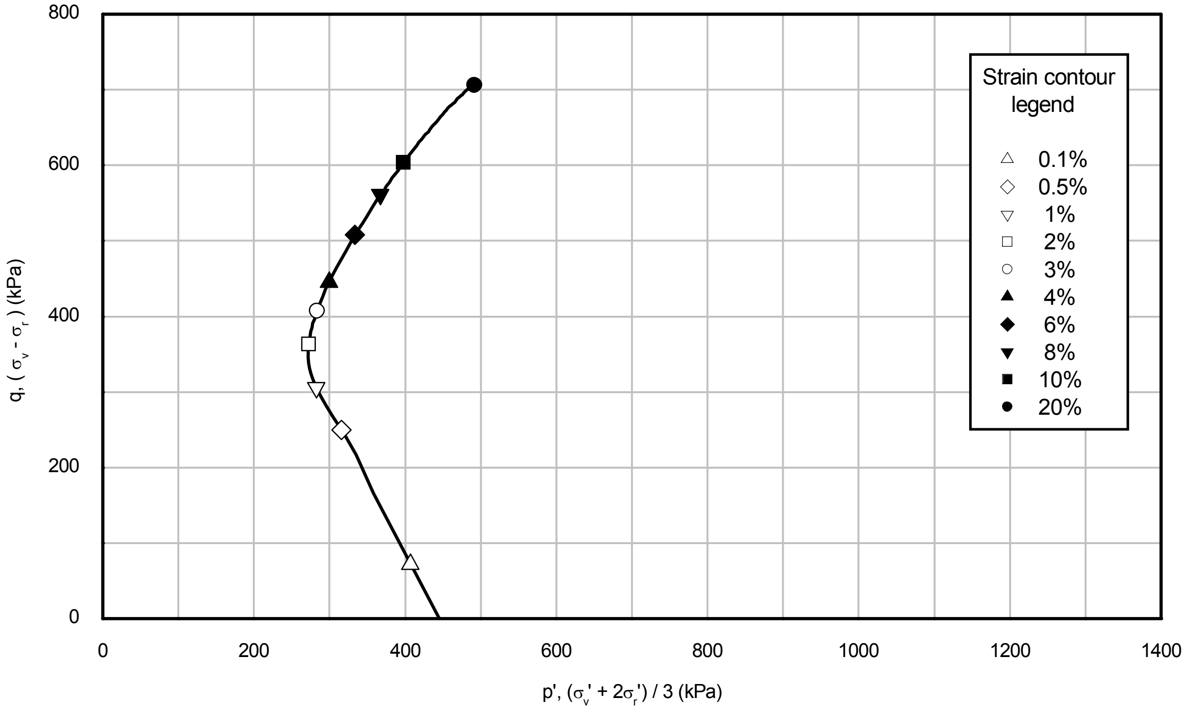
Drawn by: ALB Date: 01/09/2016

Template Issue: 4.1 Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_57WaxD_CU.OPJ

Date : 02/09/2016 Date : 05/09/2016

Checked by: MSR Approved by: PH





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	445	445	HKZ1-BH06-SA	57WaxD	54.13

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

VISUAL DESCRIPTION
High strength dark grey CLAY

GENERAL	
Date test started	09/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	[mm]	71.5
Length	[mm]	139.6
Water content	[%]	37.8
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.36
Void ratio		0.956
Degree of saturation	[%]	100

SATURATION		
Pressure increments applied	[kPa]	100
Differential pressure used	[kPa]	N/A
Pore pressure on completion	[kPa]	604
Cell pressure on completion	[kPa]	630
B value achieved		1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4
Saturation	BS 1377: Part 8: 1990: Clause 5.4 Fugro testing procedure L-T-023 Clause 5.3.7
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Fugro testing procedure L-T-023 Clause 5.3.6
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH08-SA
Sample	15WaxC
Depth [m]	13.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		
Cell pressure	[kPa]	630
Back pressure	[kPa]	500
Effective cell pressure	[kPa]	130
Pore pressure on completion	[kPa]	500
Pore pressure dissipation	[%]	100
Water content	[%]	36.7
Bulk density	[Mg/m³]	1.89
Dry density	[Mg/m³]	1.38
Void ratio		0.928
Degree of saturation	[%]	100
Volumetric strain	[%]	1.44
Axial strain	[%]	0.48

Borehole	HKZ1-BH08-SA
Sample	15WaxC
Depth [m]	13.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION

Bulk density	[Mg/m^3]	1.87
Dry density	[Mg/m^3]	1.36
Void ratio	[-]	0.956
Distance	[mm]	136.74
Effective radial pressure	[kPa]	26
Effective axial pressure	[kPa]	26

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	0.9465	4.73	144.47	39.1
0.22	0.9475	4.31	144.32	39.0
0.24	0.9535	3.97	143.41	38.5
0.26	0.9585	3.69	142.66	38.1

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION

Bulk density	[Mg/m^3]	1.89
Dry density	[Mg/m^3]	1.38
Void ratio	[-]	0.928
Distance	[mm]	136.07
Effective radial pressure	[kPa]	130
Effective axial pressure	[kPa]	130

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	0.6780	3.39	200.69	76.0
0.22	0.6820	3.10	199.51	75.1
0.24	0.6805	2.84	199.95	75.4
0.26	0.6825	2.62	199.36	75.0

Borehole	HKZ1-BH08-SA
Sample	15WaxC
Depth [m]	13.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

SHEARING		
Initial pore pressure	[kPa]	500
Initial effective cell pressure	[kPa]	130
Rate of strain	[%/hour]	0.48
At peak deviator stress		
Corrected deviator stress	[kPa]	230
Membrane correction applied	[kPa]	0.2
Drain correction applied	[kPa]	0
Axial strain	[%]	1.87
Excess pore pressure	[kPa]	71
Major principal effective stress	[kPa]	289
Minor principal effective stress	[kPa]	59
Principal effective stress ratio		4.93
Epsilon 50 [ε 50]	[%]	0.42
Secant modulus [E50] at ε 50	[kPa]	27247
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	221
Membrane correction applied	[kPa]	0.1
Drain correction applied	[kPa]	0
Axial strain	[%]	1.37
Excess pore pressure	[kPa]	77
Major principal effective stress	[kPa]	274
Minor principal effective stress	[kPa]	53
Principal effective stress ratio		5.14
At 15% axial strain		
Corrected deviator stress	[kPa]	181
Membrane correction applied	[kPa]	1.3
Drain correction applied	[kPa]	0
Axial strain	[%]	15.00
Excess pore pressure	[kPa]	40
Major principal effective stress	[kPa]	271
Minor principal effective stress	[kPa]	90
Principal effective stress ratio		3.01

FINAL CONDITIONS		
Water content	[%]	36.7
Bulk density	[Mg/m³]	1.89
Dry density	[Mg/m³]	1.38

Borehole	HKZ1-BH08-SA
Sample	15WaxC
Depth [m]	13.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION

Date: 29/09/2016 Drawn by: ALB

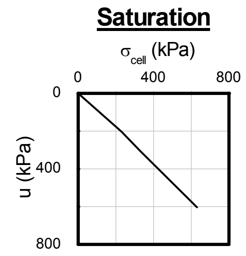
Template Issue: 3 Filename: J11335 / EFFECTIVE / HKZ1-BH08-

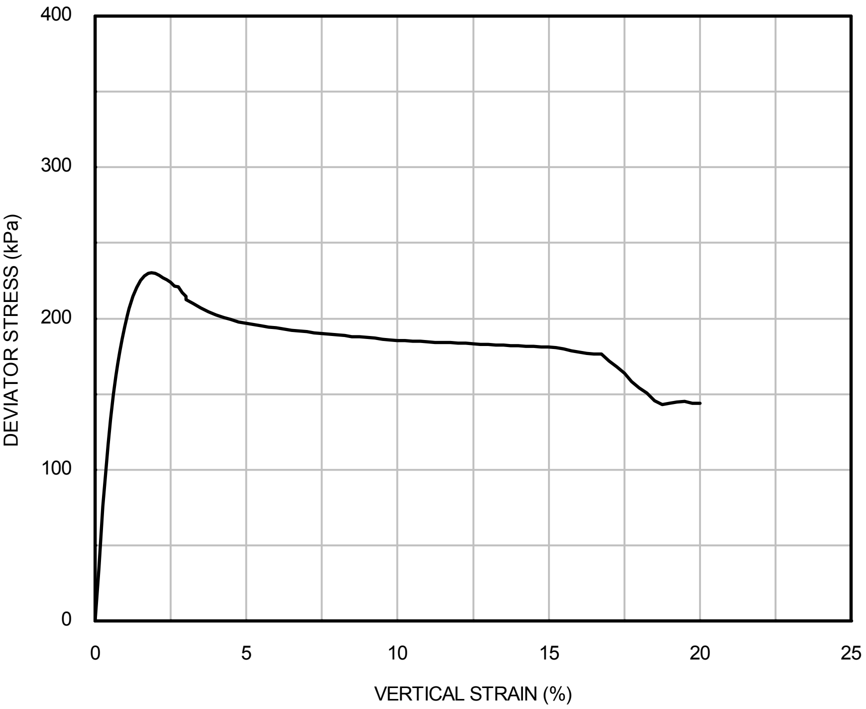
Checked by: MSR Date: 30/09/2016 Approved by: PH Date: 04/10/2016

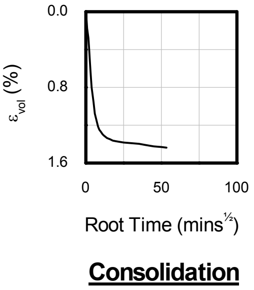
SPECIMEN PHOTOGRAPHS

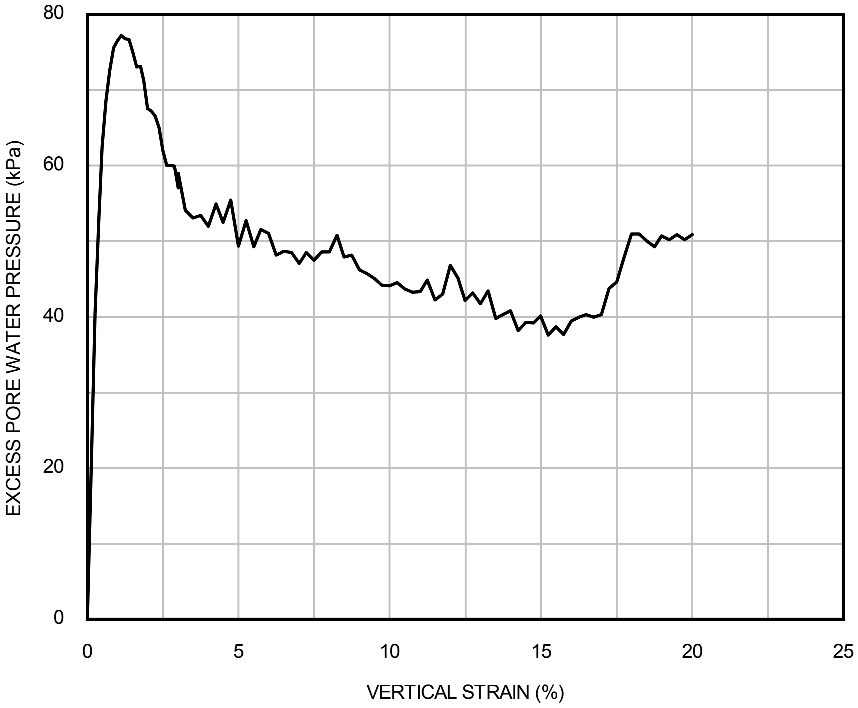
Borehole	HKZ1-BH08-SA
Sample	15WaxC
Depth [m]	13.42

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN WITH BENDER ELEMENT ADDITION



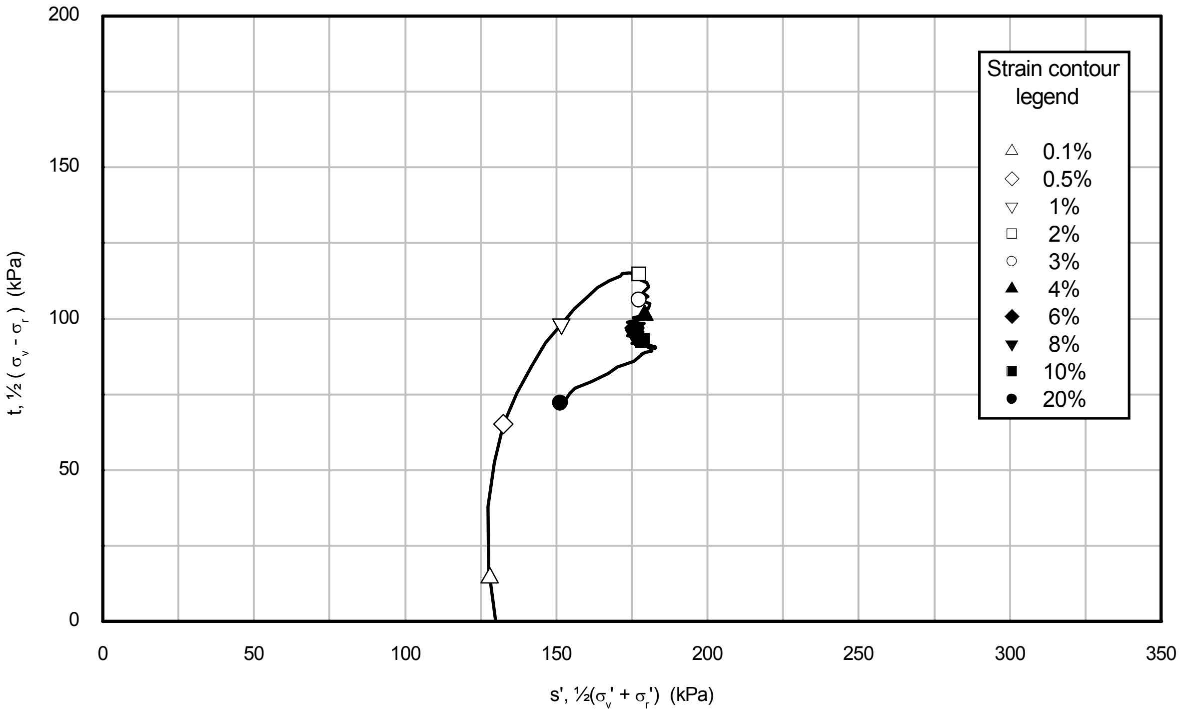


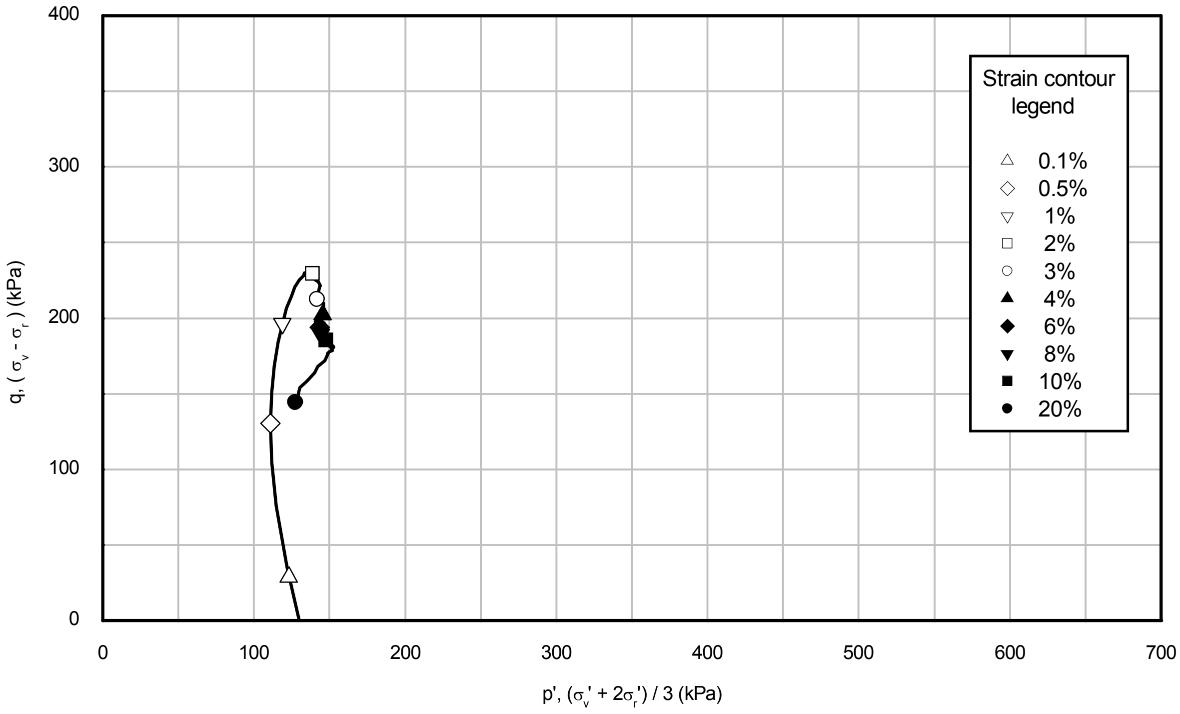




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	130	130	HKZ1-BH08 -SA	15WaxC	13.42

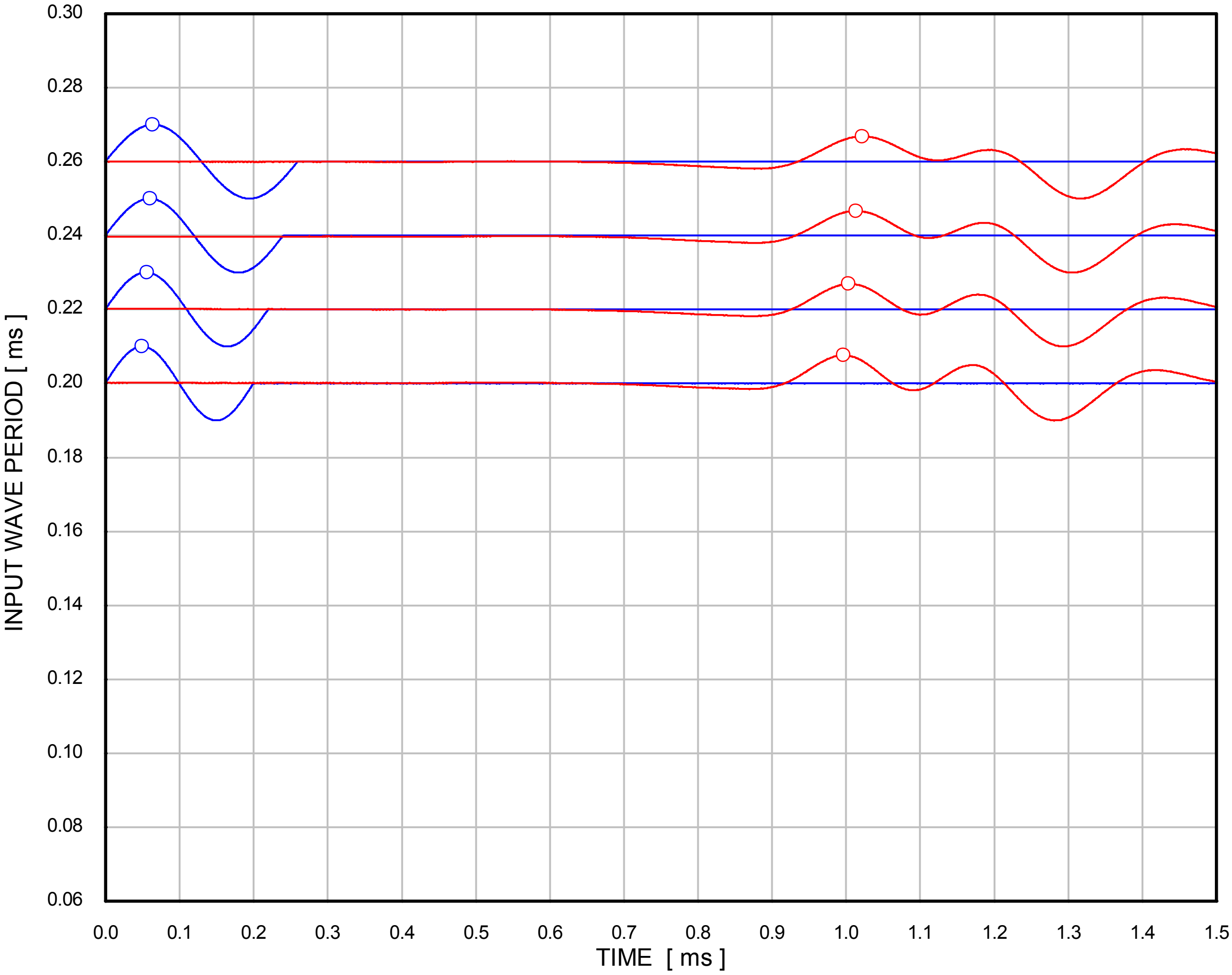
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

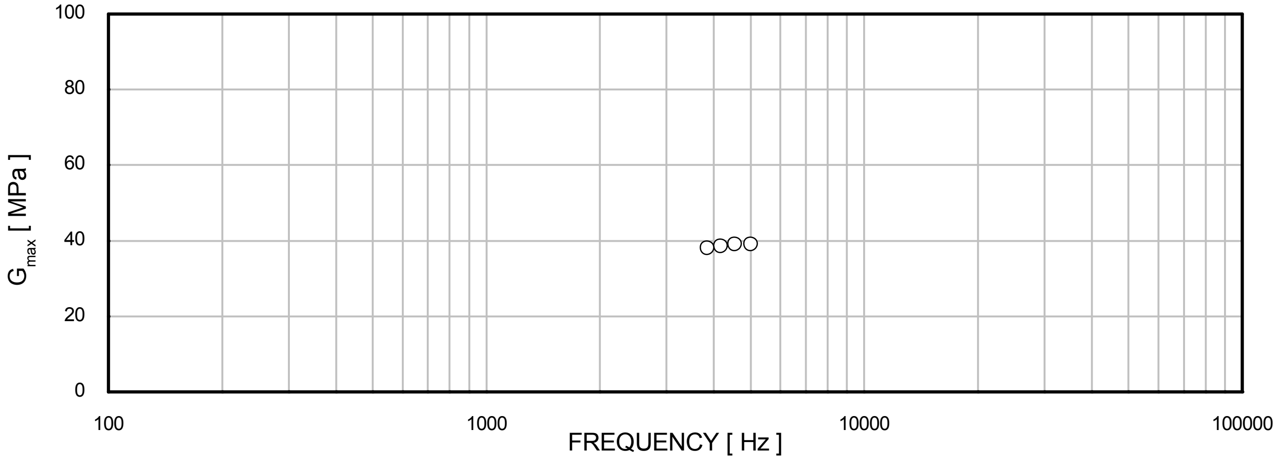




Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
──	1	130	130	HKZ1-BH08 -SA	15WaxC	13.42

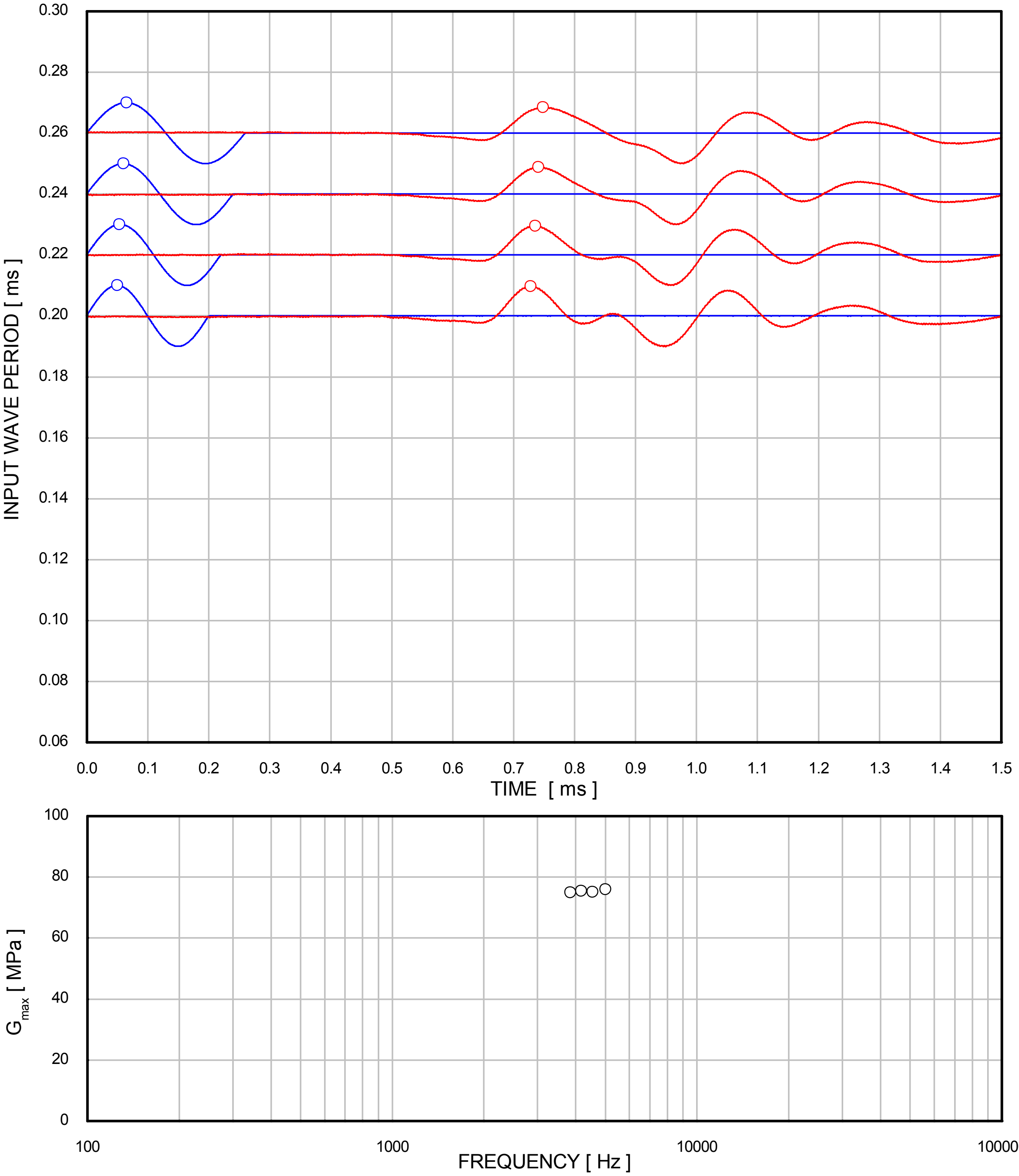
ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





σ'_{rc}	: 26 kPa	Borehole	: HKZ1-BH08-SA
σ'_{ac}	: 26 kPa	Sample	: 15WaxC
—	Source signal	Depth [m]	: 13.42
—	Received signal	Test No.	: 122
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS



σ'$_{rc}$	: 130 kPa	Borehole	: HKZ1-BH08-SA
σ'$_{ac}$	: 130 kPa	Sample	: 15WaxC
—	Source signal	Depth [m]	: 13.42
—	Received signal	Test No.	: 122
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Dark brown fine SAND

GENERAL		
Date test started		13/10/2016
Type of sample		Recompacted
Specimen orientation		Vertical
Type of drains fitted		One end

INITIAL		
Diameter	(mm)	51.5
Length	(mm)	90.0
Water content	(%)	10.2
Bulk density	(Mg/m³)	1.71
Dry density	(Mg/m³)	1.55
Void ratio		0.708
Degree of saturation	(%)	38

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	10
Pore pressure on completion	(kPa)	659
Cell pressure on completion	(kPa)	680
B value achieved		0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH08-SA
Sample	48BagA
Depth (m)	42.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	680
Back pressure	(kPa)	300
Effective cell pressure	(kPa)	380
Pore pressure on completion	(kPa)	300
Pore pressure dissipation	(%)	100
Water content	(%)	24.4
Bulk density	(Mg/m³)	2.00
Dry density	(Mg/m³)	1.61
Void ratio		0.646
Degree of saturation	(%)	100
Volumetric strain	(%)	3.64

Mode of failure: Compound failure

Borehole	HKZ1-BH08-SA
Sample	48BagA
Depth (m)	42.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

SHEARING		
Initial pore pressure	(kPa)	300
Initial effective cell pressure	(kPa)	380
Rate of strain	(%/hour)	1.33
At peak deviator stress		
Corrected deviator stress	(kPa)	697
Membrane correction applied	(kPa)	2.3
Drain correction applied	(kPa)	0
Axial strain	(%)	20.25
Excess pore pressure	(kPa)	41
Major principal effective stress	(kPa)	1036
Minor principal effective stress	(kPa)	339
Principal effective stress ratio		3.06
Epsilon 50 (ε 50)	(%)	2.82
Secant modulus (E50) at ε 50	(kPa)	12381
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	668
Membrane correction applied	(kPa)	2.1
Drain correction applied	(kPa)	0
Axial strain	(%)	16.75
Excess pore pressure	(kPa)	59
Major principal effective stress	(kPa)	989
Minor principal effective stress	(kPa)	321
Principal effective stress ratio		3.08
At 15% axial strain		
Corrected deviator stress	(kPa)	645
Membrane correction applied	(kPa)	1.9
Drain correction applied	(kPa)	0
Axial strain	(%)	15.00
Excess pore pressure	(kPa)	69
Major principal effective stress	(kPa)	956
Minor principal effective stress	(kPa)	311
Principal effective stress ratio		3.07

FINAL CONDITIONS		
Water content	(%)	24.4
Bulk density	(Mg/m³)	2.00
Dry density	(Mg/m³)	1.61

Borehole	HKZ1-BH08-SA
Sample	48BagA
Depth (m)	42.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

Date: 14/10/2016 Drawn by: ALB Template Issue: 2

Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_48BagA_CU.XLS

Date: 14/10/2016 Checked by: PH

Date: 14/10/2016 Approved by: PH

Drawn by: ALB Date: 14/10/2016

Template Issue: 4.1

Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_48BagA_CU.OPJ

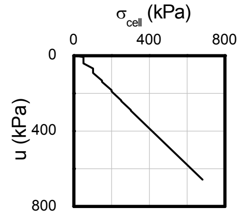
Date : 17/10/2016

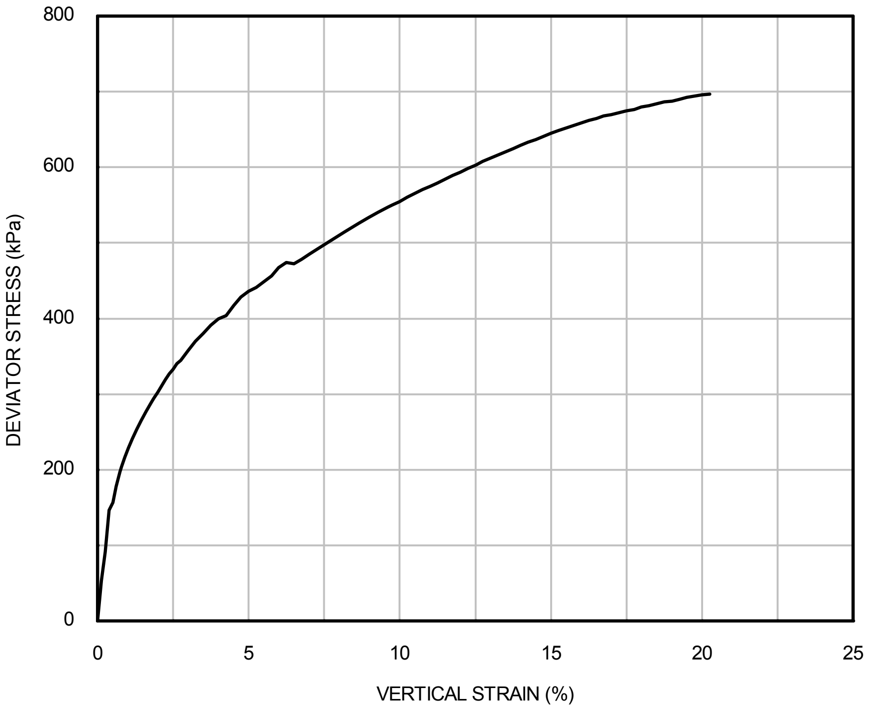
Date : 17/10/2016

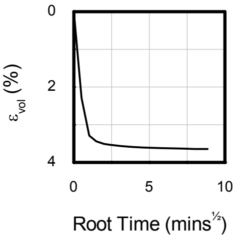
Checked by: PH

Approved by: PH

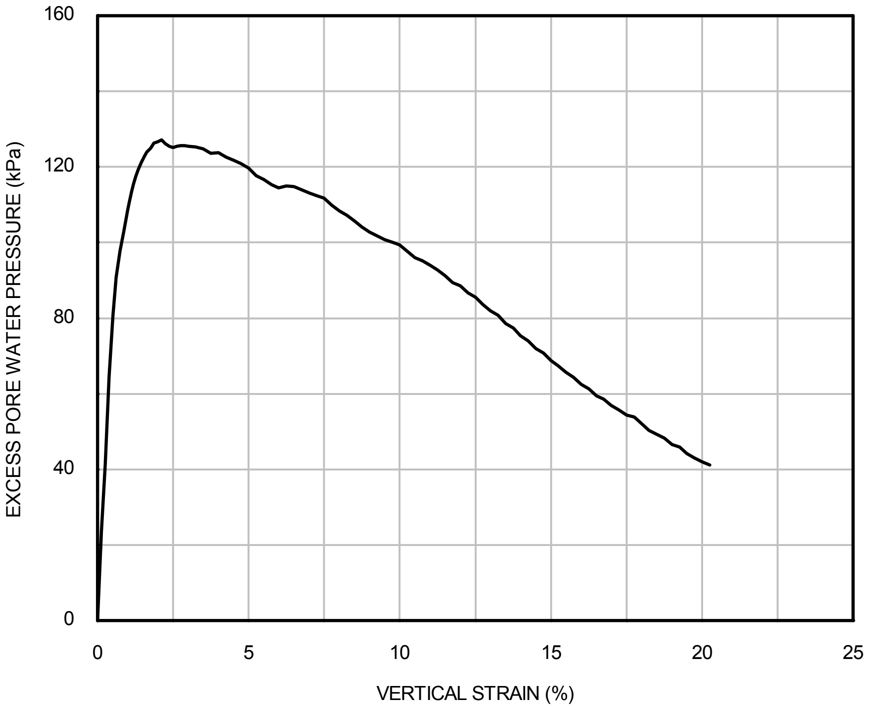
Saturation





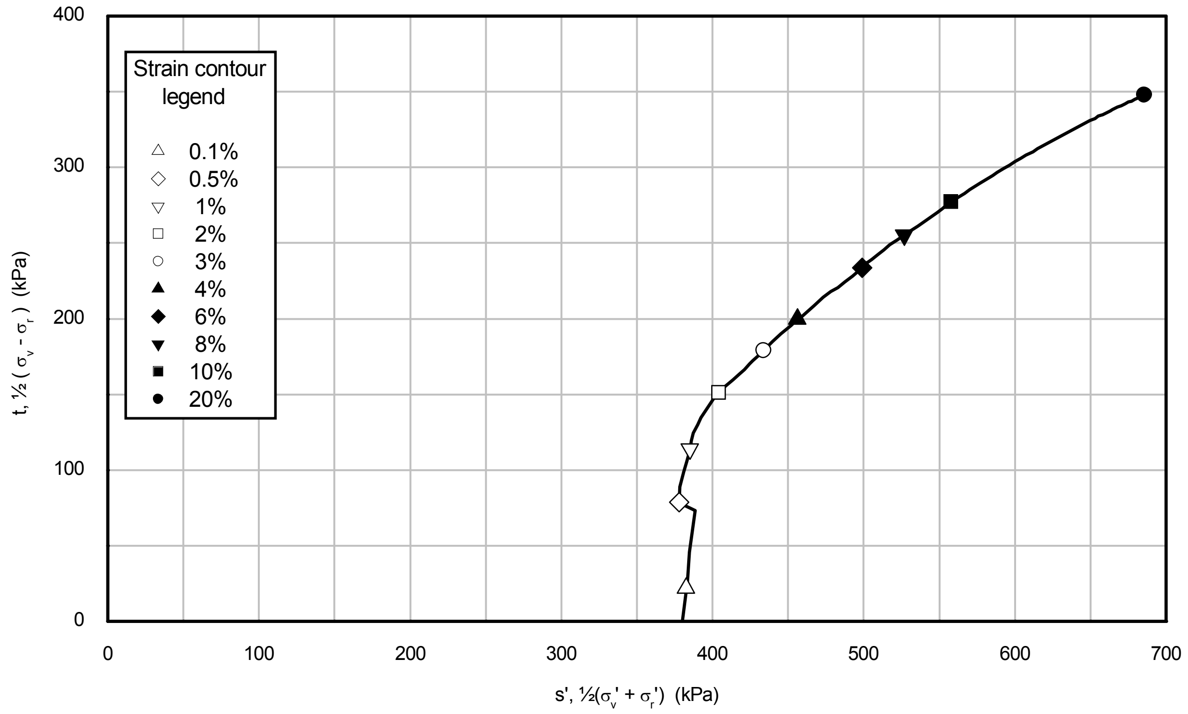


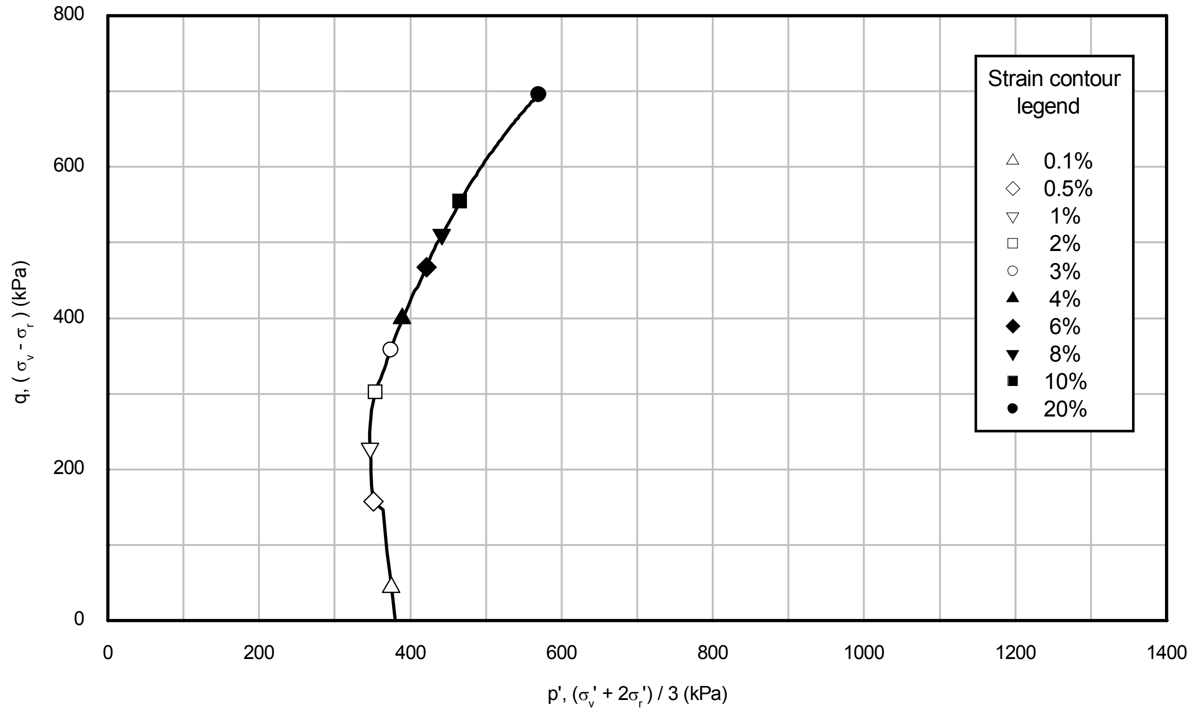
Consolidation



Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	380	380	HKZ1 -BH08-SA	48BagA	42.50

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
――	1	380	380	HKZ1 -BH08-SA	48BagA	42.50

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

Date: 22/09/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_14BagA & 14BagB_D3.XLS Date: 03/10/2016 Checked by:MSR Date: 03/10/2016 Approved by: PH

VISUAL DESCRIPTION
Brown fine to medium SAND with some shell fragments

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		14/09/2016	19/09/2016	19/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	9.9	9.9	9.9
Bulk density	(Mg/m³)	1.87	1.87	1.87
Dry density	(Mg/m³)	1.70	1.70	1.70
Void ratio		0.558	0.560	0.557
Degree of saturation	(%)	47	47	47

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	417	544	799
Cell pressure on completion	(kPa)	430	560	820
B value achieved		0.98	0.98	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	14BagA & 14BagB	14BagA & 14BagB	14BagA & 14BagB
Depth (m)	12.00	12.00	12.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	430	560	820
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	130	260	520
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	20.7	20.5	20.3
Bulk density	(Mg/m³)	2.07	2.07	2.07
Dry density	(Mg/m³)	1.71	1.72	1.72
Void ratio		0.548	0.543	0.538
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.64	1.11	1.24

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	14BagA & 14BagB	14BagA & 14BagB	14BagA & 14BagB
Depth (m)	12.00	12.00	12.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1				
Bulk density	[Mg/m^3]	2.06		
Dry density	[Mg/m^3]	1.70		
Void ratio	[-]	0.558		
Distance	[mm]	132.1		
Effective radial pressure	[kPa]	13		
Effective axial pressure	[kPa]	13		
Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.1215	5.61	117.74	28.6
0.22	1.1260	5.12	117.27	28.3
0.24	1.1245	4.69	117.43	28.4
0.26	1.1305	4.35	116.81	28.1
0.28	1.1355	4.05	116.29	27.9
0.30	1.1360	3.79	116.24	27.8
0.32	1.1375	3.55	116.09	27.8
0.34	1.1390	3.35	115.94	27.7
0.36	1.1405	3.17	115.78	27.6
0.38	1.1400	3.00	115.83	27.6

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	14BagA & 14BagB	14BagA & 14BagB	14BagA & 14BagB
Depth (m)	12.00	12.00	12.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

SHEARING	Specimen 1	Specimen 2	Specimen 3
Initial pore pressure (kPa)	300	300	300
Initial effective cell pressure (kPa)	130	260	520
Rate of strain (%/hour)	1.33	1.33	1.33
At peak deviator stress			
Corrected deviator stress (kPa)	432	813	1495
Membrane correction applied (kPa)	0.3	0.3	0.4
Drain correction applied (kPa)	0	0	0
Axial strain (%)	2.25	2.65	3.50
Volumetric strain (%)	-0.54	-0.49	-0.42
Major principal effective stress (kPa)	564	1075	2014
Minor principal effective stress (kPa)	132	262	519
Principal effective stress ratio	4.27	4.10	3.88
Epsilon 50 (ε 50) (%)	0.35	0.41	0.60
Secant modulus (E50) at ε 50 (kPa)	61202	98733	123813
At peak principal effective stress ratio			
Corrected deviator stress (kPa)	431	812	1495
Membrane correction applied (kPa)	0.3	0.3	0.4
Drain correction applied (kPa)	0	0	0
Axial strain (%)	2.38	2.77	3.50
Volumetric strain (%)	-0.61	-0.55	-0.42
Major principal effective stress (kPa)	563	1074	2014
Minor principal effective stress (kPa)	132	262	519
Principal effective stress ratio	4.28	4.10	3.88
At 15% axial strain			
Corrected deviator stress (kPa)	324	643	1147
Membrane correction applied (kPa)	1.4	1.4	1.4
Drain correction applied (kPa)	0	0	0
Axial strain (%)	15.00	15.00	15.00
Volumetric strain (%)	-3.40	-3.05	-1.83
Major principal effective stress (kPa)	457	904	1667
Minor principal effective stress (kPa)	133	261	520
Principal effective stress ratio	3.43	3.46	3.21

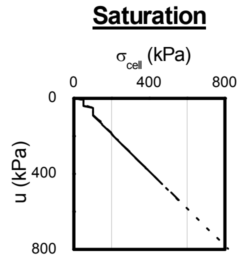
FINAL CONDITIONS			
Water content (%)	20.7	20.5	20.3
Bulk density (Mg/m³)	2.07	2.07	2.07
Dry density (Mg/m³)	1.71	1.72	1.72

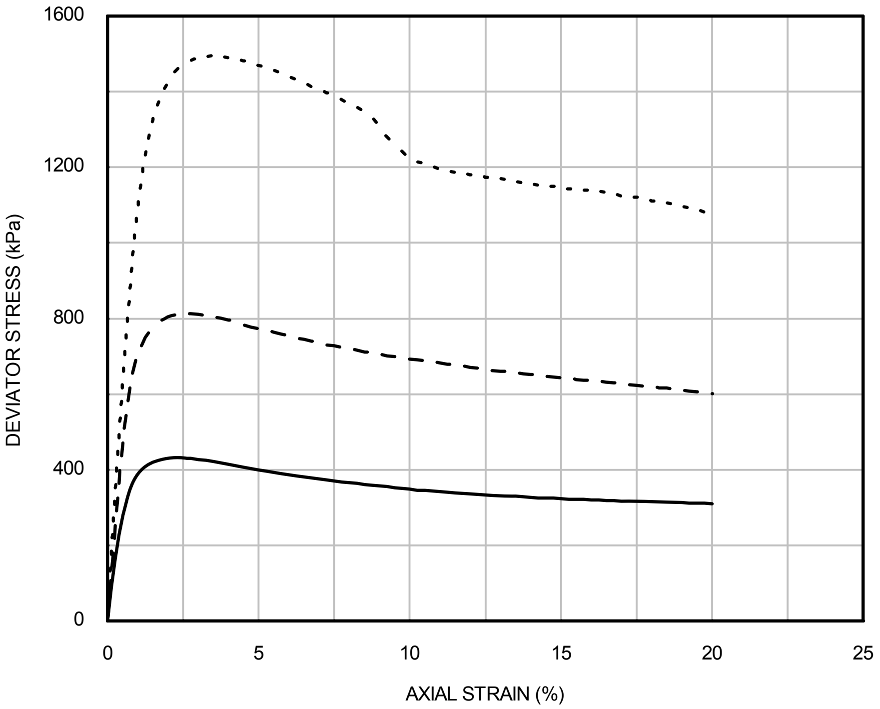
Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	14BagA & 14BagB	14BagA & 14BagB	14BagA & 14BagB
Depth (m)	12.00	12.00	12.00

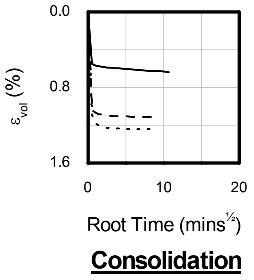
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

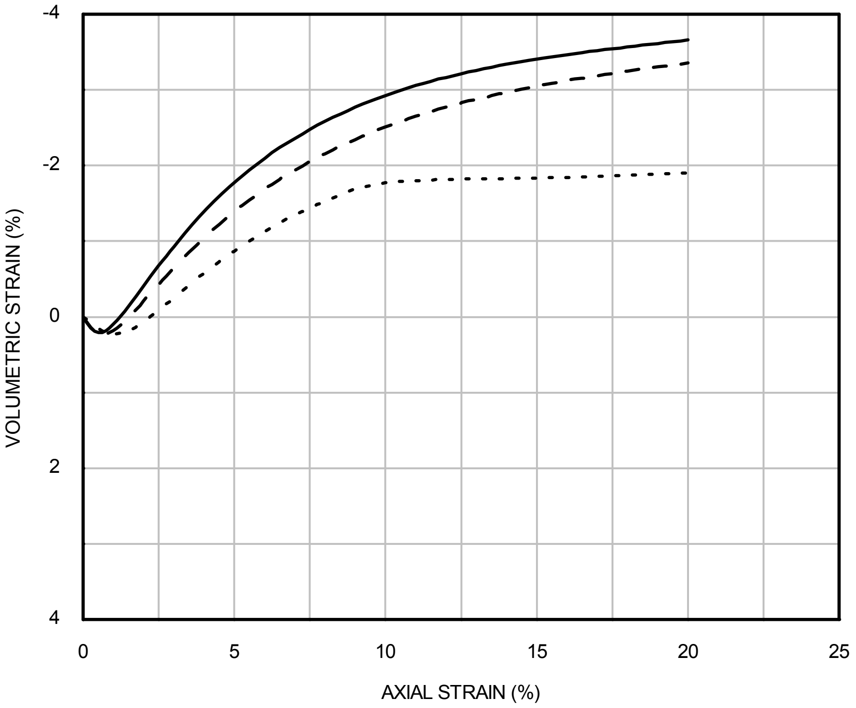
Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_14BagA & 14BagB_D3.XLS
Date: 03/10/2016
Checked by:MSR
Date: 03/10/2016
Approved by: PH

Date: 22/09/2016
Drawn by: ALB
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_14BagA & 14BagB_D3.OPJ
Template Issue: 4
Date : 28/09/2016
Date : 03/10/2016
Checked by: MSR
Approved by: PH





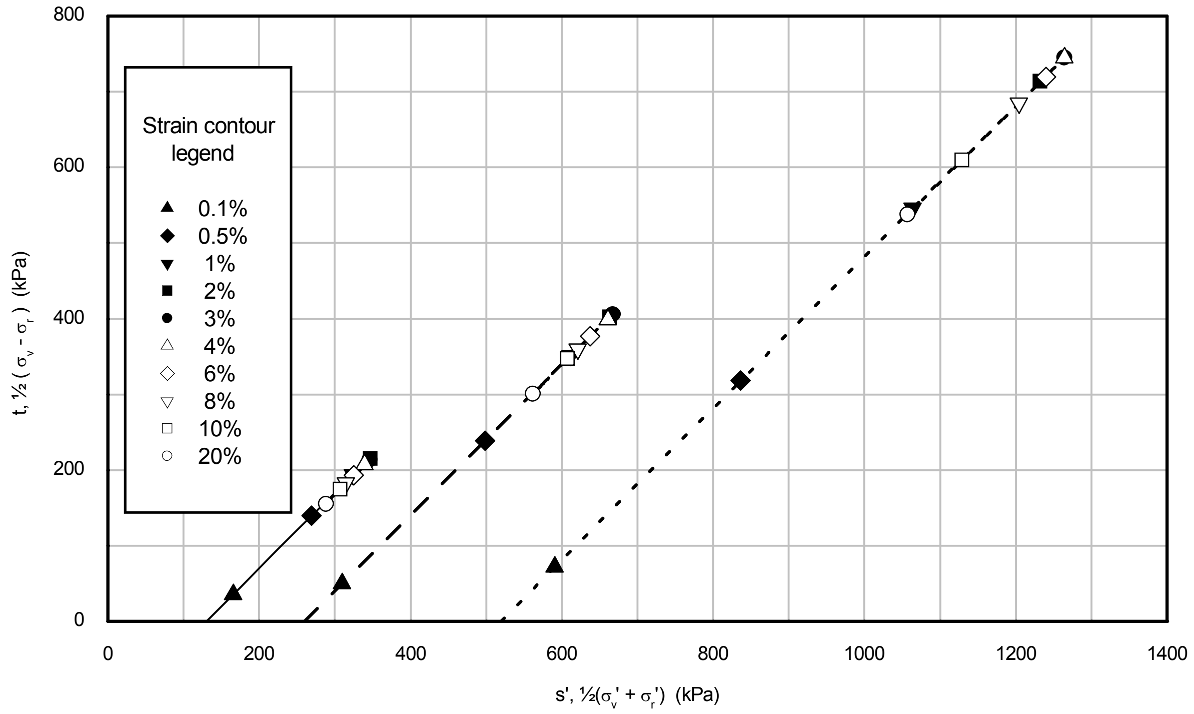


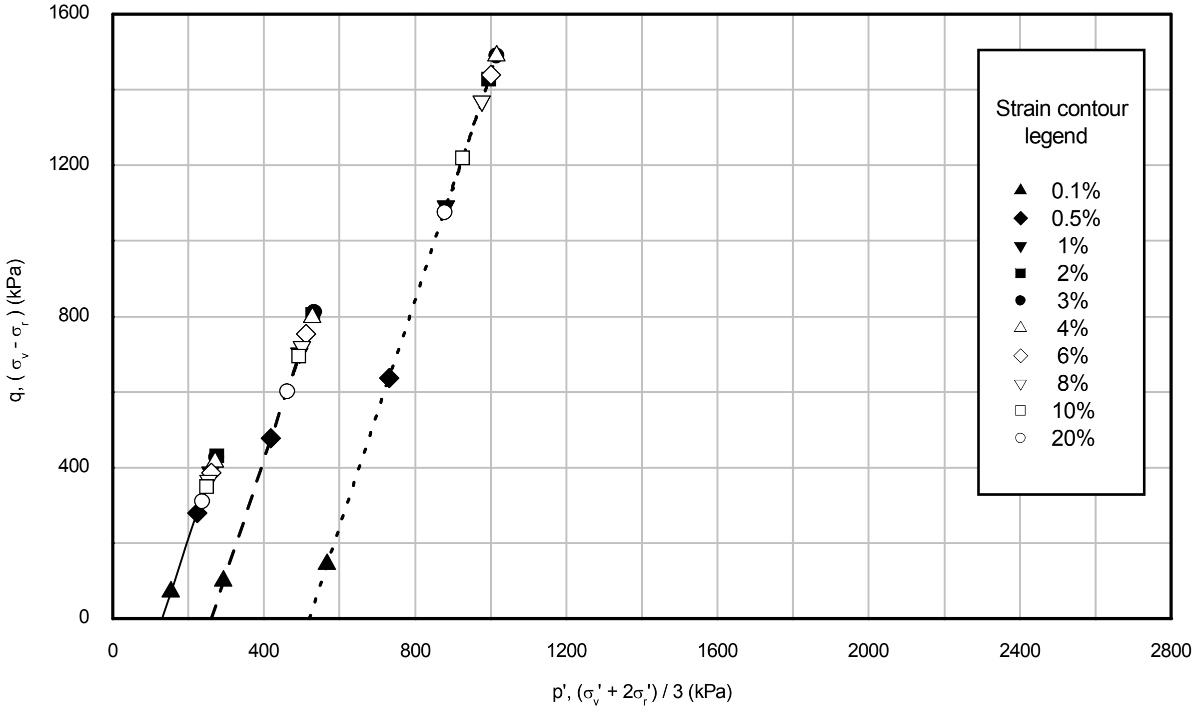


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	130	130	HKZ1-BH01 -SA	14BagA & 14BagB	12.00
– –	2	260	260			
····	3	520	520			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 22/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_14BagA & 14BagB_D3.OPJ
Date : 28/09/2016
Checked by: MSR
Date : 03/10/2016
Approved by: PH

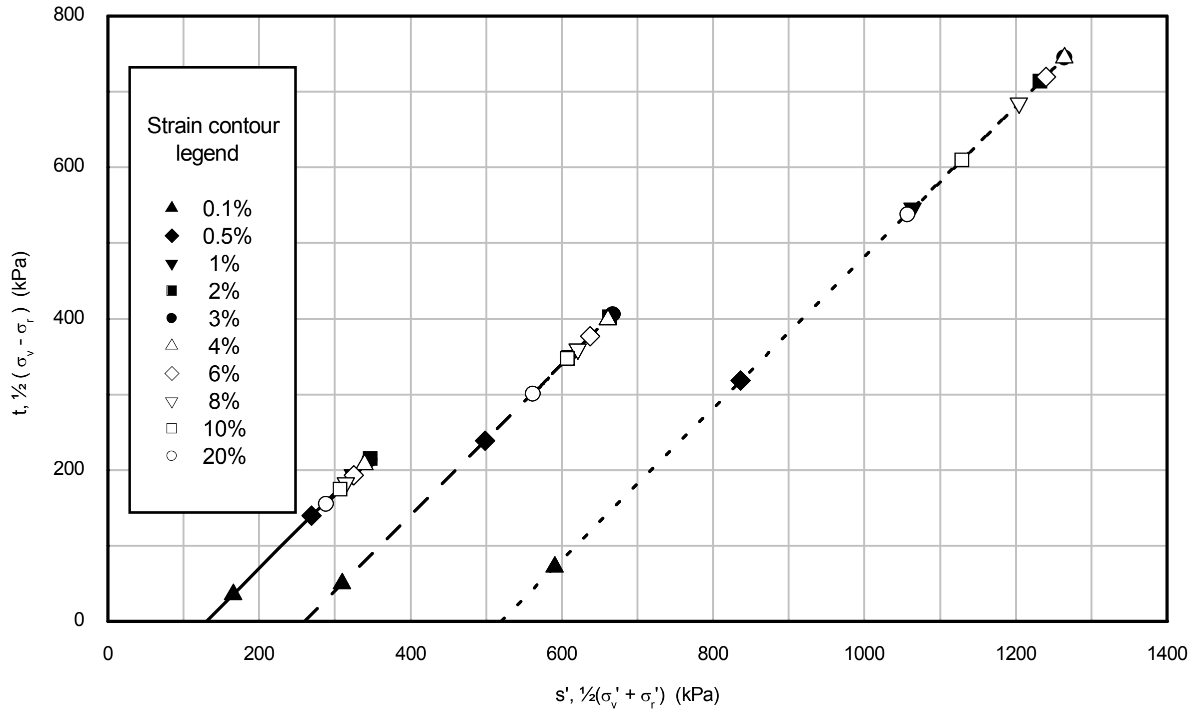


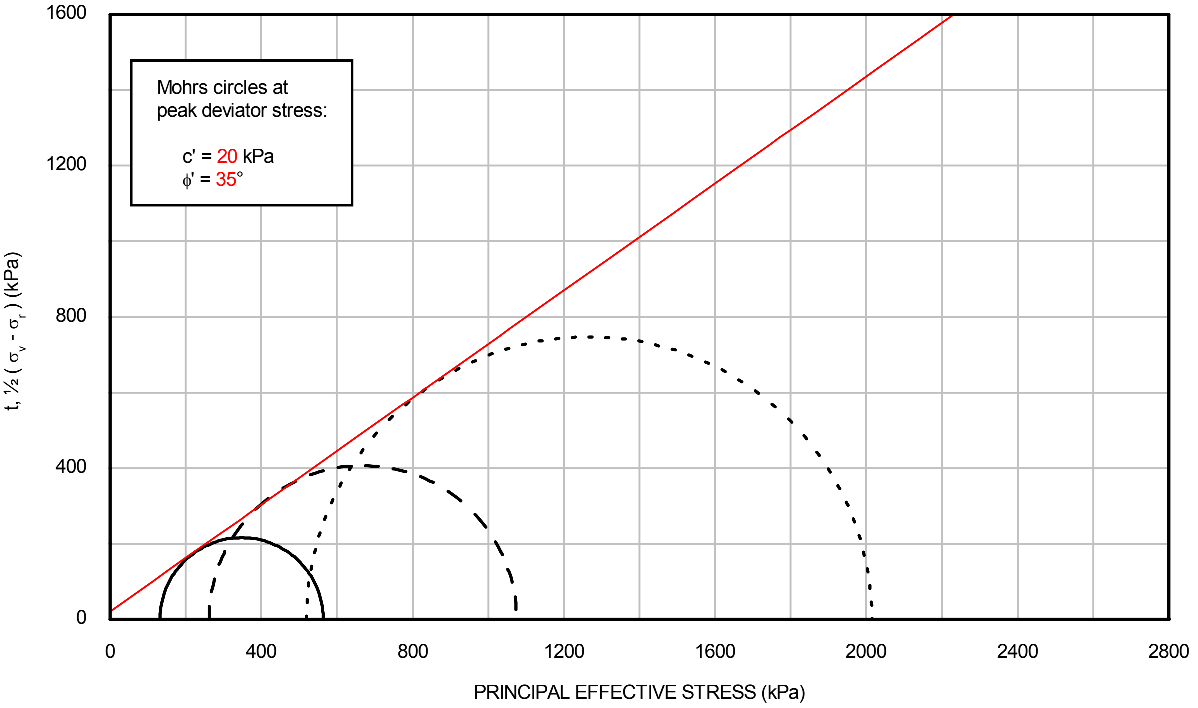


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	130	130	HKZ1-BH01 -SA	14BagA & 14BagB	12.00
– –	2	260	260			
· · · ·	3	520	520			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

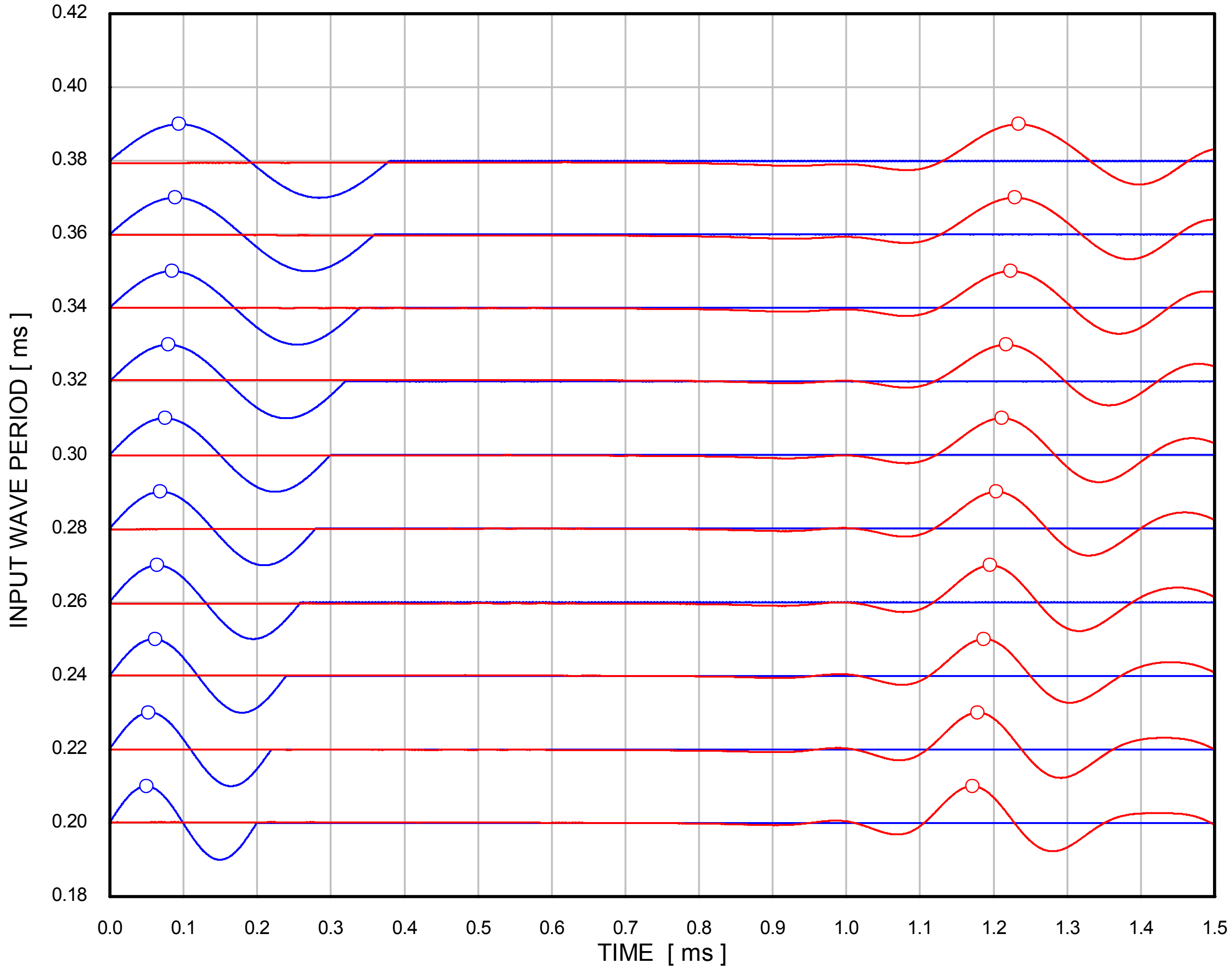
Date: 22/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_14BagA & 14BagB_D3.OPJ
Date : 28/09/2016
Checked by: MSR
Date : 03/10/2016
Approved by: PH

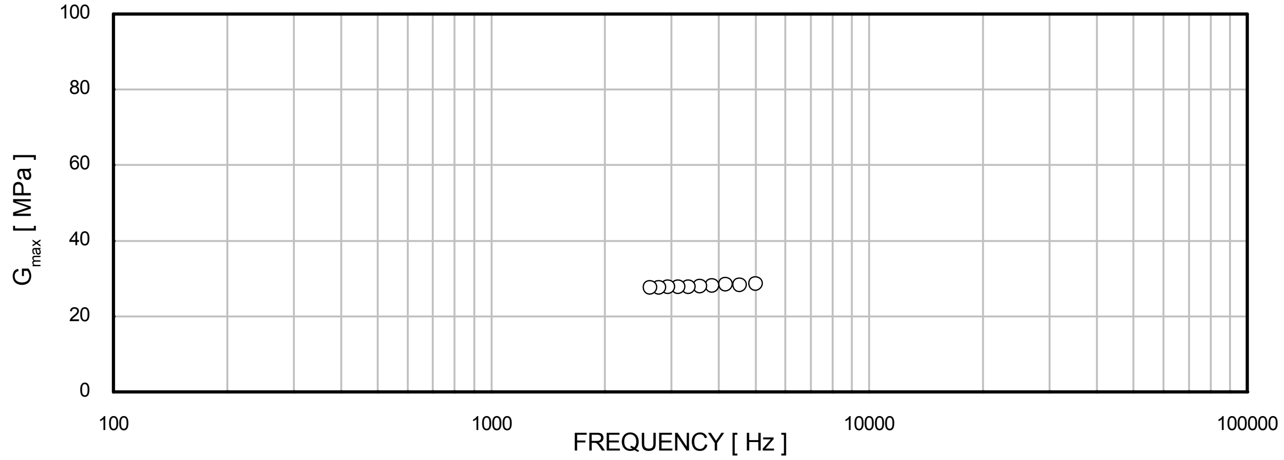




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	130	130	HKZ1-BH01 -SA	14BagA & 14BagB	12.00
— —	2	260	260			
· · · ·	3	520	520			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





σ'_{rc} : 13 kPa

σ'_{ac} : 13 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH01-SA

Sample : 14BagA & 14BagB

Depth [m] : 12

Test No. : 200A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Brown fine SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	08/09/2016	07/09/2016	07/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	9.9	9.9	9.9
Bulk density	(Mg/m³)	1.79	1.78	1.79
Dry density	(Mg/m³)	1.63	1.62	1.63
Void ratio		0.625	0.625	0.623
Degree of saturation	(%)	42	42	42

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	521	756	1234
Cell pressure on completion	(kPa)	540	780	1260
B value achieved		0.97	0.97	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	37BagA	37BagA	37BagA
Depth (m)	34.50	34.50	34.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	540	780	1260
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	240	480	960
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	22.9	22.5	21.9
Bulk density	(Mg/m³)	2.02	2.03	2.04
Dry density	(Mg/m³)	1.64	1.66	1.67
Void ratio		0.606	0.594	0.577
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.17	1.92	2.85

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	37BagA	37BagA	37BagA
Depth (m)	34.50	34.50	34.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 09/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_37BagA_D3.XLS
Date: 13/09/2016
Checked by: MSR
Date: 20/09/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	240	480	960
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	541	1079	2030
Membrane correction applied	(kPa)	1.6	2.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	11.50	15.23	14.50
Volumetric strain	(%)	1.03	1.73	2.23
Major principal effective stress	(kPa)	781	1560	2990
Minor principal effective stress	(kPa)	239	480	960
Principal effective stress ratio		3.26	3.25	3.11
Epsilon 50 (ε 50)	(%)	0.53	1.04	1.19
Secant modulus (E50) at ε 50	(kPa)	50910	52071	85027
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	541	1079	2030
Membrane correction applied	(kPa)	1.6	2.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	11.50	15.23	14.50
Volumetric strain	(%)	1.03	1.73	2.23
Major principal effective stress	(kPa)	781	1560	2990
Minor principal effective stress	(kPa)	239	480	960
Principal effective stress ratio		3.26	3.25	3.11
At 15% axial strain				
Corrected deviator stress	(kPa)	538	1079	2028
Membrane correction applied	(kPa)	2.0	2.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	1.01	1.73	2.23
Major principal effective stress	(kPa)	777	1559	2988
Minor principal effective stress	(kPa)	240	480	960
Principal effective stress ratio		3.24	3.25	3.11

FINAL CONDITIONS				
Water content	(%)	22.4	21.5	20.6
Bulk density	(Mg/m³)	2.03	2.05	2.06
Dry density	(Mg/m³)	1.66	1.68	1.71

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	37BagA	37BagA	37BagA
Depth (m)	34.50	34.50	34.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 09/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_37BagA_D3.XLS
Date: 13/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

Drawn by: ALB Date: 09/09/2016

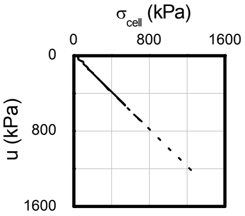
Template Issue: 4

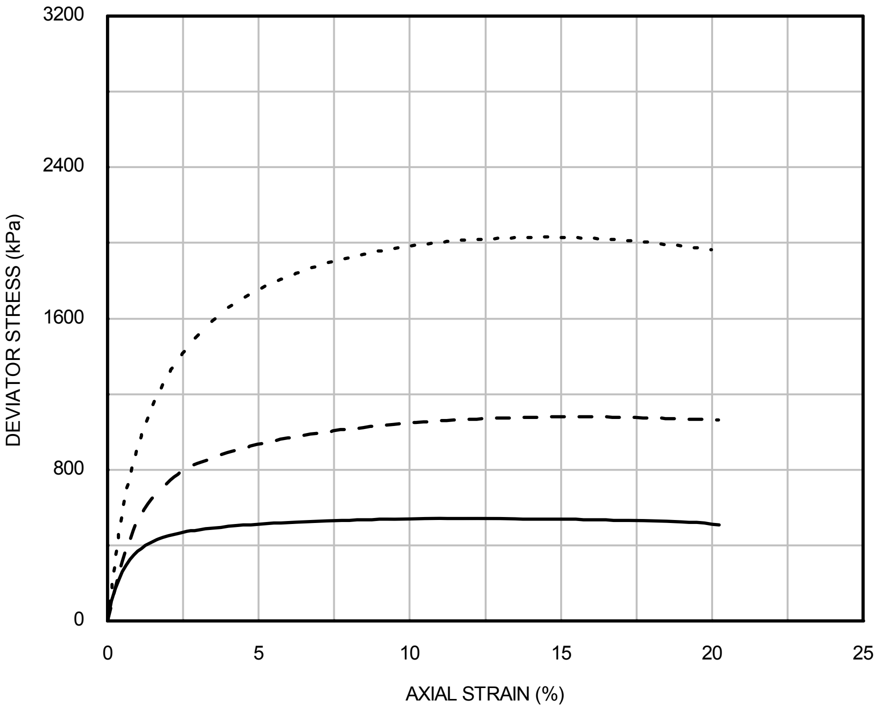
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_37BagA_D3.OPJ

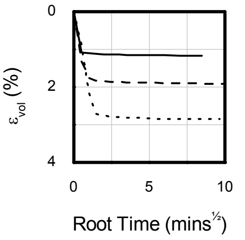
Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016

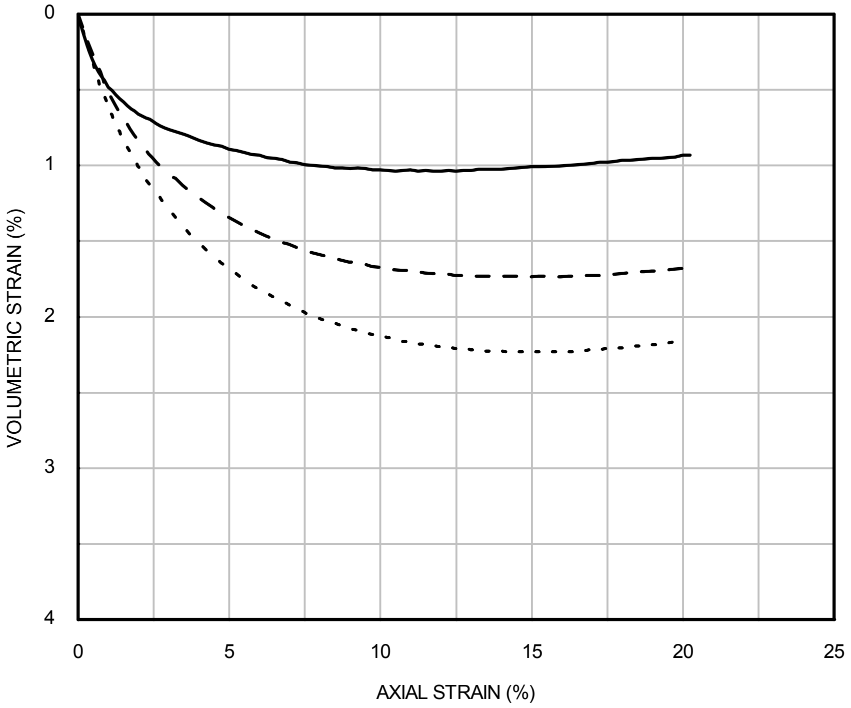
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	240	240	HKZ1-BH01 -SA	37BagA	34.50
— —	2	480	480			
· · · ·	3	960	960			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

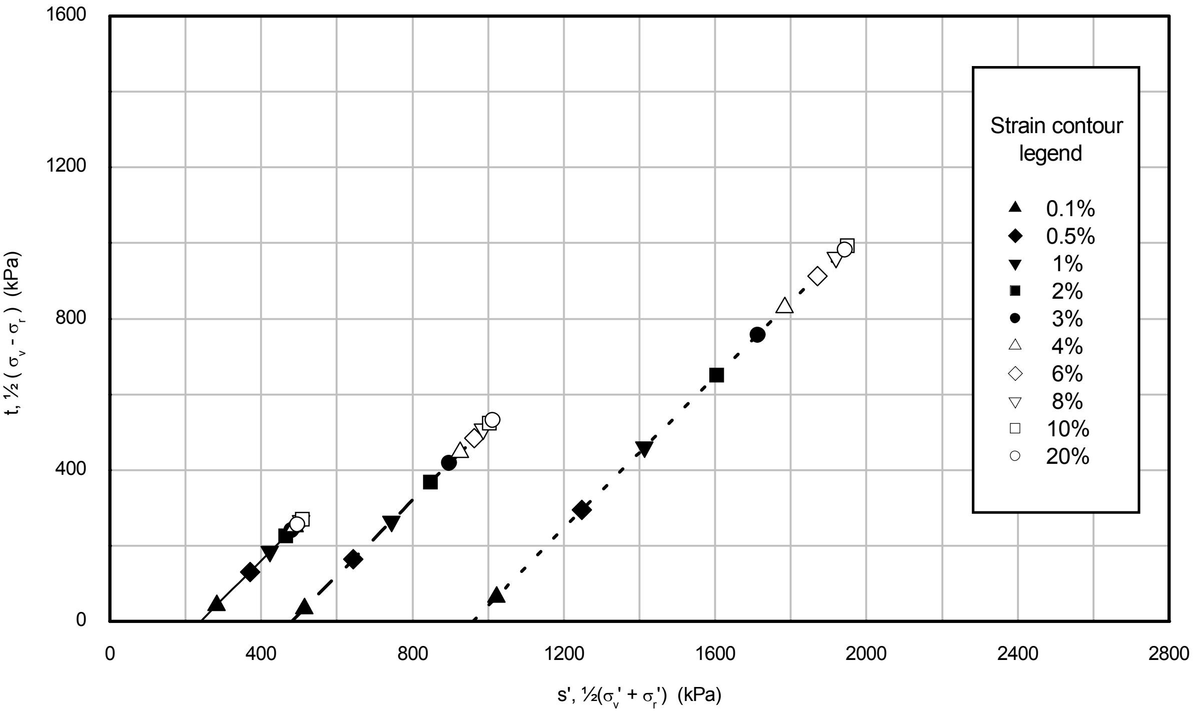
Drawn by: ALB Date: 09/09/2016

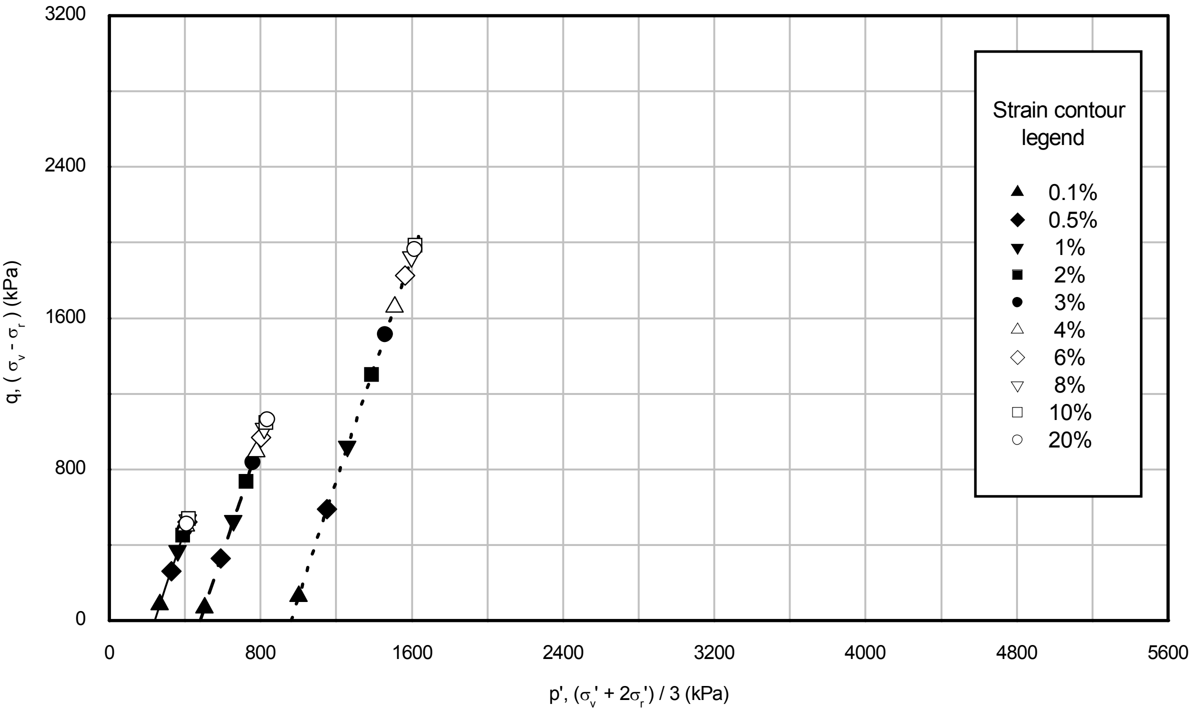
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_37BagA_D3.OPJ

Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	240	240	HKZ1-BH01 -SA	37BagA	34.50
— —	2	480	480			
- - - -	3	960	960			

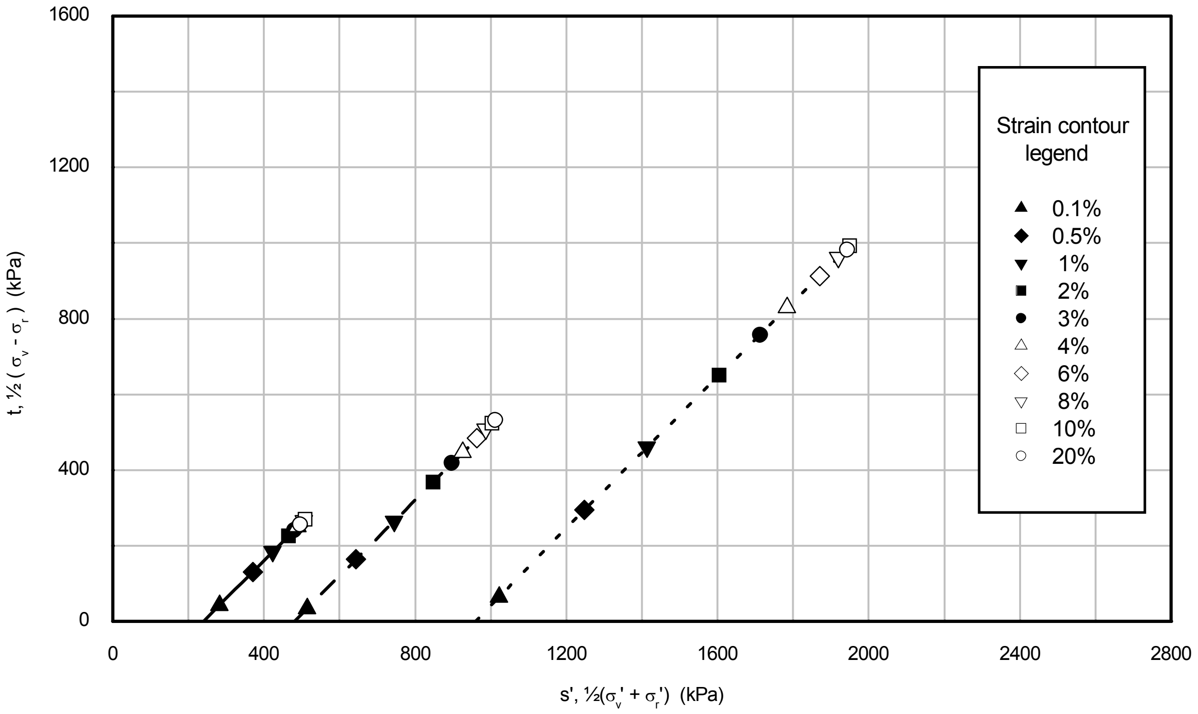
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

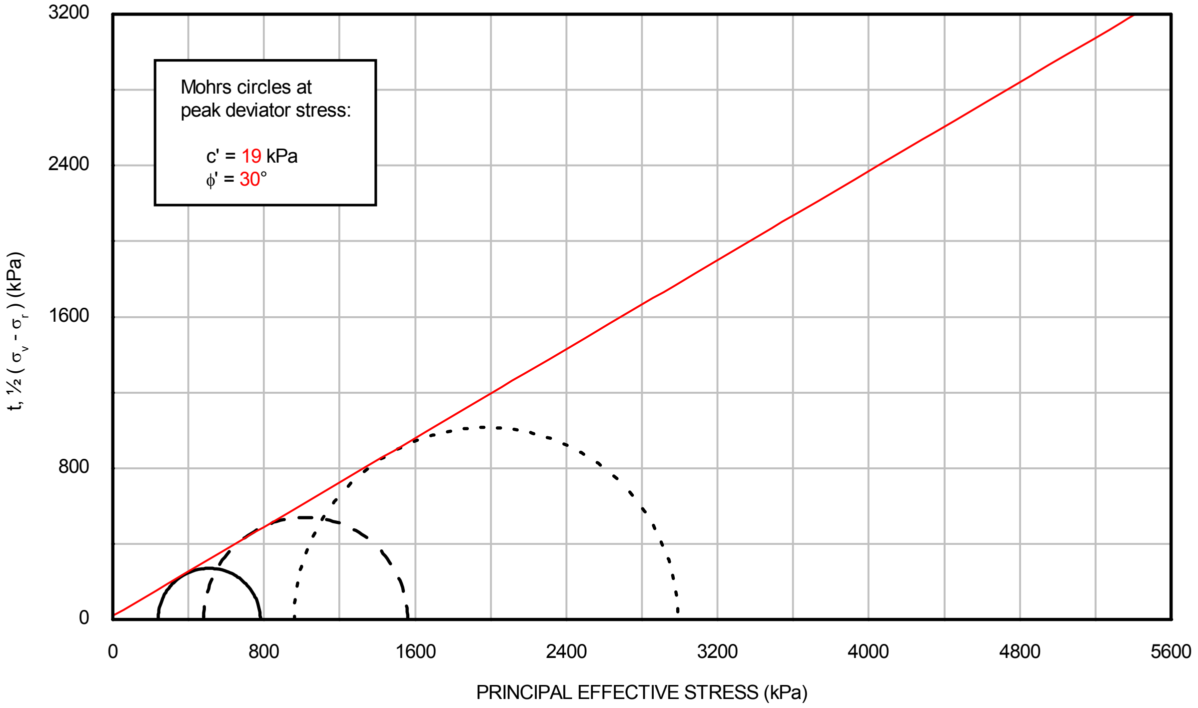
Drawn by: ALB Date: 09/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_37BagA_D3.OPJ

Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	240	240	HKZ1-BH01 -SA	37BagA	34.50
– –	2	480	480			
· · · ·	3	960	960			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Very dark grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		30/08/2016	30/08/2016	30/08/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.4	10.4	10.4
Bulk density	(Mg/m^3)	1.68	1.68	1.67
Dry density	(Mg/m^3)	1.52	1.52	1.51
Void ratio		0.752	0.751	0.757
Degree of saturation	(%)	37	37	37

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	644	1006	1740
Cell pressure on completion	(kPa)	665	1030	1760
B value achieved		0.97	0.98	0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	54BagB	54BagB	54BagB
Depth (m)	57.30	57.30	57.30

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 01/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH01-SA_54BagB_D3.XLS
Date: 02/09/2016
Checked by: MSR
Date: 05/09/2016
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	665	1030	1760
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	365	730	1460
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.5	26.1	24.6
Bulk density	(Mg/m³)	1.97	1.98	2.00
Dry density	(Mg/m³)	1.56	1.57	1.61
Void ratio		0.706	0.694	0.655
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	2.62	3.27	5.82

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	54BagB	54BagB	54BagB
Depth (m)	57.30	57.30	57.30

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	365	730	1460
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	717	1504	2963
Membrane correction applied	(kPa)	1.5	2.1	2.1
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	11.24	18.84	18.53
Volumetric strain	(%)	2.63	3.71	5.51
Major principal effective stress	(kPa)	1081	2234	4424
Minor principal effective stress	(kPa)	364	730	1460
Principal effective stress ratio		2.97	3.06	3.03
Epsilon 50 (ε 50)	(%)	1.54	1.77	2.63
Secant modulus (E50) at ε 50	(kPa)	23242	42460	56292
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	717	1504	2960
Membrane correction applied	(kPa)	1.5	2.0	2.1
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	11.24	17.84	19.03
Volumetric strain	(%)	2.63	3.67	5.54
Major principal effective stress	(kPa)	1081	2233	4417
Minor principal effective stress	(kPa)	364	729	1457
Principal effective stress ratio		2.97	3.06	3.03
At 15% axial strain				
Corrected deviator stress	(kPa)	706	1488	2896
Membrane correction applied	(kPa)	1.8	1.8	1.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	2.83	3.50	5.01
Major principal effective stress	(kPa)	1070	2217	4356
Minor principal effective stress	(kPa)	364	729	1460
Principal effective stress ratio		2.94	3.04	2.98

FINAL CONDITIONS				
Water content	(%)	24.6	23.6	21.1
Bulk density	(Mg/m³)	2.00	2.02	2.06
Dry density	(Mg/m³)	1.61	1.63	1.70

Borehole	HKZ1-BH01-SA	HKZ1-BH01-SA	HKZ1-BH01-SA
Sample	54BagB	54BagB	54BagB
Depth (m)	57.30	57.30	57.30

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Drawn by: ALB Date: 01/09/2016

Template Issue: 4

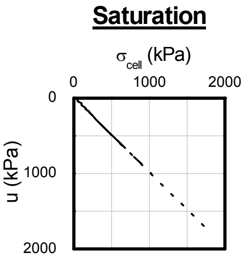
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_54BagB_D3.OPJ

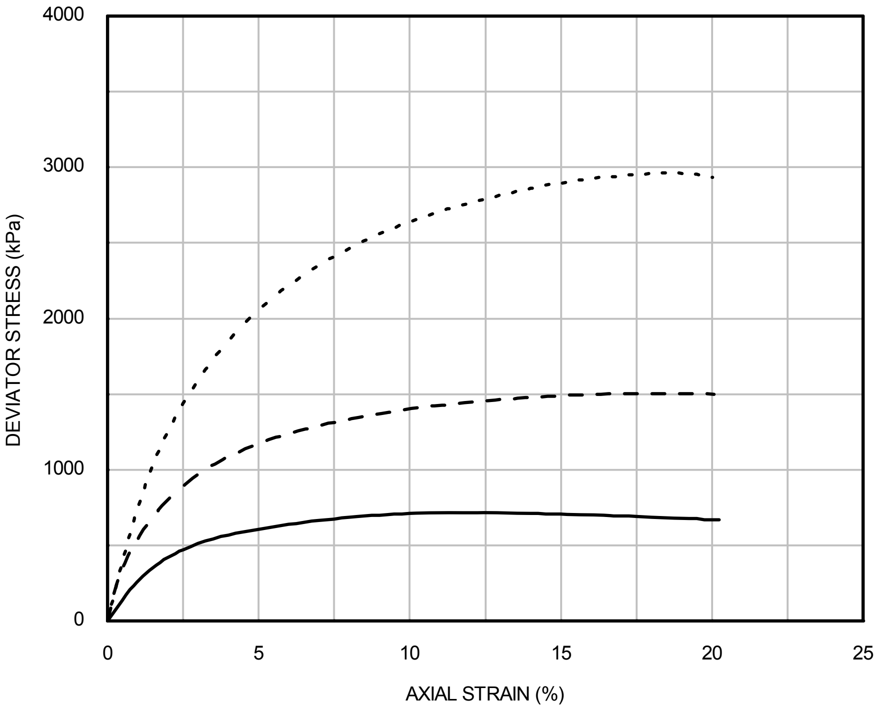
Date : 02/09/2016

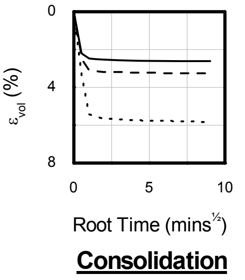
Date : 05/09/2016

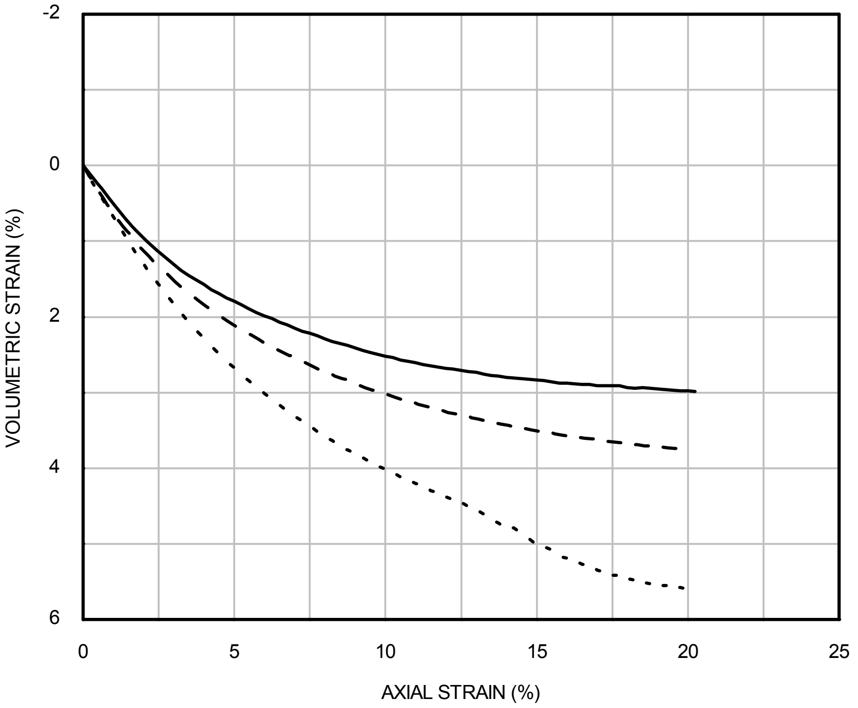
Checked by: MSR

Approved by: PH







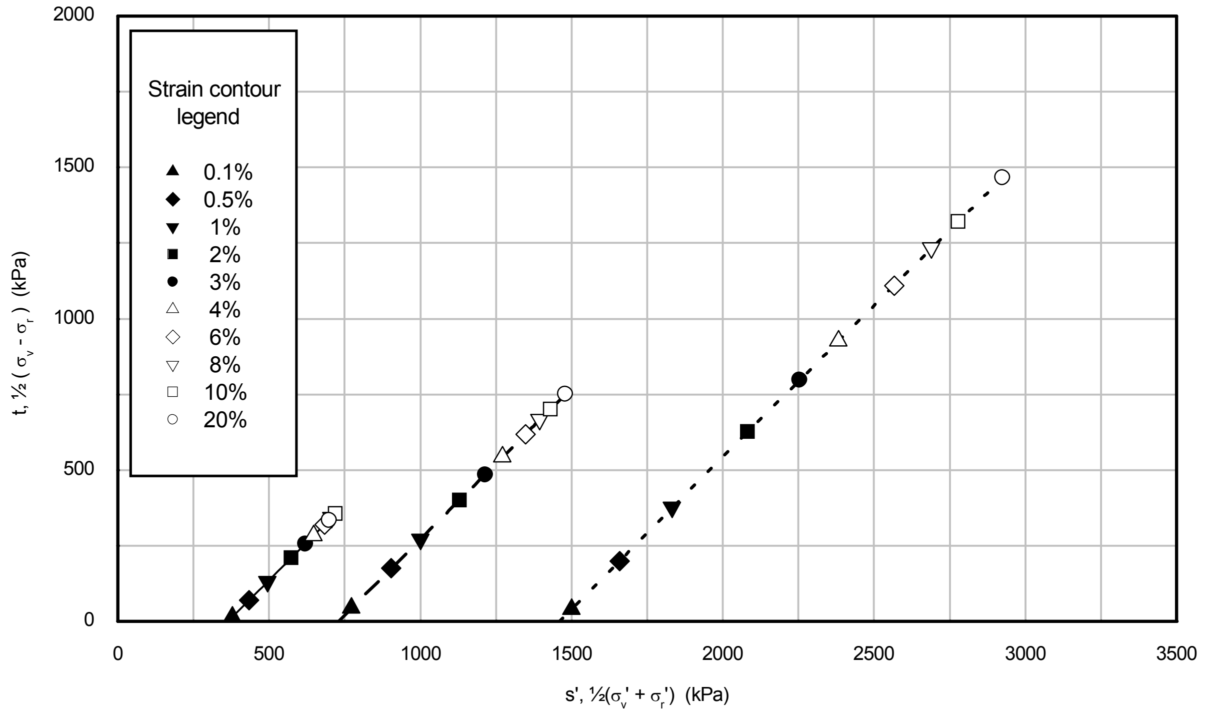


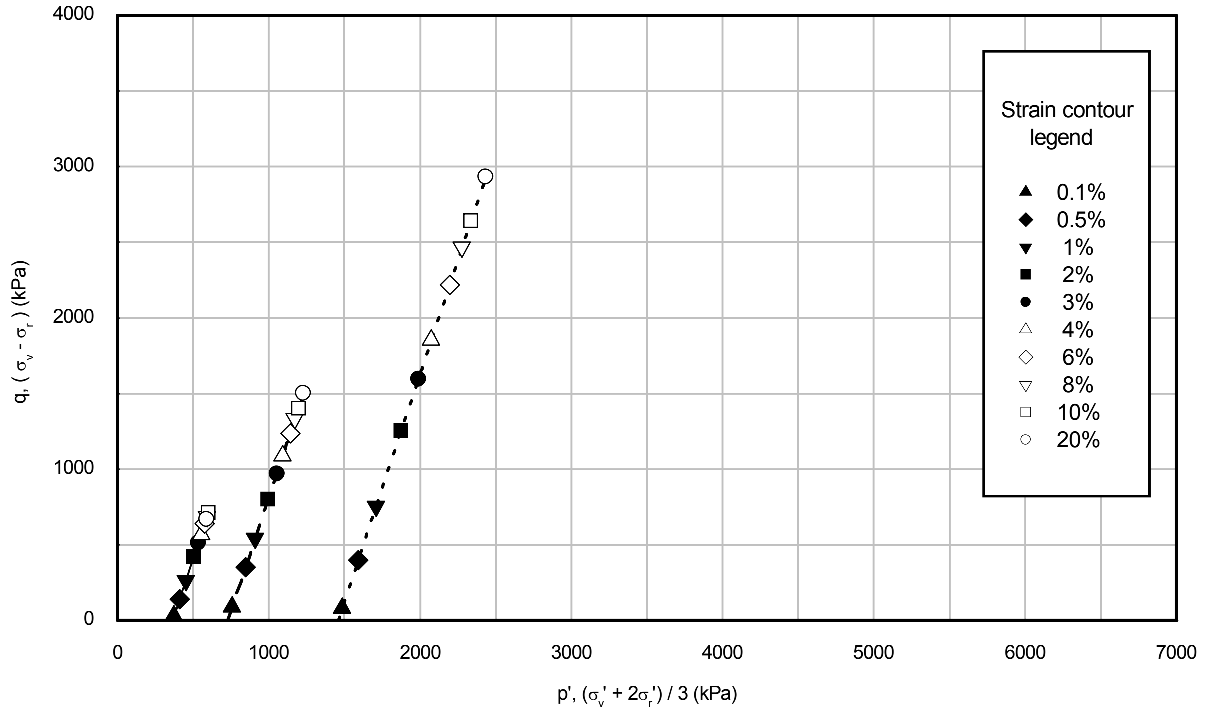
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
───	1	365	365	HKZ1-BH01 -SA	54BagB	57.30
– –	2	730	730			
· · · ·	3	1460	1460			

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Date: 01/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_54BagB_D3.OPJ
Date : 02/09/2016
Date : 05/09/2016
Checked by: MSR
Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	365	365	HKZ1-BH01 -SA	54BagB	57.30
– –	2	730	730			
- - - -	3	1460	1460			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

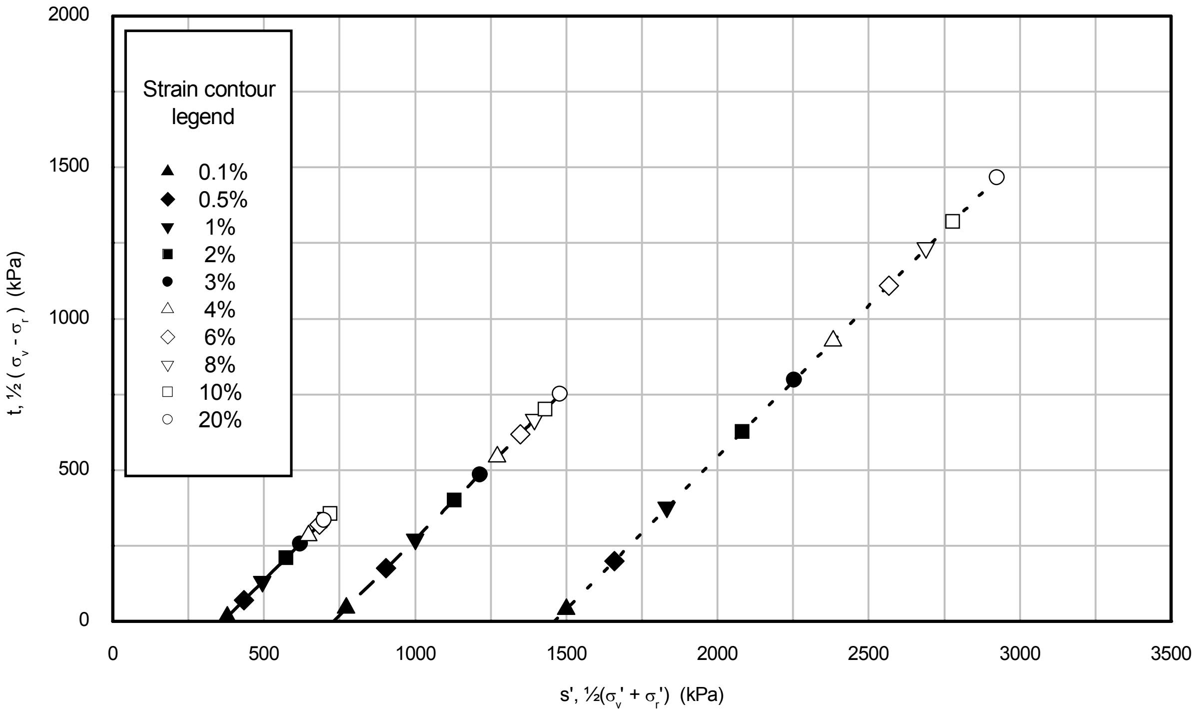
Drawn by: ALB Date: 01/09/2016

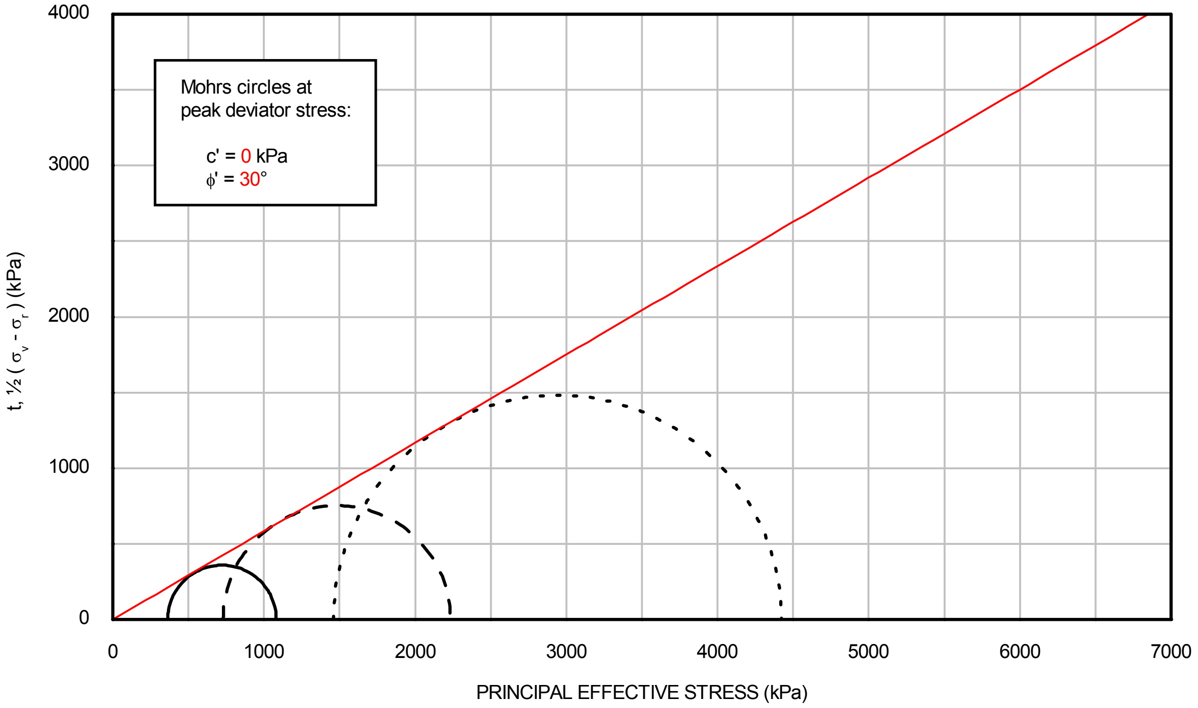
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH01-SA_54BagB_D3.OPJ

Checked by: MSR Date : 02/09/2016

Approved by: PH Date : 05/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	365	365	HKZ1-BH01-SA	54BagB	57.30
— —	2	730	730			
· · · ·	3	1460	1460			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 02/09/2016 Drawn by: ALB
Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_07BagA_D3.XLS
Date: 02/09/2016 Date: 05/09/2016
Checked by: MSR Approved by: PH

VISUAL DESCRIPTION
Dark brown fine to medium SAND with some fine to medium gravel

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		01/09/2016	01/09/2016	01/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.2	10.2	10.2
Bulk density	(Mg/m³)	1.81	1.81	1.82
Dry density	(Mg/m³)	1.65	1.64	1.65
Void ratio		0.610	0.614	0.607
Degree of saturation	(%)	44	44	44

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	343	398	503
Cell pressure on completion	(kPa)	355	410	520
B value achieved		0.96	0.98	0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	07BagA	07BagA	07BagA
Depth (m)	5.50	5.50	5.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	355	410	520
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	55	110	220
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	22.8	22.7	22.2
Bulk density	(Mg/m³)	2.03	2.03	2.04
Dry density	(Mg/m³)	1.65	1.65	1.67
Void ratio		0.605	0.602	0.589
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.33	0.75	1.08

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	07BagA	07BagA	07BagA
Depth (m)	5.50	5.50	5.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 02/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_07BagA_D3.XLS
Date: 02/09/2016
Date: 05/09/2016
Checked by: MSR
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	55	110	220
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	161	299	585
Membrane correction applied	(kPa)	0.4	0.6	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.38	4.00	4.85
Volumetric strain	(%)	-0.21	-0.01	-0.02
Major principal effective stress	(kPa)	217	410	806
Minor principal effective stress	(kPa)	56	111	221
Principal effective stress ratio		3.89	3.70	3.65
Epsilon 50 (ε 50)	(%)	0.29	0.47	0.54
Secant modulus (E50) at ε 50	(kPa)	27857	31624	54500
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	161	299	584
Membrane correction applied	(kPa)	0.4	0.6	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.51	3.75	4.35
Volumetric strain	(%)	-0.24	0.04	0.04
Major principal effective stress	(kPa)	216	410	804
Minor principal effective stress	(kPa)	55	111	220
Principal effective stress ratio		3.90	3.70	3.65
At 15% axial strain				
Corrected deviator stress	(kPa)	142	283	534
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-1.17	-1.05	-0.83
Major principal effective stress	(kPa)	198	398	756
Minor principal effective stress	(kPa)	56	115	221
Principal effective stress ratio		3.54	3.45	3.41

FINAL CONDITIONS				
Water content	(%)	23.7	23.5	22.8
Bulk density	(Mg/m³)	2.01	2.02	2.03
Dry density	(Mg/m³)	1.63	1.63	1.65

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	07BagA	07BagA	07BagA
Depth (m)	5.50	5.50	5.50

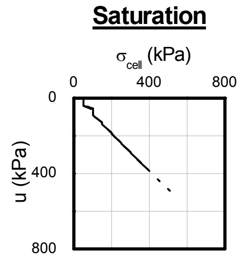
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 02/09/2016

Drawn by: ALB

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_7BagA_D3.OPJ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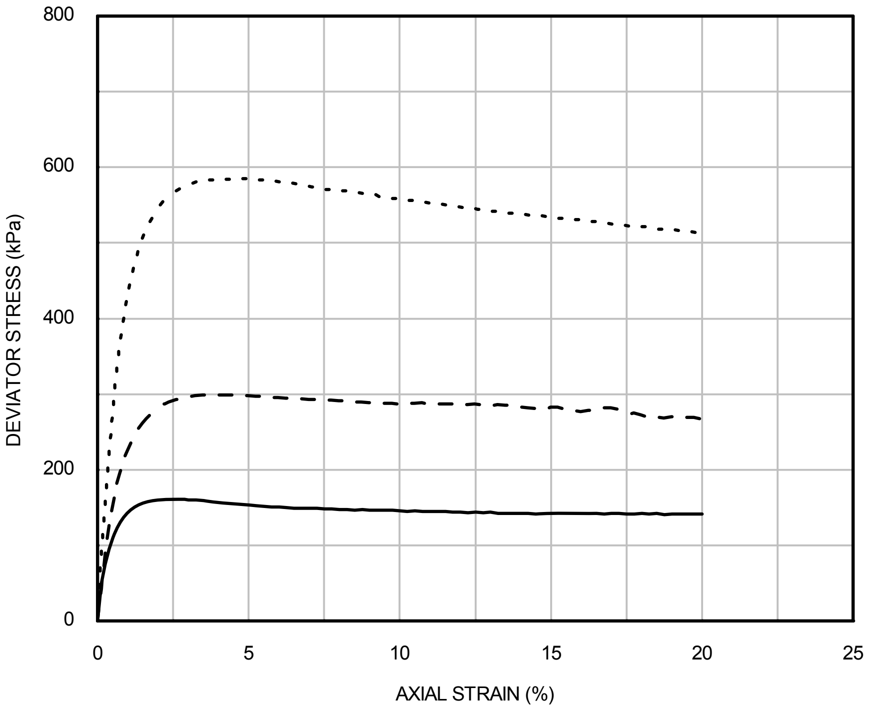

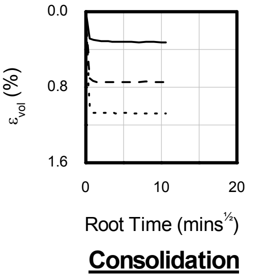
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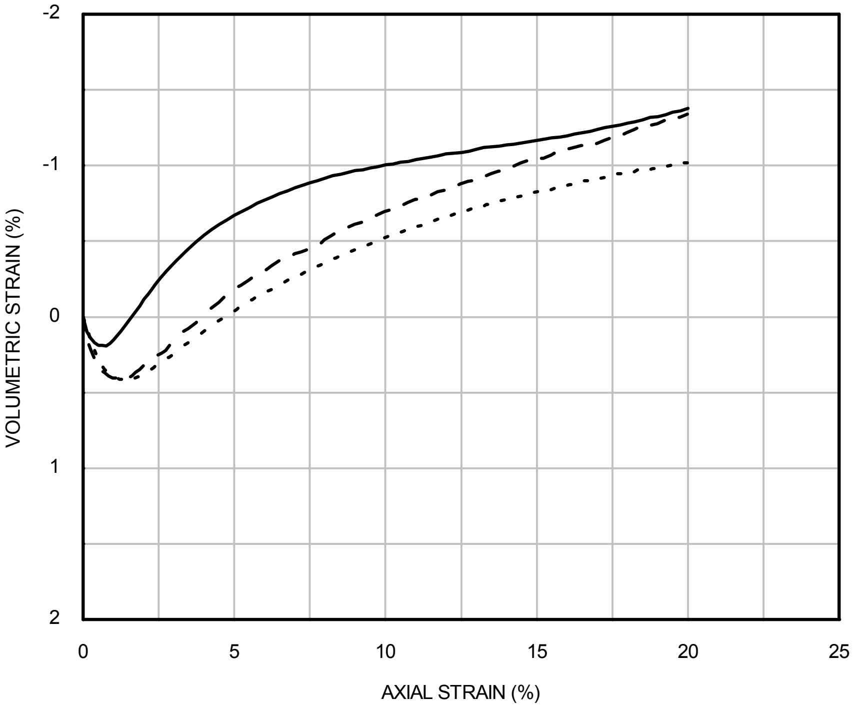


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	55	55	HKZ1-BH02 -SA	07BagA	5.50
– –	2	110	110			
· · · ·	3	220	220			

Date : 02/09/2016

Date : 05/09/2016

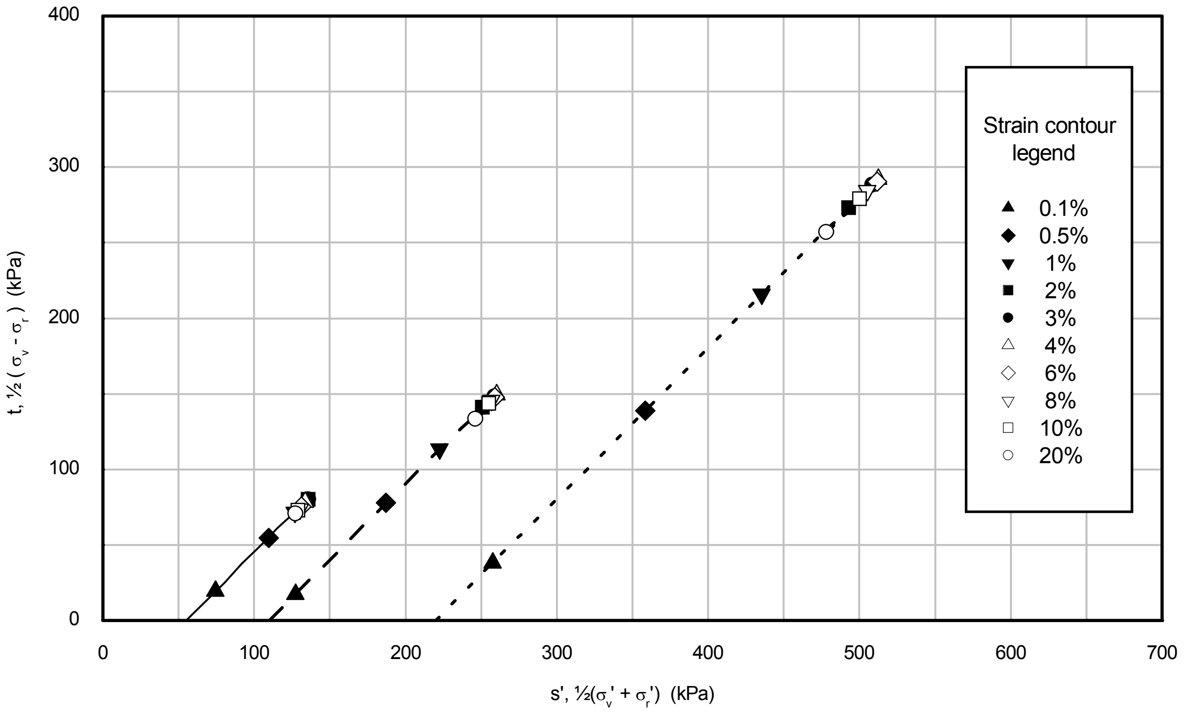
Checked by: MSR

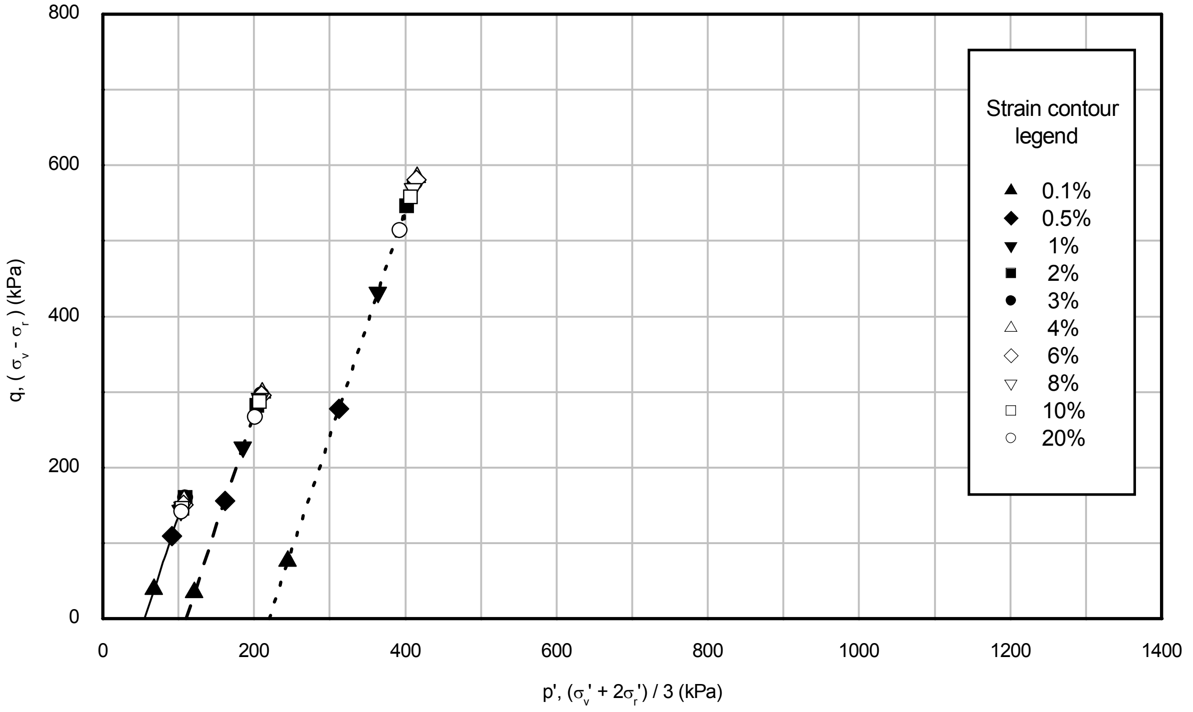
Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 02/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_7BagA_D3.OPJ





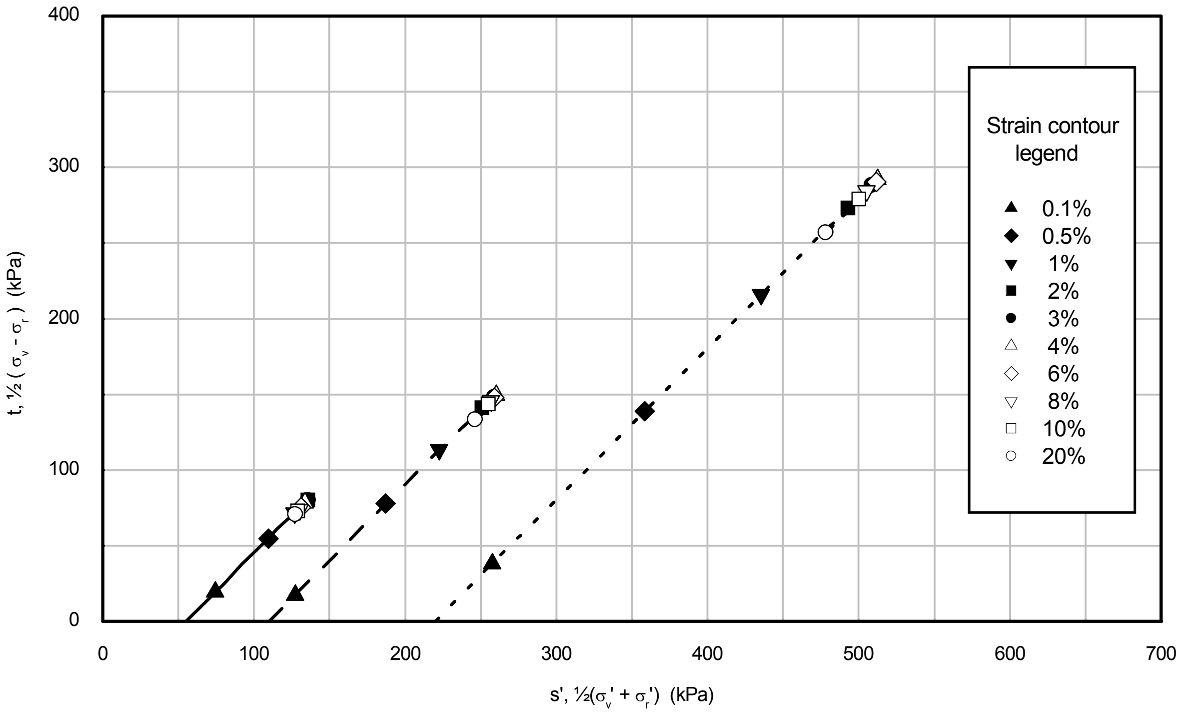
Date : 02/09/2016 Date : 05/09/2016

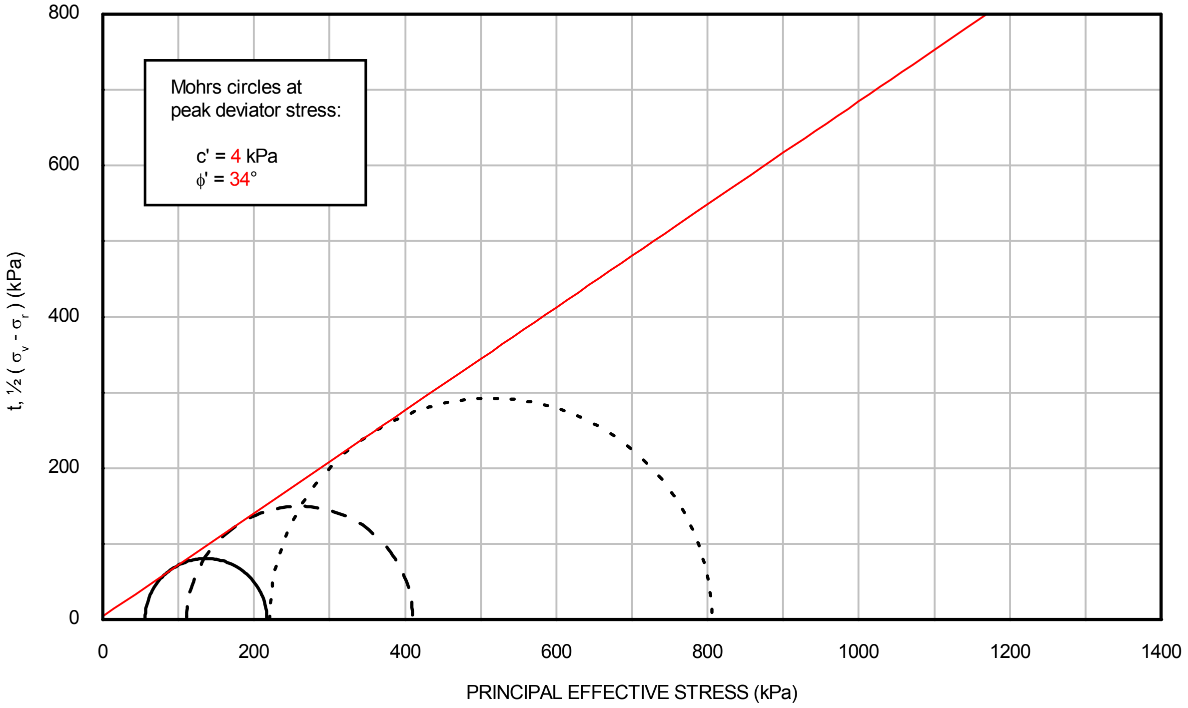
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	55	55	HKZ1-BH02 -SA	07BagA	5.50
– –	2	110	110			
· · · ·	3	220	220			

Checked by: MSR Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 02/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_7BagA_D3.OPJ





Curve	Specimen(3)	σ$_{rc}$' (kPa)	σ$_{vc}$' (kPa)	Borehole	Sample	Depth (m)
——	1	55	55	HKZ1-BH02 -SA	07BagA	5.50
— —	2	110	110			
· · · ·	3	220	220			

Date : 02/09/2016
Checked by: MSR

Date : 05/09/2016
Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 16/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_21BagB_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

VISUAL DESCRIPTION
Grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		08/09/2016	12/09/2016	15/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	9.8	10.0	9.4
Bulk density	(Mg/m³)	1.70	1.70	1.70
Dry density	(Mg/m³)	1.55	1.55	1.56
Void ratio		0.707	0.709	0.702
Degree of saturation	(%)	37	37	36

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	421	554	810
Cell pressure on completion	(kPa)	435	570	840
B value achieved		0.97	0.98	0.96

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	21BagB	21BagB	21BagB
Depth (m)	18.70	18.70	18.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	435	570	840
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	135	270	540
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.3	26.1	25.1
Bulk density	(Mg/m³)	1.97	1.98	1.99
Dry density	(Mg/m³)	1.56	1.57	1.59
Void ratio		0.697	0.691	0.664
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.62	1.07	2.21

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	21BagB	21BagB	21BagB
Depth (m)	18.70	18.70	18.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 16/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_21BagB_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	1.97
Dry density	[Mg/m^3]	1.55
Void ratio	[-]	0.707
Distance	[mm]	132.1
Effective radial pressure	[kPa]	14
Effective axial pressure	[kPa]	14

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.2530	6.27	105.46	21.9
0.22	1.2545	5.70	105.33	21.8
0.24	1.2560	5.23	105.21	21.8
0.26	1.2575	4.84	105.08	21.7
0.28	1.2560	4.49	105.21	21.8
0.30	1.2550	4.18	105.29	21.8
0.32	1.2550	3.92	105.29	21.8
0.34	1.2515	3.68	105.59	21.9
0.36	1.2530	3.48	105.46	21.9
0.38	1.2480	3.28	105.88	22.0

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	1.97
Dry density	[Mg/m^3]	1.56
Void ratio	[-]	0.697
Distance	[mm]	131.9
Effective radial pressure	[kPa]	135
Effective axial pressure	[kPa]	135

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6800	6.80	193.91	74.2
0.12	0.6825	5.69	193.20	73.6
0.14	0.6845	4.89	192.64	73.2
0.16	0.6850	4.28	192.50	73.1
0.18	0.6835	3.80	192.92	73.4
0.20	0.6795	3.40	194.06	74.3
0.22	0.6790	3.09	194.20	74.4

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	21BagB	21BagB	21BagB
Depth (m)	18.70	18.70	18.70

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 16/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_21BagB_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	135	270	540
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	336	622	1198
Membrane correction applied	(kPa)	0.5	1.0	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.42	10.75	14.61
Volumetric strain	(%)	0.21	1.23	3.36
Major principal effective stress	(kPa)	472	892	1737
Minor principal effective stress	(kPa)	136	270	539
Principal effective stress ratio		3.48	3.31	3.22
Epsilon 50 (ε 50)	(%)	0.45	0.49	1.43
Secant modulus (E50) at ε 50	(kPa)	37124	63485	41876
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	330	622	1198
Membrane correction applied	(kPa)	1.0	1.0	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	10.92	10.75	14.61
Volumetric strain	(%)	0.14	1.23	3.36
Major principal effective stress	(kPa)	462	892	1737
Minor principal effective stress	(kPa)	132	270	539
Principal effective stress ratio		3.50	3.31	3.22
At 15% axial strain				
Corrected deviator stress	(kPa)	325	607	1196
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	0.15	1.36	3.39
Major principal effective stress	(kPa)	459	877	1736
Minor principal effective stress	(kPa)	133	270	539
Principal effective stress ratio		3.44	3.25	3.22

FINAL CONDITIONS				
Water content	(%)	26.3	26.1	25.1
Bulk density	(Mg/m³)	1.97	1.98	1.99
Dry density	(Mg/m³)	1.56	1.57	1.59

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	21BagB	21BagB	21BagB
Depth (m)	18.70	18.70	18.70

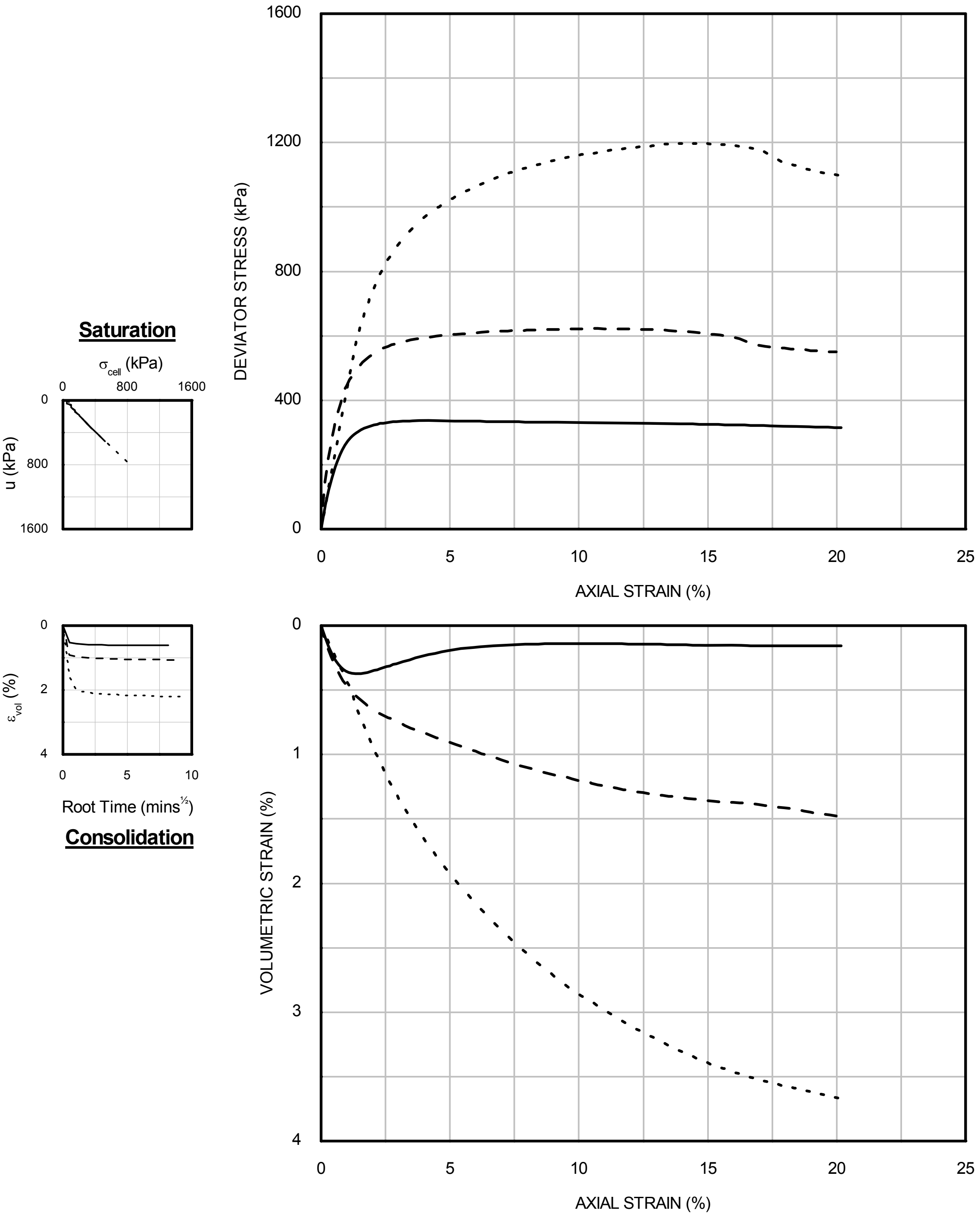
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Drawn by: ALB Date: 16/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_21BagB_D3.OPJ

Date : 03/10/2016 Date : 03/10/2016

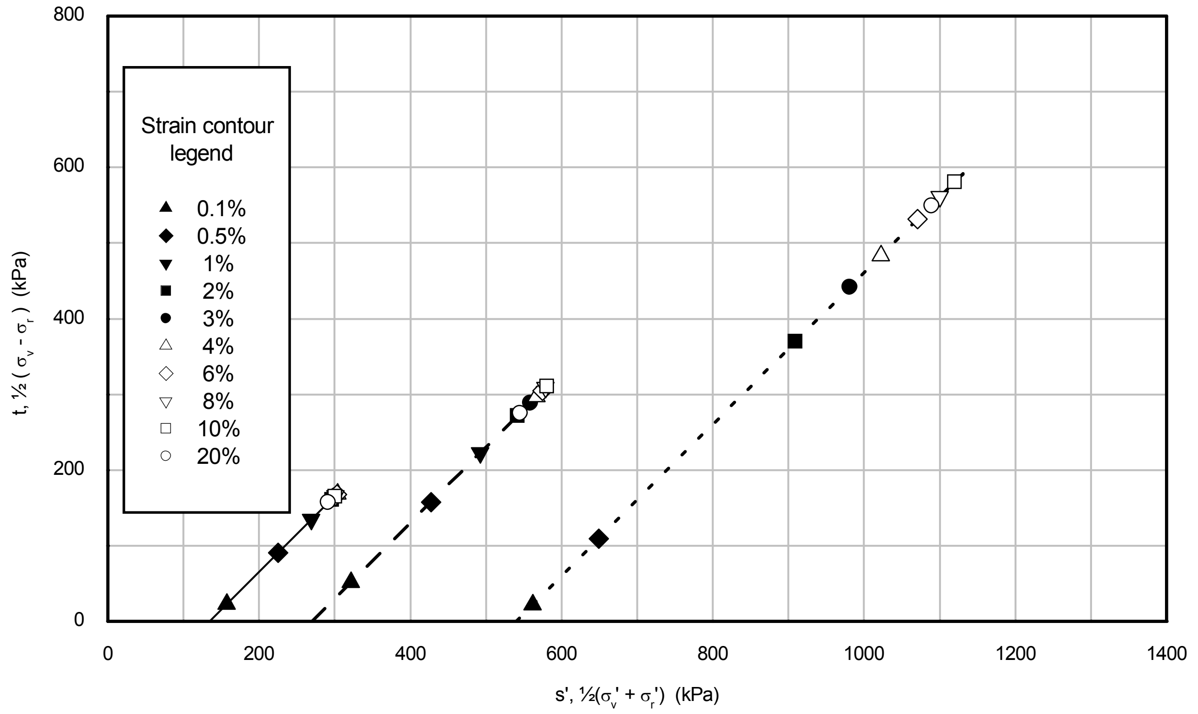
Checked by: PH Approved by: PH

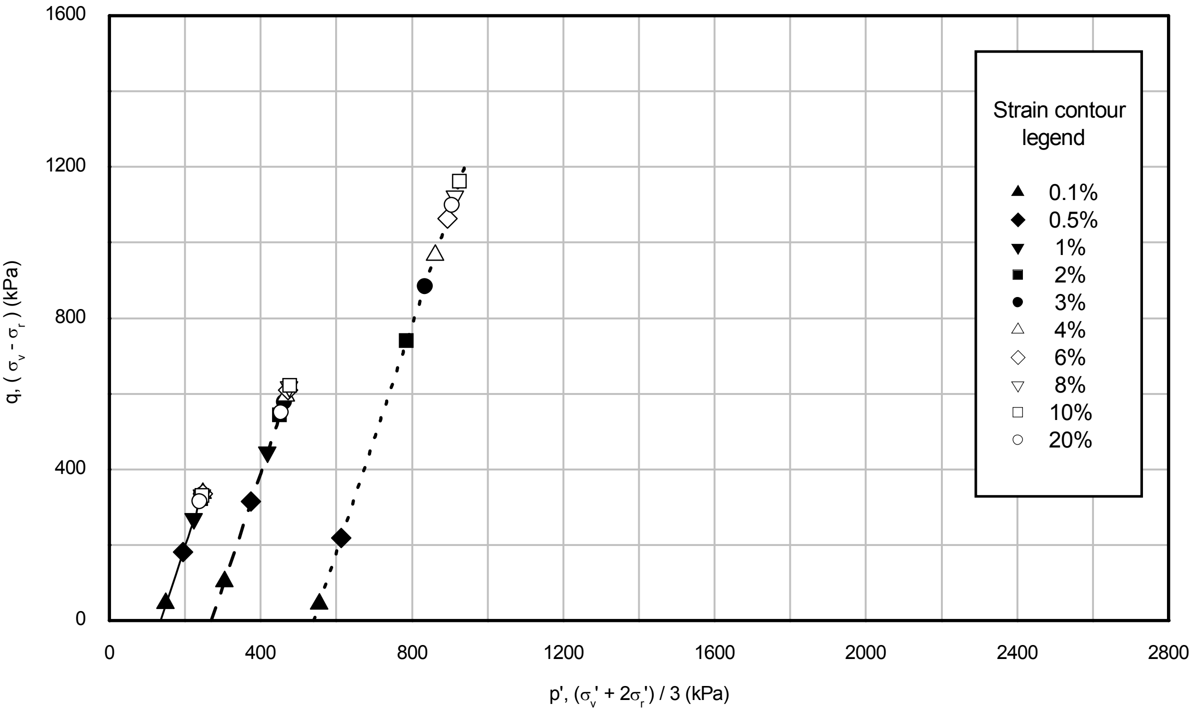


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	135	135	HKZ1-BH02 -SA	21BagB	18.70
— —	2	270	270			
· · · ·	3	540	540			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 16/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_21BagB_D3.OPJ
Date : 03/10/2016
Date : 03/10/2016
Checked by: PH
Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	135	135	HKZ1-BH02 -SA	21BagB	18.70
— —	2	270	270			
- - - -	3	540	540			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

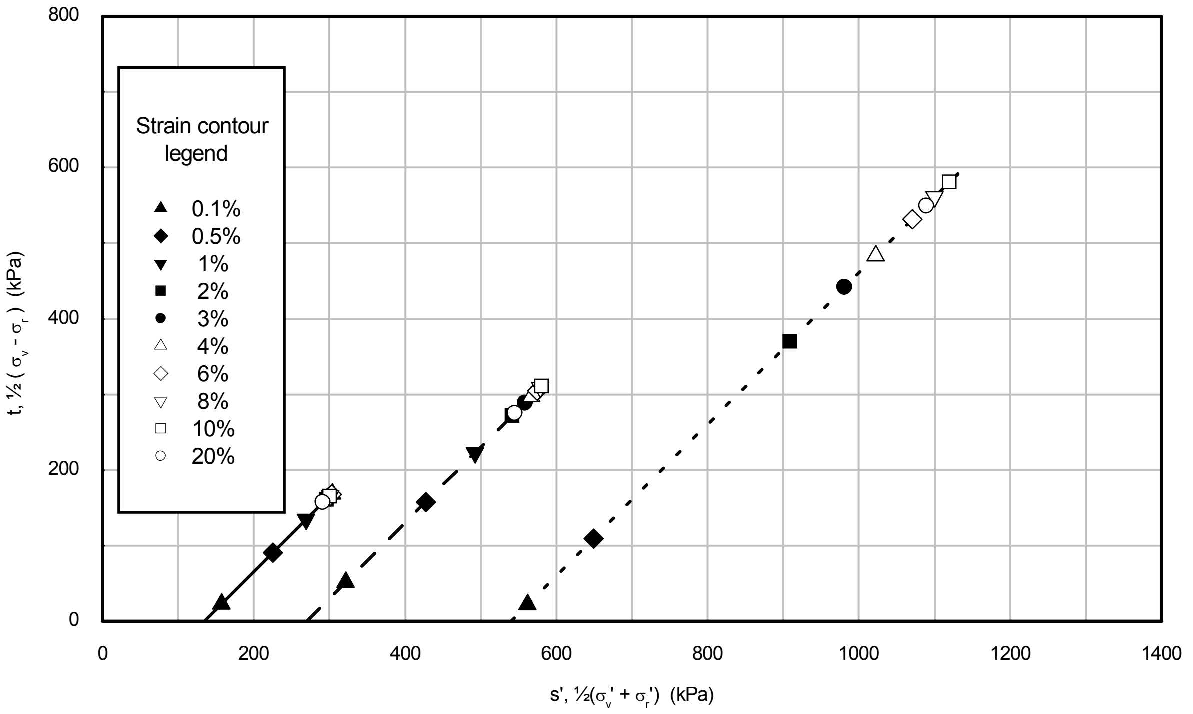
Drawn by: ALB Date: 16/09/2016

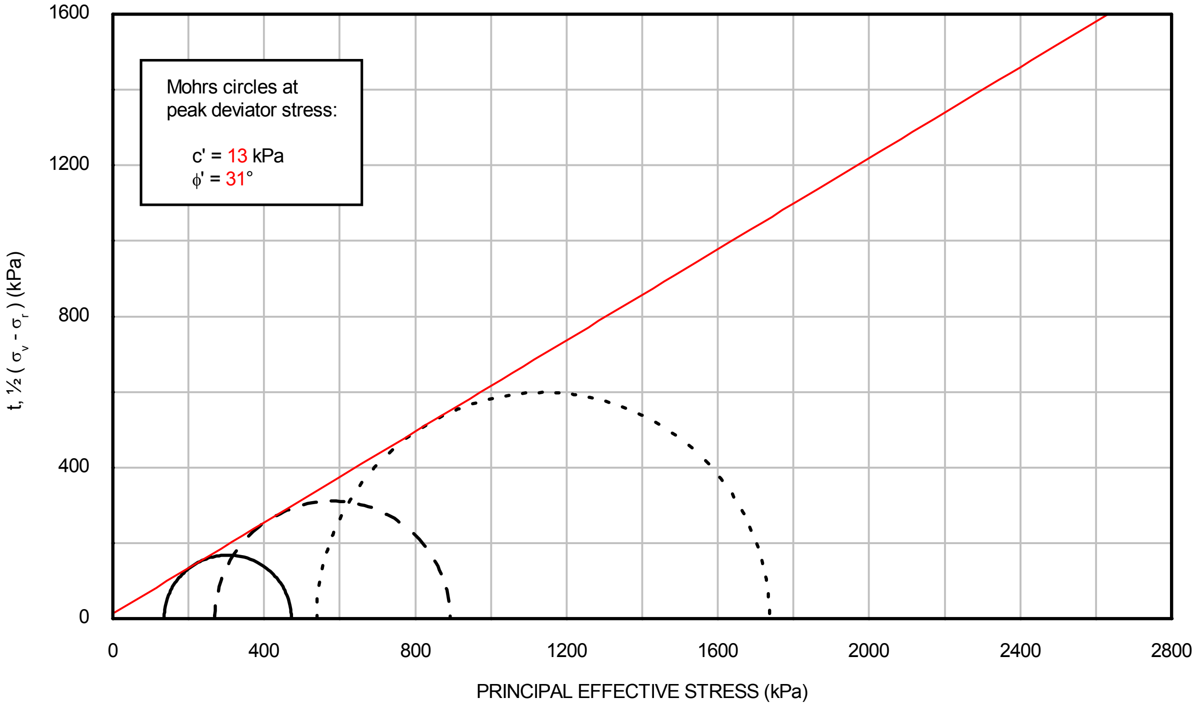
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_21BagB_D3.OPJ

Checked by: PH Date : 03/10/2016

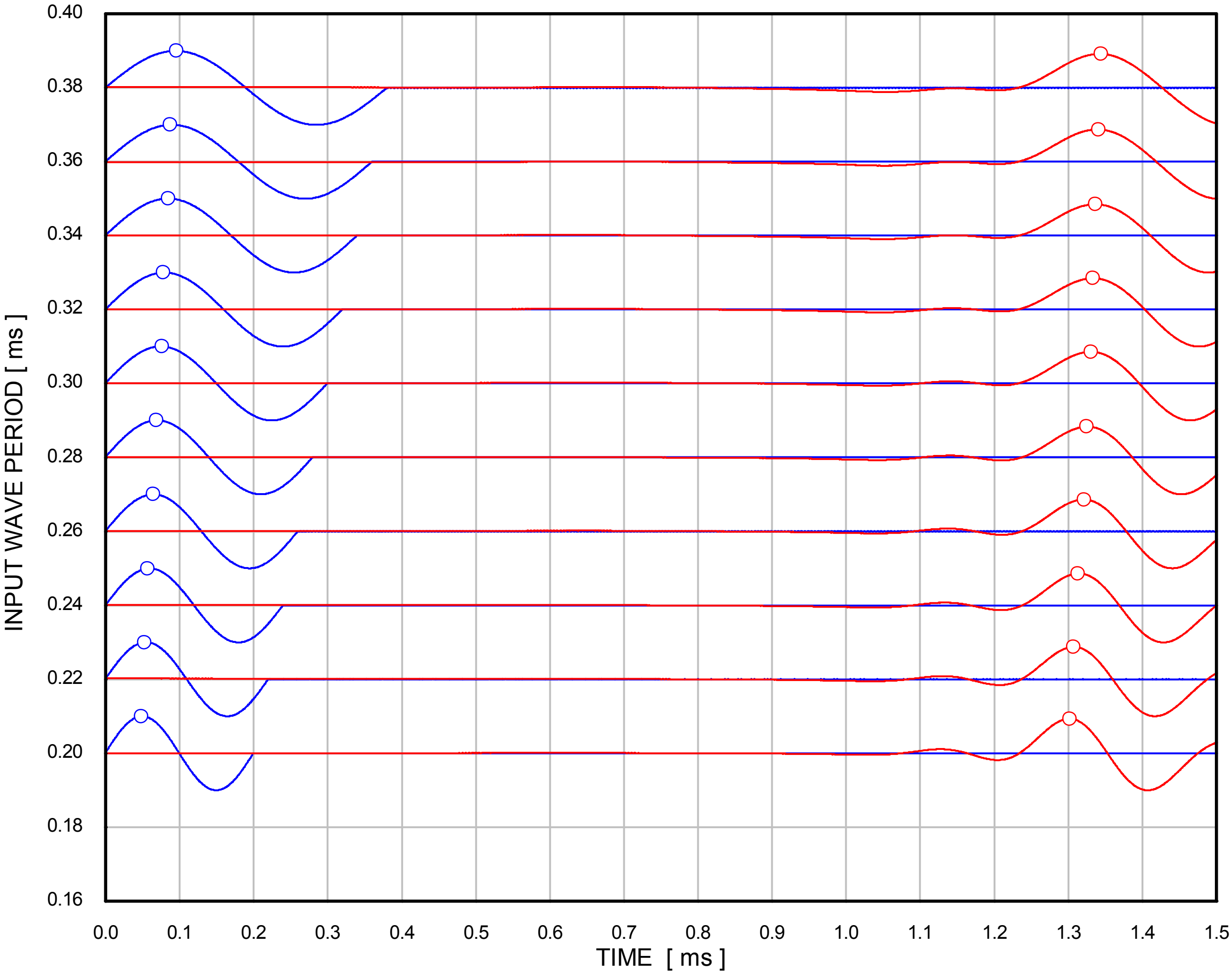
Approved by: PH Date : 03/10/2016

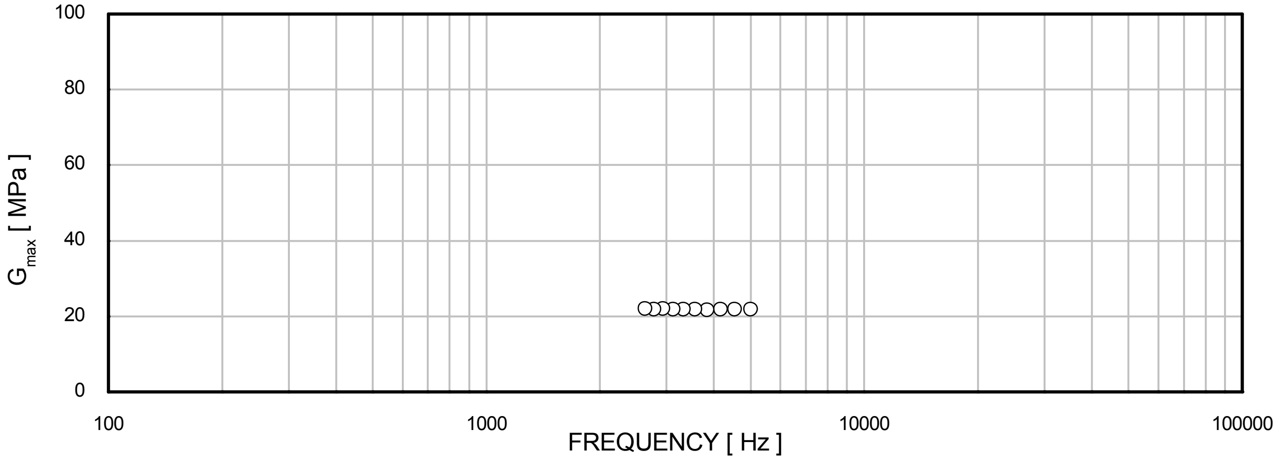




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	135	135	HKZ1-BH02 -SA	21BagB	18.70
— —	2	270	270			
· · · ·	3	540	540			

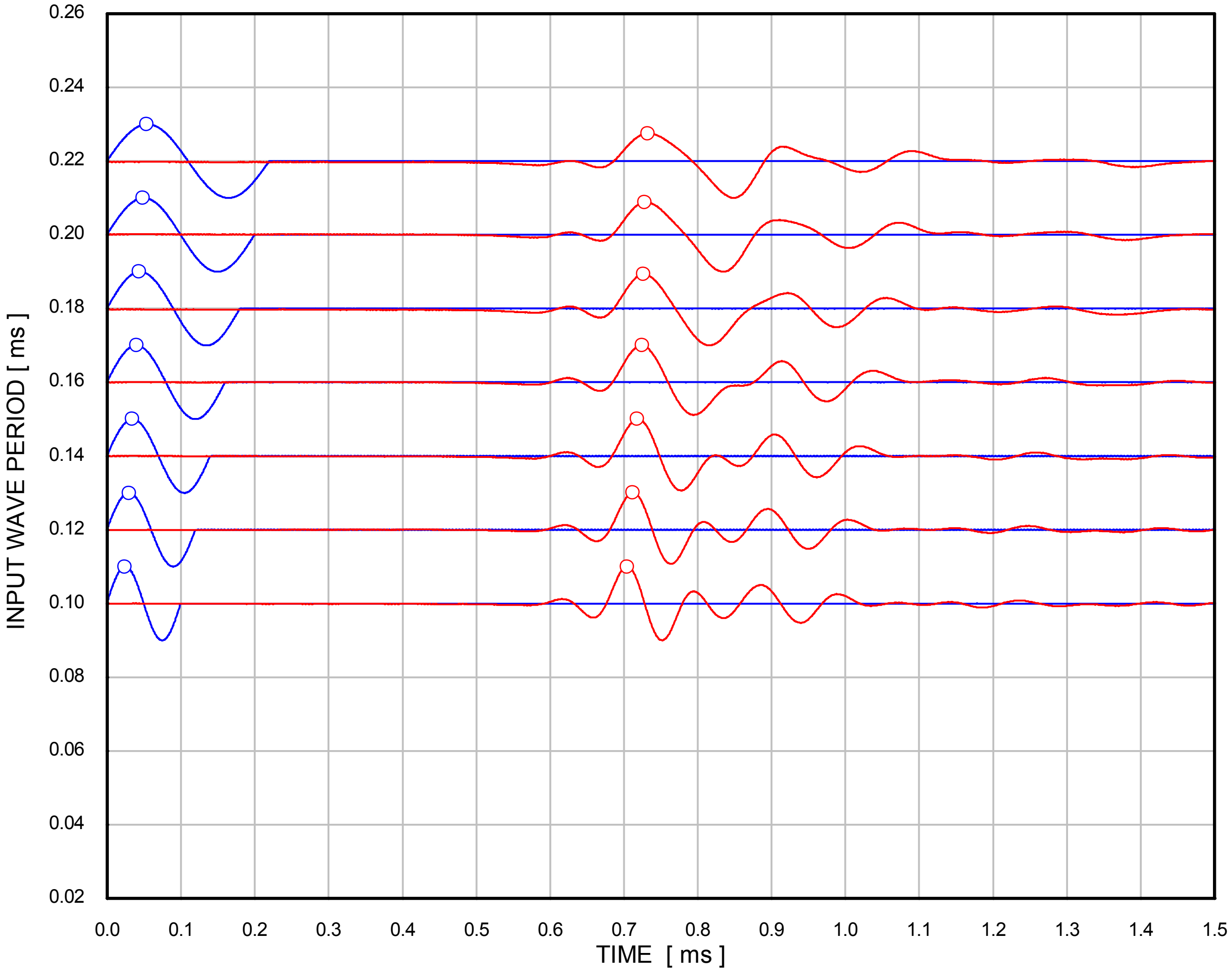
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

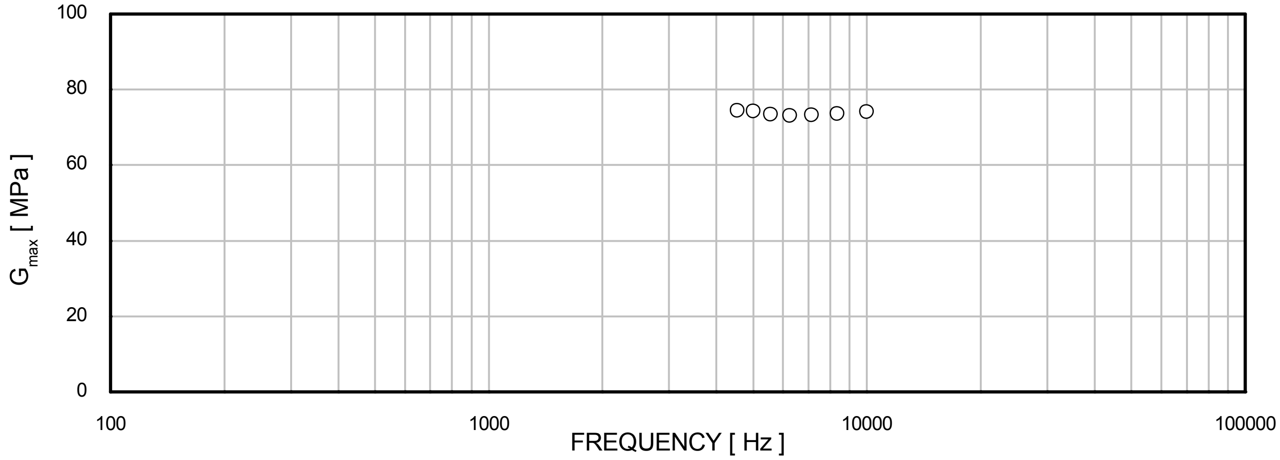




σ'_{rc}	: 14 kPa	Borehole	:	HKZ1-BH02-SA
σ'_{ac}	: 14 kPa	Sample	:	21BagB
—	Source signal	Depth [m]	:	18.70
—	Received signal	Test No.	:	205A
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc} : 135 kPa
σ'_{ac} : 135 kPa
— Source signal
— Received signal
○ / ○ Selected peak values

Borehole : HKZ1-BH02-SA
Sample : 21BagB
Depth [m] : 18.70
Test No. : 205A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 13/09/2016 Drawn by: MSR
Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_23BagA_D3.XLS
Date: 14/09/2016 Checked by: ALB
Date: 20/09/2016 Approved by: PH

VISUAL DESCRIPTION
Dark brown fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	02/09/2016	07/09/2016	02/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.0	10.2	10.0
Bulk density	(Mg/m³)	1.71	1.71	1.71
Dry density	(Mg/m³)	1.55	1.55	1.55
Void ratio		0.706	0.709	0.707
Degree of saturation	(%)	37	38	37

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	384	471	649
Cell pressure on completion	(kPa)	395	490	680
B value achieved		0.99	0.95	0.94

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 13/09/2016
Drawn by: MSR
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_23BagA_D3.XLS
Date: 14/09/2016
Date: 20/09/2016
Checked by: ALB
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	395	490	680
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	95	190	380
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.3	26.1	25.9
Bulk density	(Mg/m³)	1.97	1.97	1.98
Dry density	(Mg/m³)	1.56	1.57	1.57
Void ratio		0.697	0.692	0.686
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.53	0.99	1.27

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 13/09/2016
Drawn by: MSR
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_23BagA_D3.XLS
Date: 14/09/2016
Date: 20/09/2016
Checked by: ALB
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	95	190	380
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	267	503	939
Membrane correction applied	(kPa)	0.5	0.7	0.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.93	4.50	5.74
Volumetric strain	(%)	-0.09	-0.04	0.09
Major principal effective stress	(kPa)	362	693	1320
Minor principal effective stress	(kPa)	95	191	381
Principal effective stress ratio		3.82	3.64	3.47
Epsilon 50 (ε 50)	(%)	0.47	0.44	0.65
Secant modulus (E50) at ε 50	(kPa)	28273	57503	72602
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	267	503	939
Membrane correction applied	(kPa)	0.4	0.7	0.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.68	4.25	5.24
Volumetric strain	(%)	-0.04	0.00	0.13
Major principal effective stress	(kPa)	361	693	1319
Minor principal effective stress	(kPa)	94	190	380
Principal effective stress ratio		3.83	3.65	3.47
At 15% axial strain				
Corrected deviator stress	(kPa)	248	410	897
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-1.15	-0.77	-0.33
Major principal effective stress	(kPa)	342	601	1278
Minor principal effective stress	(kPa)	94	191	381
Principal effective stress ratio		3.62	3.15	3.35

FINAL CONDITIONS				
Water content	(%)	27.2	26.6	26.2
Bulk density	(Mg/m³)	1.96	1.97	1.97
Dry density	(Mg/m³)	1.54	1.55	1.56

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Drawn by: MSR Date: 13/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_23BagA_D3.OPJ

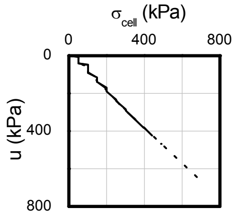
Date : 14/09/2016

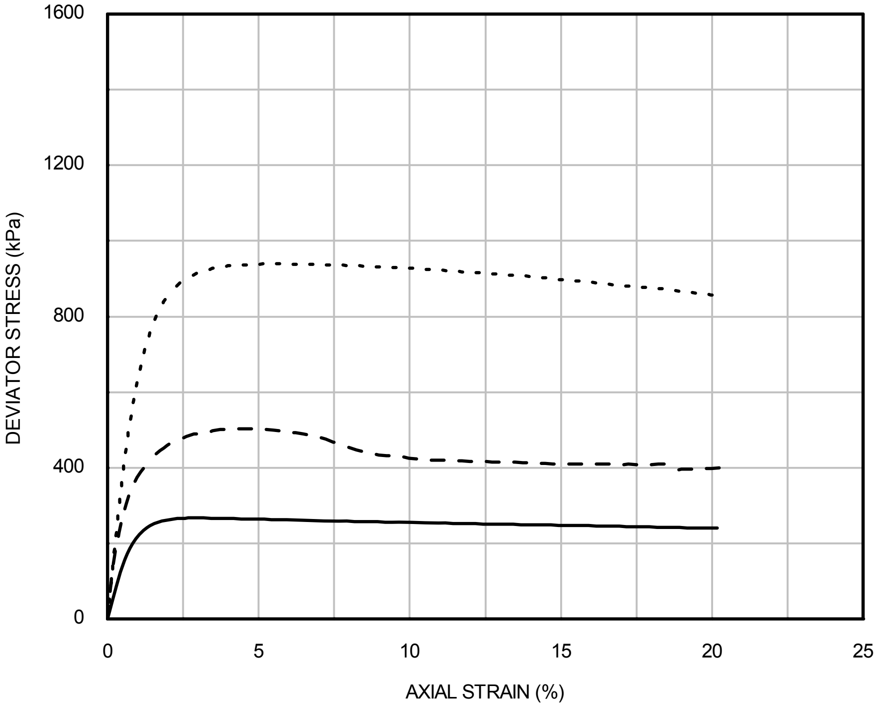
Date : 20/09/2016

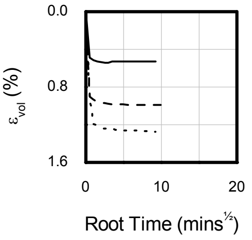
Checked by: ALB

Approved by: PH

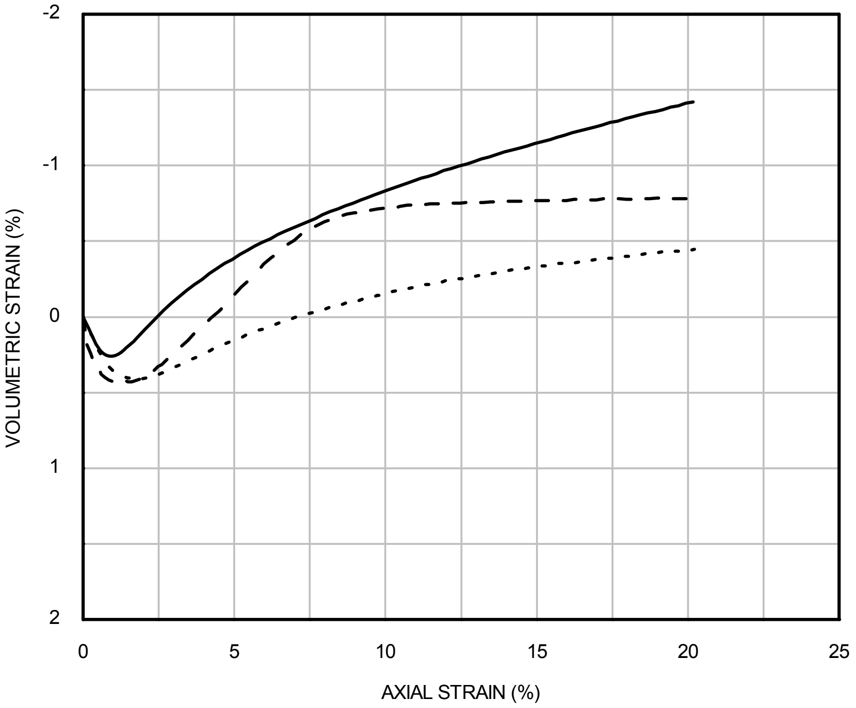
Saturation





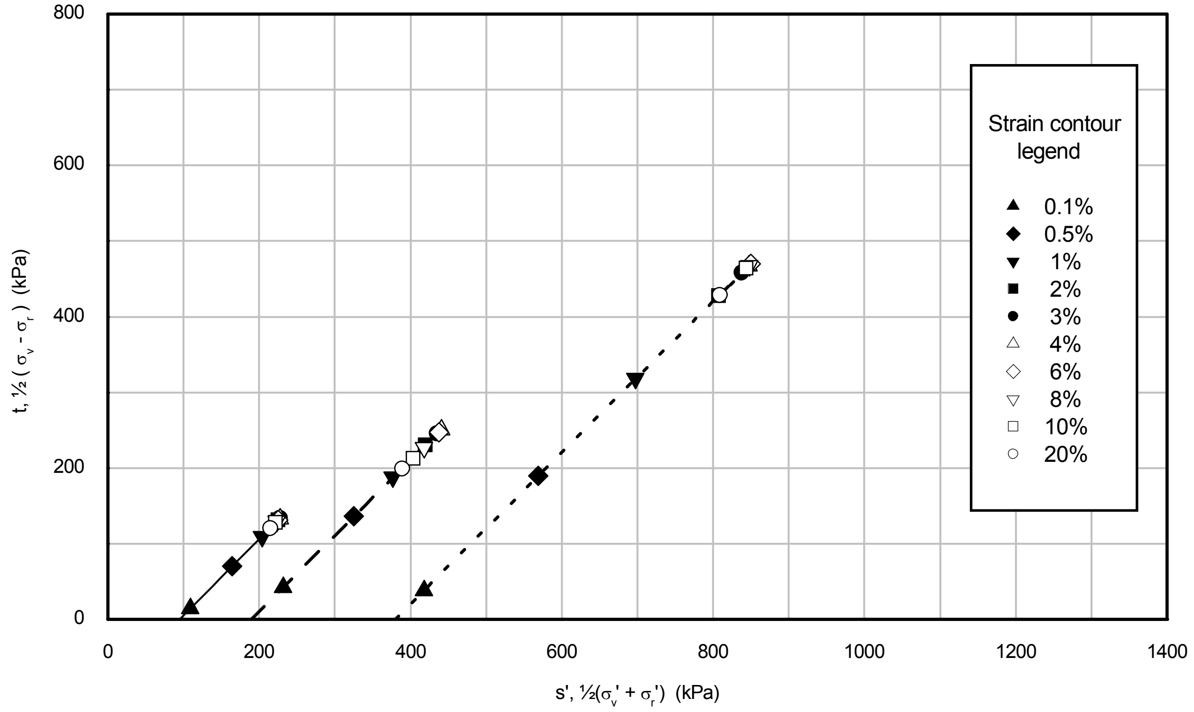


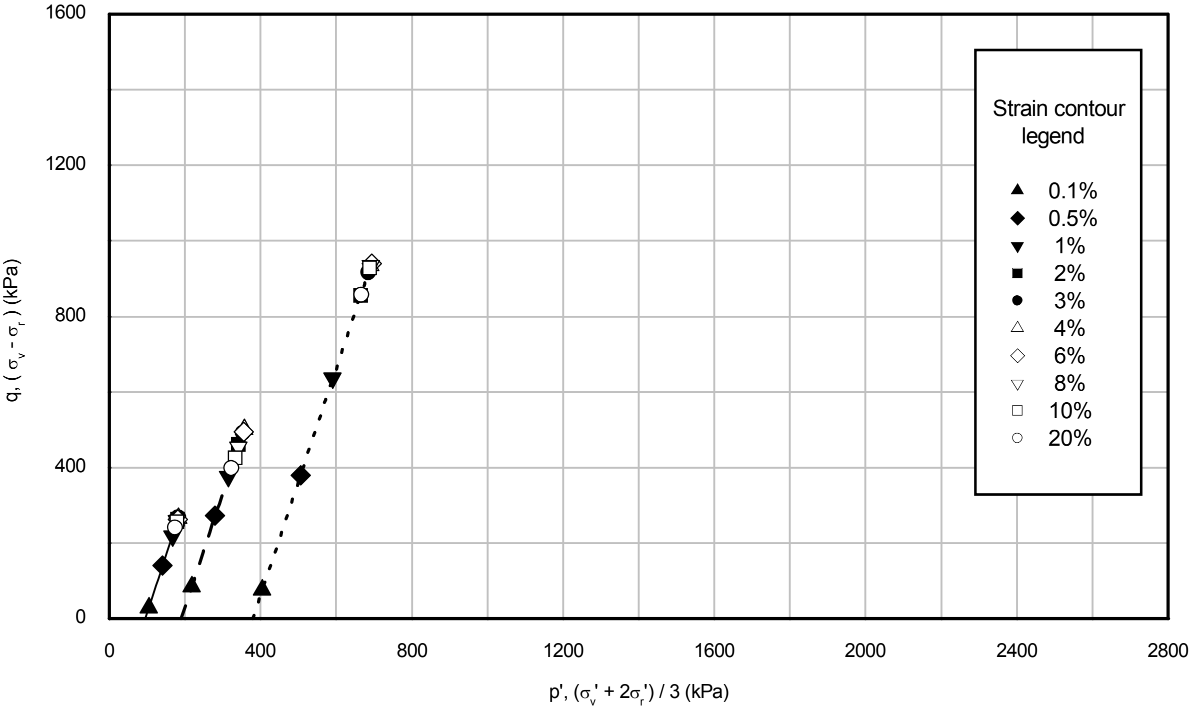
Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	95	95	HKZ1-BH02 -SA	23BagA	20.50
— —	2	190	190			
· · · ·	3	380	380			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	95	95	HKZ1-BH02 -SA	23BagA	20.50
– –	2	190	190			
- - - -	3	380	380			

Drawn by: MSR Date: 13/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_23BagA_D3.OPJ

Checked by: ALB Date : 14/09/2016

Approved by: PH Date : 20/09/2016

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

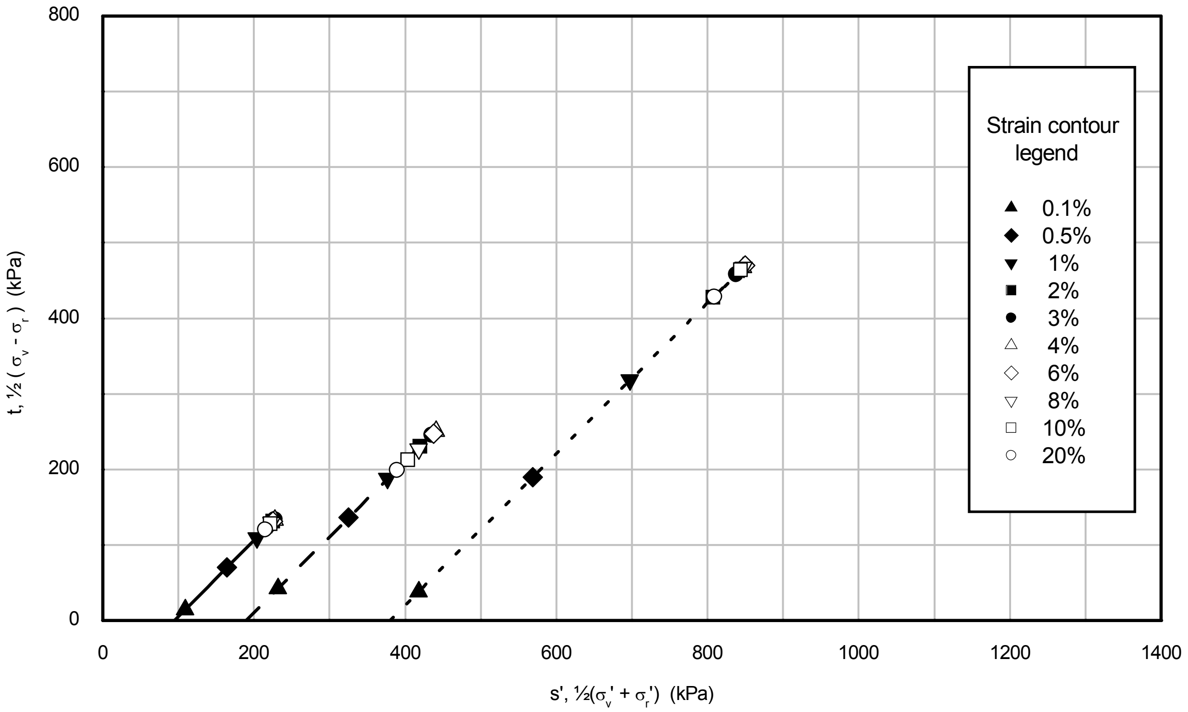
Drawn by: MSR Date: 13/09/2016

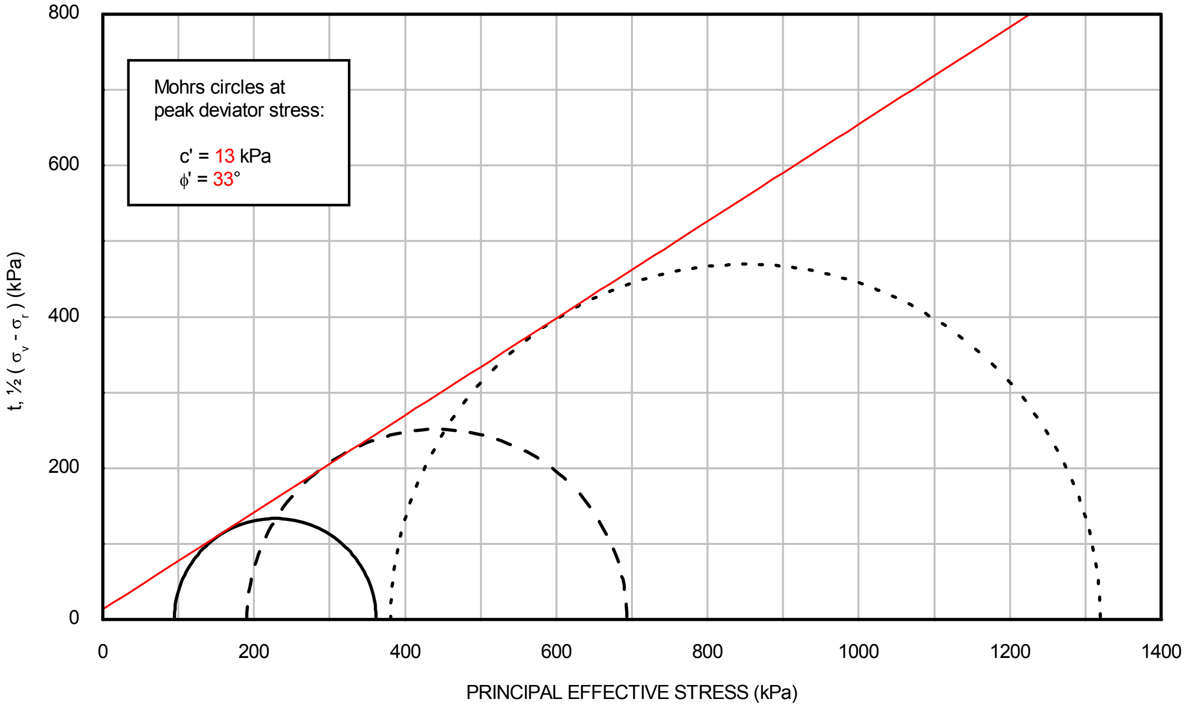
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_23BagA_D3.OPJ

Checked by: ALB Date : 14/09/2016

Approved by: PH Date : 20/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	95	95	HKZ1-BH02 -SA	23BagA	20.50
— —	2	190	190			
· · · ·	3	380	380			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Brown fine SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		07/09/2016	12/09/2016	07/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.3	10.0	10.3
Bulk density	(Mg/m^3)	1.79	1.78	1.78
Dry density	(Mg/m^3)	1.62	1.62	1.62
Void ratio		0.635	0.634	0.639
Degree of saturation	(%)	43	42	43

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	534	779	1269
Cell pressure on completion	(kPa)	555	810	1320
B value achieved		0.96	0.96	0.96

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	41BagB	41BagB	41BagB
Depth (m)	38.30	38.30	38.30

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_41BagB_D3.XLS
Date: 15/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_41BagB_D3.XLS
Date: 15/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	555	810	1320
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	255	510	1020
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	23.3	23.1	23.0
Bulk density	(Mg/m³)	2.02	2.02	2.02
Dry density	(Mg/m³)	1.64	1.64	1.65
Void ratio		0.618	0.611	0.611
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.03	1.39	1.74

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	41BagB	41BagB	41BagB
Depth (m)	38.30	38.30	38.30

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_41BagB_D3.XLS
Date: 15/09/2016
Checked by: MSR
Date: 20/09/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	255	510	1020
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	783	1357	2506
Membrane correction applied	(kPa)	0.7	0.6	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.50	3.58	4.73
Volumetric strain	(%)	-0.75	-0.29	-0.01
Major principal effective stress	(kPa)	1038	1869	3527
Minor principal effective stress	(kPa)	256	512	1021
Principal effective stress ratio		4.06	3.65	3.45
Epsilon 50 (ε 50)	(%)	0.53	0.49	0.69
Secant modulus (E50) at ε 50	(kPa)	73833	139311	180665
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	783	1357	2506
Membrane correction applied	(kPa)	0.7	0.6	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.50	3.58	4.73
Volumetric strain	(%)	-0.75	-0.29	-0.01
Major principal effective stress	(kPa)	1038	1869	3527
Minor principal effective stress	(kPa)	256	512	1021
Principal effective stress ratio		4.06	3.65	3.45
At 15% axial strain				
Corrected deviator stress	(kPa)	588	1213	2353
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-2.09	-1.67	-0.96
Major principal effective stress	(kPa)	844	1726	3374
Minor principal effective stress	(kPa)	257	512	1021
Principal effective stress ratio		3.29	3.37	3.30

FINAL CONDITIONS				
Water content	(%)	24.7	24.3	23.8
Bulk density	(Mg/m³)	2.00	2.00	2.01
Dry density	(Mg/m³)	1.60	1.61	1.62

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	41BagB	41BagB	41BagB
Depth (m)	38.30	38.30	38.30

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Drawn by: ALB Date: 14/09/2016

Template Issue: 4

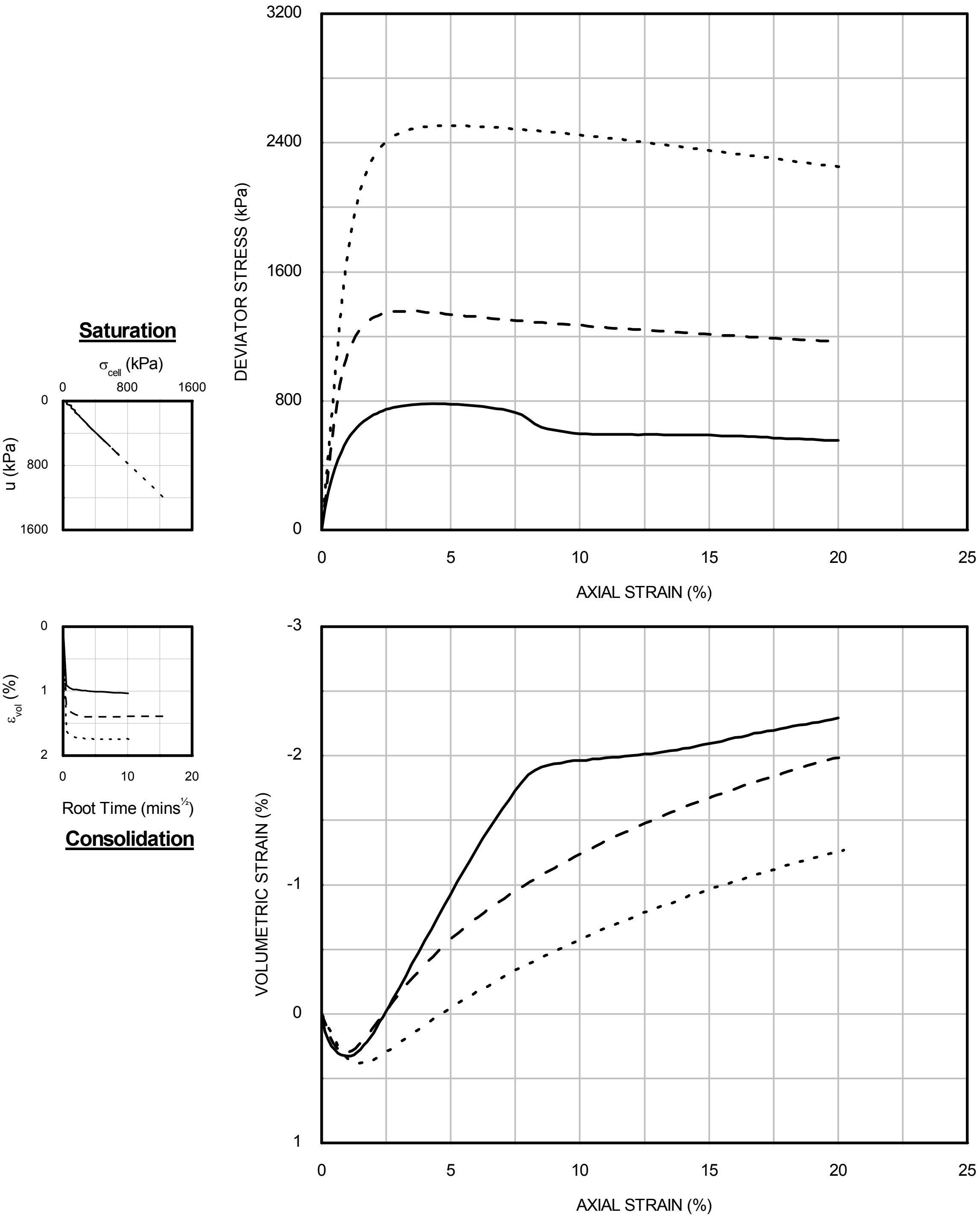
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_41BagB_D3.OPJ

Date : 15/09/2016

Date : 20/09/2016

Checked by: MSR

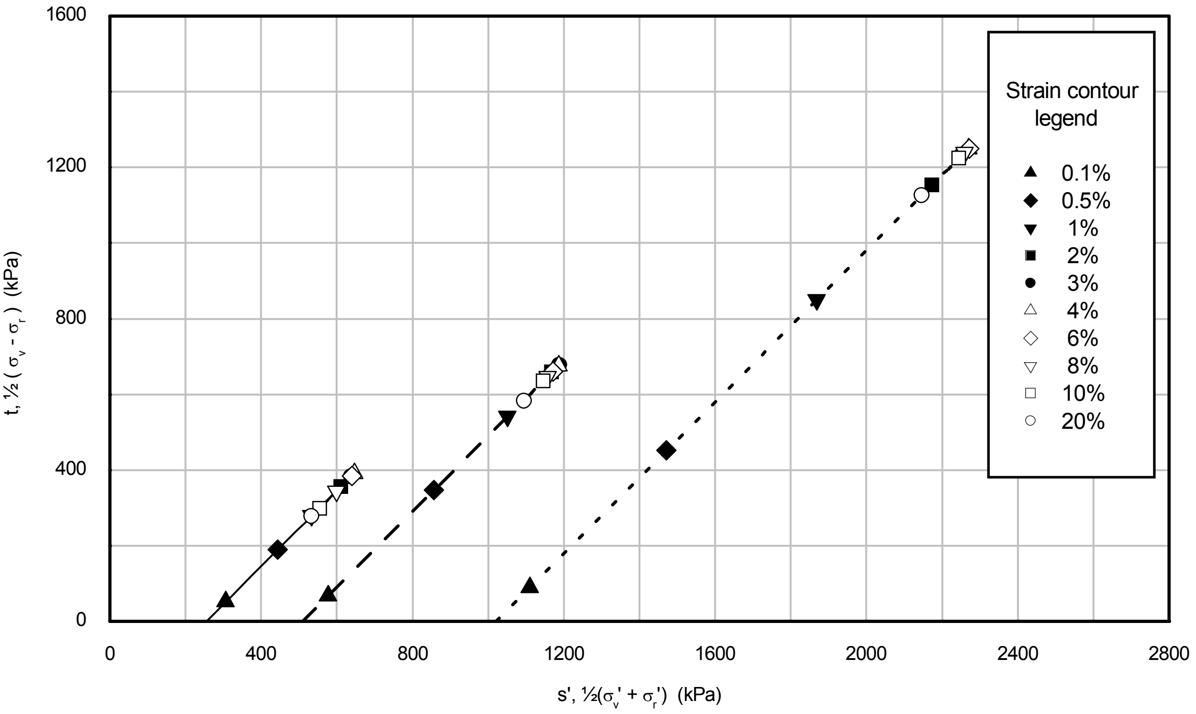
Approved by: PH

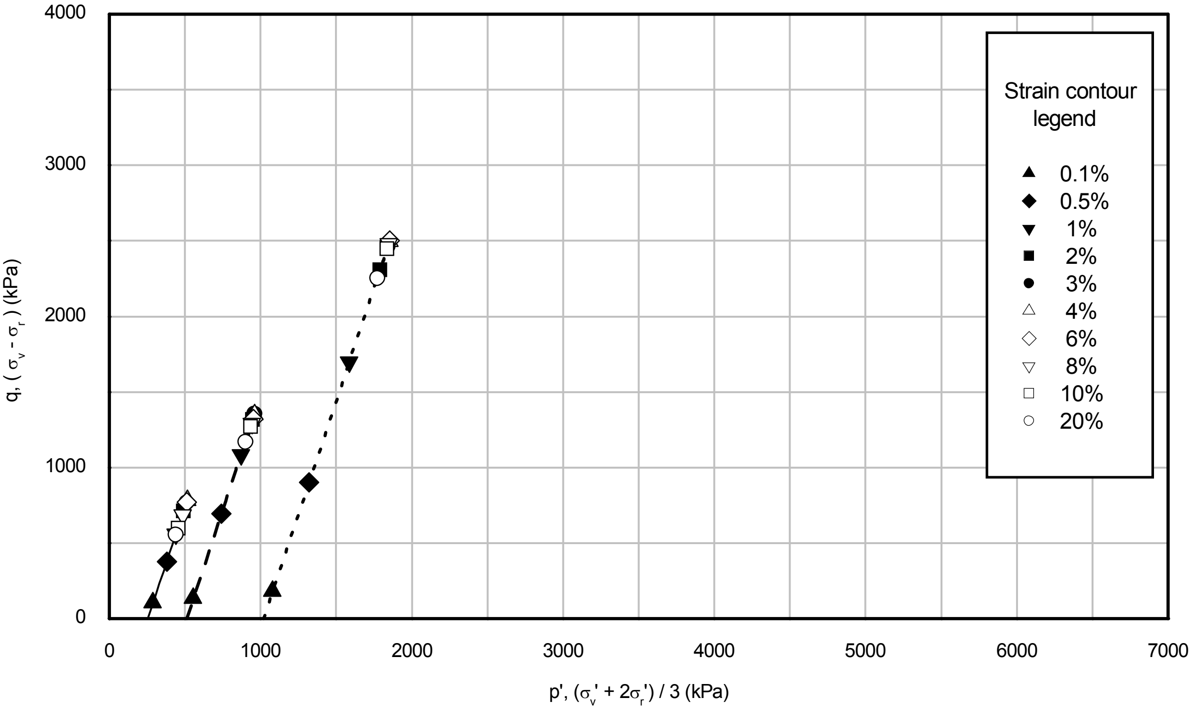


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	255	255	HKZ1-BH02-SA	41BagB	38.30
– –	2	510	510			
· · · ·	3	1020	1020			

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_41BagB_D3.OPJ
Template Issue: 4
Date : 15/09/2016
Date : 20/09/2016
Checked by: MSR
Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	255	255	HKZ1-BH02 -SA	41BagB	38.30
– –	2	510	510			
- - - -	3	1020	1020			

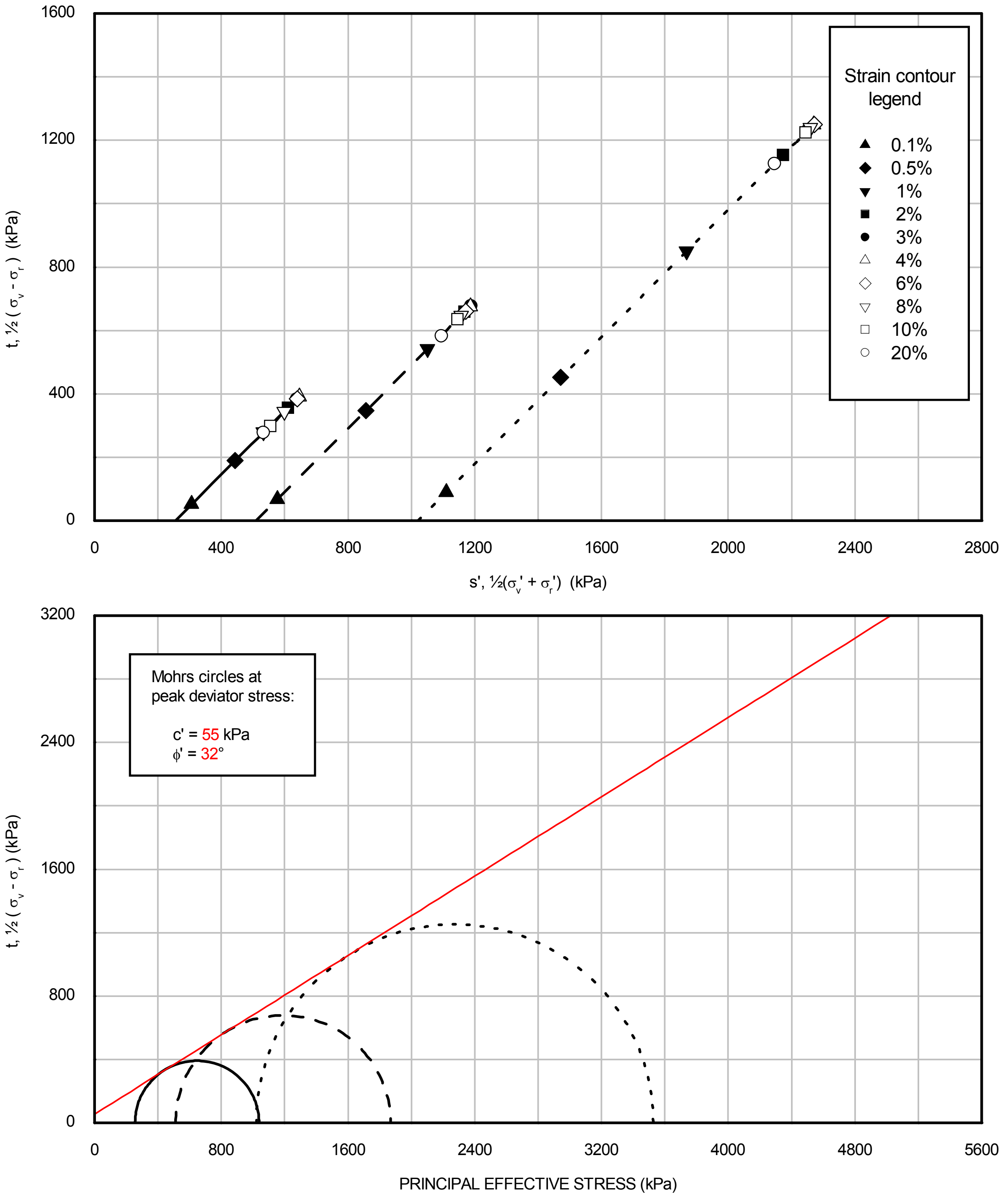
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 14/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_41BagB_D3.OPJ

Checked by: MSR Date : 15/09/2016

Approved by: PH Date : 20/09/2016



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	255	255	HKZ1-BH02 -SA	41BagB	38.30
– –	2	510	510			
· · · ·	3	1020	1020			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Dark brown fine SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		05/09/2016	05/09/2016	05/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.5	10.5	10.5
Bulk density	(Mg/m³)	1.65	1.65	1.65
Dry density	(Mg/m³)	1.50	1.50	1.50
Void ratio		0.759	0.758	0.758
Degree of saturation	(%)	37	37	37

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	517	746	1201
Cell pressure on completion	(kPa)	530	760	1220
B value achieved		0.99	0.99	0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	48BagC	48BagC	48BagC
Depth (m)	45.00	45.00	45.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 06/09/2016 Drawn by: ALB Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_48BagC_D3.XLS
Date: 07/09/2016 Checked by: MSR
Date: 13/09/2016 Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	530	760	1220
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	230	460	920
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.2	24.7	23.7
Bulk density	(Mg/m³)	1.97	1.99	2.00
Dry density	(Mg/m³)	1.56	1.59	1.62
Void ratio		0.688	0.650	0.622
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	4.01	6.15	7.69

Mode of failure:	Compound failure	Compound failure	Compound failure

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	48BagC	48BagC	48BagC
Depth (m)	45.00	45.00	45.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 06/09/2016 Drawn by: ALB Template Issue: 7 Date: 07/09/2016 Checked by: MSR

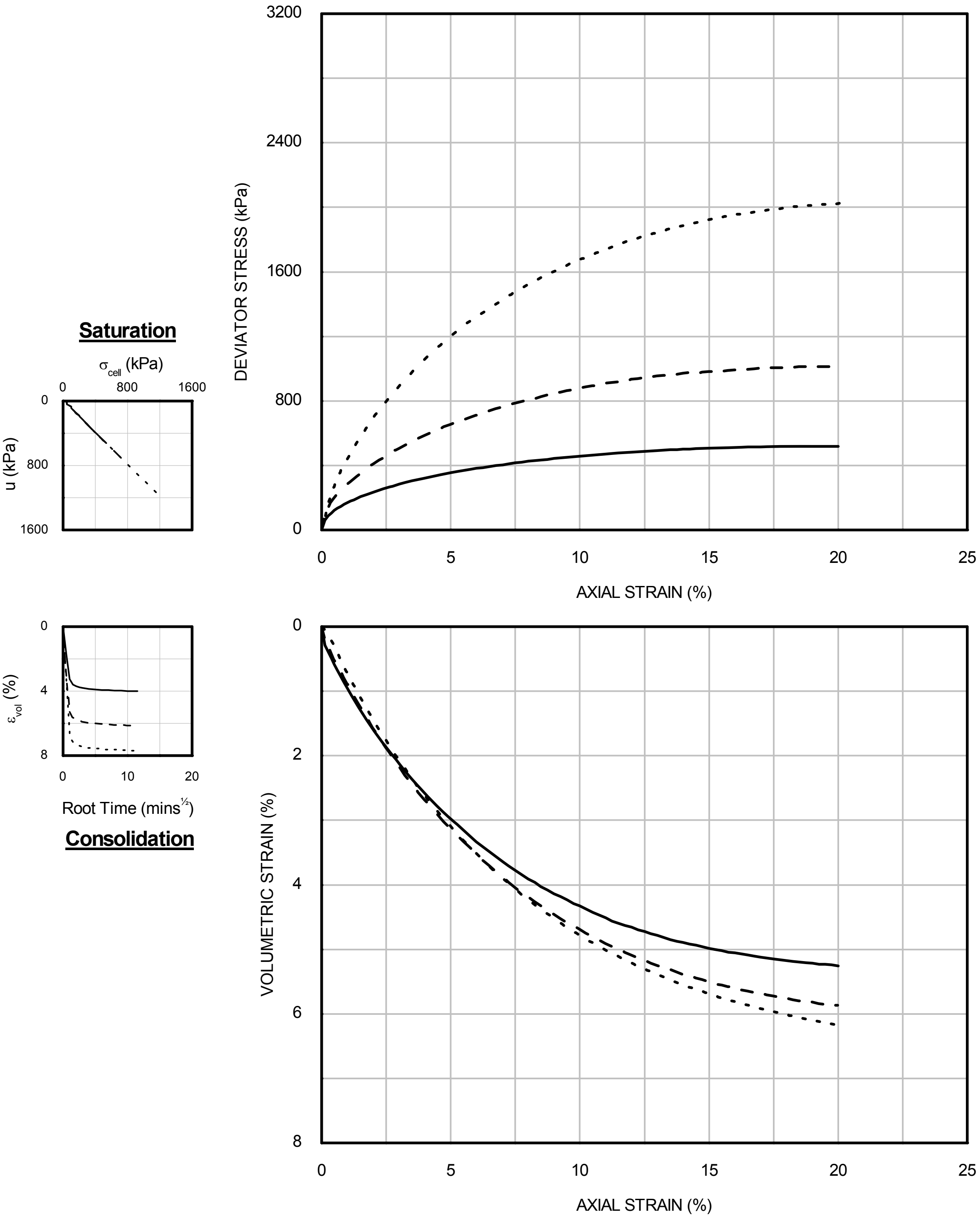
Filename: J11335 / EFFECTIV / HKZ1-BH02-SA_48BagC_D3.XLS Date: 13/09/2016 Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	230	460	920
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	519	1015	2025
Membrane correction applied	(kPa)	2.2	2.2	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	19.75	20.01	20.13
Volumetric strain	(%)	5.24	5.87	6.19
Major principal effective stress	(kPa)	749	1469	2944
Minor principal effective stress	(kPa)	229	453	919
Principal effective stress ratio		3.27	3.24	3.20
Epsilon 50 (ε 50)	(%)	2.48	3.00	3.70
Secant modulus (E50) at ε 50	(kPa)	10471	16932	27340
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	519	1014	2025
Membrane correction applied	(kPa)	2.2	2.2	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	19.75	19.51	20.13
Volumetric strain	(%)	5.24	5.85	6.19
Major principal effective stress	(kPa)	749	1466	2944
Minor principal effective stress	(kPa)	229	452	919
Principal effective stress ratio		3.27	3.24	3.20
At 15% axial strain				
Corrected deviator stress	(kPa)	506	980	1923
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	4.98	5.50	5.69
Major principal effective stress	(kPa)	736	1432	2841
Minor principal effective stress	(kPa)	229	452	918
Principal effective stress ratio		3.21	3.17	3.09

FINAL CONDITIONS				
Water content	(%)	22.8	21.0	19.9
Bulk density	(Mg/m^3)	2.02	2.05	2.07
Dry density	(Mg/m^3)	1.64	1.69	1.73

Borehole	HKZ1-BH02-SA	HKZ1-BH02-SA	HKZ1-BH02-SA
Sample	48BagC	48BagC	48BagC
Depth (m)	45.00	45.00	45.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

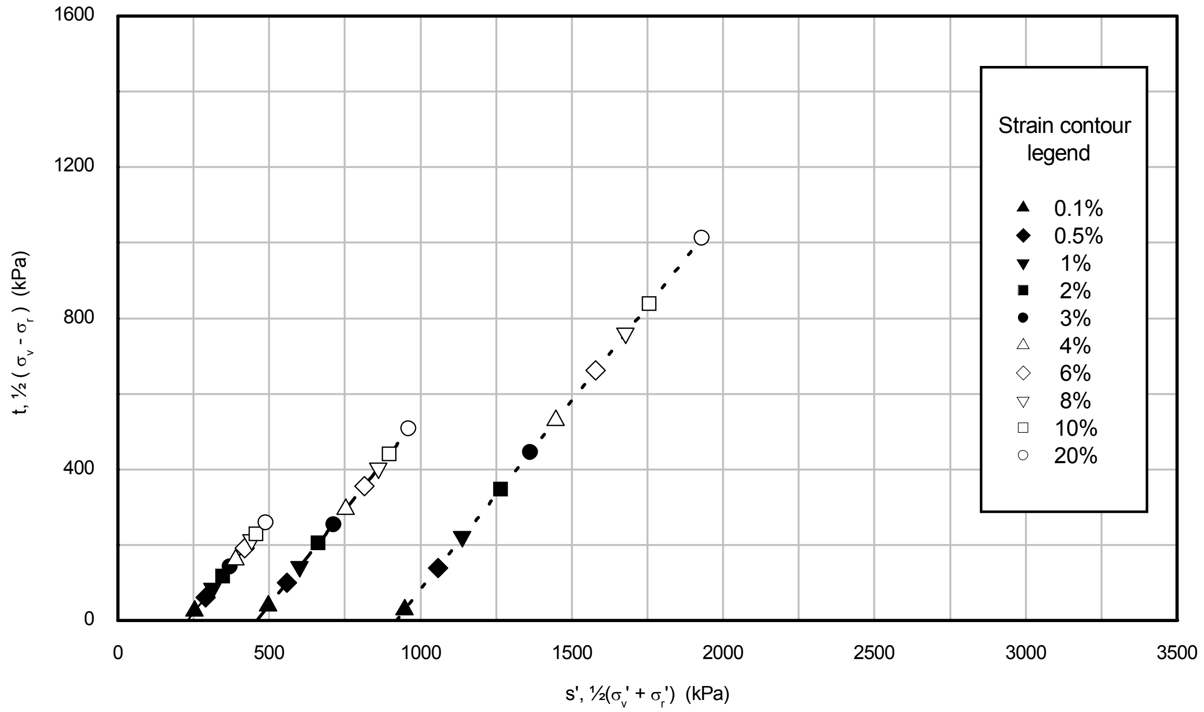


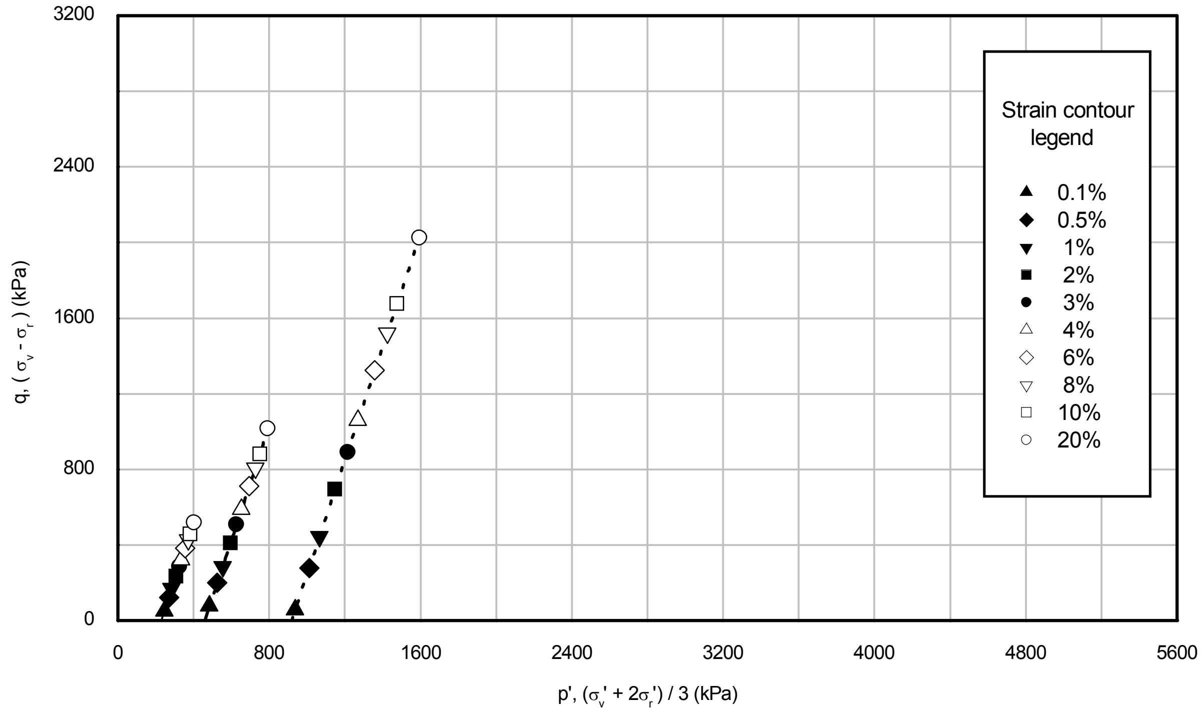
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	230	230	HKZ1-BH02 -SA	48BagC	45.00
– –	2	460	460			
· · · ·	3	920	920			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 06/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_48BagC_D3.OPJ
Date : 07/09/2016
Date : 13/09/2016
Checked by: MSR
Approved by: PH

Date: 06/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_48BagC_D3.OPJ
Date : 07/09/2016
Date : 13/09/2016
Checked by: MSR
Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	230	230	HKZ1-BH02 -SA	48BagC	45.00
– –	2	460	460			
- - - -	3	920	920			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

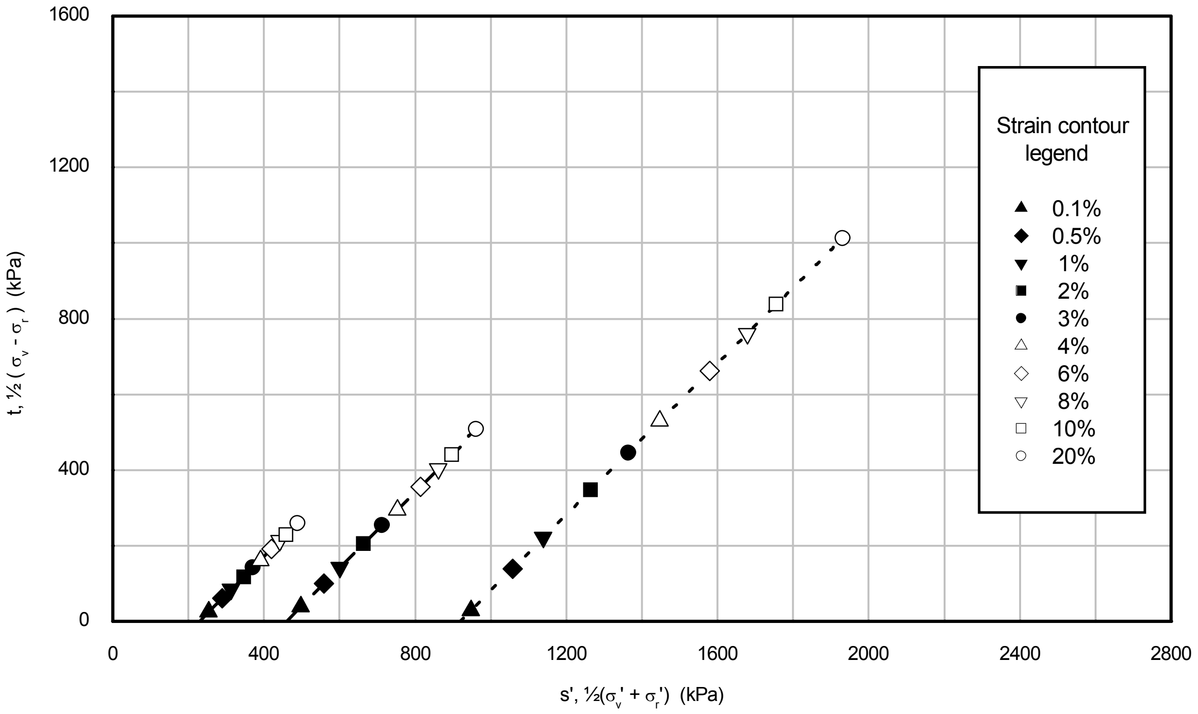
Drawn by: ALB Date: 06/09/2016

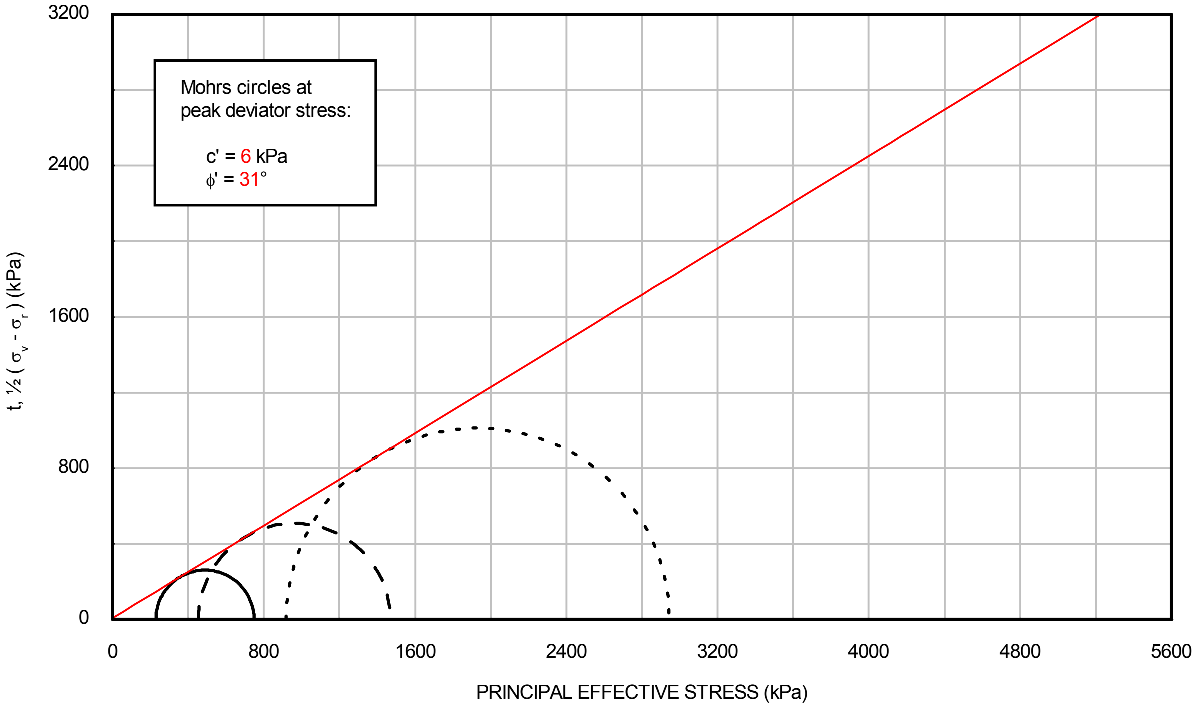
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH02-SA_48BagC_D3.OPJ

Checked by: MSR Date : 07/09/2016

Approved by: PH Date : 13/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	230	230	HKZ1-BH02 -SA	48BagC	45.00
– –	2	460	460			
· · · ·	3	920	920			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		29/08/2016	01/09/2016	08/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.2	10.4	10.1
Bulk density	(Mg/m³)	1.82	1.81	1.81
Dry density	(Mg/m³)	1.65	1.64	1.65
Void ratio		0.607	0.613	0.607
Degree of saturation	(%)	44	45	44

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	367	445	602
Cell pressure on completion	(kPa)	380	460	620
B value achieved		0.98	0.97	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	7.50	7.50	7.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_14BagA_D3.XLS
Date 13/09/2016:
Date: 20/09/2016
Checked by:MSR
Approved by: PH

Date: 09/09/2016 Drawn by: ALB Template Issue: 2 Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_14BagA_D3.XLS

Date 13/09/2016: Checked by:MSR Date: 20/09/2016 Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	380	460	620
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	80	160	320
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	22.7	22.6	22.3
Bulk density	(Mg/m³)	2.03	2.03	2.04
Dry density	(Mg/m³)	1.65	1.66	1.67
Void ratio		0.601	0.599	0.591
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.33	0.83	1.02

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	7.50	7.50	7.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_14BagA_D3.XLS
Date 13/09/2016:
Date: 20/09/2016
Checked by:MSR
Approved by: PH

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1

Bulk density	[Mg/m^3]	2.03
Dry density	[Mg/m^3]	1.65
Void ratio	[-]	0.607
Distance	[mm]	132.1
Effective radial pressure	[kPa]	13
Effective axial pressure	[kPa]	13

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.1850	5.93	111.43	25.2
0.22	1.1915	5.42	110.83	24.9
0.24	1.1915	4.96	110.83	24.9
0.26	1.1925	4.59	110.73	24.9
0.28	1.1935	4.26	110.64	24.8
0.30	1.1935	3.98	110.64	24.8
0.32	1.1970	3.74	110.32	24.7
0.34	1.1980	3.52	110.23	24.6
0.36	1.1920	3.31	110.78	24.9
0.38	1.1935	3.14	110.64	24.8

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1

Bulk density	[Mg/m^3]	2.03
Dry density	[Mg/m^3]	1.65
Void ratio	[-]	0.601
Distance	[mm]	131.9
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6865	6.87	192.13	75.0
0.11	0.6885	6.26	191.57	74.5
0.12	0.6910	5.76	190.88	74.0
0.13	0.6930	5.33	190.33	73.6
0.14	0.6925	4.95	190.47	73.7
0.15	0.6930	4.62	190.33	73.6
0.16	0.6950	4.34	189.78	73.1
0.17	0.6975	4.10	189.10	72.6
0.18	0.6970	3.87	189.24	72.7
0.19	0.6950	3.66	189.78	73.1

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	7.50	7.50	7.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	80	160	320
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	243	493	927
Membrane correction applied	(kPa)	0.3	0.3	0.4
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.52	2.38	3.72
Volumetric strain	(%)	-0.50	-0.53	-0.34
Major principal effective stress	(kPa)	322	656	1249
Minor principal effective stress	(kPa)	80	163	322
Principal effective stress ratio		4.04	4.02	3.88
Epsilon 50 (ε 50)	(%)	0.65	0.35	0.67
Secant modulus (E50) at ε 50	(kPa)	18688	70951	69363
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	242	492	927
Membrane correction applied	(kPa)	0.3	0.3	0.4
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.27	2.25	3.47
Volumetric strain	(%)	-0.39	-0.48	-0.27
Major principal effective stress	(kPa)	322	655	1248
Minor principal effective stress	(kPa)	79	163	322
Principal effective stress ratio		4.05	4.02	3.88
At 15% axial strain				
Corrected deviator stress	(kPa)	174	374	763
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-1.81	-2.69	-1.56
Major principal effective stress	(kPa)	254	538	1086
Minor principal effective stress	(kPa)	80	164	323
Principal effective stress ratio		3.17	3.29	3.36

FINAL CONDITIONS				
Water content	(%)	22.7	22.6	22.3
Bulk density	(Mg/m³)	2.03	2.03	2.04
Dry density	(Mg/m³)	1.65	1.66	1.67

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	7.50	7.50	7.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_14BagA_D3.XLS
Date 13/09/2016:
Checked by:MSR
Date: 20/09/2016
Approved by: PH

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 09/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_14BagA_D3.OPJ

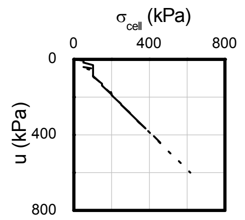
Date : 13/09/2016

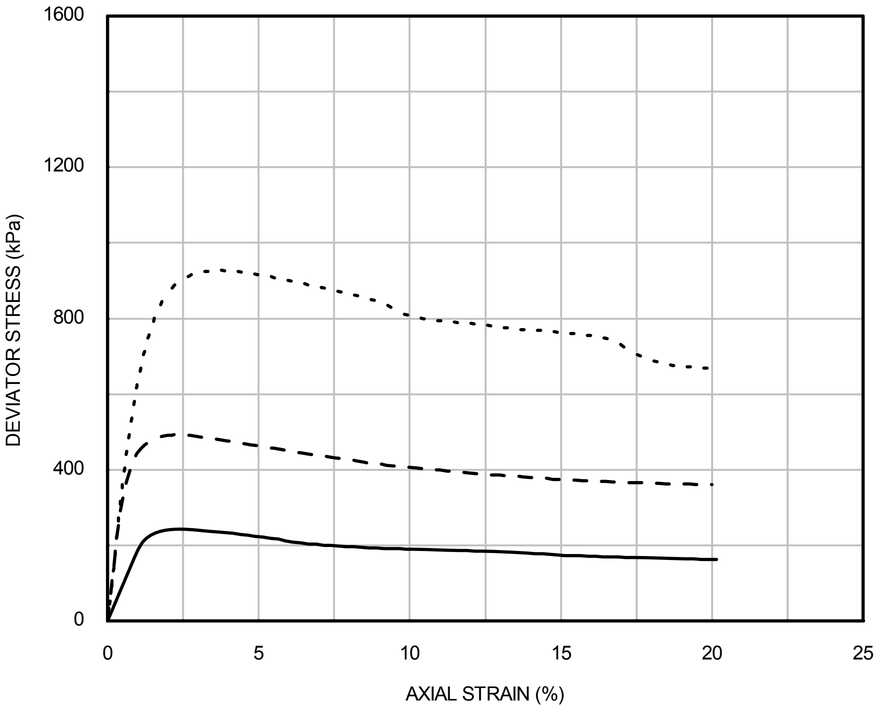
Date : 20/09/2016

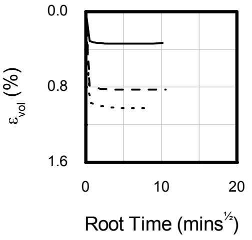
Checked by: MSR

Approved by: PH

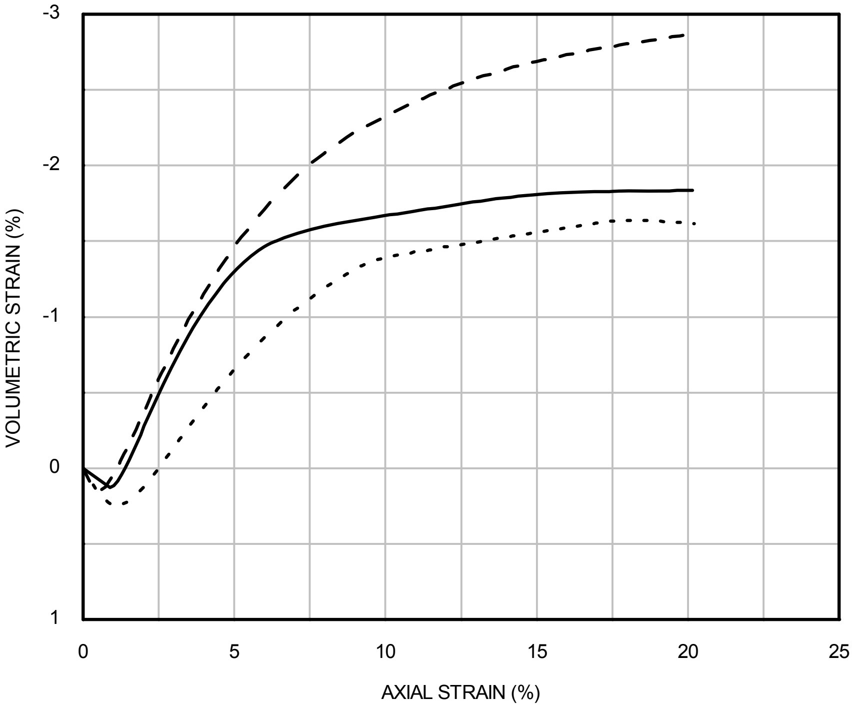
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	80	80	HKZ1-BH03 -SA	14BagA	7.50
— —	2	160	160			
· · · ·	3	320	320			

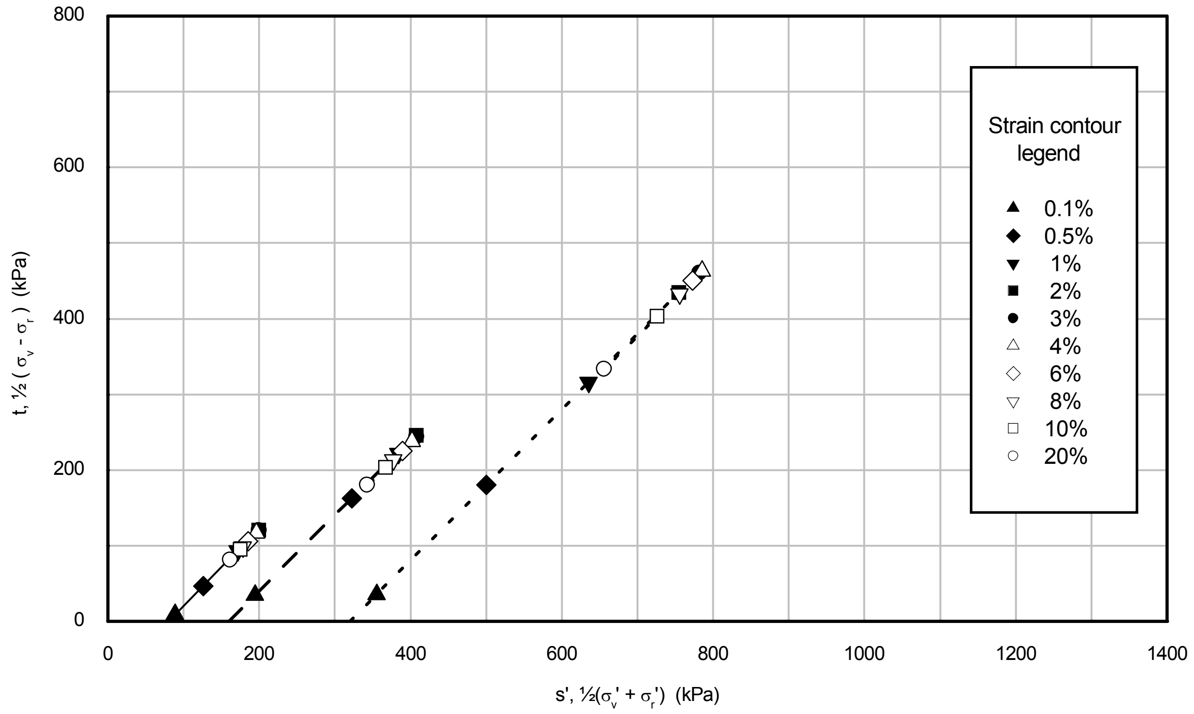
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

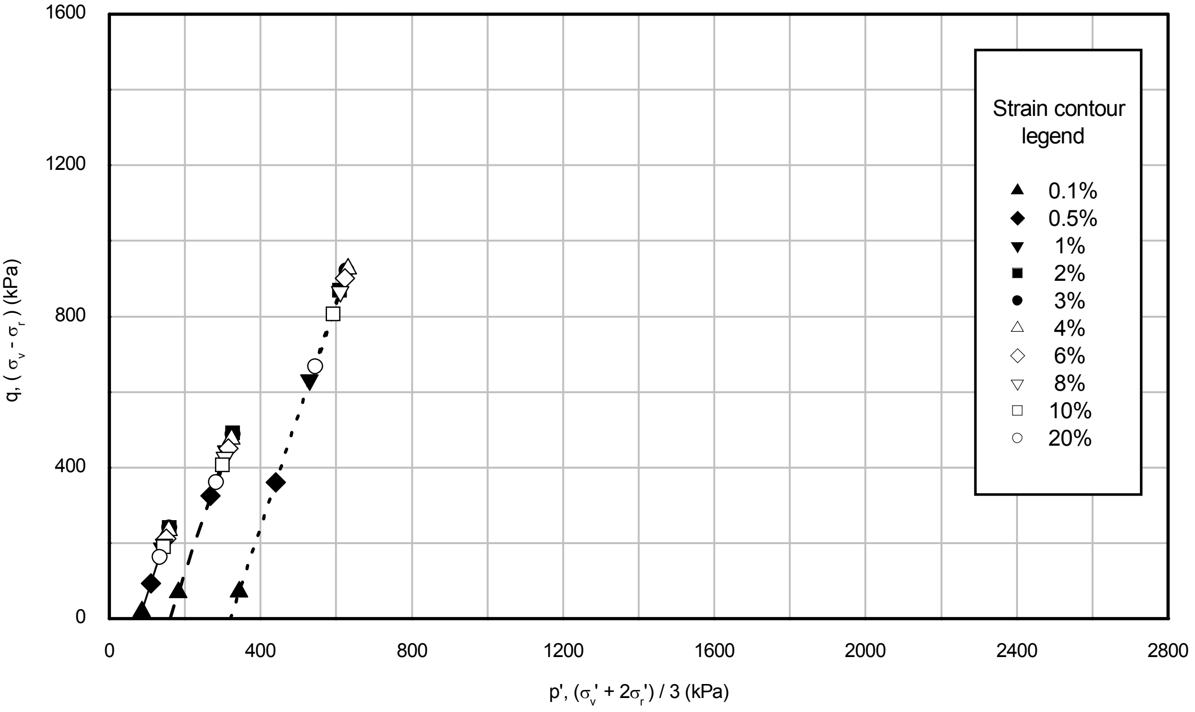
Drawn by: ALB Date: 09/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_14BagA_D3.OPJ

Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016





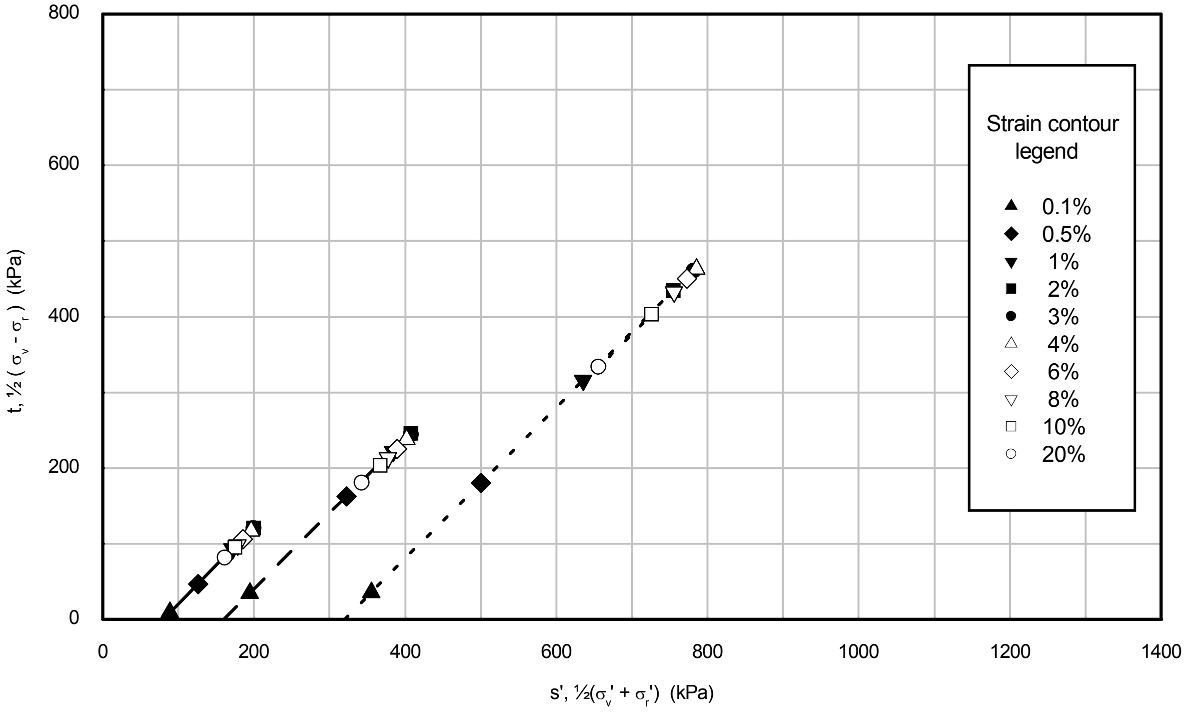
Curve	Specimen(3)	σ$_{rc}$' (kPa)	σ$_{vc}$' (kPa)	Borehole	Sample	Depth (m)
——	1	80	80	HKZ1-BH03 -SA	14BagA	7.50
– –	2	160	160			
· · · ·	3	320	320			

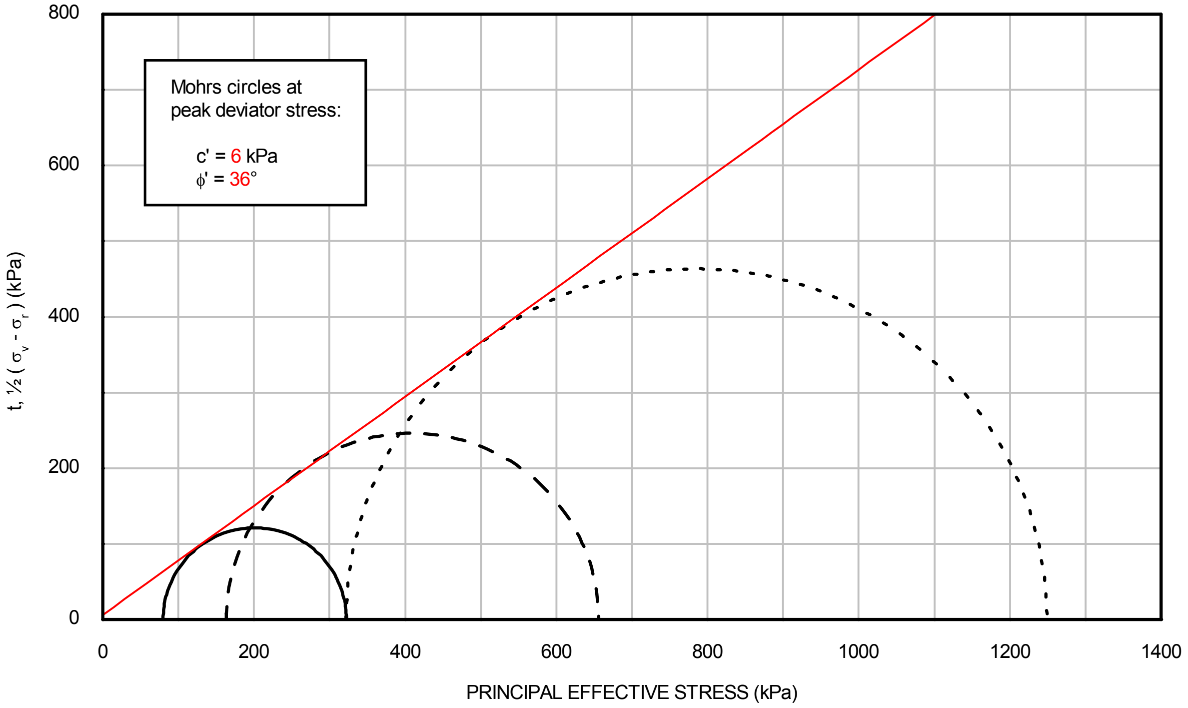
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 09/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_14BagA_D3.OPJ



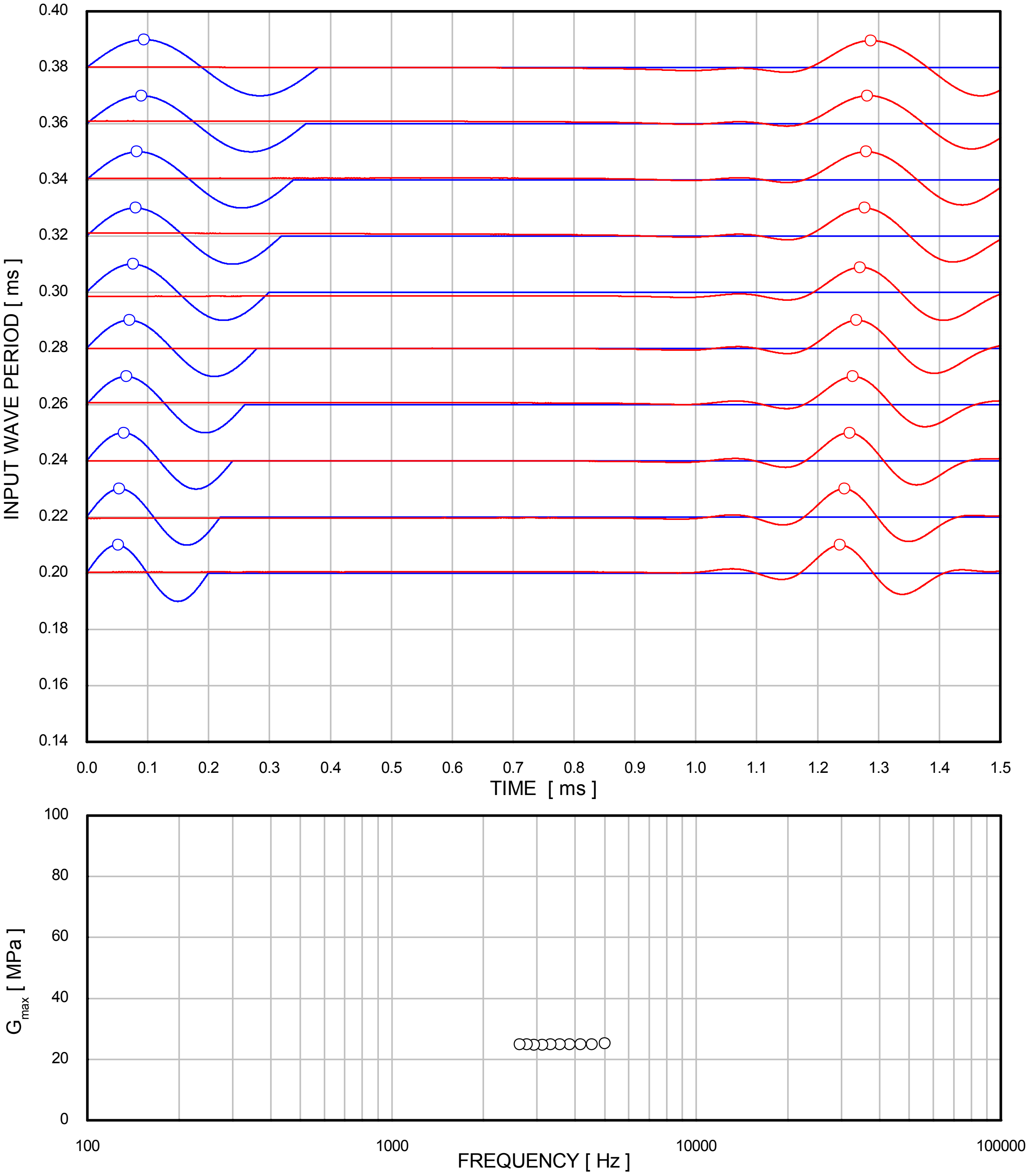


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	80	80	HKZ1-BH03 -SA	14BagA	7.50
— —	2	160	160			
· · · ·	3	320	320			

Checked by: MSR Date : 13/09/2016

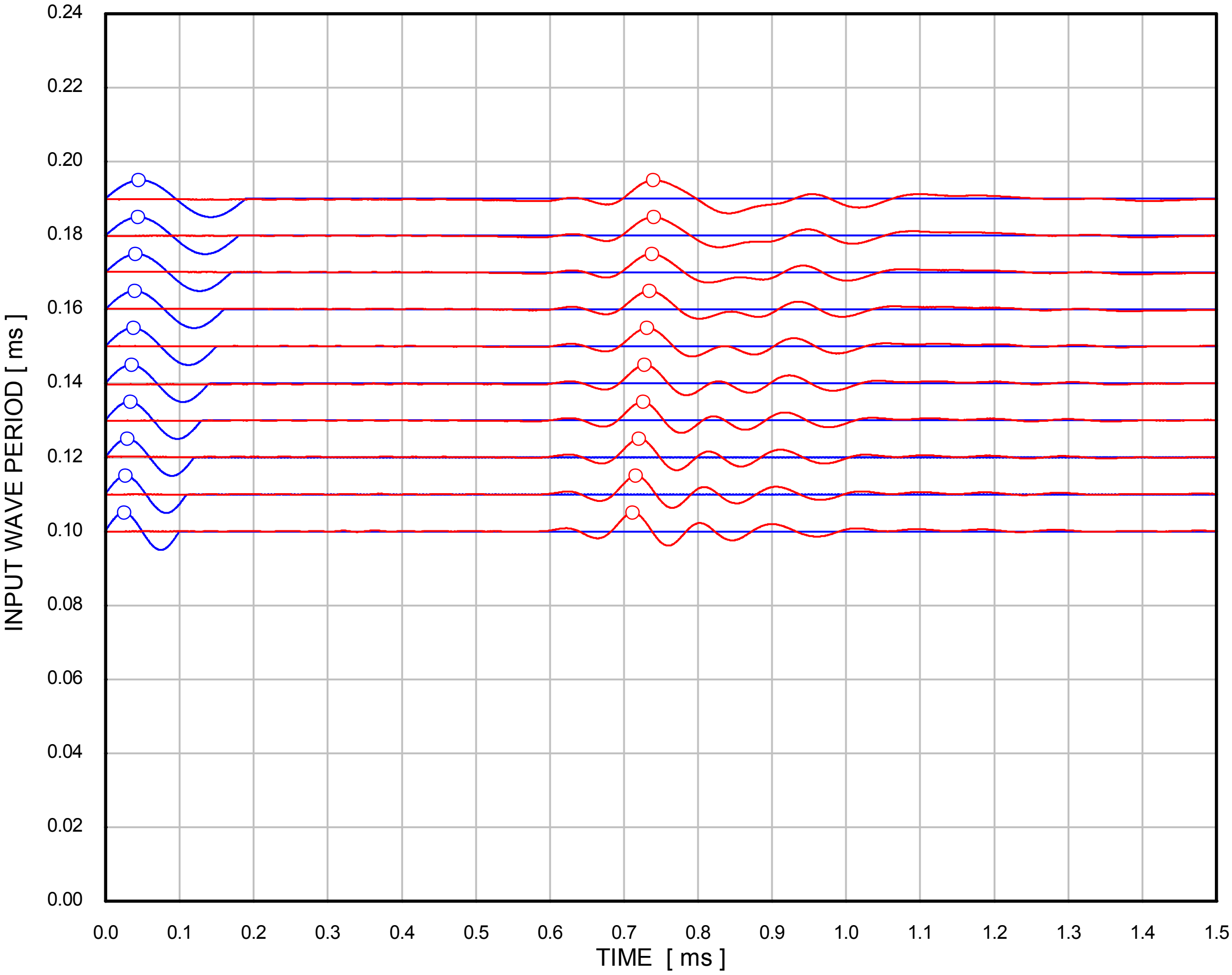
Approved by: PH Date : 20/09/2016

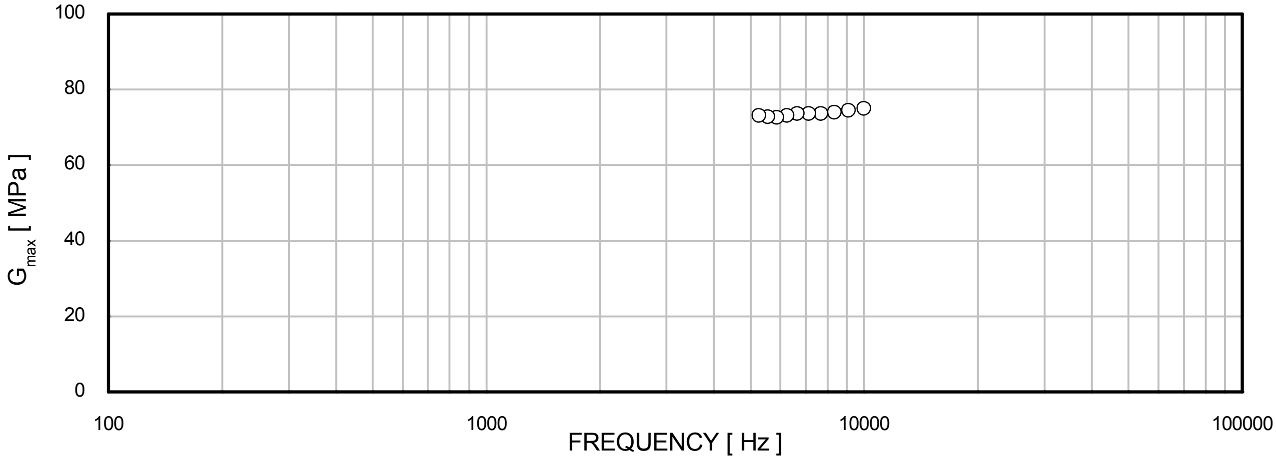
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS



			Borehole	: HKZ1-BH03-SA
σ'_{rc}	: 13	kPa	Sample	: 14BagA
σ'_{ac}	: 13	kPa	Depth [m]	: 7.50
━ (blue)	Source signal		Test No.	: 210A
━ (red)	Received signal			
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 80 kPa	Borehole	:	HKZ1-BH03-SA
σ'_{ac}	: 80 kPa	Sample	:	14BagA
—	Source signal	Depth [m]	:	7.50
—	Received signal	Test No.	:	210A
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Dark grey fine SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	31/08/2016	04/09/2016	31/08/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.0	9.6	9.5
Bulk density	(Mg/m³)	1.65	1.65	1.65
Dry density	(Mg/m³)	1.50	1.51	1.51
Void ratio		0.785	0.780	0.779
Degree of saturation	(%)	34	33	33

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	441	591	898
Cell pressure on completion	(kPa)	455	610	920
B value achieved		0.97	0.97	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	33BagA	33BagA	33BagA
Depth (m)	24.00	24.00	24.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_33BagA_D3.XLS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	455	610	920
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	155	310	620
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	27.6	25.6	24.5
Bulk density	(Mg/m³)	1.97	2.00	2.01
Dry density	(Mg/m³)	1.54	1.59	1.62
Void ratio		0.739	0.687	0.658
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	2.59	5.20	6.80

Mode of failure:	Compound failure	Compound failure	Compound failure

Checked by: MSR Date: 07/10/2016
Approved by: PH Date: 10/10/2016

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	33BagA	33BagA	33BagA
Depth (m)	24.00	24.00	24.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$	1.94		
Dry density	$[Mg/m^3]$	1.50		
Void ratio	[-]	0.785		
Distance	[mm]	132.1		
Effective radial pressure	[kPa]	14		
Effective axial pressure	[kPa]	14		
Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.4995	7.50	88.12	15.1
0.21	1.5040	7.16	87.86	15.0
0.22	1.5020	6.83	87.98	15.0
0.23	1.5040	6.54	87.86	15.0
0.24	1.5060	6.28	87.74	14.9
0.25	1.5070	6.03	87.68	14.9
0.26	1.5075	5.80	87.66	14.9
0.27	1.5060	5.58	87.74	14.9
0.28	1.5065	5.38	87.71	14.9
0.29	1.5060	5.19	87.74	14.9

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$	1.97		
Dry density	$[Mg/m^3]$	1.54		
Void ratio	[-]	0.739		
Distance	[mm]	131.0		
Effective radial pressure	[kPa]	155		
Effective axial pressure	[kPa]	155		
Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	0.7850	3.93	166.82	54.7
0.21	0.7825	3.73	167.35	55.1
0.22	0.7835	3.56	167.14	54.9
0.23	0.7845	3.41	166.92	54.8
0.24	0.7790	3.25	168.10	55.6
0.25	0.7820	3.13	167.46	55.1
0.26	0.7780	2.99	168.32	55.7
0.27	0.7795	2.89	168.00	55.5
0.28	0.7800	2.79	167.89	55.4
0.29	0.7760	2.68	168.75	56.0

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	33BagA	33BagA	33BagA
Depth (m)	24.00	24.00	24.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_33BagA_D3.XLS
Date: 07/10/2016
Checked by: MSR
Date: 10/10/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	155	310	620
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	381	746	1421
Membrane correction applied	(kPa)	1.5	1.5	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	19.52	19.77	15.34
Volumetric strain	(%)	5.45	6.23	5.47
Major principal effective stress	(kPa)	538	1053	2038
Minor principal effective stress	(kPa)	157	308	617
Principal effective stress ratio		3.43	3.42	3.30
Epsilon 50 (ε 50)	(%)	3.42	3.92	3.73
Secant modulus (E50) at ε 50	(kPa)	5573	9509	19074
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	381	746	1421
Membrane correction applied	(kPa)	1.5	1.5	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	19.77	19.52	15.34
Volumetric strain	(%)	5.45	6.22	5.47
Major principal effective stress	(kPa)	538	1053	2038
Minor principal effective stress	(kPa)	156	307	617
Principal effective stress ratio		3.44	3.43	3.30
At 15% axial strain				
Corrected deviator stress	(kPa)	370	713	1416
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	5.26	5.85	5.45
Major principal effective stress	(kPa)	526	1021	2032
Minor principal effective stress	(kPa)	156	308	616
Principal effective stress ratio		3.36	3.32	3.30

FINAL CONDITIONS				
Water content	(%)	27.6	25.6	24.5
Bulk density	(Mg/m³)	1.97	2.00	2.01
Dry density	(Mg/m³)	1.54	1.59	1.62

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	33BagA	33BagA	33BagA
Depth (m)	24.00	24.00	24.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_33BagA_D3.XLS
Date: 07/10/2016
Checked by: MSR
Date: 10/10/2016
Approved by: PH

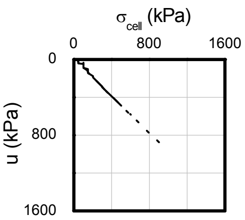
Drawn by: ALB Date: 22/09/2016

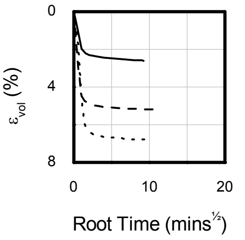
Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_33BagA_D3.OPJ

Checked by: MSR Date : 07/10/2016

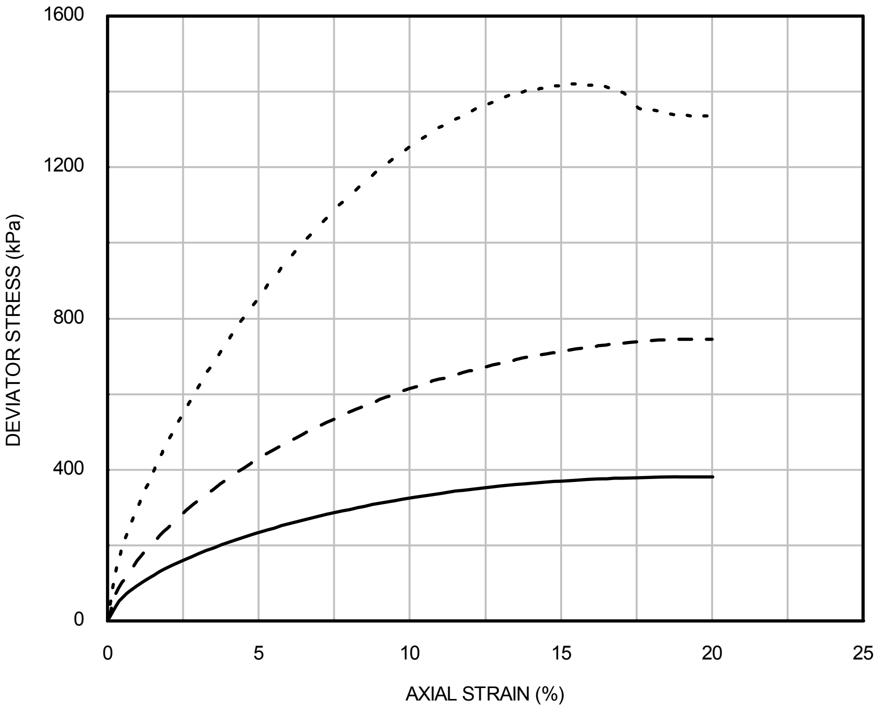
Approved by: PH Date : 10/10/2016

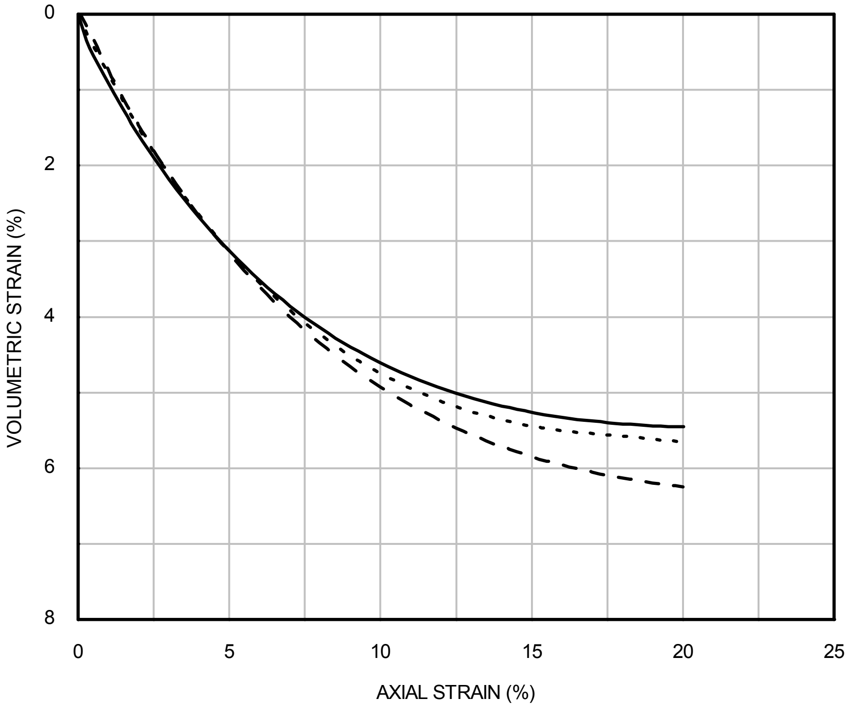
Saturation





Consolidation





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	155	155	HKZ1 -BH03-SA	33BagA	24.00
– –	2	310	310			
· · · ·	3	620	620			

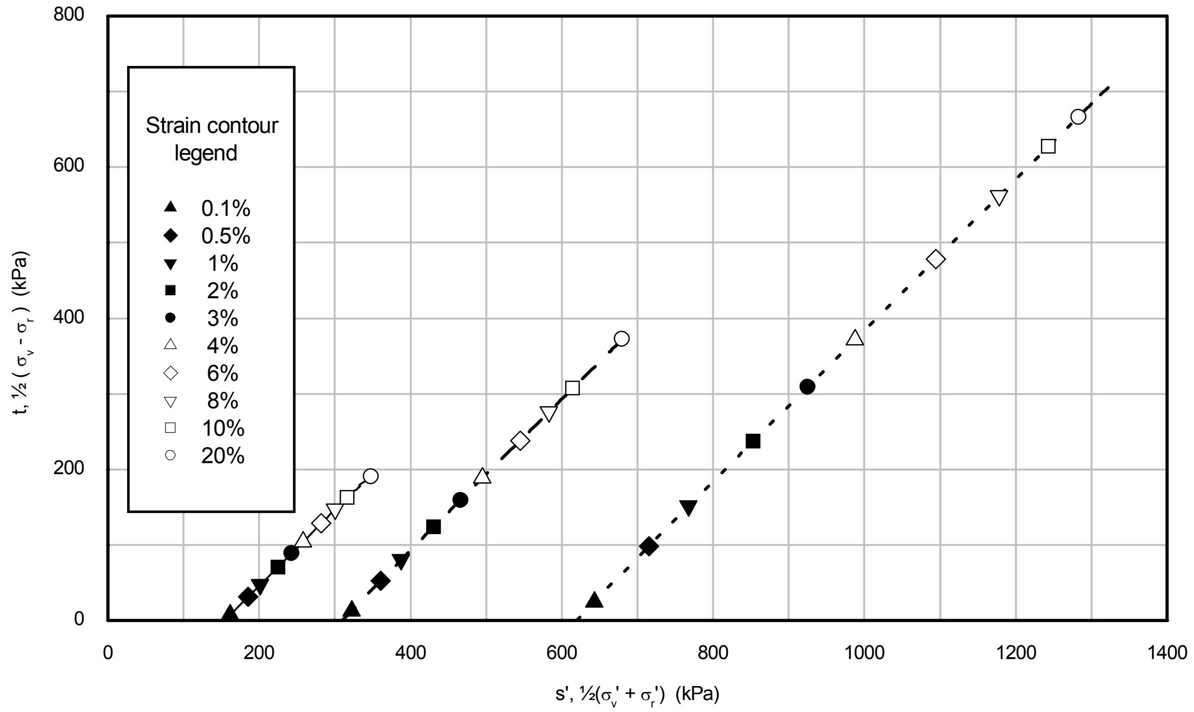
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

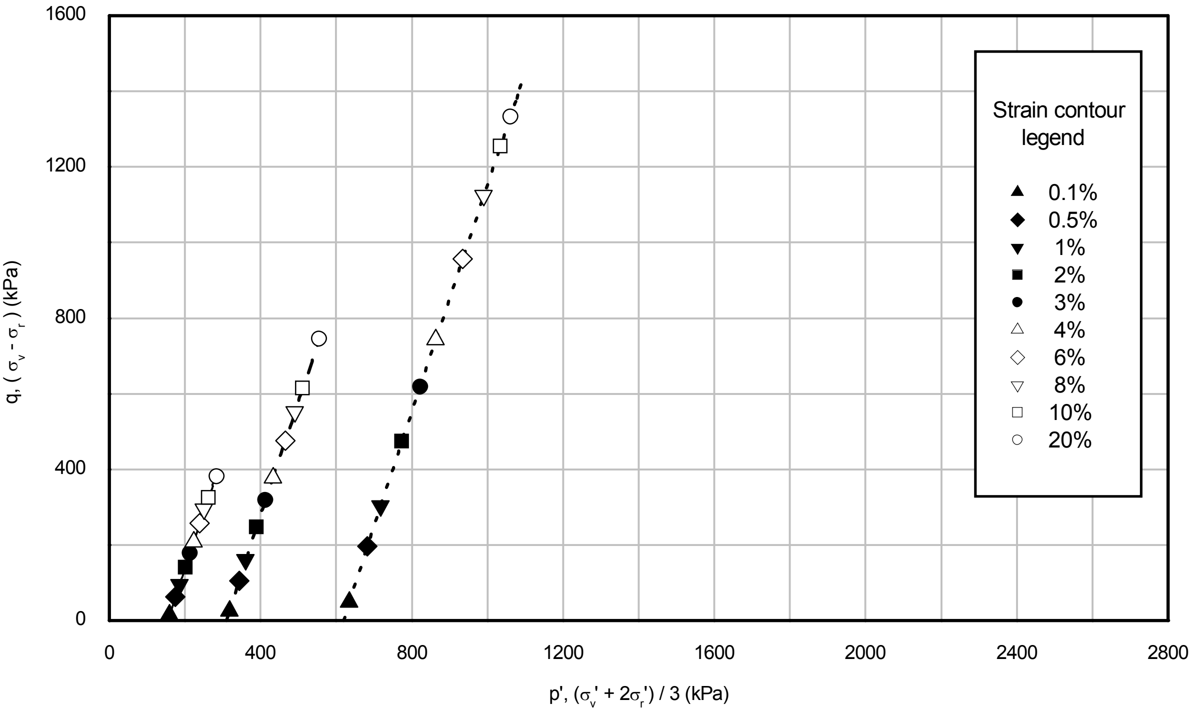
Drawn by: ALB Date: 22/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_33BagA_D3.OPJ

Checked by: MSR Date : 07/10/2016

Approved by: PH Date : 10/10/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	155	155	HKZ1 -BH03-SA	33BagA	24.00
— —	2	310	310			
- - - -	3	620	620			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

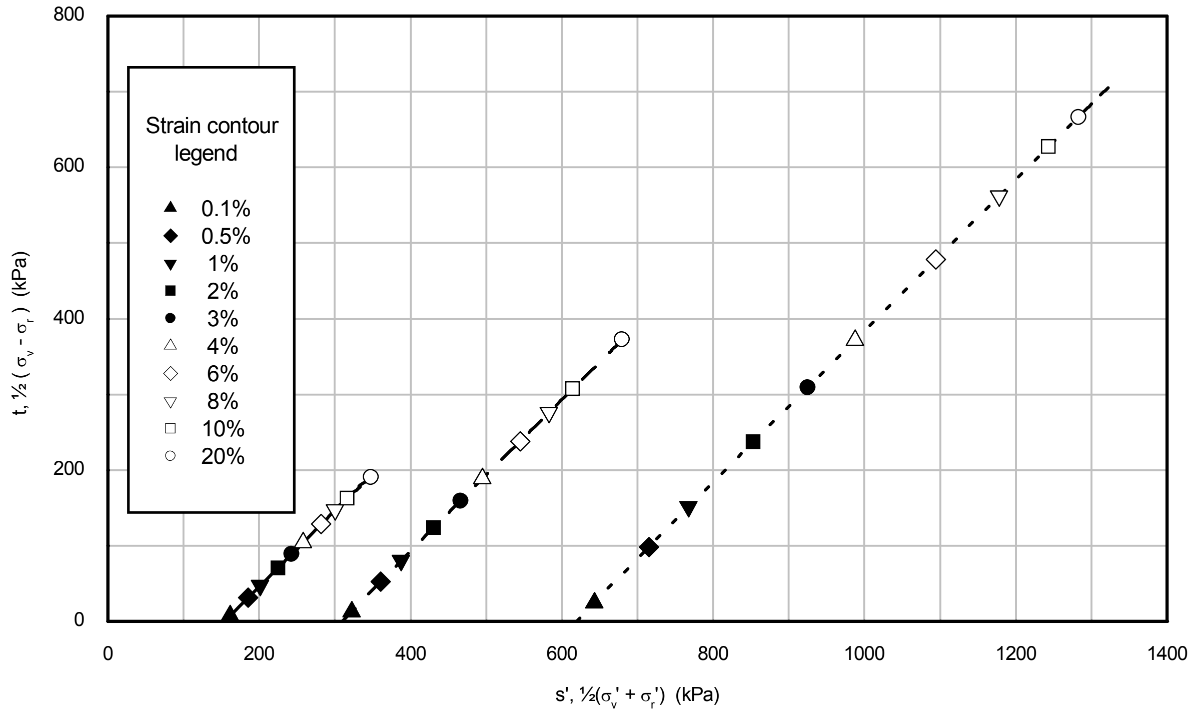
Drawn by: ALB Date: 22/09/2016

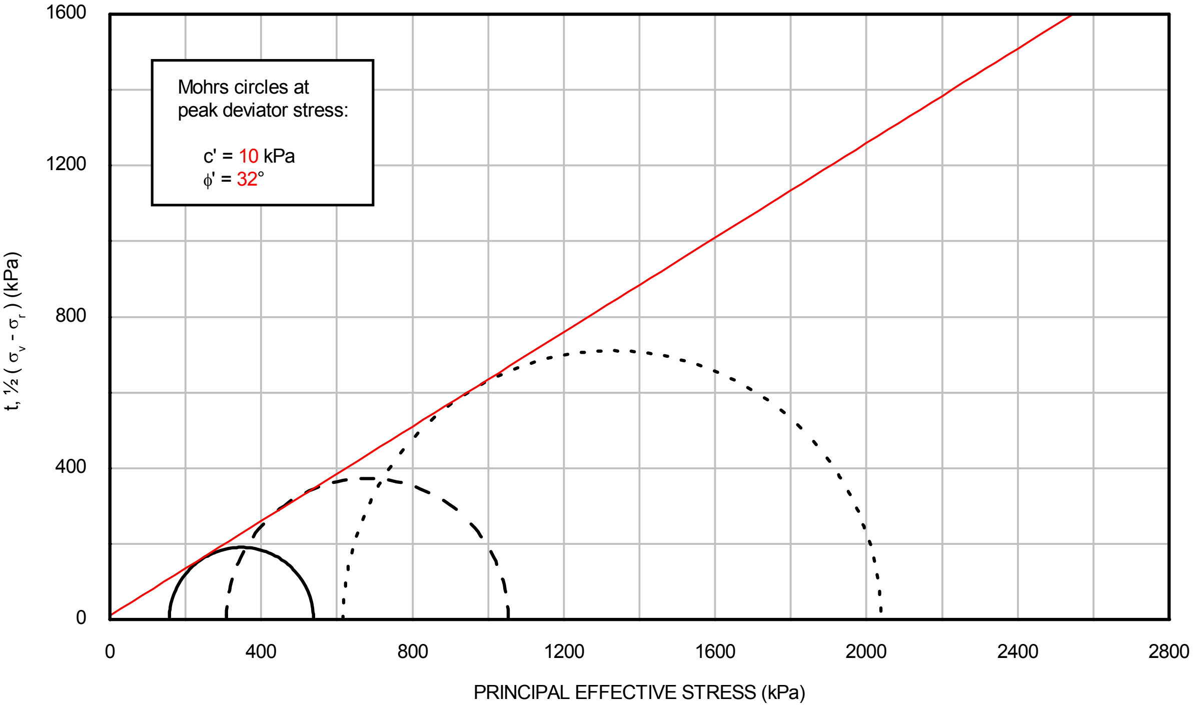
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_33BagA_D3.OPJ

Checked by: MSR Date : 07/10/2016

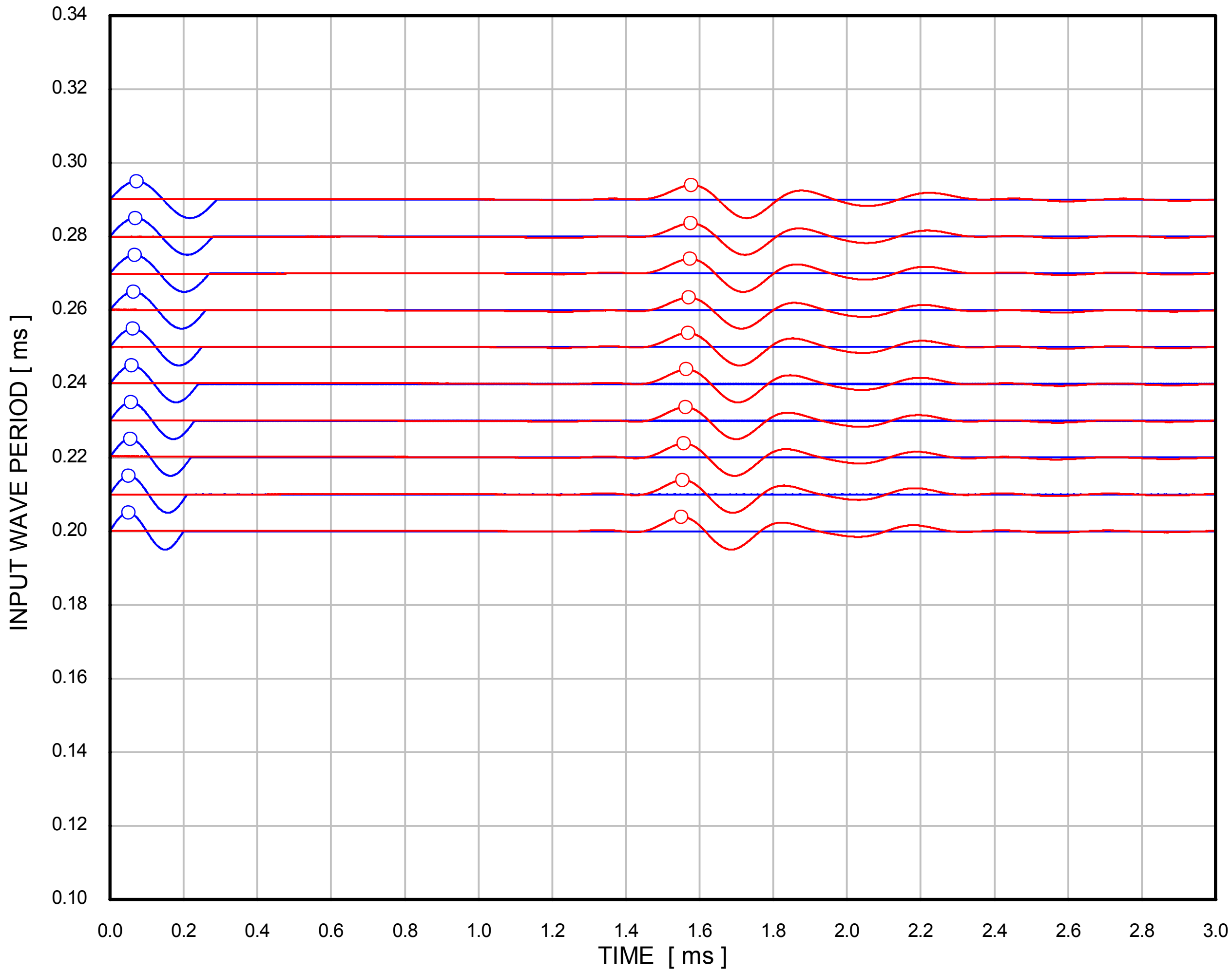
Approved by: PH Date : 10/10/2016

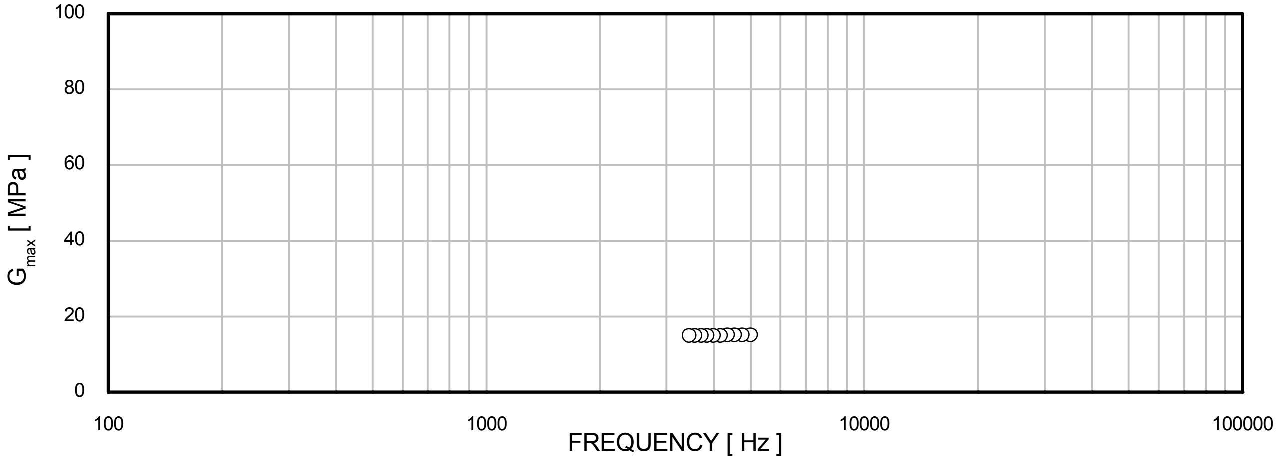




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	155	155	HKZ1 -BH03-SA	33BagA	24.00
– –	2	310	310			
· · · ·	3	620	620			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





σ'_{rc} : 14 kPa

σ'_{ac} : 14 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

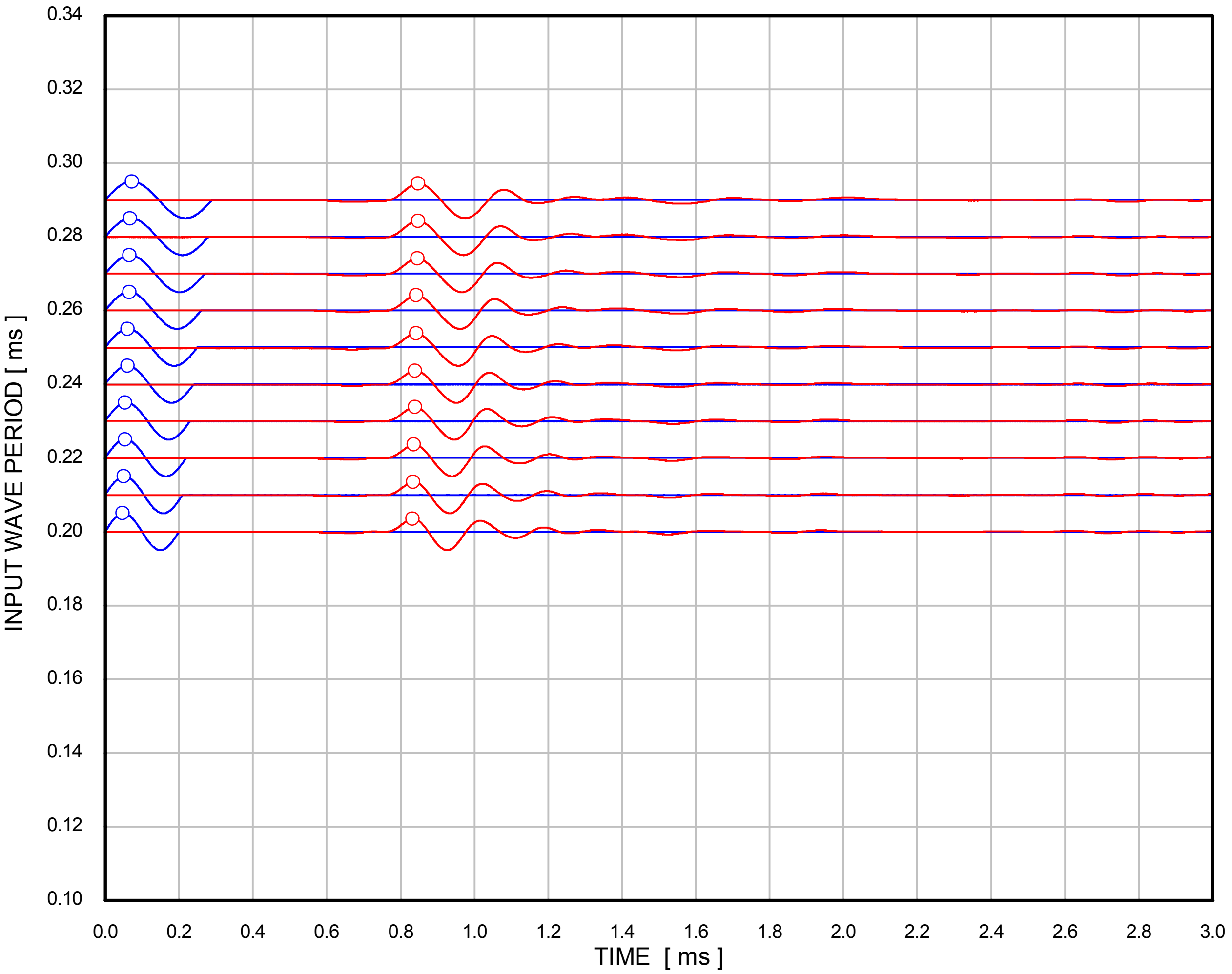
Borehole : HKZ1-BH03-SA

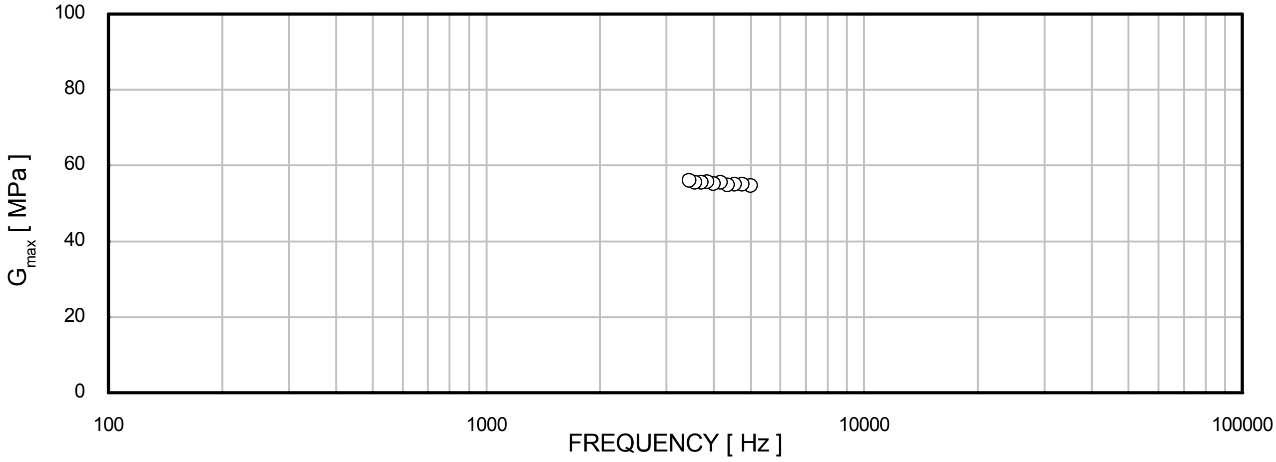
Sample : 33BagA

Depth [m] : 24.00

Test No. : 211A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc} : 155 kPa
σ'_{ac} : 155 kPa
— Source signal
— Received signal
○ / ○ Selected peak values

Borehole : HKZ1-BH03-SA
Sample : 33BagA
Depth [m] : 24.00
Test No. : 211A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Very dark grey fine sandy CLAY

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		01/09/2016	01/09/2016	01/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.3	10.3	10.3
Bulk density	(Mg/m³)	1.62	1.62	1.62
Dry density	(Mg/m³)	1.47	1.47	1.47
Void ratio		0.825	0.820	0.823
Degree of saturation	(%)	33	34	33

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	561	638	989
Cell pressure on completion	(kPa)	580	660	1020
B value achieved		0.95	0.97	0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	42BagA	42BagA	42BagA
Depth (m)	33.00	33.00	33.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 02/09/2016 Drawn by: ALB Template Issue: 7 Date: 02/09/2016 Checked by: MSR

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_42BagA_D3.XLS Date: 05/09/2016 Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	580	660	1020
Back pressure	(kPa)	400	300	300
Effective cell pressure	(kPa)	180	360	720
Pore pressure on completion	(kPa)	400	300	301
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	30.2	29.3	29.3
Bulk density	(Mg/m³)	1.93	1.94	1.94
Dry density	(Mg/m³)	1.48	1.50	1.50
Void ratio		0.808	0.785	0.784
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.92	1.89	2.13

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	42BagA	42BagA	42BagA
Depth (m)	33.00	33.00	33.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 02/09/2016 Drawn by: ALB
Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_42BagA_D3.XLS
Date: 02/09/2016 Checked by: MSR
Date: 05/09/2016 Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	400	300	300
Initial effective cell pressure	(kPa)	180	360	720
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	473	899	1554
Membrane correction applied	(kPa)	1.9	2.0	2.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	13.04	13.94	17.13
Volumetric strain	(%)	1.52	2.34	-1.97
Major principal effective stress	(kPa)	653	1259	2275
Minor principal effective stress	(kPa)	180	360	721
Principal effective stress ratio		3.62	3.50	3.16
Epsilon 50 (ε 50)	(%)	0.75	0.85	1.46
Secant modulus (E50) at ε 50	(kPa)	31587	53150	53294
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	472	899	1554
Membrane correction applied	(kPa)	1.8	1.9	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	12.79	13.69	16.63
Volumetric strain	(%)	1.52	2.33	-1.88
Major principal effective stress	(kPa)	652	1259	2274
Minor principal effective stress	(kPa)	180	360	720
Principal effective stress ratio		3.63	3.50	3.16
At 15% axial strain				
Corrected deviator stress	(kPa)	472	898	1548
Membrane correction applied	(kPa)	2.1	2.1	2.1
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	1.57	2.39	-1.59
Major principal effective stress	(kPa)	652	1258	2268
Minor principal effective stress	(kPa)	180	360	720
Principal effective stress ratio		3.62	3.50	3.15

FINAL CONDITIONS				
Water content	(%)	29.1	27.6	30.9
Bulk density	(Mg/m³)	1.94	1.97	1.92
Dry density	(Mg/m³)	1.51	1.54	1.47

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	42BagA	42BagA	42BagA
Depth (m)	33.00	33.00	33.00

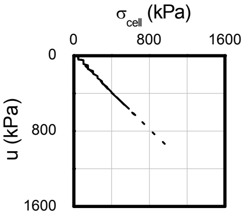
SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

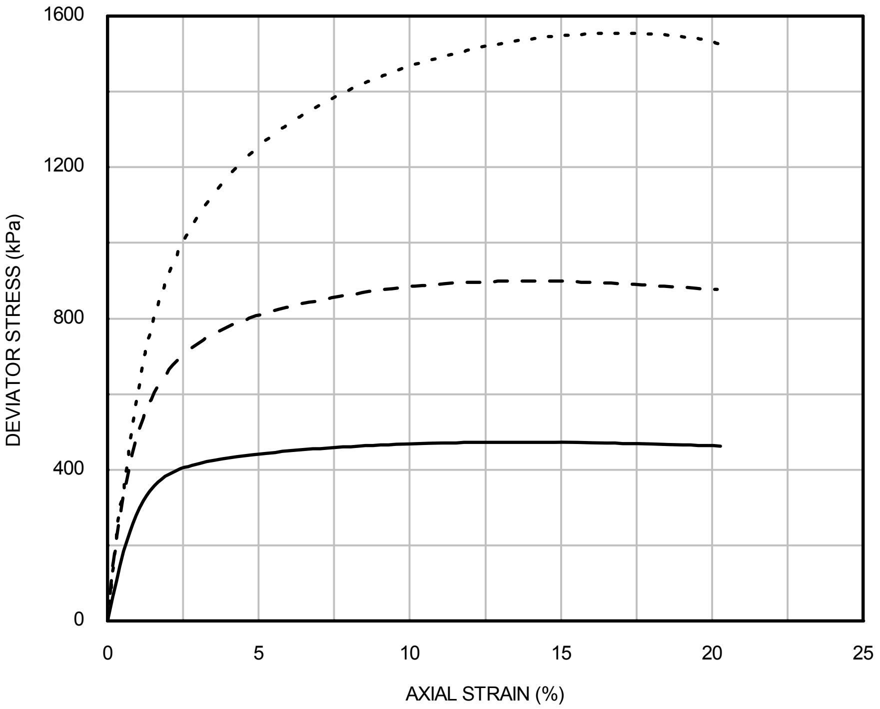
Drawn by: ALB Date: 02/09/2016

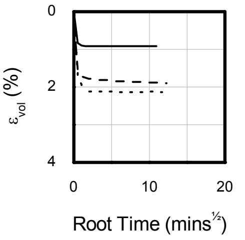
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_42BagA_D3.OPJ

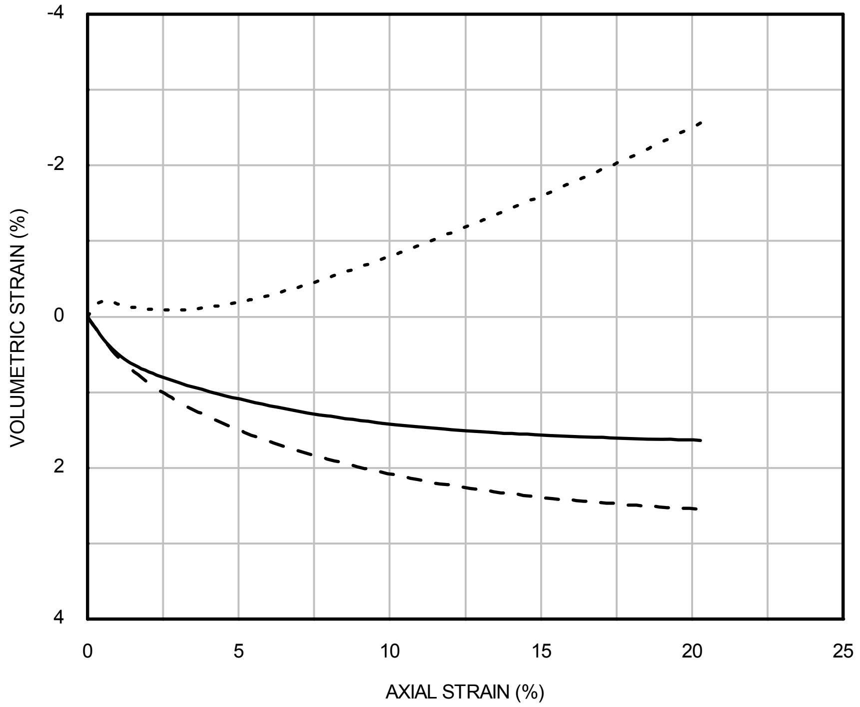
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	180	180	HKZ1-BH03 -SA	42BagA	33.00
— —	2	360	360			
· · · ·	3	720	720			

Checked by: PH Date : 05/09/2016

Approved by: PH Date : 05/09/2016

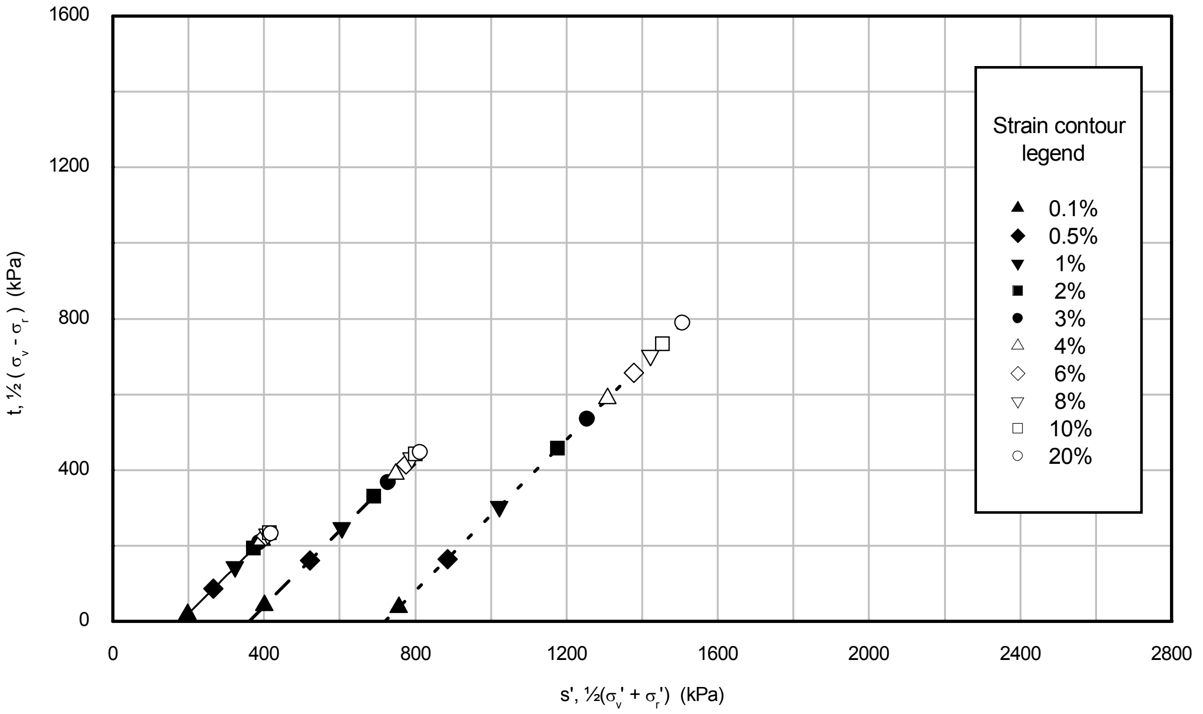
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

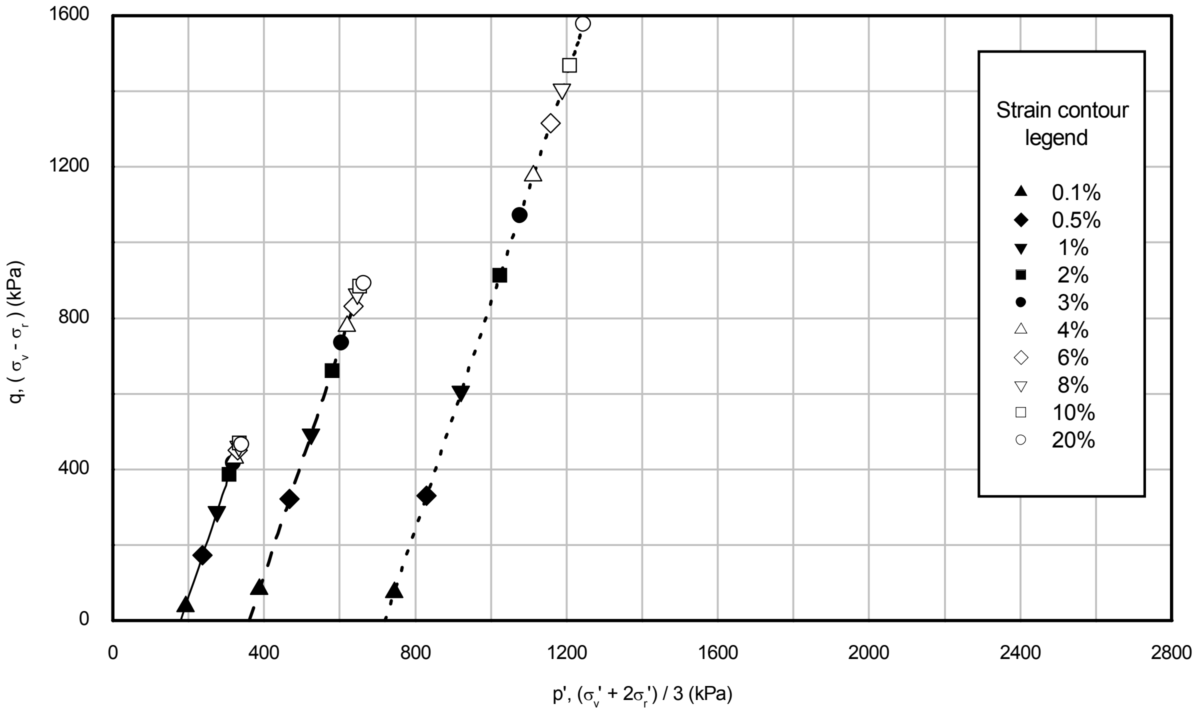
Drawn by: ALB Date: 02/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_42BagA_D3.OPJ

Date : 05/09/2016 Date : 05/09/2016

Checked by: PH Approved by: PH





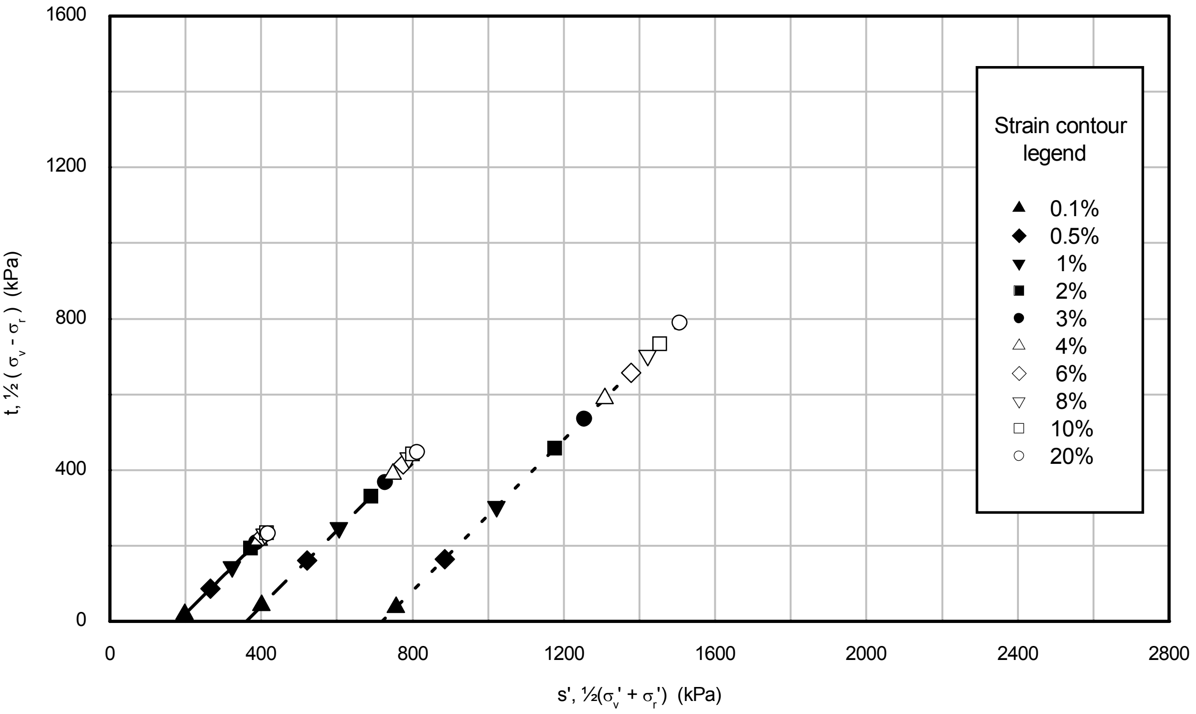
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	180	180	HKZ1-BH03 -SA	42BagA	33.00
— —	2	360	360			
- - - -	3	720	720			

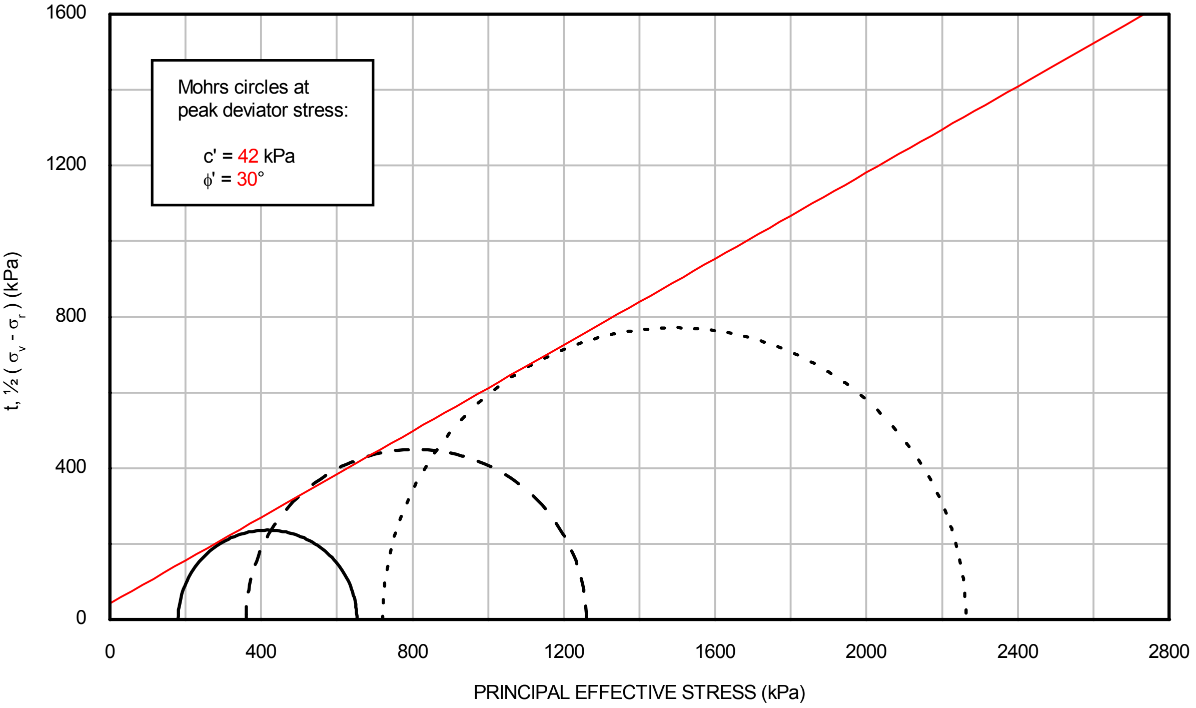
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 02/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_42BagA_D3.OPJ





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	180	180	HKZ1-BH03 -SA	42BagA	33.00
— —	2	360	360			
· · · ·	3	720	720			

Checked by: PH Date : 05/09/2016

Approved by: PH Date : 05/09/2016

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 13/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_57BagA_D3.XLS
Date: 14/09/2016
Checked by: MSR
Date: 20/09/2016
Approved by: PH

VISUAL DESCRIPTION
Dark brown fine SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	08/09/2016	08/09/2016	08/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	9.3	9.3	9.3
Bulk density	(Mg/m³)	1.64	1.64	1.64
Dry density	(Mg/m³)	1.50	1.50	1.50
Void ratio		0.775	0.775	0.777
Degree of saturation	(%)	32	32	32

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	546	803	1311
Cell pressure on completion	(kPa)	560	820	1340
B value achieved		0.99	0.99	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	57BagA	57BagA	57BagA
Depth (m)	48.00	48.00	48.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 13/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_57BagA_D3.XLS
Date: 14/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	560	820	1340
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	260	520	1040
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.0	24.9	24.2
Bulk density	(Mg/m³)	1.99	2.00	2.02
Dry density	(Mg/m³)	1.58	1.60	1.62
Void ratio		0.693	0.665	0.645
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	4.63	6.20	7.44

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	57BagA	57BagA	57BagA
Depth (m)	48.00	48.00	48.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	260	520	1040
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	593	1212	2527
Membrane correction applied	(kPa)	2.1	2.3	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	18.29	20.02	19.02
Volumetric strain	(%)	4.76	5.41	5.76
Major principal effective stress	(kPa)	851	1732	3567
Minor principal effective stress	(kPa)	258	519	1040
Principal effective stress ratio		3.29	3.33	3.43
Epsilon 50 (ε 50)	(%)	2.89	3.47	3.96
Secant modulus (E50) at ε 50	(kPa)	10259	17490	31893
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	593	1212	2527
Membrane correction applied	(kPa)	2.1	2.3	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	17.79	20.02	19.02
Volumetric strain	(%)	4.75	5.41	5.76
Major principal effective stress	(kPa)	851	1732	3567
Minor principal effective stress	(kPa)	258	519	1040
Principal effective stress ratio		3.30	3.33	3.43
At 15% axial strain				
Corrected deviator stress	(kPa)	584	1175	2443
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	4.63	5.18	5.51
Major principal effective stress	(kPa)	842	1695	3483
Minor principal effective stress	(kPa)	258	519	1040
Principal effective stress ratio		3.26	3.26	3.35

FINAL CONDITIONS				
Water content	(%)	22.9	21.5	20.6
Bulk density	(Mg/m³)	2.04	2.06	2.08
Dry density	(Mg/m³)	1.66	1.70	1.72

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	57BagA	57BagA	57BagA
Depth (m)	48.00	48.00	48.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Drawn by: ALB Date: 13/09/2016

Template Issue: 4

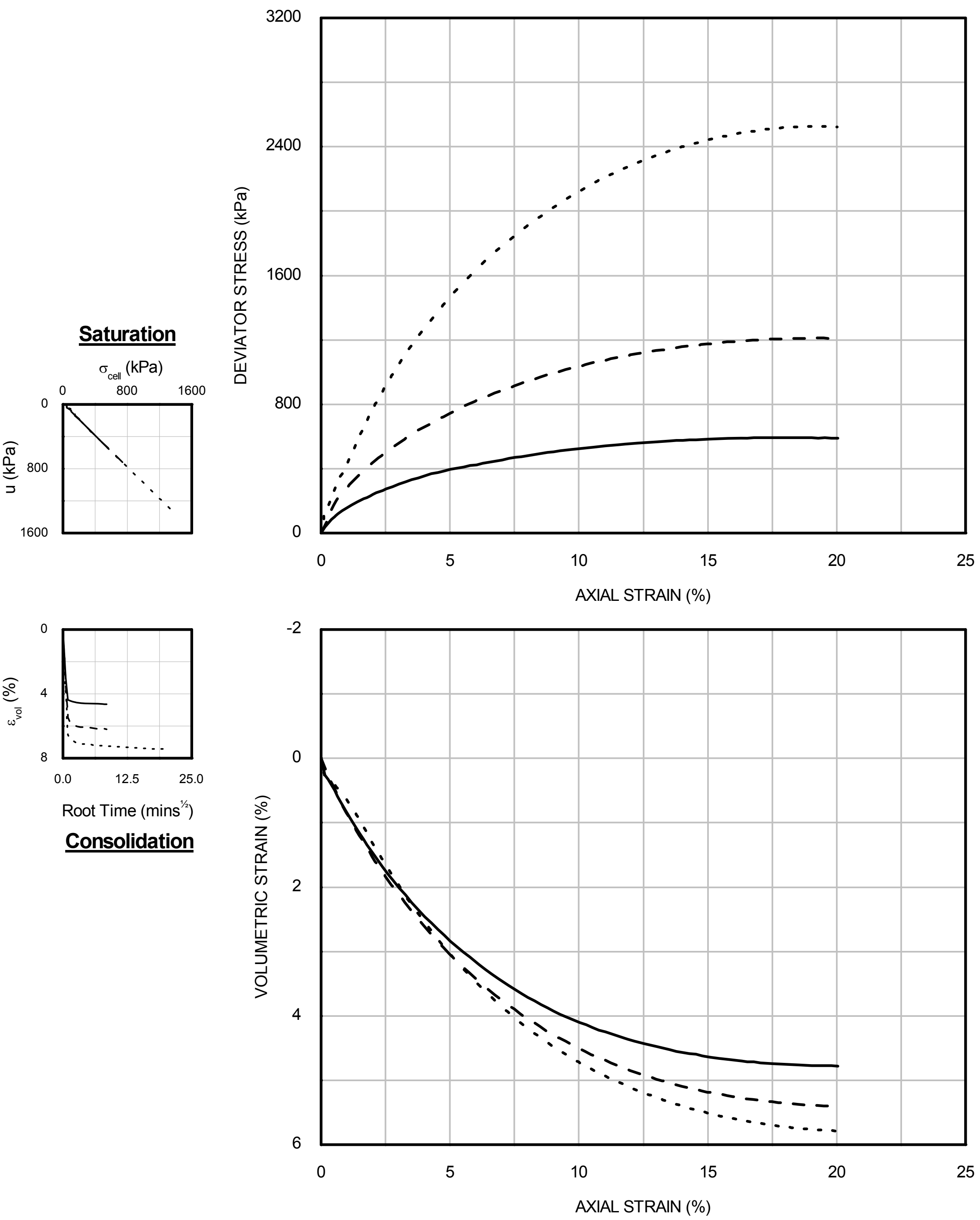
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_57BagA_D3.OPJ

Date : 13/09/2016

Date : 20/09/2016

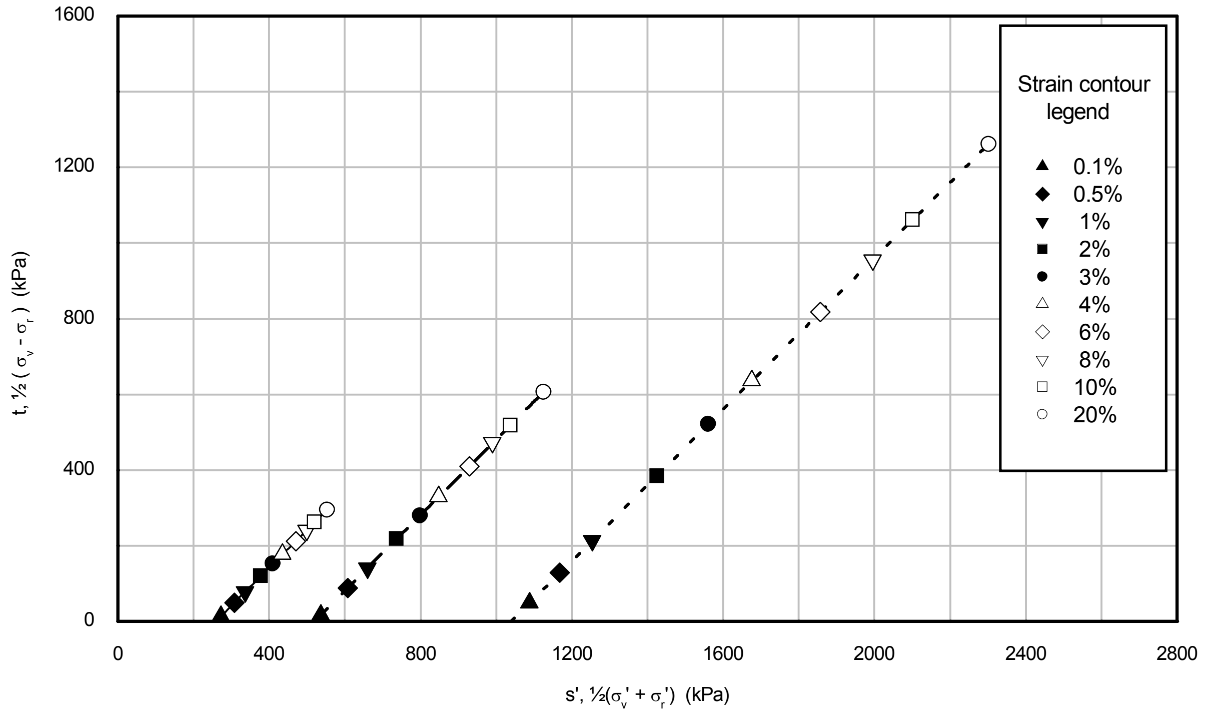
Checked by: MSR

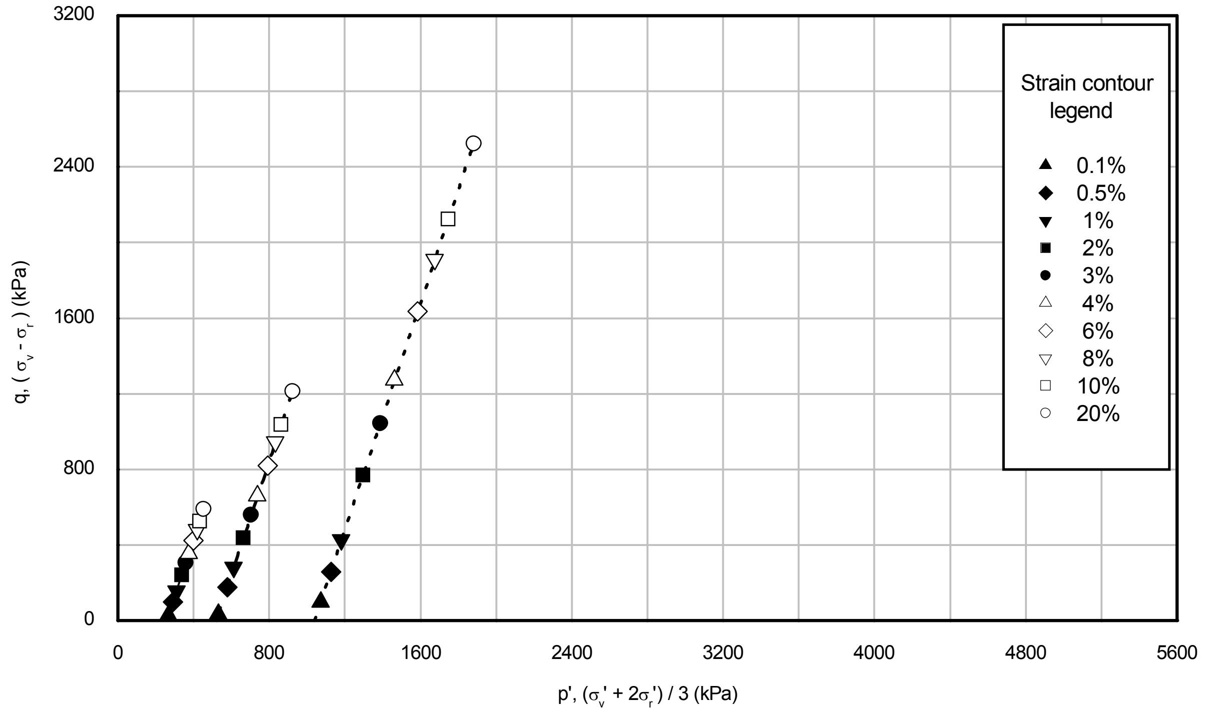
Approved by: PH



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	260	260	HKZ1-BH03 -SA	57BagA	48.00
— —	2	520	520			
· · · ·	3	1040	1040			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	260	260	HKZ1-BH03 -SA	57BagA	48.00
— —	2	520	520			
- - - -	3	1040	1040			

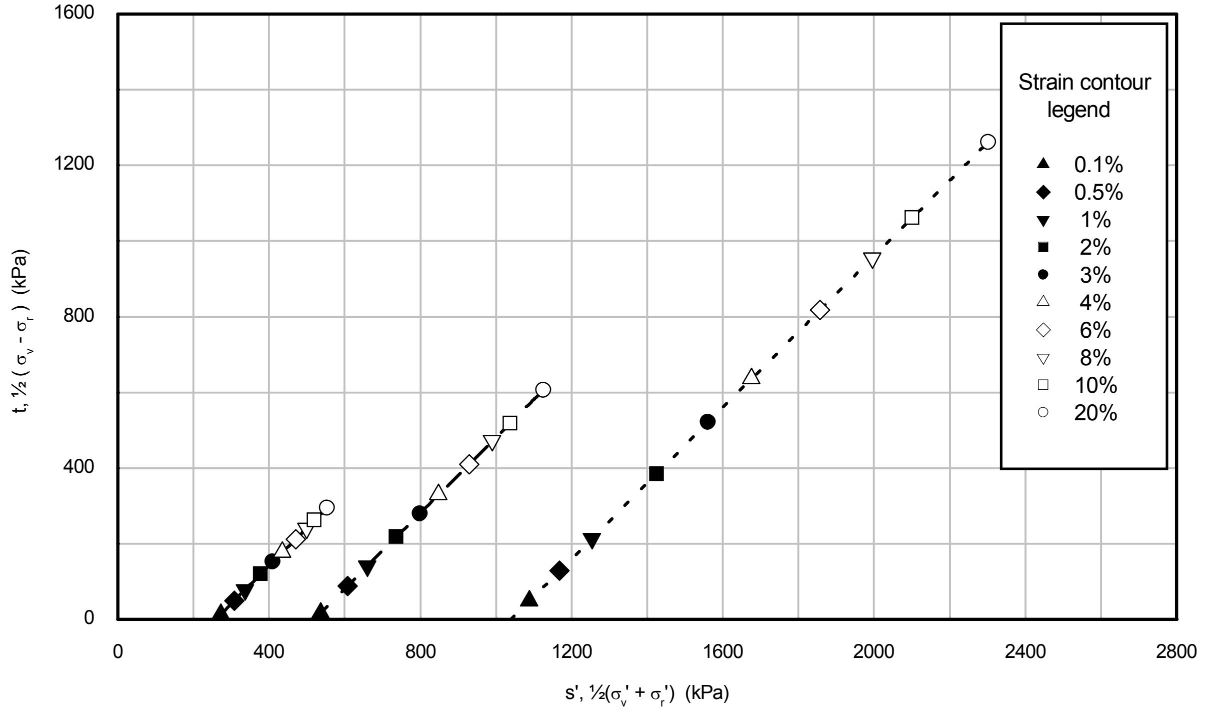
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

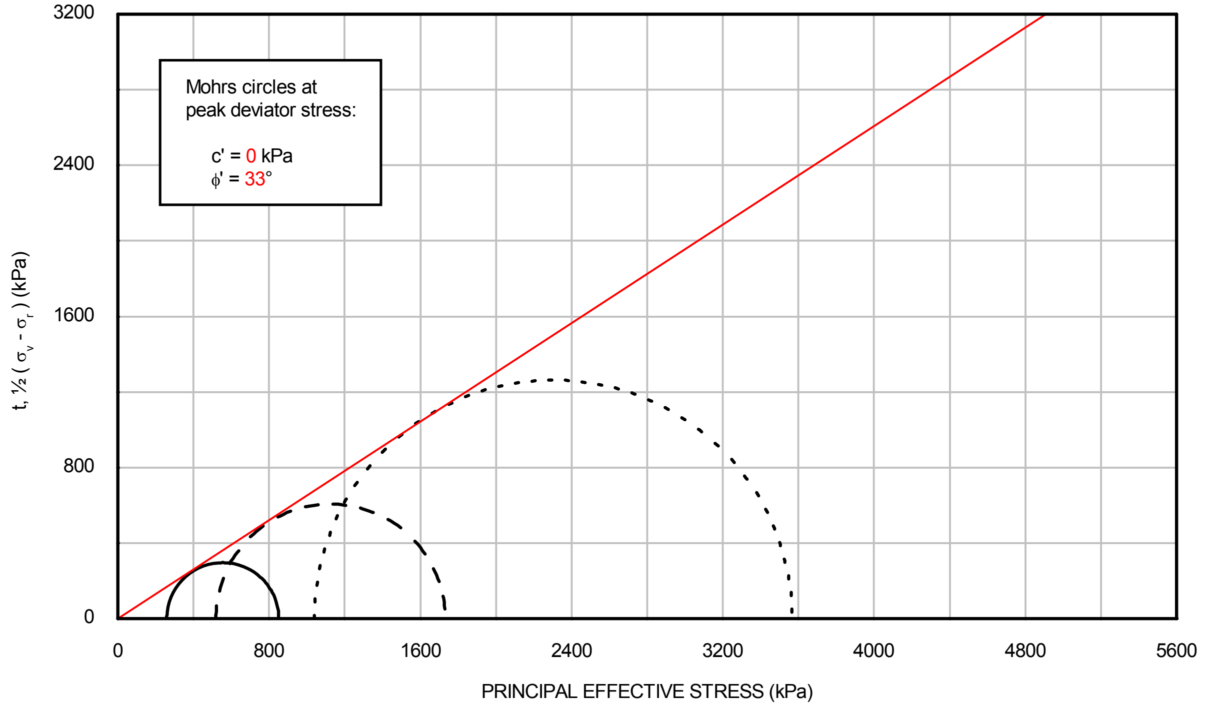
Date: 13/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_57BagA_D3.OPJ
Date : 13/09/2016
Date : 20/09/2016
Checked by: MSR
Approved by: PH

Drawn by: ALB Date: 13/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_57BagA_D3.OPJ





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	260	260	HKZ1-BH03 -SA	57BagA	48.00
— —	2	520	520			
· · · ·	3	1040	1040			

Date : 13/09/2016

Date : 20/09/2016

Checked by: MSR

Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 09/09/2016 Drawn by: ALB
Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_59BagC_D3.XLS
Date: 13/09/2016 Checked by: MSR
Date: 20/09/2016 Approved by: PH

VISUAL DESCRIPTION
Dark brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		08/09/2016	05/09/2016	01/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end
INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.4	10.1	10.1
Bulk density	(Mg/m³)	1.71	1.71	1.71
Dry density	(Mg/m³)	1.54	1.55	1.55
Void ratio		0.709	0.702	0.702
Degree of saturation	(%)	39	38	38
SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	576	856	1442
Cell pressure on completion	(kPa)	595	890	1480
B value achieved		0.97	0.96	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	59BagC	59BagC	59BagC
Depth (m)	54.75	54.75	54.75

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	595	890	1480
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	295	590	1180
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.0	24.9	24.6
Bulk density	(Mg/m³)	1.97	1.99	1.99
Dry density	(Mg/m³)	1.57	1.59	1.60
Void ratio		0.685	0.657	0.649
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.41	2.64	3.11

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	59BagC	59BagC	59BagC
Depth (m)	54.75	54.75	54.75

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	295	590	1180
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	640	1336	2535
Membrane correction applied	(kPa)	1.9	2.0	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	14.75	16.72	19.16
Volumetric strain	(%)	2.13	3.12	4.20
Major principal effective stress	(kPa)	934	1925	3715
Minor principal effective stress	(kPa)	294	589	1180
Principal effective stress ratio		3.18	3.27	3.15
Epsilon 50 (ε 50)	(%)	0.88	1.37	1.33
Secant modulus (E50) at ε 50	(kPa)	36359	48637	95426
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	640	1336	2535
Membrane correction applied	(kPa)	1.9	2.0	2.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	14.75	16.72	18.91
Volumetric strain	(%)	2.13	3.12	4.18
Major principal effective stress	(kPa)	934	1925	3715
Minor principal effective stress	(kPa)	294	589	1179
Principal effective stress ratio		3.18	3.27	3.15
At 15% axial strain				
Corrected deviator stress	(kPa)	639	1334	2497
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	2.14	3.03	3.87
Major principal effective stress	(kPa)	933	1923	3676
Minor principal effective stress	(kPa)	294	589	1179
Principal effective stress ratio		3.17	3.26	3.12

FINAL CONDITIONS				
Water content	(%)	24.5	22.8	21.9
Bulk density	(Mg/m³)	2.00	2.02	2.04
Dry density	(Mg/m³)	1.60	1.65	1.67

Borehole	HKZ1-BH03-SA	HKZ1-BH03-SA	HKZ1-BH03-SA
Sample	59BagC	59BagC	59BagC
Depth (m)	54.75	54.75	54.75

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 09/09/2016

Drawn by: ALB

Template Issue: 7

Filename: J11335 / EFFECTIV / HKZ1-BH03-SA_59BagC_D3.XLS

Date: 13/09/2016

Date: 20/09/2016

Checked by: MSR

Approved by: PH

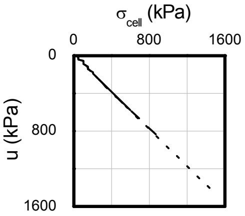
Drawn by: ALB Date: 09/09/2016

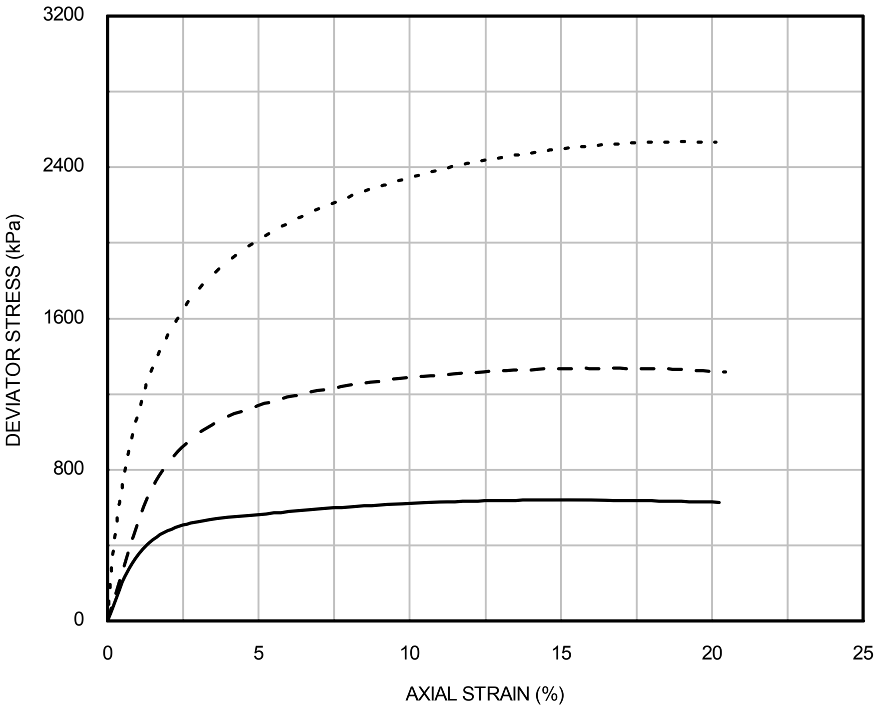
Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_59BagC_D3.OPJ

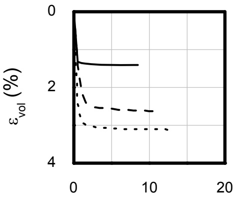
Date : 13/09/2016 Date : 20/09/2016

Checked by: MSR Approved by: PH

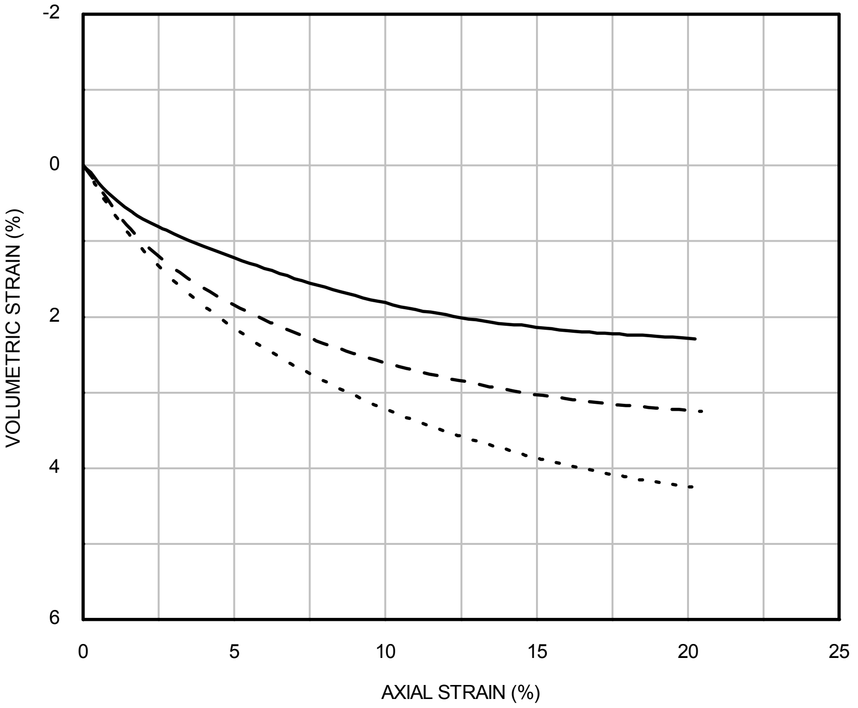
Saturation







Consolidation



Curve	Specimen(3)	σ$_{rc}$' (kPa)	σ$_{vc}$' (kPa)	Borehole	Sample	Depth (m)
———	1	295	295	HKZ1-BH03 -SA	59BagC	54.75
– –	2	590	590			
· · · ·	3	1180	1180			

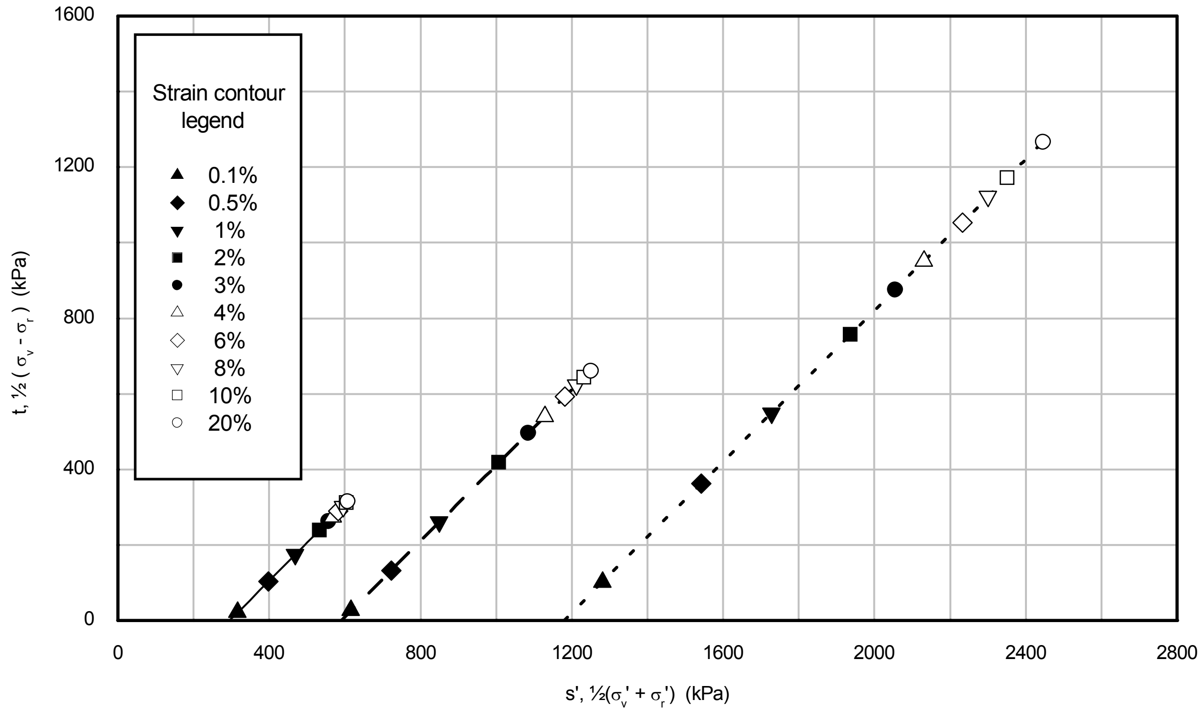
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

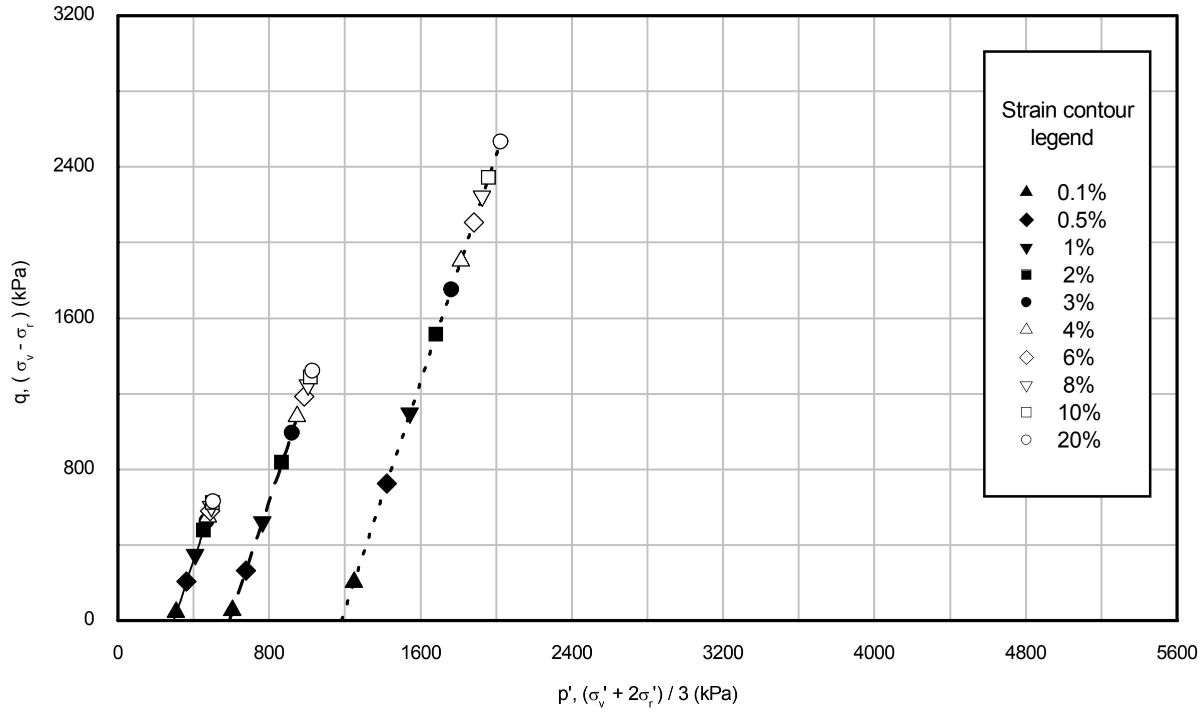
Drawn by: ALB Date: 09/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_59BagC_D3.OPJ

Date : 13/09/2016 Date : 20/09/2016

Checked by: MSR Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	295	295	HKZ1-BH03 -SA	59BagC	54.75
– –	2	590	590			
- - - -	3	1180	1180			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 09/09/2016

Drawn by: ALB

Template Issue: 4

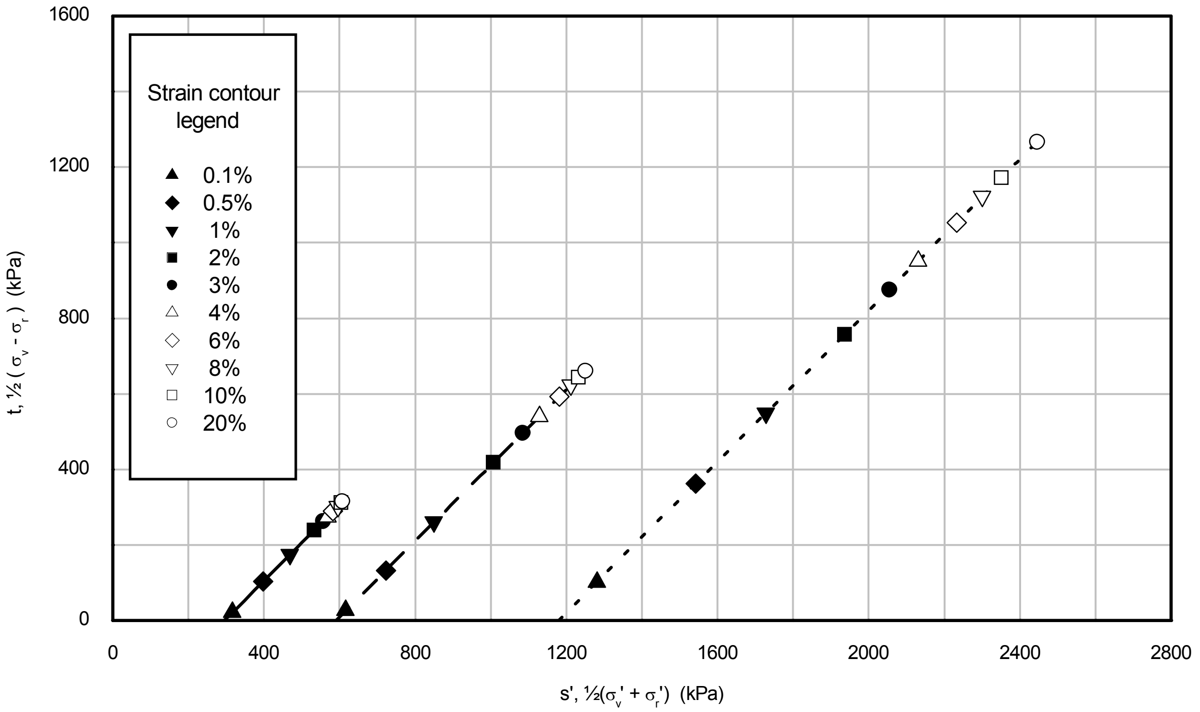
Filename: J11335 \ EFFECTIV \ HKZ1-BH03-SA_59BagC_D3.OPJ

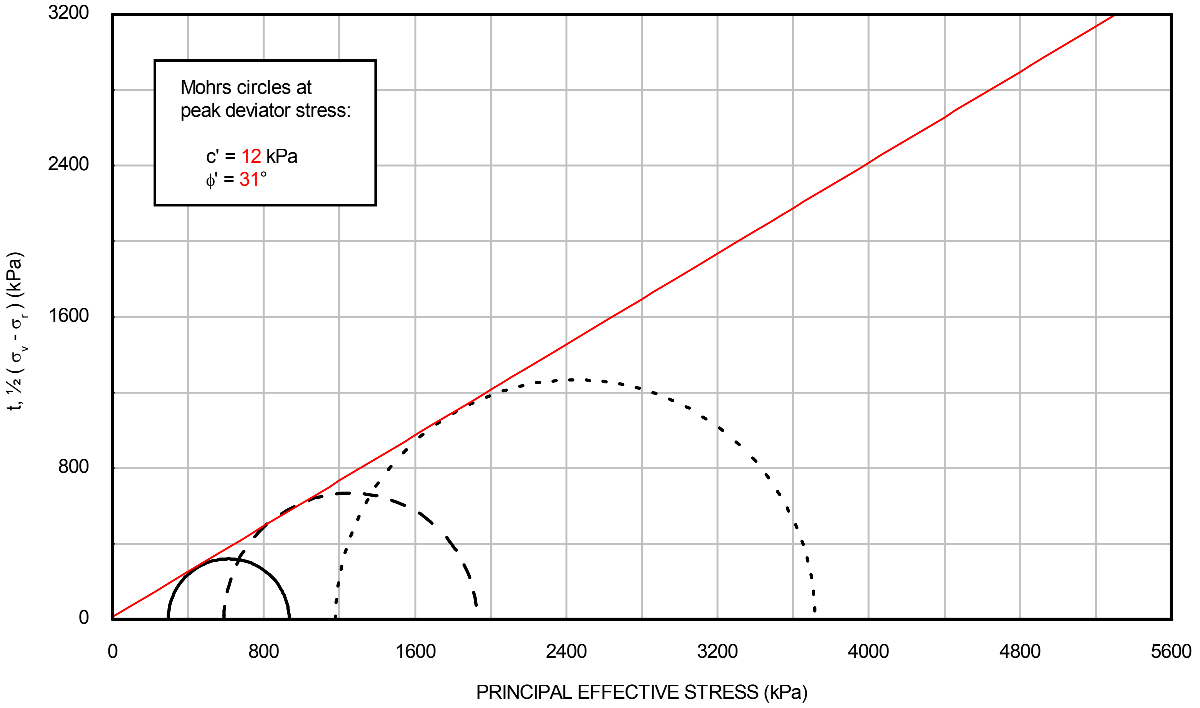
Date : 13/09/2016

Checked by: MSR

Date : 20/09/2016

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	295	295	HKZ1-BH03 -SA	59BagC	54.75
— —	2	590	590			
· · · ·	3	1180	1180			

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_10BagA_D3.XLS
Date: 20/09/2016
Checked by: PH
Date: 20/09/2016
Approved by: PH

VISUAL DESCRIPTION
Brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		01/09/2016	07/09/2016	12/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.8	10.1	10.1
Bulk density	(Mg/m³)	1.86	1.86	1.86
Dry density	(Mg/m³)	1.68	1.69	1.69
Void ratio		0.581	0.570	0.567
Degree of saturation	(%)	49	47	47

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	361	438	590
Cell pressure on completion	(kPa)	375	450	600
B value achieved		0.95	0.99	1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	10BagA	10BagA	10BagA
Depth (m)	7.00	7.00	7.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	375	450	600
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	75	150	300
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	21.7	21.1	20.6
Bulk density	(Mg/m³)	2.05	2.06	2.07
Dry density	(Mg/m³)	1.68	1.70	1.71
Void ratio		0.575	0.559	0.547
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.35	0.75	1.30

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	10BagA	10BagA	10BagA
Depth (m)	7.00	7.00	7.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1				
Bulk density	[Mg/m^3]		2.04	
Dry density	[Mg/m^3]		1.68	
Void ratio	[-]		0.581	
Distance	[mm]		132.1	
Effective radial pressure	[kPa]		14	
Effective axial pressure	[kPa]		14	
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.20	1.0870	5.44	121.56	30.2
0.21	1.0910	5.20	121.12	30.0
0.22	1.0915	4.96	121.06	30.0
0.23	1.0935	4.75	120.84	29.8
0.24	1.0925	4.55	120.95	29.9
0.25	1.0965	4.39	120.51	29.7
0.26	1.0960	4.22	120.57	29.7
0.27	1.0975	4.07	120.40	29.6
0.28	1.0980	3.92	120.35	29.6
0.29	1.1005	3.79	120.07	29.5

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1				
Bulk density	[Mg/m^3]		2.05	
Dry density	[Mg/m^3]		1.68	
Void ratio	[-]		0.575	
Distance	[mm]		132.0	
Effective radial pressure	[kPa]		75	
Effective axial pressure	[kPa]		75	
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.10	0.6670	6.67	197.88	80.2
0.11	0.6695	6.09	197.14	79.6
0.12	0.6705	5.59	196.84	79.3
0.13	0.6715	5.17	196.55	79.1
0.14	0.6740	4.81	195.82	78.5
0.15	0.6750	4.50	195.53	78.3
0.16	0.6780	4.24	194.67	77.6
0.17	0.6780	3.99	194.67	77.6
0.18	0.6780	3.77	194.67	77.6
0.19	0.6765	3.56	195.10	77.9

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	10BagA	10BagA	10BagA
Depth (m)	7.00	7.00	7.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	75	150	300
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	280	501	911
Membrane correction applied	(kPa)	0.2	0.2	0.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.12	2.00	2.50
Volumetric strain	(%)	-0.78	-0.70	-0.66
Major principal effective stress	(kPa)	358	653	1212
Minor principal effective stress	(kPa)	77	152	302
Principal effective stress ratio		4.62	4.30	4.02
Epsilon 50 (ε 50)	(%)	0.31	0.28	0.32
Secant modulus (E50) at ε 50	(kPa)	45033	89481	140649
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	280	501	910
Membrane correction applied	(kPa)	0.2	0.2	0.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	1.87	1.87	2.38
Volumetric strain	(%)	-0.62	-0.63	-0.59
Major principal effective stress	(kPa)	357	653	1212
Minor principal effective stress	(kPa)	77	152	302
Principal effective stress ratio		4.63	4.31	4.02
At 15% axial strain				
Corrected deviator stress	(kPa)	210	358	653
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-4.55	-4.28	-3.20
Major principal effective stress	(kPa)	289	511	956
Minor principal effective stress	(kPa)	79	153	304
Principal effective stress ratio		3.64	3.34	3.15

FINAL CONDITIONS				
Water content	(%)	21.7	21.1	20.6
Bulk density	(Mg/m³)	2.05	2.06	2.07
Dry density	(Mg/m³)	1.68	1.70	1.71

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	10BagA	10BagA	10BagA
Depth (m)	7.00	7.00	7.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

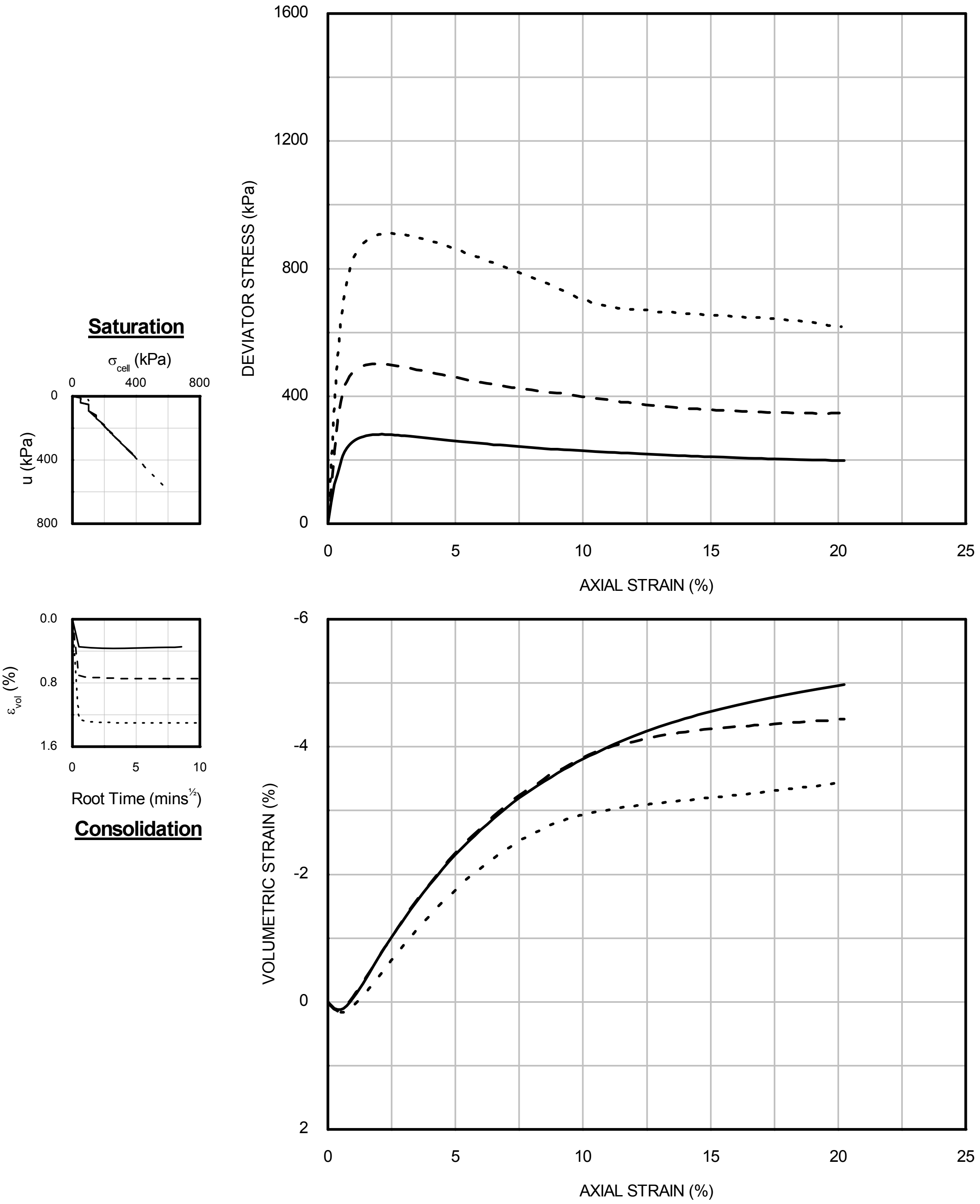
Drawn by: ALB Date: 14/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_10BagA_D3.OPJ

Checked by: MSR Date : 15/09/2016

Approved by: PH Date : 20/09/2016



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	75	75	HKZ1-BH04 -SA	10BagA	7.00
– –	2	150	150			
· · · ·	3	300	300			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 14/09/2016

Drawn by: ALB

Template Issue: 4

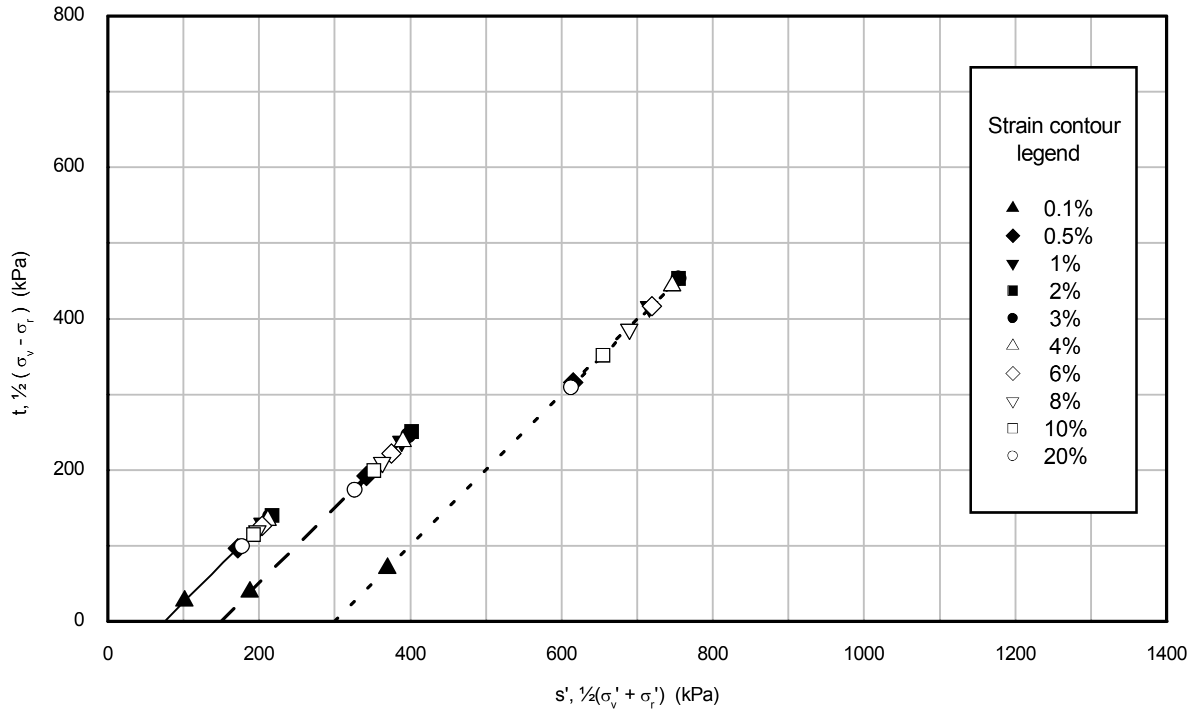
Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_10BagA_D3.OPJ

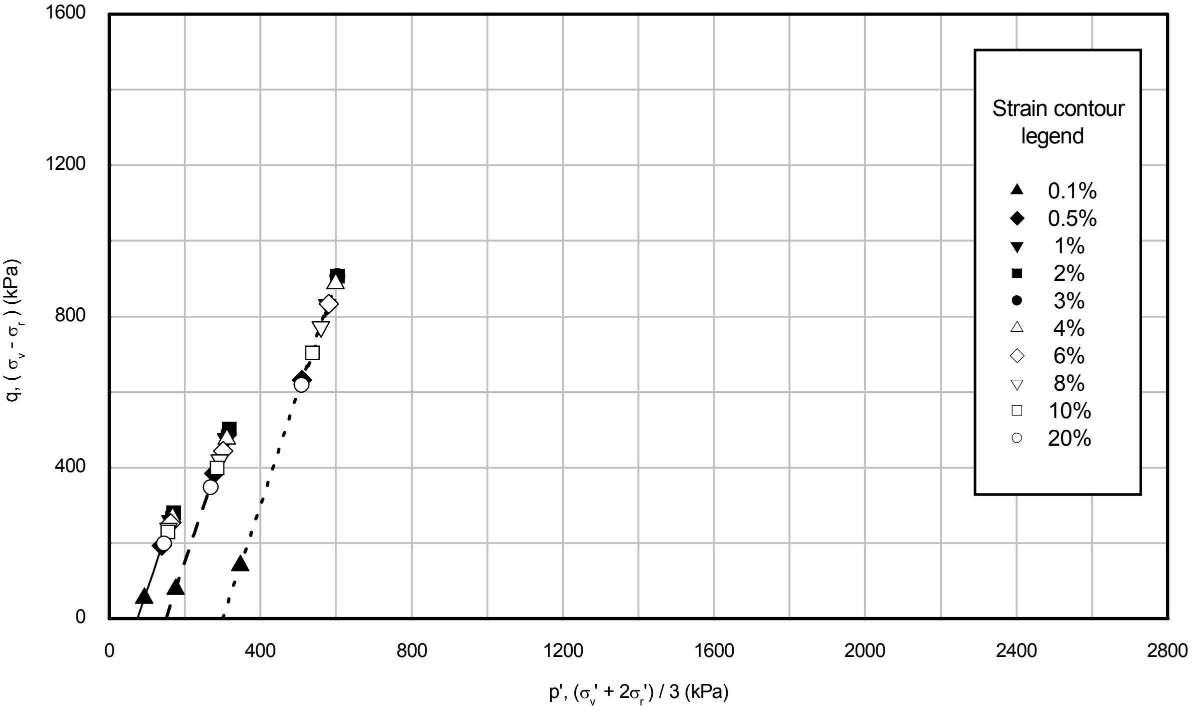
Date : 15/09/2016

Date : 20/09/2016

Checked by: MSR

Approved by: PH





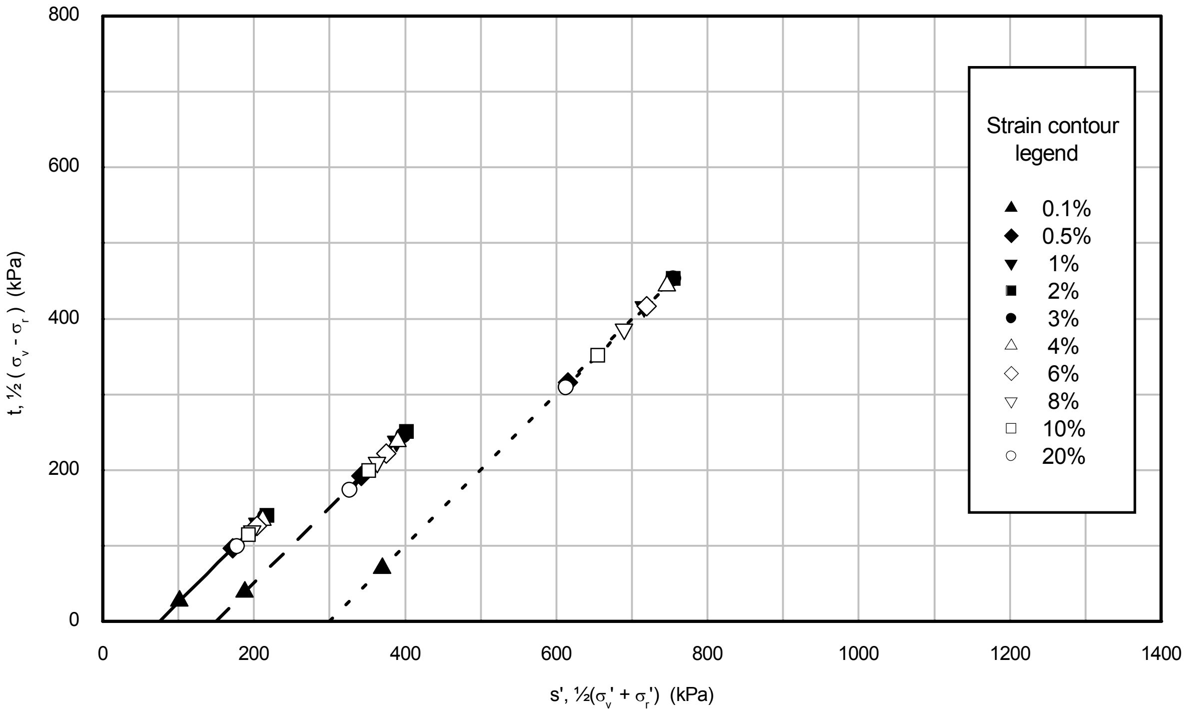
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	75	75	HKZ1-BH04 -SA	10BagA	7.00
— —	2	150	150			
- - - -	3	300	300			

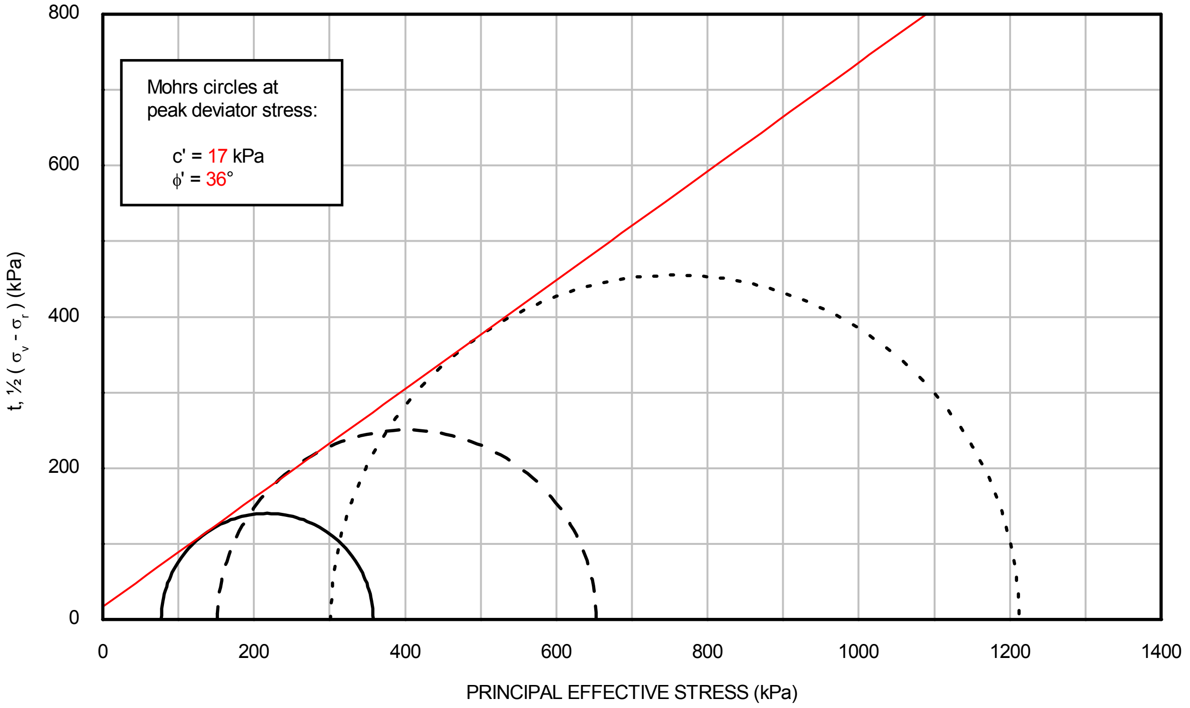
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 14/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_10BagA_D3.OPJ





Date : 15/09/2016

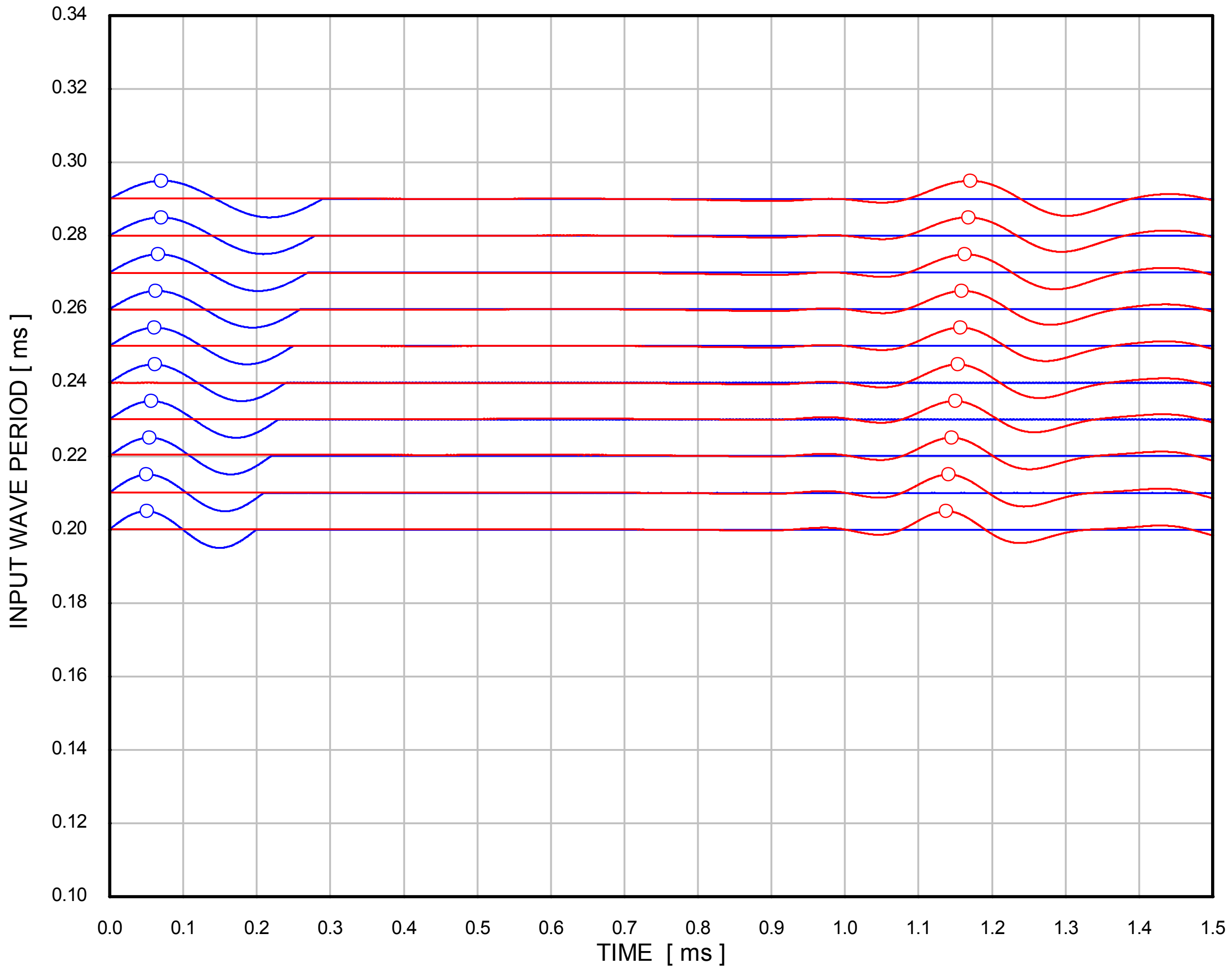
Date : 20/09/2016

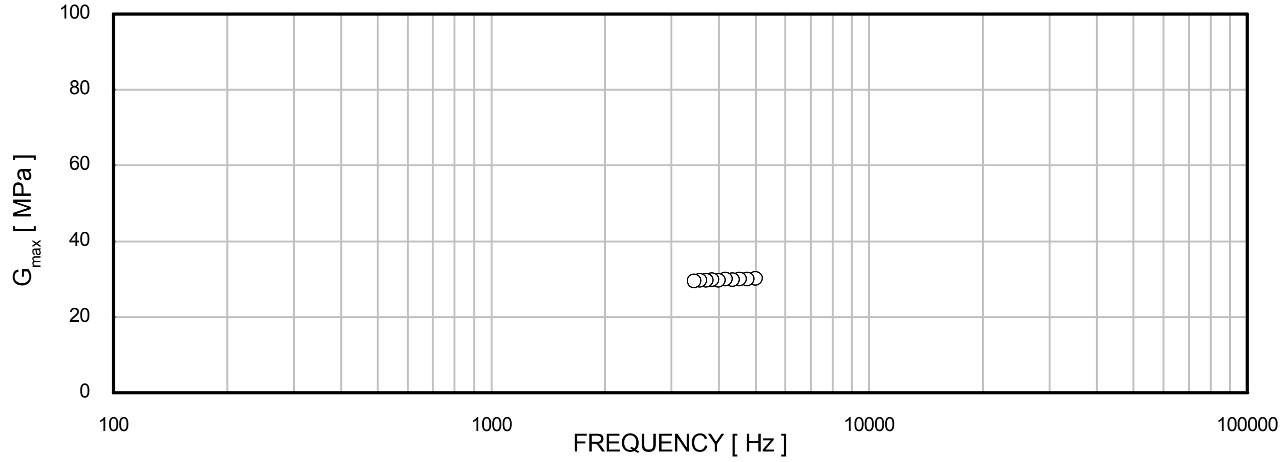
Checked by: MSR

Approved by: PH

Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	75	75	HKZ1-BH04 -SA	10BagA	7.00
– –	2	150	150			
· · · ·	3	300	300			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





σ'_{rc} : 14 kPa

σ'_{ac} : 14 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

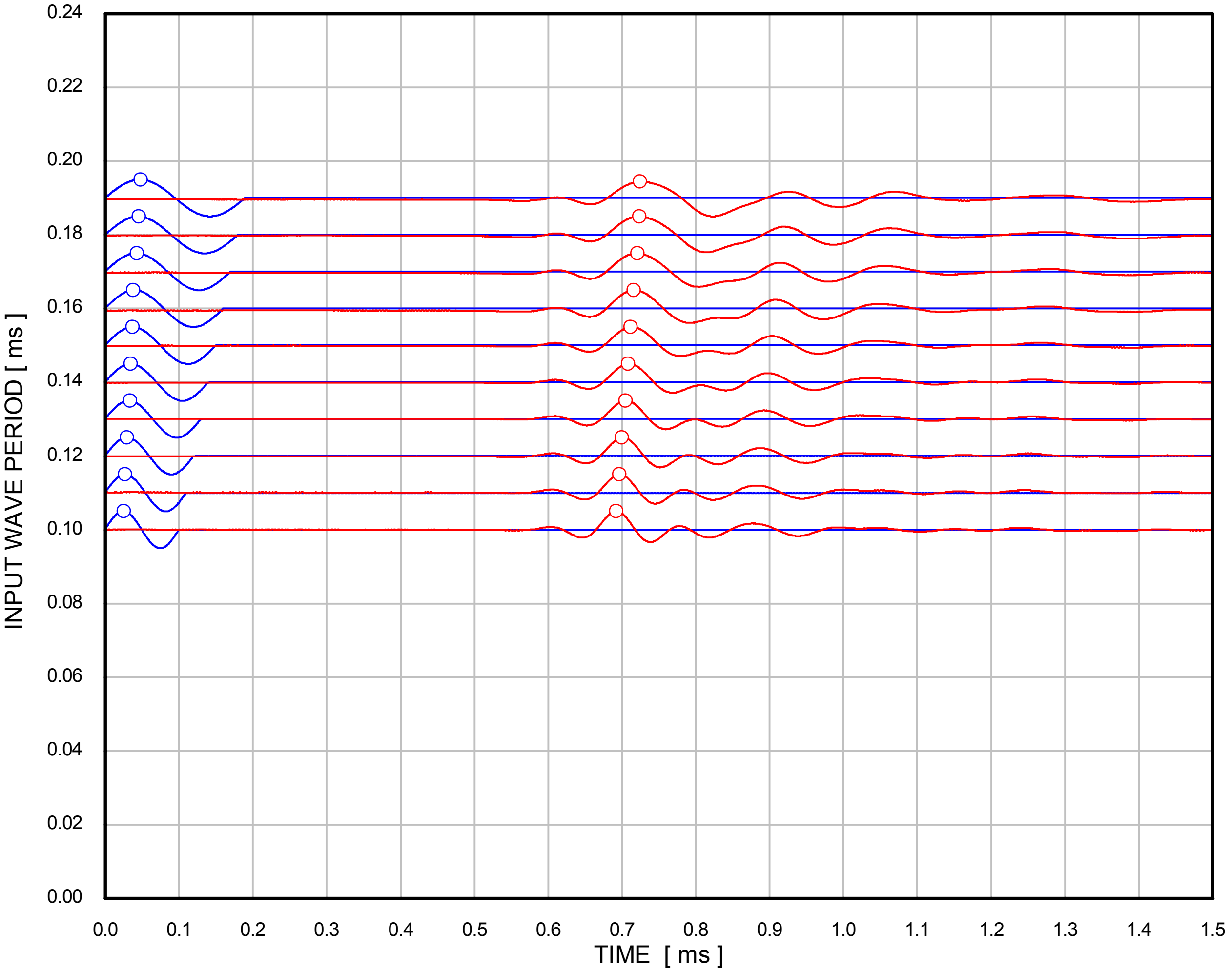
Borehole : HKZ1-BH04-SA

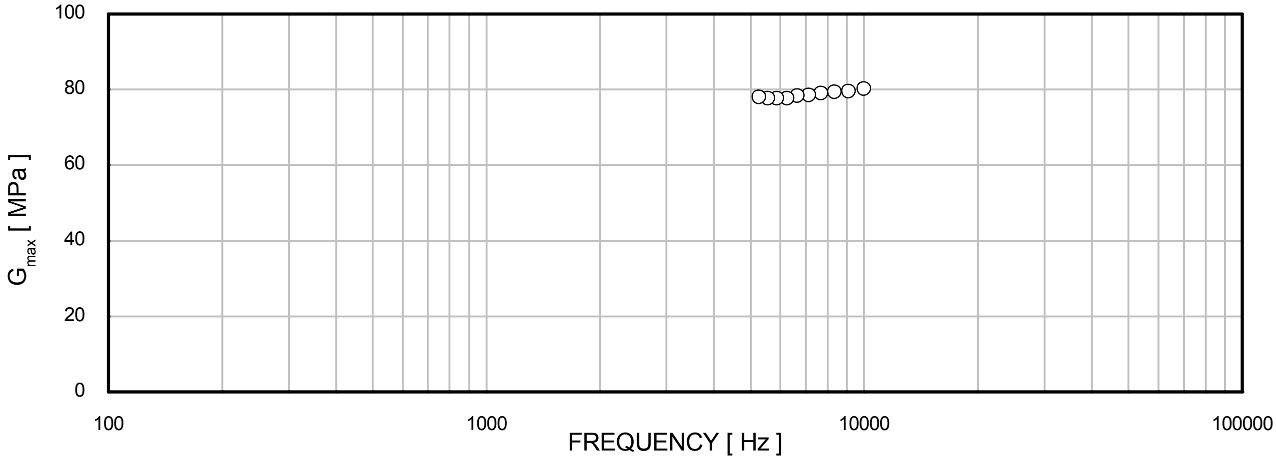
Sample : 10BagA

Depth [m] : 7.00

Test No. : 215A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc} : 75 kPa

σ'_{ac} : 75 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH04-SA

Sample : 10BagA

Depth [m] : 7.00

Test No. : 215A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Dark grey fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	30/08/2016	30/08/2016	30/08/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.2	10.2	10.2
Bulk density	(Mg/m³)	1.68	1.68	1.68
Dry density	(Mg/m³)	1.53	1.53	1.52
Void ratio		0.744	0.741	0.745
Degree of saturation	(%)	37	37	36

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	575	760	1112
Cell pressure on completion	(kPa)	590	780	1160
B value achieved		0.98	0.98	0.95

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	34BagB	34BagB	34BagB
Depth (m)	30.80	30.80	30.80

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 01/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_34BagB_D3.XLS
Date: 28/09/2016
Date: 03/10/2016
Checked by: MSR
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	590	780	1160
Back pressure	(kPa)	400	400	400
Effective cell pressure	(kPa)	190	380	760
Pore pressure on completion	(kPa)	400	400	400
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	27.3	27.0	26.4
Bulk density	(Mg/m³)	1.96	1.97	1.97
Dry density	(Mg/m³)	1.54	1.55	1.56
Void ratio		0.726	0.718	0.704
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.00	1.34	2.40

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	34BagB	34BagB	34BagB
Depth (m)	30.80	30.80	30.80

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 01/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_34BagB_D3.XLS
Date: 28/09/2016
Date: 03/10/2016
Checked by: MSR
Approved by: PH

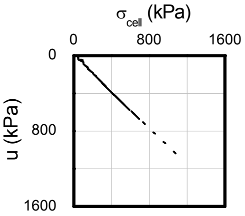
SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	400	400	400
Initial effective cell pressure	(kPa)	190	380	760
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	521	970	1767
Membrane correction applied	(kPa)	0.6	1.0	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.69	6.10	13.67
Volumetric strain	(%)	-0.07	-0.13	1.26
Major principal effective stress	(kPa)	712	1350	2528
Minor principal effective stress	(kPa)	191	380	761
Principal effective stress ratio		3.73	3.55	3.32
Epsilon 50 (ε 50)	(%)	0.69	0.94	0.93
Secant modulus (E50) at ε 50	(kPa)	37632	51792	95464
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	521	970	1766
Membrane correction applied	(kPa)	0.5	1.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.19	6.10	13.92
Volumetric strain	(%)	0.01	-0.13	1.26
Major principal effective stress	(kPa)	712	1350	2527
Minor principal effective stress	(kPa)	191	380	760
Principal effective stress ratio		3.73	3.55	3.32
At 15% axial strain				
Corrected deviator stress	(kPa)	474	864	1764
Membrane correction applied	(kPa)	2.1	2.1	2.1
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-1.12	-0.96	1.27
Major principal effective stress	(kPa)	666	1246	2525
Minor principal effective stress	(kPa)	192	382	761
Principal effective stress ratio		3.47	3.26	3.32

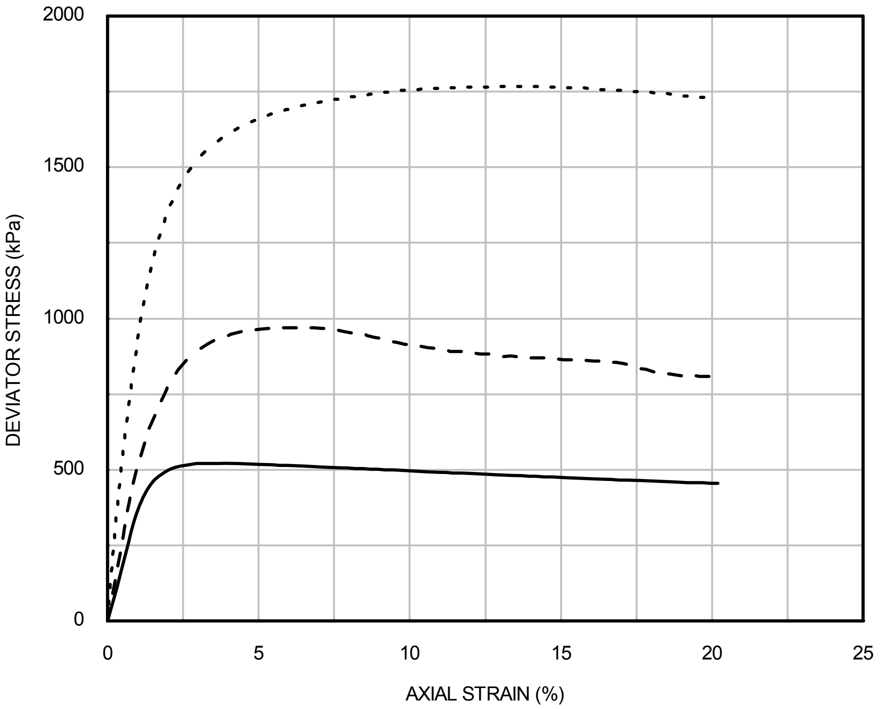
FINAL CONDITIONS				
Water content	(%)	28.3	27.7	25.6
Bulk density	(Mg/m³)	1.95	1.96	1.99
Dry density	(Mg/m³)	1.52	1.53	1.58

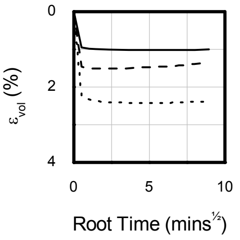
Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	34BagB	34BagB	34BagB
Depth (m)	30.80	30.80	30.80

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

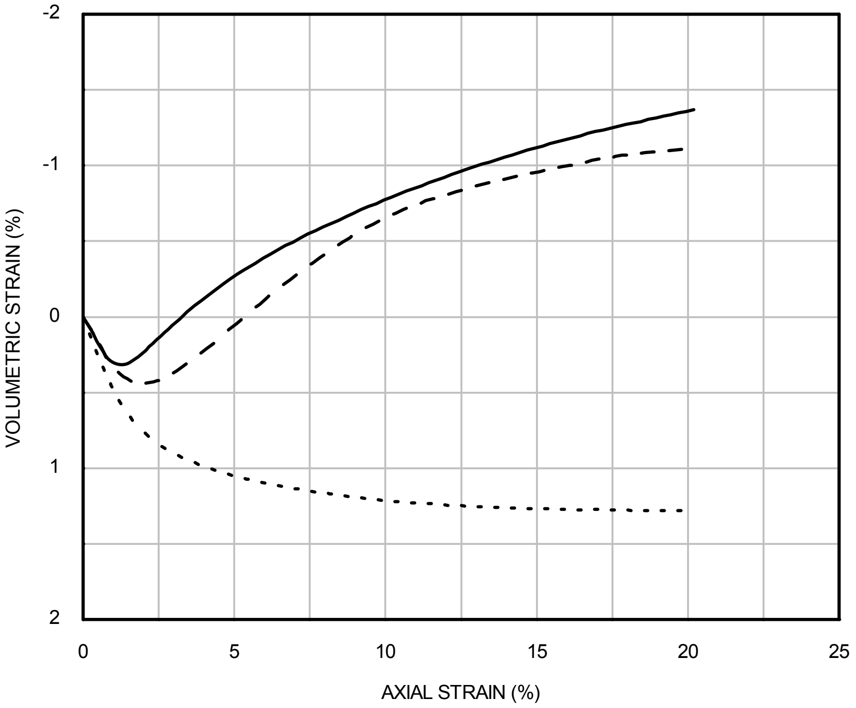
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	190	190	HKZ1-BH04 -SA	34BagB	30.80
– –	2	380	380			
· · · ·	3	760	760			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 01/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_34BagB_D3.OPJ

Checked by: MSR Date : 28/09/2016

Approved by: PH Date : 03/10/2016

Date: 01/09/2016

Drawn by: ALB

Template Issue: 4

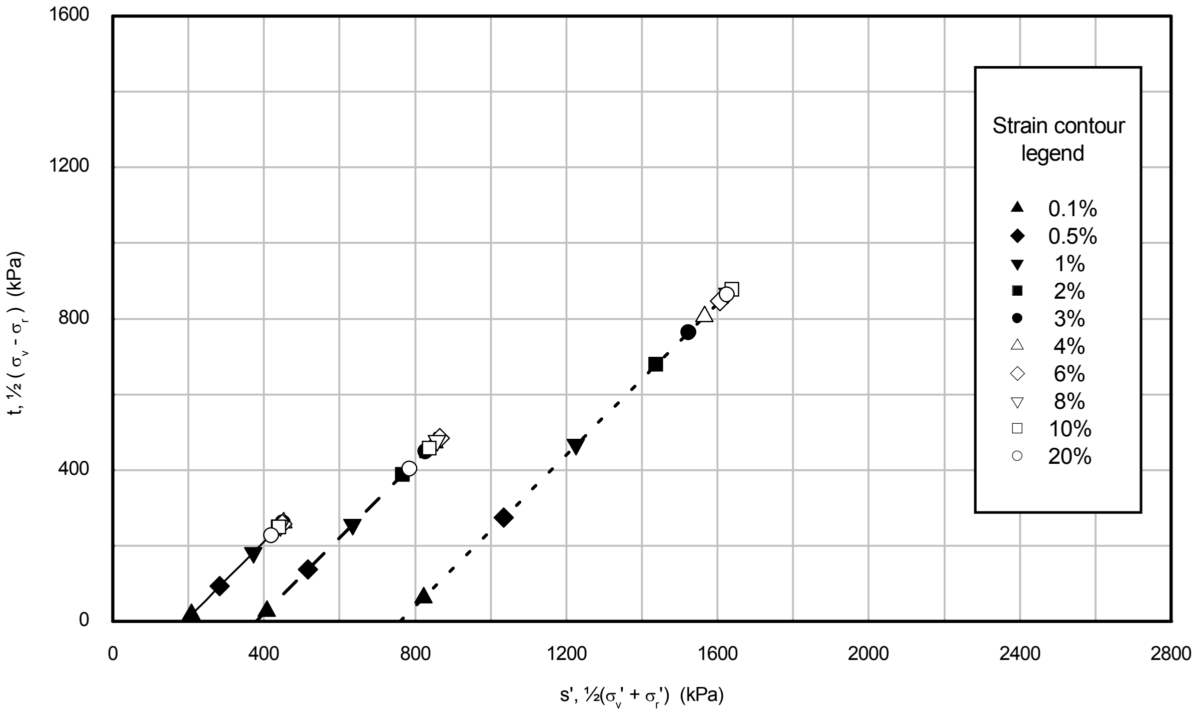
Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_34BagB_D3.OPJ

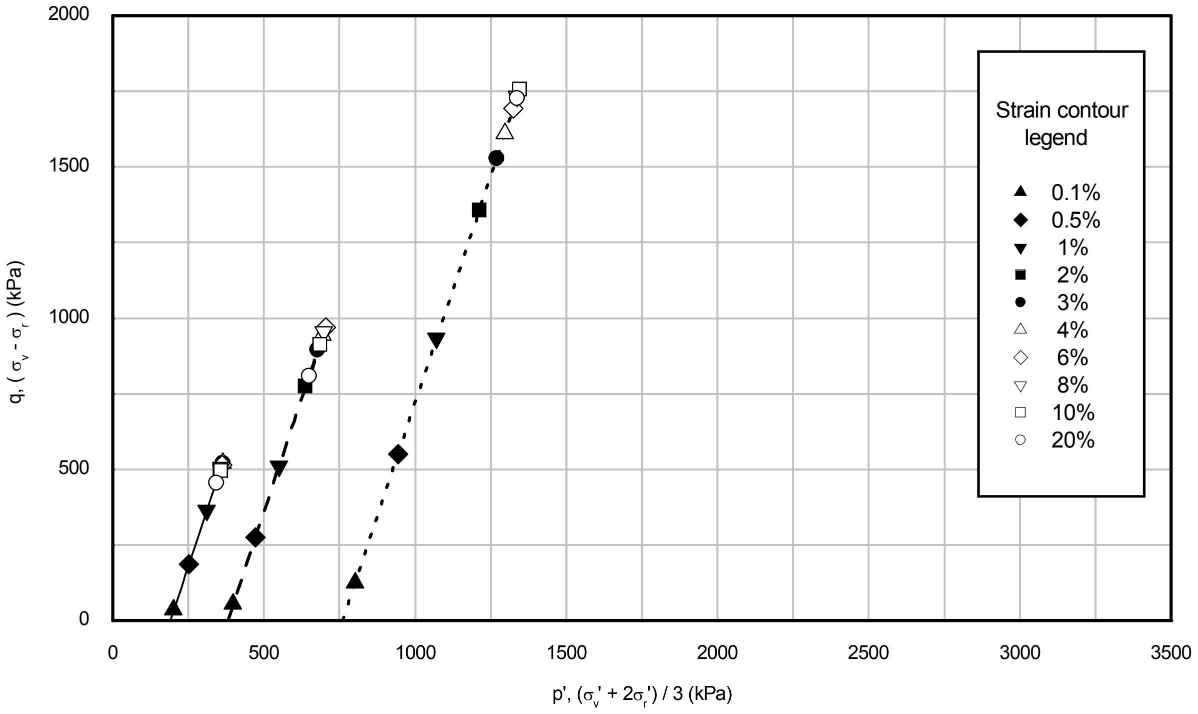
Date : 28/09/2016

Date : 03/10/2016

Checked by: MSR

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	190	190	HKZ1-BH04 -SA	34BagB	30.80
– –	2	380	380			
- - - -	3	760	760			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

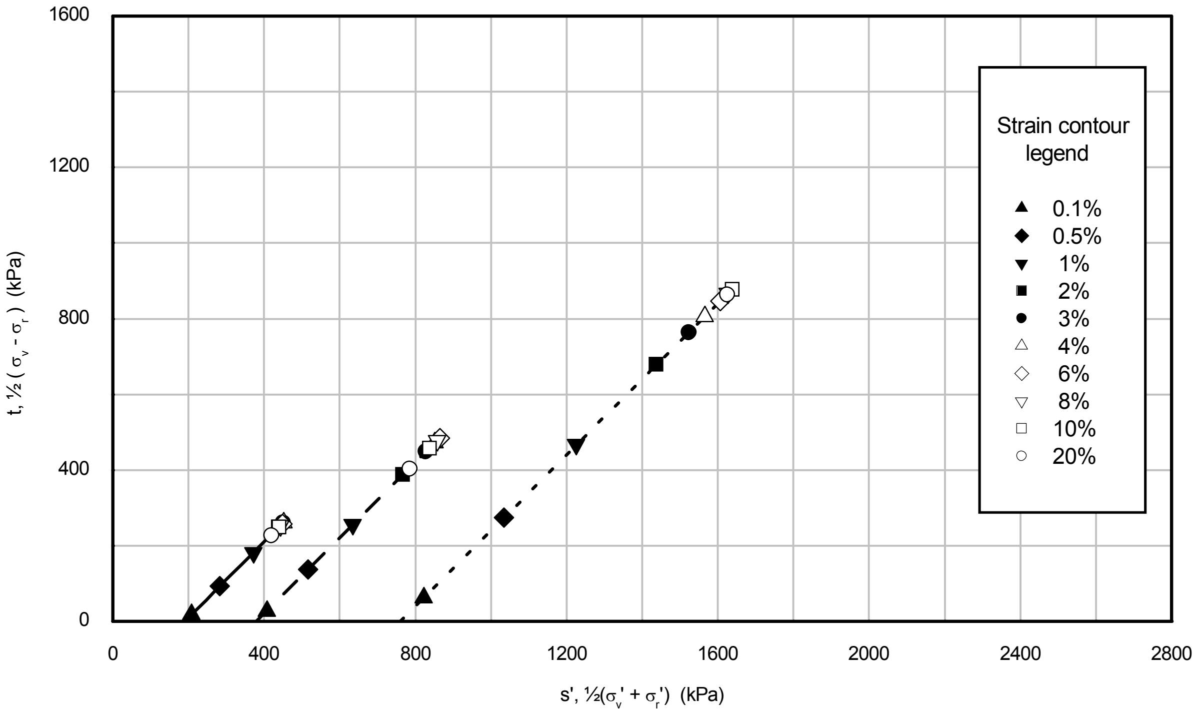
Drawn by: ALB Date: 01/09/2016

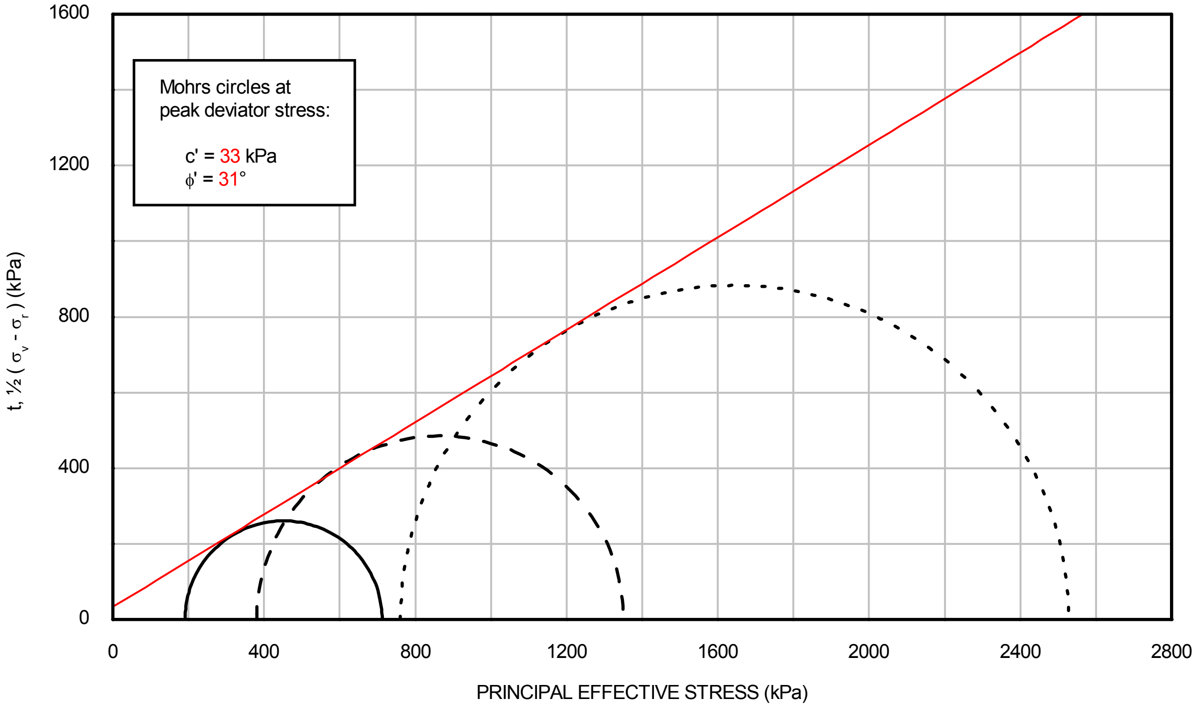
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_34BagB_D3.OPJ

Checked by: MSR Date : 28/09/2016

Approved by: PH Date : 03/10/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	190	190	HKZ1-BH04 -SA	34BagB	30.80
— —	2	380	380			
· · · ·	3	760	760			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 06/09/2016 Drawn by: ALB
Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_56BagA_D3.XLS
Date: 07/09/2016 Date: 13/09/2016
Checked by: MSR Approved by: PH

VISUAL DESCRIPTION
Dark brownish grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		30/08/2016	01/09/2016	05/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.3	9.7	10.0
Bulk density	(Mg/m³)	1.65	1.65	1.65
Dry density	(Mg/m³)	1.50	1.50	1.50
Void ratio		0.768	0.761	0.764
Degree of saturation	(%)	36	34	35

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	666	951	1416
Cell pressure on completion	(kPa)	685	970	1440
B value achieved		0.97	0.99	0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	56BagA	56BagA	56BagA
Depth (m)	50.00	50.00	50.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	685	970	1440
Back pressure	(kPa)	400	400	300
Effective cell pressure	(kPa)	285	570	1140
Pore pressure on completion	(kPa)	400	400	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	27.9	27.0	26.0
Bulk density	(Mg/m³)	1.95	1.96	1.98
Dry density	(Mg/m³)	1.52	1.54	1.57
Void ratio		0.739	0.716	0.689
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.60	2.55	4.23

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	56BagA	56BagA	56BagA
Depth (m)	50.00	50.00	50.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 06/09/2016 Drawn by: ALB

Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH04-SA_56BagA_D3.XLS

Date: 07/09/2016 Checked by: MSR

Date: 13/09/2016 Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	400	400	300
Initial effective cell pressure	(kPa)	285	570	1140
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	671	1311	2570
Membrane correction applied	(kPa)	2.0	2.1	2.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.75	17.25	20.10
Volumetric strain	(%)	2.14	3.37	5.73
Major principal effective stress	(kPa)	955	1881	3711
Minor principal effective stress	(kPa)	284	571	1141
Principal effective stress ratio		3.36	3.30	3.25
Epsilon 50 (ε 50)	(%)	0.60	1.17	2.01
Secant modulus (E50) at ε 50	(kPa)	55653	56160	63937
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	671	1311	2570
Membrane correction applied	(kPa)	2.0	2.1	2.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.75	17.25	20.10
Volumetric strain	(%)	2.14	3.37	5.73
Major principal effective stress	(kPa)	955	1881	3711
Minor principal effective stress	(kPa)	284	571	1141
Principal effective stress ratio		3.36	3.30	3.25
At 15% axial strain				
Corrected deviator stress	(kPa)	669	1303	2487
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	2.11	3.24	5.11
Major principal effective stress	(kPa)	953	1873	3628
Minor principal effective stress	(kPa)	284	570	1141
Principal effective stress ratio		3.35	3.28	3.18

FINAL CONDITIONS				
Water content	(%)	26.4	24.8	22.4
Bulk density	(Mg/m³)	1.97	2.00	2.04
Dry density	(Mg/m³)	1.56	1.60	1.66

Borehole	HKZ1-BH04-SA	HKZ1-BH04-SA	HKZ1-BH04-SA
Sample	56BagA	56BagA	56BagA
Depth (m)	50.00	50.00	50.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 06/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_56BagA_D3.OPJ

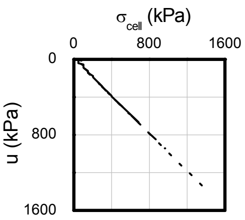
Date : 07/09/2016

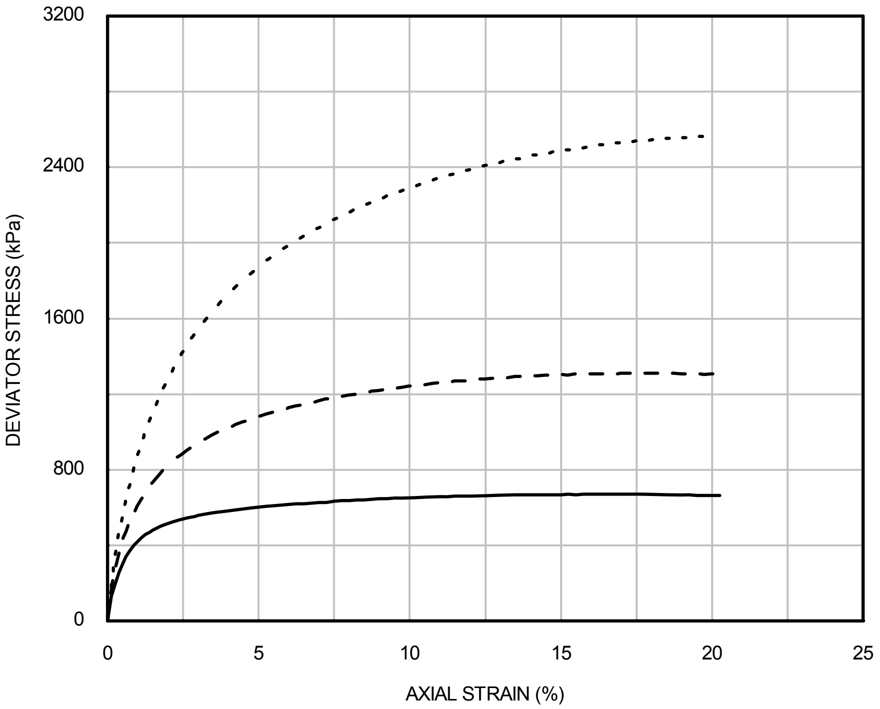
Date : 13/09/2016

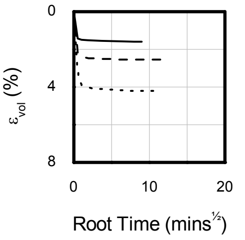
Checked by: MSR

Approved by: PH

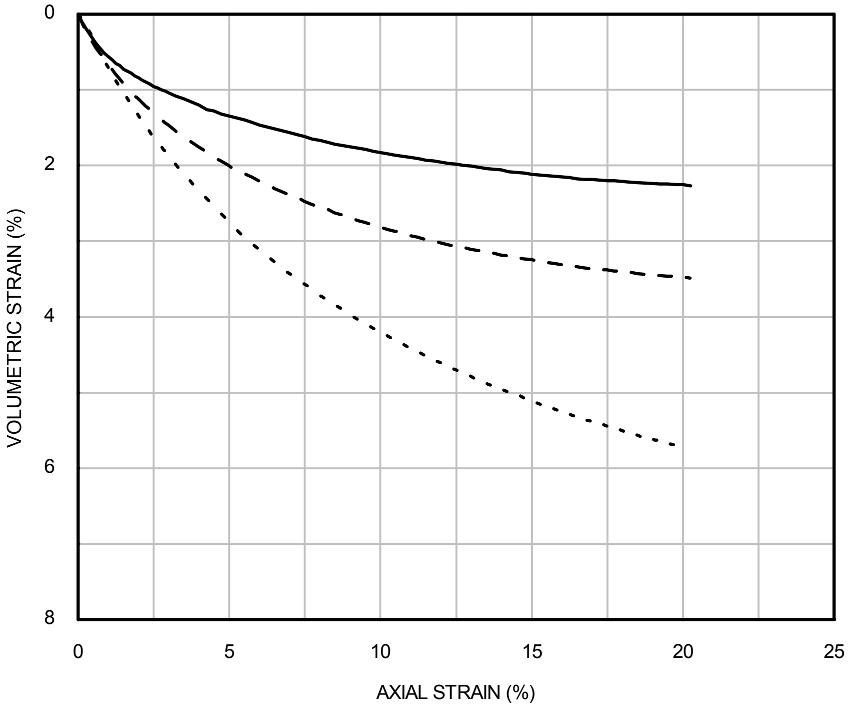
Saturation





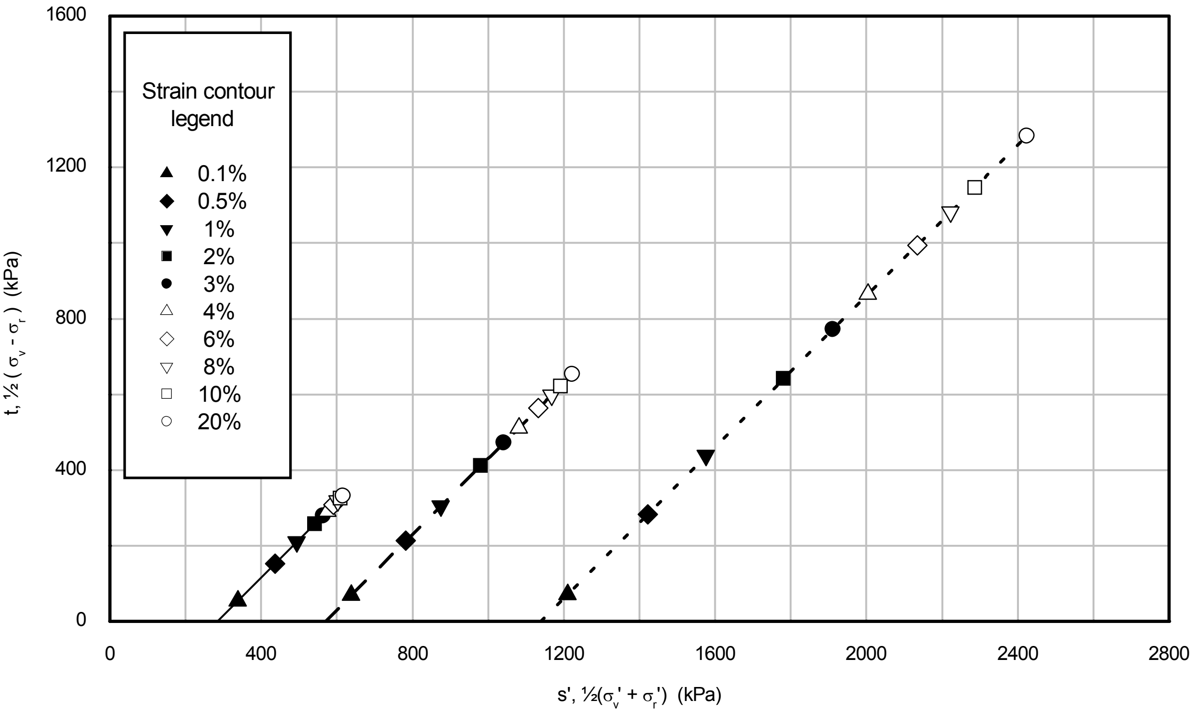


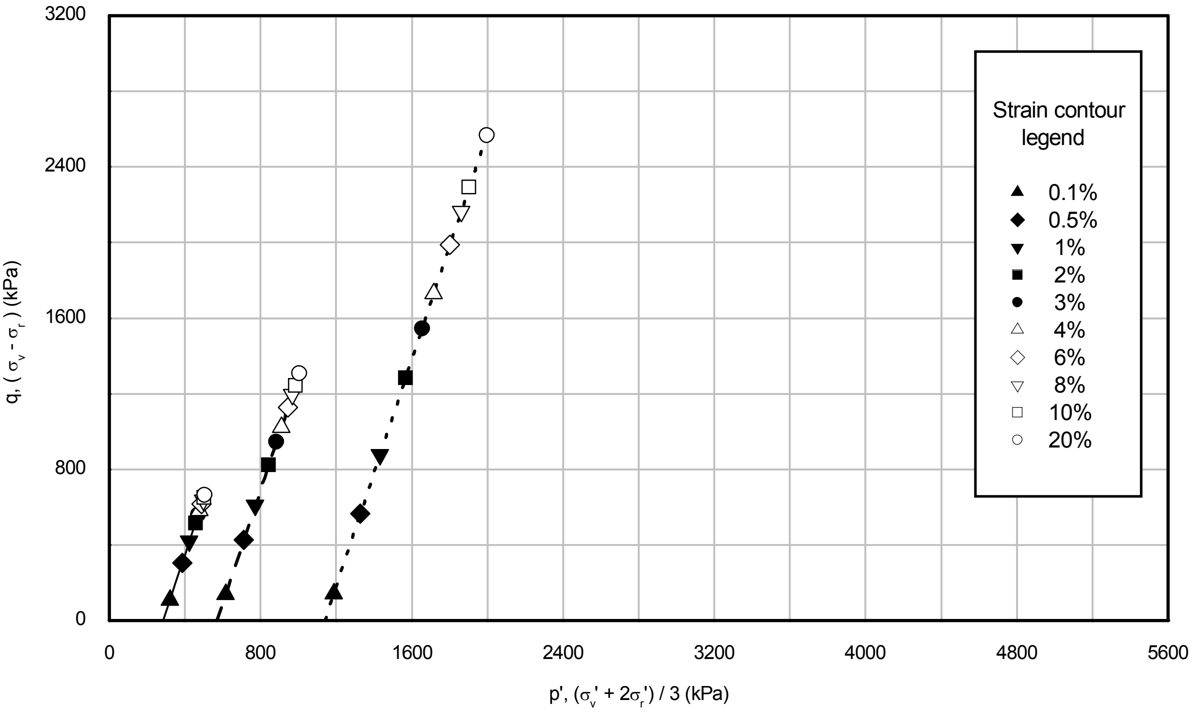
Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	285	285	HKZ1-BH04 -SA	56BagA	50.00
– –	2	570	570			
· · · ·	3	1140	1140			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	285	285	HKZ1-BH04 -SA	56BagA	50.00
– –	2	570	570			
- - - -	3	1140	1140			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

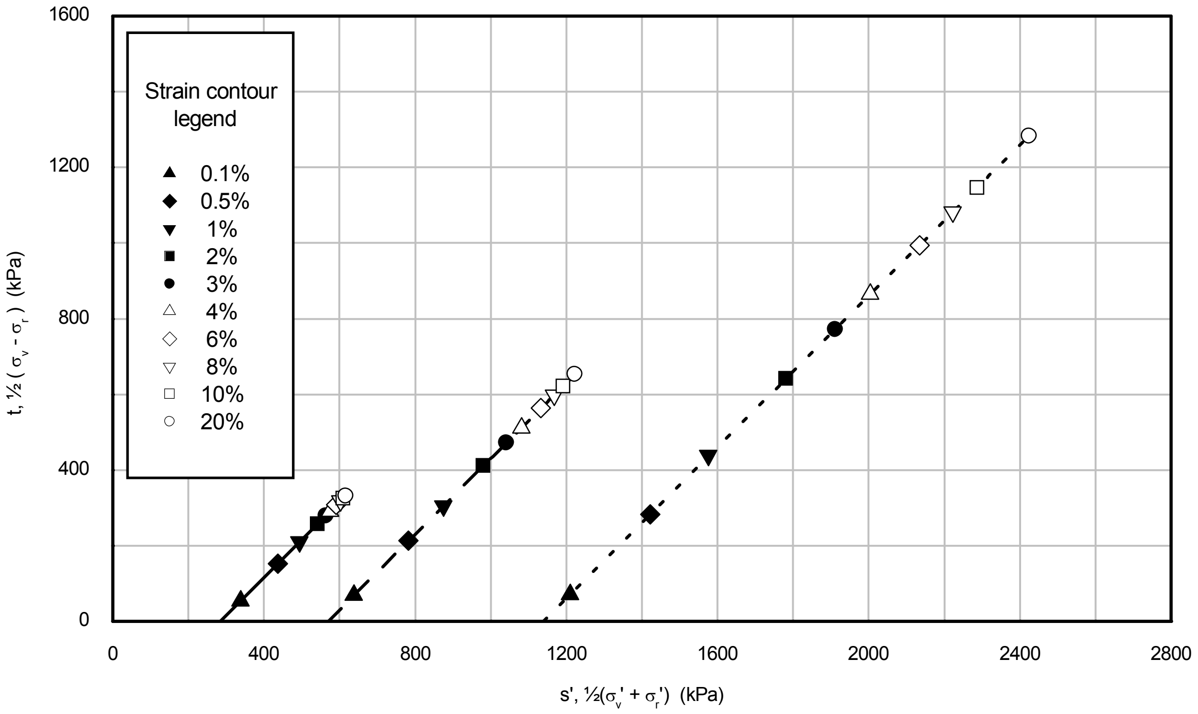
Drawn by: ALB Date: 06/09/2016

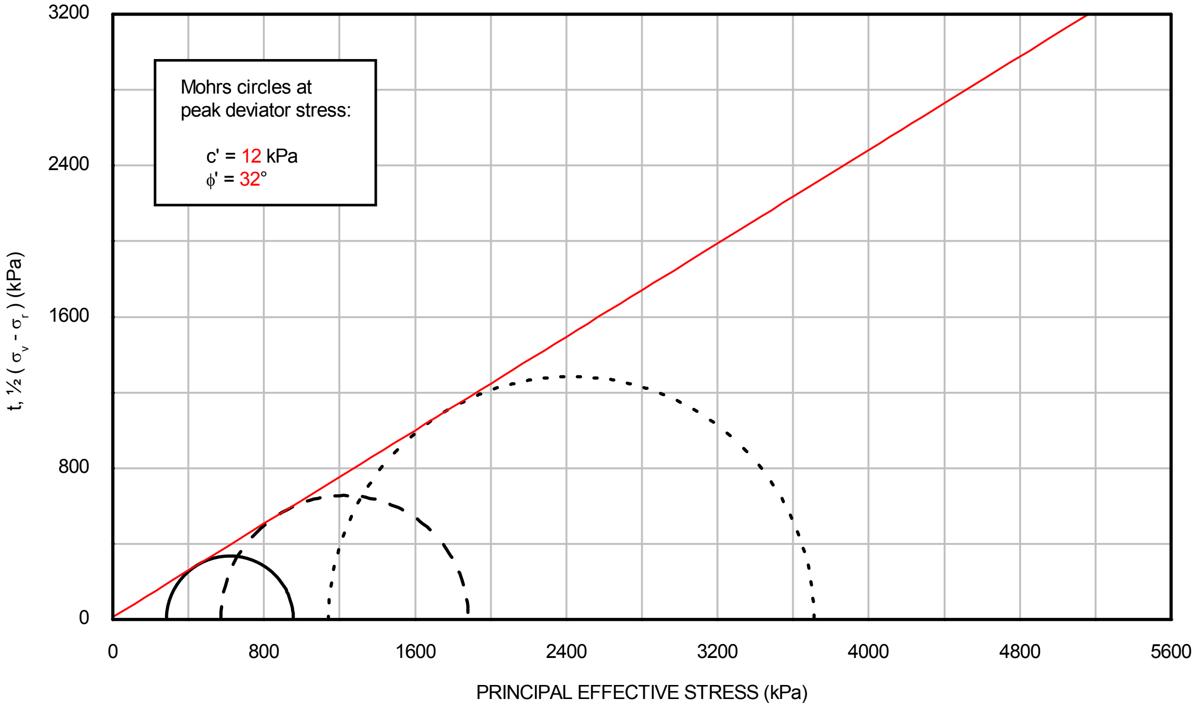
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH04-SA_56BagA_D3.OPJ

Checked by: MSR Date : 07/09/2016

Approved by: PH Date : 13/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	285	285	HKZ1-BH04-SA	56BagA	50.00
— —	2	570	570			
· · · ·	3	1140	1140			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 23/09/2016

Drawn by: ALB

Template Issue: 2

Filename: J11335 / EFFECTIV / HKZ1-BH05-SA_07BagB_D3.XLS

Checked by: PH

Date: 03/10/2016

Approved by: PH

Date: 03/10/2016

VISUAL DESCRIPTION
Brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		02/09/2016	07/09/2016	12/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.0	10.6	10.3
Bulk density	(Mg/m^3)	1.81	1.81	1.80
Dry density	(Mg/m^3)	1.65	1.64	1.63
Void ratio		0.607	0.615	0.626
Degree of saturation	(%)	44	45	43

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	358	427	562
Cell pressure on completion	(kPa)	370	440	580
B value achieved		0.97	0.99	0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	07BagB	07BagB	07BagB
Depth (m)	6.20	6.20	6.20

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 23/09/2016 Drawn by: ALB Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH05-SA_07BagB_D3.XLS
Date: 03/10/2016 Checked by: PH
Date: 03/10/2016 Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	370	440	580
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	70	140	280
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	22.6	22.7	23.0
Bulk density	(Mg/m³)	2.03	2.03	2.02
Dry density	(Mg/m³)	1.66	1.65	1.65
Void ratio		0.600	0.602	0.610
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.40	0.84	0.95

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	07BagB	07BagB	07BagB
Depth (m)	6.20	6.20	6.20

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$		2.03	
Dry density	$[Mg/m^3]$		1.65	
Void ratio	[-]		0.607	
Distance	[mm]		132.1	
Effective radial pressure	[kPa]		12	
Effective axial pressure	[kPa]		12	
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.25	1.1355	4.54	116.29	27.4
0.26	1.1360	4.37	116.24	27.4
0.27	1.1370	4.21	116.14	27.3
0.28	1.1375	4.06	116.09	27.3
0.29	1.1430	3.94	115.53	27.1
0.30	1.1385	3.79	115.99	27.3
0.31	1.1390	3.67	115.94	27.2
0.32	1.1385	3.56	115.99	27.3
0.33	1.1440	3.47	115.43	27.0
0.34	1.1425	3.36	115.58	27.1

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$		2.03	
Dry density	$[Mg/m^3]$		1.66	
Void ratio	[-]		0.600	
Distance	[mm]		131.9	
Effective radial pressure	[kPa]		70	
Effective axial pressure	[kPa]		70	
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.05	0.6670	13.34	197.70	79.4
0.06	0.6645	11.08	198.45	80.0
0.07	0.6680	9.54	197.41	79.2
0.08	0.6710	8.39	196.53	78.4
0.09	0.6730	7.48	195.94	78.0
0.10	0.6735	6.74	195.80	77.9
0.11	0.6755	6.14	195.22	77.4
0.12	0.6765	5.64	194.93	77.2
0.13	0.6775	5.21	194.64	76.9
0.14	0.6790	4.85	194.21	76.6

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	07BagB	07BagB	07BagB
Depth (m)	6.20	6.20	6.20

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 23/09/2016
Drawn by: ALB
Template Issue: 2
Date: 03/10/2016
Checked by: PH

Filename: J11335 / EFFECTIV / HKZ1-BH05-SA_07BagB_D3.XLS
Date: 03/10/2016
Approved by: PH

Date: 23/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH05-SA_07BagB_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	70	140	280
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	225	406	800
Membrane correction applied	(kPa)	0.2	0.2	0.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.25	2.18	2.43
Volumetric strain	(%)	-0.53	-0.49	-0.36
Major principal effective stress	(kPa)	297	547	1080
Minor principal effective stress	(kPa)	72	141	280
Principal effective stress ratio		4.13	3.88	3.86
Epsilon 50 (ε 50)	(%)	0.32	0.27	0.35
Secant modulus (E50) at ε 50	(kPa)	34704	74114	113300
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	225	406	800
Membrane correction applied	(kPa)	0.2	0.2	0.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	1.87	2.05	2.43
Volumetric strain	(%)	-0.36	-0.43	-0.36
Major principal effective stress	(kPa)	296	547	1080
Minor principal effective stress	(kPa)	72	141	280
Principal effective stress ratio		4.14	3.88	3.86
At 15% axial strain				
Corrected deviator stress	(kPa)	171	311	594
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-2.59	-2.91	-1.76
Major principal effective stress	(kPa)	244	453	874
Minor principal effective stress	(kPa)	73	142	280
Principal effective stress ratio		3.35	3.19	3.12

FINAL CONDITIONS				
Water content	(%)	22.6	22.7	23.0
Bulk density	(Mg/m³)	2.03	2.03	2.02
Dry density	(Mg/m³)	1.66	1.65	1.65

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	07BagB	07BagB	07BagB
Depth (m)	6.20	6.20	6.20

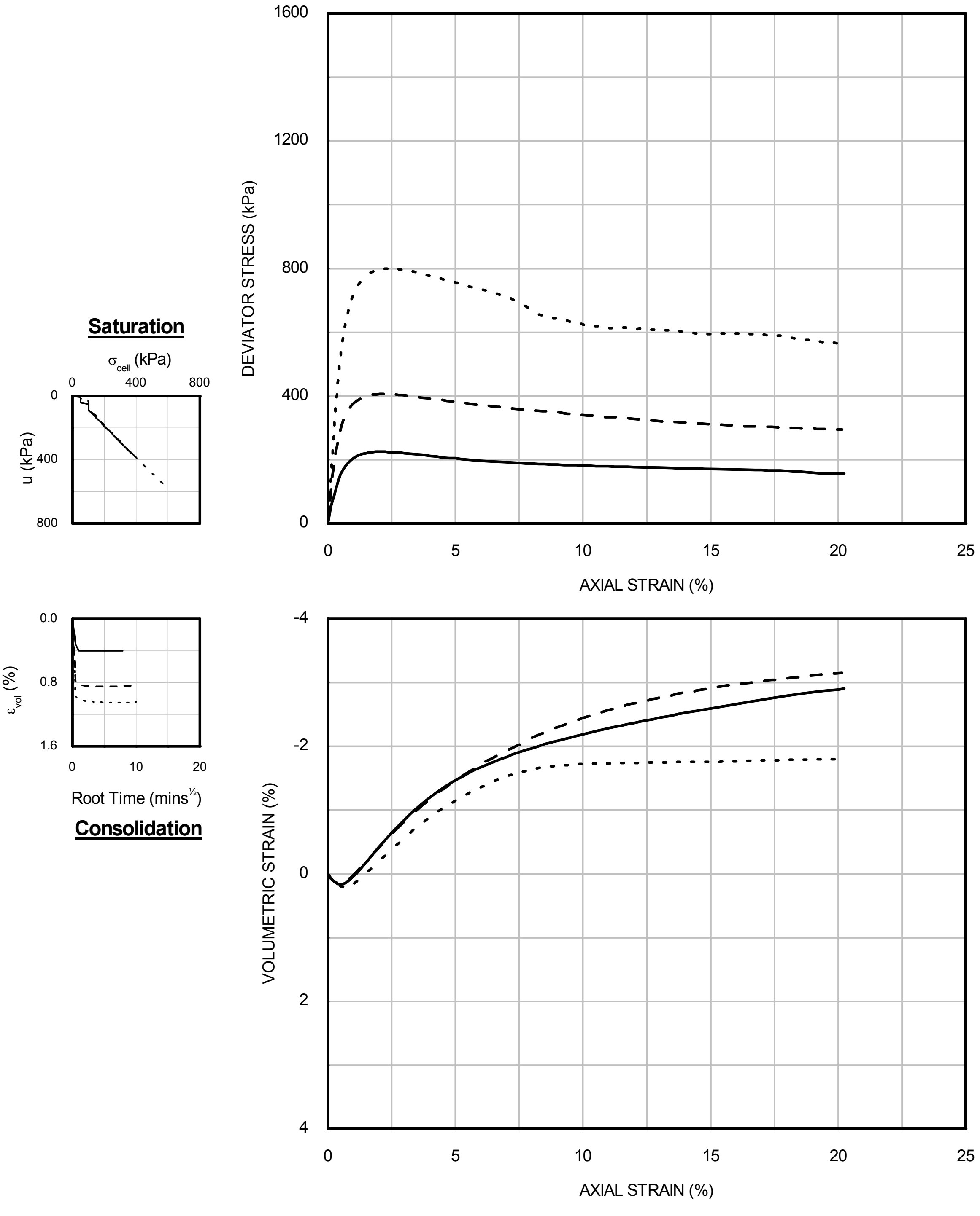
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Drawn by: ALB Date: 23/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_07BagB_D3.OPJ

Date : 03/10/2016 Date : 03/10/2016

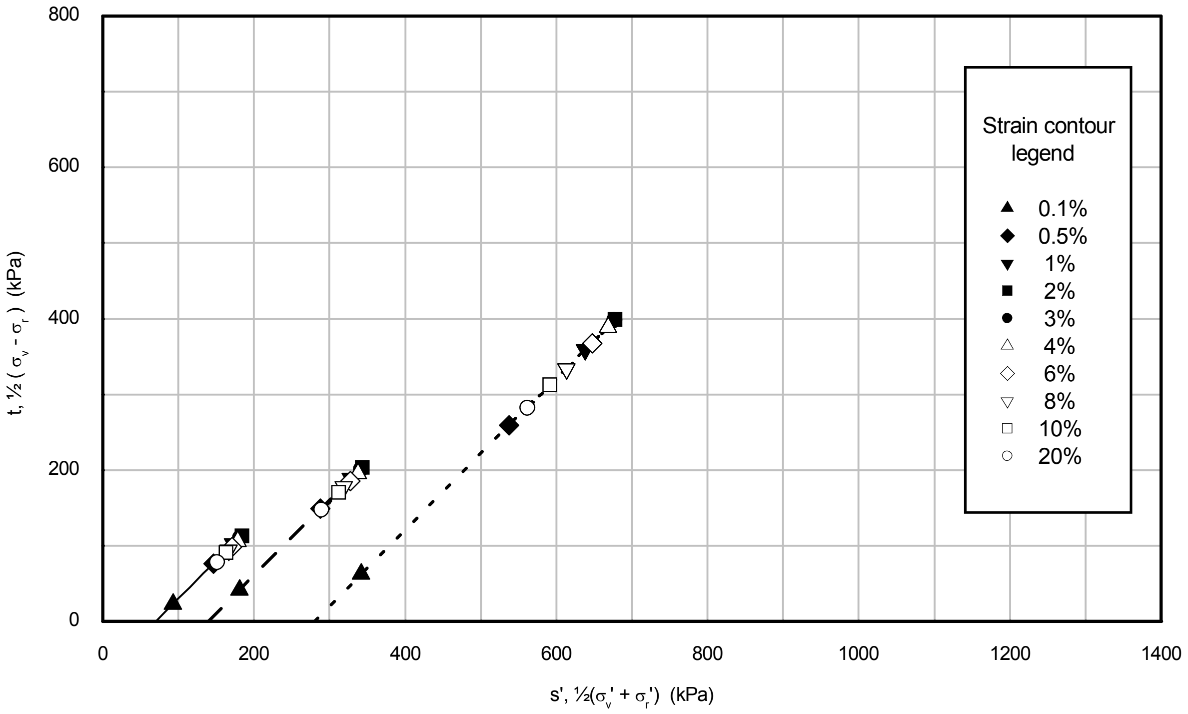
Checked by: PH Approved by: PH

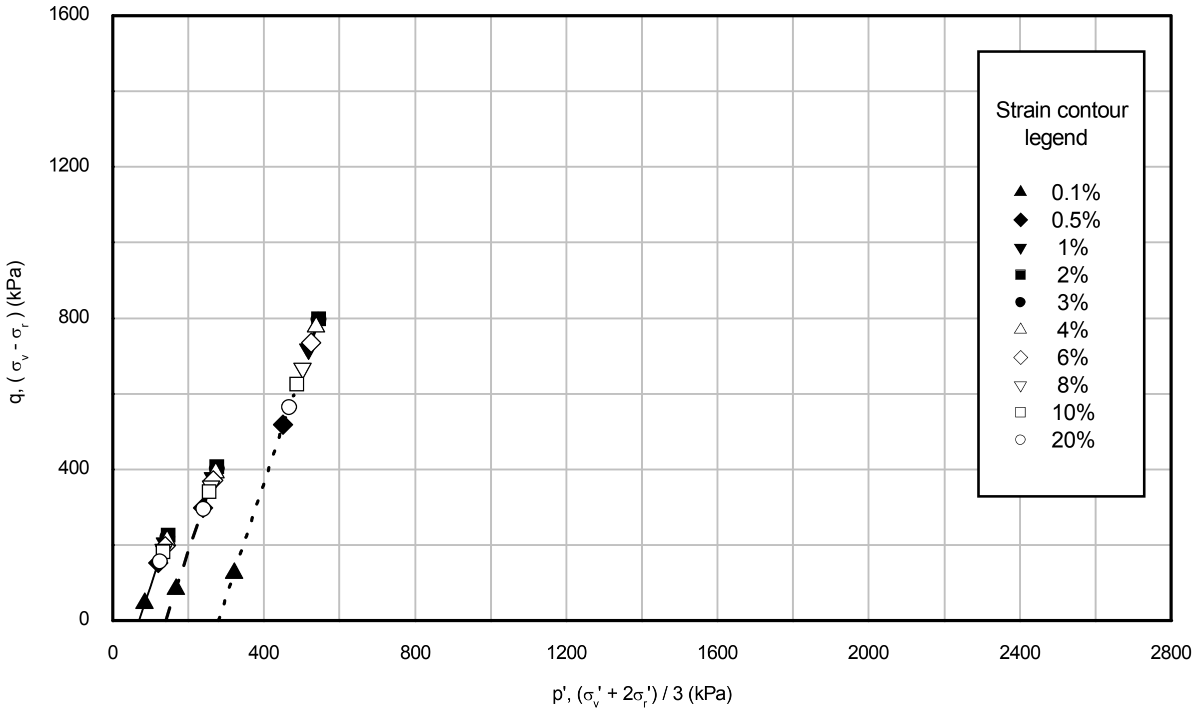


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
───	1	70	70	HKZ1-BH05 -SA	07BagB	6.20
– –	2	140	140			
· · · ·	3	280	280			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 23/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_07BagB_D3.OPJ
Date : 03/10/2016
Date : 03/10/2016
Checked by: PH
Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	70	70	HKZ1-BH05 -SA	07BagB	6.20
– –	2	140	140			
- - - -	3	280	280			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

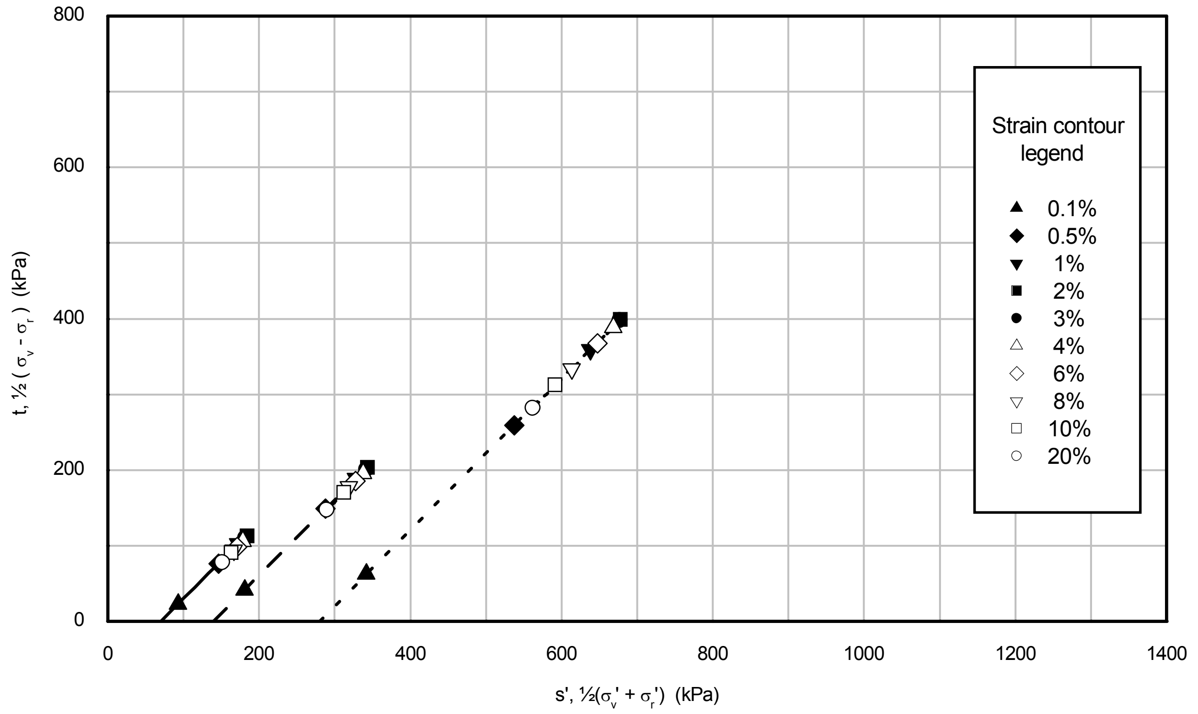
Drawn by: ALB Date: 23/09/2016

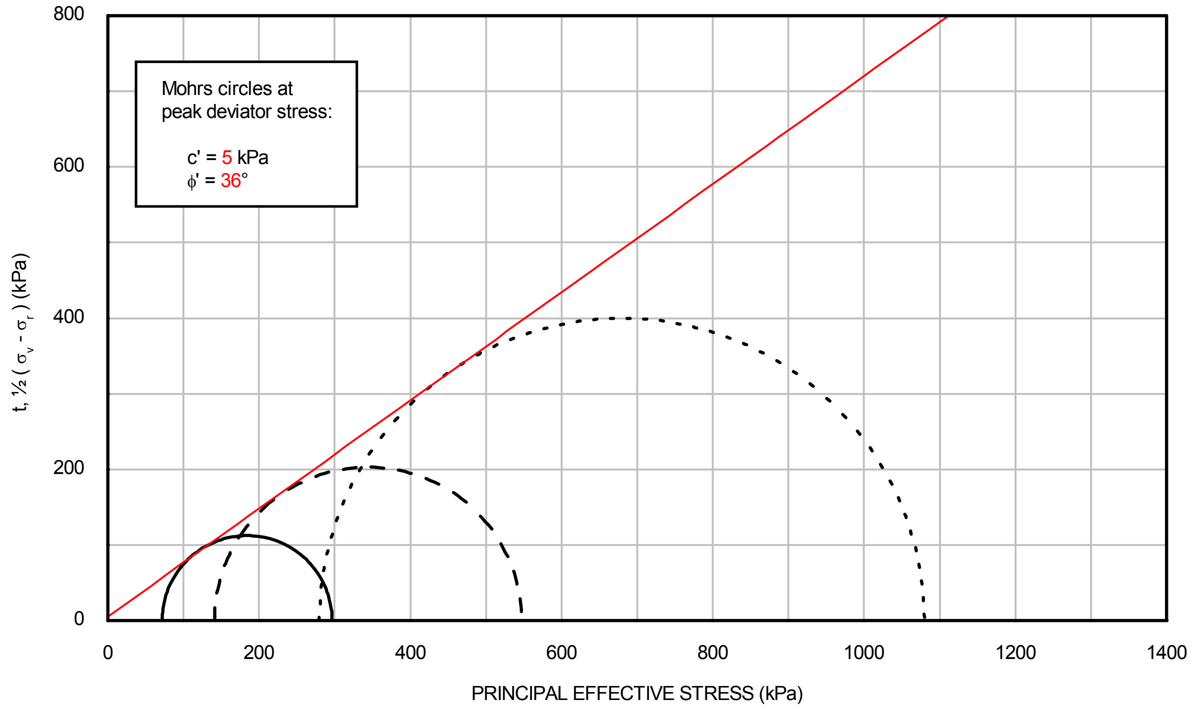
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_07BagB_D3.OPJ

Checked by: PH Date : 03/10/2016

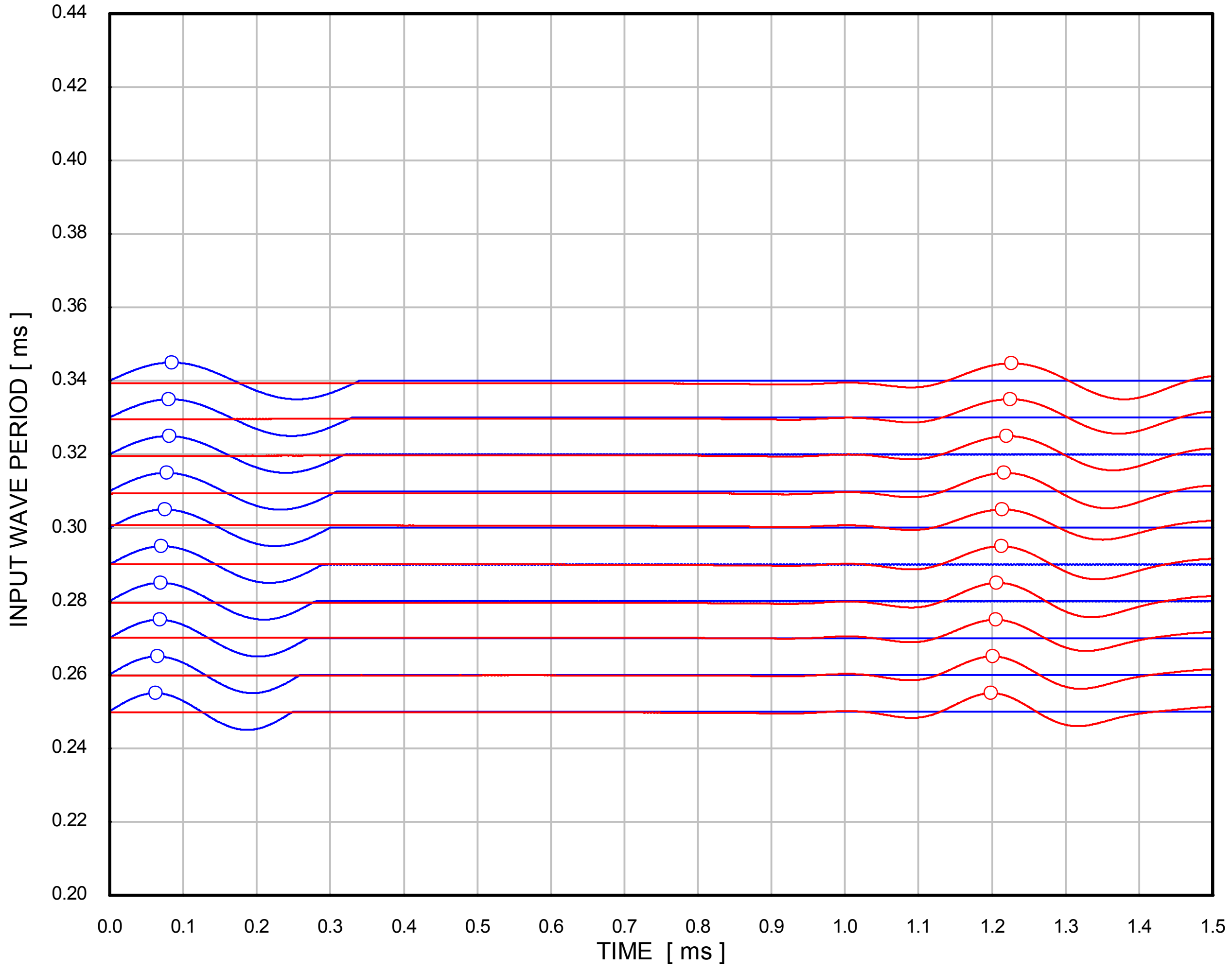
Approved by: PH Date : 03/10/2016

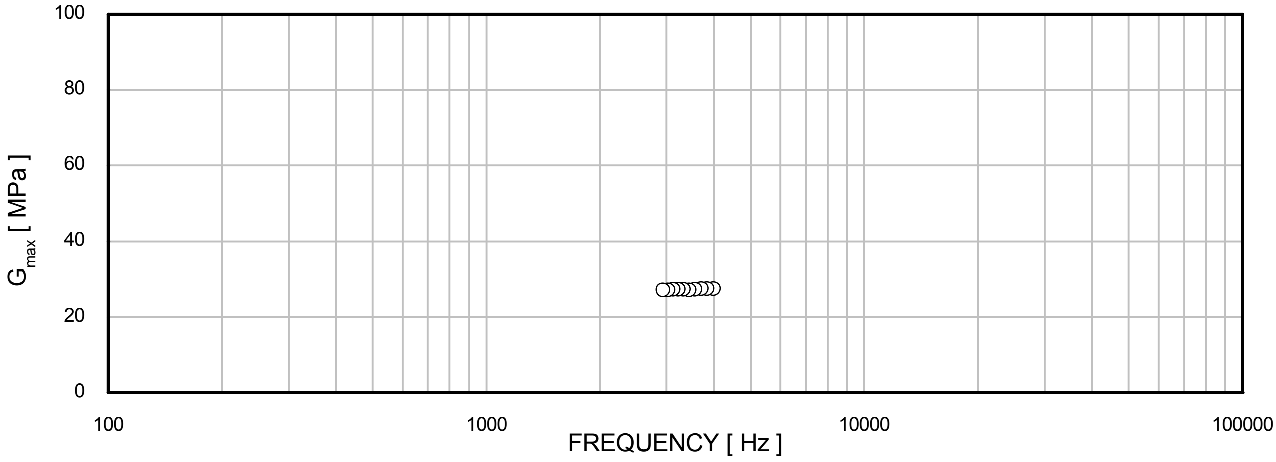




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	70	70	HKZ1-BH05 -SA	07BagB	6.20
— —	2	140	140			
· · · ·	3	280	280			

ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

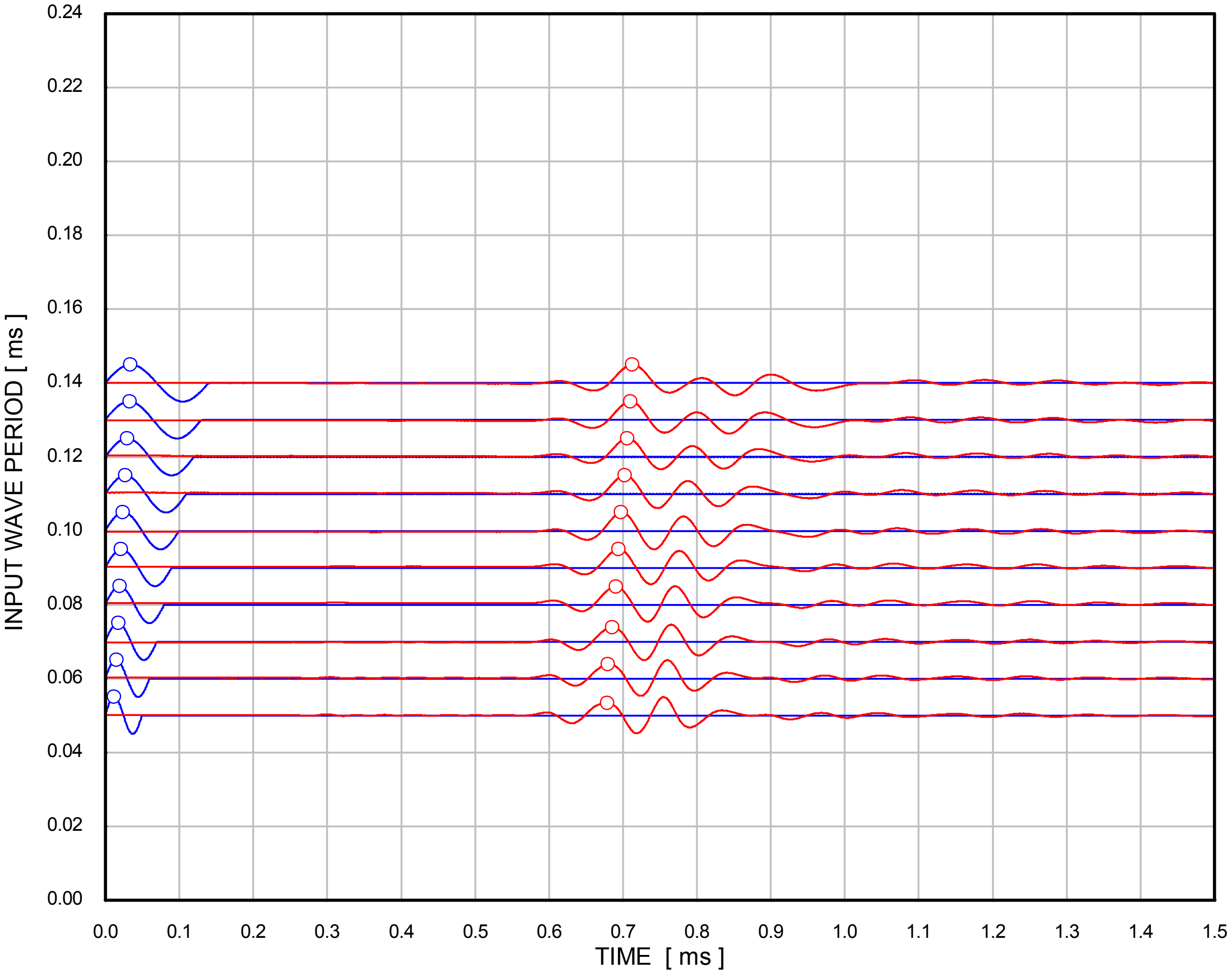


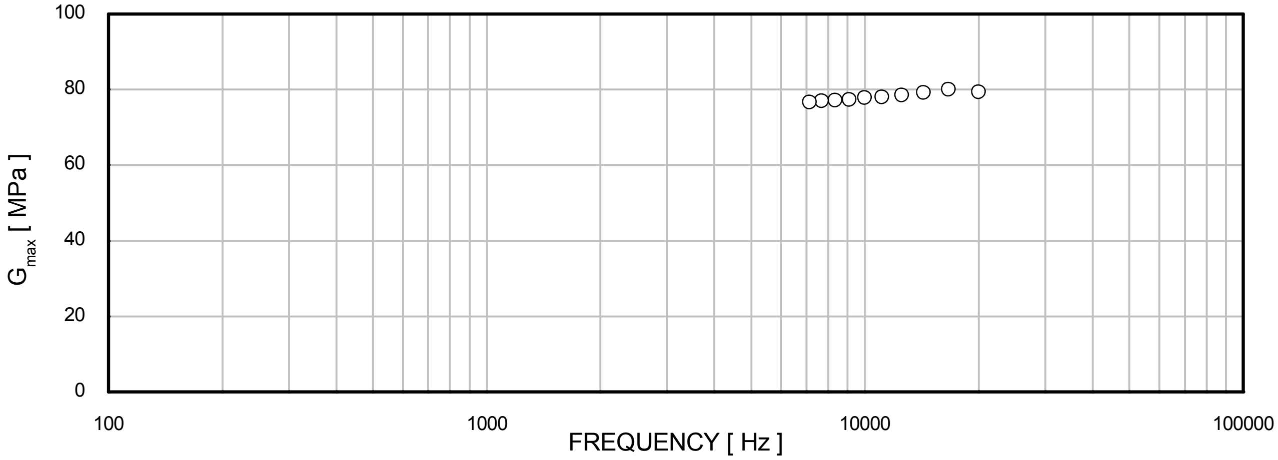


σ'_{rc}	:	12 kPa
σ'_{ac}	:	12 kPa
—		Source signal
—		Received signal
○ / ○		Selected peak values

Borehole	:	HKZ1-BH05-SA
Sample	:	07BagB
Depth [m]	:	6.20
Test No.	:	219A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 70 kPa	Borehole	: HKZ1-BH05-SA
σ'_{ac}	: 70 kPa	Sample	: 07BagB
—	Source signal	Depth [m]	: 6.20
—	Received signal	Test No.	: 219A
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

VISUAL DESCRIPTION
Brown fine SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		12/09/2016	02/09/2016	02/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.1	9.9	9.9
Bulk density	(Mg/m³)	1.78	1.79	1.79
Dry density	(Mg/m³)	1.62	1.62	1.62
Void ratio		0.638	0.632	0.631
Degree of saturation	(%)	42	42	42

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	564	819	1391
Cell pressure on completion	(kPa)	585	870	1440
B value achieved		0.96	0.93	0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	45BagC	45BagC	45BagC
Depth (m)	40.85	40.85	40.85

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	585	870	1440
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	285	570	1140
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	23.5	23.0	22.7
Bulk density	(Mg/m³)	2.02	2.02	2.03
Dry density	(Mg/m³)	1.63	1.65	1.66
Void ratio		0.623	0.611	0.600
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.92	1.28	1.90

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	45BagC	45BagC	45BagC
Depth (m)	40.85	40.85	40.85

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH05-SA_45BagC_D3.XLS
Date: 15/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	285	570	1140
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	866	1596	2920
Membrane correction applied	(kPa)	0.4	0.5	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.64	3.24	4.50
Volumetric strain	(%)	-0.21	-0.04	0.25
Major principal effective stress	(kPa)	1152	2167	4062
Minor principal effective stress	(kPa)	285	571	1142
Principal effective stress ratio		4.03	3.79	3.56
Epsilon 50 (ε 50)	(%)	0.57	0.63	0.64
Secant modulus (E50) at ε 50	(kPa)	75779	126347	227002
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	866	1595	2920
Membrane correction applied	(kPa)	0.4	0.5	0.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.64	2.99	4.50
Volumetric strain	(%)	-0.21	0.01	0.25
Major principal effective stress	(kPa)	1152	2166	4062
Minor principal effective stress	(kPa)	285	571	1142
Principal effective stress ratio		4.03	3.79	3.56
At 15% axial strain				
Corrected deviator stress	(kPa)	735	1373	2716
Membrane correction applied	(kPa)	1.8	1.8	1.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-2.00	-1.24	-0.44
Major principal effective stress	(kPa)	1022	1945	3861
Minor principal effective stress	(kPa)	287	572	1144
Principal effective stress ratio		3.56	3.40	3.37

FINAL CONDITIONS				
Water content	(%)	25.0	23.9	23.0
Bulk density	(Mg/m³)	1.99	2.01	2.02
Dry density	(Mg/m³)	1.59	1.62	1.65

Borehole	HKZ1-BH05-SA	HKZ1-BH05-SA	HKZ1-BH05-SA
Sample	45BagC	45BagC	45BagC
Depth (m)	40.85	40.85	40.85

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016

Drawn by: ALB

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_45BagC_D3.OPJ

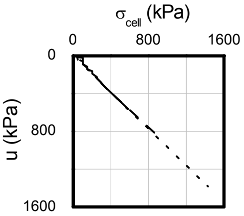
Date : 15/09/2016

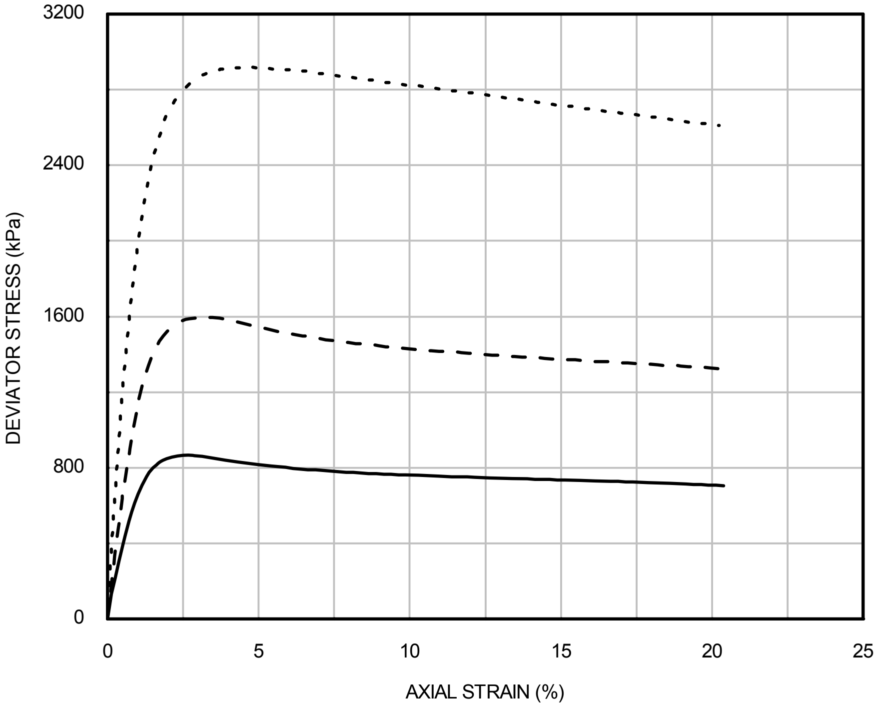
Date : 20/09/2016

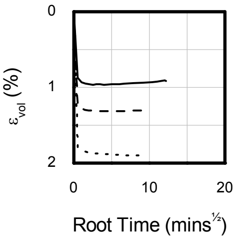
Checked by: MSR

Approved by: PH

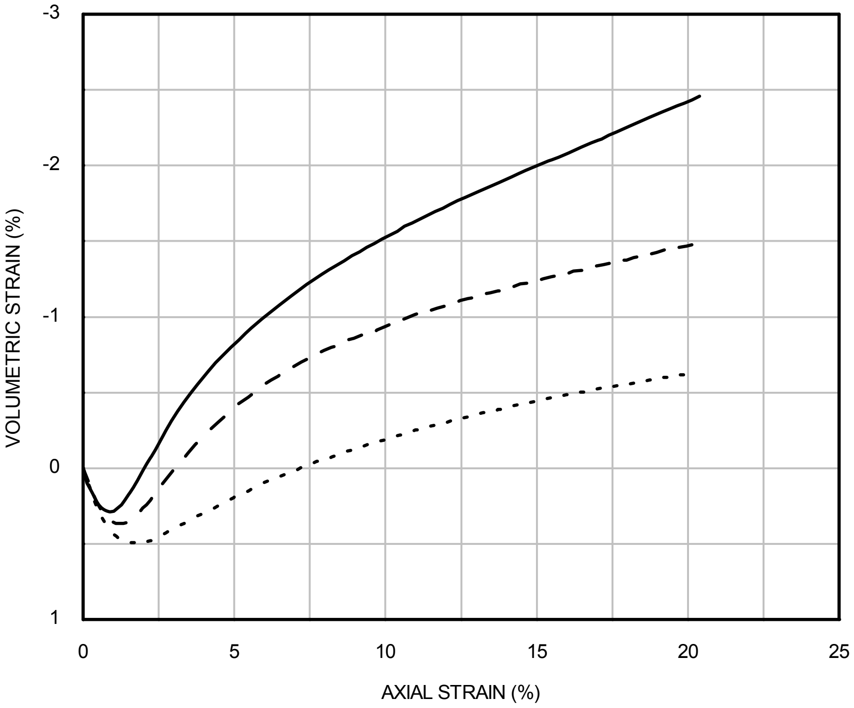
Saturation





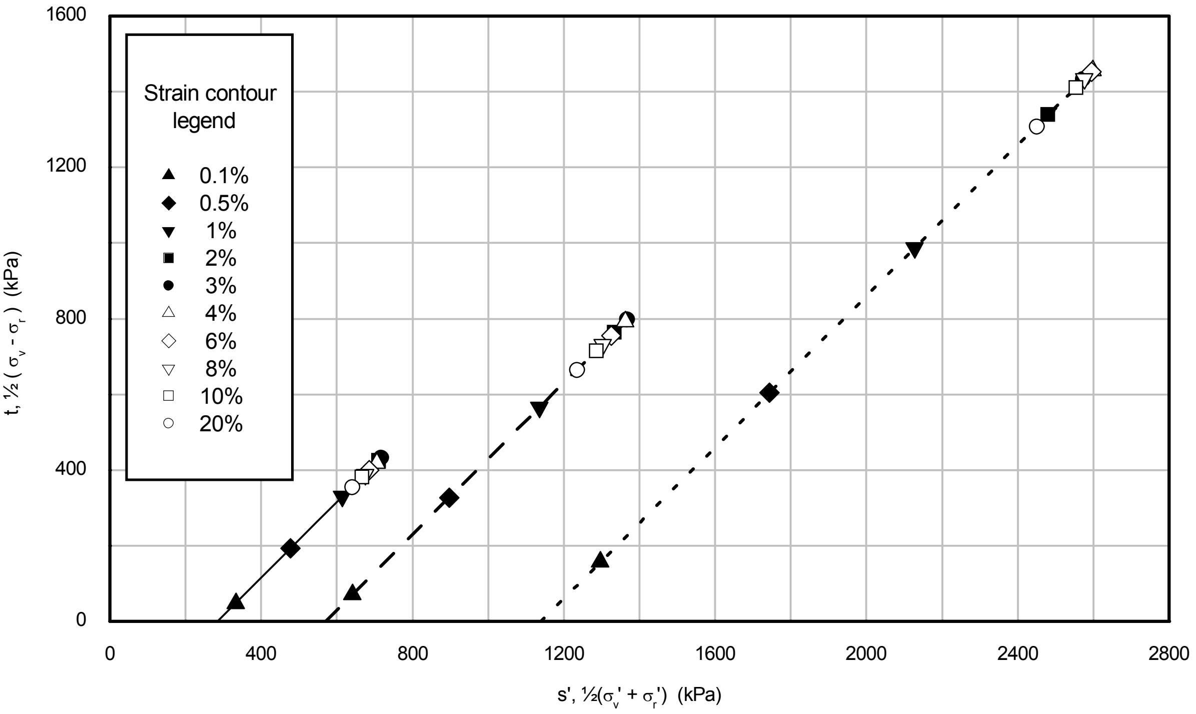


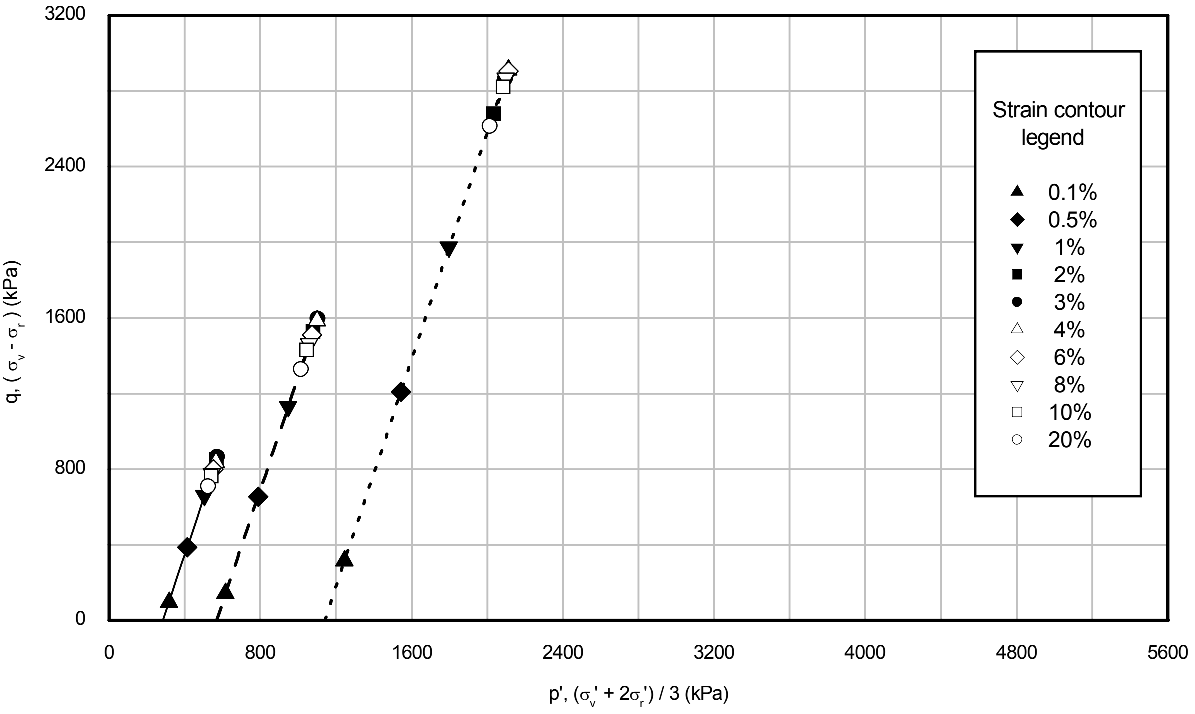
Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
━━	1	285	285	HKZ1-BH05 -SA	45BagC	40.85
– –	2	570	570			
· · · ·	3	1140	1140			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	285	285	HKZ1-BH05 -SA	45BagC	40.85
— —	2	570	570			
- - - -	3	1140	1140			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 14/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_45BagC_D3.OPJ

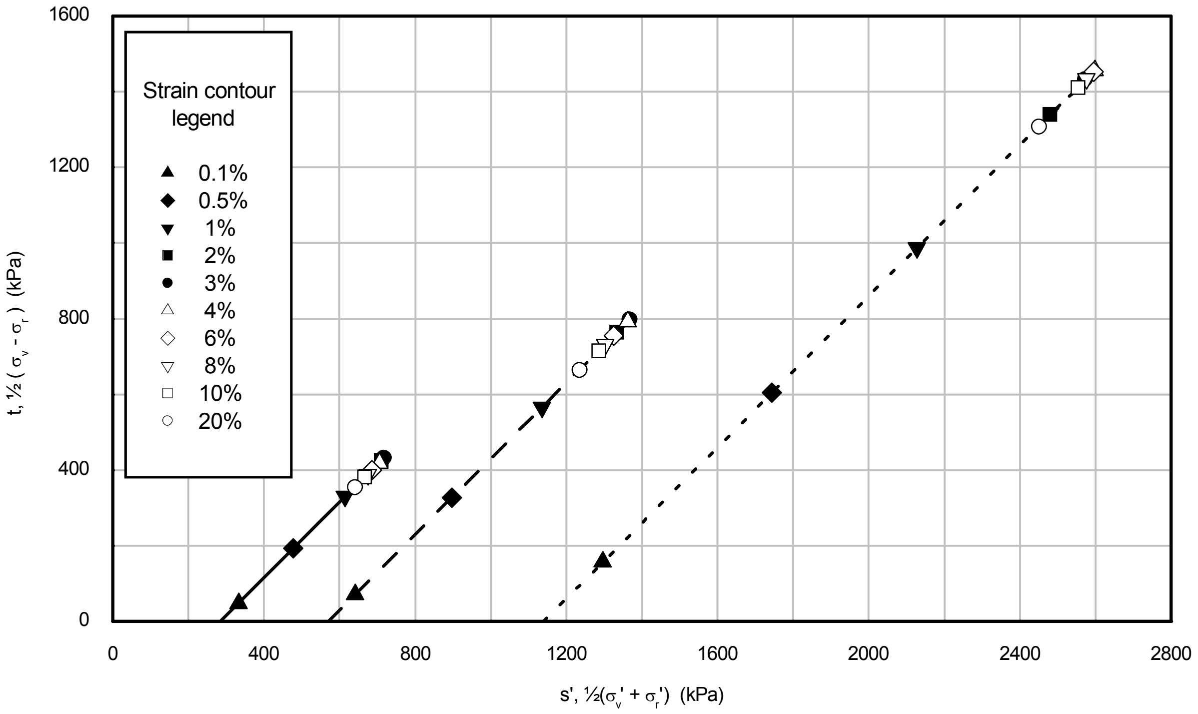
Checked by: MSR Date : 15/09/2016

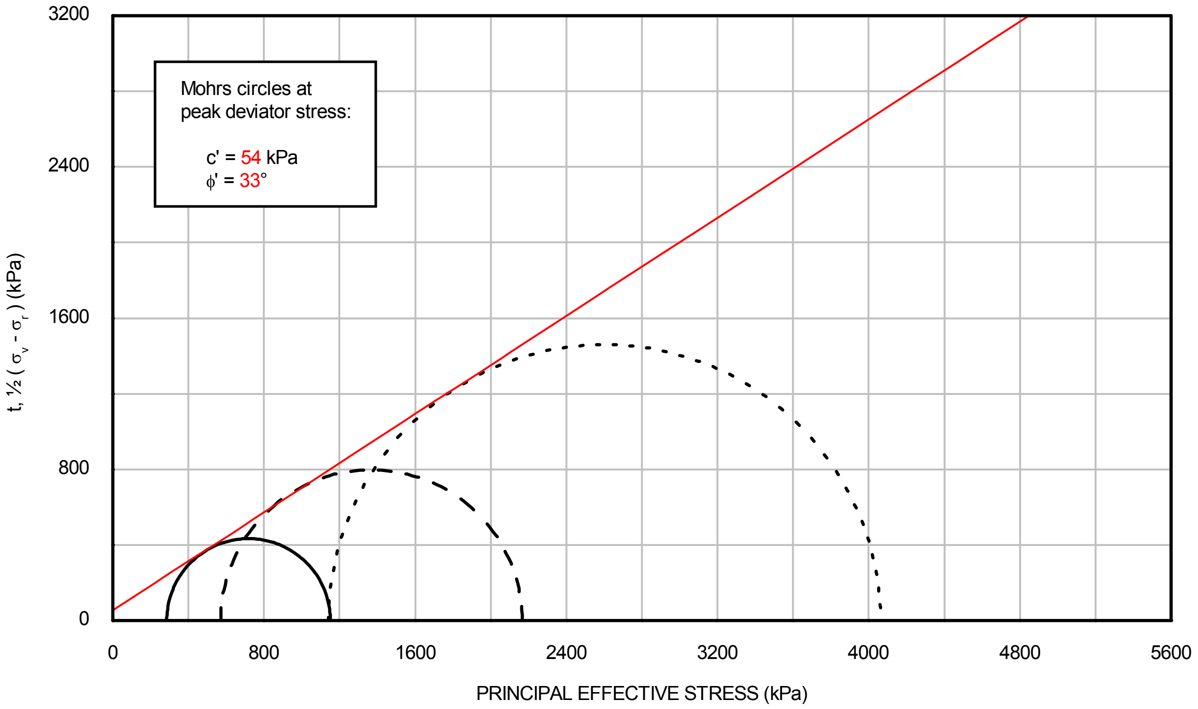
Approved by: PH Date : 20/09/2016

Drawn by: ALB Date: 14/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH05-SA_45BagC_D3.OPJ





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	285	285	HKZ1-BH05 -SA	45BagC	40.85
– –	2	570	570			
· · · ·	3	1140	1140			

Date : 15/09/2016

Date : 20/09/2016

Checked by: MSR

Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_03BagB_D3.XLS
Date: 15/09/2016
Checked by: MSR
Date: 20/09/2016
Approved by: PH

VISUAL DESCRIPTION
Yellowish brown fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	12/09/2016	12/09/2016	12/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.2	10.2	10.2
Bulk density	(Mg/m³)	1.86	1.87	1.87
Dry density	(Mg/m³)	1.69	1.69	1.70
Void ratio		0.567	0.564	0.563
Degree of saturation	(%)	48	48	48

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	314	337	388
Cell pressure on completion	(kPa)	325	350	400
B value achieved		0.96	0.94	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	03BagB	03BagB	03BagB
Depth (m)	2.30	2.30	2.30

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	325	350	400
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	25	50	100
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	21.3	21.1	20.8
Bulk density	(Mg/m³)	2.05	2.06	2.06
Dry density	(Mg/m³)	1.69	1.70	1.71
Void ratio		0.565	0.560	0.552
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.15	0.29	0.70

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	03BagB	03BagB	03BagB
Depth (m)	2.30	2.30	2.30

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_03BagB_D3.XLS
Date: 15/09/2016
Date: 20/09/2016
Checked by: MSR
Approved by: PH

Date: 14/09/2016 Drawn by: ALB Template Issue: 7 Date: 15/09/2016 Checked by: MSR
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_03BagB_D3.XLS Date: 20/09/2016 Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	25	50	100
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	116	235	426
Membrane correction applied	(kPa)	0.2	0.3	0.4
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	1.50	1.87	2.53
Volumetric strain	(%)	-1.00	-0.85	-1.00
Major principal effective stress	(kPa)	142	286	528
Minor principal effective stress	(kPa)	26	52	102
Principal effective stress ratio		5.42	5.53	5.20
Epsilon 50 (ε 50)	(%)	0.14	0.29	0.56
Secant modulus (E50) at ε 50	(kPa)	40119	40345	37772
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	114	235	424
Membrane correction applied	(kPa)	0.2	0.3	0.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	1.25	1.87	2.28
Volumetric strain	(%)	-0.76	-0.85	-0.79
Major principal effective stress	(kPa)	140	286	525
Minor principal effective stress	(kPa)	26	52	101
Principal effective stress ratio		5.48	5.53	5.20
At 15% axial strain				
Corrected deviator stress	(kPa)	73	144	250
Membrane correction applied	(kPa)	1.7	1.7	1.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-3.67	-3.35	-5.51
Major principal effective stress	(kPa)	99	196	352
Minor principal effective stress	(kPa)	26	52	103
Principal effective stress ratio		3.77	3.78	3.43

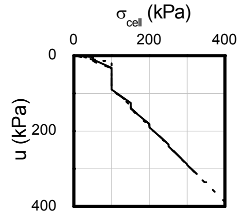
FINAL CONDITIONS				
Water content	(%)	23.6	23.3	24.2
Bulk density	(Mg/m³)	2.01	2.02	2.01
Dry density	(Mg/m³)	1.63	1.64	1.62

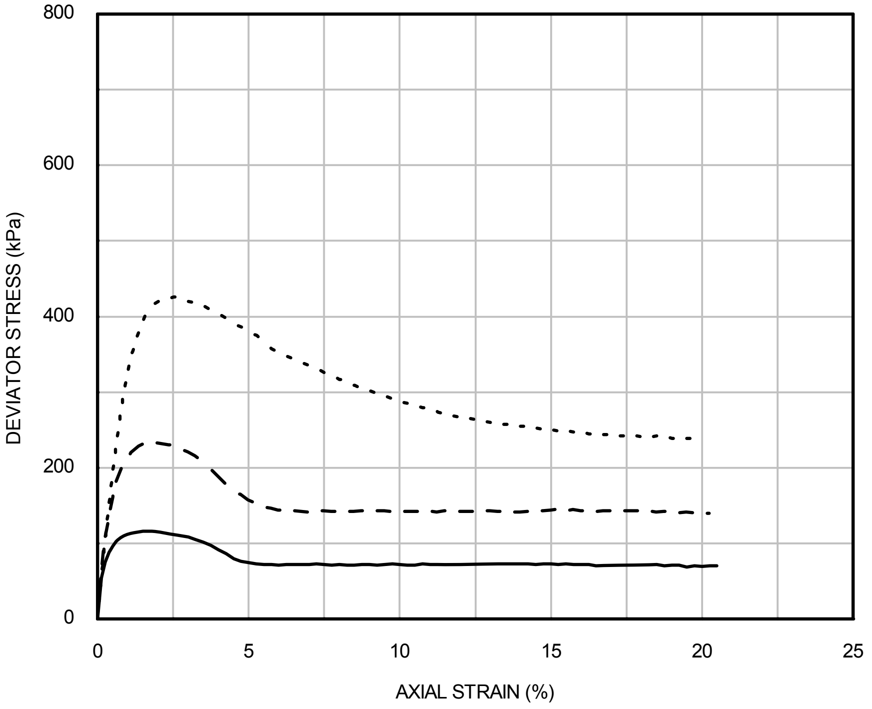
Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	03BagB	03BagB	03BagB
Depth (m)	2.30	2.30	2.30

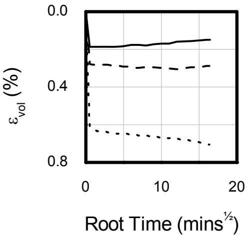
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 14/09/2016
Drawn by: ALB
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_03BagB_D3.OPJ
Template Issue: 4
Date : 15/09/2016
Date : 20/09/2016
Checked by: MSR
Approved by: PH

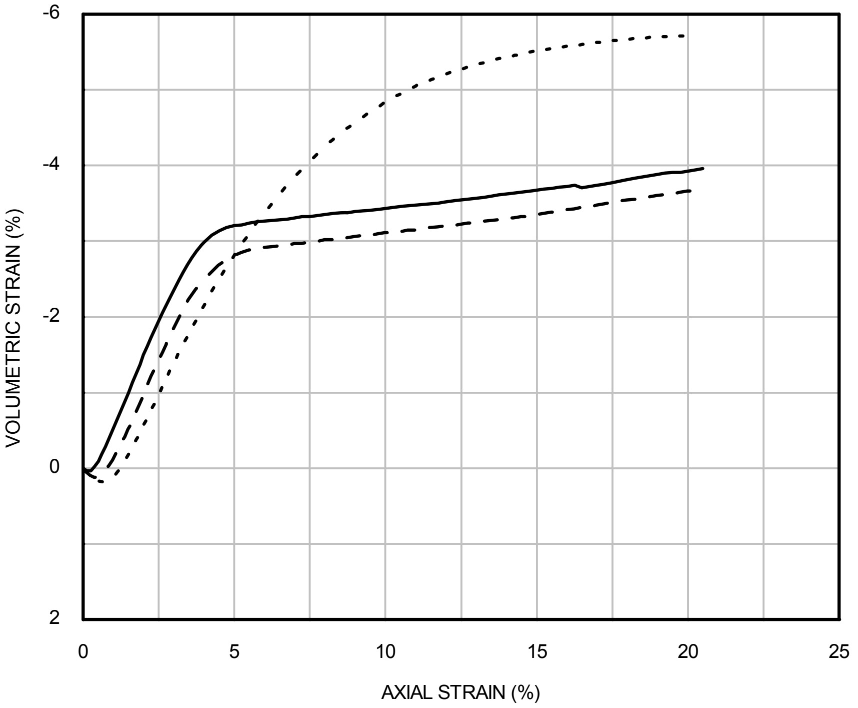
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	25	25	HKZ1-BH06 -SA	03BagB	2.30
– –	2	50	50			
· · · ·	3	100	100			

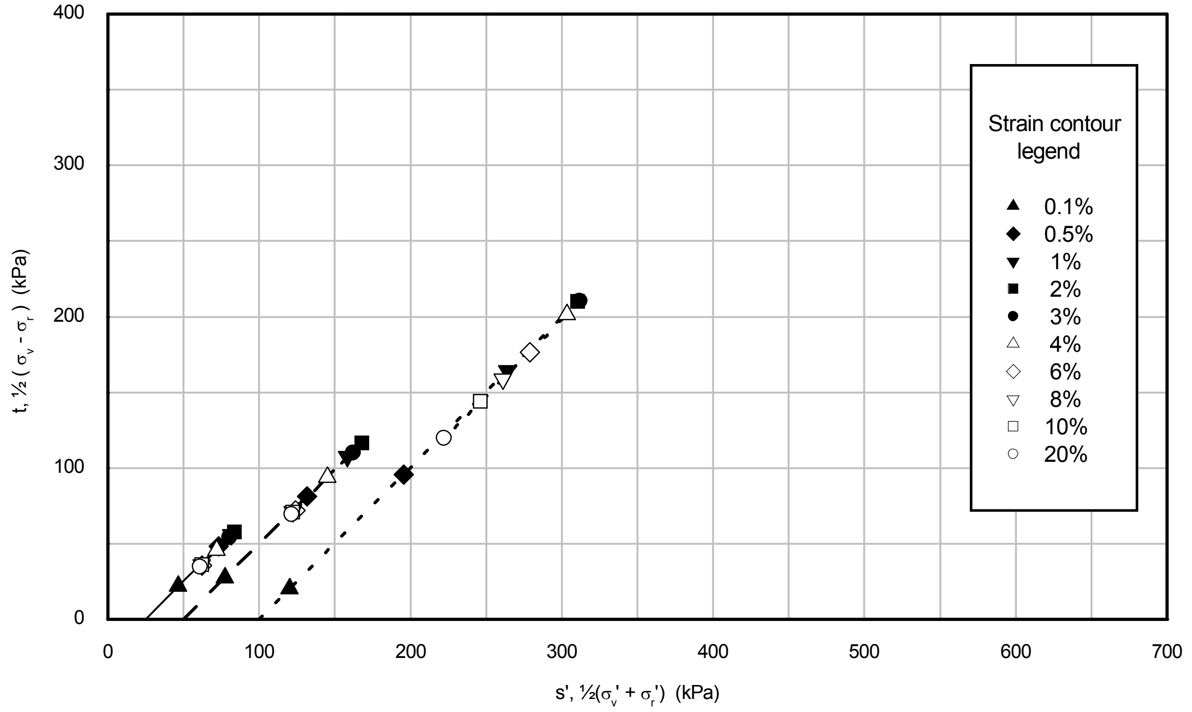
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

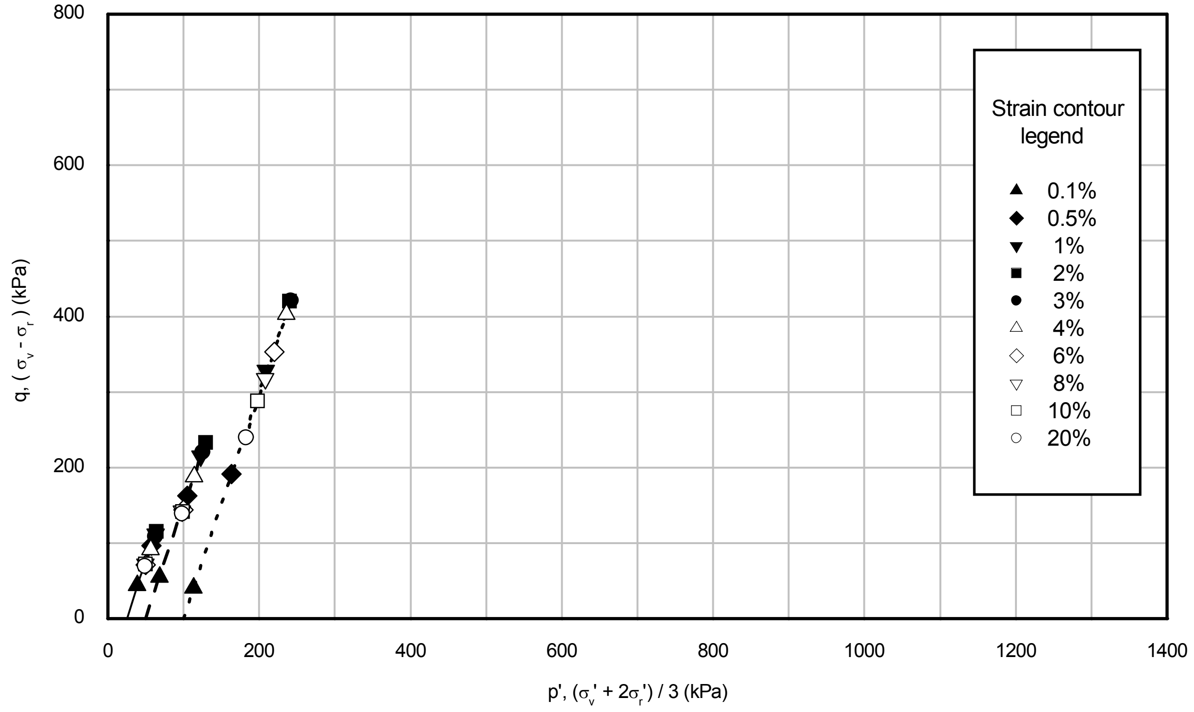
Drawn by: ALB Date: 14/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_03BagB_D3.OPJ

Checked by: MSR Date : 15/09/2016

Approved by: PH Date : 20/09/2016





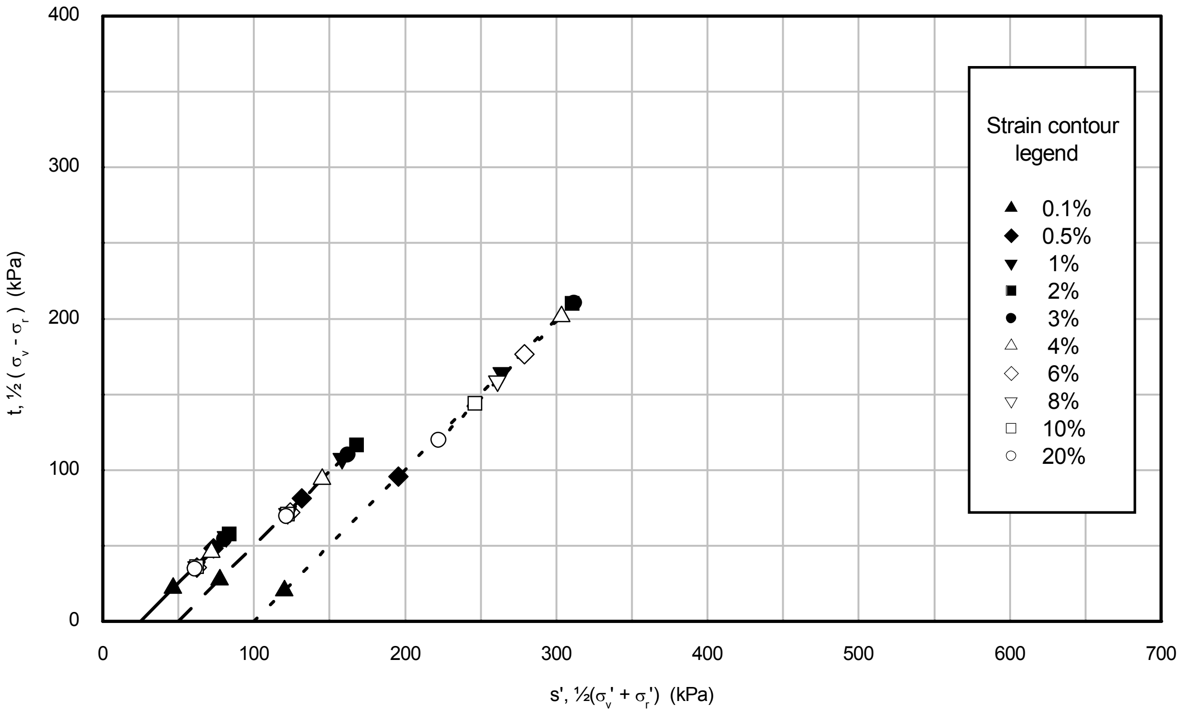
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	25	25	HKZ1-BH06 -SA	03BagB	2.30
— —	2	50	50			
- - - -	3	100	100			

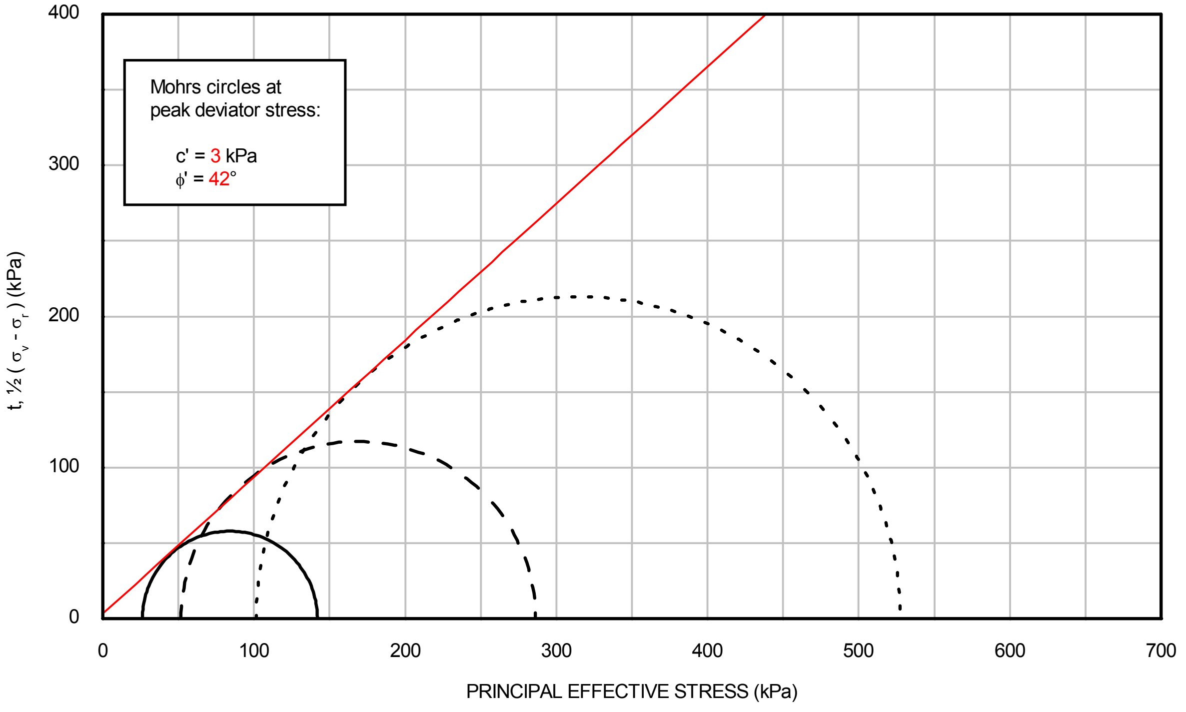
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 14/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_03BagB_D3.OPJ





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	25	25	HKZ1-BH06 -SA	03BagB	2.30
— —	2	50	50			
· · · ·	3	100	100			

Checked by: MSR Date : 15/09/2016

Approved by: PH Date : 20/09/2016

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Dark grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		27/08/2016	27/08/2016	27/08/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.3	10.3	10.3
Bulk density	(Mg/m³)	1.60	1.60	1.60
Dry density	(Mg/m³)	1.45	1.45	1.45
Void ratio		0.845	0.846	0.847
Degree of saturation	(%)	33	33	33

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	443	604	916
Cell pressure on completion	(kPa)	460	620	940
B value achieved		0.96	0.98	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	26BagB	26BagB	26BagB
Depth (m)	21.40	21.40	21.40

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	460	620	940
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	160	320	640
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	30.3	29.1	27.4
Bulk density	(Mg/m³)	1.93	1.94	1.97
Dry density	(Mg/m³)	1.48	1.51	1.55
Void ratio		0.811	0.781	0.733
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.87	3.56	6.14

Mode of failure:	Compound failure	Compound failure	Compound failure

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	26BagB	26BagB	26BagB
Depth (m)	21.40	21.40	21.40

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 30/08/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_26BagB_D3.XLS
Date: 31/08/2016
Date: 05/09/2016
Checked by: MSR
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	160	320	640
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	378	750	1512
Membrane correction applied	(kPa)	1.9	2.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	17.50	20.06	20.19
Volumetric strain	(%)	2.92	5.58	6.99
Major principal effective stress	(kPa)	538	1070	2151
Minor principal effective stress	(kPa)	160	320	639
Principal effective stress ratio		3.37	3.34	3.36
Epsilon 50 (ε 50)	(%)	1.88	3.05	3.45
Secant modulus (E50) at ε 50	(kPa)	10069	12295	21895
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	378	750	1512
Membrane correction applied	(kPa)	1.8	2.0	2.0
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	17.00	19.81	20.19
Volumetric strain	(%)	2.94	5.57	6.99
Major principal effective stress	(kPa)	537	1070	2151
Minor principal effective stress	(kPa)	159	320	639
Principal effective stress ratio		3.37	3.34	3.36
At 15% axial strain				
Corrected deviator stress	(kPa)	375	720	1440
Membrane correction applied	(kPa)	1.7	1.7	1.7
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	2.94	5.13	6.35
Major principal effective stress	(kPa)	534	1040	2080
Minor principal effective stress	(kPa)	159	320	639
Principal effective stress ratio		3.36	3.25	3.25

FINAL CONDITIONS				
Water content	(%)	28.3	25.4	22.9
Bulk density	(Mg/m³)	1.96	2.00	2.04
Dry density	(Mg/m³)	1.52	1.59	1.66

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	26BagB	26BagB	26BagB
Depth (m)	21.40	21.40	21.40

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 30/08/2016

Drawn by: ALB

Template Issue: 4

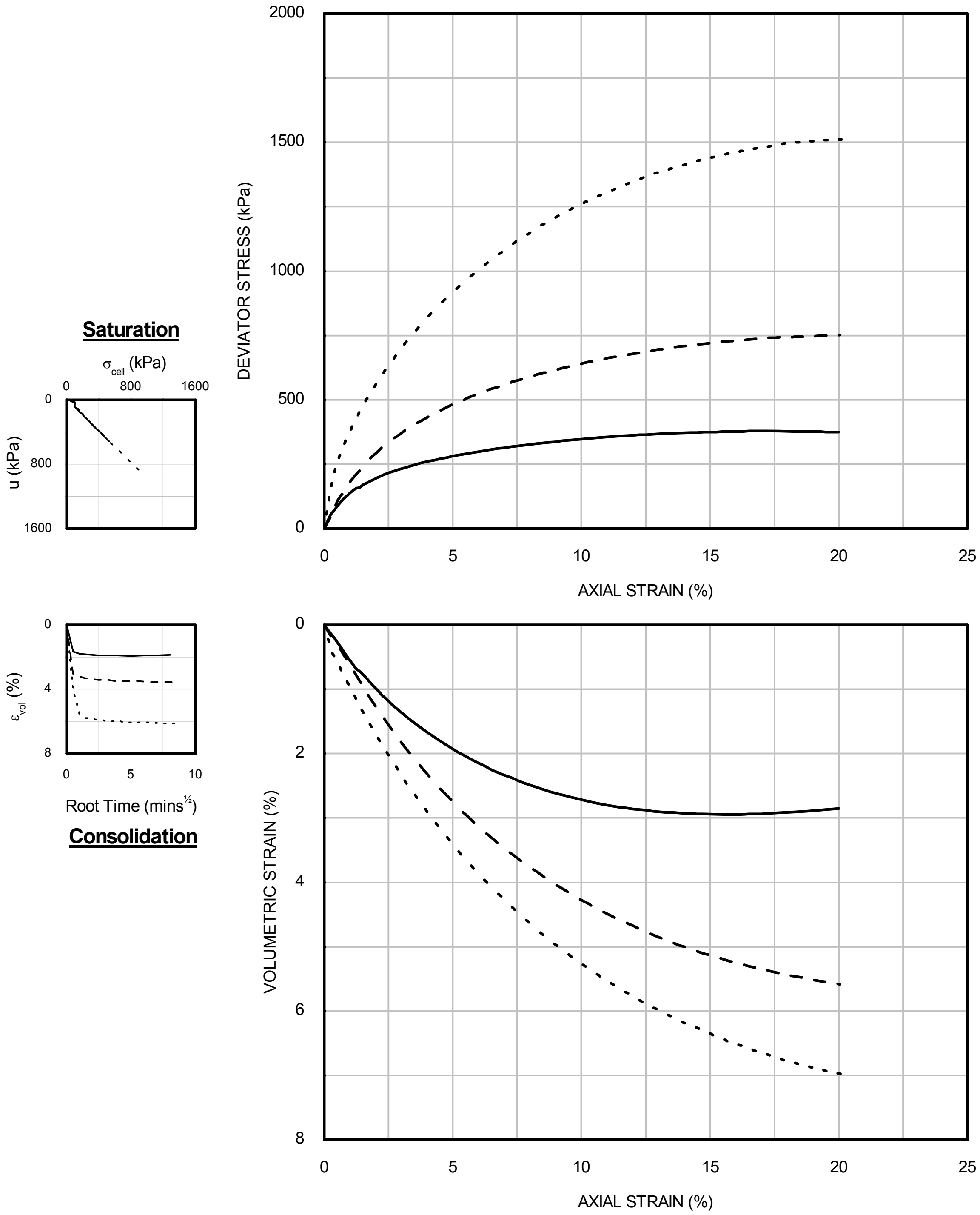
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_26BagB_D3.OPJ

Date : 31/08/2016

Date : 05/09/2016

Checked by: MSR

Approved by: PH



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH06 -SA	26BagB	21.40
— —	2	320	320			
· · · ·	3	640	640			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 30/08/2016

Template Issue: 4

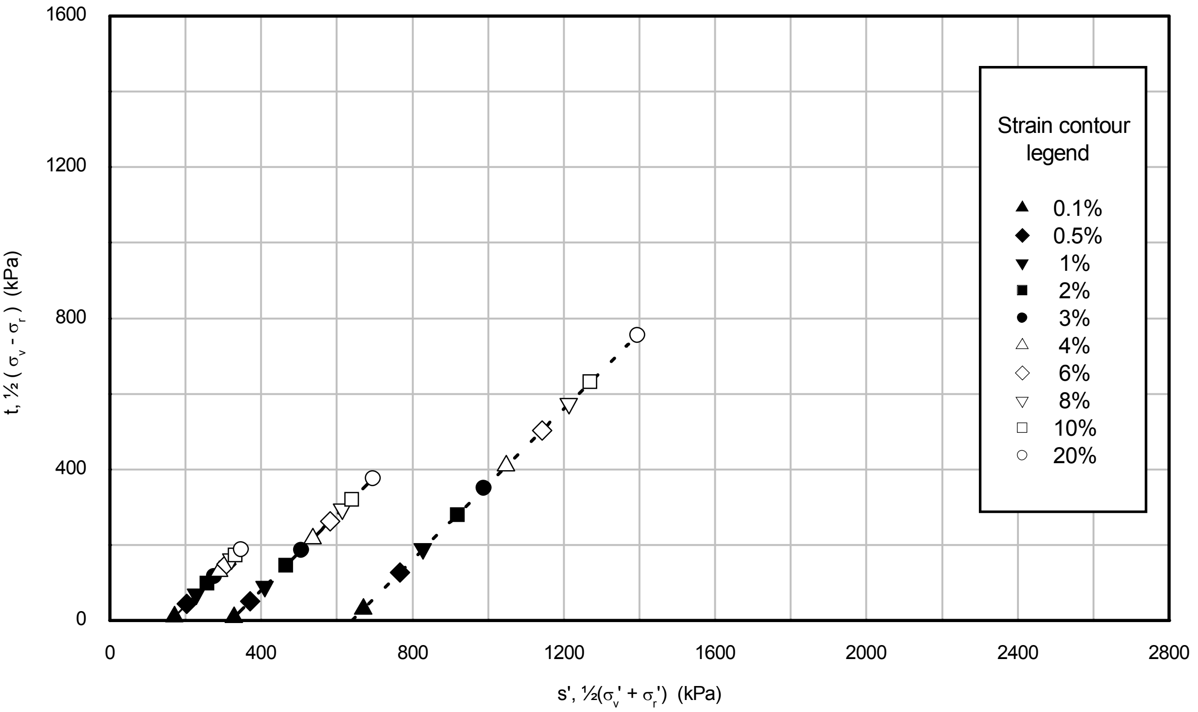
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_26BagB_D3.OPJ

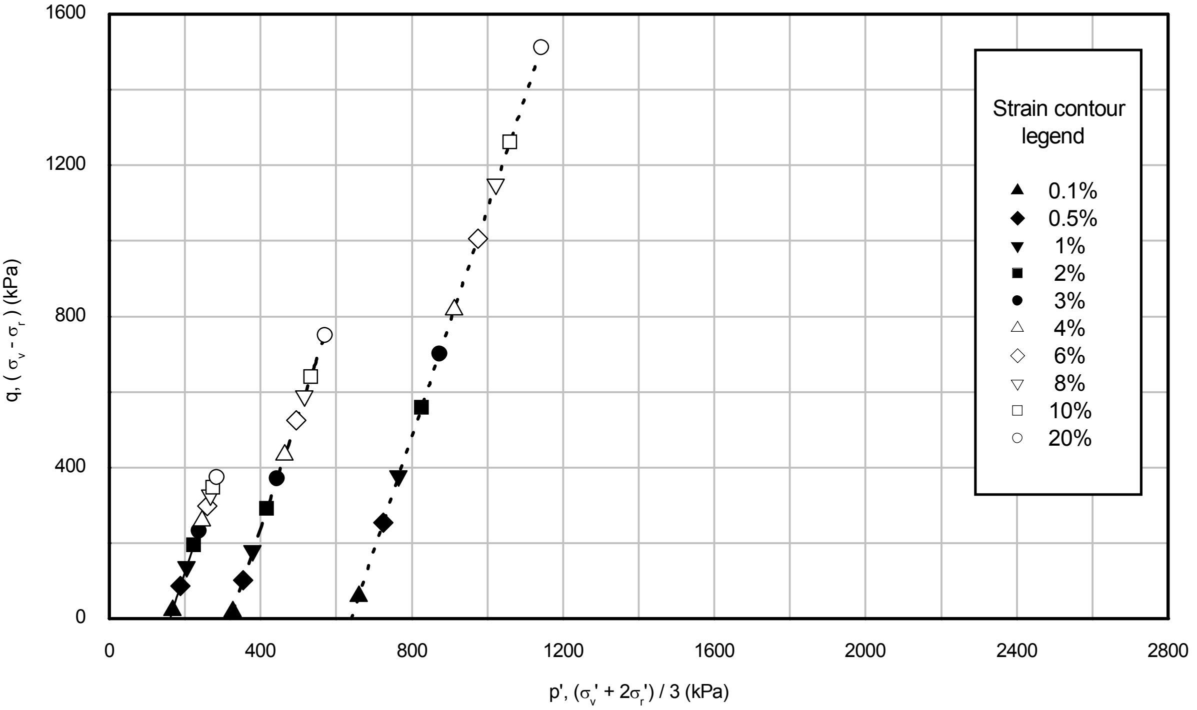
Date : 31/08/2016

Date : 05/09/2016

Checked by: MSR

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH06 -SA	26BagB	21.40
– –	2	320	320			
- - - -	3	640	640			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 30/08/2016

Drawn by: ALB

Template Issue: 4

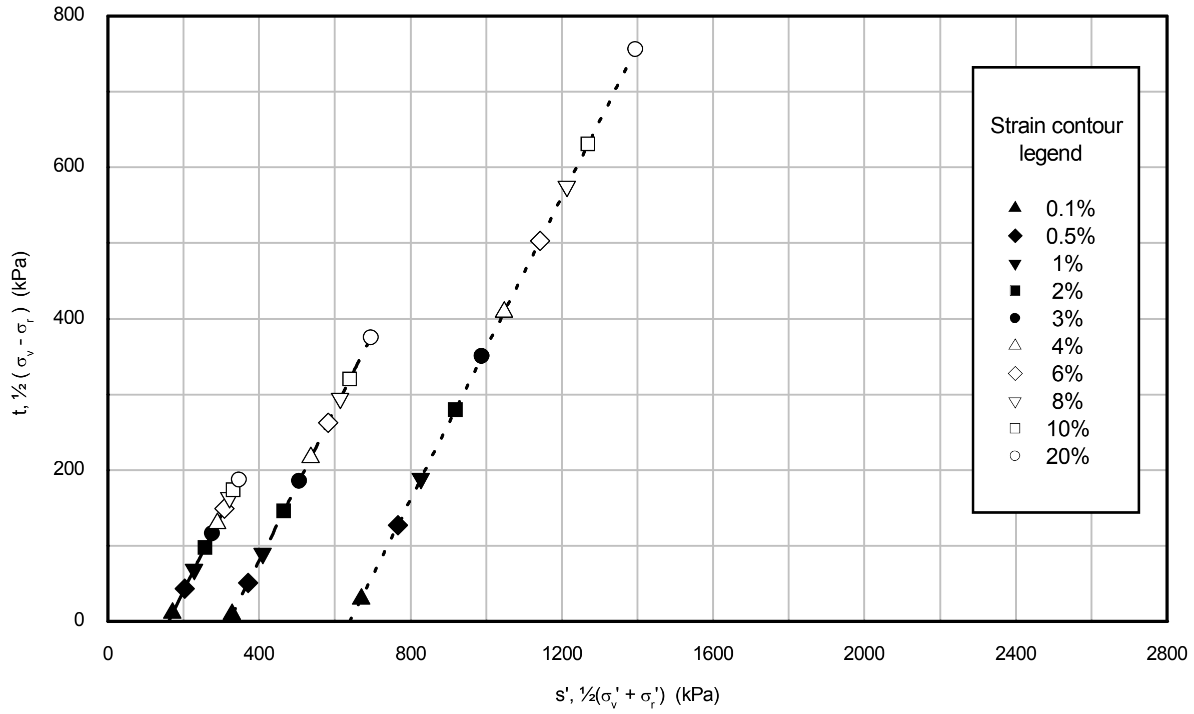
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_26BagB_D3.OPJ

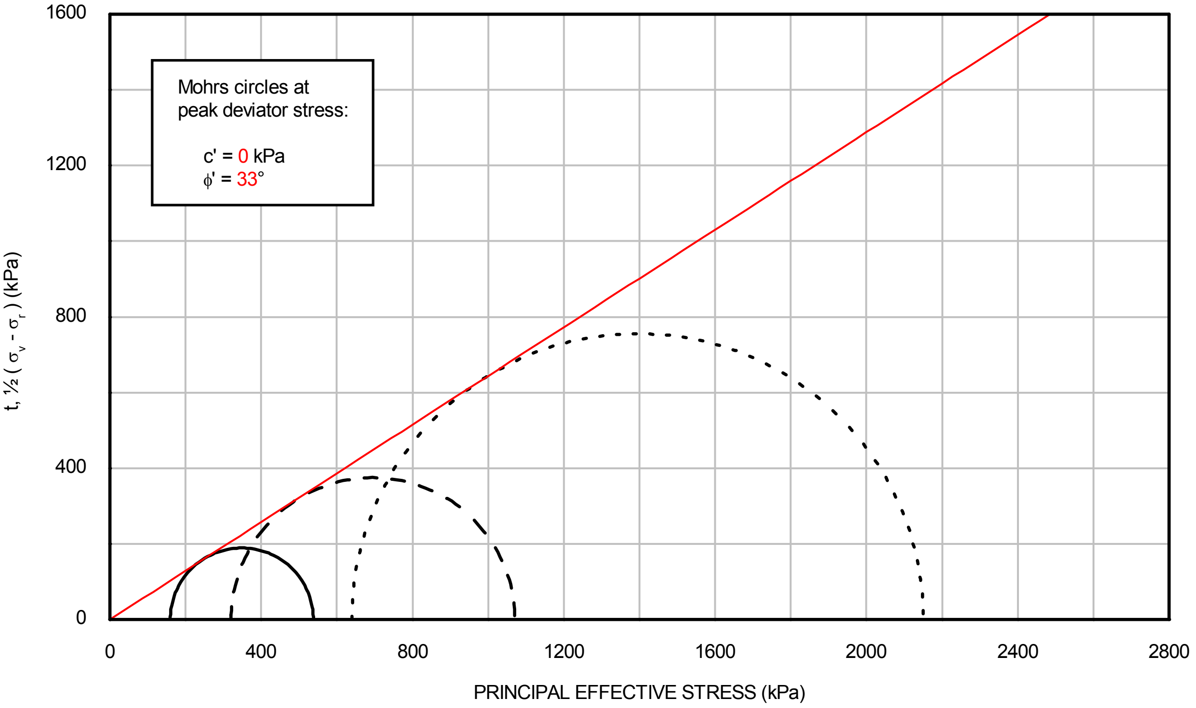
Date : 31/08/2016

Date : 05/09/2016

Checked by: MSR

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH06 -SA	26BagB	21.40
– –	2	320	320			
· · · ·	3	640	640			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Light grey fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	26/09/2016	26/09/2016	26/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.0	9.8	10.4
Bulk density	(Mg/m³)	1.68	1.68	1.68
Dry density	(Mg/m³)	1.53	1.53	1.52
Void ratio		0.731	0.729	0.741
Degree of saturation	(%)	36	36	37

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	608	817	1265
Cell pressure on completion	(kPa)	625	850	1300
B value achieved		0.97	0.95	0.98

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	39BagA&B	39BagA&B	39BagA&B
Depth (m)	34.00	34.00	34.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 14/10/2016
Drawn by: MSR
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_39BagA&B_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	625	850	1300
Back pressure	(kPa)	400	400	400
Effective cell pressure	(kPa)	225	450	900
Pore pressure on completion	(kPa)	400	400	400
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	26.8	26.6	26.4
Bulk density	(Mg/m³)	1.97	1.97	1.97
Dry density	(Mg/m³)	1.55	1.56	1.56
Void ratio		0.709	0.704	0.701
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.27	1.42	2.27

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	39BagA&B	39BagA&B	39BagA&B
Depth (m)	34.00	34.00	34.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 14/10/2016
Drawn by: MSR
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_39BagA&B_D3.XLS
Date: 03/10/2016
Date: 03/10/2016
Checked by: PH
Approved by: PH

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	1.95
Dry density	[Mg/m^3]	1.53
Void ratio	[-]	0.731
Distance	[mm]	132.1
Effective radial pressure	[kPa]	17
Effective axial pressure	[kPa]	17

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.30	1.3655	4.55	96.70	18.3
0.32	1.3575	4.24	97.27	18.5
0.34	1.3610	4.00	97.02	18.4
0.36	1.3595	3.78	97.13	18.4
0.38	1.3585	3.58	97.20	18.5
0.40	1.3565	3.39	97.35	18.5
0.42	1.3520	3.22	97.67	18.6
0.44	1.3535	3.08	97.56	18.6

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	1.97
Dry density	[Mg/m^3]	1.55
Void ratio	[-]	0.709
Distance	[mm]	131.5
Effective radial pressure	[kPa]	225
Effective axial pressure	[kPa]	225

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6150	6.15	213.78	89.8
0.11	0.6145	5.59	213.95	90.0
0.12	0.6170	5.14	213.08	89.2
0.13	0.6165	4.74	213.26	89.4
0.14	0.6175	4.41	212.91	89.1
0.15	0.6155	4.10	213.60	89.7
0.16	0.6145	3.84	213.95	90.0
0.17	0.6140	3.61	214.12	90.1
0.18	0.6095	3.39	215.70	91.4
0.19	0.6085	3.20	216.06	91.7

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	39BagA&B	39BagA&B	39BagA&B
Depth (m)	34.00	34.00	34.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 14/10/2016
Drawn by: MSR
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_39BagA&B_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	400	400	400
Initial effective cell pressure	(kPa)	225	450	900
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	514	1094	2085
Membrane correction applied	(kPa)	1.0	1.2	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	10.50	13.52	18.15
Volumetric strain	(%)	1.12	1.27	3.53
Major principal effective stress	(kPa)	738	1542	2985
Minor principal effective stress	(kPa)	224	449	900
Principal effective stress ratio		3.29	3.44	3.32
Epsilon 50 (ε 50)	(%)	0.68	0.80	1.01
Secant modulus (E50) at ε 50	(kPa)	37612	68071	103483
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	514	1093	2085
Membrane correction applied	(kPa)	1.0	1.2	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	10.50	13.27	18.40
Volumetric strain	(%)	1.12	1.27	3.55
Major principal effective stress	(kPa)	738	1542	2985
Minor principal effective stress	(kPa)	224	449	899
Principal effective stress ratio		3.29	3.44	3.32
At 15% axial strain				
Corrected deviator stress	(kPa)	509	1092	2070
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	1.18	1.29	3.29
Major principal effective stress	(kPa)	734	1541	2971
Minor principal effective stress	(kPa)	224	449	900
Principal effective stress ratio		3.27	3.43	3.30

FINAL CONDITIONS				
Water content	(%)	26.8	26.6	26.4
Bulk density	(Mg/m³)	1.97	1.97	1.97
Dry density	(Mg/m³)	1.55	1.56	1.56

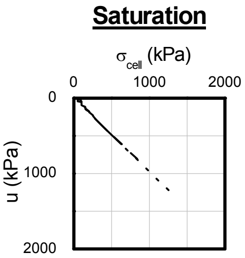
Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	39BagA&B	39BagA&B	39BagA&B
Depth (m)	34.00	34.00	34.00

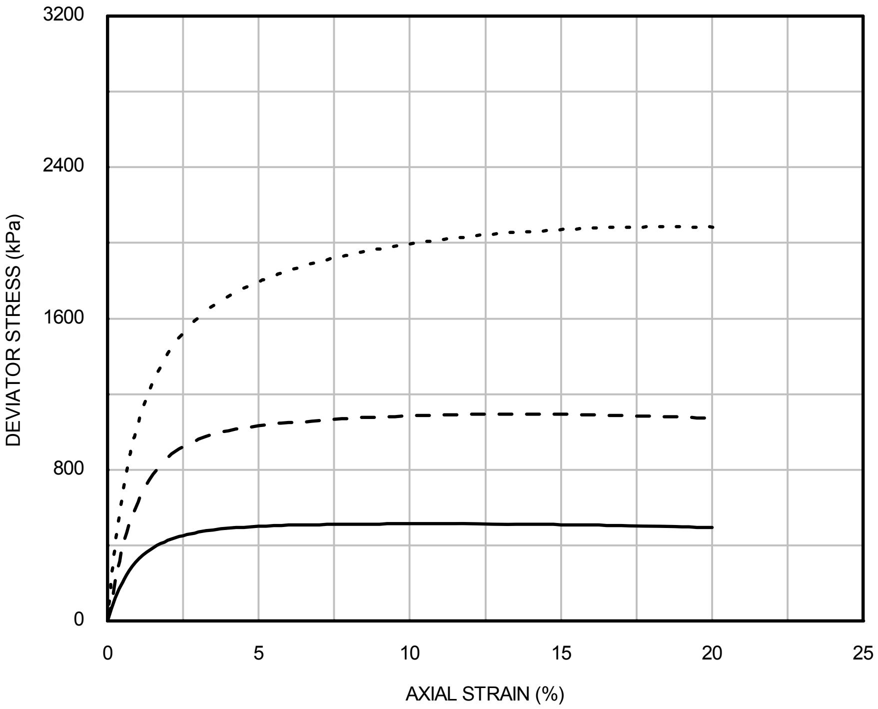
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

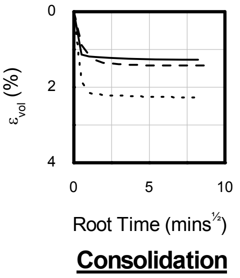
Drawn by: MSR Date: 14/10/2016

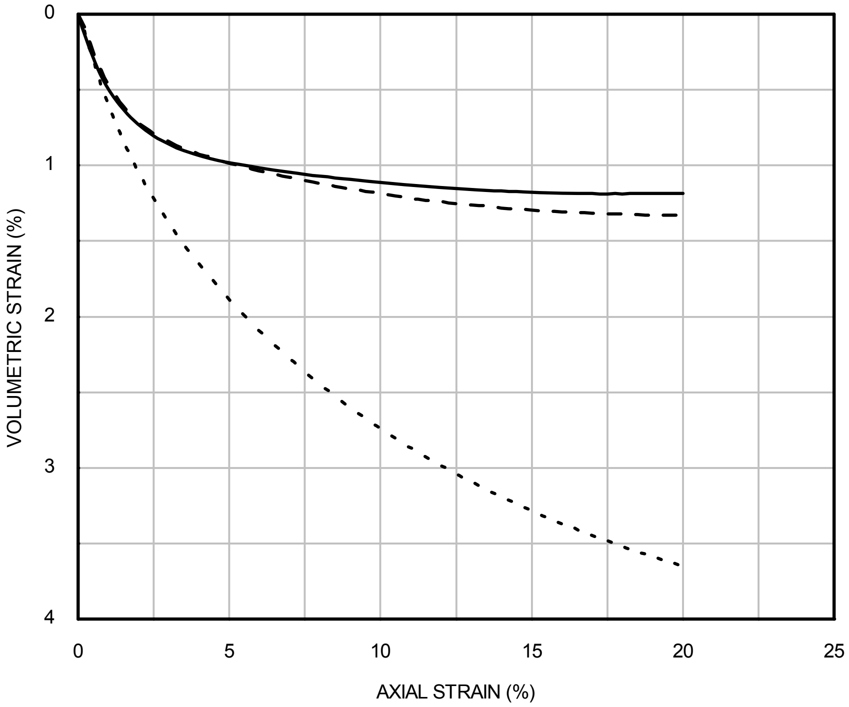
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_39BagA&B_D3.OPJ







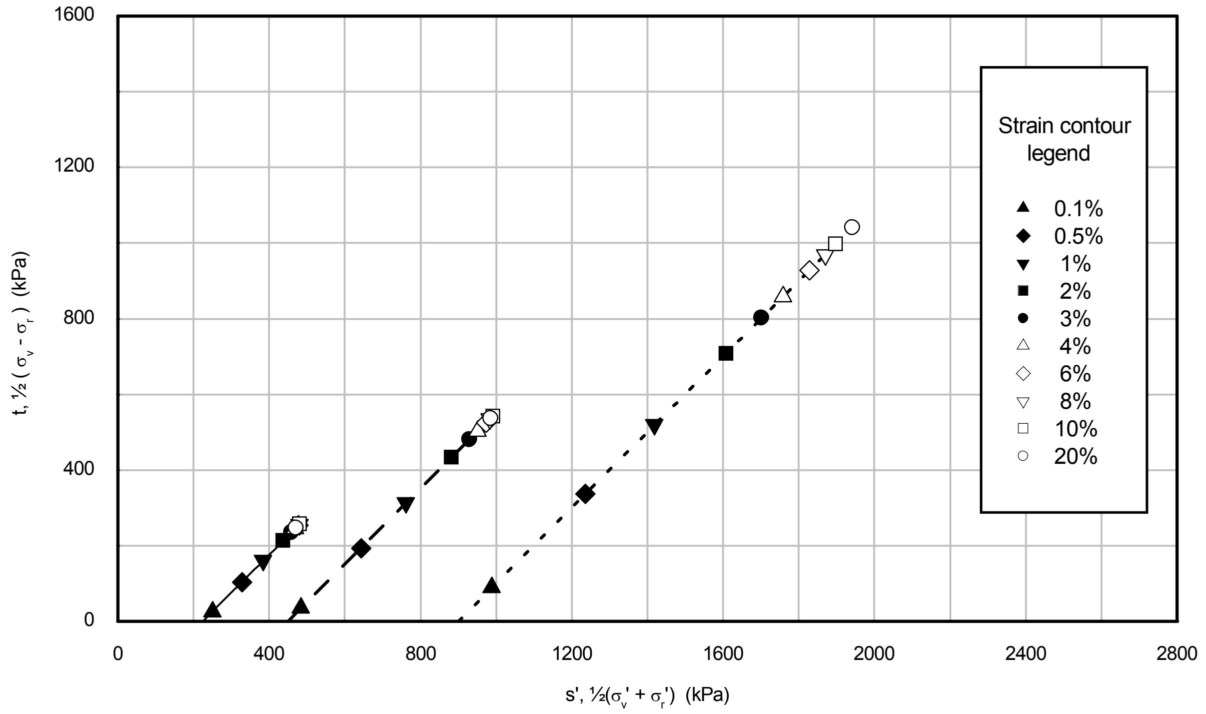


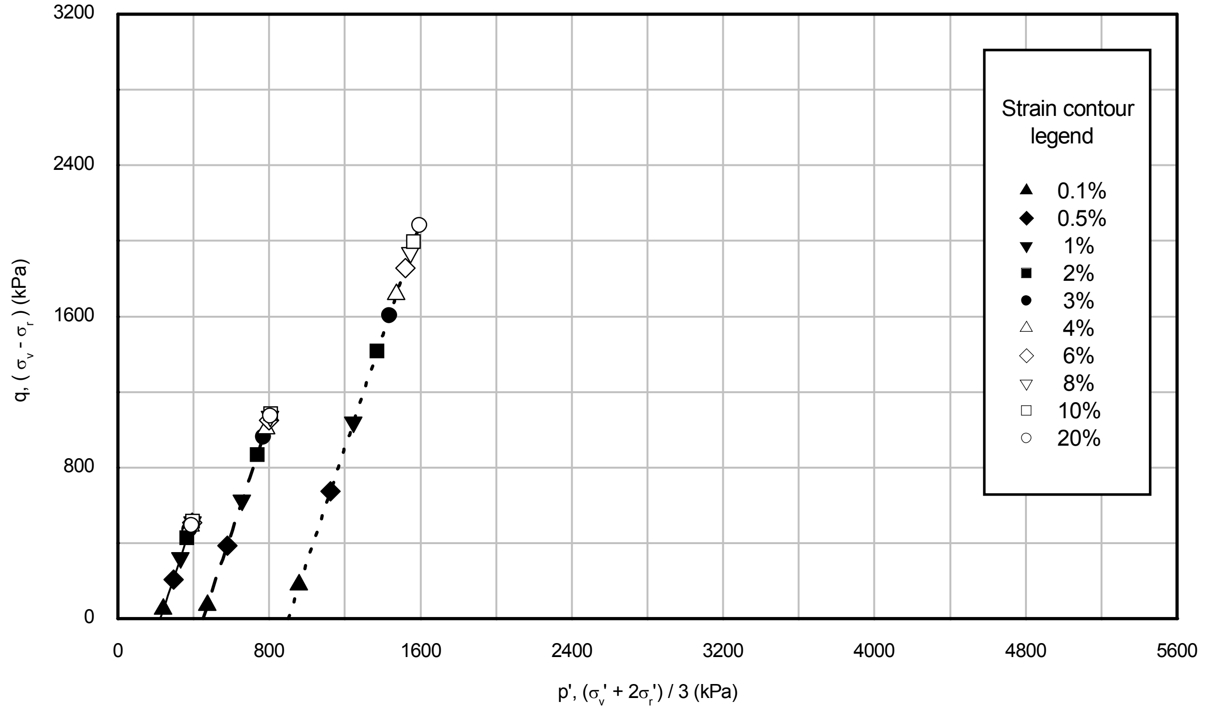
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
—	1	225	225	HKZ1-BH06-SA	39BagA&B	34.00
– –	2	450	450			
· · · ·	3	900	900			

Date : 14/10/2016 Date : 14/10/2016

Checked by: PH Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	225	225	HKZ1-BH06-SA	39BagA&B	34.00
– –	2	450	450			
- - - -	3	900	900			

Date: 14/10/2016

Drawn by: MSR

Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_39BagA&B_D3.OPJ

Template Issue: 4

Date : 14/10/2016

Date : 14/10/2016

Checked by: PH

Approved by: PH

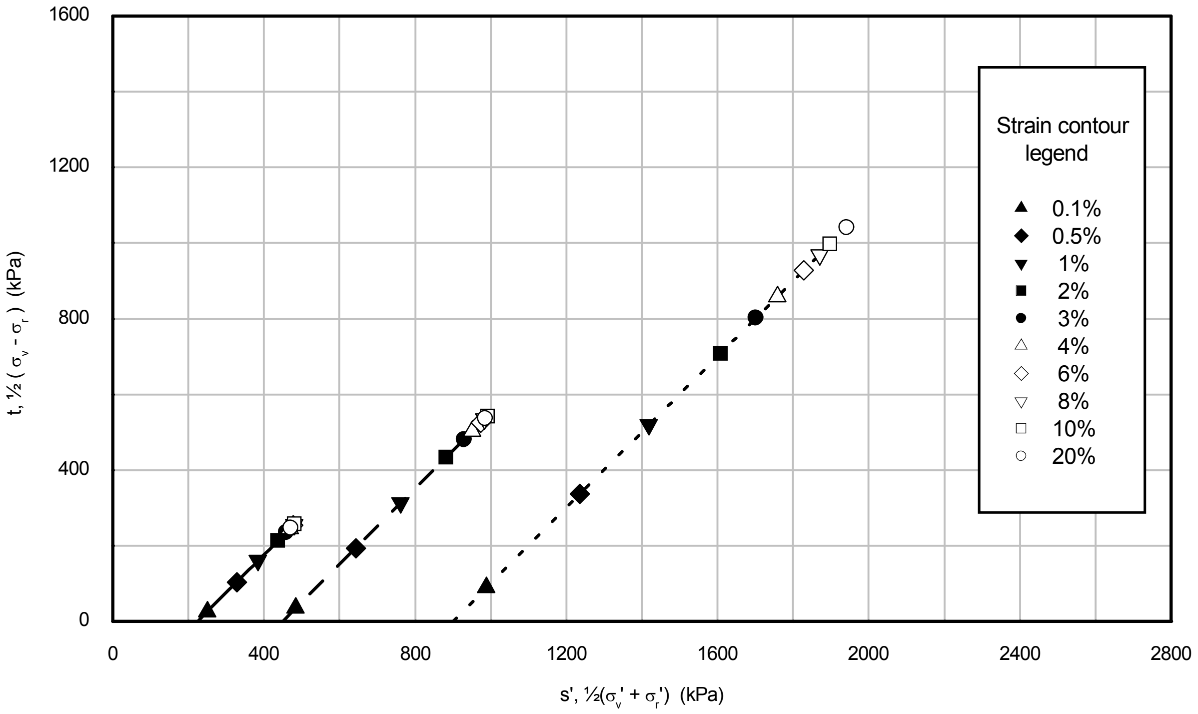
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

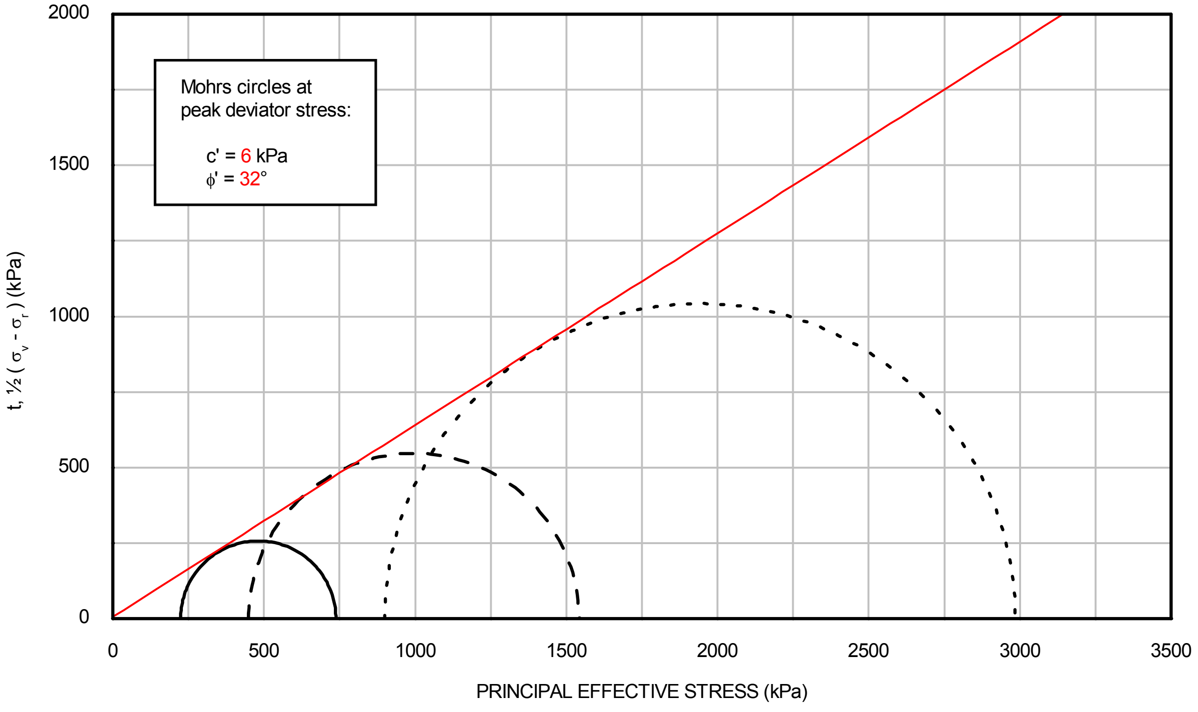
Date: 14/10/2016
Drawn by: MSR

Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_39BagA&B_D3.OPJ

Date : 14/10/2016
Checked by: PH

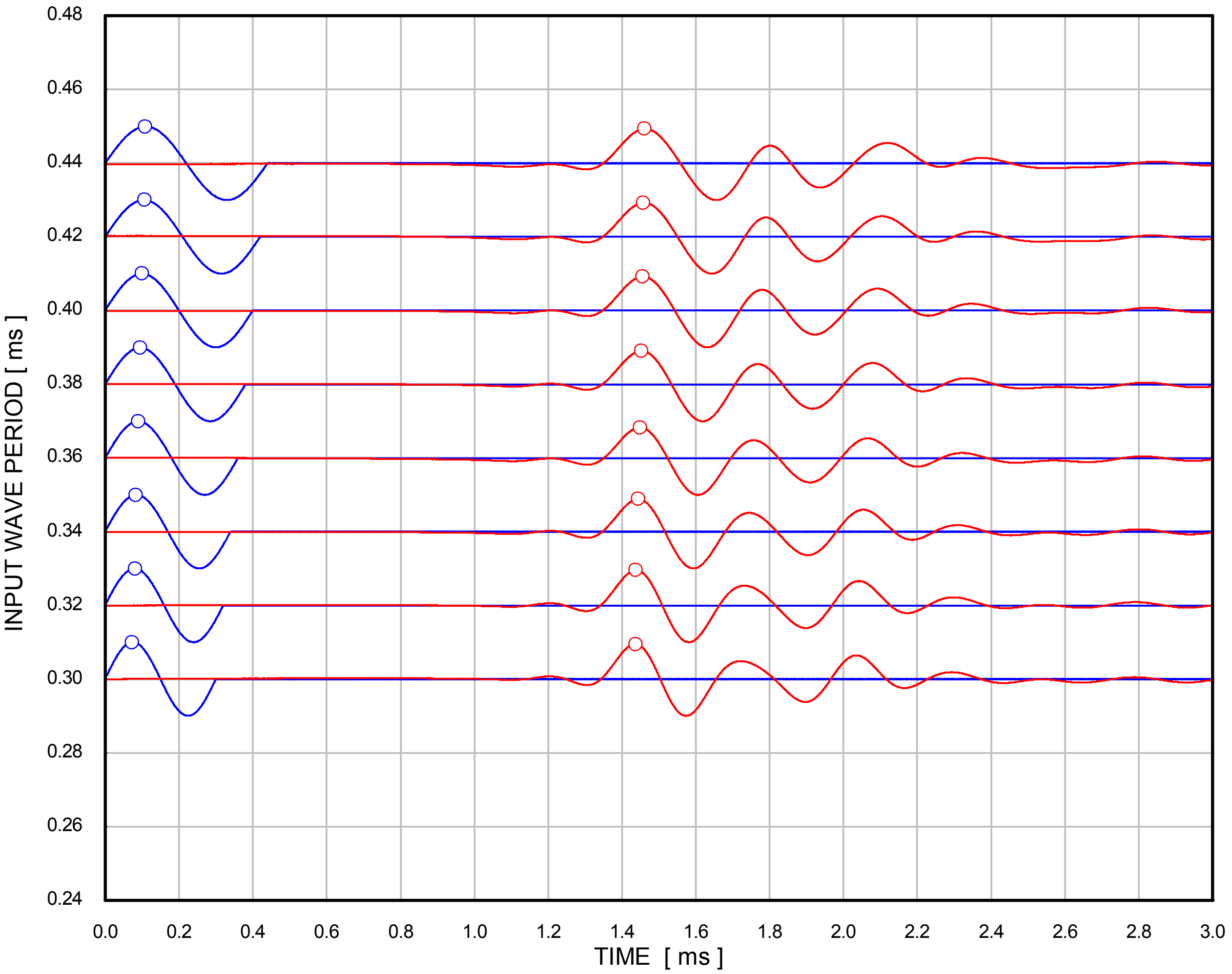
Date : 14/10/2016
Approved by: PH

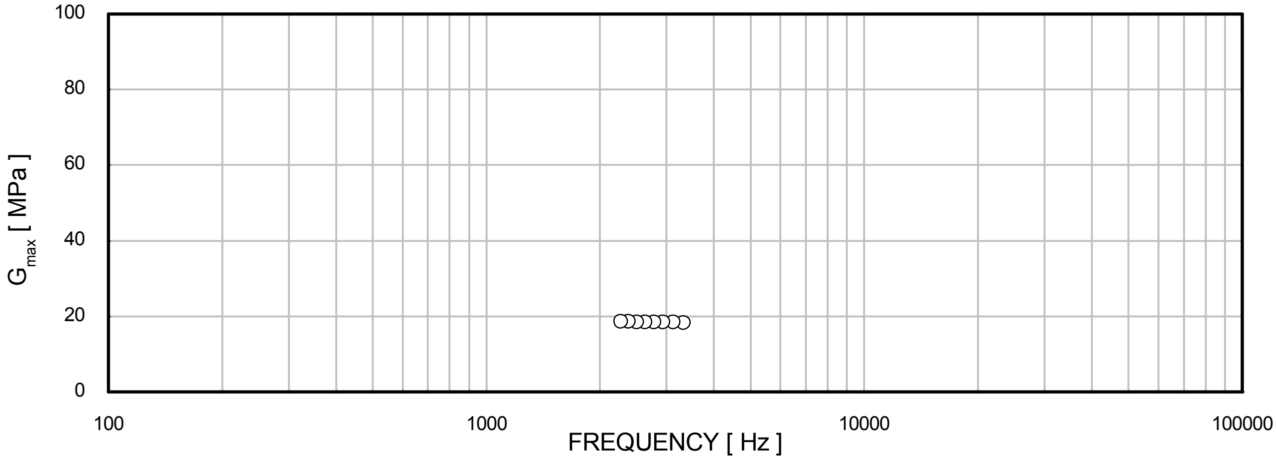




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	225	225	HKZ1- BH06-SA	39BagA&B	34.00
— —	2	450	450			
· · · ·	3	900	900			

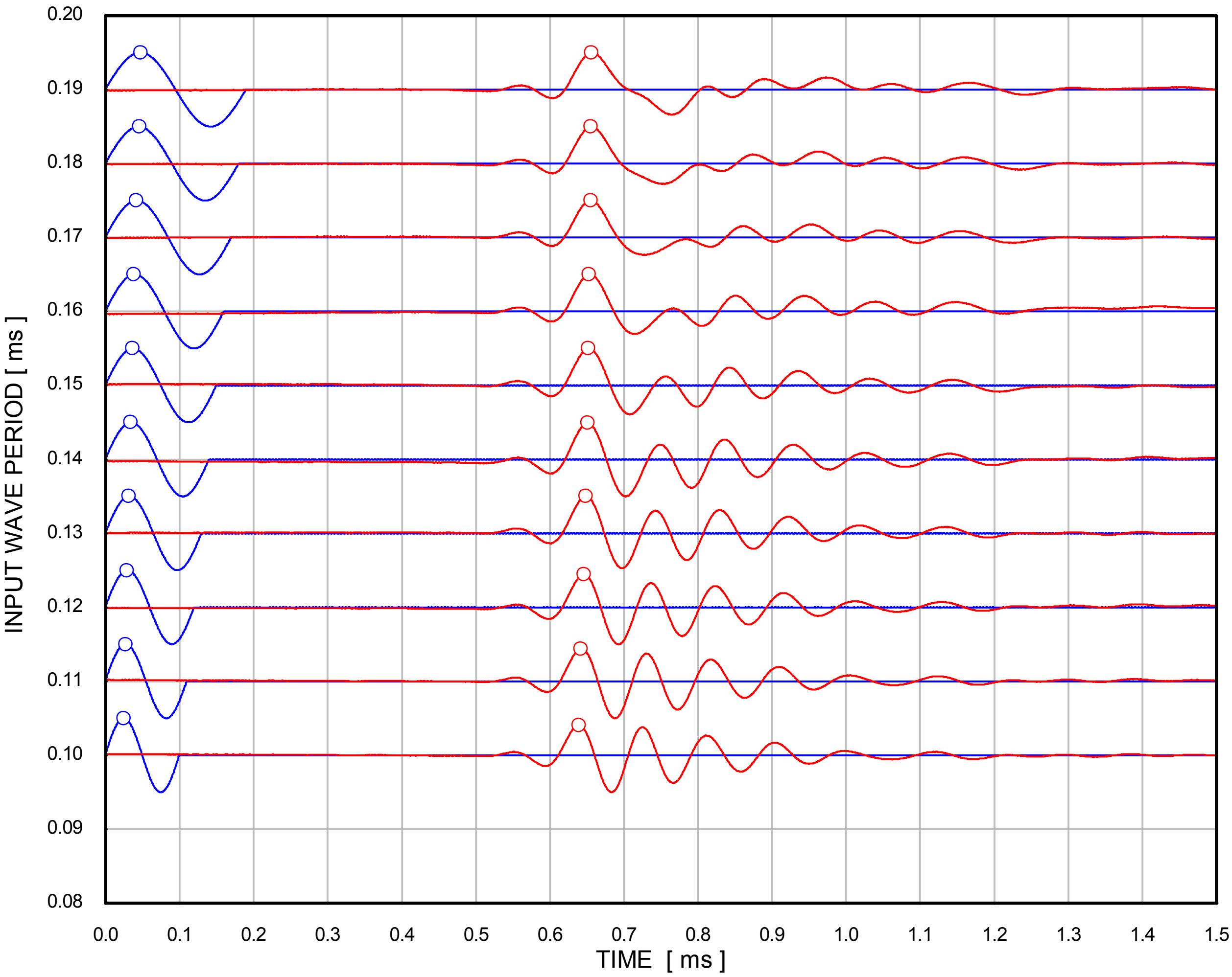
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

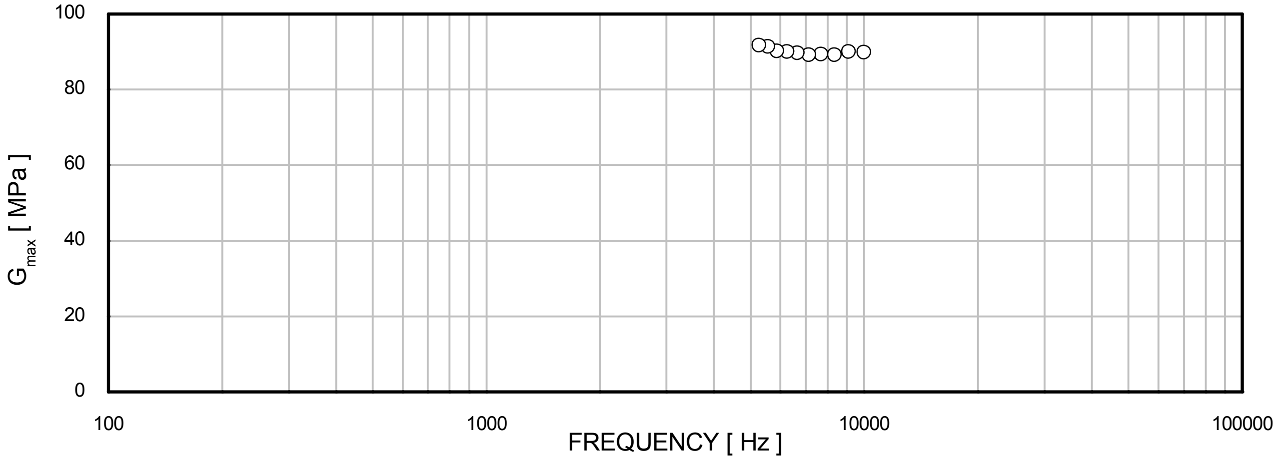




σ'$_{rc}$	: 17 kPa	Borehole	: HKZ1-BH06-SA
σ'$_{ac}$	: 17 kPa	Sample	: 39BagA&B
—	Source signal	Depth [m]	: 34.00
—	Received signal	Test No.	: 224a
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S$_{VH}$ BENDER ELEMENT DETERMINATIONS





σ'_{rc} : 225 kPa

σ'_{ac} : 225 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

Borehole : HKZ1-BH06-SA

Sample : 39BagA&B

Depth [m] : 34.00

Test No. : 224a

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 20/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_59BagA_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

VISUAL DESCRIPTION
Dark brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		15/09/2016	19/09/2016	15/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.2	10.2	9.9
Bulk density	(Mg/m³)	1.84	1.84	1.84
Dry density	(Mg/m³)	1.67	1.67	1.67
Void ratio		0.589	0.587	0.583
Degree of saturation	(%)	46	46	45

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	767	1212	2195
Cell pressure on completion	(kPa)	780	1260	2220
B value achieved		0.99	0.96	0.99

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	59BagA	59BagA	59BagA
Depth (m)	59.00	59.00	59.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 20/09/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_59BagA_D3.XLS
Date: 03/10/2016
Date: 03/10/2016
Checked by: PH
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	780	1260	2220
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	480	960	1920
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	21.3	20.9	20.3
Bulk density	(Mg/m³)	2.06	2.06	2.07
Dry density	(Mg/m³)	1.69	1.71	1.72
Void ratio		0.564	0.553	0.538
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.57	2.10	2.85

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	59BagA	59BagA	59BagA
Depth (m)	59.00	59.00	59.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	480	960	1920
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	1482	2588	4514
Membrane correction applied	(kPa)	0.6	0.8	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.04	5.25	9.56
Volumetric strain	(%)	-0.21	0.21	1.15
Major principal effective stress	(kPa)	1963	3551	6434
Minor principal effective stress	(kPa)	481	962	1920
Principal effective stress ratio		4.08	3.69	3.35
Epsilon 50 (ε 50)	(%)	0.84	0.84	1.07
Secant modulus (E50) at ε 50	(kPa)	88150	154276	211561
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	1482	2588	4514
Membrane correction applied	(kPa)	0.6	0.8	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.04	5.25	9.56
Volumetric strain	(%)	-0.21	0.21	1.15
Major principal effective stress	(kPa)	1963	3551	6434
Minor principal effective stress	(kPa)	481	962	1920
Principal effective stress ratio		4.08	3.69	3.35
At 15% axial strain				
Corrected deviator stress	(kPa)	1197	2312	4422
Membrane correction applied	(kPa)	1.8	1.8	1.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-2.11	-0.73	1.11
Major principal effective stress	(kPa)	1679	3276	6342
Minor principal effective stress	(kPa)	482	964	1920
Principal effective stress ratio		3.48	3.40	3.30

FINAL CONDITIONS				
Water content	(%)	22.7	21.4	19.7
Bulk density	(Mg/m³)	2.03	2.05	2.08
Dry density	(Mg/m³)	1.65	1.69	1.74

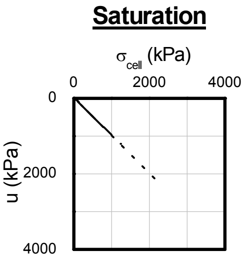
Borehole	HKZ1-BH06-SA	HKZ1-BH06-SA	HKZ1-BH06-SA
Sample	59BagA	59BagA	59BagA
Depth (m)	59.00	59.00	59.00

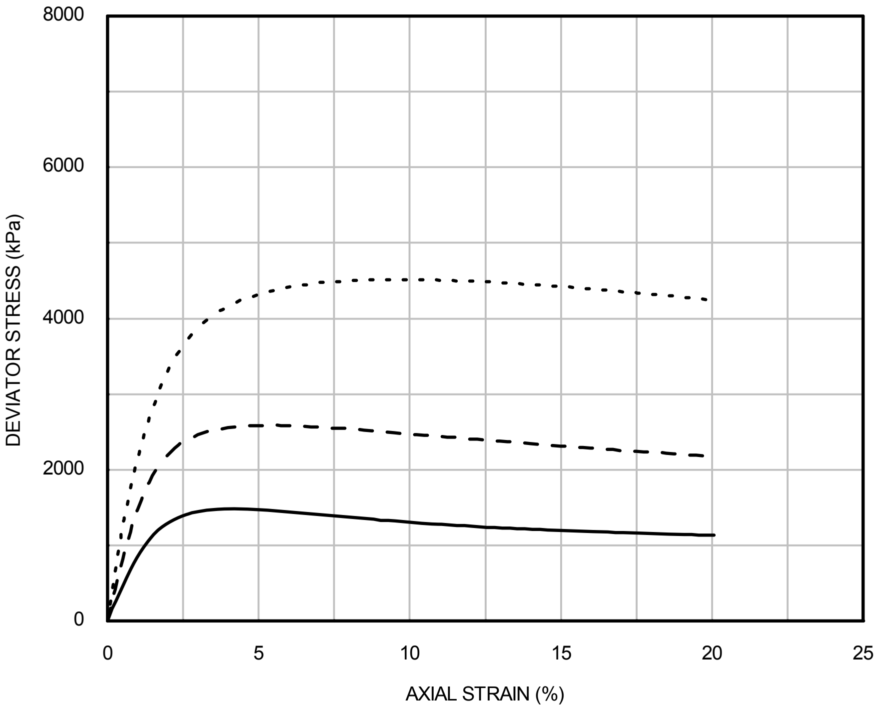
SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

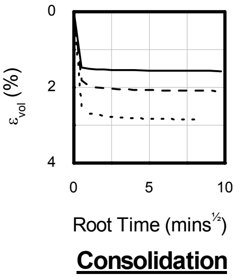
Date: 20/09/2016 Drawn by: ALB Template Issue: 7 Date: 03/10/2016 Checked by: PH

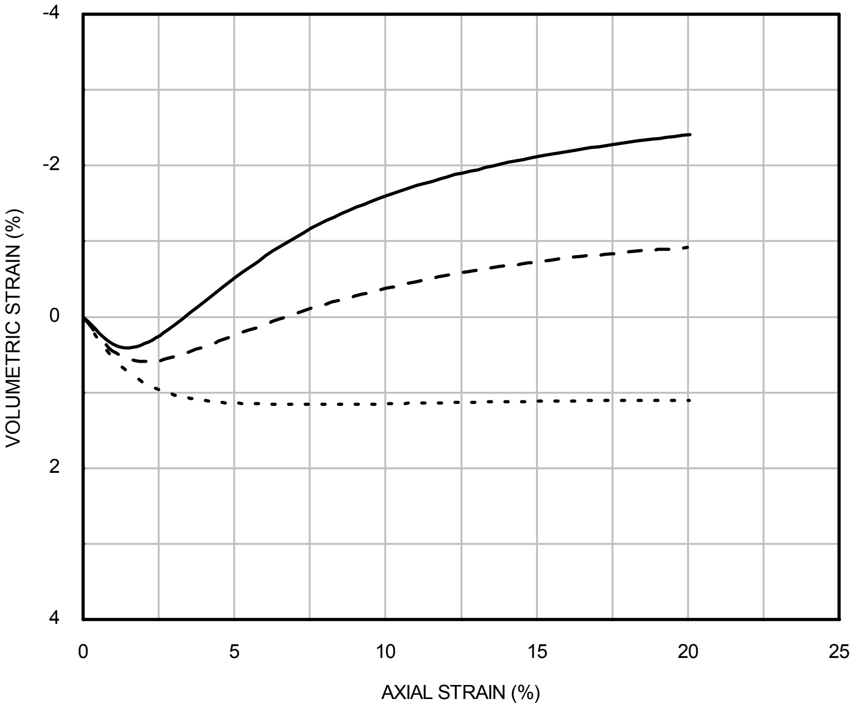
Filename: J11335 / EFFECTIV / HKZ1-BH06-SA_59BagA_D3.XLS Date: 03/10/2016 Approved by: PH

Date: 20/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_59BagA_D3.OPJ
Date : 03/10/2016
Date : 03/10/2016
Checked by: PH
Approved by: PH









Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	480	480	HKZ1-BH06 -SA	59BagA	59.00
– –	2	960	960			
· · · ·	3	1920	1920			

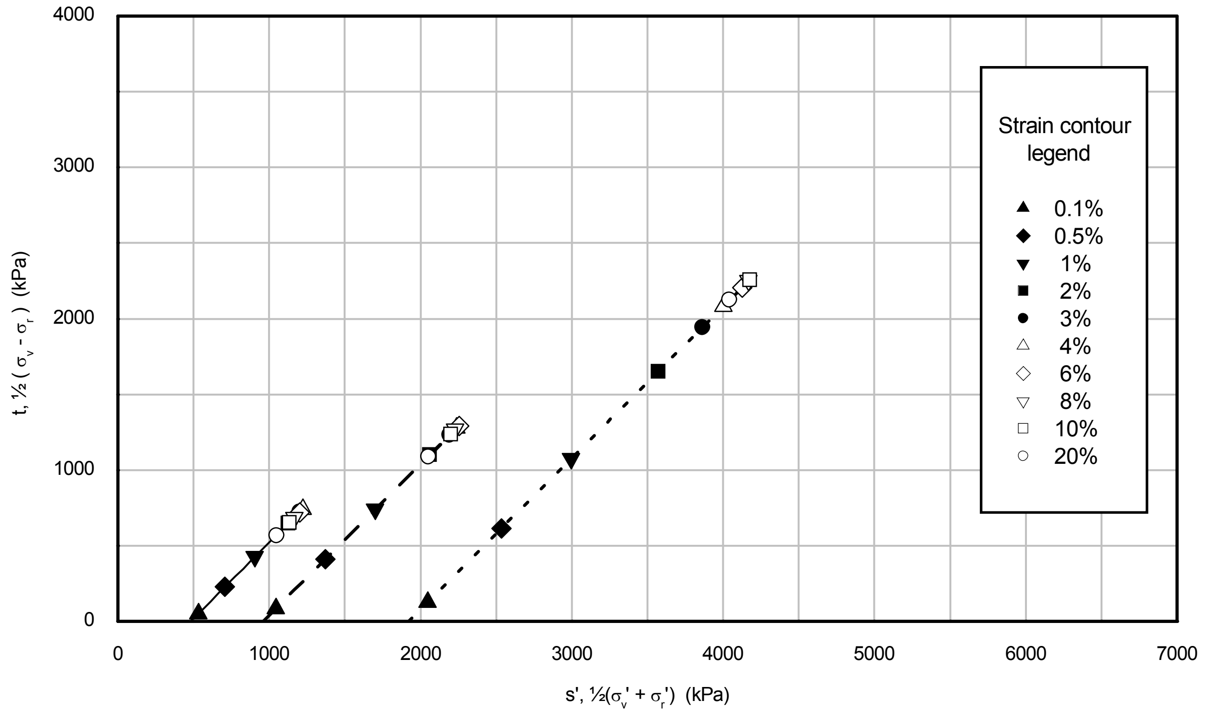
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

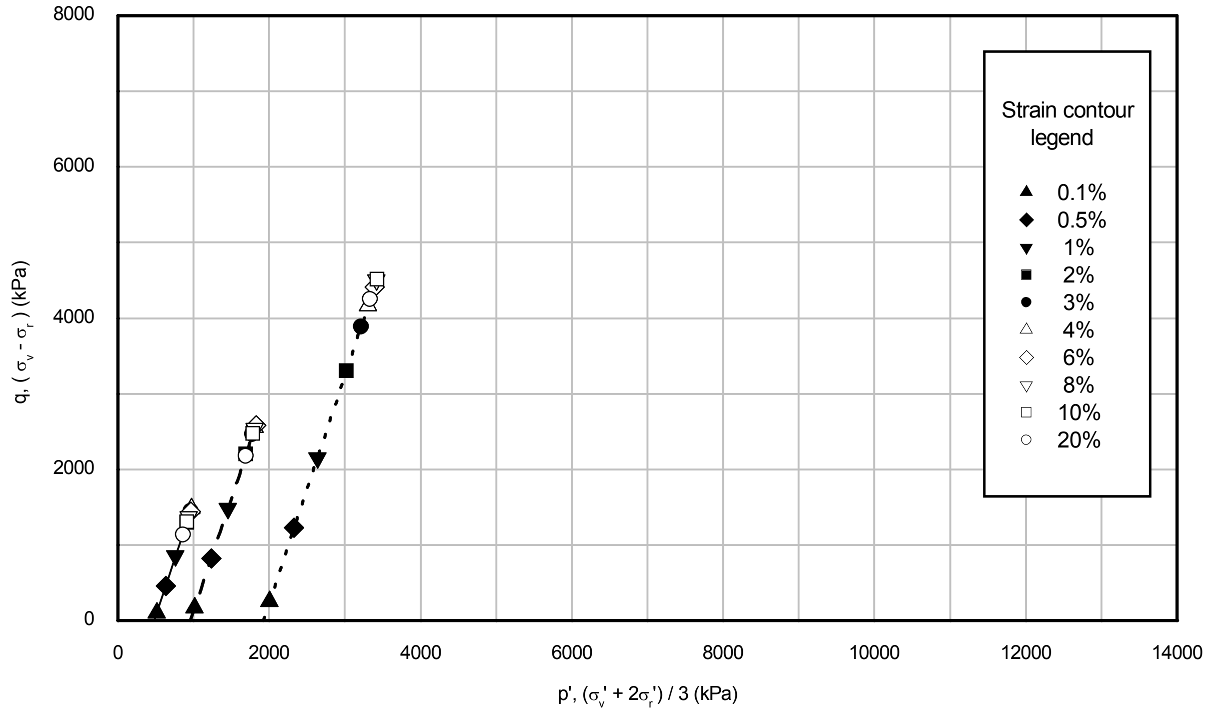
Drawn by: ALB Date: 20/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_59BagA_D3.OPJ

Checked by: PH Date : 03/10/2016

Approved by: PH Date : 03/10/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	480	480	HKZ1-BH06 -SA	59BagA	59.00
– –	2	960	960			
- - - -	3	1920	1920			

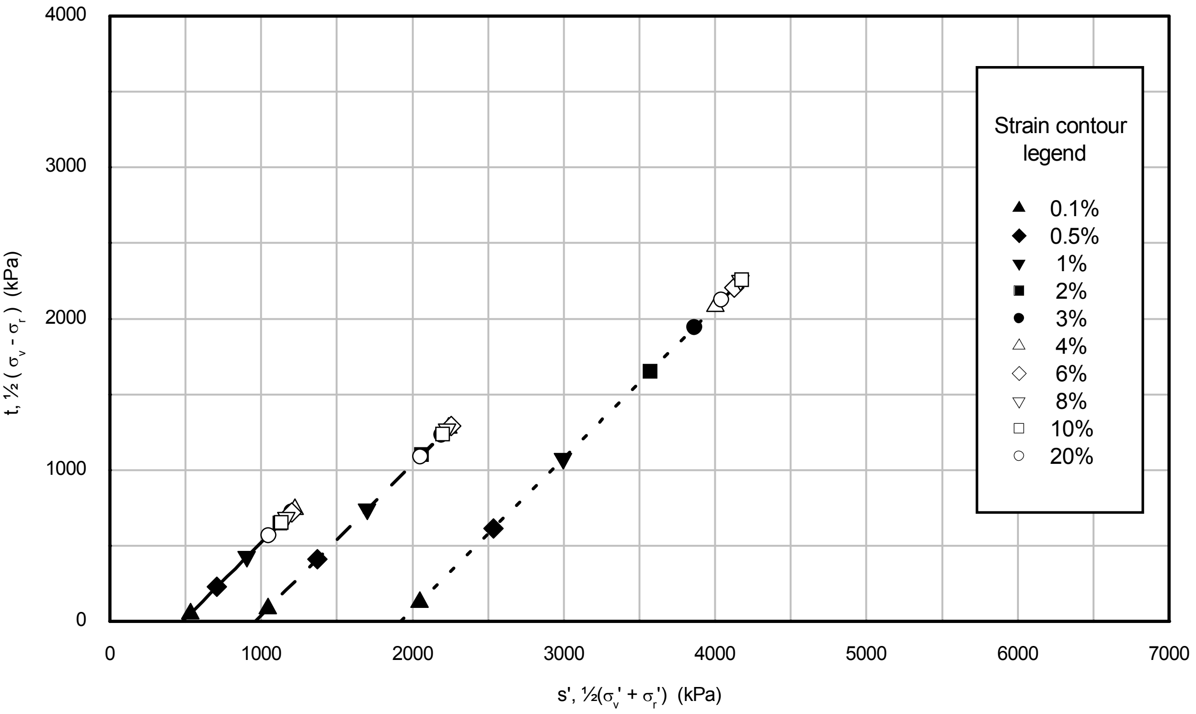
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

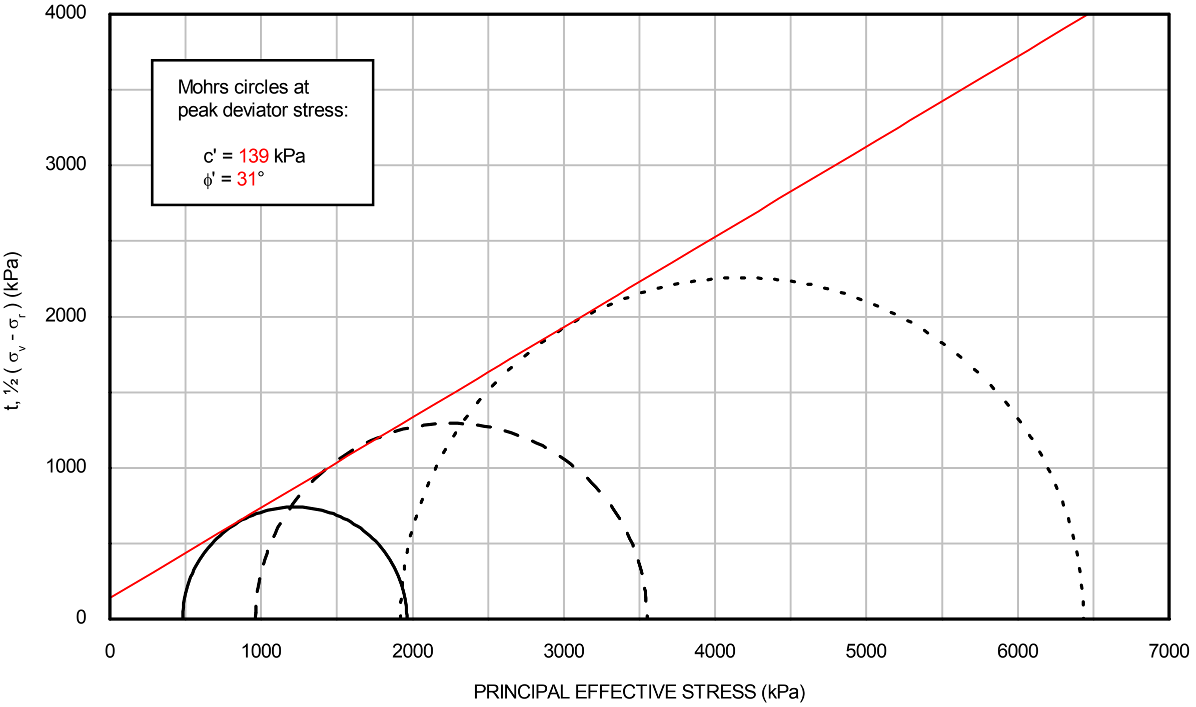
Drawn by: ALB Date: 20/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH06-SA_59BagA_D3.OPJ

Checked by: PH Date : 03/10/2016

Approved by: PH Date : 03/10/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	480	480	HKZ1-BH06 -SA	59BagA	59.00
— —	2	960	960			
· · · ·	3	1920	1920			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 26/08/2016 Drawn by: ALB Template Issue: 7 Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_14BagA_D3.XLS Date: 30/08/2016 Date: 05/09/2016 Checked by: MSR Approved by: PH

VISUAL DESCRIPTION
Yellowish brown fine to medium SAND with some shell fragments and fine to medium gravel

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		24/08/2016	24/08/2016	24/08/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.3	10.3	10.3
Bulk density	(Mg/m³)	1.89	1.89	1.89
Dry density	(Mg/m³)	1.71	1.71	1.71
Void ratio		0.547	0.549	0.550
Degree of saturation	(%)	50	50	50

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	493	603	809
Cell pressure on completion	(kPa)	510	620	840
B value achieved		0.96	0.97	0.95

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	9.50	9.50	9.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 26/08/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_14BagA_D3.XLS
Date: 30/08/2016
Checked by: MSR
Date: 05/09/2016
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	510	620	840
Back pressure	(kPa)	400	400	400
Effective cell pressure	(kPa)	110	220	440
Pore pressure on completion	(kPa)	400	400	400
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	20.2	20.0	19.7
Bulk density	(Mg/m³)	2.08	2.08	2.08
Dry density	(Mg/m³)	1.73	1.73	1.74
Void ratio		0.535	0.530	0.521
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.78	1.21	1.85

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	9.50	9.50	9.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	400	400	400
Initial effective cell pressure	(kPa)	110	220	440
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	406	720	1384
Membrane correction applied	(kPa)	0.4	0.4	0.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.72	2.62	3.67
Volumetric strain	(%)	-0.69	-0.46	-0.56
Major principal effective stress	(kPa)	517	941	1825
Minor principal effective stress	(kPa)	111	221	440
Principal effective stress ratio		4.66	4.26	4.14
Epsilon 50 (ε 50)	(%)	0.68	0.39	0.50
Secant modulus (E50) at ε 50	(kPa)	29991	92475	137478
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	406	720	1384
Membrane correction applied	(kPa)	0.4	0.4	0.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	2.72	2.62	3.67
Volumetric strain	(%)	-0.69	-0.46	-0.56
Major principal effective stress	(kPa)	517	941	1825
Minor principal effective stress	(kPa)	111	221	440
Principal effective stress ratio		4.66	4.26	4.14
At 15% axial strain				
Corrected deviator stress	(kPa)	299	542	1032
Membrane correction applied	(kPa)	1.8	1.8	1.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-4.18	-3.17	-3.19
Major principal effective stress	(kPa)	411	764	1474
Minor principal effective stress	(kPa)	112	222	442
Principal effective stress ratio		3.66	3.45	3.34

FINAL CONDITIONS				
Water content	(%)	22.9	22.0	21.6
Bulk density	(Mg/m³)	2.03	2.04	2.05
Dry density	(Mg/m³)	1.65	1.67	1.69

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	14BagA	14BagA	14BagA
Depth (m)	9.50	9.50	9.50

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Drawn by: ALB Date: 26/08/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_14BagA_D3.OPJ

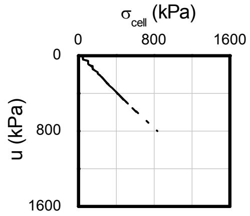
Date : 30/08/2016

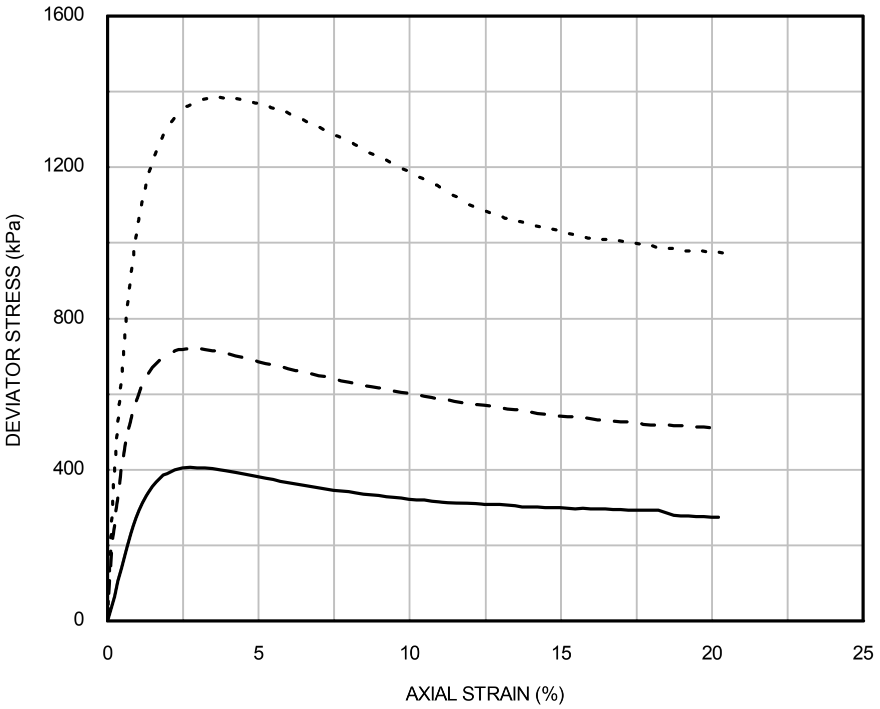
Date : 05/09/2016

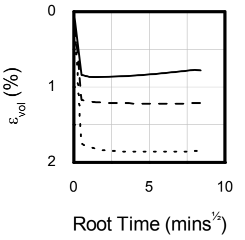
Checked by: MSR

Approved by: PH

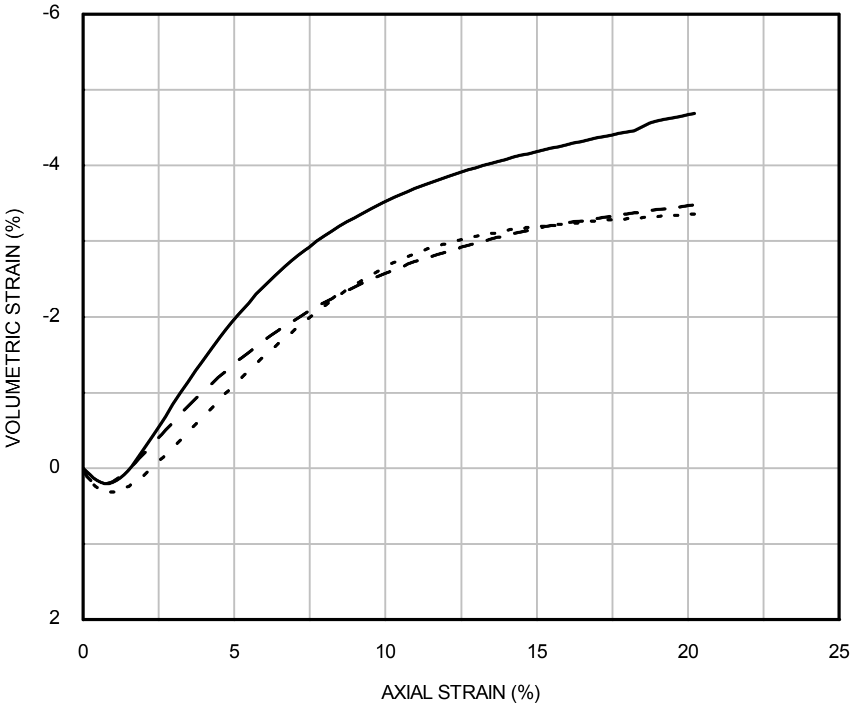
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	110	110	HKZ1-BH07 -SA	14BagA	9.50
— —	2	220	220			
· · · ·	3	440	440			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 26/08/2016

Template Issue: 4

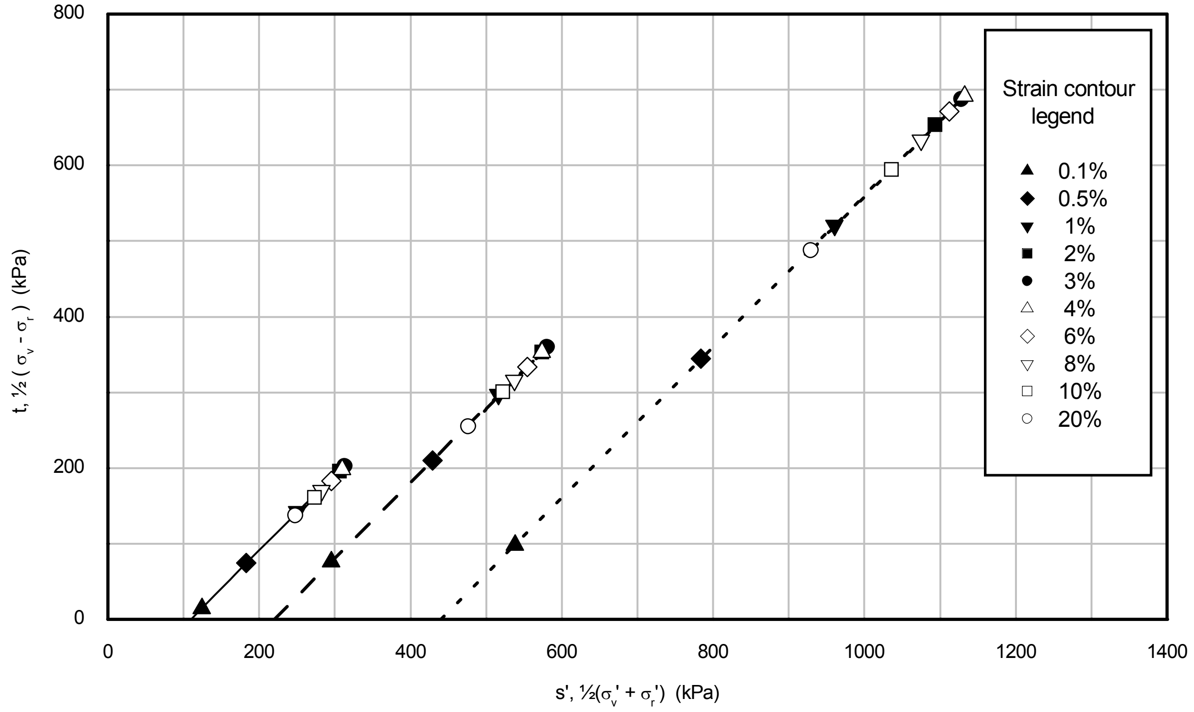
Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_14BagA_D3.OPJ

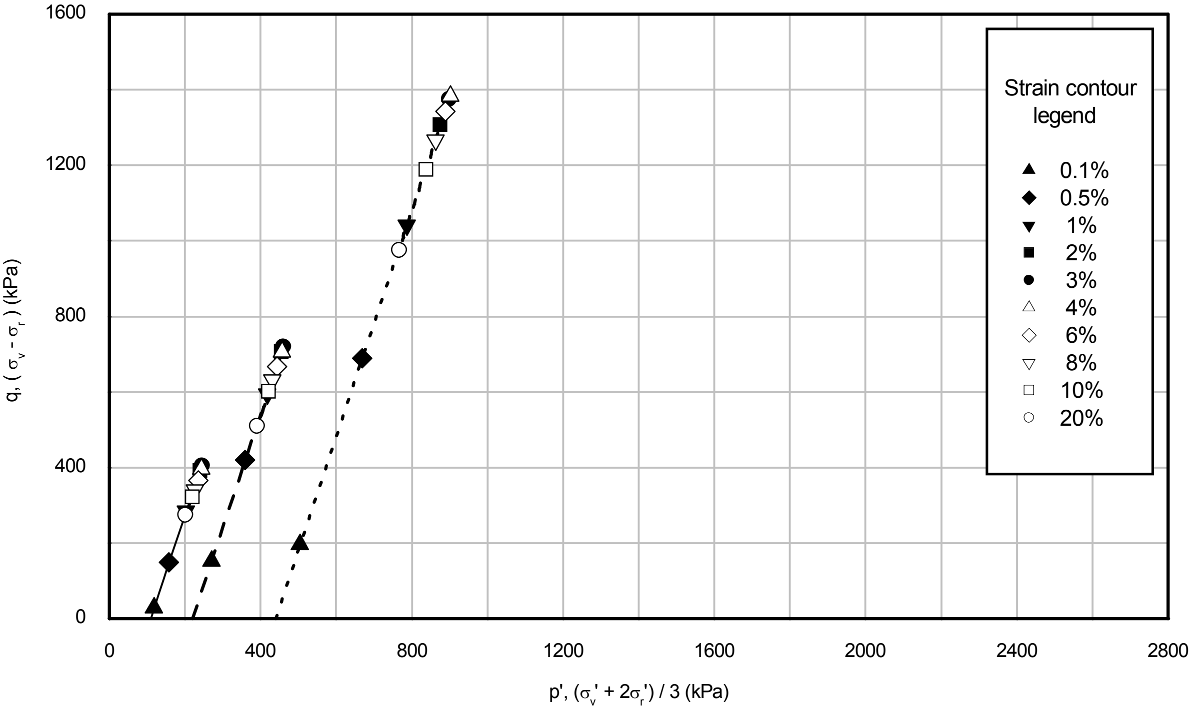
Date : 30/08/2016

Date : 05/09/2016

Checked by: MSR

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	110	110	HKZ1-BH07 -SA	14BagA	9.50
— —	2	220	220			
- - - -	3	440	440			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

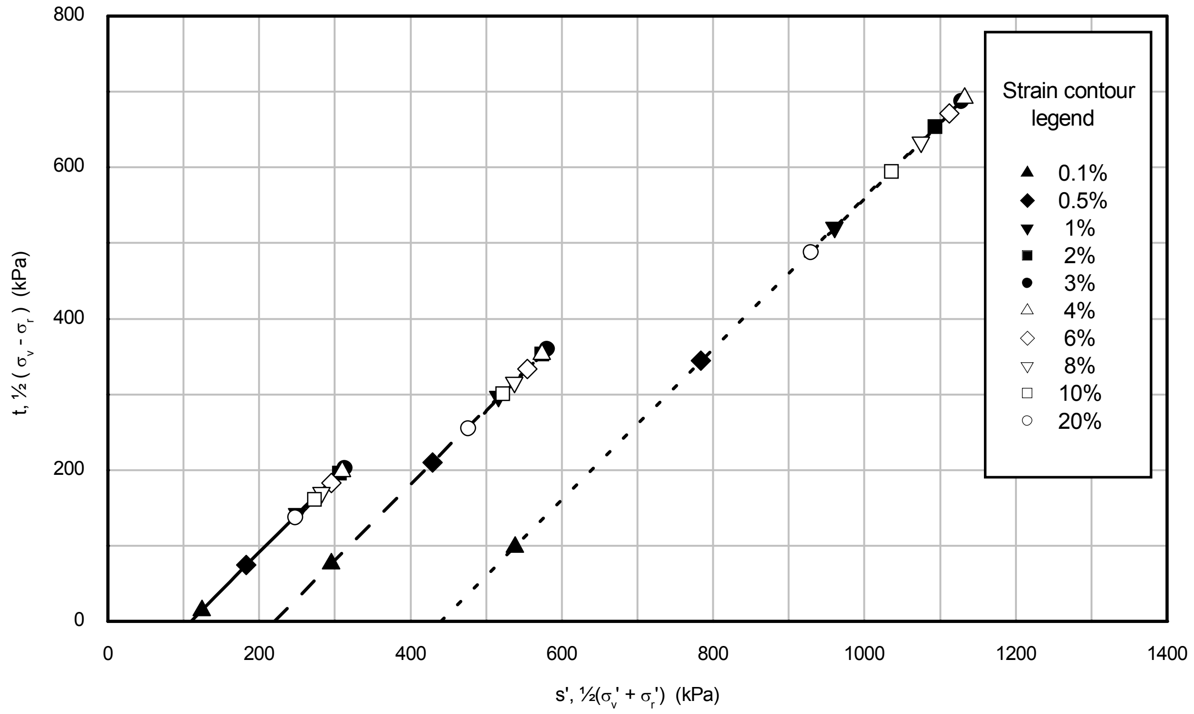
Drawn by: ALB Date: 26/08/2016

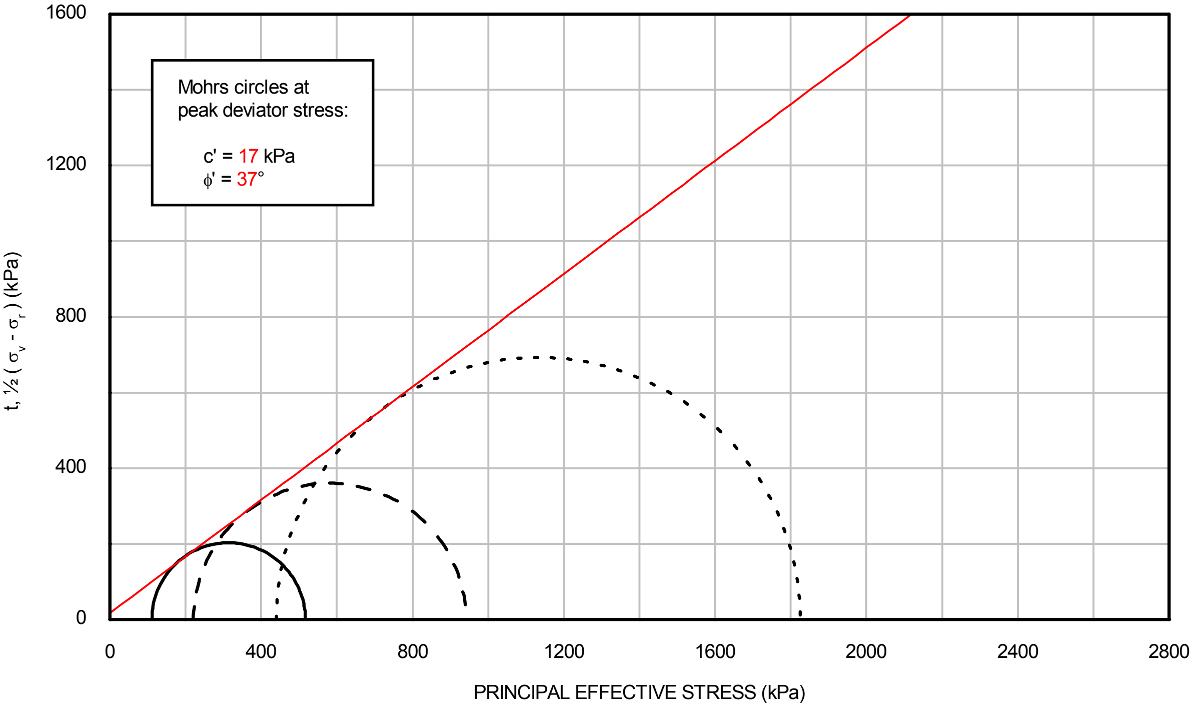
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_14BagA_D3.OPJ

Checked by: MSR Date : 30/08/2016

Approved by: PH Date : 05/09/2016





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	110	110	HKZ1-BH07 -SA	14BagA	9.50
— —	2	220	220			
· · · ·	3	440	440			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Dark grey fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	31/08/2016	04/09/2016	08/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.2	10.0	10.3
Bulk density	(Mg/m³)	1.60	1.60	1.59
Dry density	(Mg/m³)	1.45	1.45	1.45
Void ratio		0.830	0.825	0.833
Degree of saturation	(%)	32	32	33

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	408	529	756
Cell pressure on completion	(kPa)	420	540	780
B value achieved		0.98	1.00	0.97

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	24BagA	24BagA	24BagA
Depth (m)	17.00	17.00	17.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_24BagA_D3.XLS
Date: 20/09/2016
Checked by: PH
Date: 20/09/2016
Approved by: PH

Date: 09/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_24BagA_D3.XLS
Date: 20/09/2016
Date: 20/09/2016
Checked by: PH
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	420	540	780
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	120	240	480
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	30.0	28.1	28.7
Bulk density	(Mg/m³)	1.92	1.95	1.94
Dry density	(Mg/m³)	1.48	1.52	1.51
Void ratio		0.795	0.746	0.760
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.91	4.36	4.02

Mode of failure:	Compound failure	Compound failure	Compound failure

	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	24BagA	24BagA	24BagA
Depth (m)	17.00	17.00	17.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$	1.90		
Dry density	$[Mg/m^3]$	1.45		
Void ratio	[-]	0.830		
Distance	[mm]	132.1		
Effective radial pressure	[kPa]	12		
Effective axial pressure	[kPa]	12		
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.30	1.6565	5.52	79.72	12.1
0.32	1.6585	5.18	79.62	12.1
0.34	1.6570	4.87	79.69	12.1
0.36	1.6565	4.60	79.72	12.1
0.38	1.6515	4.35	79.96	12.2
0.40	1.6525	4.13	79.91	12.1
0.42	1.6515	3.93	79.96	12.2
0.44	1.6510	3.75	79.98	12.2
0.46	1.6495	3.59	80.05	12.2
0.48	1.6490	3.43	80.08	12.2

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1				
Bulk density	$[Mg/m^3]$	1.92		
Dry density	$[Mg/m^3]$	1.48		
Void ratio	[-]	0.795		
Distance	[mm]	131.2		
Effective radial pressure	[kPa]	120		
Effective axial pressure	[kPa]	120		
Input Wave Period	Peak-to-Peak Arrival Time	Wavelength Ratio	Velocity	G_{max}
[ms]	[ms]	[-]	[m/s]	[MPa]
0.20	0.8610	4.31	152.36	44.5
0.21	0.8600	4.10	152.54	44.7
0.22	0.8585	3.90	152.80	44.8
0.23	0.8590	3.73	152.71	44.8
0.24	0.8545	3.56	153.52	45.2
0.25	0.8570	3.43	153.07	45.0
0.26	0.8550	3.29	153.43	45.2
0.27	0.8540	3.16	153.61	45.3
0.28	0.8515	3.04	154.06	45.5
0.29	0.8495	2.93	154.42	45.8

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	24BagA	24BagA	24BagA
Depth (m)	17.00	17.00	17.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	120	240	480
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	263	536	1071
Membrane correction applied	(kPa)	1.5	1.4	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	19.01	16.95	17.97
Volumetric strain	(%)	5.13	4.40	4.44
Major principal effective stress	(kPa)	381	773	1549
Minor principal effective stress	(kPa)	118	237	478
Principal effective stress ratio		3.22	3.26	3.24
Epsilon 50 (ε 50)	(%)	2.90	3.11	3.23
Secant modulus (E50) at ε 50	(kPa)	4531	8625	16563
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	262	536	1071
Membrane correction applied	(kPa)	1.5	1.5	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	18.76	17.45	17.97
Volumetric strain	(%)	5.13	4.40	4.44
Major principal effective stress	(kPa)	381	772	1549
Minor principal effective stress	(kPa)	118	236	478
Principal effective stress ratio		3.22	3.27	3.24
At 15% axial strain				
Corrected deviator stress	(kPa)	257	531	1057
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	4.97	4.35	4.40
Major principal effective stress	(kPa)	376	768	1535
Minor principal effective stress	(kPa)	118	237	478
Principal effective stress ratio		3.18	3.24	3.21

FINAL CONDITIONS				
Water content	(%)	30.0	28.1	28.7
Bulk density	(Mg/m³)	1.92	1.95	1.94
Dry density	(Mg/m³)	1.48	1.52	1.51

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	24BagA	24BagA	24BagA
Depth (m)	17.00	17.00	17.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Checked by: PH Date: 20/09/2016 Template Issue: 2 Drawn by: ALB Date: 09/09/2016

Approved by: PH Date: 20/09/2016 Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_24BagA_D3.XLS

Drawn by: ALB Date: 09/09/2016

Template Issue: 4

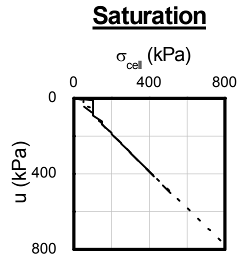
Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_24BagA_D3.OPJ

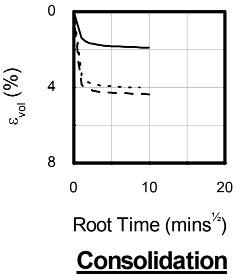
Date : 13/09/2016

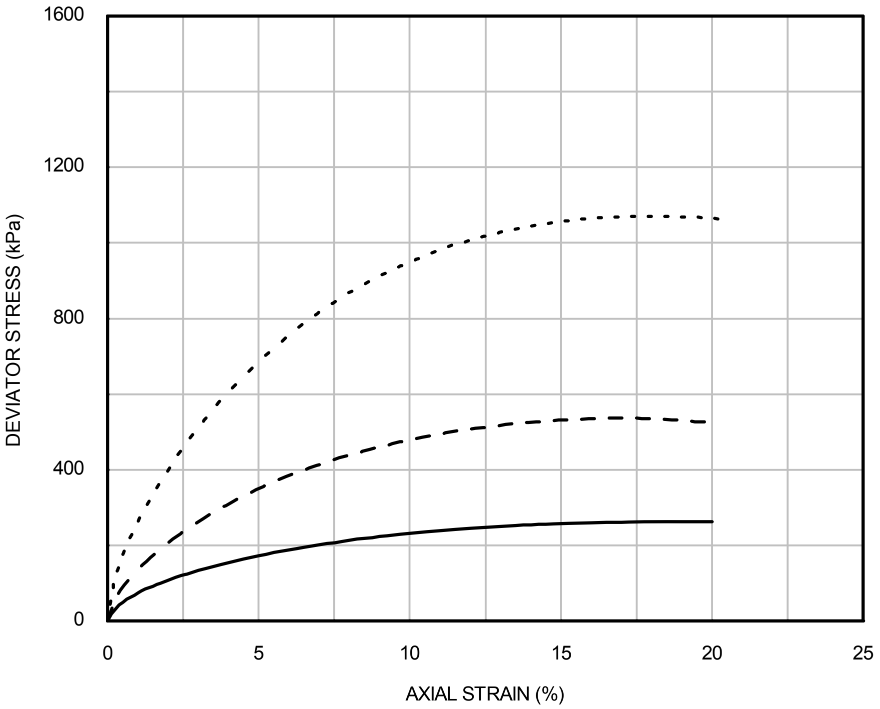
Date : 20/09/2016

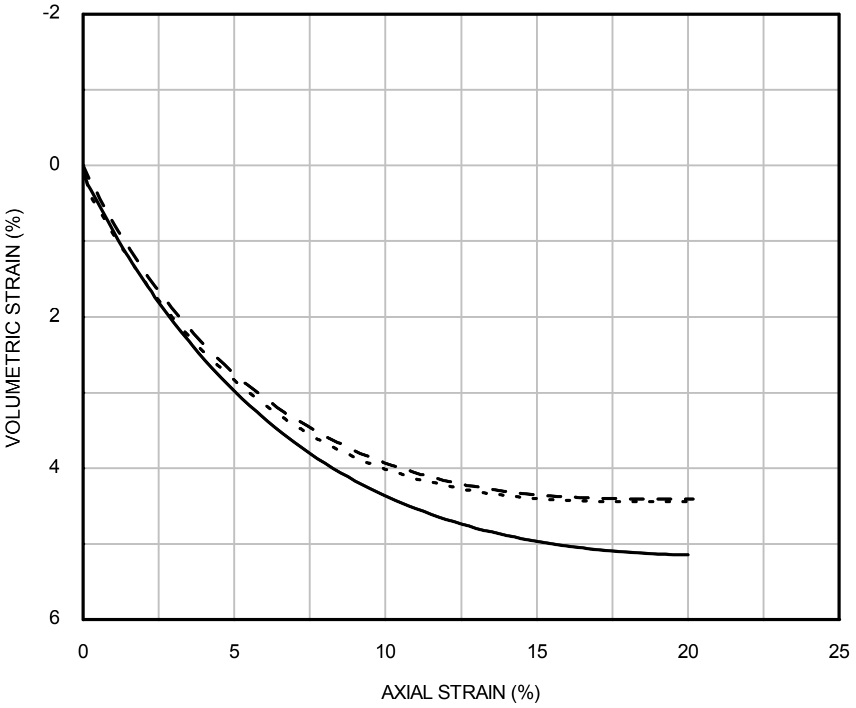
Checked by: MSR

Approved by: PH









Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	120	120	HKZ1-BH07-SA	24BagA	17.00
– –	2	240	240			
· · · ·	3	480	480			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

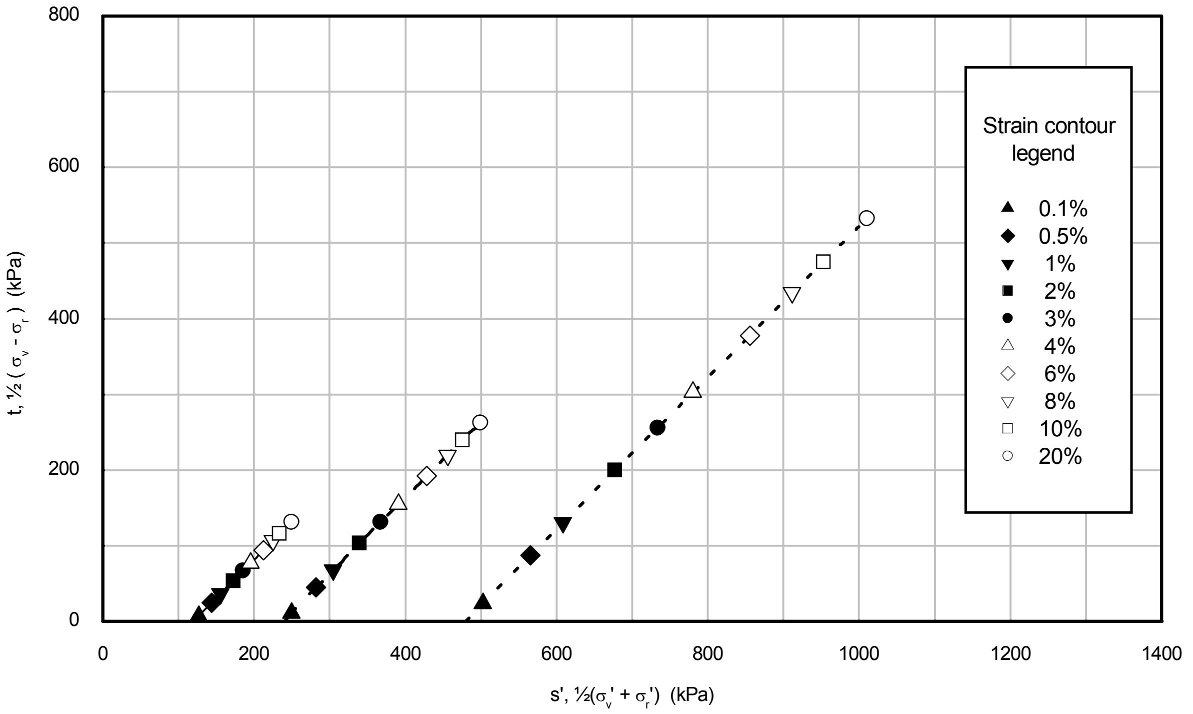
Drawn by: ALB Date: 09/09/2016

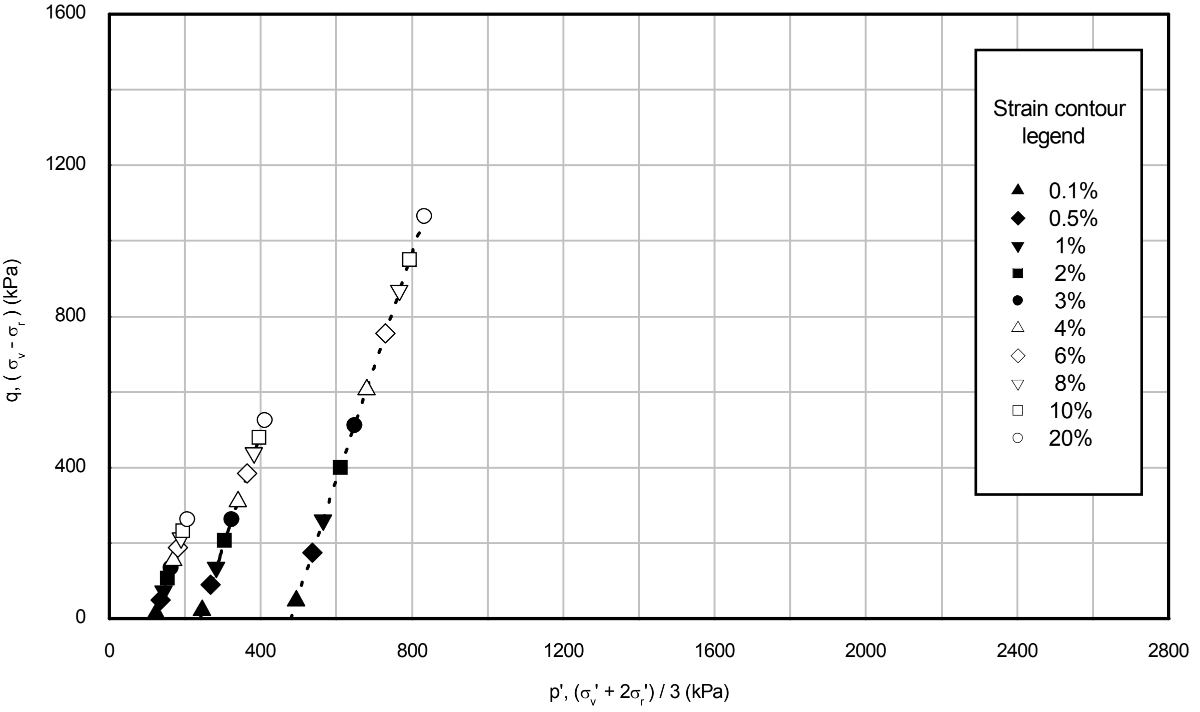
Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_24BagA_D3.OPJ

Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016





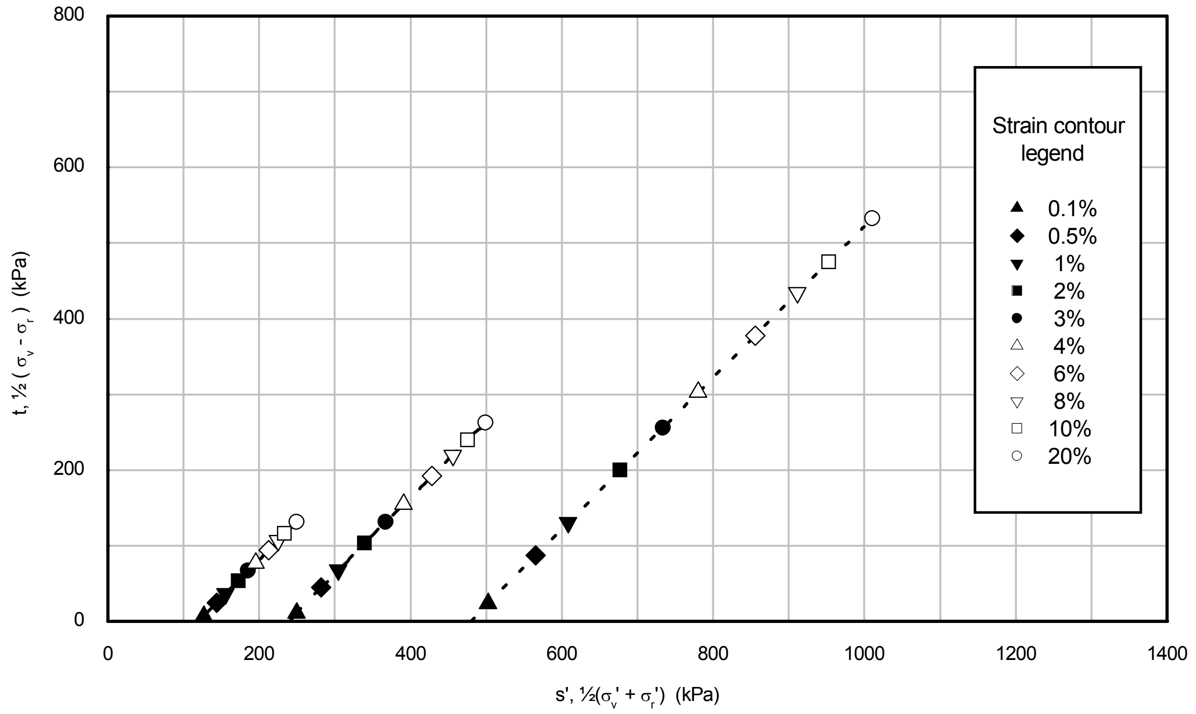
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	120	120	HKZ1-BH07 -SA	24BagA	17.00
– –	2	240	240			
- - - -	3	480	480			

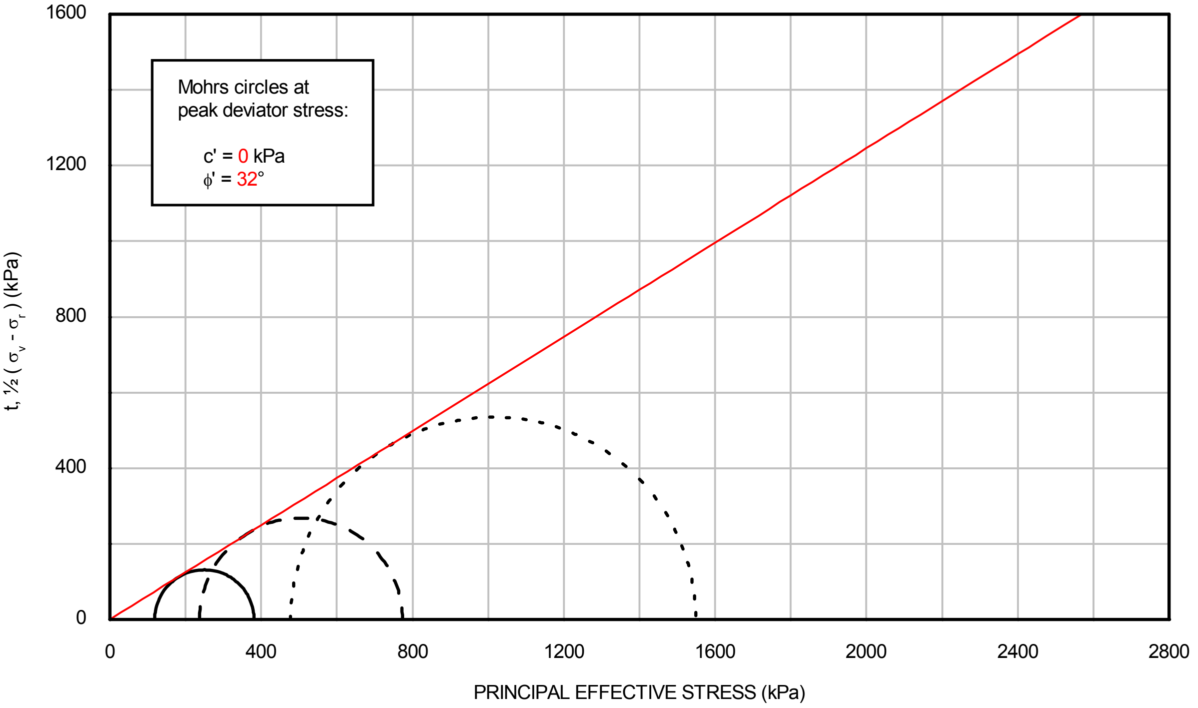
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 09/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_24BagA_D3.OPJ



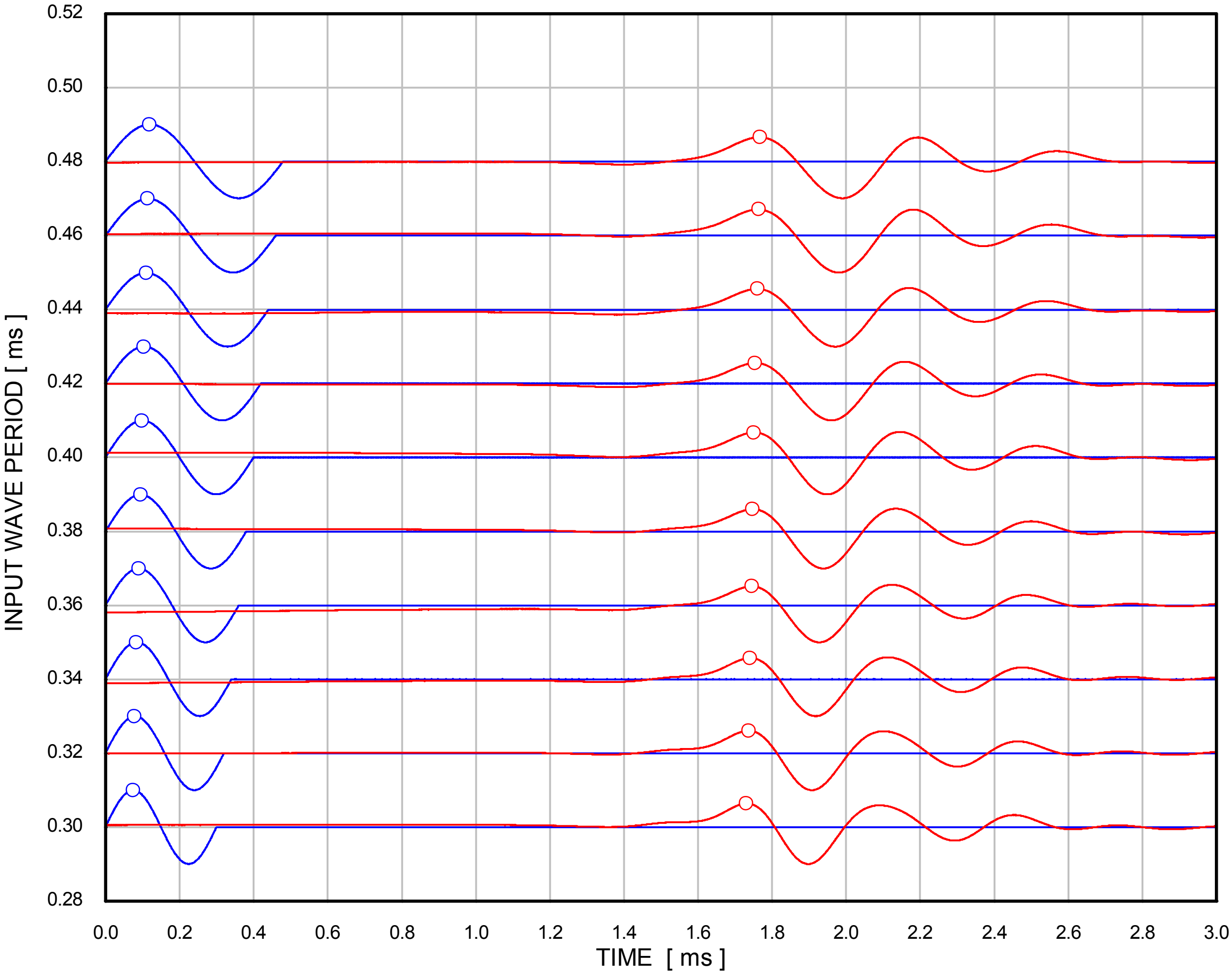


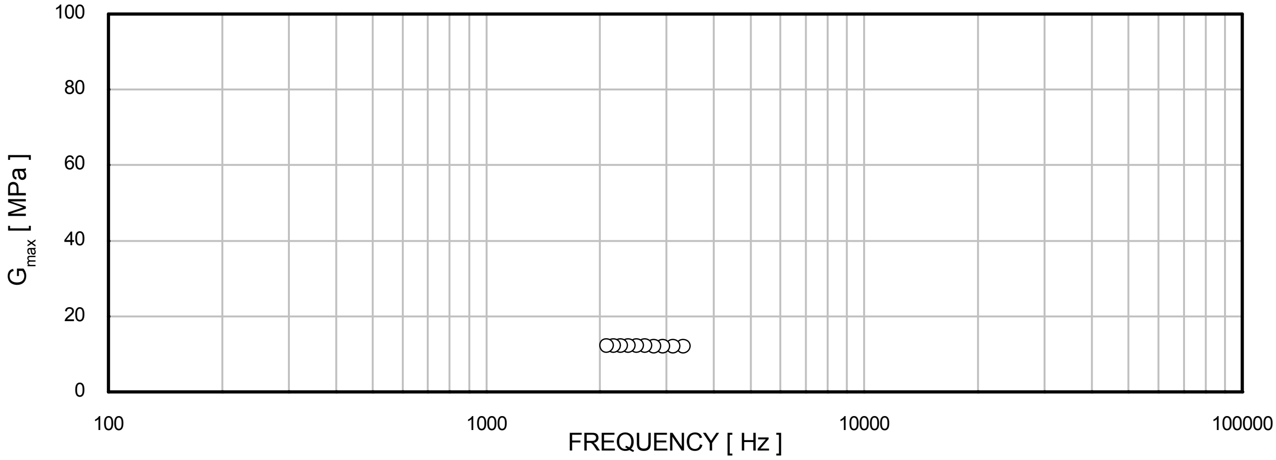
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	120	120	HKZ1-BH07 -SA	24BagA	17.00
— —	2	240	240			
· · · ·	3	480	480			

Checked by: MSR Date : 13/09/2016

Approved by: PH Date : 20/09/2016

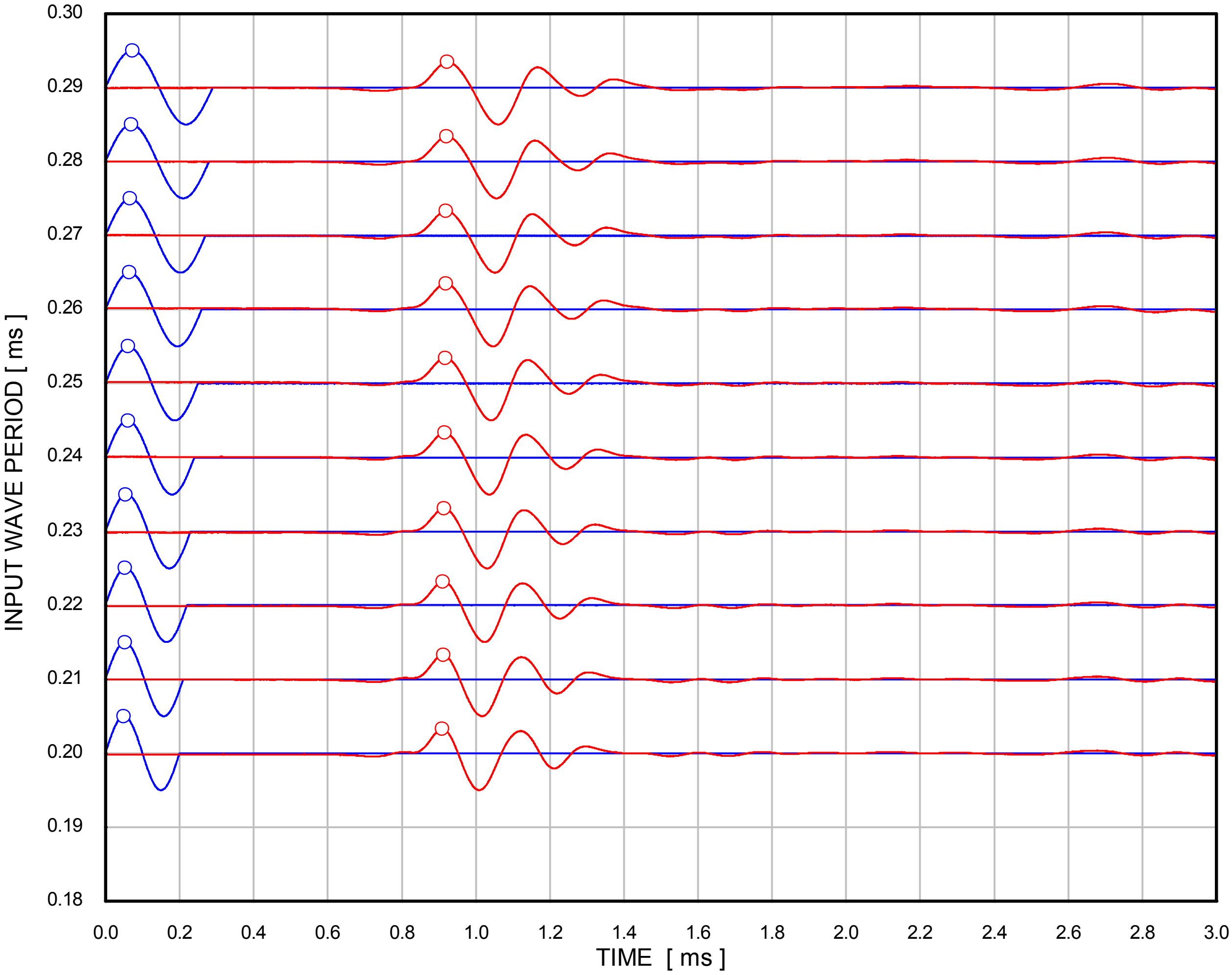
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

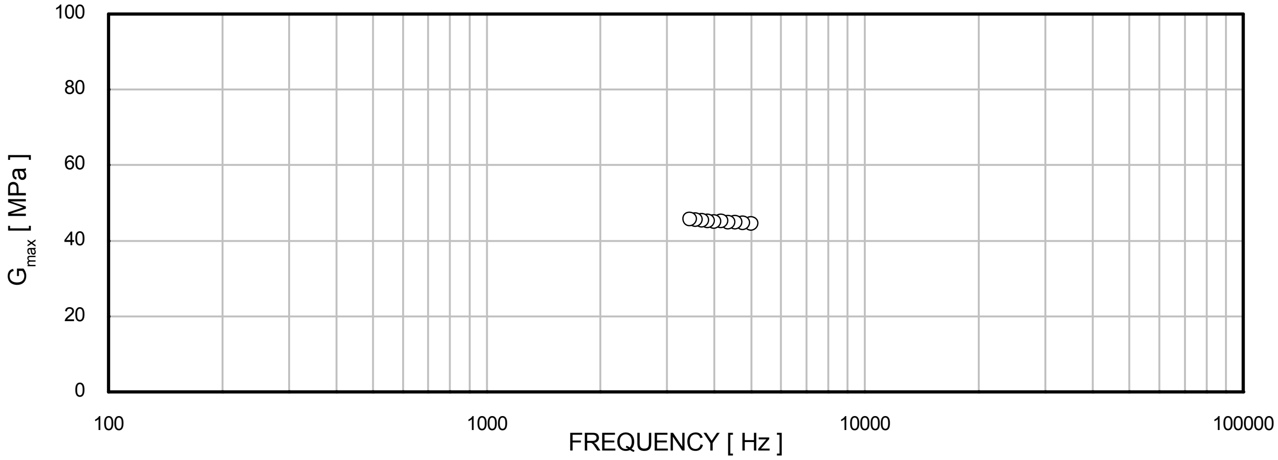




σ'_{rc}	: 12 kPa		Borehole	: HKZ1-BH07-SA
σ'_{ac}	: 12 kPa		Sample	: 24BagA
—	Source signal		Depth [m]	: 17.00
—	Received signal		Test No.	: 227A
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 120 kPa	Borehole	: HKZ1-BH07-SA
σ'_{ac}	: 120 kPa	Sample	: 24BagA
—	Source signal	Depth [m]	: 17.00
—	Received signal	Test No.	: 227A
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_44BagA_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

VISUAL DESCRIPTION
Grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		29/08/2016	04/09/2016	12/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	10.3	10.7	9.7
Bulk density	(Mg/m³)	1.76	1.76	1.76
Dry density	(Mg/m³)	1.60	1.59	1.60
Void ratio		0.658	0.670	0.654
Degree of saturation	(%)	42	43	39

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	528	768	1286
Cell pressure on completion	(kPa)	550	800	1300
B value achieved		0.95	0.96	1.00

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	44BagA	44BagA	44BagA
Depth (m)	36.00	36.00	36.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	550	800	1300
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	250	500	1000
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	24.2	24.4	23.5
Bulk density	(Mg/m³)	2.00	2.00	2.02
Dry density	(Mg/m³)	1.61	1.61	1.63
Void ratio		0.642	0.646	0.621
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.95	1.44	1.98

	Specimen 1	Specimen 2	Specimen 3
Mode of failure:	Compound failure	Compound failure	Compound failure

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	44BagA	44BagA	44BagA
Depth (m)	36.00	36.00	36.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	2.00
Dry density	[Mg/m^3]	1.60
Void ratio	[-]	0.658
Distance	[mm]	132.1
Effective radial pressure	[kPa]	22
Effective axial pressure	[kPa]	22

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.0060	5.03	131.35	34.4
0.21	1.0065	4.79	131.29	34.4
0.22	1.0080	4.58	131.09	34.3
0.23	1.0105	4.39	130.77	34.1
0.24	1.0100	4.21	130.83	34.2
0.25	1.0125	4.05	130.51	34.0
0.26	1.0115	3.89	130.64	34.1
0.27	1.0115	3.75	130.64	34.1
0.28	1.0120	3.61	130.57	34.0

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1		
Bulk density	[Mg/m^3]	2.00
Dry density	[Mg/m^3]	1.61
Void ratio	[-]	0.642
Distance	[mm]	131.7
Effective radial pressure	[kPa]	250
Effective axial pressure	[kPa]	250

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.5175	5.18	254.51	129.9
0.11	0.5180	4.71	254.26	129.6
0.12	0.5160	4.30	255.25	130.6
0.13	0.5175	3.98	254.51	129.9
0.14	0.5155	3.68	255.50	130.9
0.15	0.5120	3.41	257.24	132.7
0.16	0.5125	3.20	256.99	132.4
0.17	0.5070	2.98	259.78	135.3

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	44BagA	44BagA	44BagA
Depth (m)	36.00	36.00	36.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 22/09/2016
Drawn by: ALB
Template Issue: 2
Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_44BagA_D3.XLS
Date: 03/10/2016
Checked by: PH
Date: 03/10/2016
Approved by: PH

Date: 22/09/2016 Drawn by: ALB Template Issue: 2 Checked by: PH Date: 03/10/2016

Filename: J11335 / EFFECTIV / HKZ1-BH07-SA_44BagA_D3.XLS Approved by: PH Date: 03/10/2016

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	250	500	1000
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	667	1221	2309
Membrane correction applied	(kPa)	0.4	0.6	0.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.34	5.20	7.79
Volumetric strain	(%)	-0.21	0.14	0.38
Major principal effective stress	(kPa)	918	1720	3306
Minor principal effective stress	(kPa)	251	499	997
Principal effective stress ratio		3.65	3.45	3.31
Epsilon 50 (ε 50)	(%)	0.42	0.46	0.58
Secant modulus (E50) at ε 50	(kPa)	78595	132069	198479
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	667	1220	2309
Membrane correction applied	(kPa)	0.4	0.5	0.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.34	4.95	7.79
Volumetric strain	(%)	-0.21	0.14	0.38
Major principal effective stress	(kPa)	918	1719	3306
Minor principal effective stress	(kPa)	251	498	997
Principal effective stress ratio		3.65	3.45	3.31
At 15% axial strain				
Corrected deviator stress	(kPa)	566	1000	2217
Membrane correction applied	(kPa)	1.3	1.3	1.3
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-1.48	0.14	0.18
Major principal effective stress	(kPa)	818	1496	3216
Minor principal effective stress	(kPa)	253	497	998
Principal effective stress ratio		3.24	3.01	3.22

FINAL CONDITIONS				
Water content	(%)	24.2	24.4	23.5
Bulk density	(Mg/m³)	2.00	2.00	2.02
Dry density	(Mg/m³)	1.61	1.61	1.63

Borehole	HKZ1-BH07-SA	HKZ1-BH07-SA	HKZ1-BH07-SA
Sample	44BagA	44BagA	44BagA
Depth (m)	36.00	36.00	36.00

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Drawn by: ALB   Date: 22/09/2016

Template Issue: 4

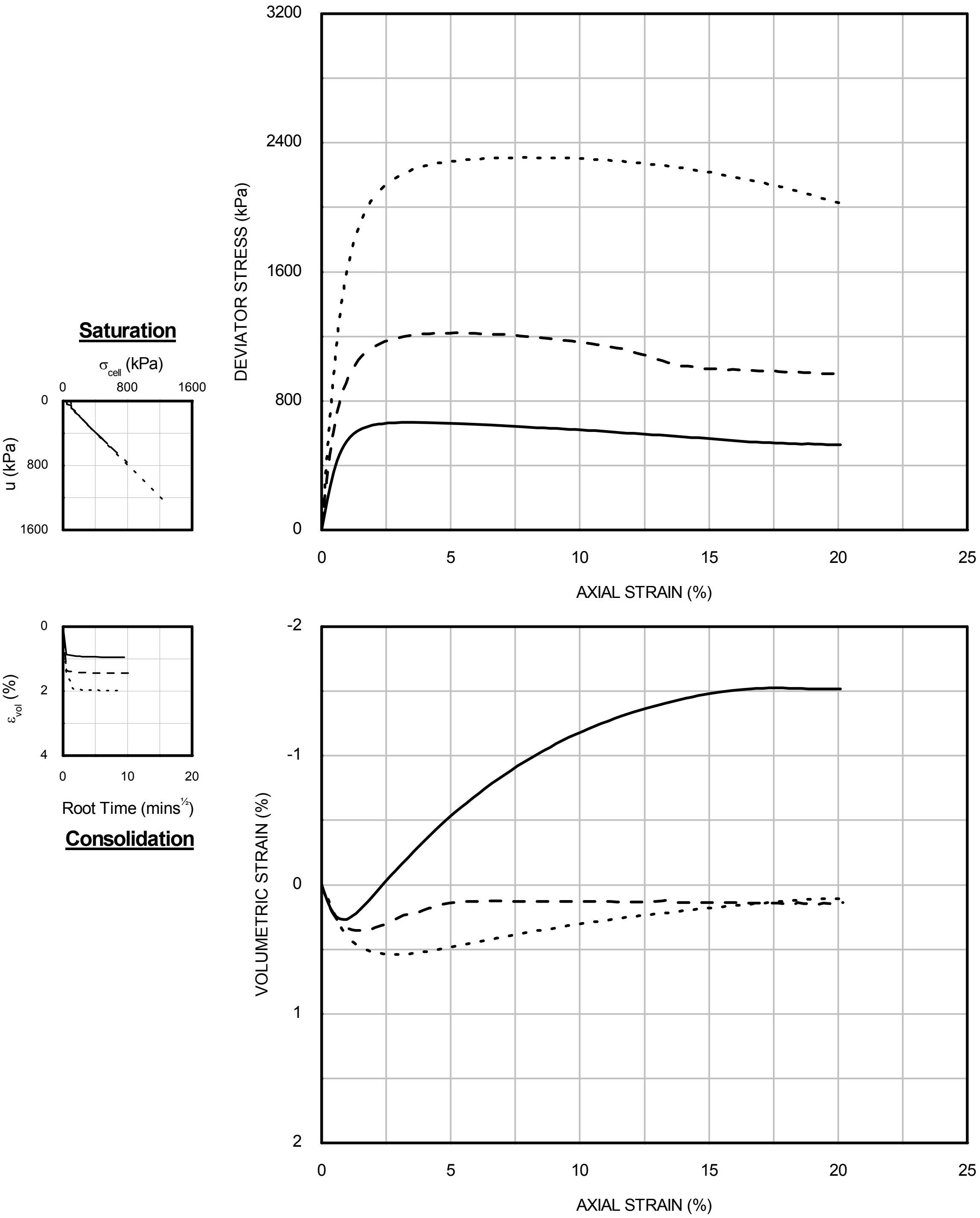
Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_44BagA_D3.OPJ

Date : 03/10/2016

Date : 03/10/2016

Checked by: PH

Approved by: PH



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	250	250	HKZ1-BH07-SA	44BagA	36.00
– –	2	500	500			
· · · ·	3	1000	1000			

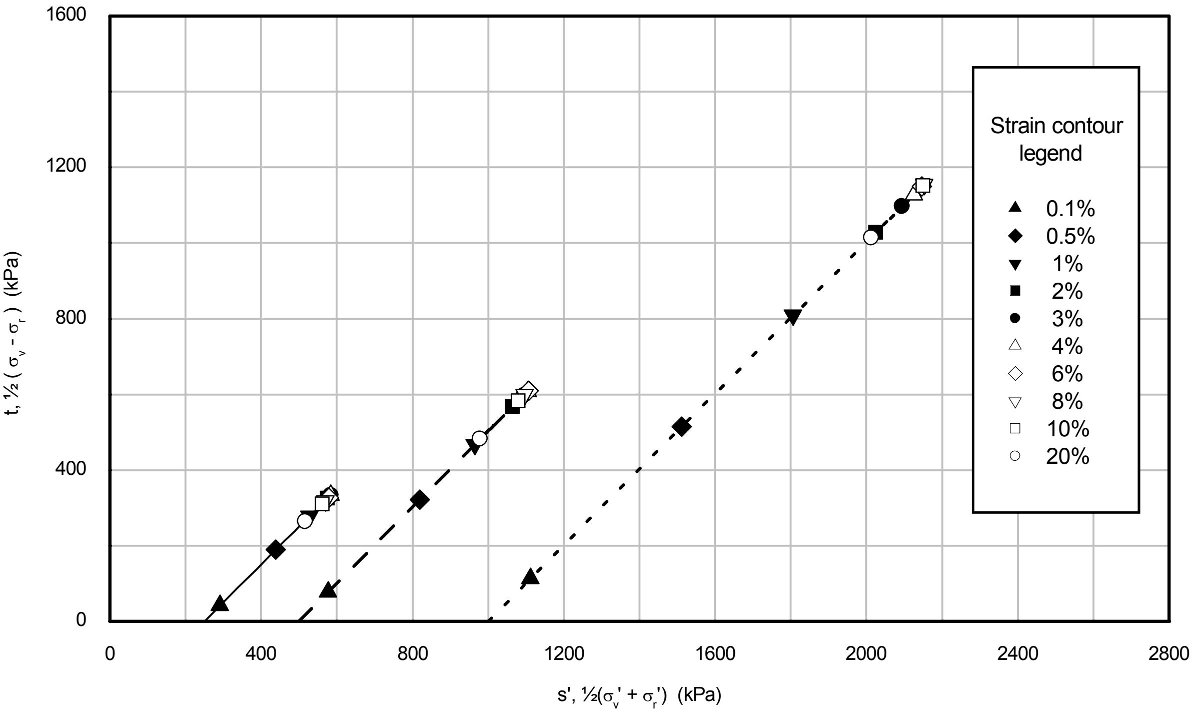
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

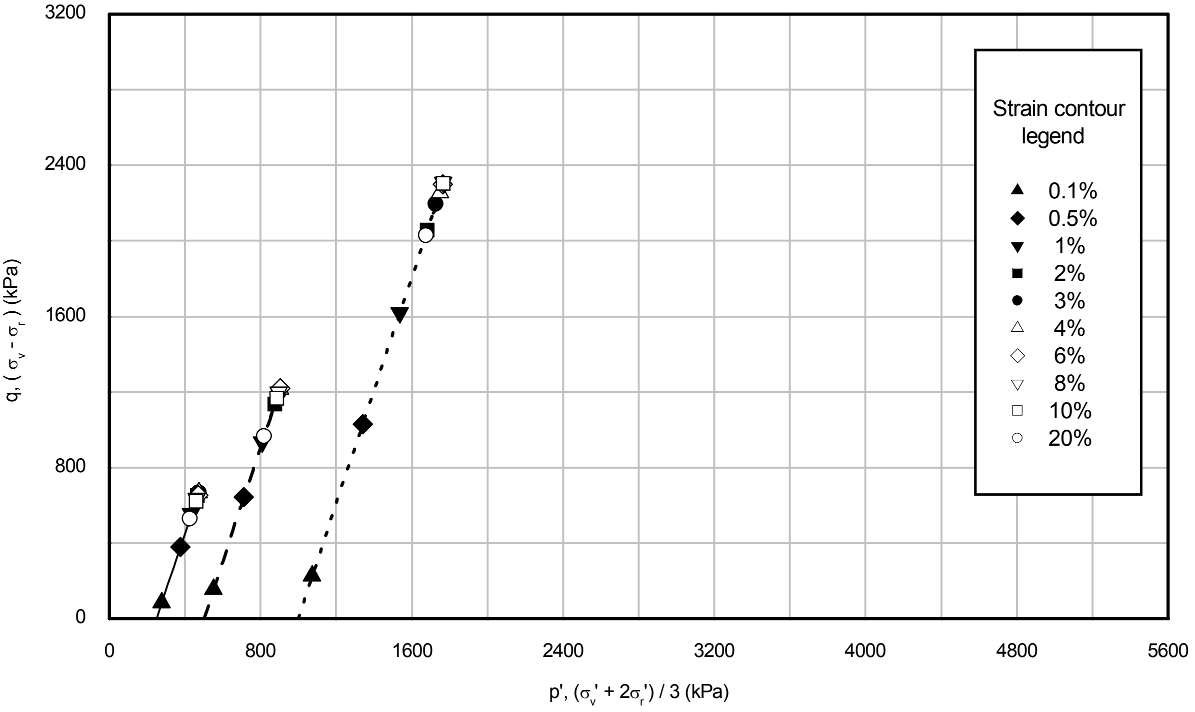
Drawn by: ALB Date: 22/09/2016

Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_44BagA_D3.OPJ

Date : 03/10/2016 Date : 03/10/2016

Checked by: PH Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	250	250	HKZ1-BH07 -SA	44BagA	36.00
– –	2	500	500			
· · · ·	3	1000	1000			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 22/09/2016

Template Issue: 4

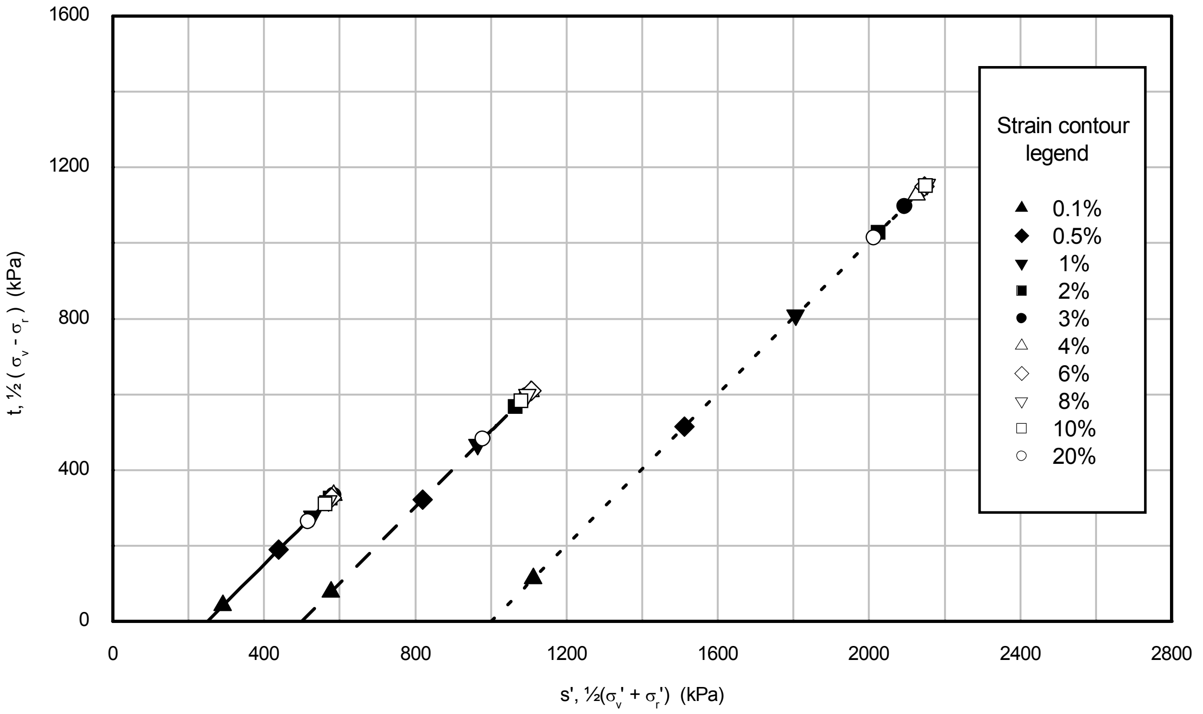
Filename: J11335 \ EFFECTIV \ HKZ1-BH07-SA_44BagA_D3.OPJ

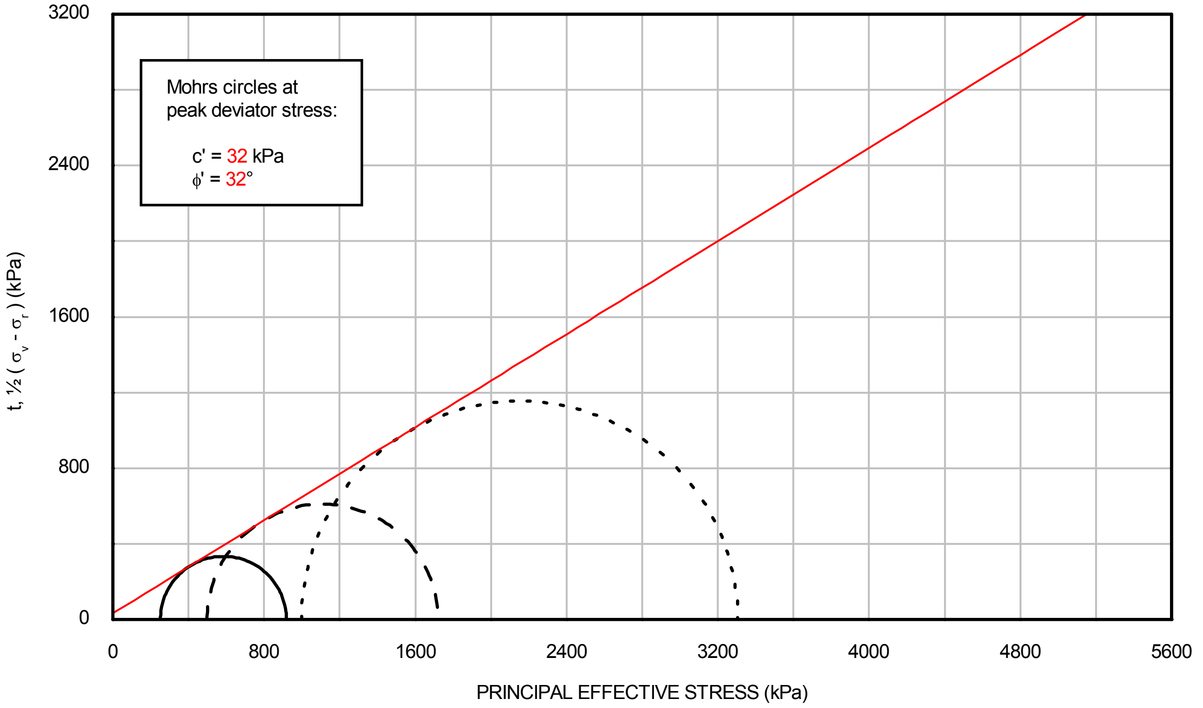
Date : 03/10/2016

Date : 03/10/2016

Checked by: PH

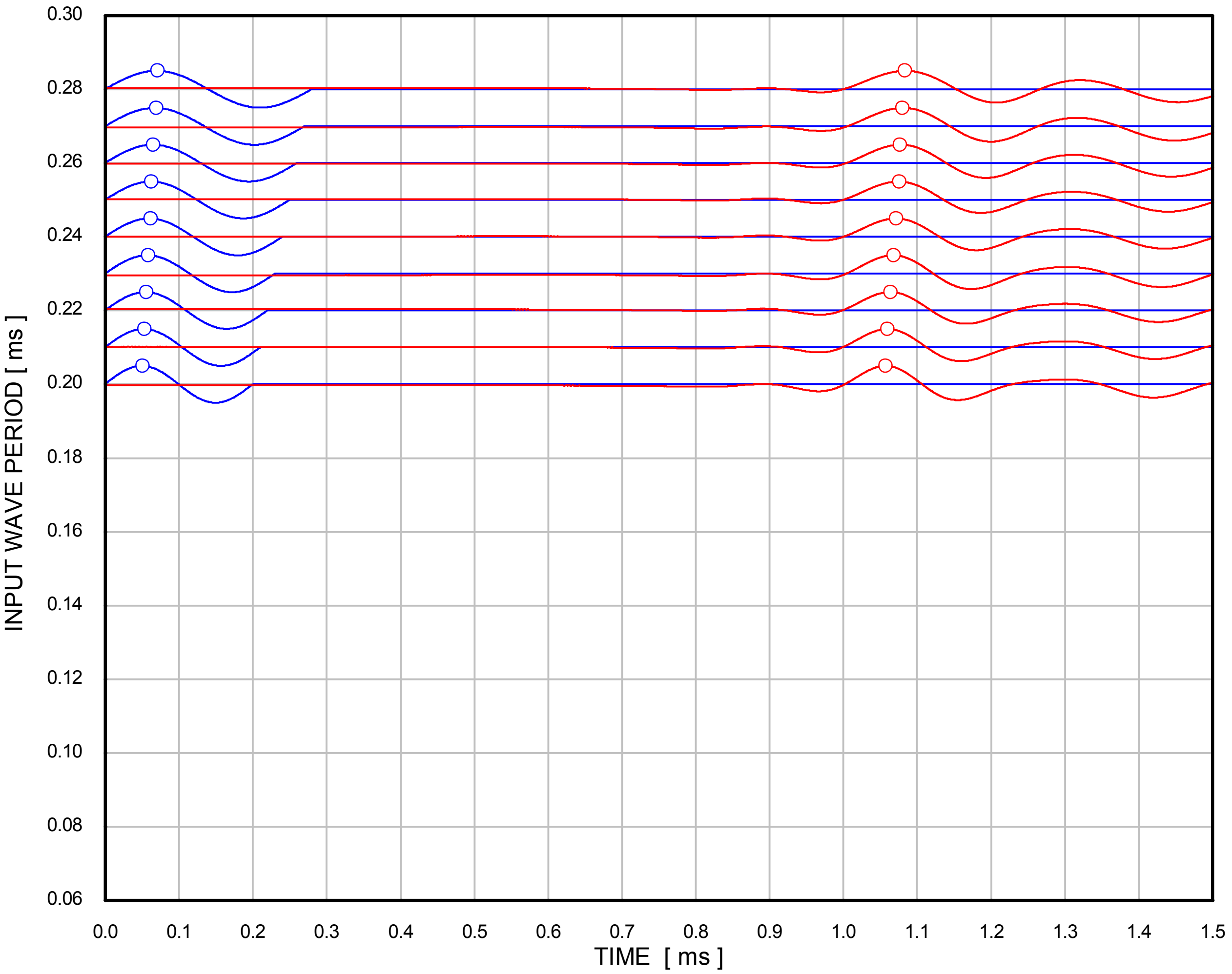
Approved by: PH

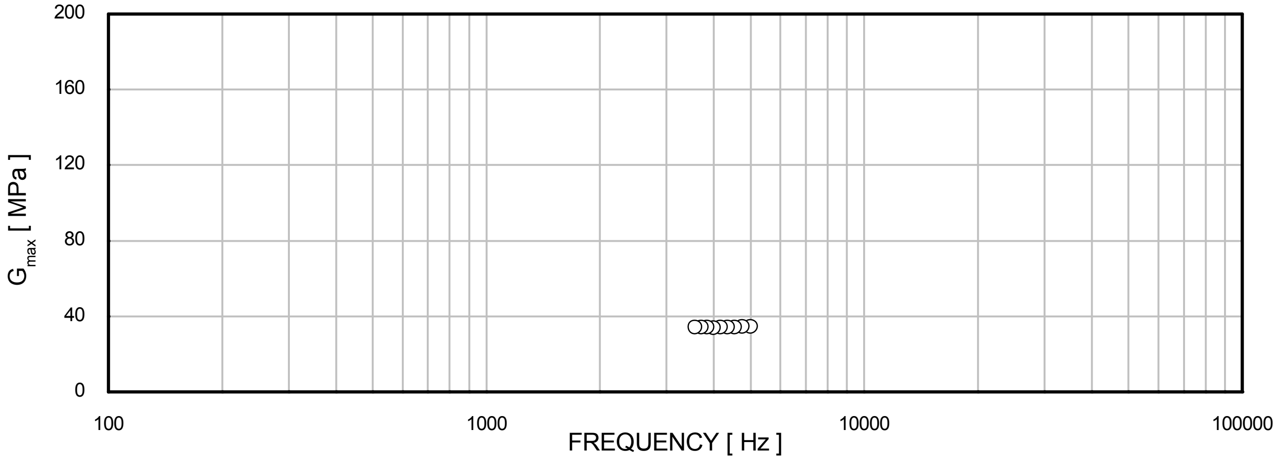




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	250	250	HKZ1-BH07 -SA	44BagA	36.00
— —	2	500	500			
· · · ·	3	1000	1000			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





σ'_{rc} : 22 kPa

σ'_{ac} : 22 kPa

— Source signal

— Received signal

○ / ○ Selected peak values

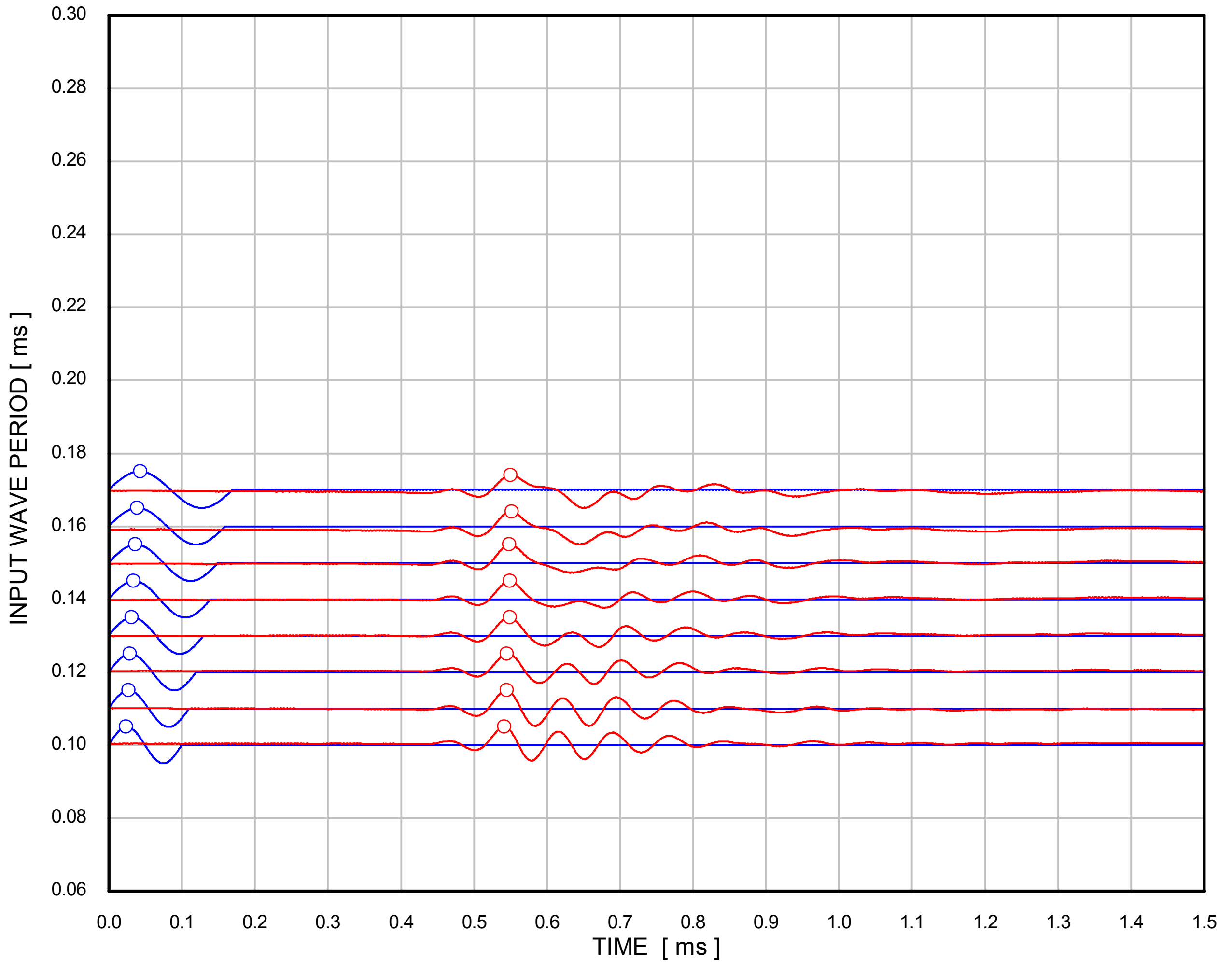
Borehole : HKZ1-BH07-SA

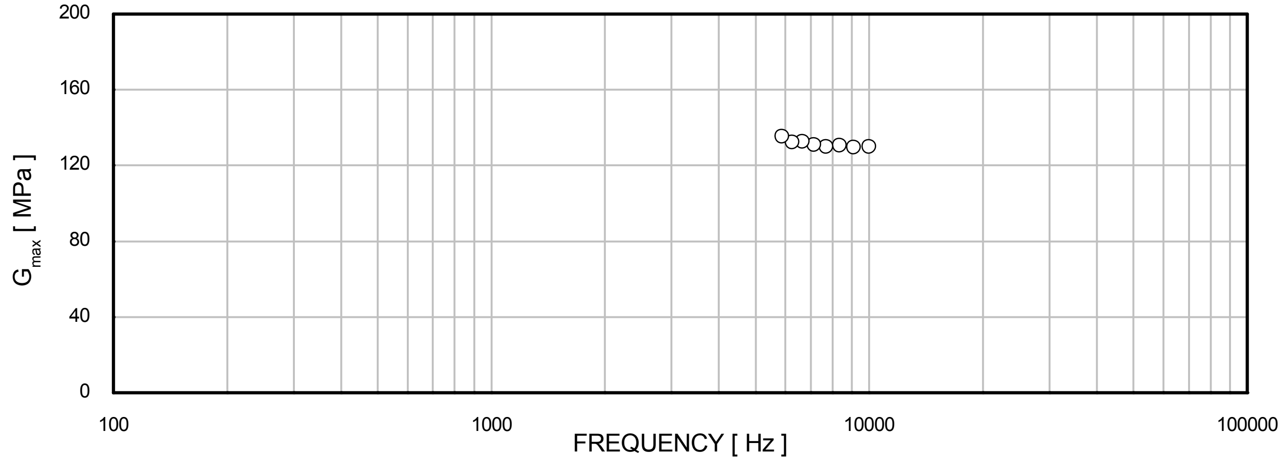
Sample : 44BagA

Depth [m] : 36.00

Test No. : 228A

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 250 kPa	Borehole	: HKZ1-BH07-SA
σ'_{ac}	: 250 kPa	Sample	: 44BagA
─	Source signal	Depth [m]	: 36.00
─	Received signal	Test No.	: 228A
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 16/09/2016
Drawn by: MSR
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_11BagB_D3.XLS
Date: 22/09/2016
Date: 03/10/2016
Checked by: ALB
Approved by: PH

VISUAL DESCRIPTION
Brown fine to medium SAND

GENERAL	Specimen 1	Specimen 2	Specimen 3
Date test started	04/09/2016	02/09/2016	08/09/2016
Type of sample	Recompacted	Recompacted	Recompacted
Specimen orientation	Vertical	Vertical	Vertical
Type of drains fitted	One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	9.7	10.1	10.1
Bulk density	(Mg/m³)	1.81	1.81	1.81
Dry density	(Mg/m³)	1.65	1.64	1.65
Void ratio		0.607	0.611	0.609
Degree of saturation	(%)	43	44	44

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	372	453	616
Cell pressure on completion	(kPa)	385	470	640
B value achieved		0.96	0.96	0.96

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	11BagB	11BagB	11BagB
Depth (m)	9.25	9.25	9.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 16/09/2016
Drawn by: MSR
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_11BagB_D3.XLS
Date: 22/09/2016
Date: 03/10/2016
Checked by: ALB
Approved by: PH

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	385	470	640
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	85	170	340
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	22.5	22.5	22.3
Bulk density	(Mg/m³)	2.03	2.03	2.04
Dry density	(Mg/m³)	1.66	1.66	1.67
Void ratio		0.597	0.597	0.590
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.57	0.90	1.22

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	11BagB	11BagB	11BagB
Depth (m)	9.25	9.25	9.25

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	85	170	340
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	277	519	972
Membrane correction applied	(kPa)	0.5	0.5	0.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.42	3.25	3.28
Volumetric strain	(%)	-0.76	-0.54	-0.44
Major principal effective stress	(kPa)	364	690	1312
Minor principal effective stress	(kPa)	87	171	341
Principal effective stress ratio		4.20	4.04	3.85
Epsilon 50 (ε 50)	(%)	0.62	0.51	0.55
Secant modulus (E50) at ε 50	(kPa)	22450	50430	89016
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	277	519	972
Membrane correction applied	(kPa)	0.5	0.5	0.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	3.17	3.00	3.28
Volumetric strain	(%)	-0.65	-0.44	-0.44
Major principal effective stress	(kPa)	363	690	1312
Minor principal effective stress	(kPa)	86	171	341
Principal effective stress ratio		4.21	4.04	3.85
At 15% axial strain				
Corrected deviator stress	(kPa)	213	398	830
Membrane correction applied	(kPa)	1.9	1.9	1.9
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-2.72	-2.09	-2.42
Major principal effective stress	(kPa)	300	570	1172
Minor principal effective stress	(kPa)	86	172	342
Principal effective stress ratio		3.47	3.32	3.42

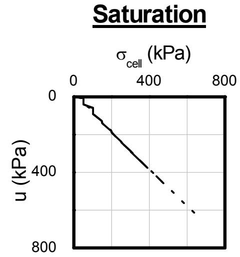
FINAL CONDITIONS				
Water content	(%)	24.2	23.9	24.0
Bulk density	(Mg/m³)	2.00	2.01	2.01
Dry density	(Mg/m³)	1.61	1.62	1.62

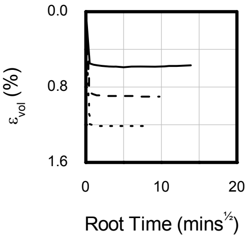
Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	11BagB	11BagB	11BagB
Depth (m)	9.25	9.25	9.25

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

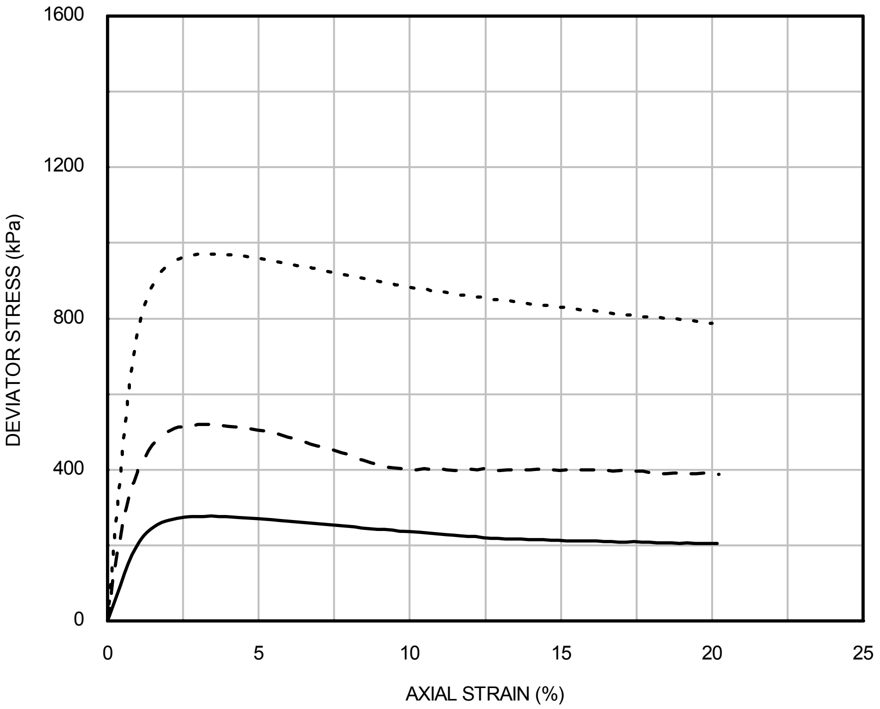
Date: 16/09/2016
Drawn by: MSR
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_11BagB_D3.OPJ
Date : 03/10/2016
Date : 03/10/2016
Checked by: PH
Approved by: PH

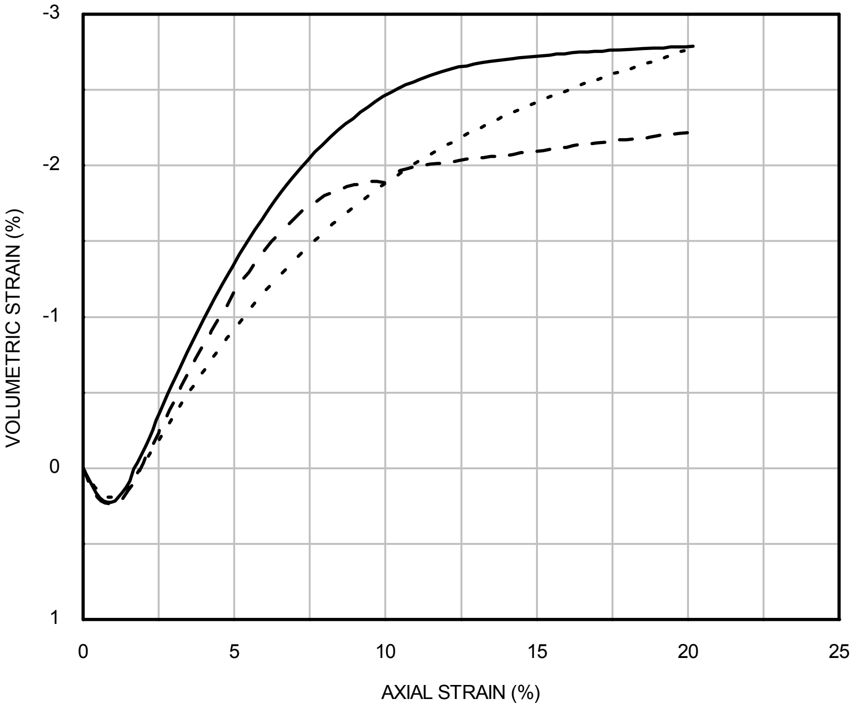
Saturation





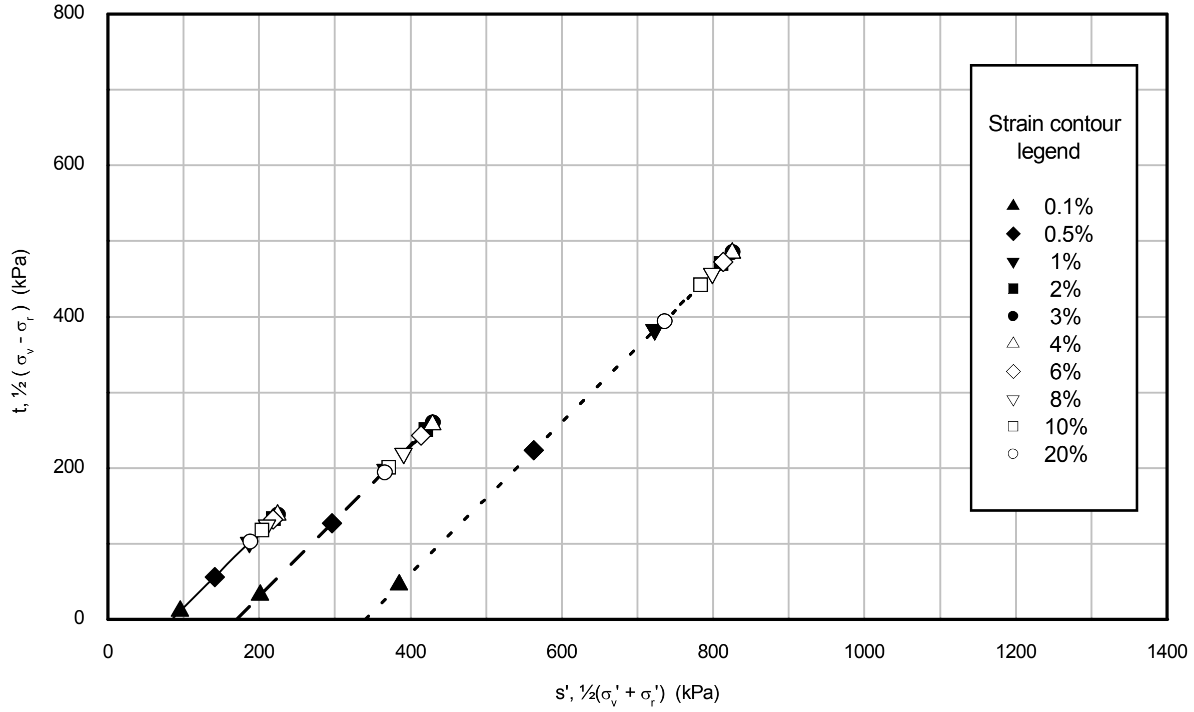
Consolidation

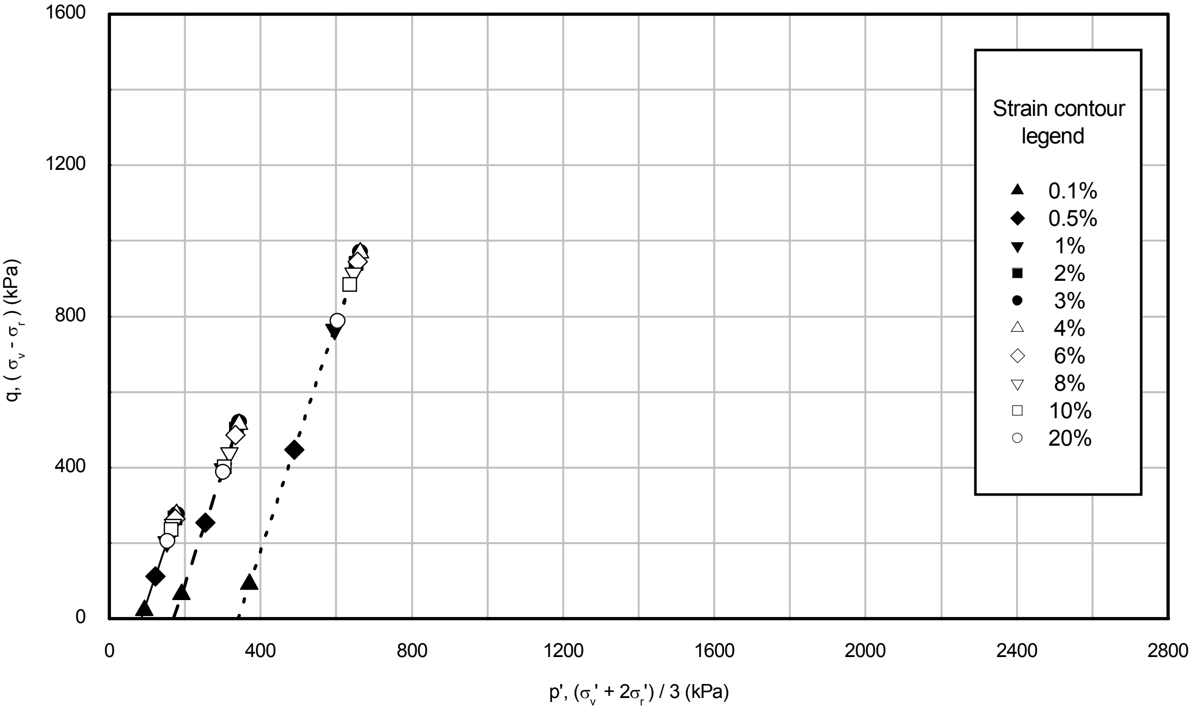




Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	85	85	HKZ1-BH08 -SA	11BagB	9.25
– –	2	170	170			
· · · ·	3	340	340			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	85	85	HKZ1-BH08 -SA	11BagB	9.25
— —	2	170	170			
- - - -	3	340	340			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: MSR Date: 16/09/2016

Template Issue: 4

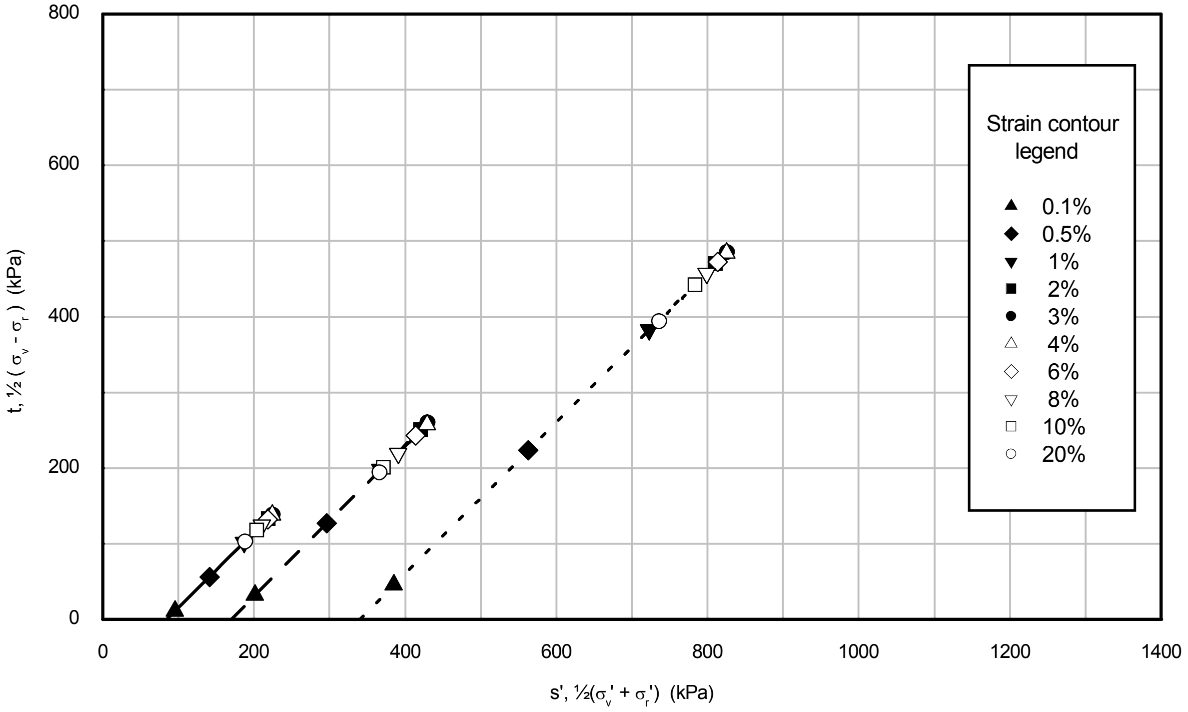
Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_11BagB_D3.OPJ

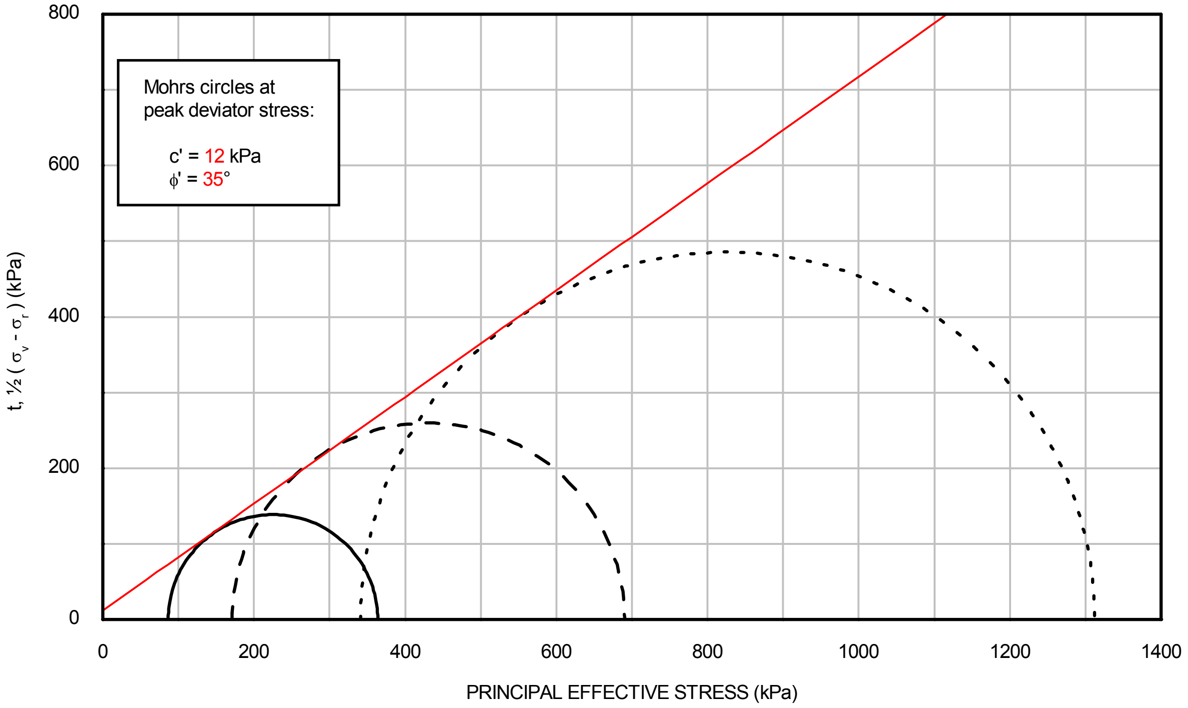
Date : 03/10/2016

Date : 03/10/2016

Checked by: PH

Approved by: PH





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	85	85	HKZ1-BH08 -SA	11BagB	9.25
— —	2	170	170			
· · · ·	3	340	340			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

VISUAL DESCRIPTION
Dark brownish grey fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		01/09/2016	01/09/2016	01/09/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	71.7	71.7	71.7
Length	(mm)	135.0	135.0	135.0
Water content	(%)	11.4	10.3	9.9
Bulk density	(Mg/m³)	1.69	1.69	1.69
Dry density	(Mg/m³)	1.52	1.54	1.54
Void ratio		0.743	0.726	0.720
Degree of saturation	(%)	41	38	37

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	445	604	905
Cell pressure on completion	(kPa)	460	620	940
B value achieved		0.97	0.98	0.96

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic Consolidation - Anisotropic	BS 1377: Part 8: 1990 Clause 6 Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	460	620	940
Back pressure	(kPa)	400	300	300
Effective cell pressure	(kPa)	60	320	640
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	322	100	100
Water content	(%)	27.4	26.6	25.9
Bulk density	(Mg/m³)	1.96	1.97	1.98
Dry density	(Mg/m³)	1.53	1.56	1.57
Void ratio		0.727	0.704	0.687
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	0.94	1.30	1.92

Mode of failure:	Compound failure	Compound failure	Compound failure

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

BENDER ELEMENT DETERMINATIONS - POST SATURATION - SPECIMEN 1		
Bulk density	[Mg/m³]	1.95
Dry density	[Mg/m³]	1.52
Void ratio	[-]	0.743
Distance	[mm]	132.1
Effective radial pressure	[kPa]	15
Effective axial pressure	[kPa]	15

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.20	1.2295	6.15	107.40	22.5
0.22	1.2285	5.58	107.49	22.5
0.24	1.2300	5.13	107.36	22.4
0.26	1.2345	4.75	106.97	22.3
0.28	1.2350	4.41	106.92	22.3
0.30	1.2400	4.13	106.49	22.1
0.32	1.2370	3.87	106.75	22.2
0.34	1.2320	3.62	107.18	22.4
0.36	1.2330	3.43	107.10	22.3
0.38	1.2325	3.24	107.14	22.3

BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC CONSOLIDATION - SPECIMEN 1		
Bulk density	[Mg/m³]	1.96
Dry density	[Mg/m³]	1.53
Void ratio	[-]	0.727
Distance	[mm]	131.6
Effective radial pressure	[kPa]	160
Effective axial pressure	[kPa]	160

Input Wave Period [ms]	Peak-to-Peak Arrival Time [ms]	Wavelength Ratio [-]	Velocity [m/s]	G_{max} [MPa]
0.10	0.6440	6.44	204.39	81.7
0.11	0.6445	5.86	204.23	81.6
0.12	0.6475	5.40	203.28	80.8
0.13	0.6450	4.96	204.07	81.4
0.14	0.6435	4.60	204.55	81.8
0.15	0.6445	4.30	204.23	81.6
0.16	0.6430	4.02	204.70	81.9
0.17	0.6425	3.78	204.86	82.1
0.18	0.6385	3.55	206.15	83.1
0.19	0.6415	3.38	205.18	82.3

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 02/09/2016 Drawn by: ALB Template Issue: 2

Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_23BagA_D3.XLS

Checked by: PH Date: 06/09/2016

Approved by: PH Date: 06/09/2016

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	160	320	640
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	404	790	1445
Membrane correction applied	(kPa)	0.5	0.6	1.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.75	5.73	12.77
Volumetric strain	(%)	0.05	0.27	2.17
Major principal effective stress	(kPa)	563	1110	2082
Minor principal effective stress	(kPa)	159	320	637
Principal effective stress ratio		3.54	3.46	3.27
Epsilon 50 (ε 50)	(%)	0.50	0.55	0.67
Secant modulus (E50) at ε 50	(kPa)	40612	72332	108251
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	404	790	1445
Membrane correction applied	(kPa)	0.5	0.6	1.2
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	4.75	5.48	12.52
Volumetric strain	(%)	0.05	0.28	2.15
Major principal effective stress	(kPa)	563	1110	2081
Minor principal effective stress	(kPa)	159	320	636
Principal effective stress ratio		3.54	3.47	3.27
At 15% axial strain				
Corrected deviator stress	(kPa)	374	668	1441
Membrane correction applied	(kPa)	1.4	1.4	1.4
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-0.45	0.03	2.33
Major principal effective stress	(kPa)	533	988	2077
Minor principal effective stress	(kPa)	160	320	636
Principal effective stress ratio		3.34	3.08	3.26

FINAL CONDITIONS				
Water content	(%)	27.4	26.6	25.9
Bulk density	(Mg/m³)	1.96	1.97	1.98
Dry density	(Mg/m³)	1.53	1.56	1.57

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	23BagA	23BagA	23BagA
Depth (m)	20.50	20.50	20.50

SUMMARY OF ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS WITH BENDER ELEMENT ADDITION

Date: 02/09/2016

Drawn by: ALB

Template Issue: 4

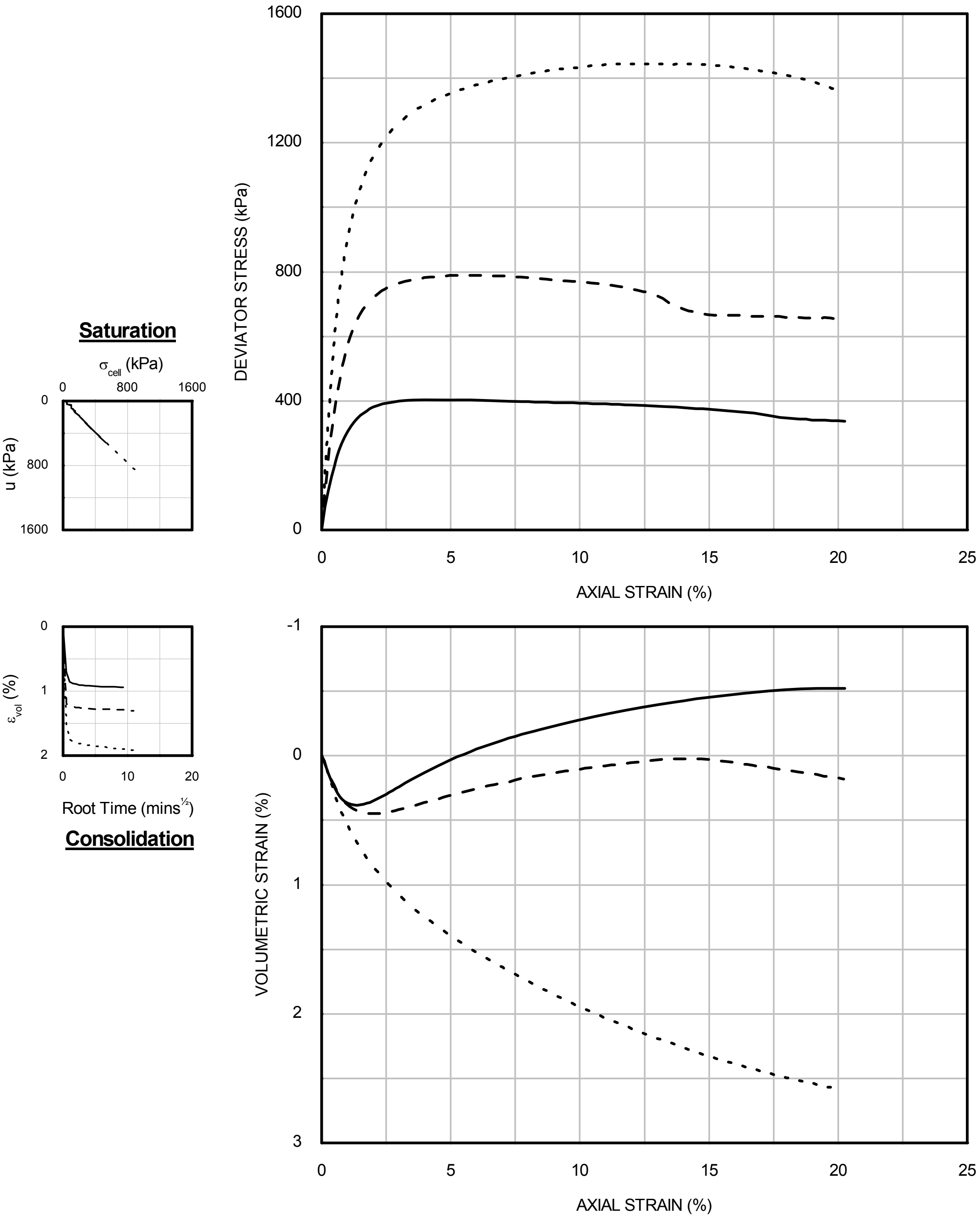
Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_23BagA_D3.OPJ

Date : 06/09/2016

Date : 06/09/2016

Checked by: PH

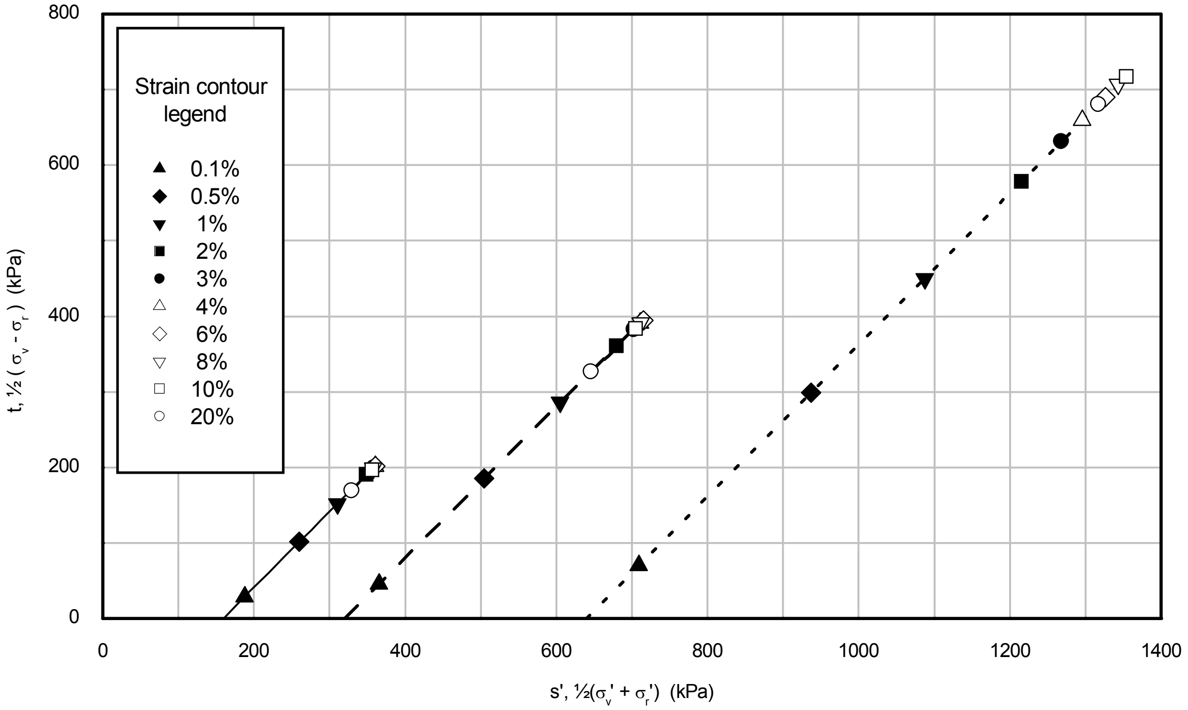
Approved by: PH

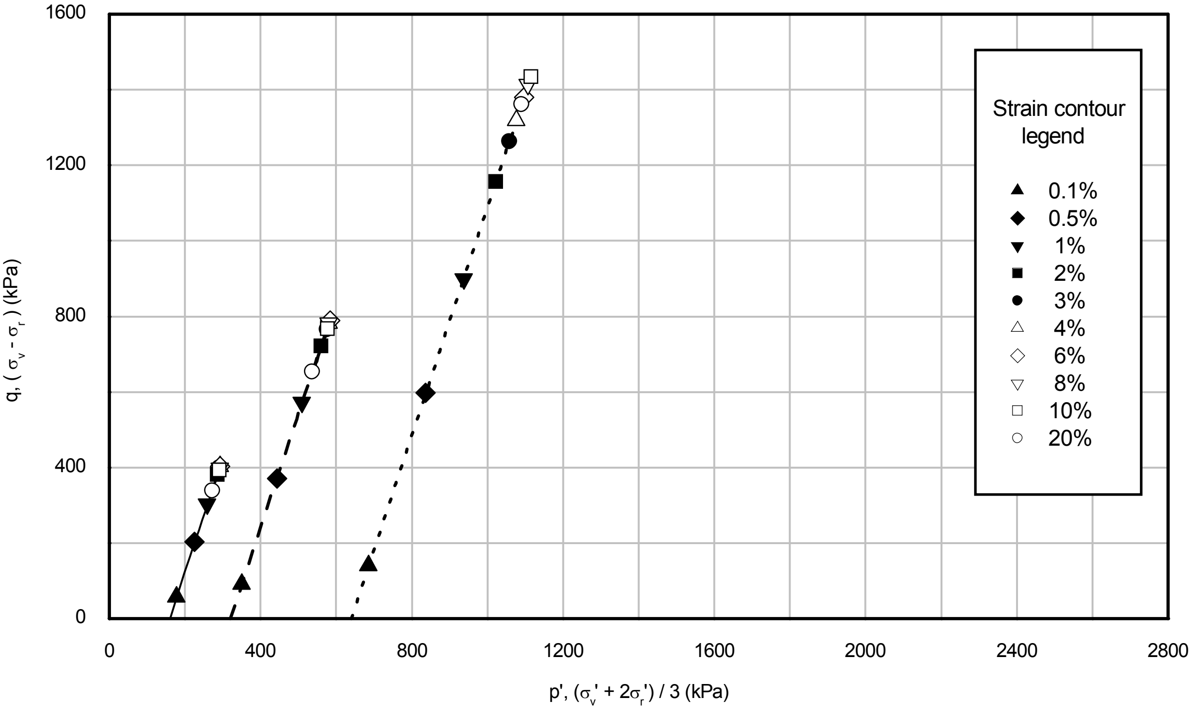


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH08 -SA	23BagA	20.50
— —	2	320	320			
· · · ·	3	640	640			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 02/09/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_23BagA_D3.OPJ
Date : 06/09/2016
Date : 06/09/2016
Checked by: PH
Approved by: PH





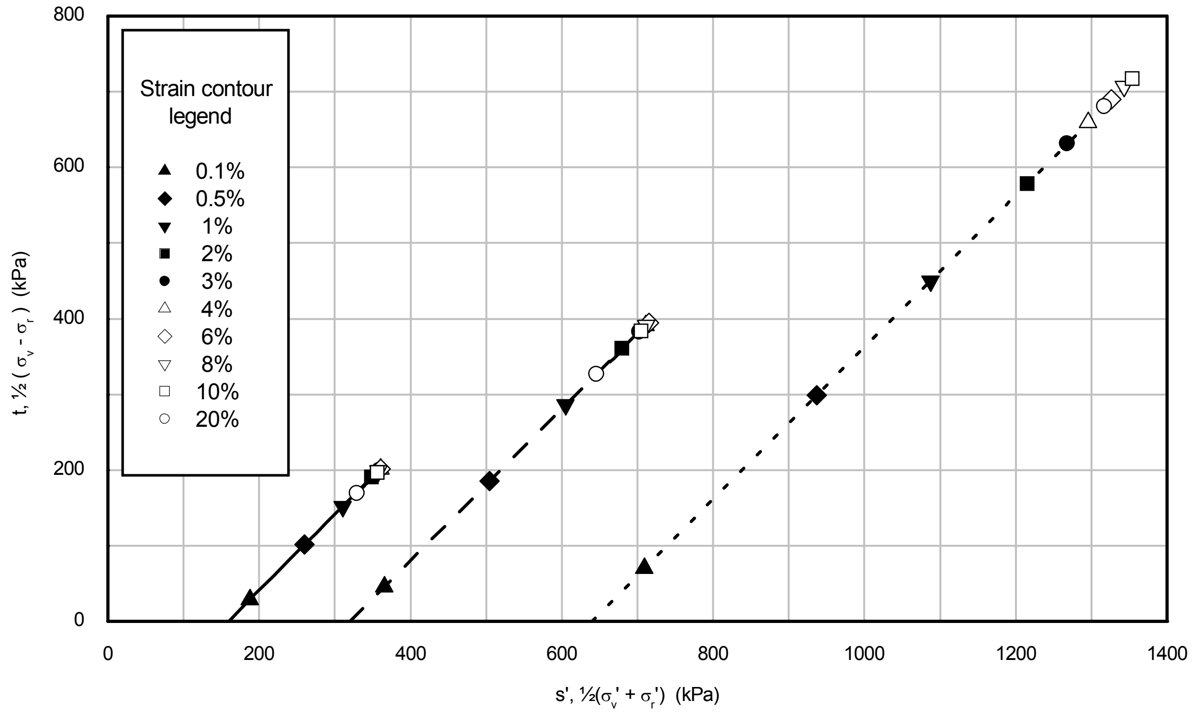
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH08 -SA	23BagA	20.50
— —	2	320	320			
- - - -	3	640	640			

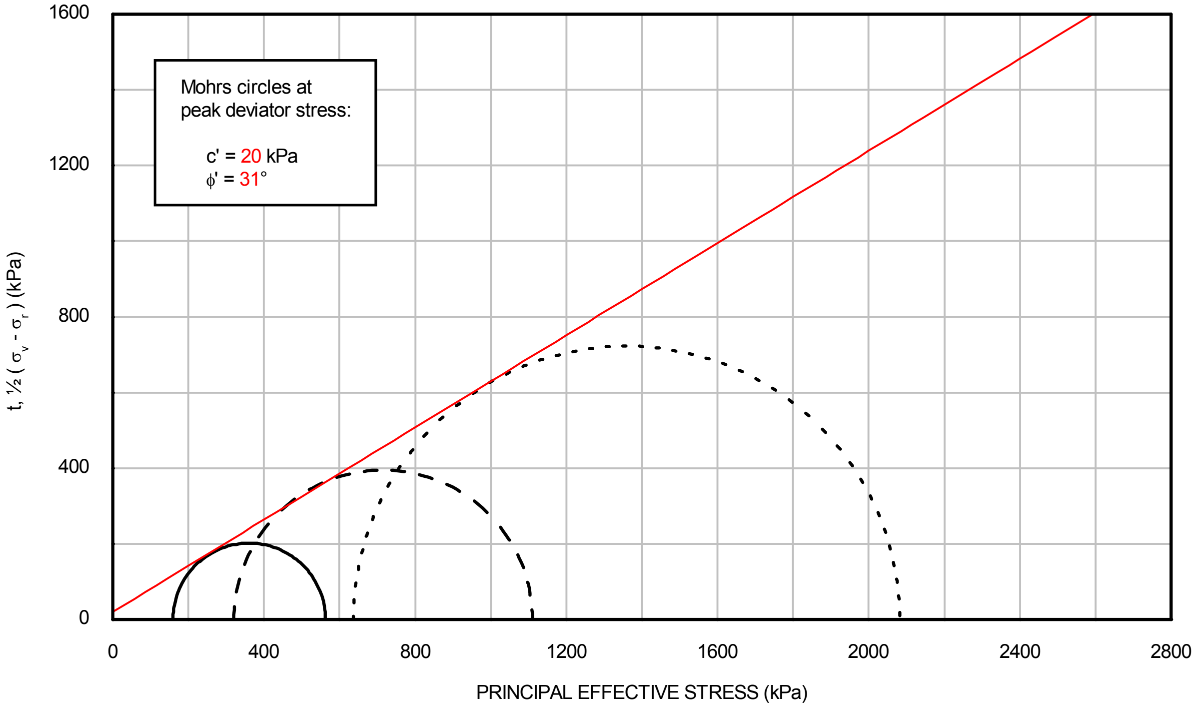
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Drawn by: ALB Date: 02/09/2016

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_23BagA_D3.OPJ



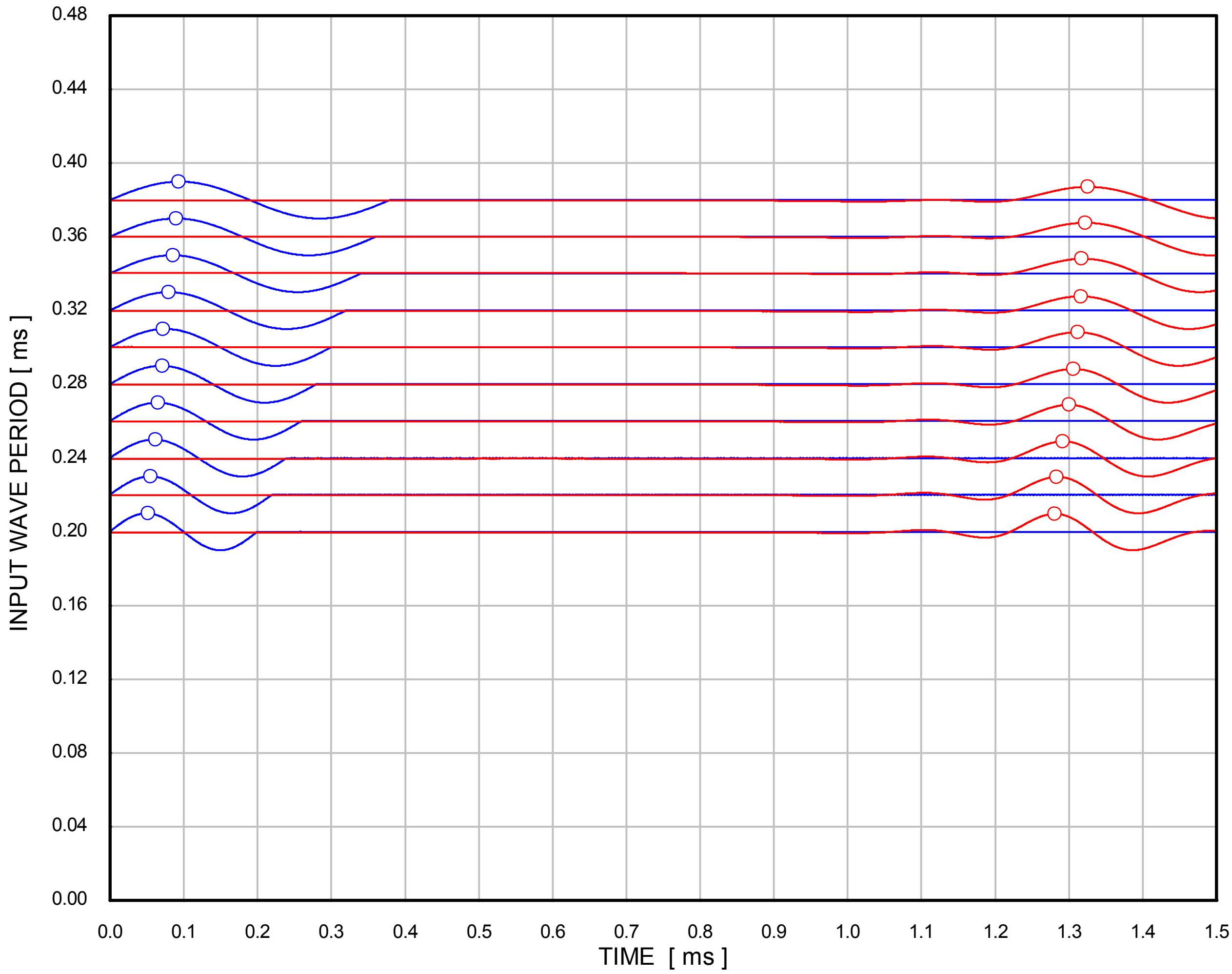


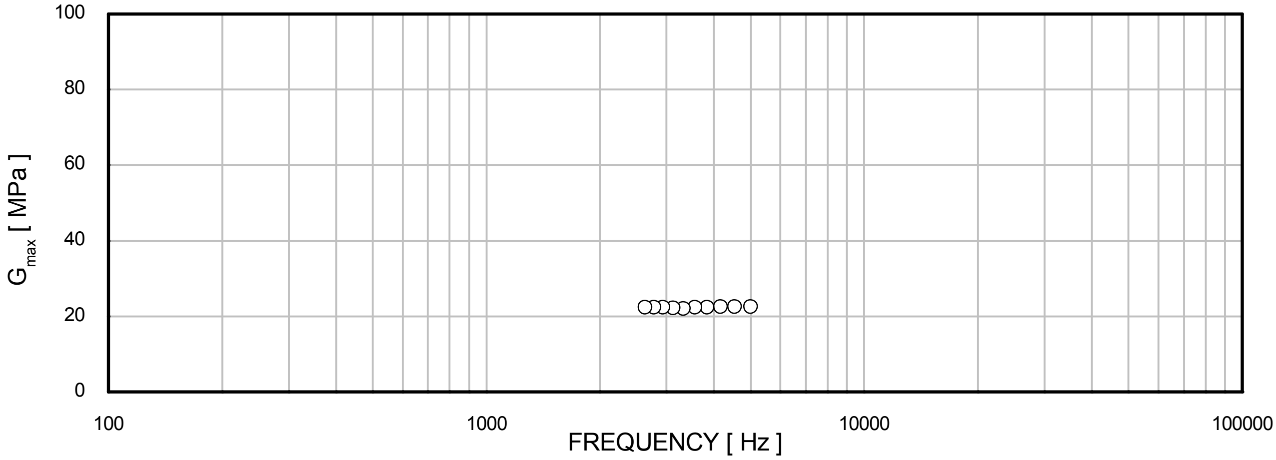
Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	160	160	HKZ1-BH08 -SA	23BagA	20.50
– –	2	320	320			
· · · ·	3	640	640			

Checked by: PH Date : 06/09/2016

Approved by: PH Date : 06/09/2016

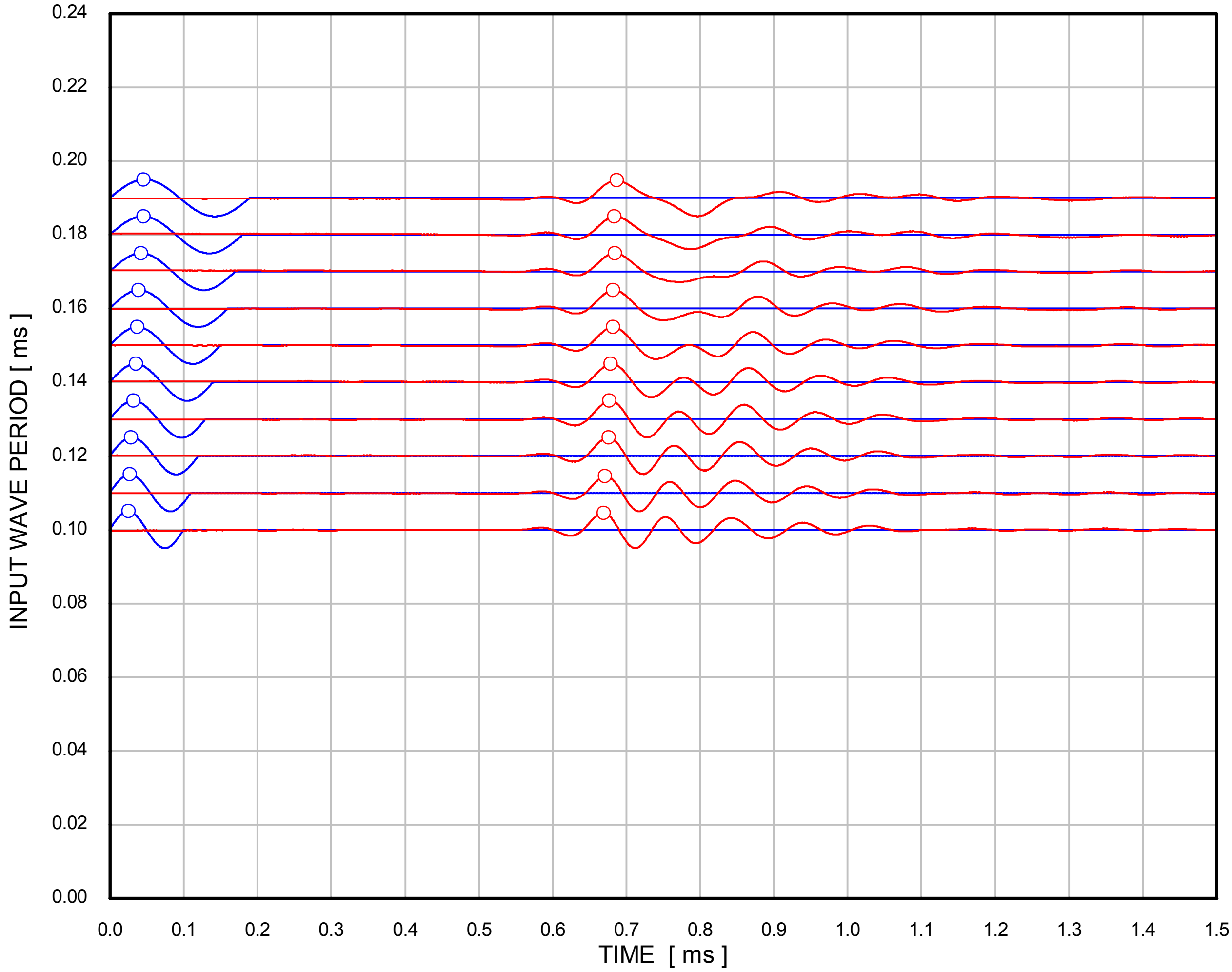
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

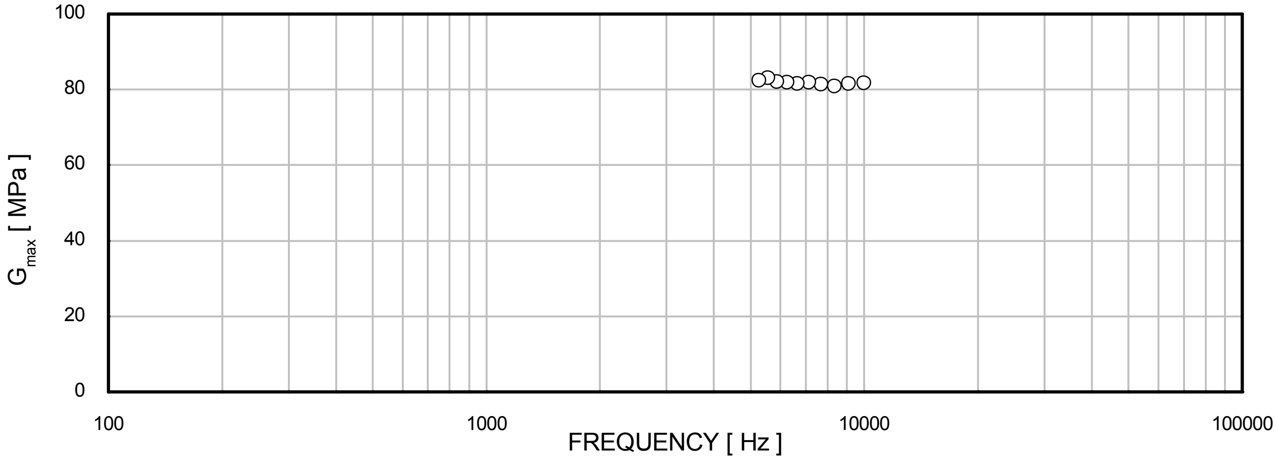




σ'_{rc}	: 15 kPa	Borehole	: HKZ1-BH08-SA
σ'_{ac}	: 15 kPa	Sample	: 23BagA
—	Source signal	Depth [m]	: 20.50
—	Received signal	Test No.	: 230A
○ / ○	Selected peak values		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-SATURATION S_{VH} BENDER ELEMENT DETERMINATIONS





σ'_{rc}	: 160 kPa	Borehole	:	HKZ1-BH08-SA
σ'_{ac}	: 160 kPa	Sample	:	23BagA
—	Source signal	Depth [m]	:	20.50
—	Received signal	Test No.	:	230A
○ / ○	Selected peak values			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
POST-ISOTROPIC CONSOLIDATION S_{VH} BENDER ELEMENT DETERMINATIONS

Date: 26/08/2016 Drawn by: ALB Template Issue: 7 Date: 30/08/2016 Checked by: MSR

Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_38BagA_D3.XLS Date: 05/09/2016 Approved by: PH

VISUAL DESCRIPTION
Dark brown fine to medium SAND

GENERAL		Specimen 1	Specimen 2	Specimen 3
Date test started		24/08/2016	24/08/2016	24/08/2016
Type of sample		Recompacted	Recompacted	Recompacted
Specimen orientation		Vertical	Vertical	Vertical
Type of drains fitted		One end	One end	One end

INITIAL				
Diameter	(mm)	51.5	51.5	51.5
Length	(mm)	90.0	90.0	90.0
Water content	(%)	10.1	10.1	10.1
Bulk density	(Mg/m³)	1.67	1.67	1.67
Dry density	(Mg/m³)	1.52	1.52	1.52
Void ratio		0.740	0.739	0.739
Degree of saturation	(%)	36	36	36

SATURATION				
Pressure increments applied	(kPa)	50	50	50
Differential pressure used	(kPa)	10	10	10
Pore pressure on completion	(kPa)	506	727	1156
Cell pressure on completion	(kPa)	525	750	1200
B value achieved		0.96	0.97	0.96

TESTING PROCEDURES USED	
Specimen Set-up	BS 1377: Part 8: 1990 Clause 4 Fugro testing procedure L-T-023 Clause 5.2.2
Saturation	Fugro testing procedure L-T-023 Clause 5.2.3 BS 1377: Part 8: 1990: Clause 5.3
Consolidation - Isotropic	BS 1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS 1377: Part 8: 1990 Clause 8
Note: Fugro testing procedures are available on request	

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	38BagA	38BagA	38BagA
Depth (m)	35.00	35.00	35.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

CONSOLIDATION : ISOTROPIC		Specimen 1	Specimen 2	Specimen 3
Cell pressure	(kPa)	525	750	1200
Back pressure	(kPa)	300	300	300
Effective cell pressure	(kPa)	225	450	900
Pore pressure on completion	(kPa)	300	300	300
Pore pressure dissipation	(%)	100	100	100
Water content	(%)	27.2	26.9	26.4
Bulk density	(Mg/m³)	1.95	1.96	1.97
Dry density	(Mg/m³)	1.54	1.54	1.55
Void ratio		0.719	0.710	0.698
Degree of saturation	(%)	100	100	100
Volumetric strain	(%)	1.19	1.71	2.37

Mode of failure:	Compound failure	Compound failure	Compound failure

	Specimen 1	Specimen 2	Specimen 3
Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	38BagA	38BagA	38BagA
Depth (m)	35.00	35.00	35.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

SHEARING		Specimen 1	Specimen 2	Specimen 3
Initial pore pressure	(kPa)	300	300	300
Initial effective cell pressure	(kPa)	225	450	900
Rate of strain	(%/hour)	1.33	1.33	1.33
At peak deviator stress				
Corrected deviator stress	(kPa)	542	1089	2003
Membrane correction applied	(kPa)	0.7	1.3	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	5.00	9.25	11.57
Volumetric strain	(%)	0.00	-0.07	1.03
Major principal effective stress	(kPa)	768	1540	2903
Minor principal effective stress	(kPa)	226	451	900
Principal effective stress ratio		3.40	3.42	3.23
Epsilon 50 (ε 50)	(%)	0.28	0.75	0.79
Secant modulus (E50) at ε 50	(kPa)	97717	72187	126732
At peak principal effective stress ratio				
Corrected deviator stress	(kPa)	542	1089	2002
Membrane correction applied	(kPa)	0.7	1.2	1.5
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	5.00	8.75	11.82
Volumetric strain	(%)	0.00	-0.02	1.02
Major principal effective stress	(kPa)	768	1540	2902
Minor principal effective stress	(kPa)	226	451	899
Principal effective stress ratio		3.40	3.42	3.23
At 15% axial strain				
Corrected deviator stress	(kPa)	476	1030	1981
Membrane correction applied	(kPa)	1.8	1.8	1.8
Drain correction applied	(kPa)	0	0	0
Axial strain	(%)	15.00	15.00	15.00
Volumetric strain	(%)	-0.69	-0.57	0.95
Major principal effective stress	(kPa)	702	1482	2881
Minor principal effective stress	(kPa)	226	452	900
Principal effective stress ratio		3.10	3.28	3.20

FINAL CONDITIONS				
Water content	(%)	27.7	27.4	25.9
Bulk density	(Mg/m^3)	1.95	1.95	1.97
Dry density	(Mg/m^3)	1.52	1.53	1.57

Borehole	HKZ1-BH08-SA	HKZ1-BH08-SA	HKZ1-BH08-SA
Sample	38BagA	38BagA	38BagA
Depth (m)	35.00	35.00	35.00

SUMMARY OF
ISOTROPICALLY CONSOLIDATED DRAINED
TRIAXIAL COMPRESSION TEST : SET OF THREE SPECIMENS

Date: 26/08/2016
Drawn by: ALB
Template Issue: 7
Filename: J11335 / EFFECTIV / HKZ1-BH08-SA_38BagA_D3.XLS
Date: 30/08/2016
Date: 05/09/2016
Checked by: MSR
Approved by: PH

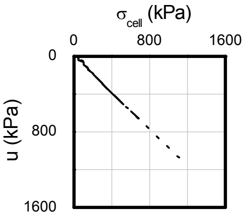
Drawn by: ALB Date: 26/08/2016

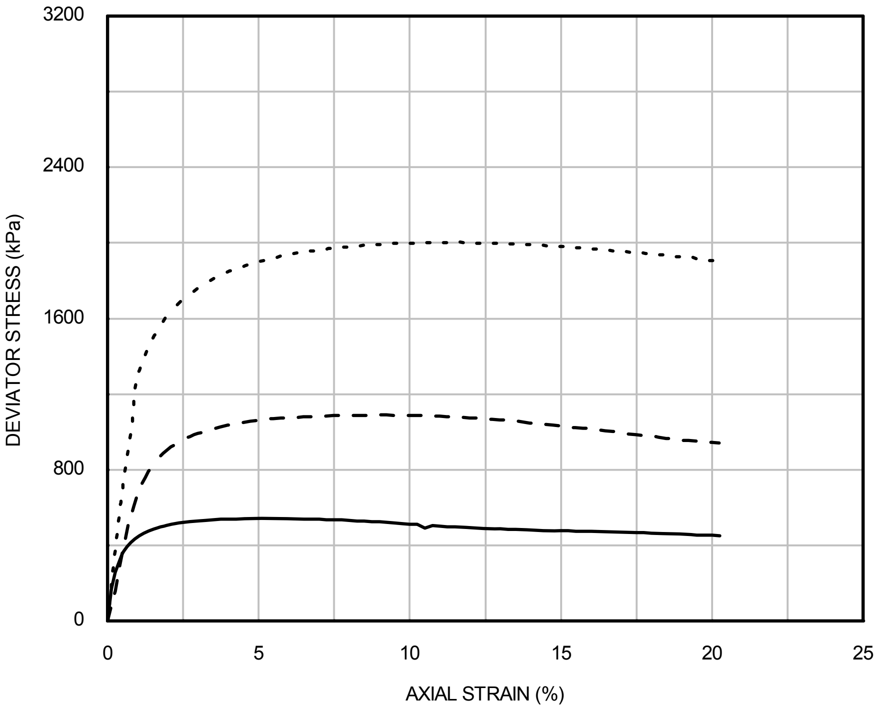
Template Issue: 4 Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_38BagA_D3.OPJ

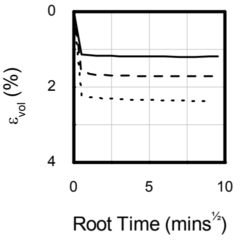
Date : 30/08/2016 Date : 05/09/2016

Checked by: MSR Approved by: PH

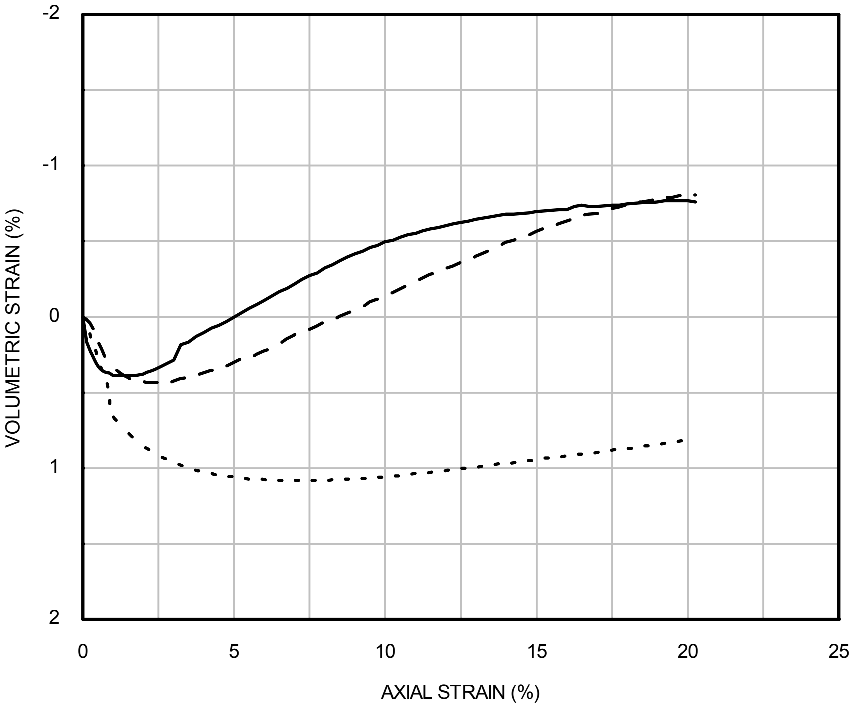
Saturation







Consolidation



Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
———	1	225	225	HKZ1-BH08 -SA	38BagA	35.00
— —	2	450	450			
· · · ·	3	900	900			

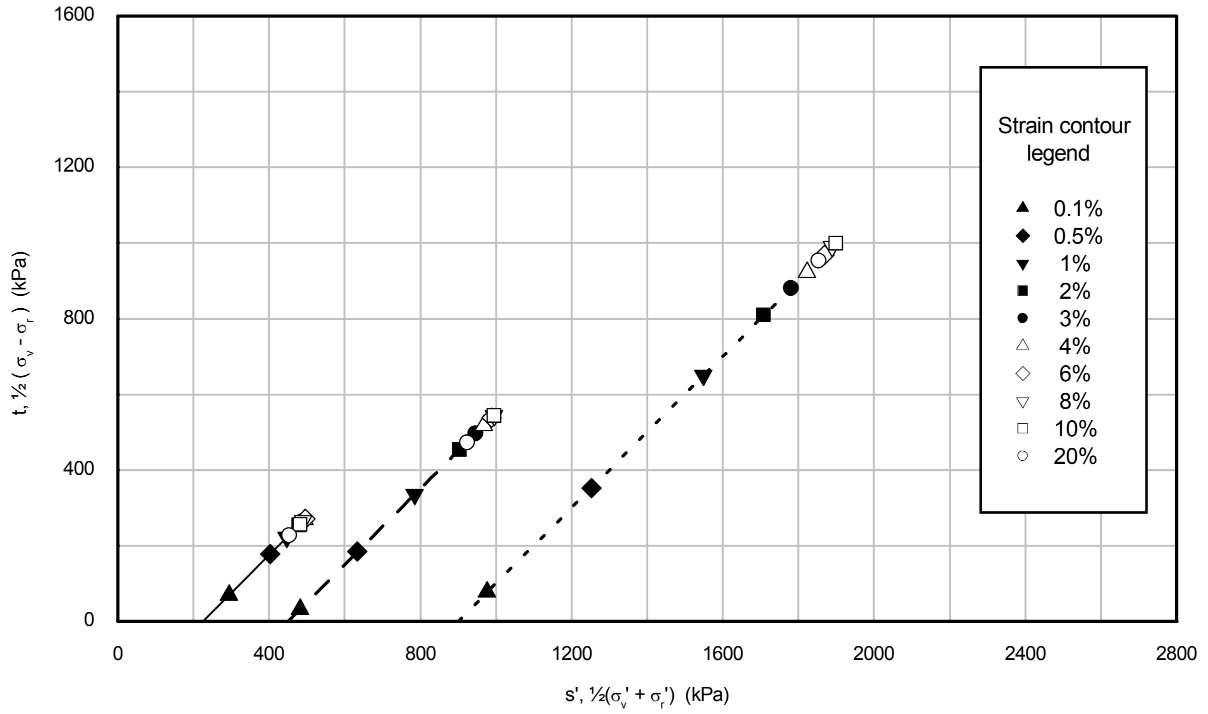
ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

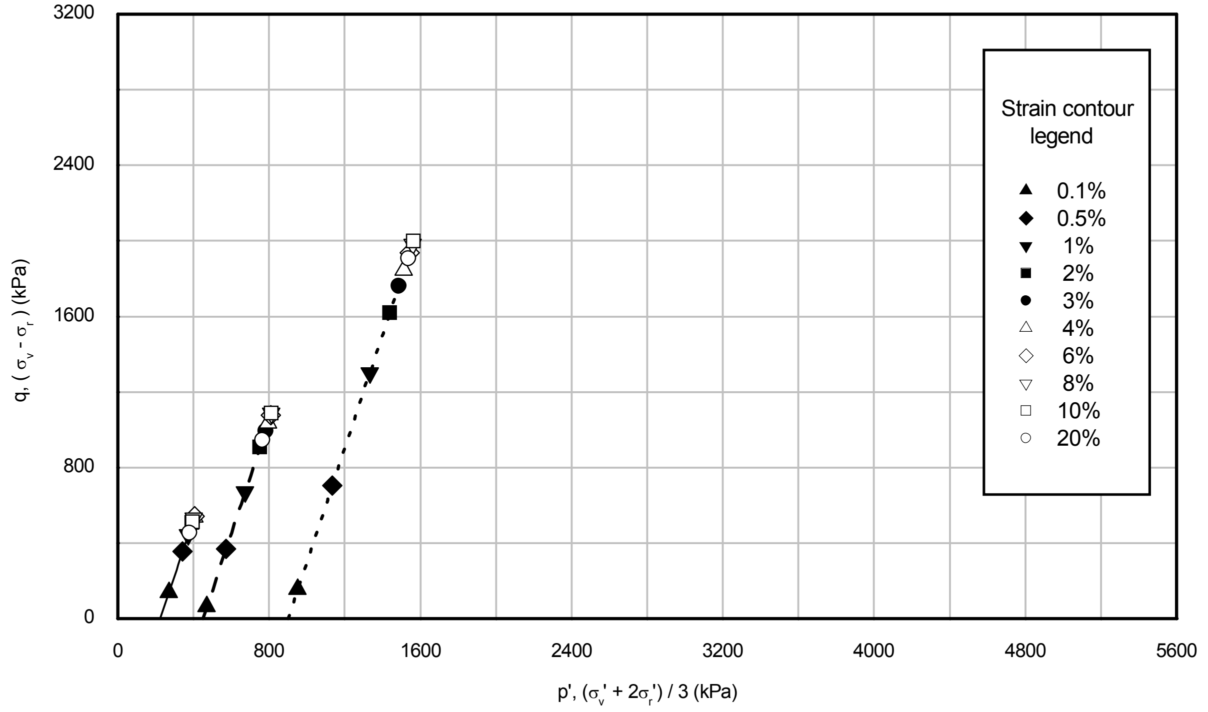
Date: 26/08/2016

Drawn by: ALB

Template Issue: 4

Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_38BagA_D3.OPJ





Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	225	225	HKZ1-BH08 -SA	38BagA	35.00
– –	2	450	450			
- - - -	3	900	900			

Date : 30/08/2016

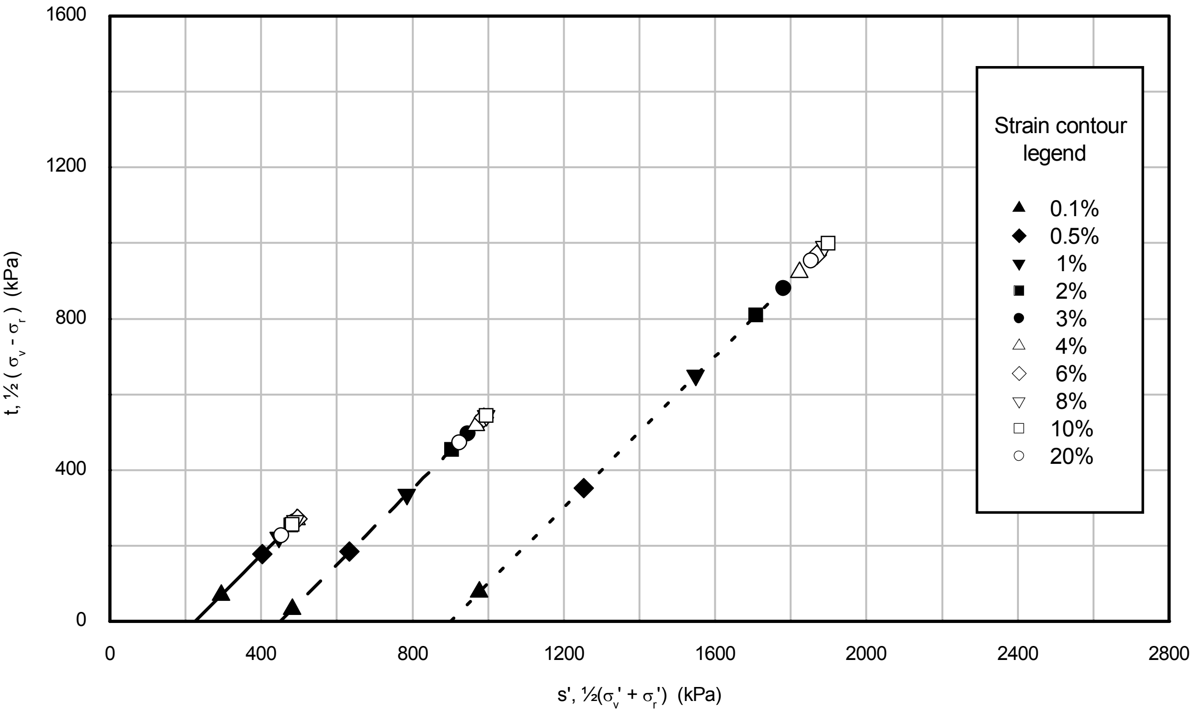
Date : 05/09/2016

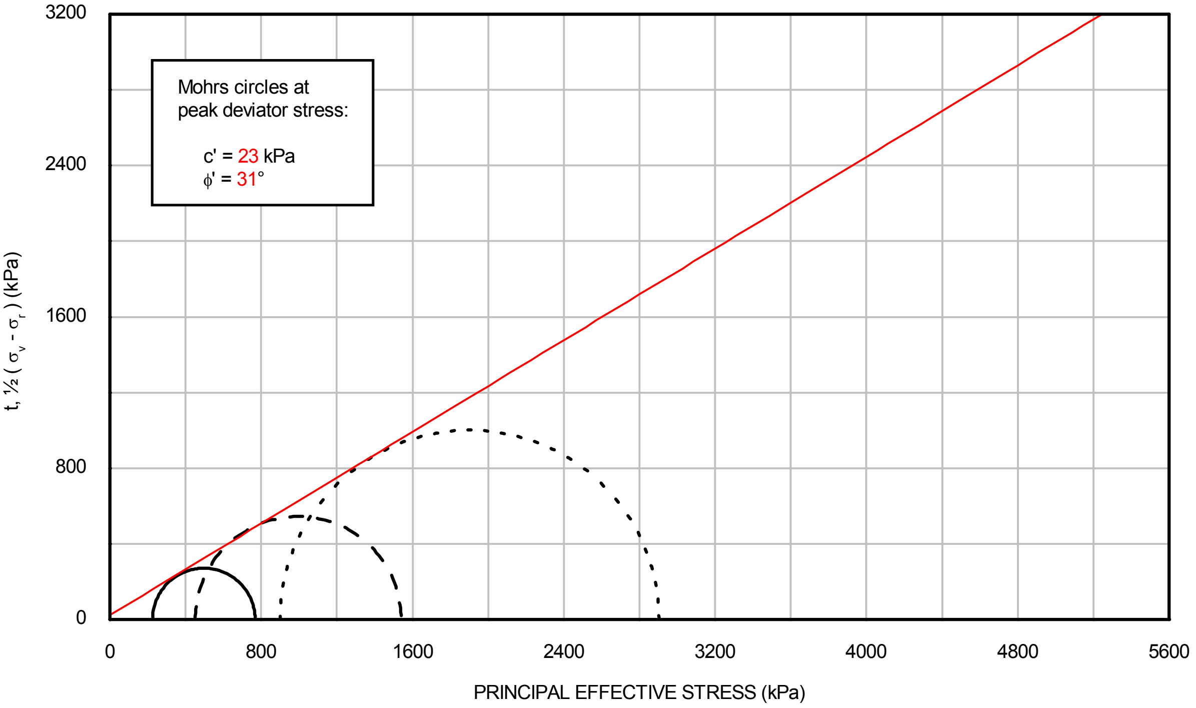
Checked by: MSR

Approved by: PH

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

Date: 26/08/2016
Drawn by: ALB
Template Issue: 4
Filename: J11335 \ EFFECTIV \ HKZ1-BH08-SA_38BagA_D3.OPJ
Date : 30/08/2016
Date : 05/09/2016
Checked by: MSR
Approved by: PH



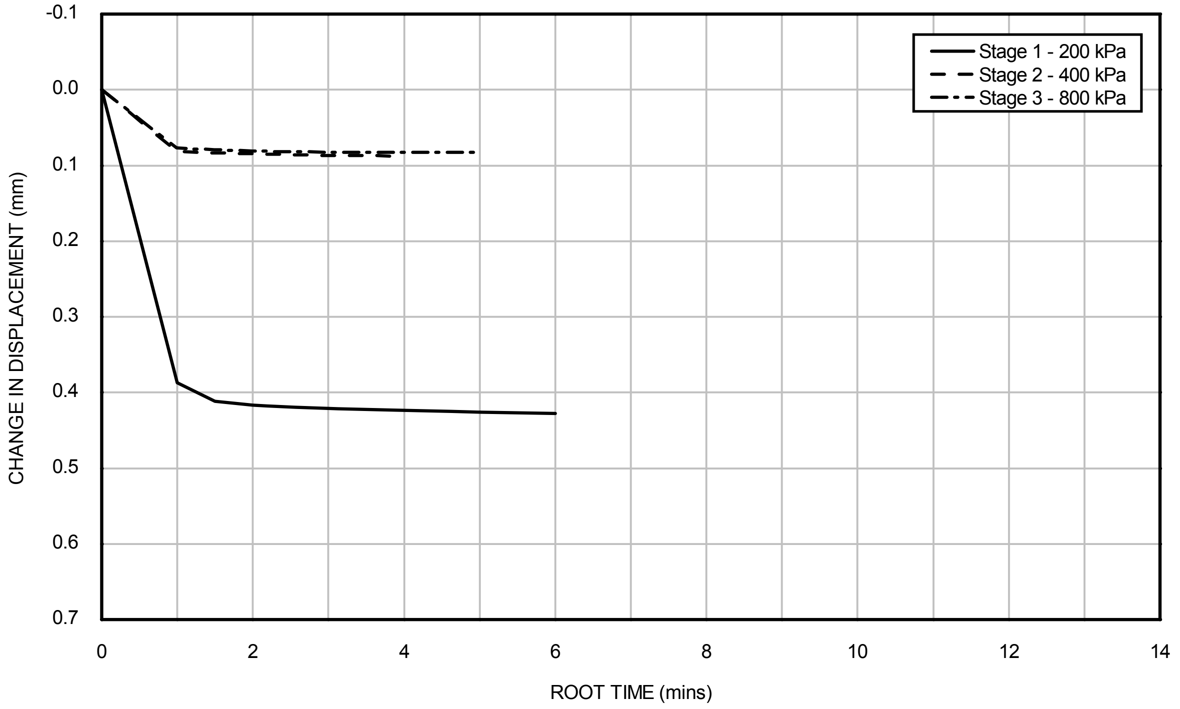


Curve	Specimen(3)	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	225	225	HKZ1-BH08 -SA	38BagA	35.00
– –	2	450	450			
· · · ·	3	900	900			

ISOTROPICALLY CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST: SET OF THREE SPECIMENS

SECTION C5: RING SHEAR TESTS

LIST OF PLATES IN SECTION C5:



INITIAL CONDITIONS

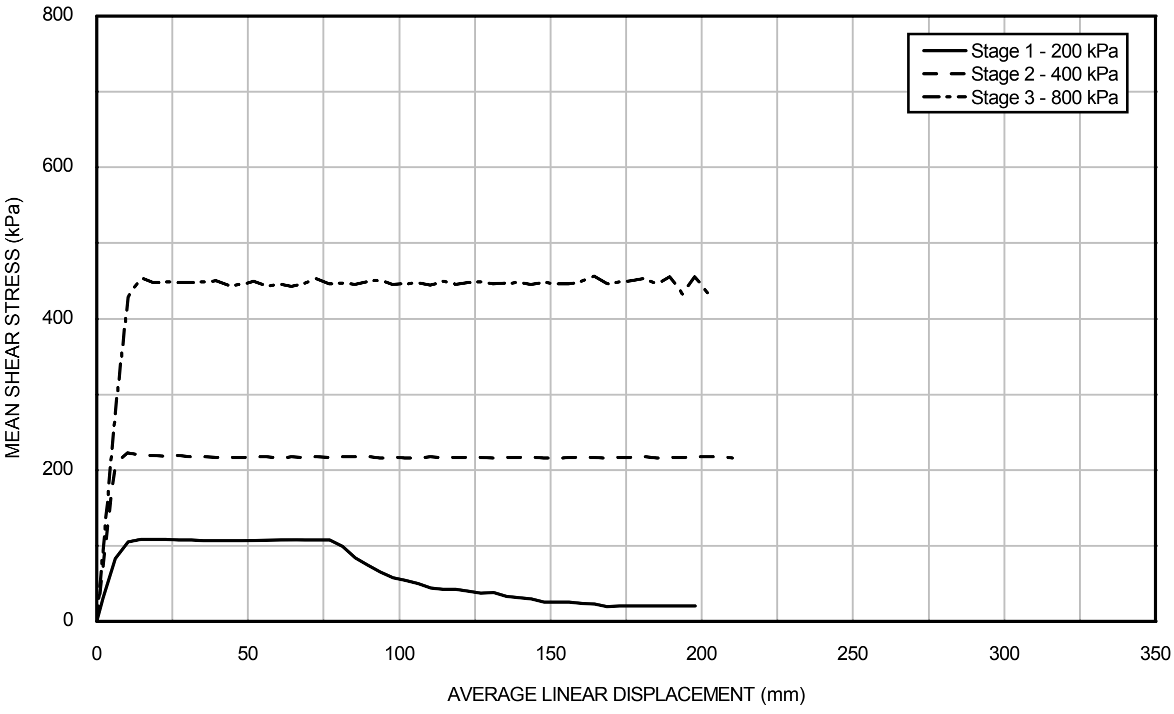
Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	8 %

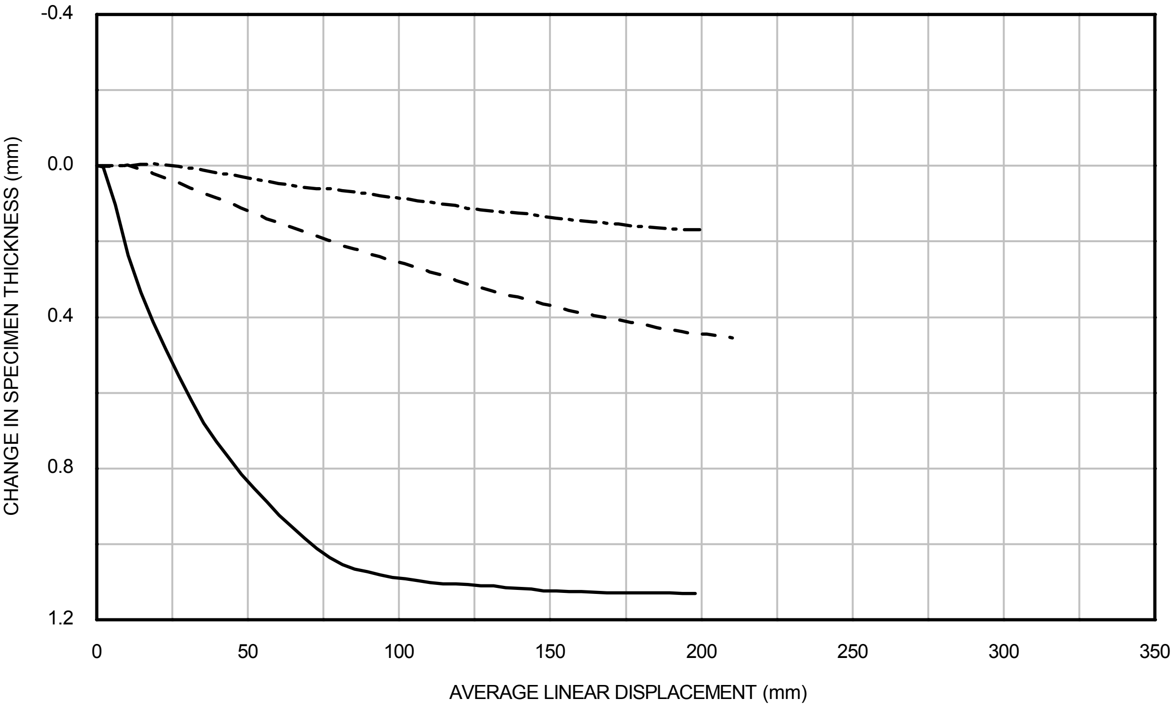
BOREHOLE : HKZ1-BH01-SA
SAMPLE : 46BagA
DEPTH (m) : 43.00

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE



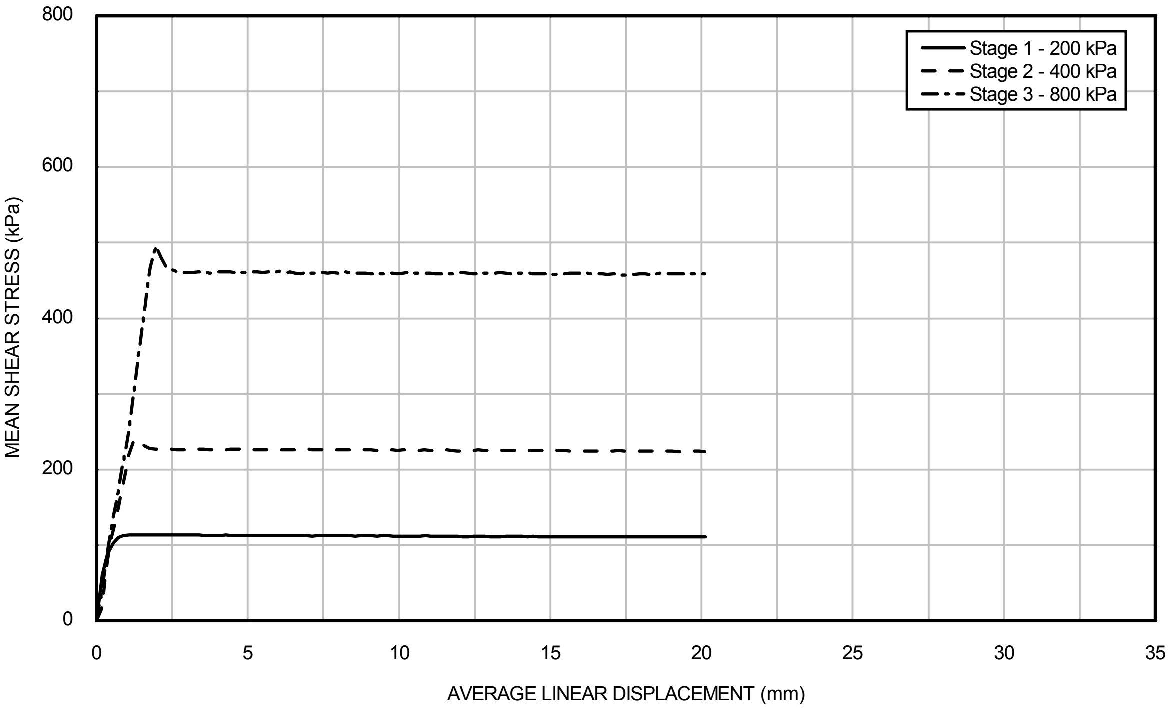


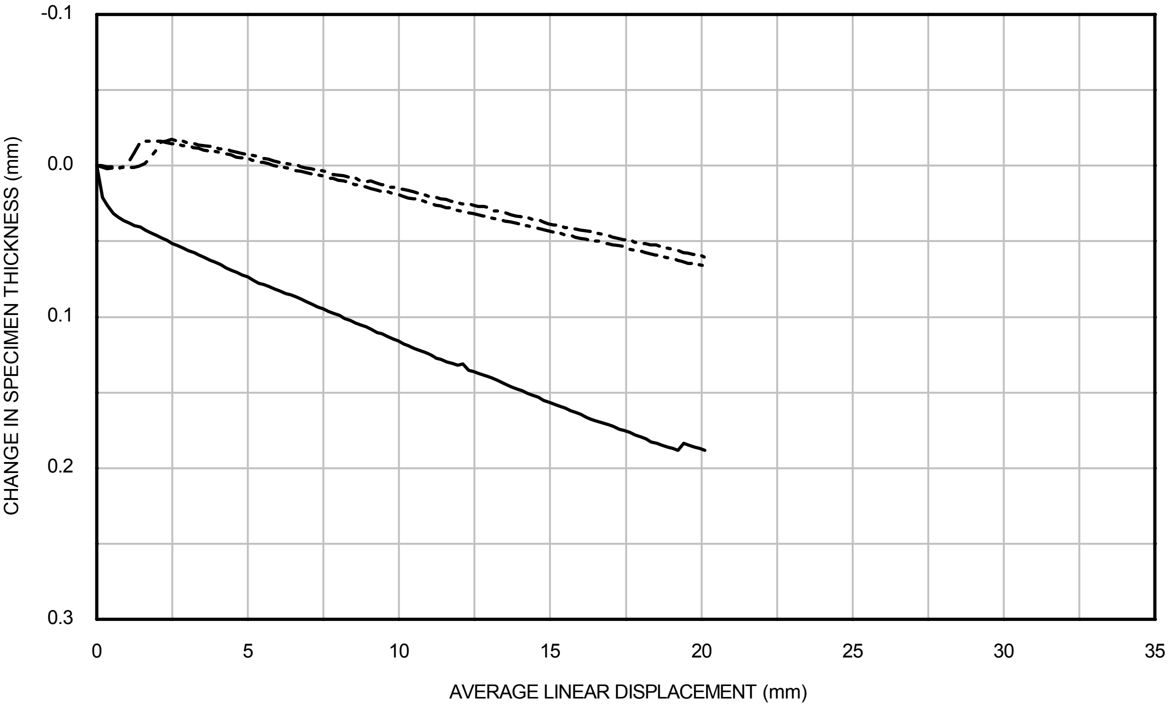
BOREHOLE	: HKZ1-BH01-SA
SAMPLE	: 46BagA
DEPTH (m)	: 43.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 10/10/2016
Drawn By : MSR
Filename: J11335 \ SHEAR \ HKZ1-BH01-SA_46BagA_R3.OPJ
Date:17/10/2016
Date:17/10/2016
Checked By: PH
Checked By: PH





BOREHOLE : HKZ1-BH01-SA

SAMPLE : 46BagA

DEPTH (m) : 43.00

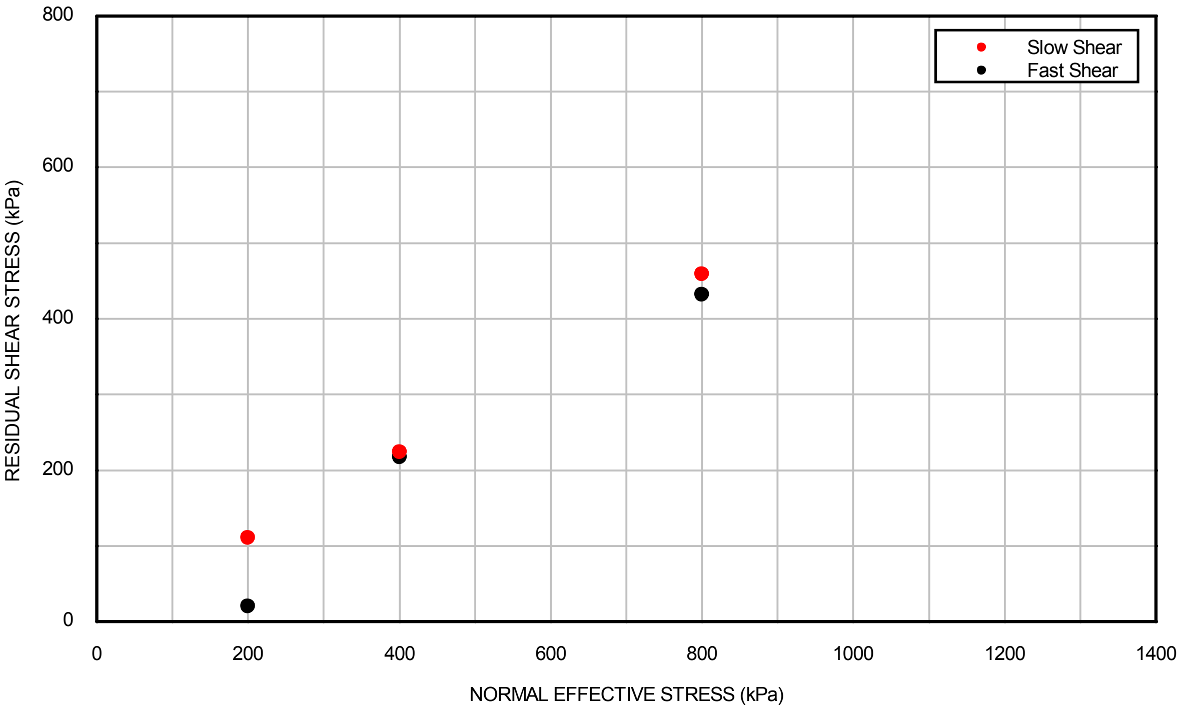
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH01-SA_46BagA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	200	200	400	400	800	800
Residual shear stress τ_n (kPa)	111.0	20.2	223.9	217.2	459.1	432.5
Mean linear displacement at end of shearing stage (mm)	20.1	193.7	20.1	197.9	20.1	193.7
Angle of residual shear resistance °	29.0	5.8	29.3	28.5	29.9	28.4

Date:17/10/2016

Date:17/10/2016

Checked By : PH

Checked By : PH

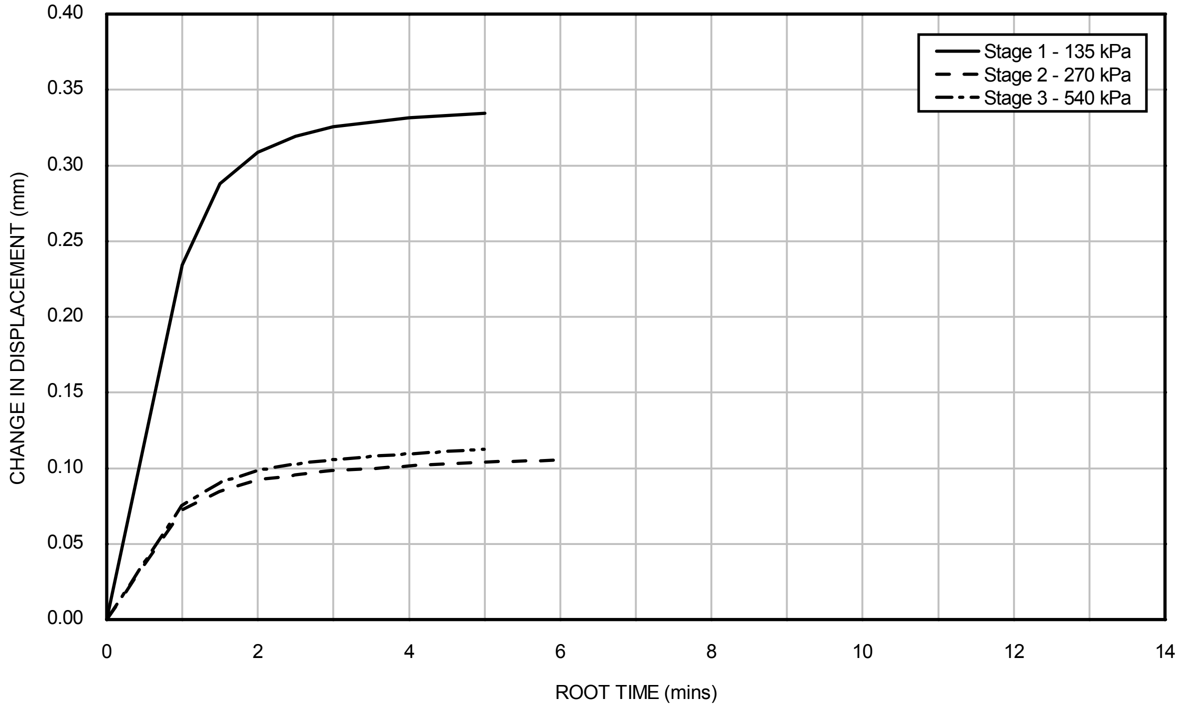
BOREHOLE : HKZ1-BH01-SA

SAMPLE : 46BagA

DEPTH (m) : 43.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	33 %

BOREHOLE : HKZ1-BH02-SA

SAMPLE : 16WaxD

DEPTH (m) : 14.10

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

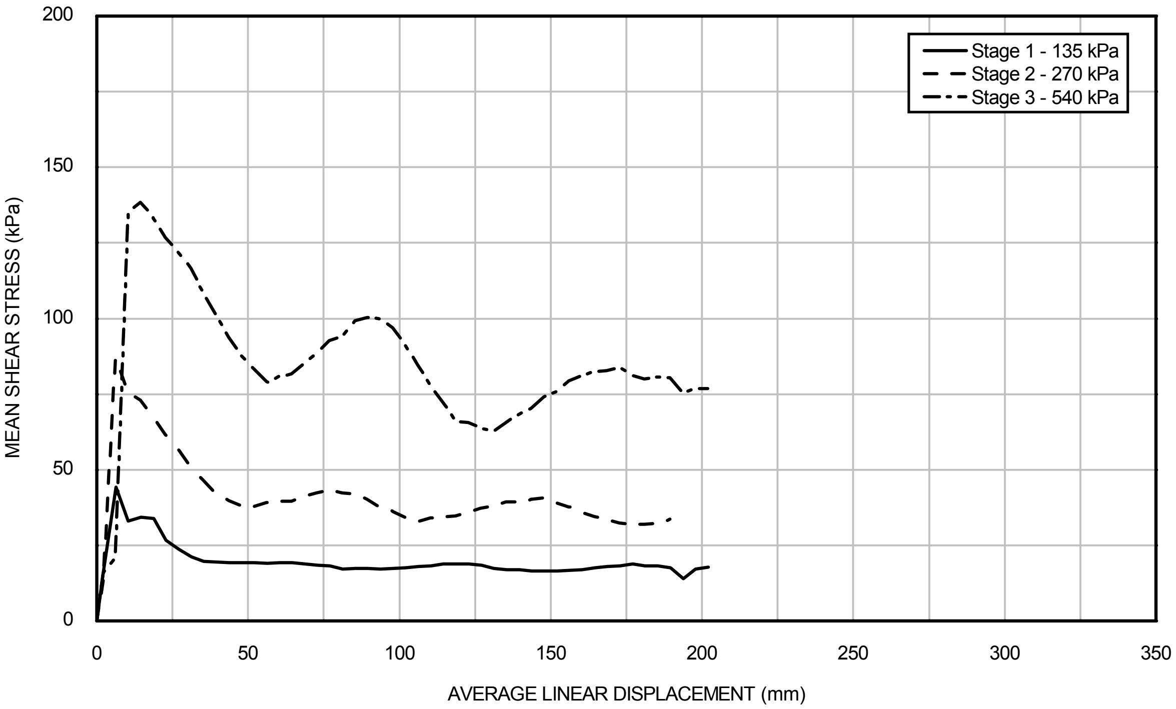
CONSOLIDATION STAGE

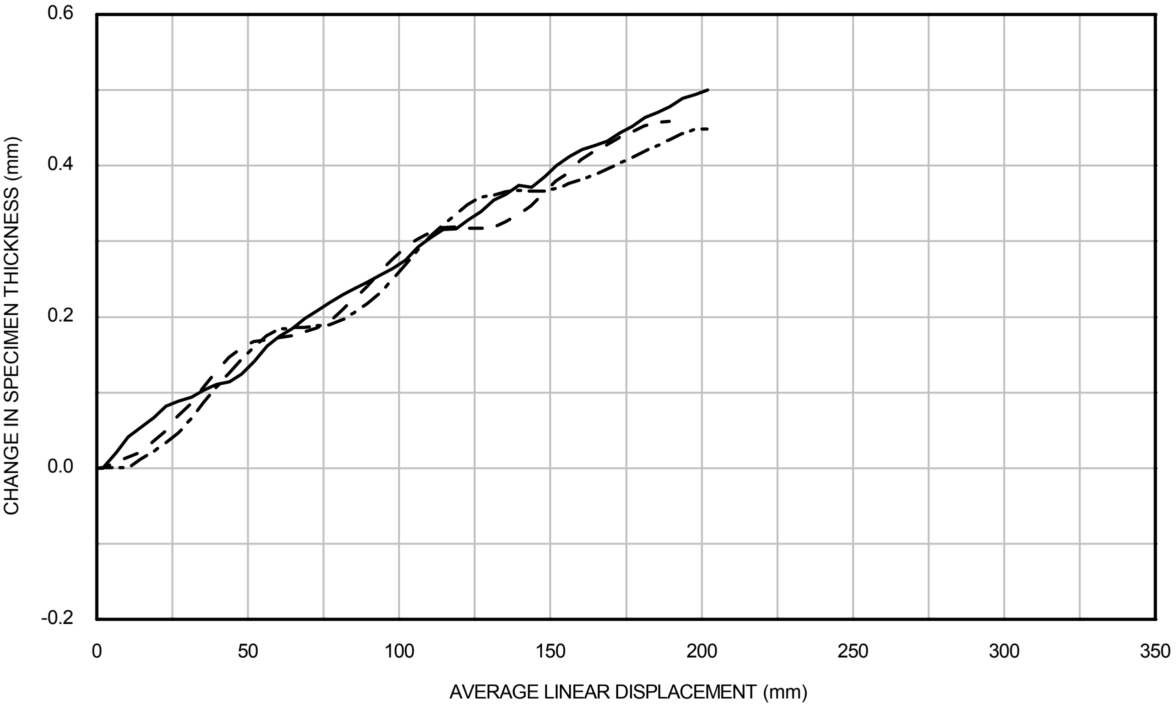
Date: 21/09/2016 Drawn By : ALB

Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_16WaxD_R3.OPJ

Date:04/10/2016 Checked By: PH

Date:04/10/2016 Checked By: PH





BOREHOLE : HKZ1-BH02-SA

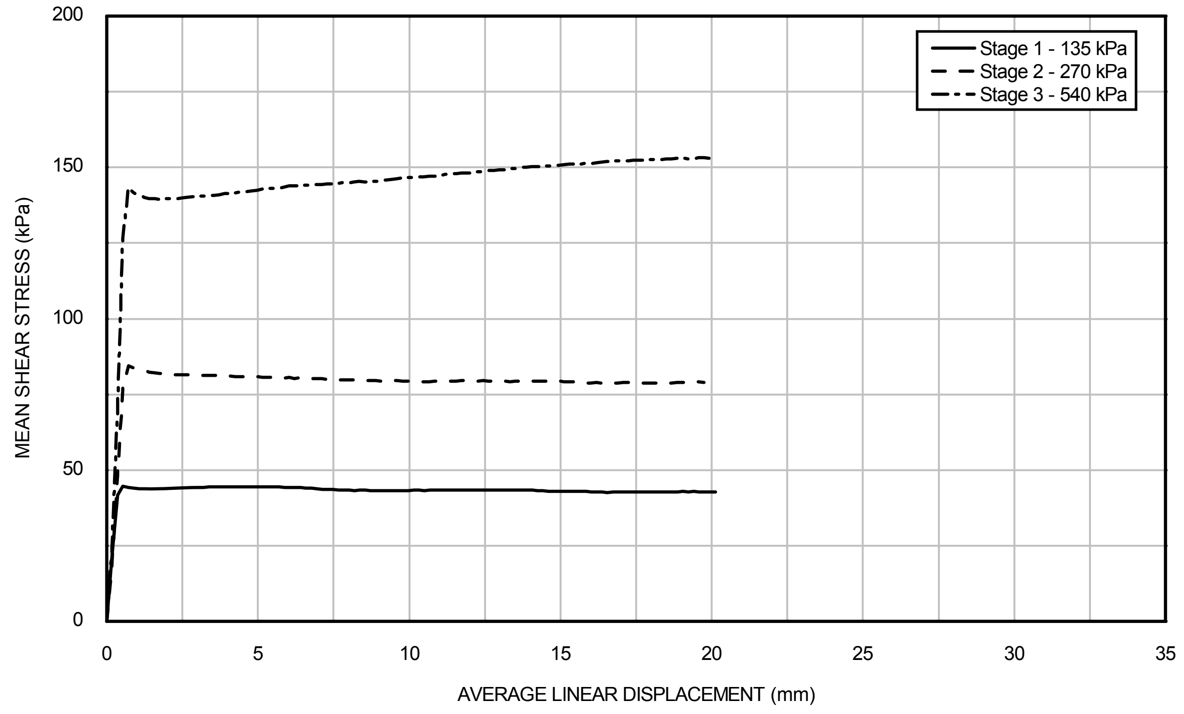
SAMPLE : 16WaxD

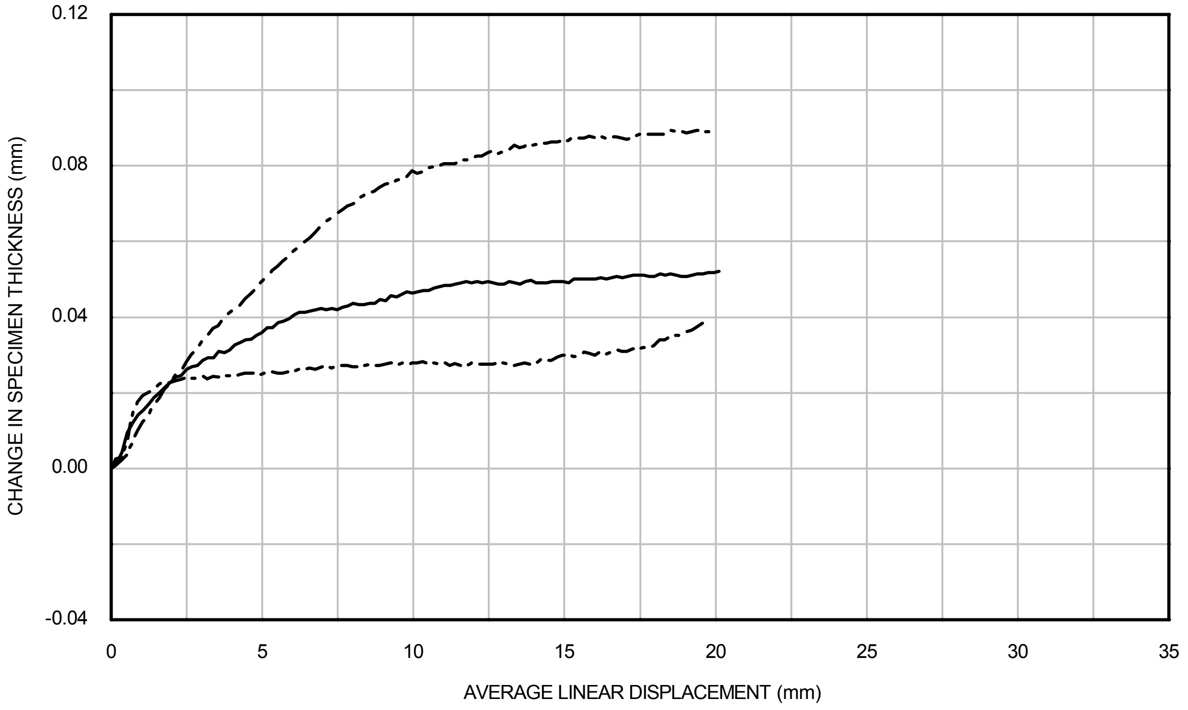
DEPTH (m) : 14.10

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 21/09/2016
Drawn By : ALB
Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_16WaxD_R3.OPJ
Date:04/10/2016
Date:04/10/2016
Checked By: PH
Checked By: PH





BOREHOLE	: HKZ1-BH02-SA
SAMPLE	: 16WaxD
DEPTH (m)	: 14.10

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

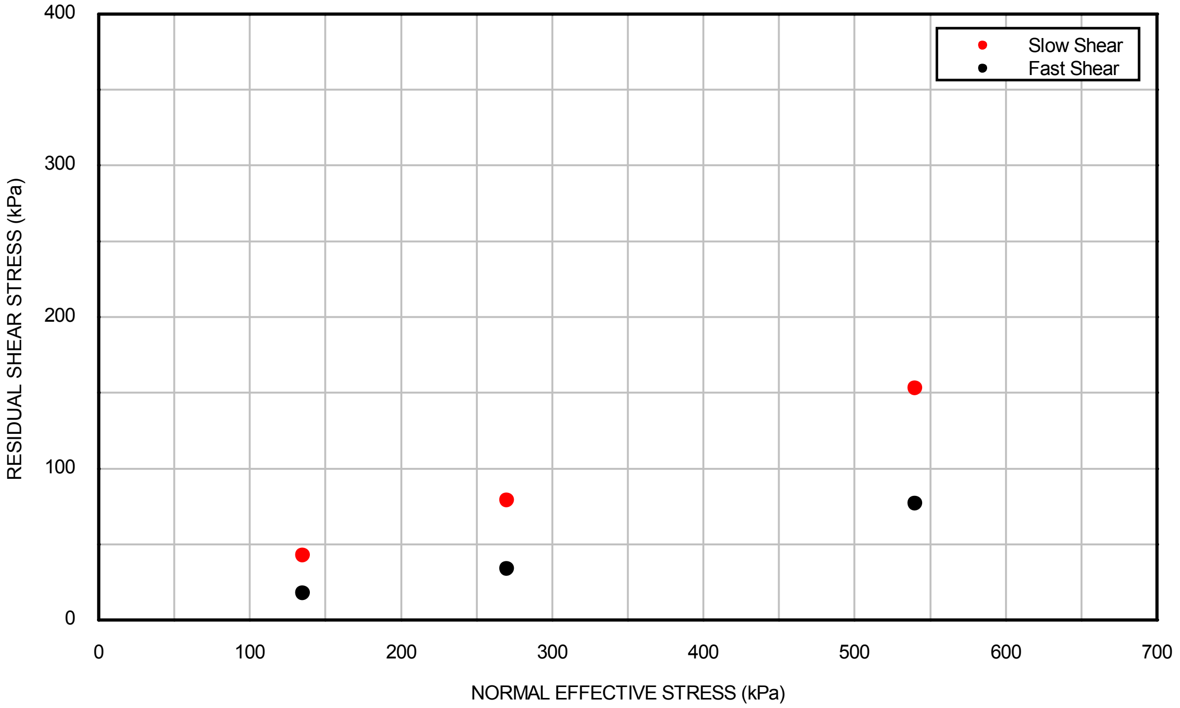
SLOW SHEARING STAGES

Date: 21/09/2016 Drawn By : ALB

Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_16WaxD_R3.OPJ

Date:04/10/2016 Checked By : PH

Date:04/10/2016 Checked By : PH

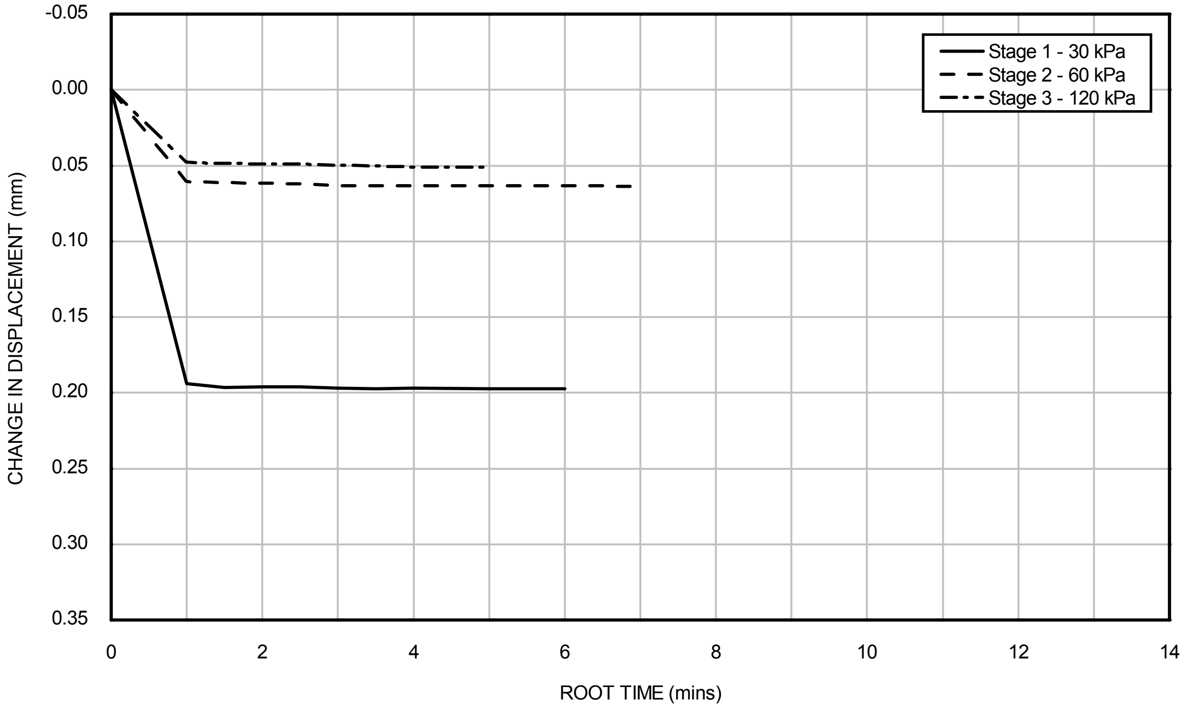


SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	135	135	270	270	540	540
Residual shear stress τ_n (kPa)	42.8	17.8	78.9	33.7	153.1	76.8
Mean linear displacement at end of shearing stage (mm)	20.1	202.1	19.8	189.5	19.9	197.9
Angle of residual shear resistance °	17.6	7.6	16.3	7.1	15.8	8.1

BOREHOLE : HKZ1-BH02-SA
SAMPLE : 16WaxD
DEPTH (m) : 14.10

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	8 %

BOREHOLE : HKZ1-BH03-SA
SAMPLE : 07BagA
DEPTH (m) : 3.00

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

Date: 10/10/2016

Drawn By : MSR

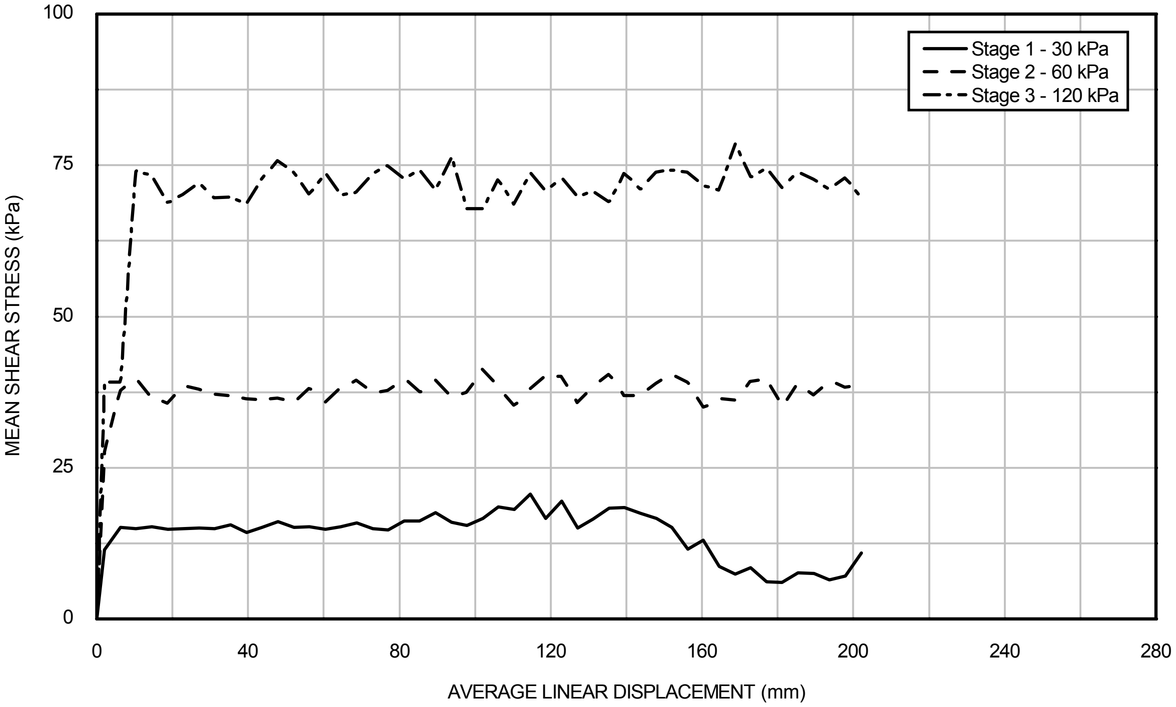
Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_7BagA_R3.OPJ

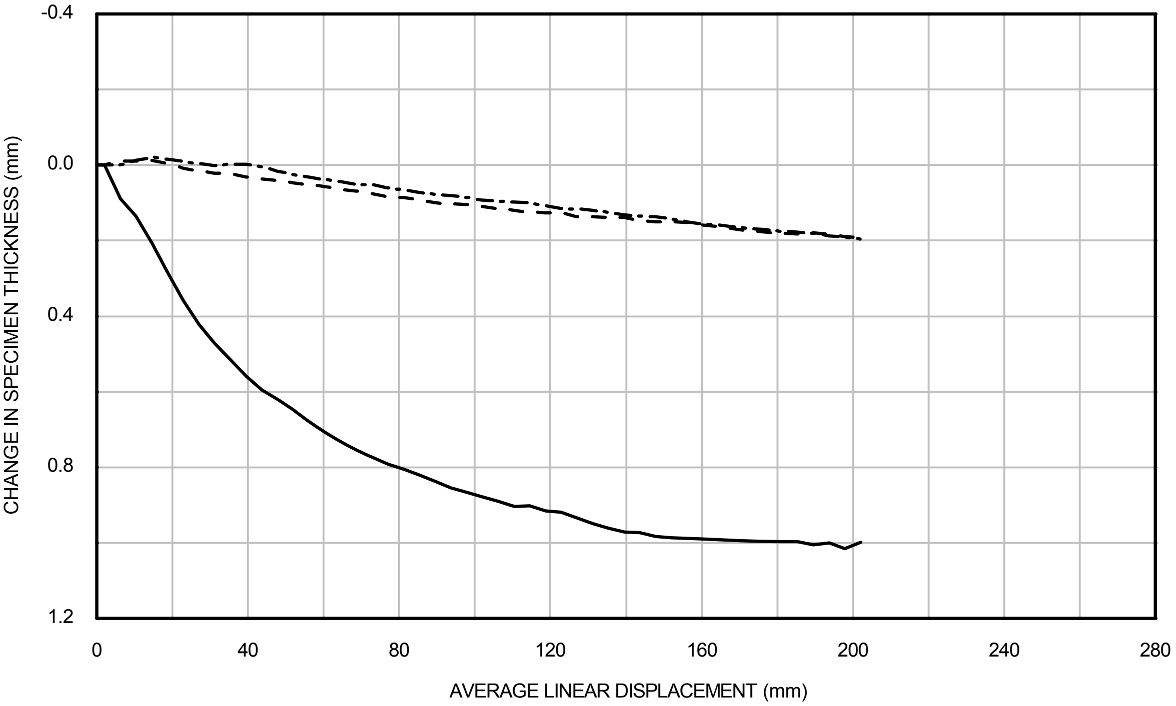
Date:17/10/2016

Date:17/10/2016

Checked By: PH

Checked By: PH





BOREHOLE : HKZ1-BH03-SA

SAMPLE : 07BagA

DEPTH (m) : 3.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

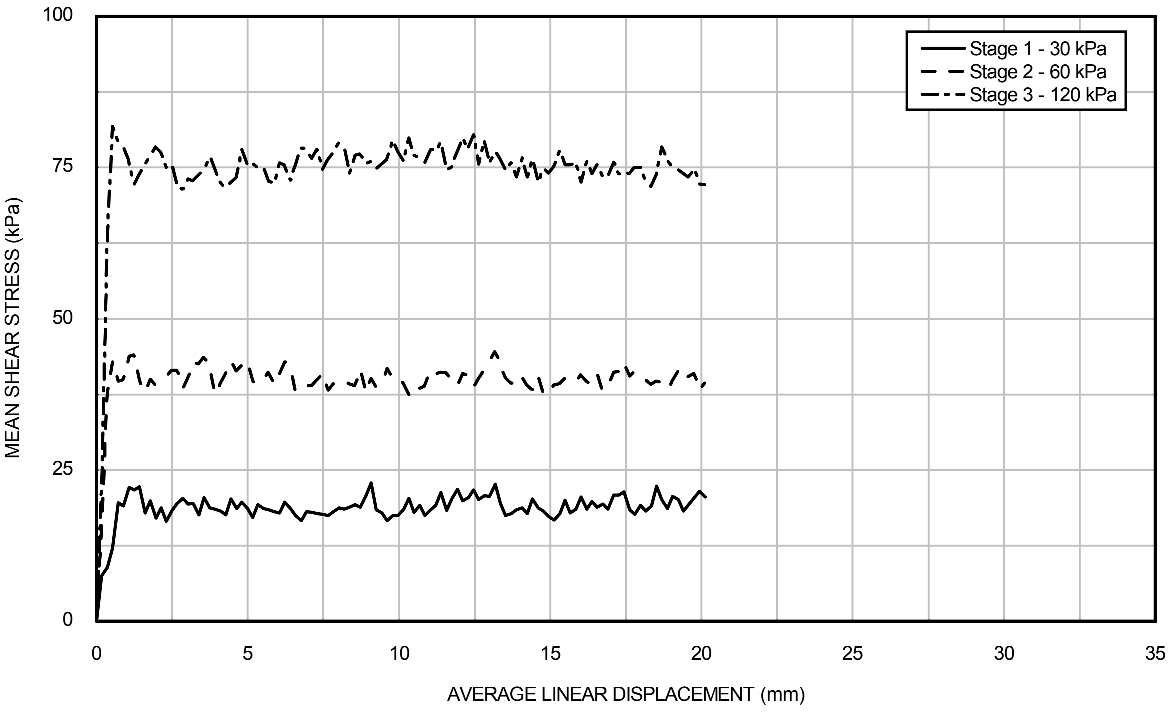
Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_7BagA_R3.OPJ

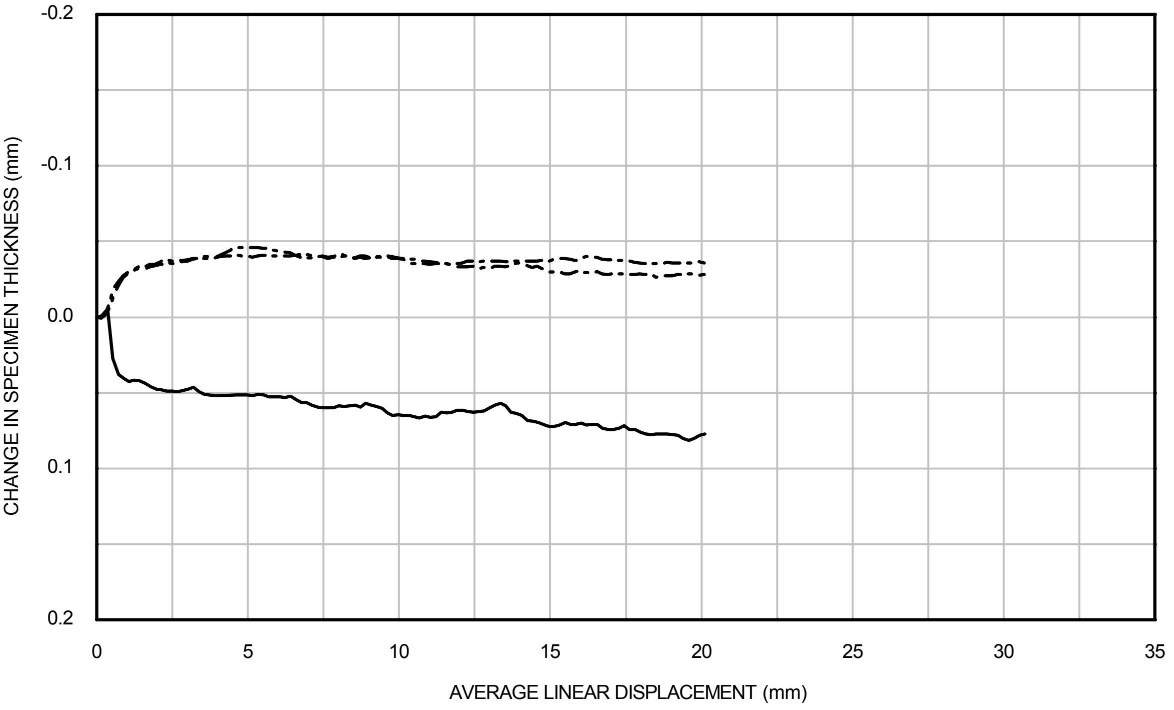
Date:17/10/2016

Date:17/10/2016

Checked By: PH

Checked By: PH





BOREHOLE	: HKZ1-BH03-SA
SAMPLE	: 07BagA
DEPTH (m)	: 3.00

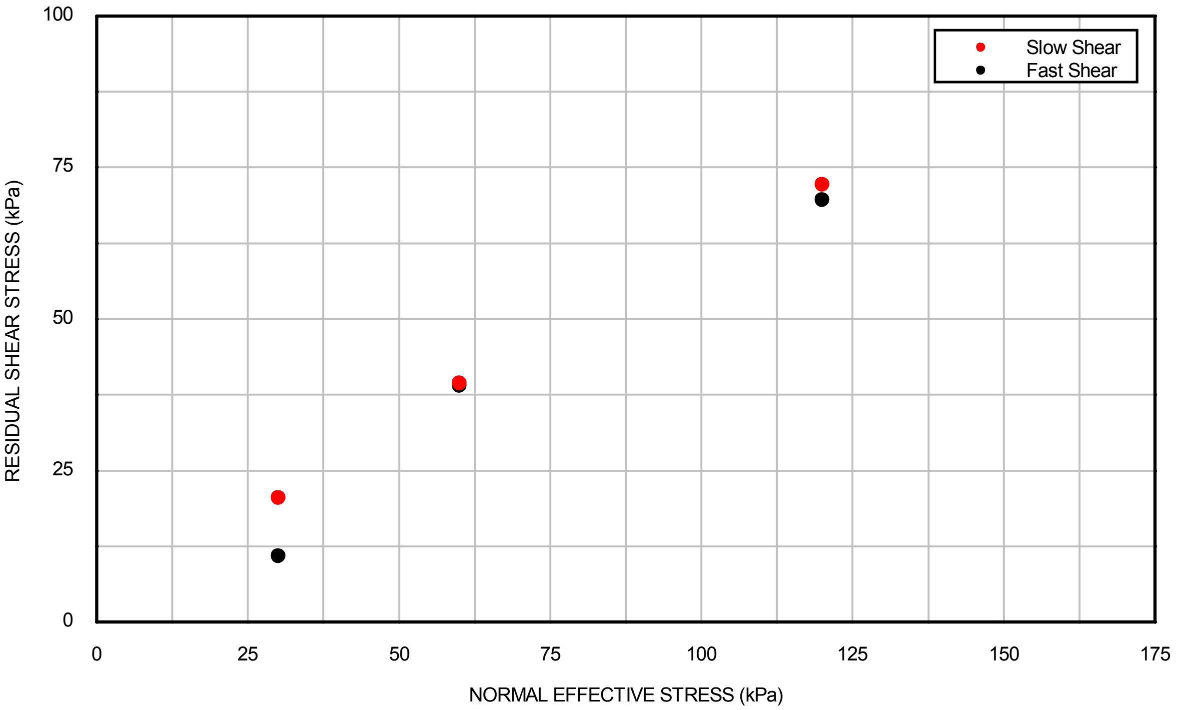
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_7BagA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	30	30	60	60	120	120
Residual shear stress τ_n (kPa)	20.5	10.9	39.5	39.0	72.2	69.6
Mean linear displacement at end of shearing stage (mm)	20.1	202.0	20.1	202.1	20.1	202.0
Angle of residual shear resistance °	34.6	20.2	33.2	32.9	31.0	30.0

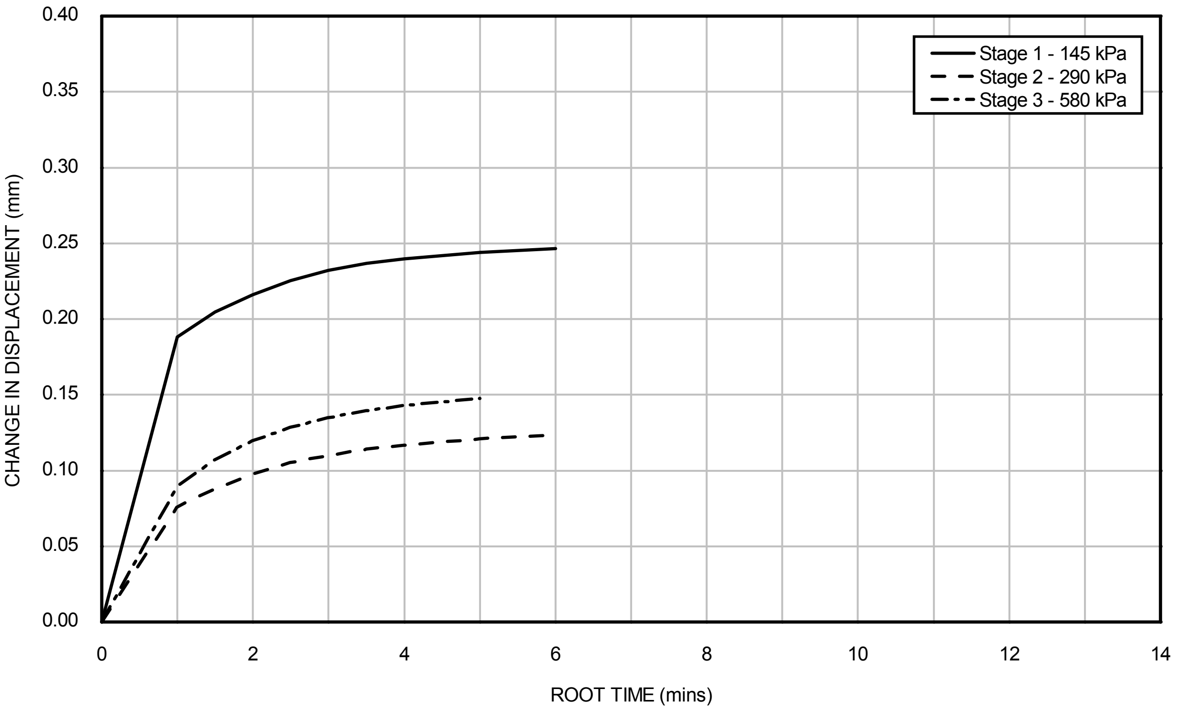
Date:17/10/2016 Checked By: PH

Date:17/10/2016 Checked By: PH

BOREHOLE : HKZ1-BH03-SA
SAMPLE : 07BagA
DEPTH (m) : 3.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

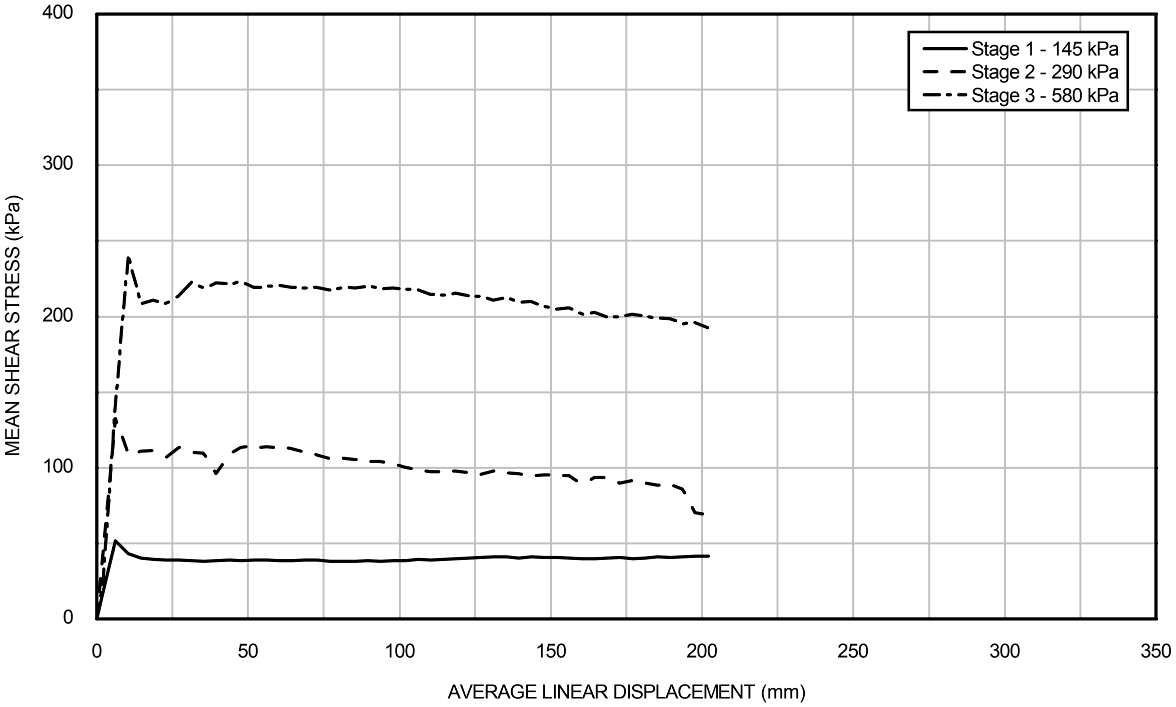
Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	27 %

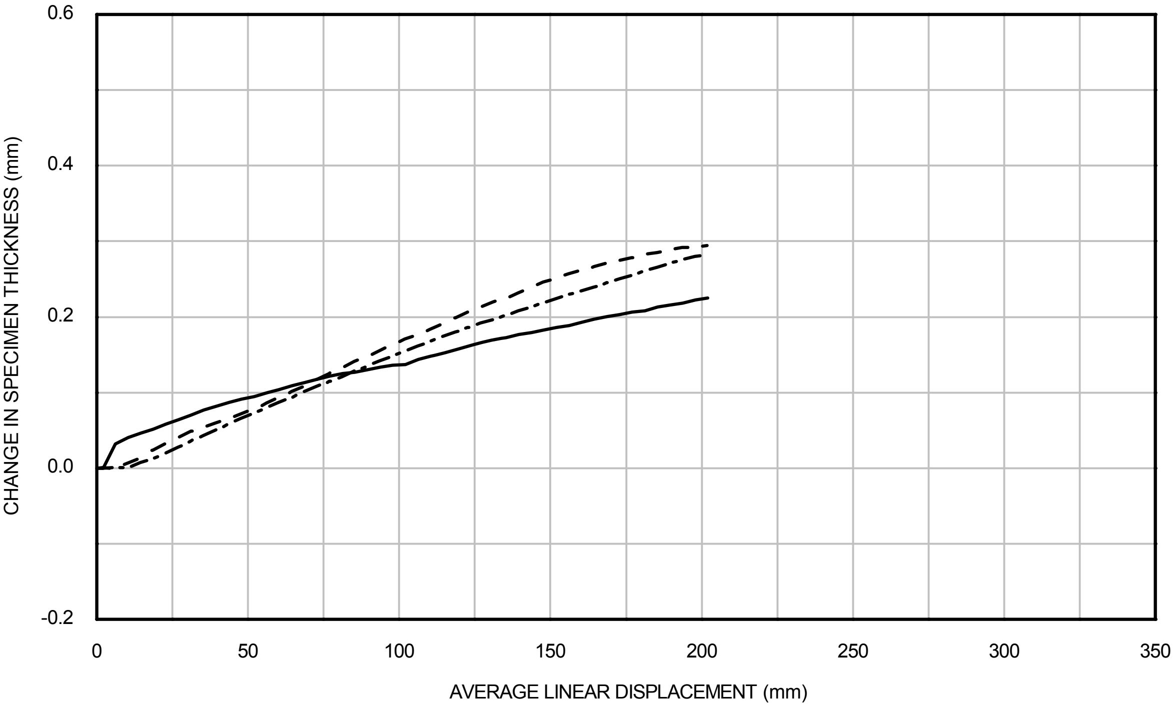
BOREHOLE : HKZ1-BH03-SA
SAMPLE : 24WaxA
DEPTH (m) : 15.00

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE





BOREHOLE : HKZ1-BH03-SA

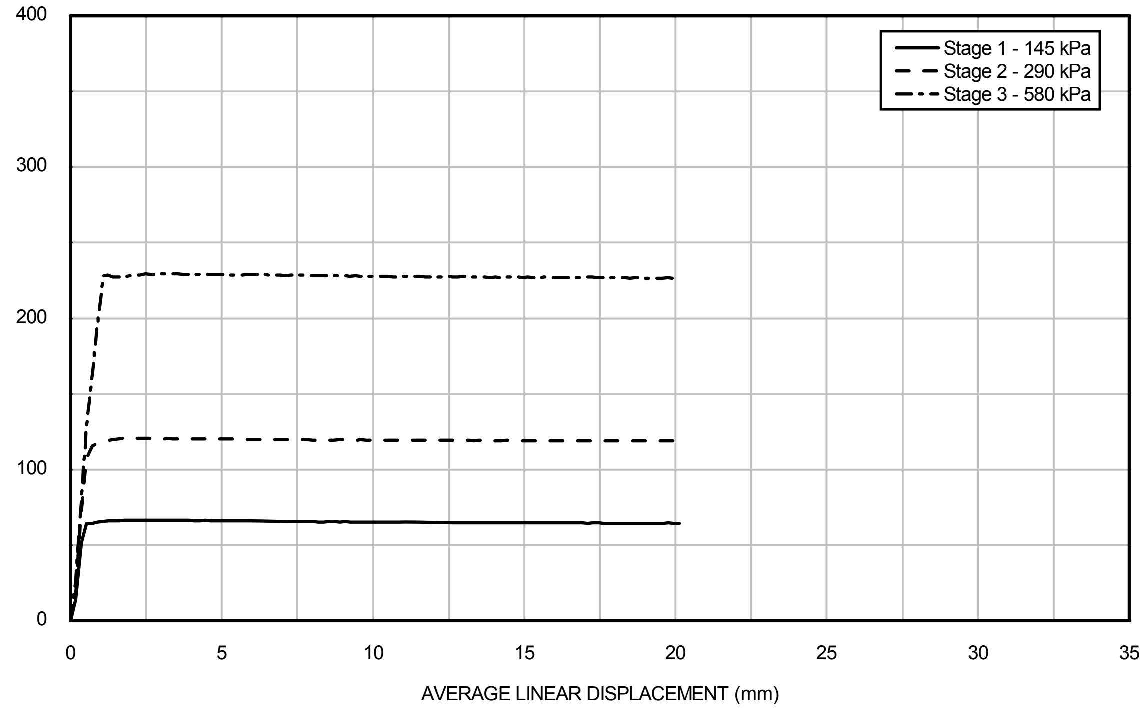
SAMPLE : 24WaxA

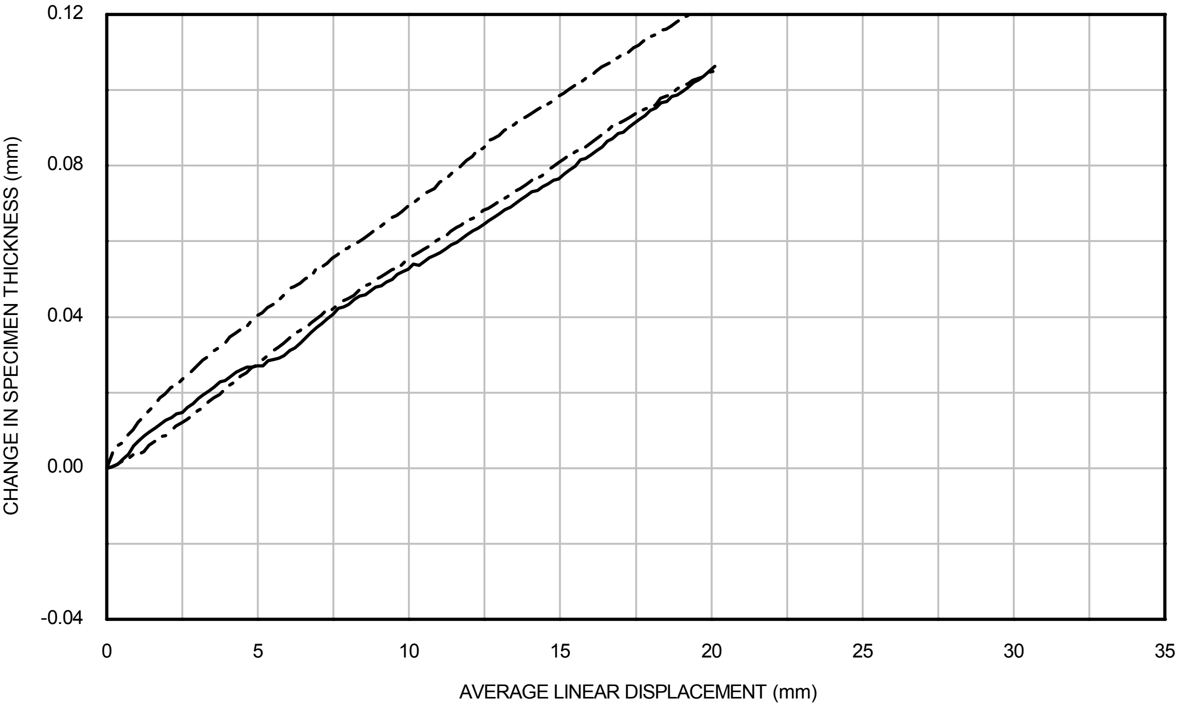
DEPTH (m) : 15.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 21/09/2016
Drawn By : ALB
Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_24WaxA_R3.OPJ
Date:04/10/2016
Checked By: PH
Date:04/10/2016
Checked By: PH





BOREHOLE	: HKZ1-BH03-SA
SAMPLE	: 24WaxA
DEPTH (m)	: 15.00

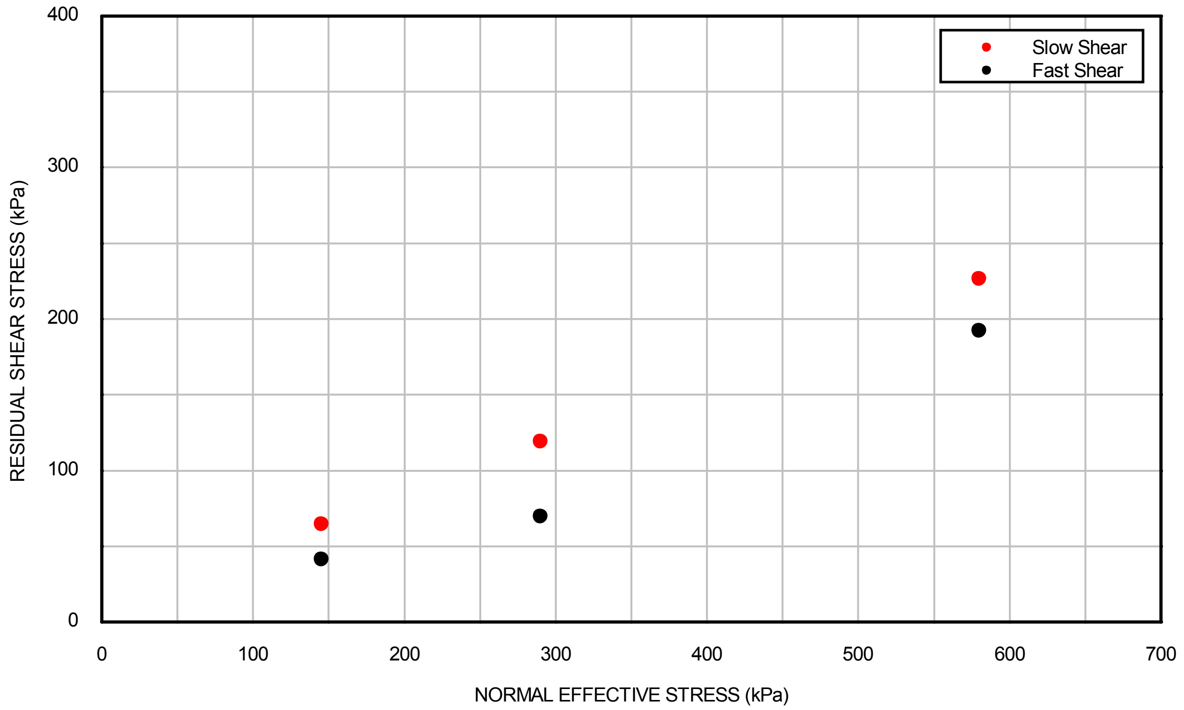
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 21/09/2016

Drawn By : ALB

Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_24WaxA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	145	145	290	290	580	580
Residual shear stress τ_n (kPa)	64.5	41.3	119.1	69.6	226.6	192.4
Mean linear displacement at end of shearing stage (mm)	20.1	202.0	19.9	202.1	20.1	202.0
Angle of residual shear resistance °	24.0	15.9	22.3	13.5	21.3	18.3

Date:04/10/2016

Date:04/10/2016

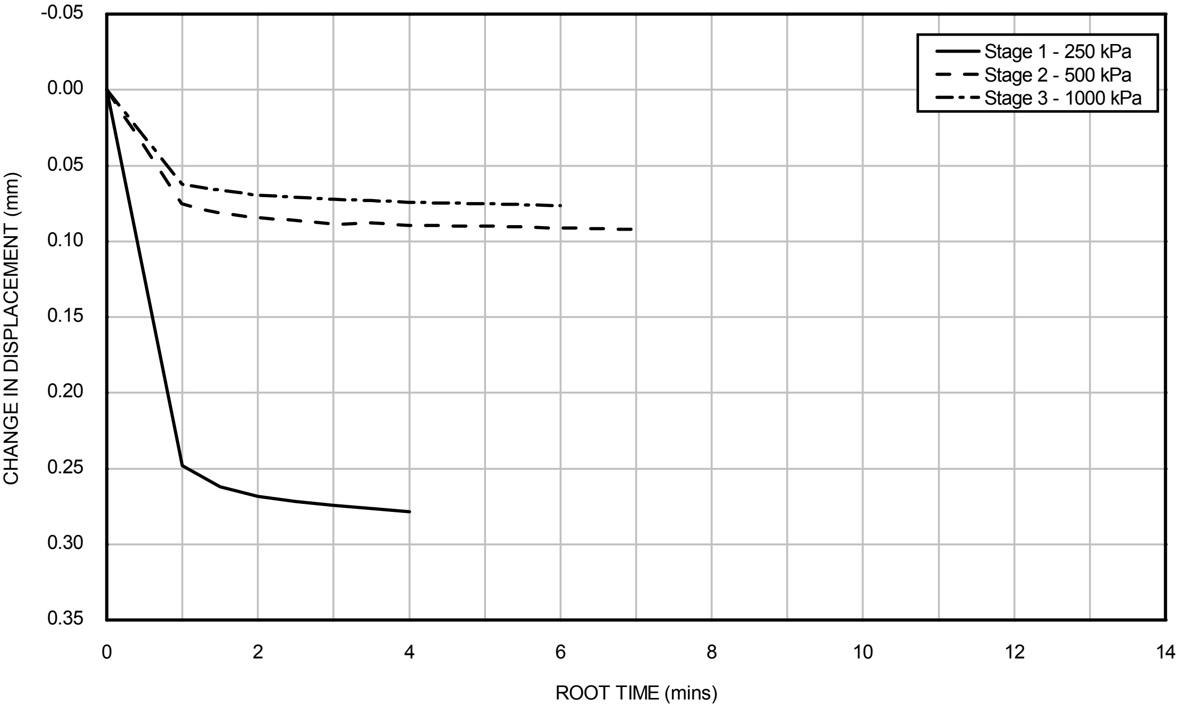
Checked By : PH

Checked By : PH

BOREHOLE : HKZ1-BH03-SA
SAMPLE : 24WaxA
DEPTH (m) : 15.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	18 %

BOREHOLE : HKZ1-BH04-SA

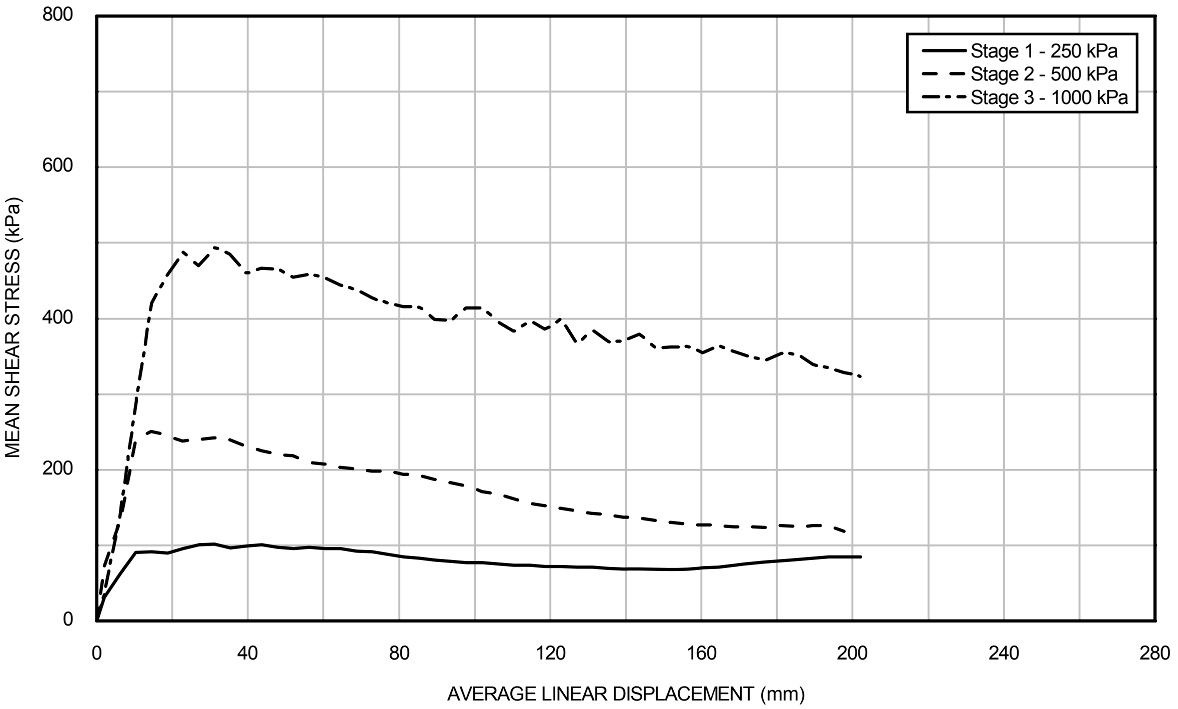
SAMPLE : 30BagA

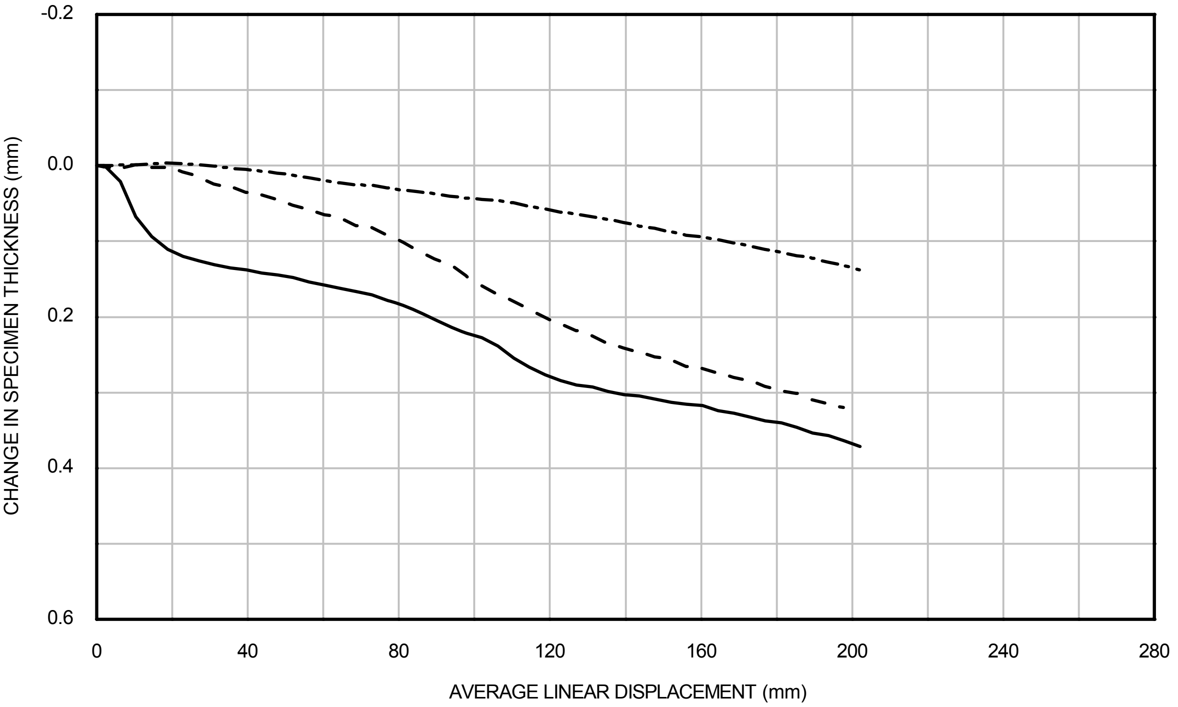
DEPTH (m) : 26.50

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE





BOREHOLE	: HKZ1-BH04-SA
SAMPLE	: 30BagA
DEPTH (m)	: 26.50

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

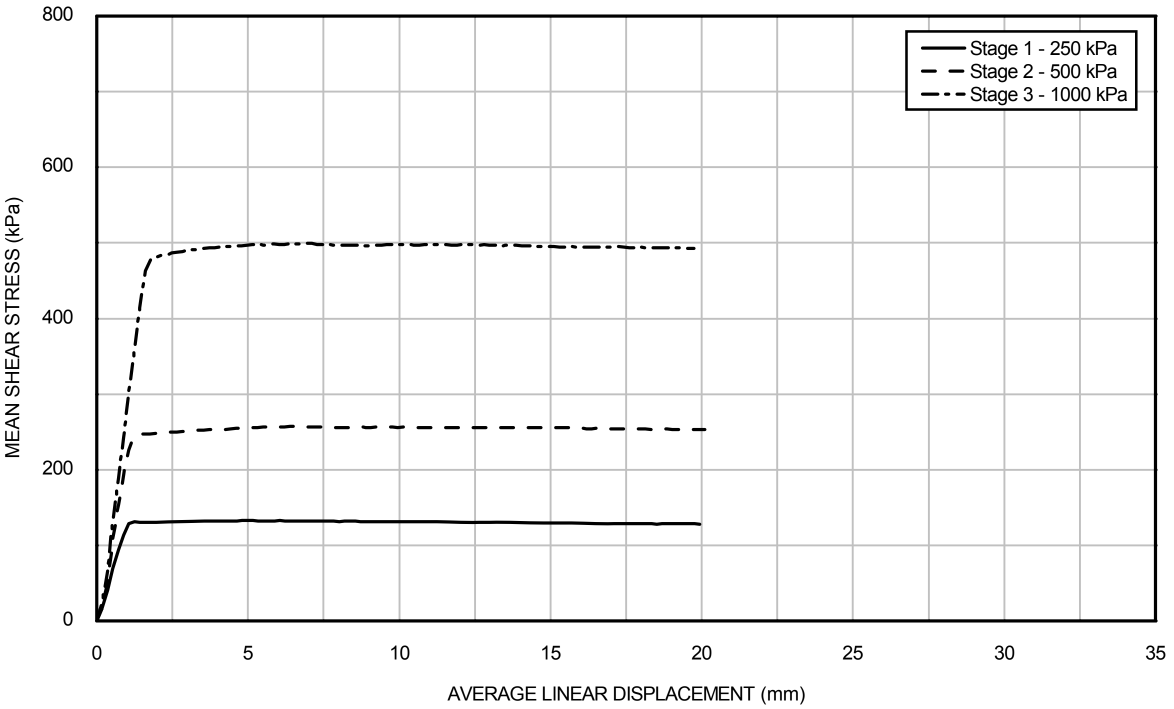
Filename: J11335 \ SHEAR \ HKZ1-BH04-SA_30BagA_R3.OPJ

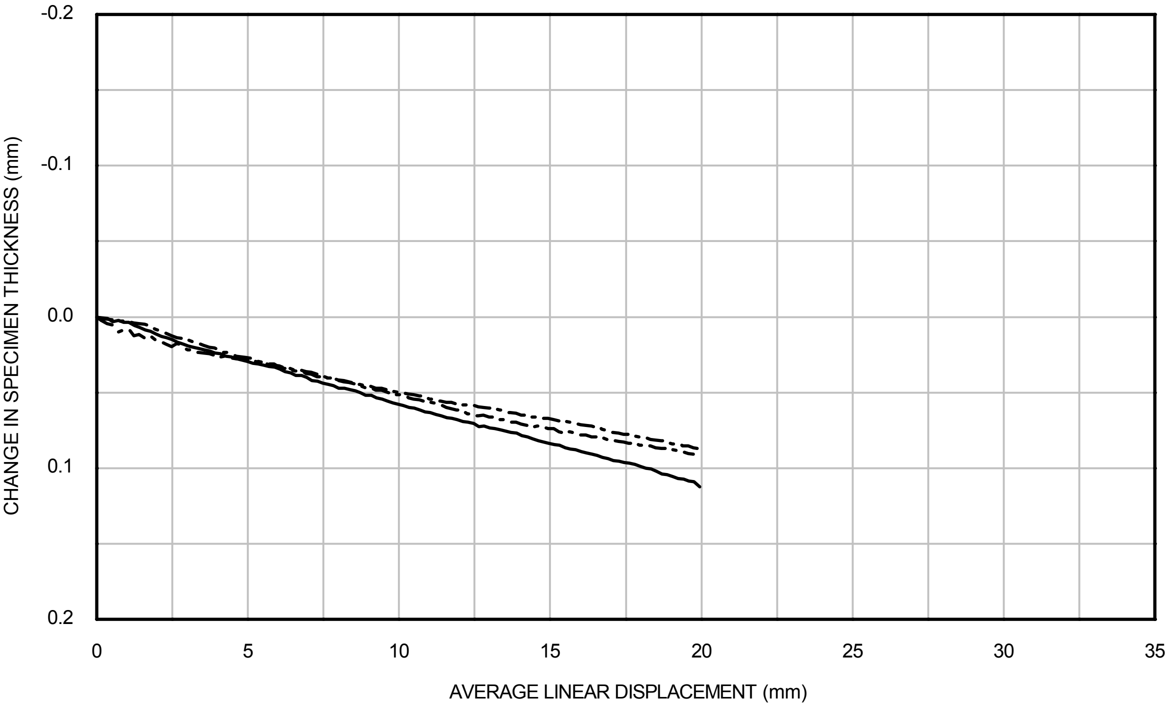
Date:17/10/2016

Checked By: PH

Date:17/10/2016

Checked By: PH





BOREHOLE	: HKZ1-BH04-SA
SAMPLE	: 30BagA
DEPTH (m)	: 26.50

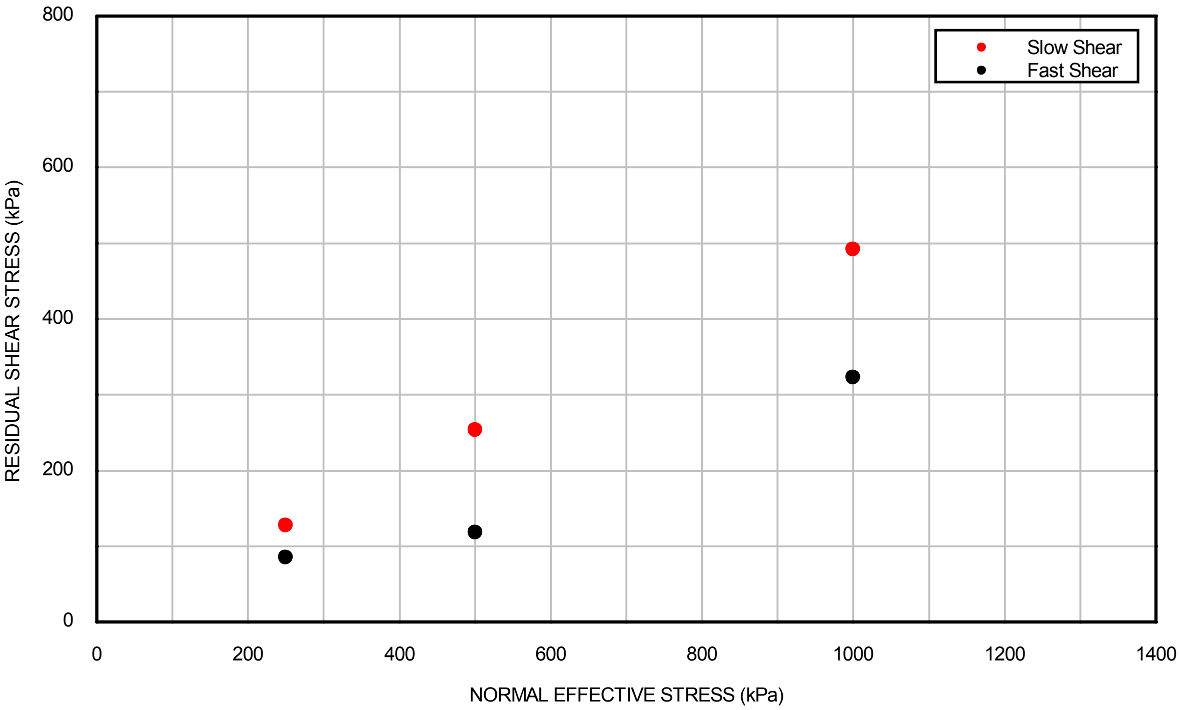
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH04-SA_30BagA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	250	250	500	500	1000	1000
Residual shear stress τ_n (kPa)	128.1	85.1	253.4	118.7	492.5	323.0
Mean linear displacement at end of shearing stage (mm)	19.9	202.0	20.1	197.9	19.8	202.1
Angle of residual shear resistance °	27.2	18.8	26.9	13.4	26.2	17.9

BOREHOLE : HKZ1-BH04-SA

SAMPLE : 30BagA

DEPTH (m) : 26.50

Date:17/10/2016

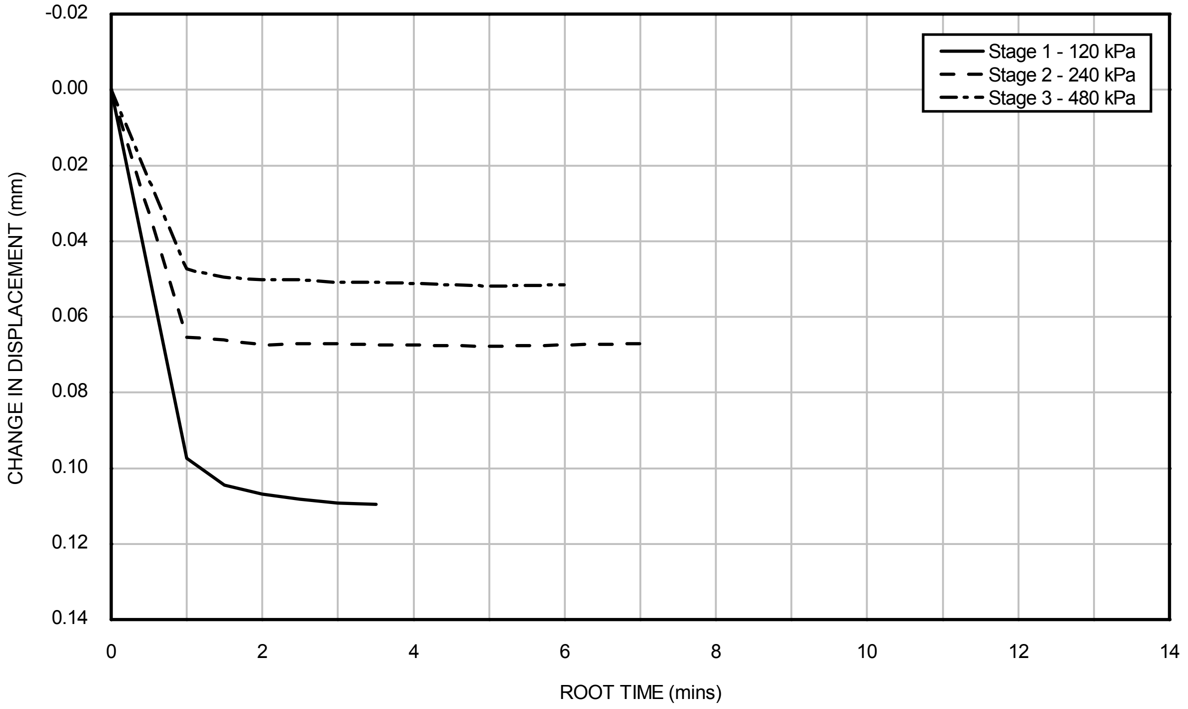
Date:17/10/2016

Checked By: PH

Checked By: PH

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	9 %

BOREHOLE : HKZ1-BH05-SA

SAMPLE : 15BagA

DEPTH (m) : 12.00

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

Date: 11/10/2016

Drawn By : MSR

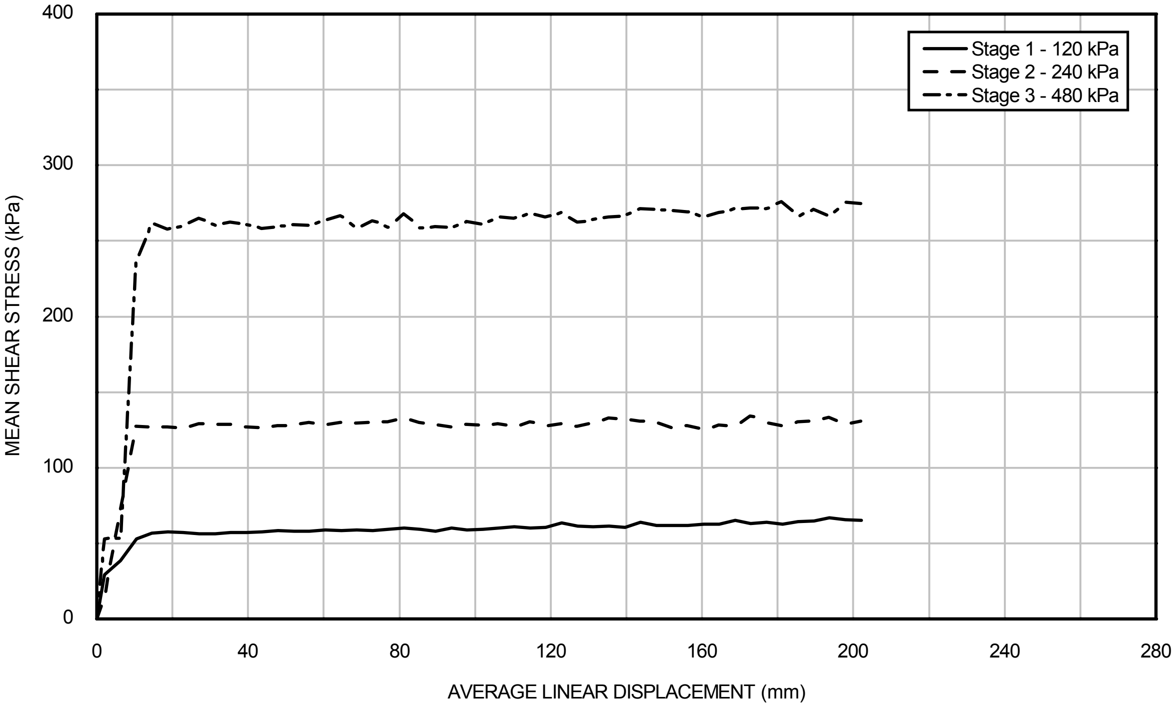
Filename: J11335 \ SHEAR \ HKZ1-BH05-SA_B_R3.OPJ

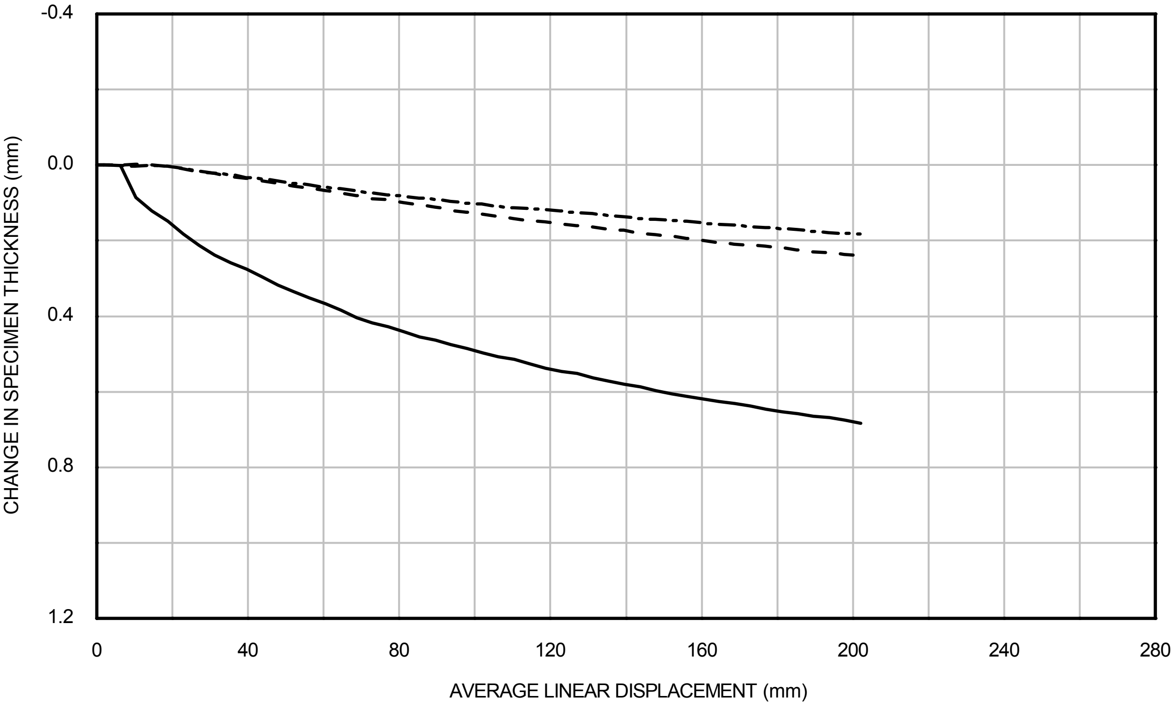
Date:20/10/2016

Date:20/10/2016

Checked By: PH

Checked By: PH





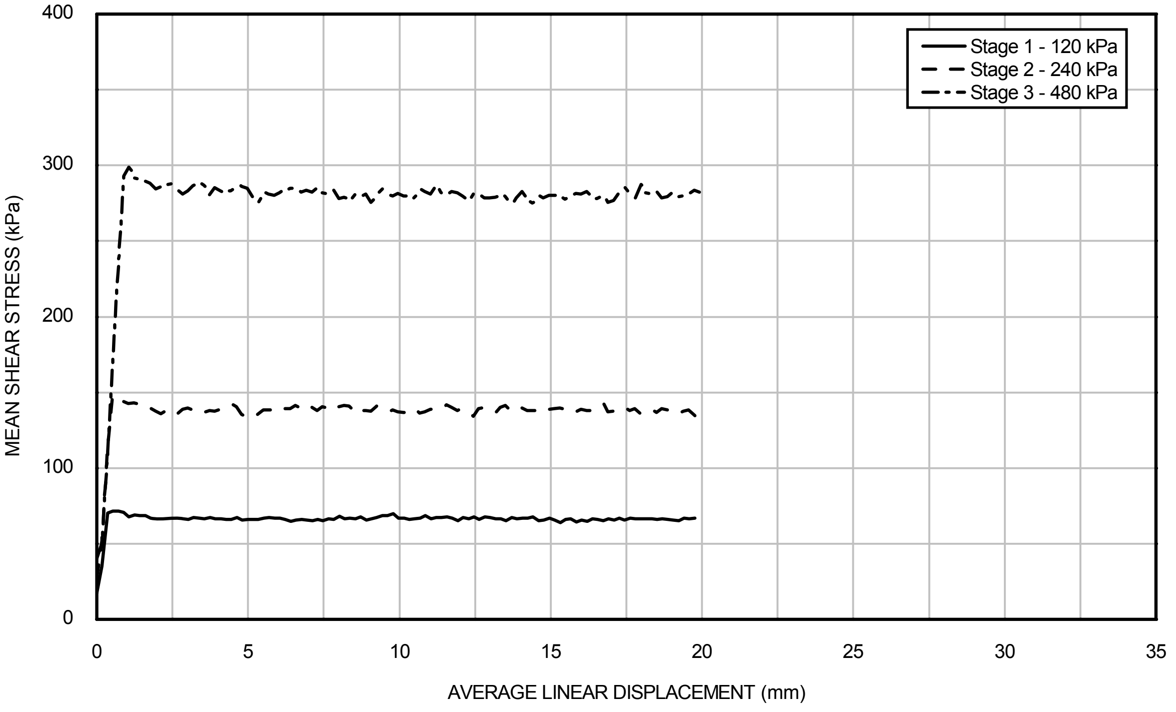
BOREHOLE : HKZ1-BH05-SA

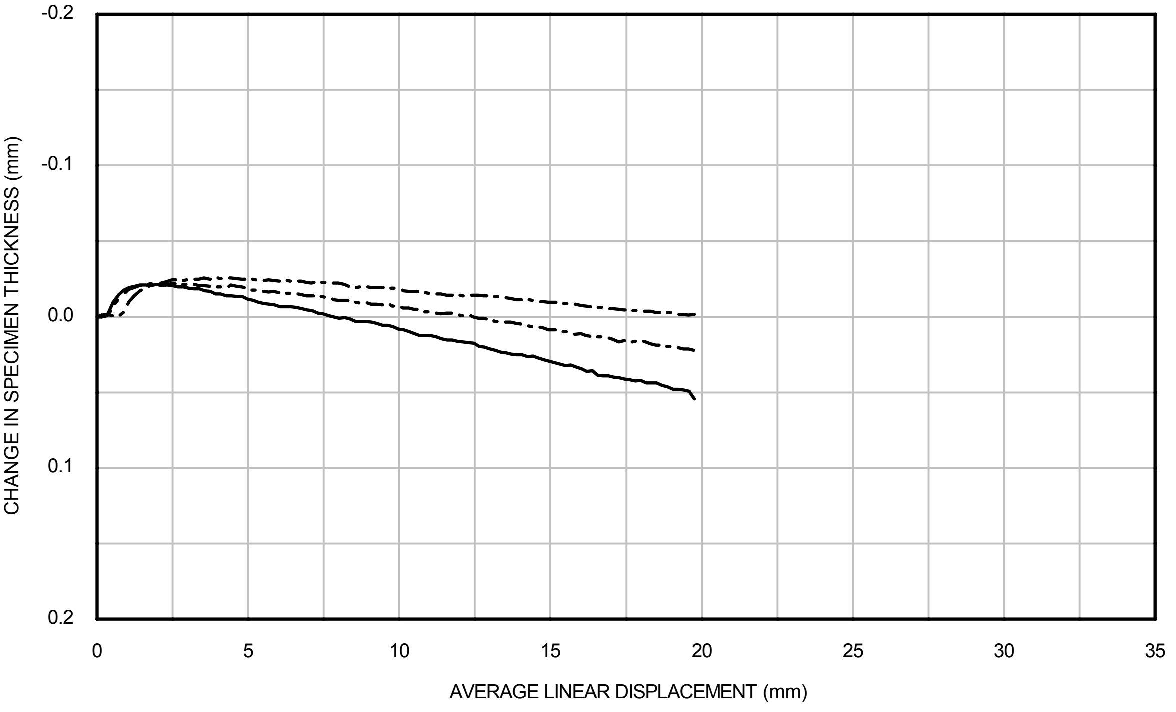
SAMPLE : 15BagA

DEPTH (m) : 12.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES





BOREHOLE : HKZ1-BH05-SA

SAMPLE : 15BagA

DEPTH (m) : 12.00

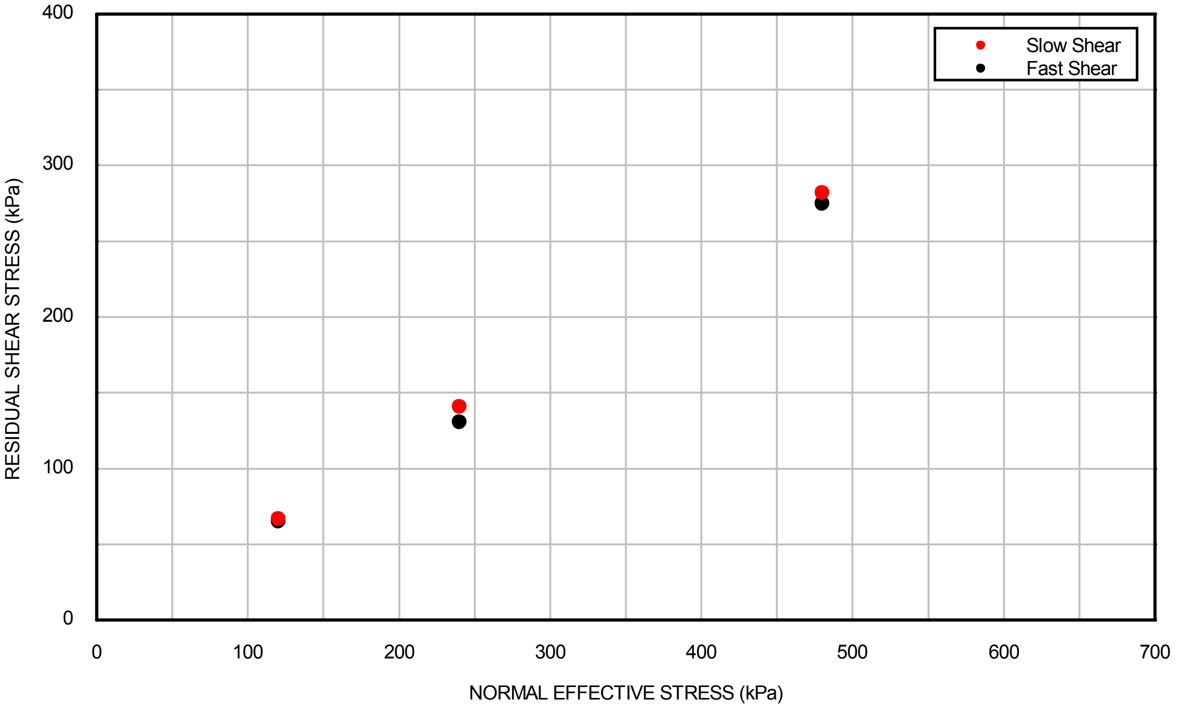
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 11/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH05-SA_B_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	120	120	240	240	480	480
Residual shear stress τ_n (kPa)	67.0	65.2	140.7	130.8	282.0	274.9
Mean linear displacement at end of shearing stage (mm)	19.8	202.1	19.9	202.0	19.9	202.0
Angle of residual shear resistance °	29.2	28.6	30.4	28.6	30.4	29.8

Date:20/10/2016

Date:20/10/2016

Checked By: PH

Checked By: PH

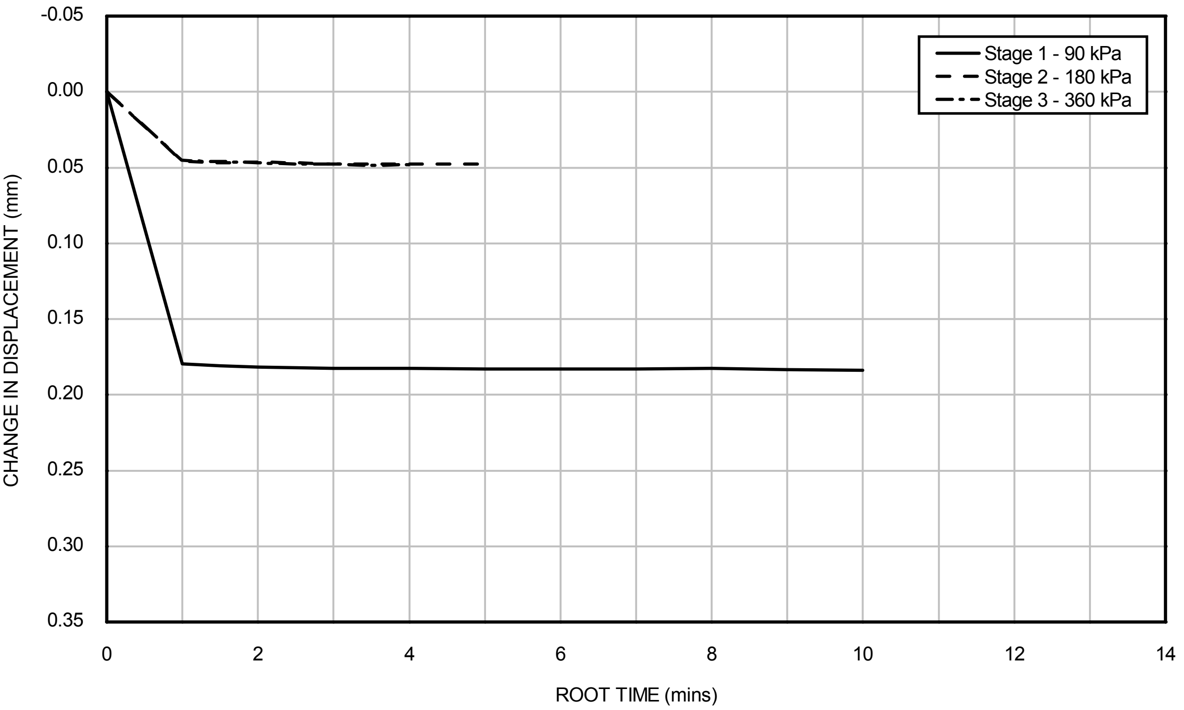
BOREHOLE : HKZ1-BH05-SA

SAMPLE : 15BagA

DEPTH (m) : 12.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

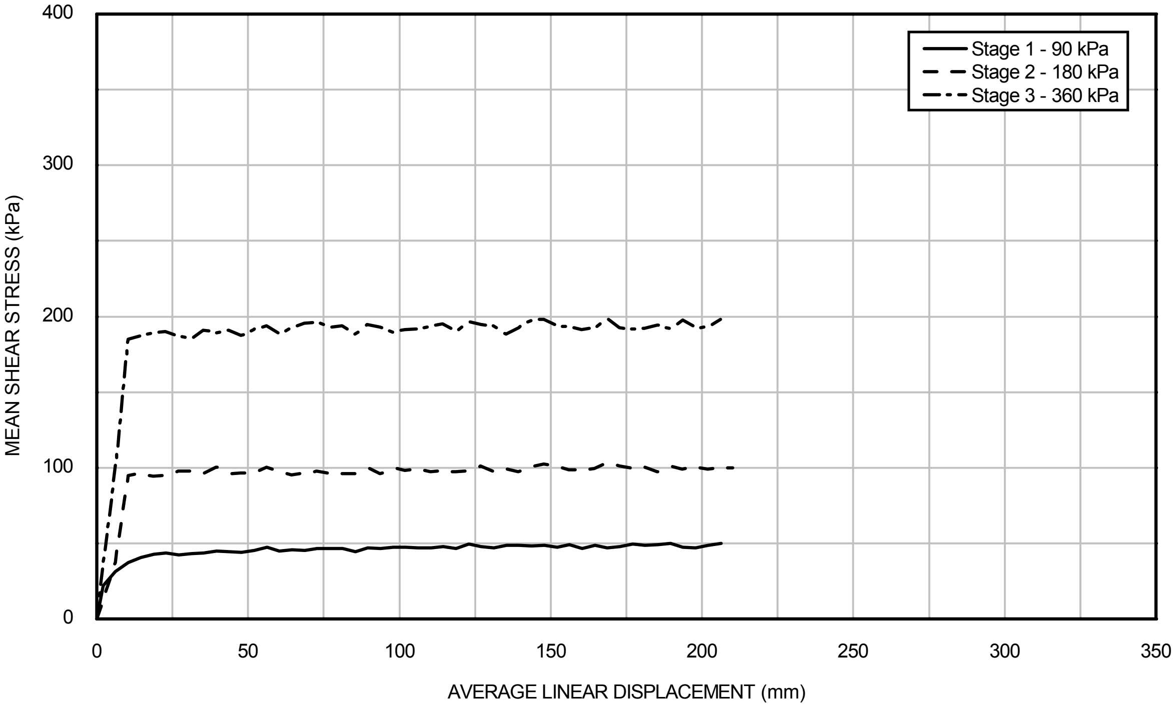
Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	8 %

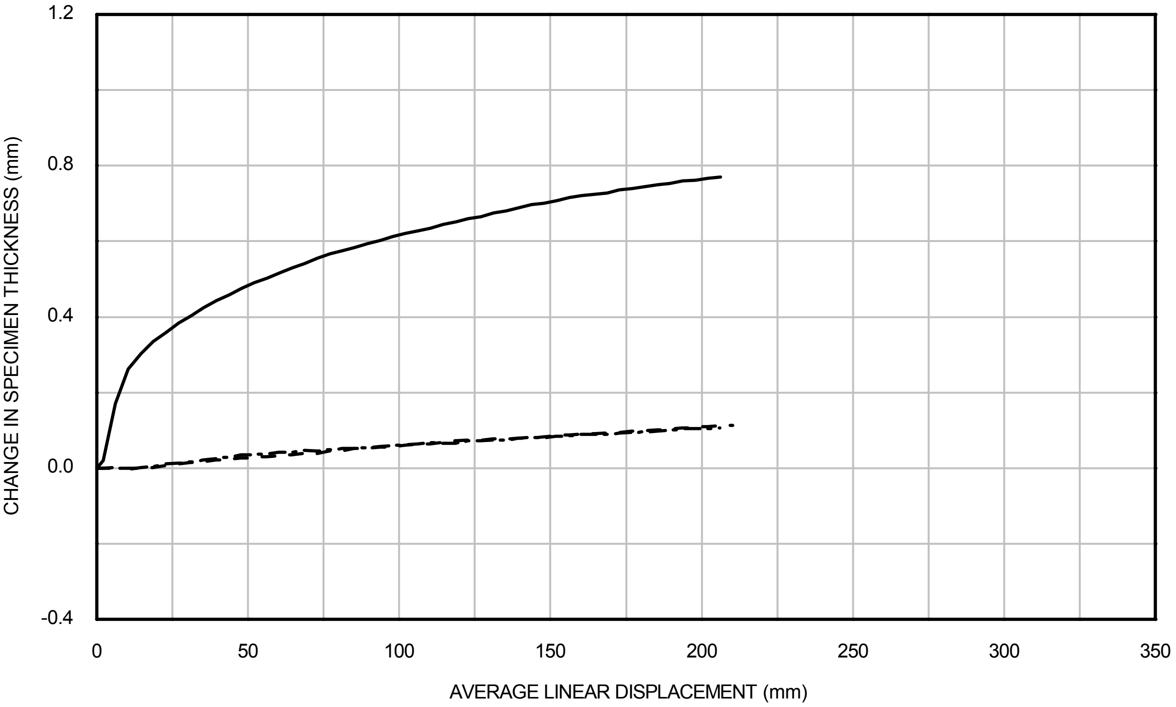
BOREHOLE : HKZ1-BH06-SA
SAMPLE : 12BagA
DEPTH (m) : 9.00

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE





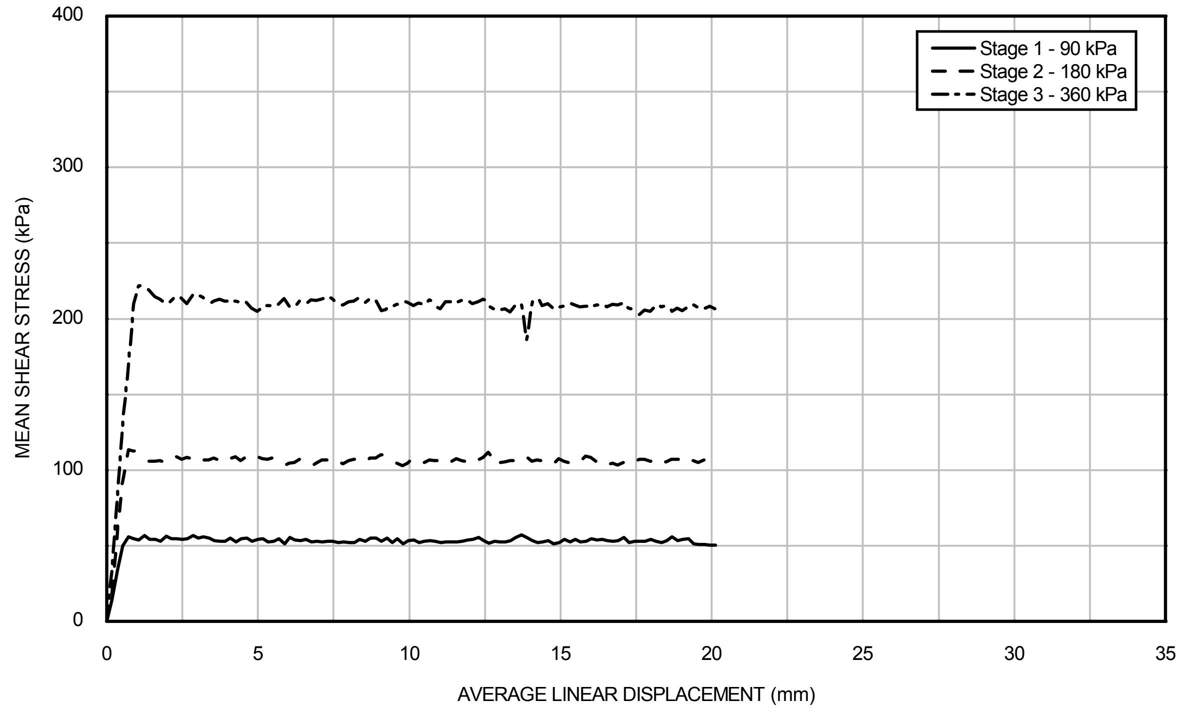
BOREHOLE : HKZ1-BH06-SA

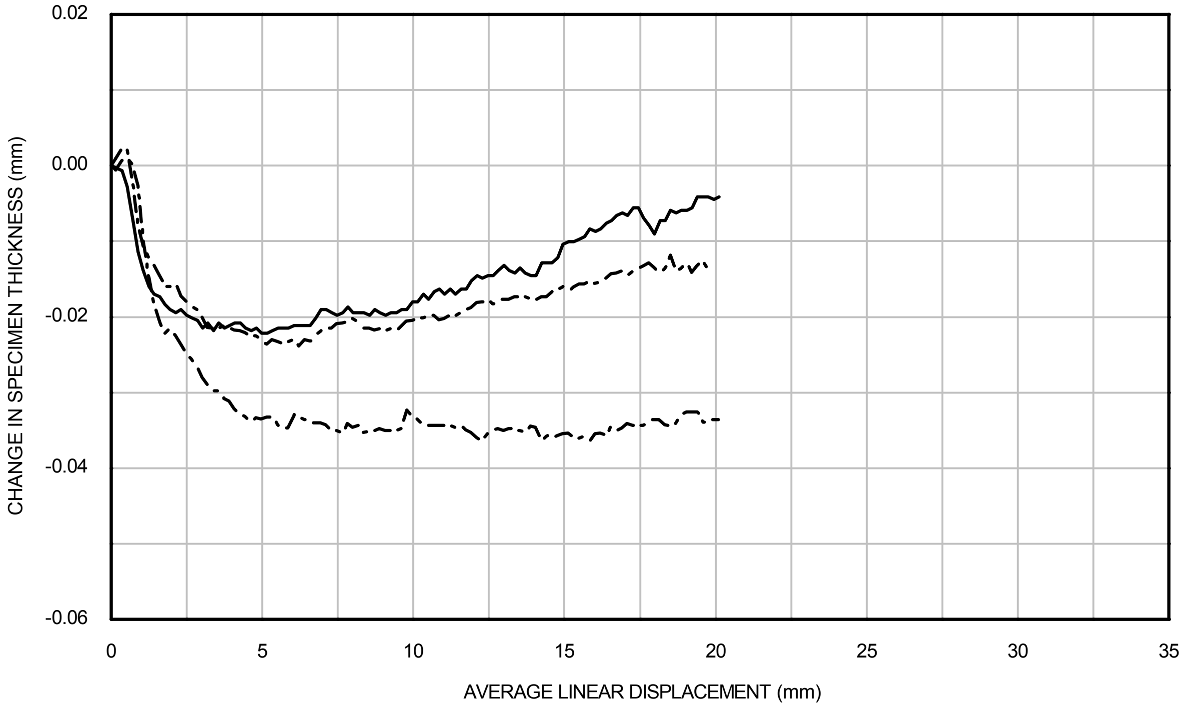
SAMPLE : 12BagA

DEPTH (m) : 9.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES





BOREHOLE : HKZ1-BH06-SA

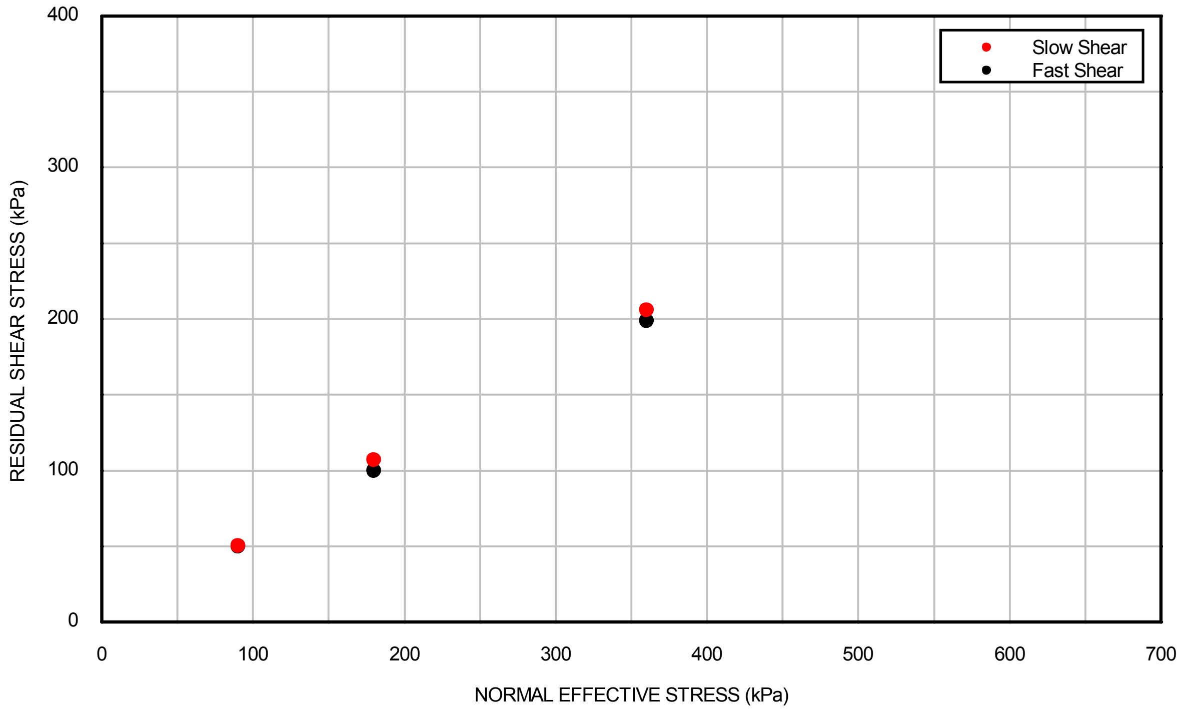
SAMPLE : 12BagA

DEPTH (m) : 9.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 26/09/2016
Drawn By : ALB
Filename: J11335 \ SHEAR \ HKZ1-BH06-SA_12BagA_R3.OPJ
Date:10/10/2016 Checked By : PH
Date:10/10/2016 Checked By : PH

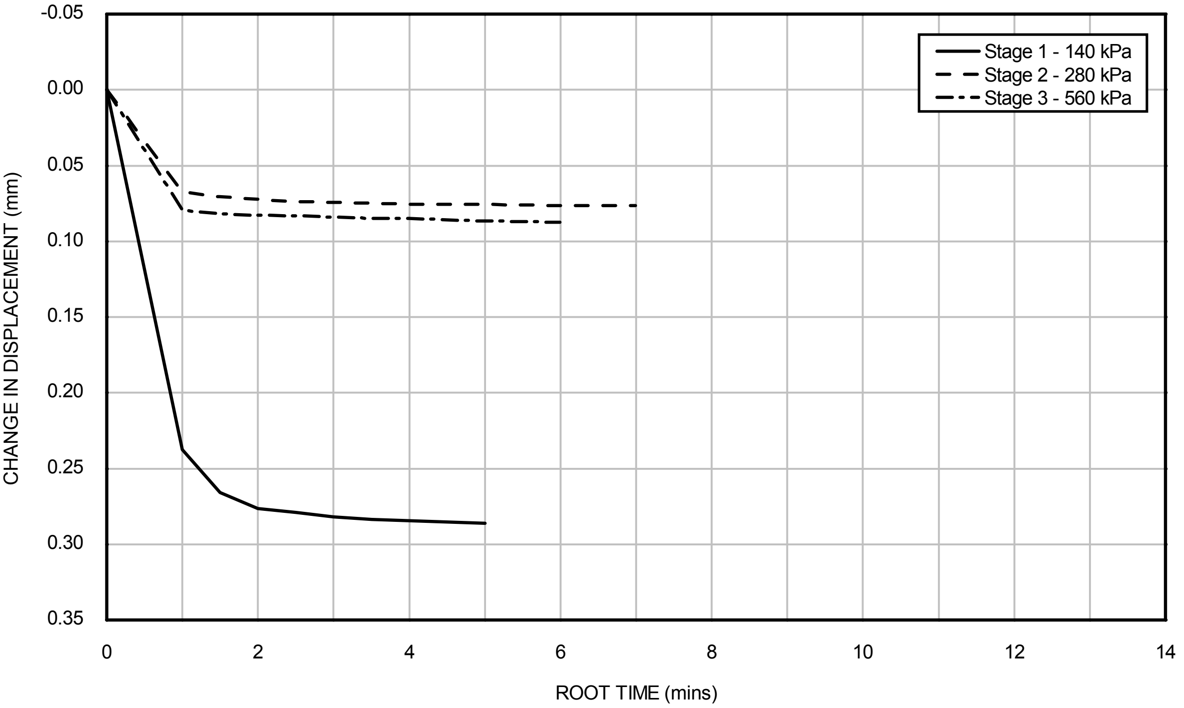


SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	90	90	180	180	360	360
Residual shear stress τ_n (kPa)	50.5	50.0	106.8	99.7	206.0	198.6
Mean linear displacement at end of shearing stage (mm)	20.1	206.2	19.8	210.4	20.1	206.2
Angle of residual shear resistance °	29.0	28.7	30.6	28.9	29.7	28.9

BOREHOLE : HKZ1-BH06-SA
SAMPLE : 12BagA
DEPTH (m) : 9.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	9 %

BOREHOLE : HKZ1-BH06-SA

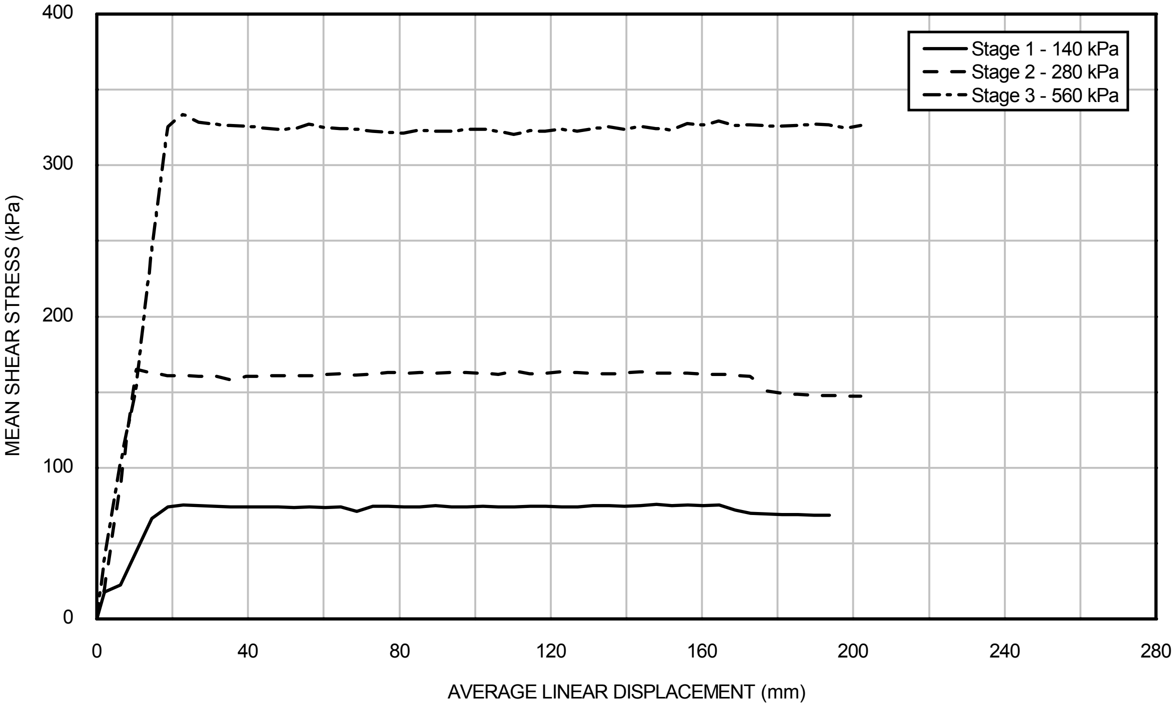
SAMPLE : 35BagB

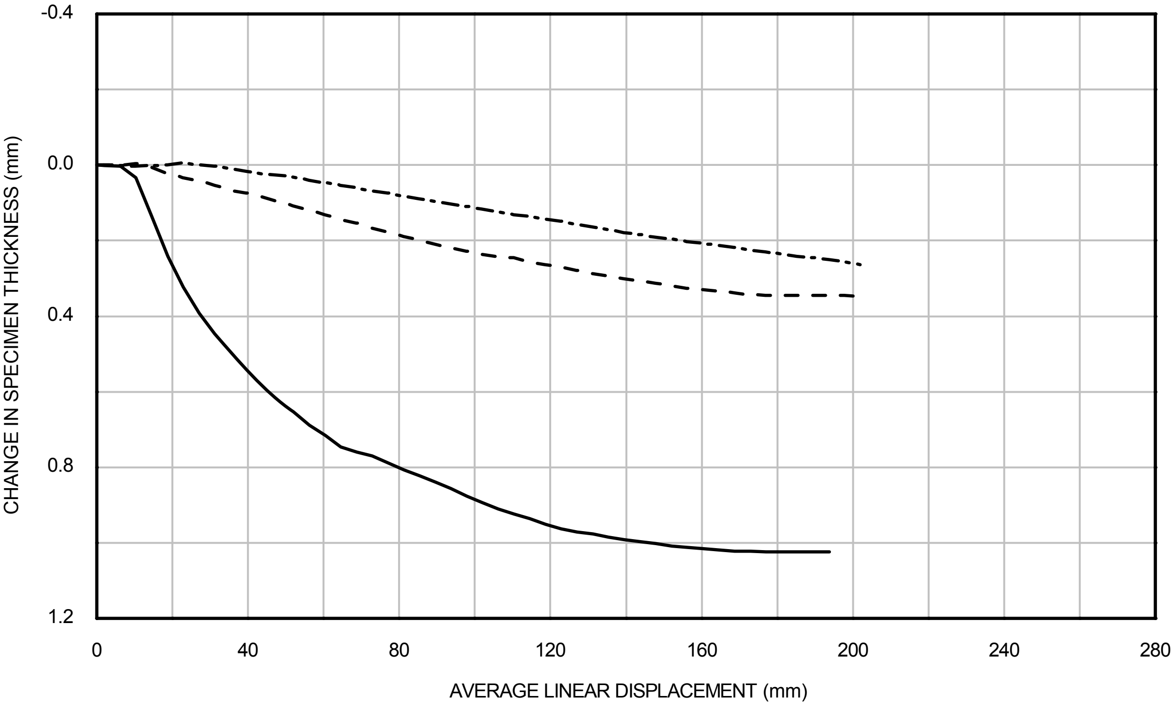
DEPTH (m) : 30.05

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

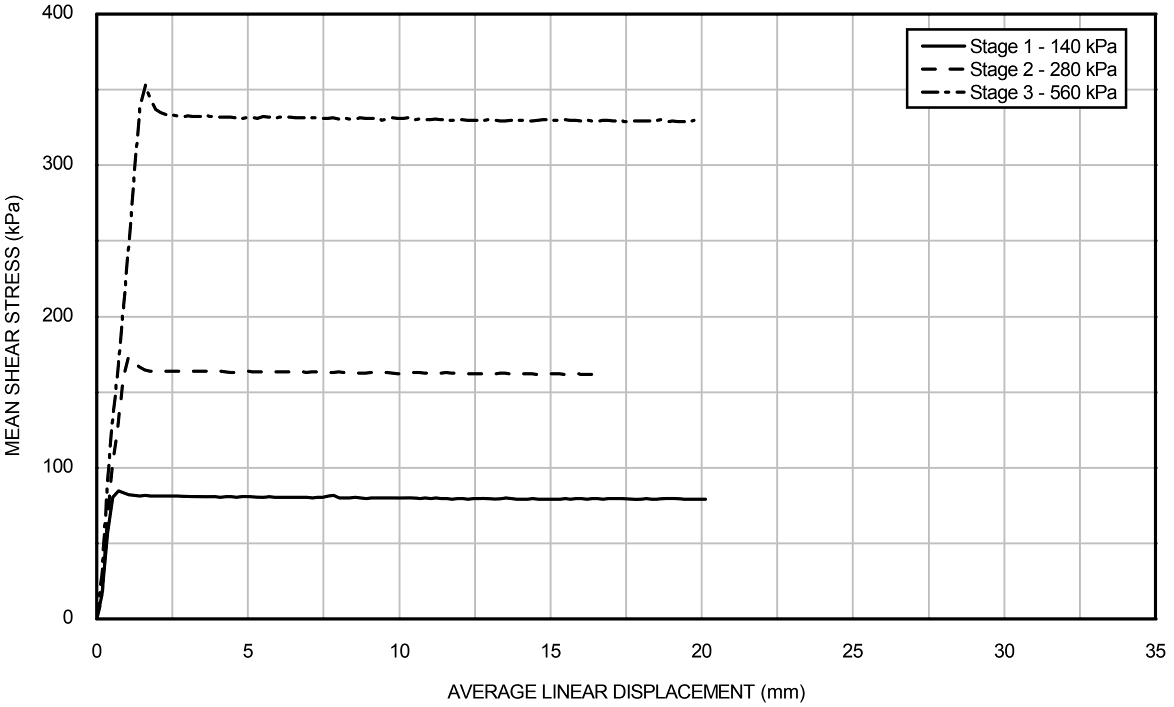


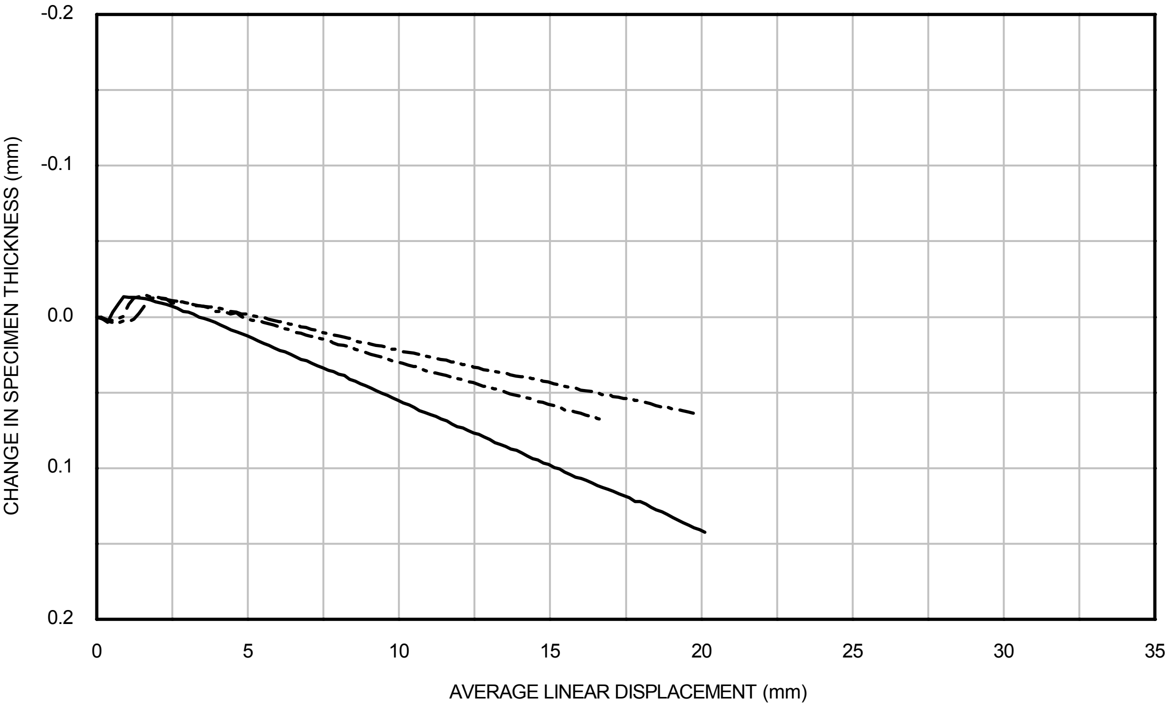


BOREHOLE	: HKZ1-BH06-SA
SAMPLE	: 35BagB
DEPTH (m)	: 30.05

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES





BOREHOLE : HKZ1-BH06-SA

SAMPLE : 35BagB

DEPTH (m) : 30.05

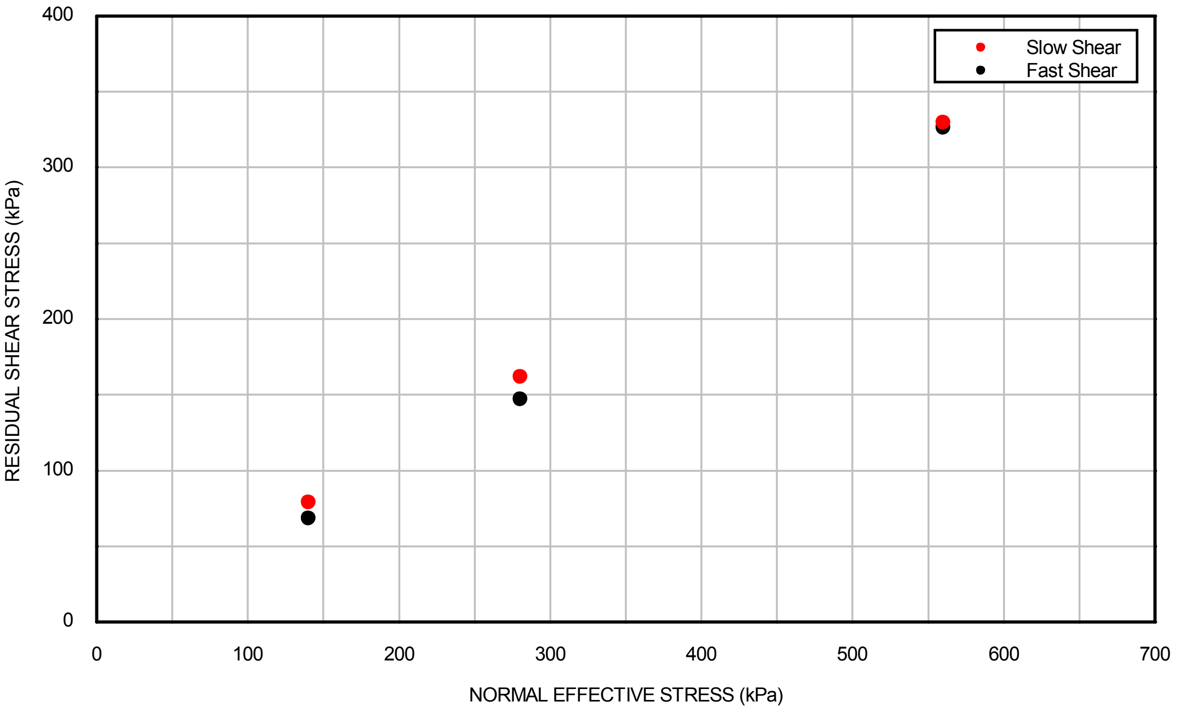
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 11/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH06-SA_35BagB_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	140	140	280	280	560	560
Residual shear stress τ_n (kPa)	79.2	68.6	161.8	147.2	329.7	326.3
Mean linear displacement at end of shearing stage (mm)	20.1	193.7	16.7	202.1	19.8	202.0
Angle of residual shear resistance °	29.5	26.1	30.1	27.8	30.5	30.2

BOREHOLE : HKZ1-BH06-SA
SAMPLE : 35BagB
DEPTH (m) : 30.05

Date:20/10/2016
Checked By : PH

Date:20/10/2016
Checked By : PH

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES

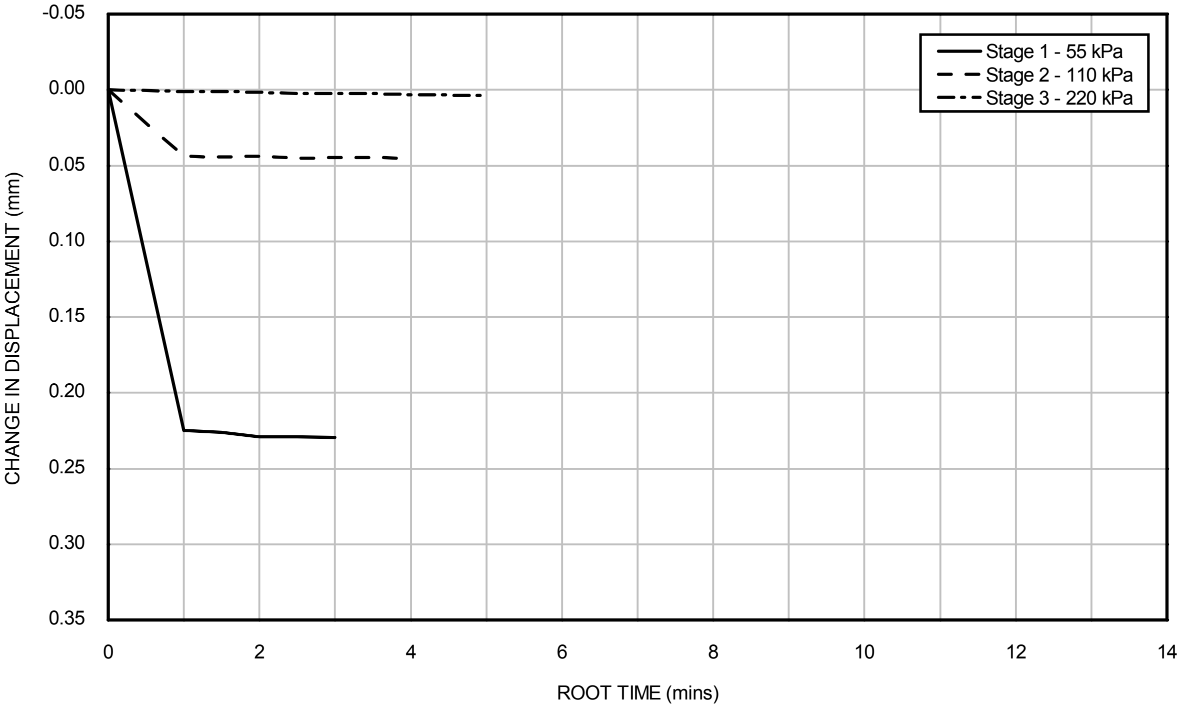
Date: 10/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_7BagA_R3.OPJ

Date:20/10/2016 Checked By: PH

Date:20/10/2016 Checked By: PH



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	10 %

BOREHOLE : HKZ1-BH07-SA

SAMPLE : 07BagA

DEPTH (m) : 5.50

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

Date: 10/10/2016

Drawn By : MSR

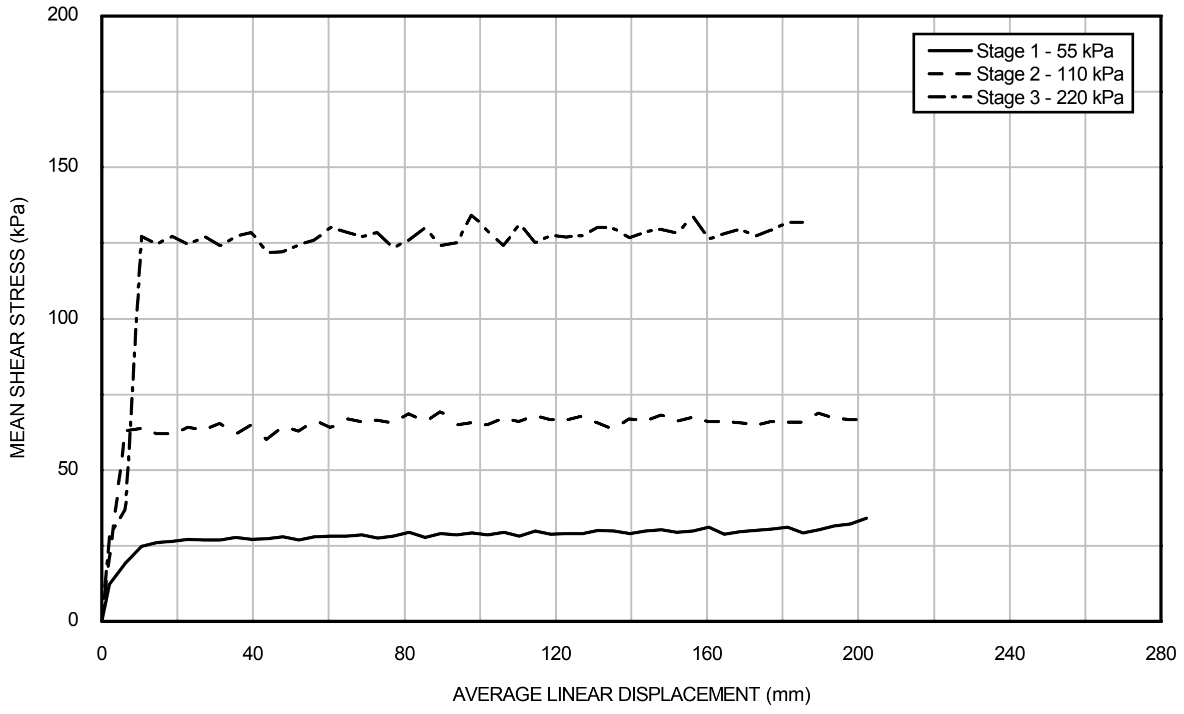
Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_7BagA_R3.OPJ

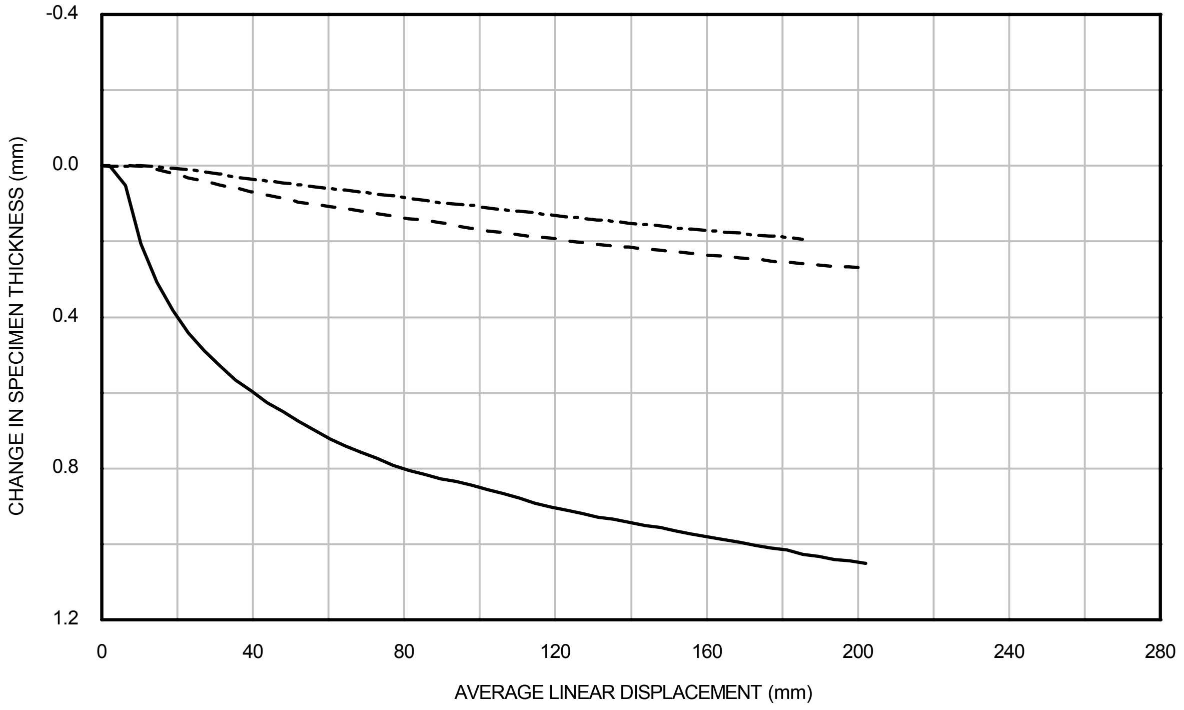
Date:20/10/2016

Date:20/10/2016

Checked By: PH

Checked By: PH





BOREHOLE	: HKZ1-BH07-SA
SAMPLE	: 07BagA
DEPTH (m)	: 5.50

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

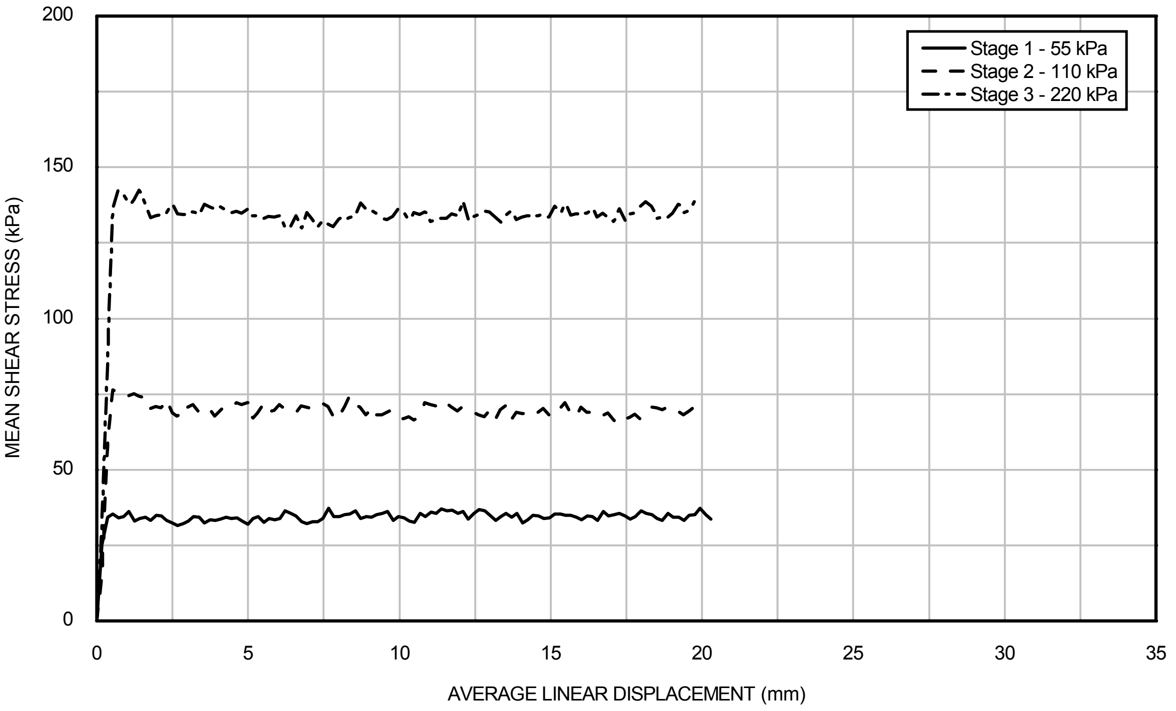
Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_7BagA_R3.OPJ

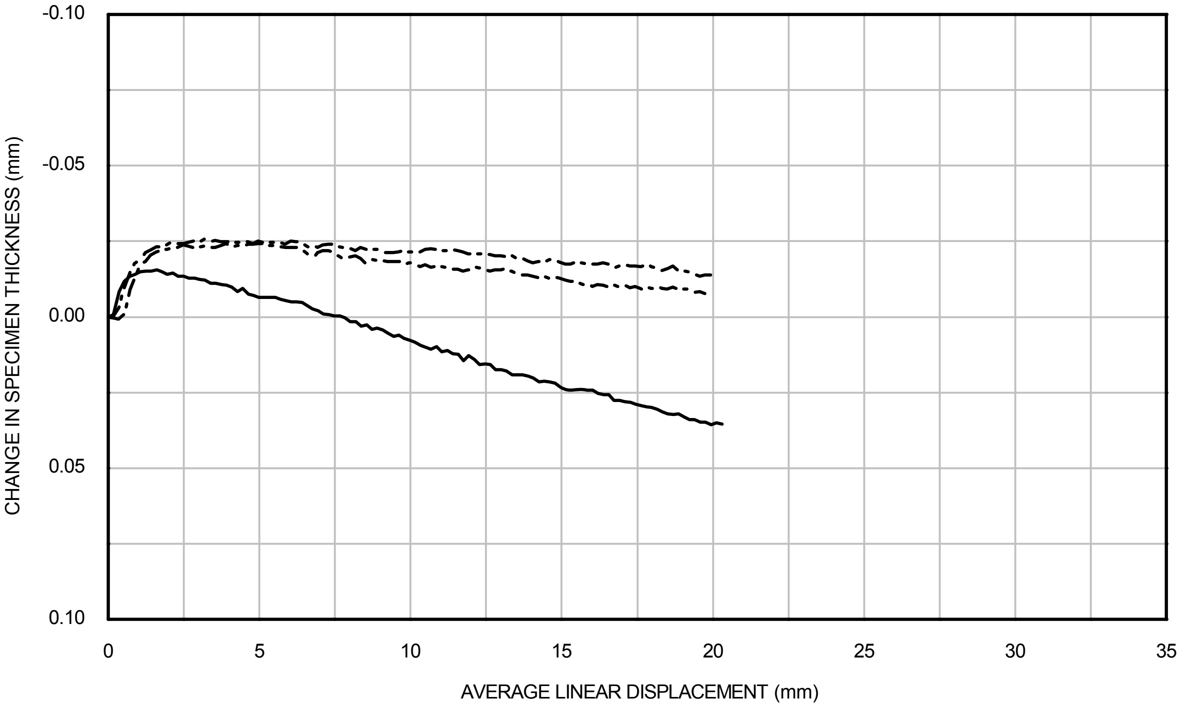
Date:20/10/2016

Date:20/10/2016

Checked By: PH

Checked By: PH





BOREHOLE : HKZ1-BH07-SA

SAMPLE : 07BagA

DEPTH (m) : 5.50

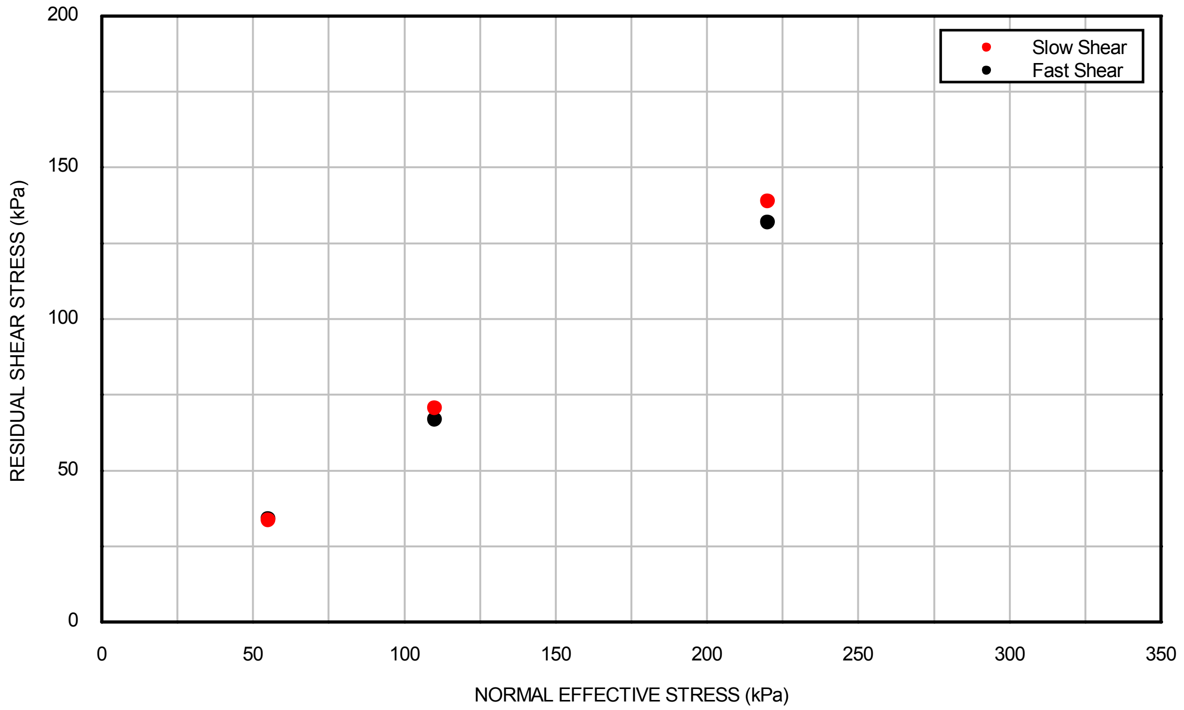
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 10/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_7BagA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	55	55	110	110	220	220
Residual shear stress τ_n (kPa)	33.6	34.1	70.6	66.8	138.9	131.9
Mean linear displacement at end of shearing stage (mm)	20.3	202.1	19.9	202.1	19.8	185.4
Angle of residual shear resistance °	31.5	31.8	32.7	31.2	32.2	30.9

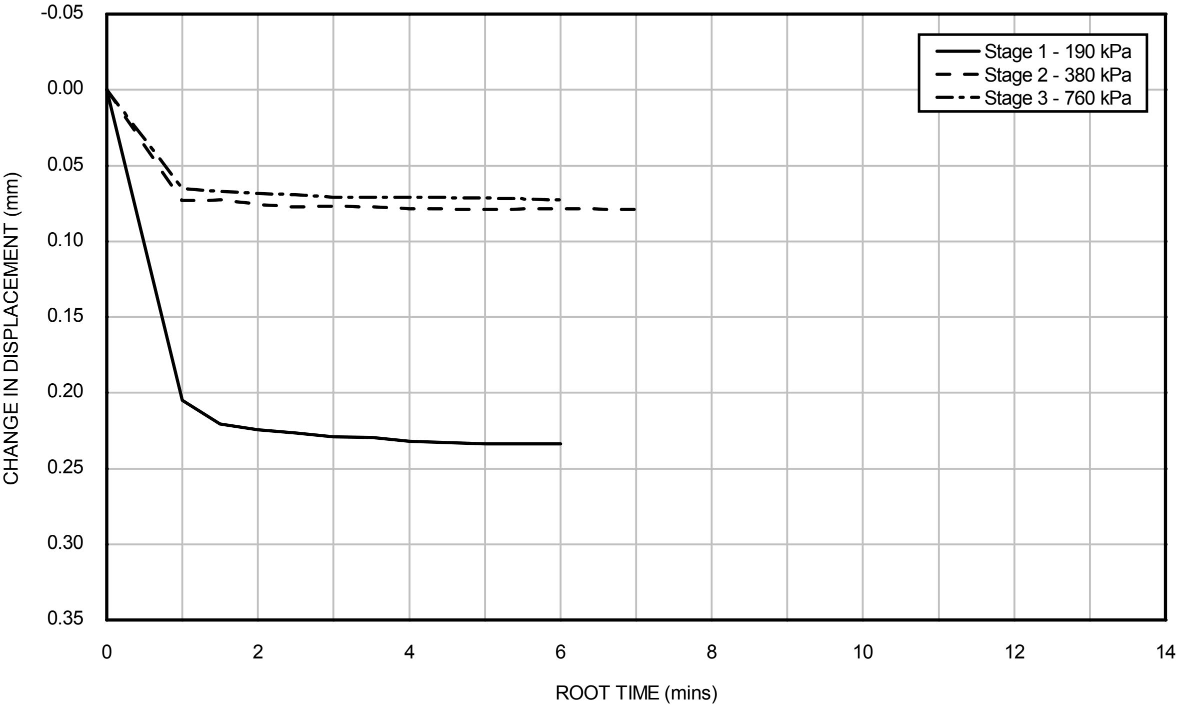
Date:20/10/2016 Checked By : PH

Date:20/10/2016 Checked By : PH

BOREHOLE : HKZ1-BH07-SA
SAMPLE : 07BagA
DEPTH (m) : 5.50

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	9 %

BOREHOLE	: HKZ1-BH07-SA
SAMPLE	: 27BagA
DEPTH (m)	: 20.00

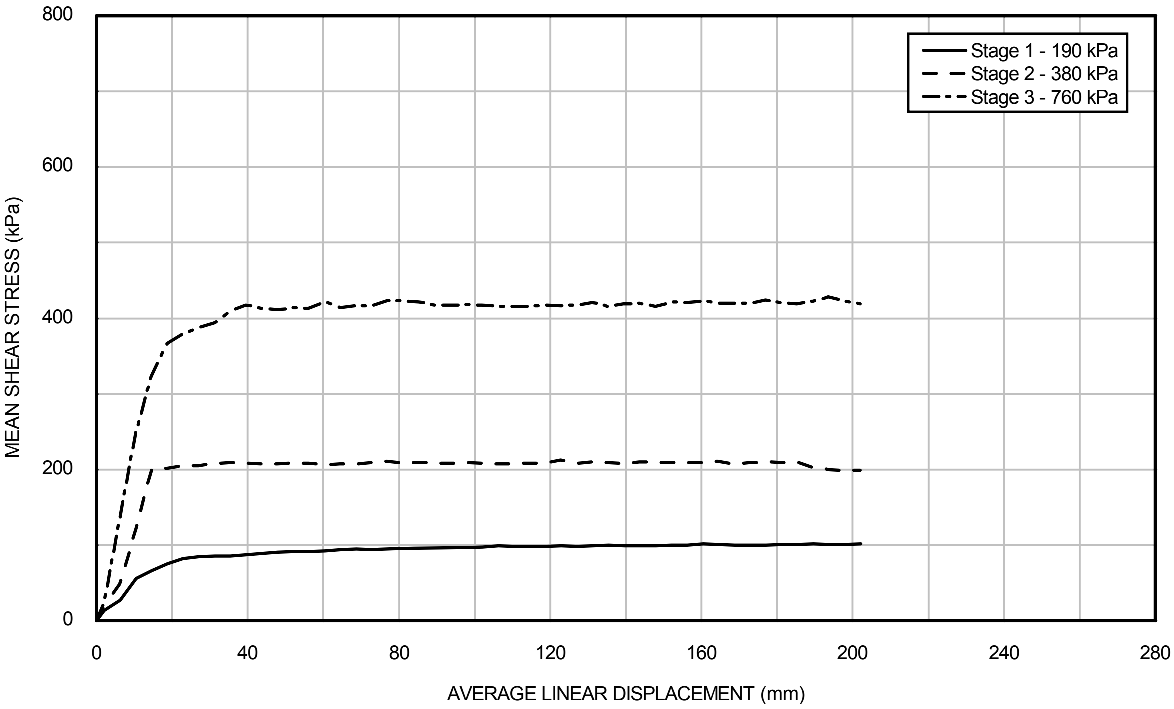
Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

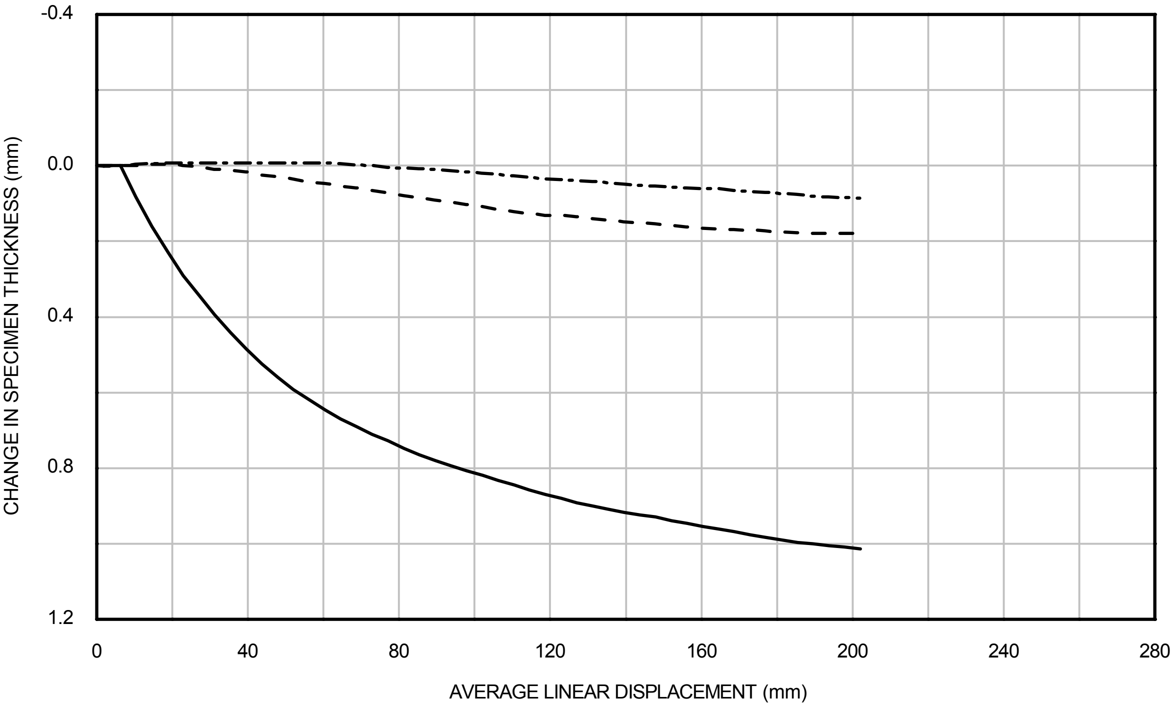
Date:20/10/2016 Checked By : PH

Date:20/10/2016 Checked By : PH

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

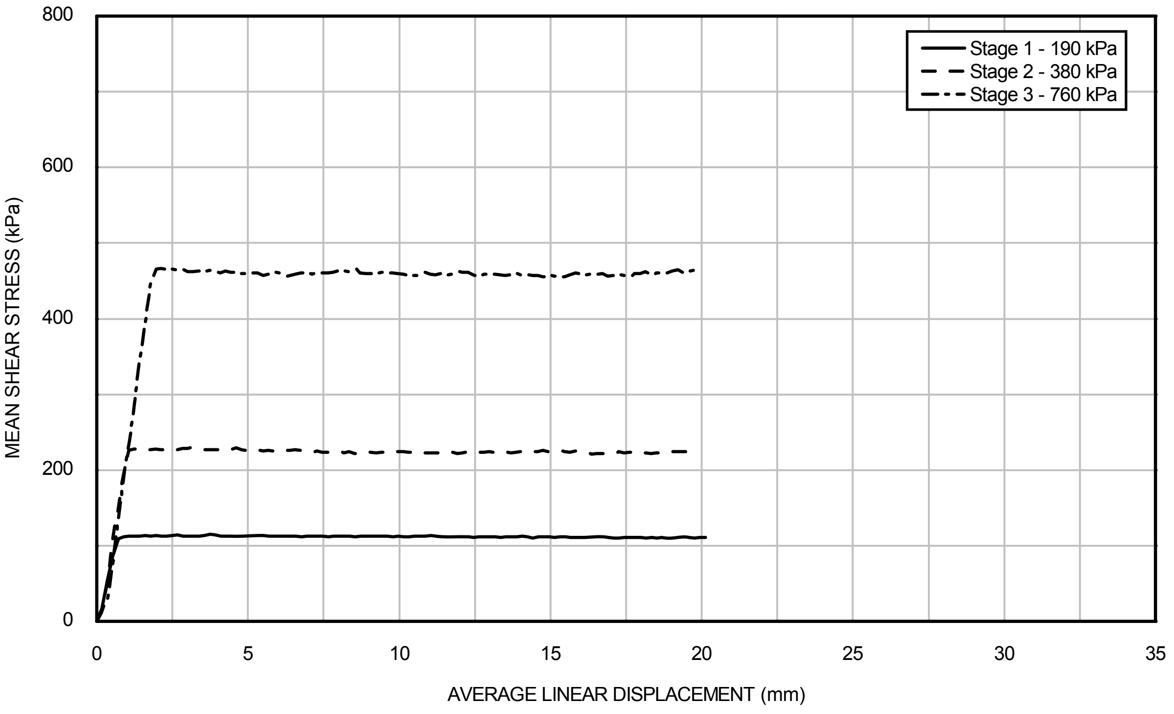


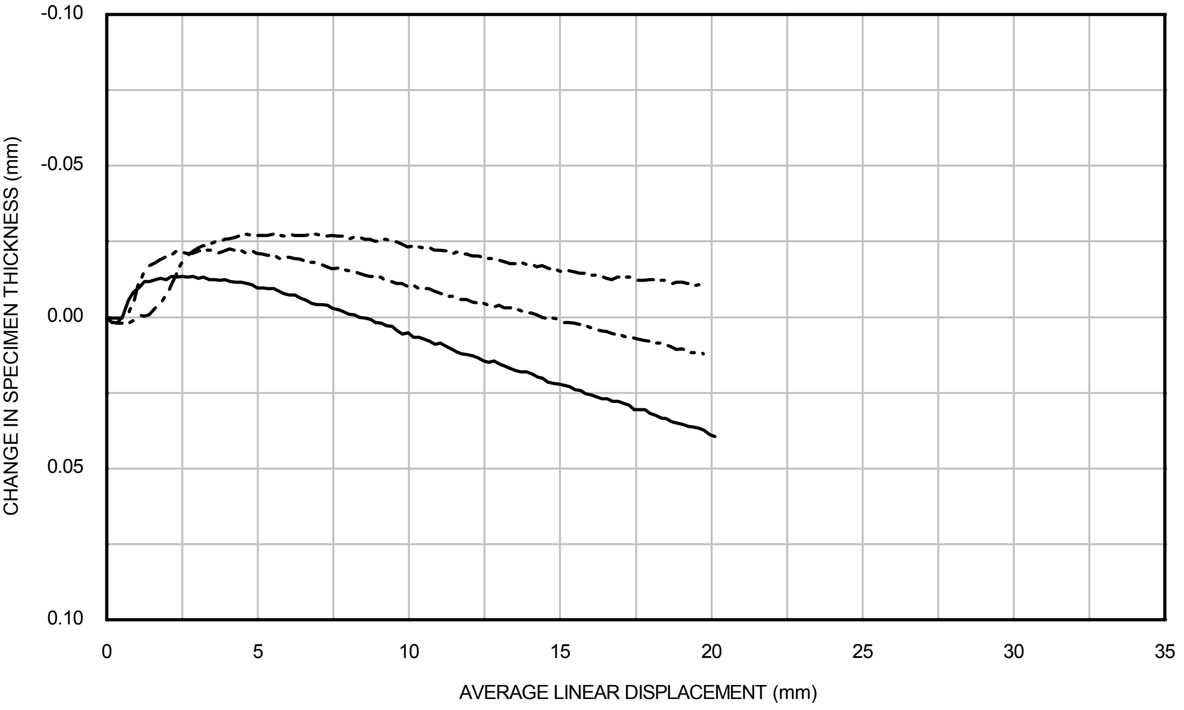


BOREHOLE	: HKZ1-BH07-SA
SAMPLE	: 27BagA
DEPTH (m)	: 20.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

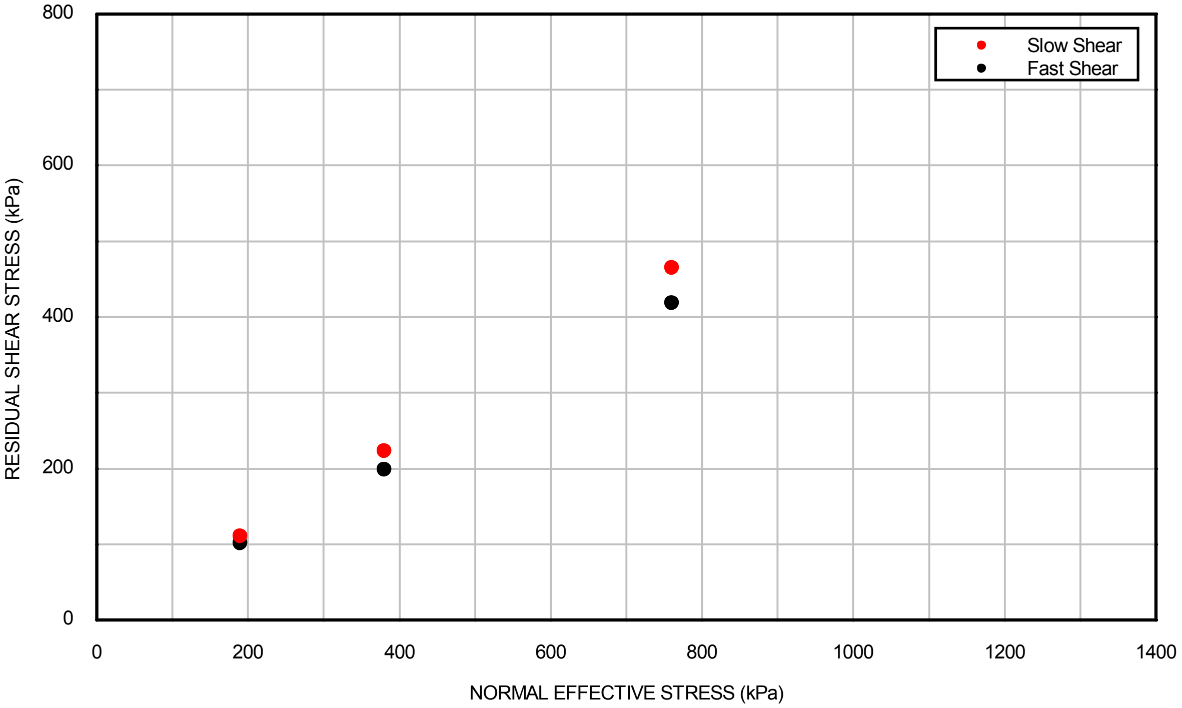




BOREHOLE	: HKZ1-BH07-SA
SAMPLE	: 27BagA
DEPTH (m)	: 20.00

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	190	190	380	380	760	760
Residual shear stress τ_n (kPa)	110.6	101.2	223.6	199.0	465.0	419.0
Mean linear displacement at end of shearing stage (mm)	20.1	202.1	19.8	202.1	19.2	202.0
Angle of residual shear resistance °	30.2	28.0	30.5	27.6	31.5	28.9

BOREHOLE : HKZ1-BH07-SA

SAMPLE : 27BagA

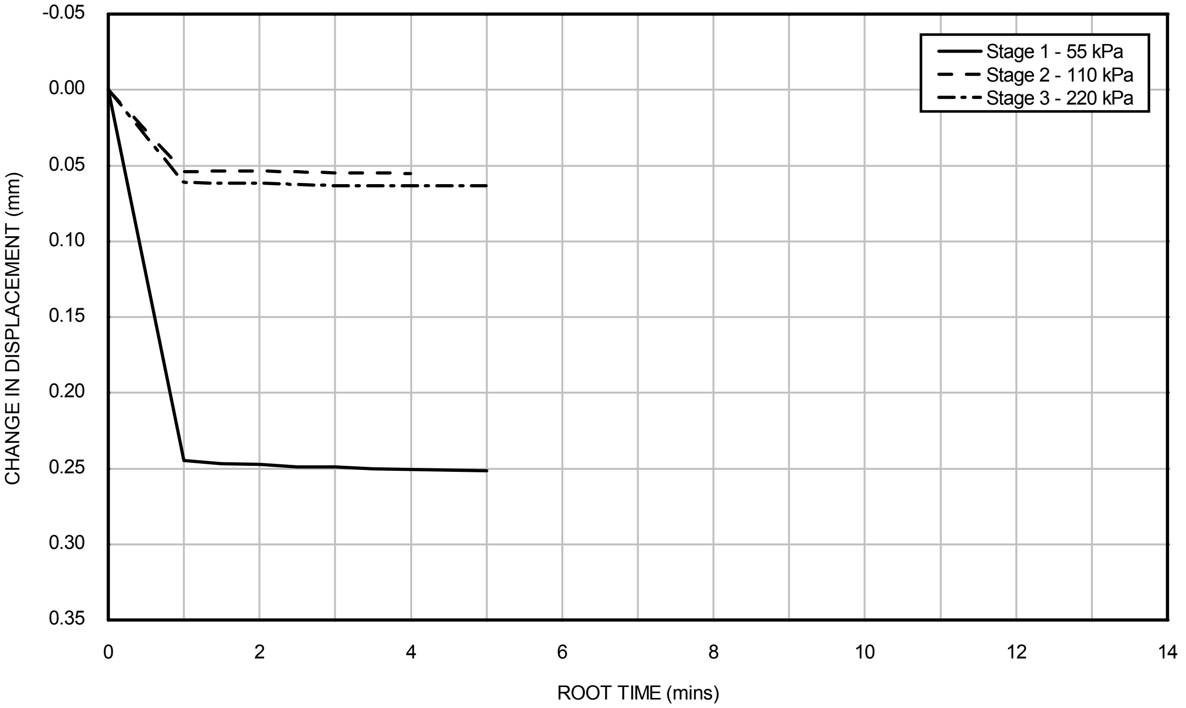
DEPTH (m) : 20.00

Checked By : PH Date:20/10/2016

Checked By : PH Date:20/10/2016

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES



INITIAL CONDITIONS

Sample Height	5 mm	Outer Radius	50 mm
Inner Radius	35 mm	Water Content	9 %

BOREHOLE	: HKZ1-BH08-SA
SAMPLE	: 07BagA
DEPTH (m)	: 5.50

Tested in accordance with BS1377 : Part 7 : 1990 : Clause 6

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

CONSOLIDATION STAGE

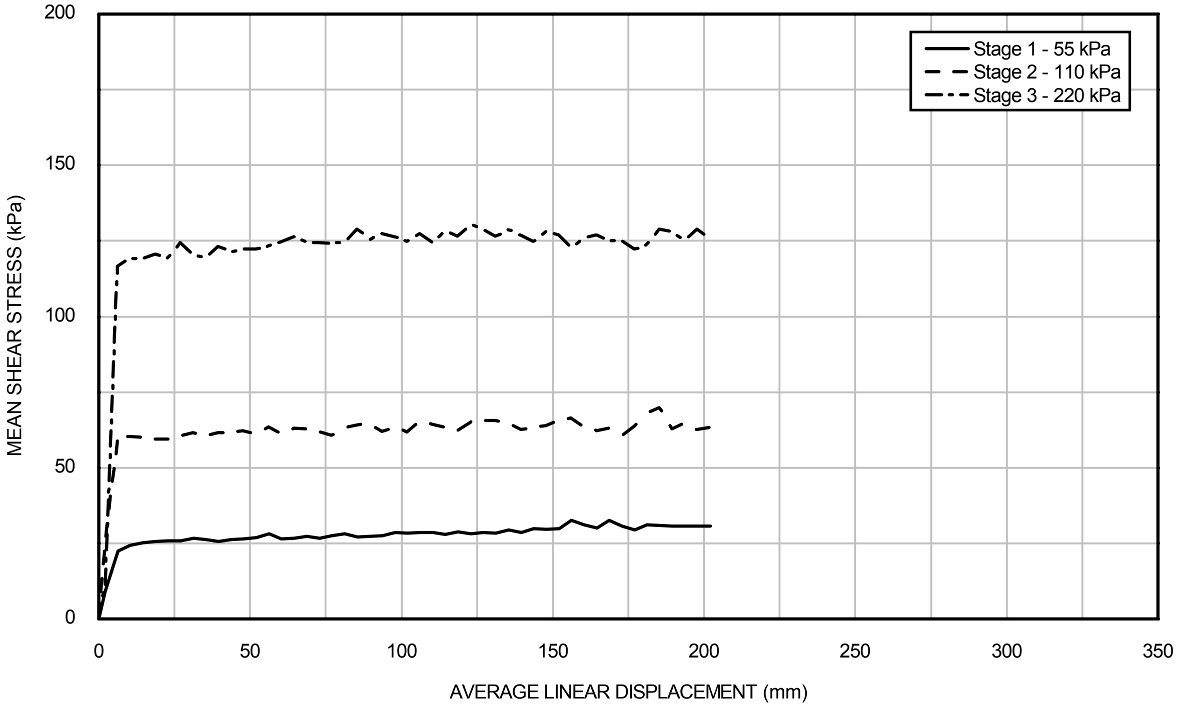
Date: 11/10/2016

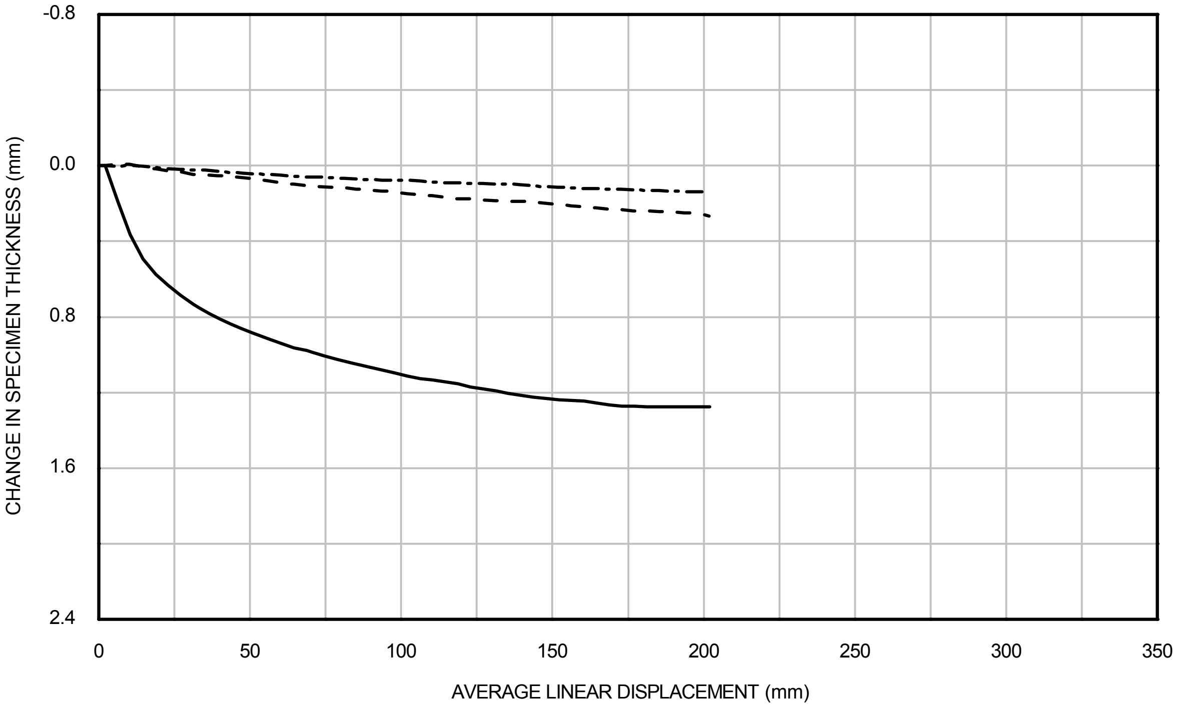
Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH08-SA_7BagA_R3.OPJ

Date:20/10/2016 Date:20/10/2016

Checked By: PH Checked By: PH





BOREHOLE : HKZ1-BH08-SA

SAMPLE : 07BagA

DEPTH (m) : 5.50

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

FAST SHEARING STAGES

Date: 11/10/2016

Drawn By : MSR

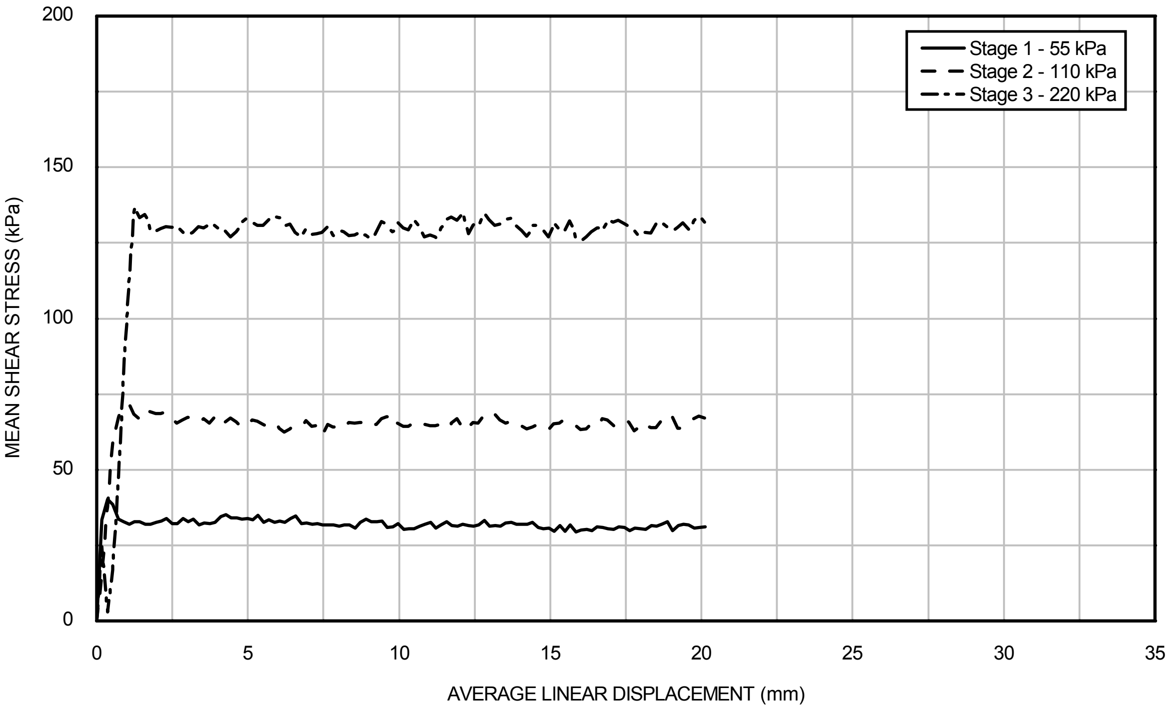
Filename: J11335 \ SHEAR \ HKZ1-BH08-SA_7BagA_R3.OPJ

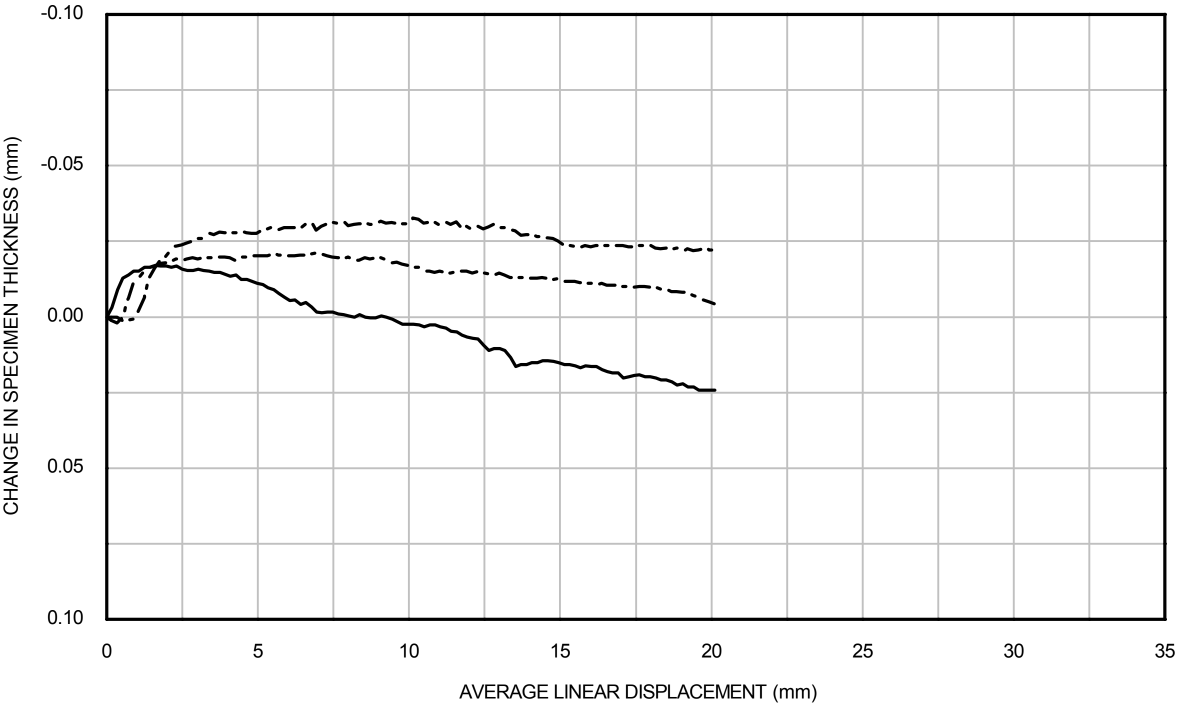
Date:20/10/2016

Date:20/10/2016

Checked By: PH

Checked By: PH





BOREHOLE : HKZ1-BH08-SA

SAMPLE : 07BagA

DEPTH (m) : 5.50

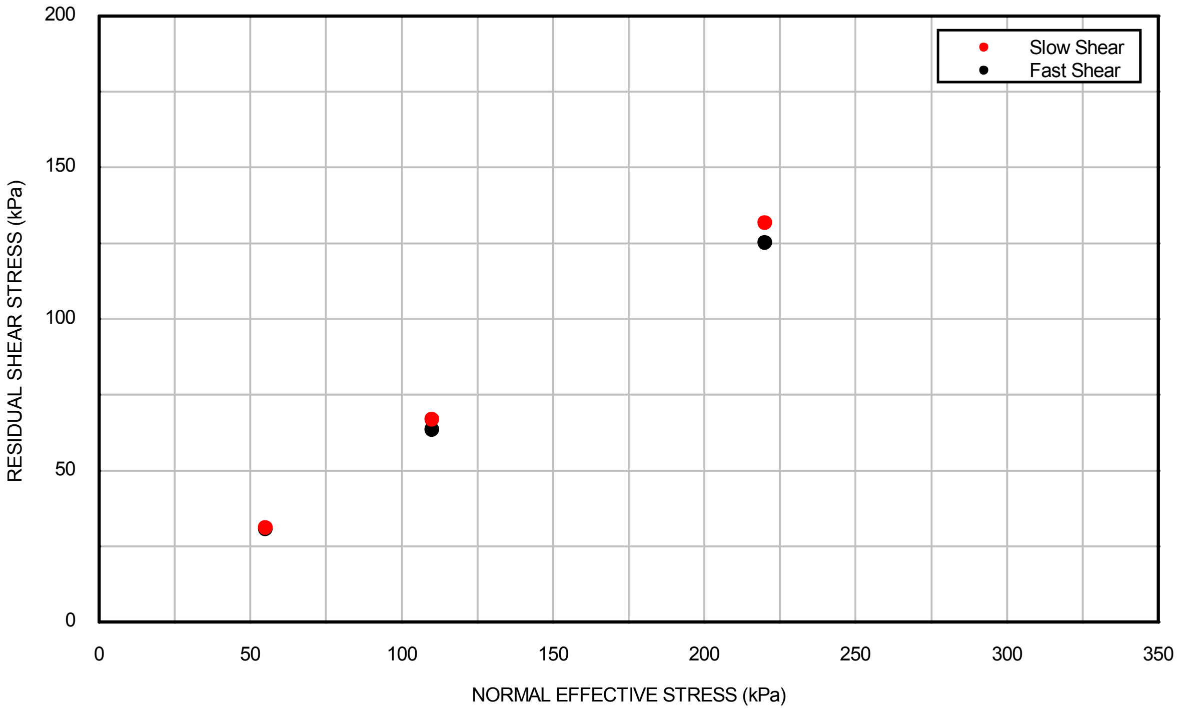
DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SLOW SHEARING STAGES

Date: 11/10/2016

Drawn By : MSR

Filename: J11335 \ SHEAR \ HKZ1-BH08-SA_7BagA_R3.OPJ



SHEARING	Shear Stage 1		Shear Stage 2		Shear Stage 3	
Rate of angular displacement (° / min)	0.16	674	0.16	674	0.16	674
Normal effective stress σ'_n (kPa)	55	55	110	110	220	220
Residual shear stress τ_n (kPa)	31.0	30.7	66.8	63.5	131.6	125.1
Mean linear displacement at end of shearing stage (mm)	20.1	202.1	20.1	202.1	20.1	202.0
Angle of residual shear resistance °	29.4	29.2	31.3	30.0	30.9	29.6

Date:20/10/2016 Date:20/10/2016

Checked By : PH Checked By : PH

BOREHOLE	: HKZ1-BH08-SA
SAMPLE	: 07BagA
DEPTH (m)	: 5.50

DETERMINATION OF RESIDUAL STRENGTH USING THE SMALL RING SHEAR TEST - SOIL - SOIL

SHEARING STAGES

Date: 07/09/2016

Drawn By : MSR

Template Issue: 2

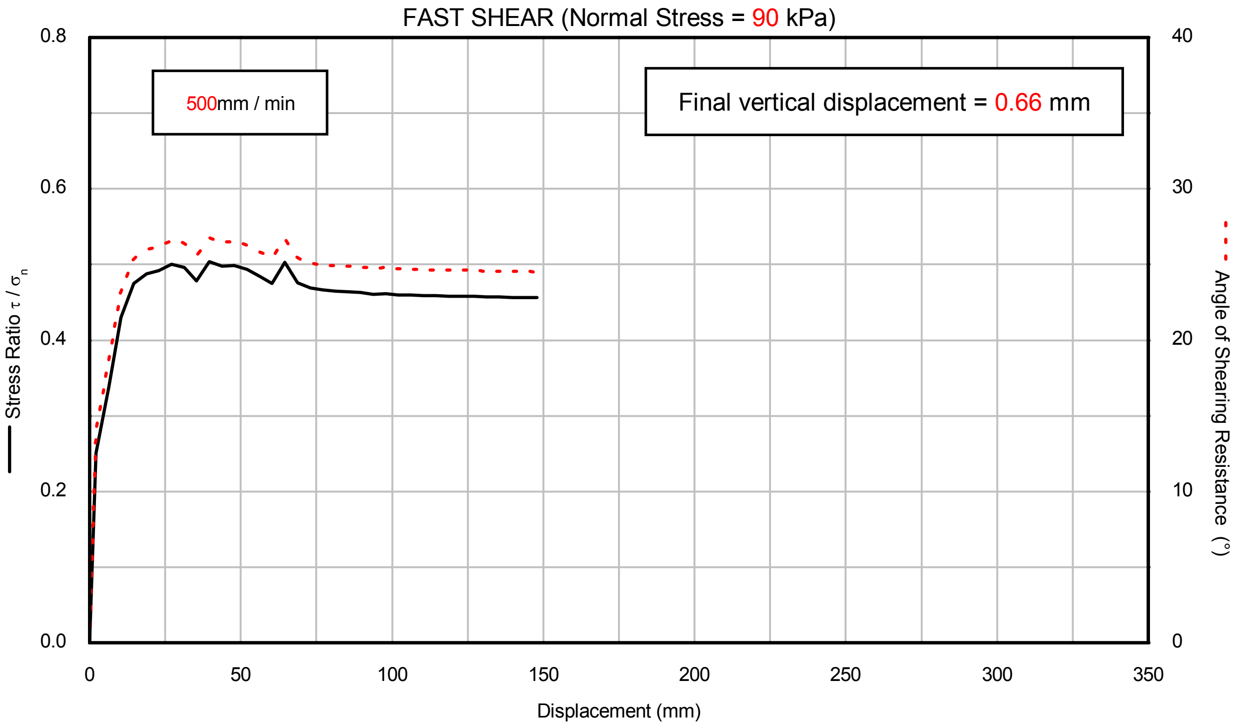
Filename: J11335 \ SHEAR \ HKZ1-BH01-SA_9BagA_RS.OPJ

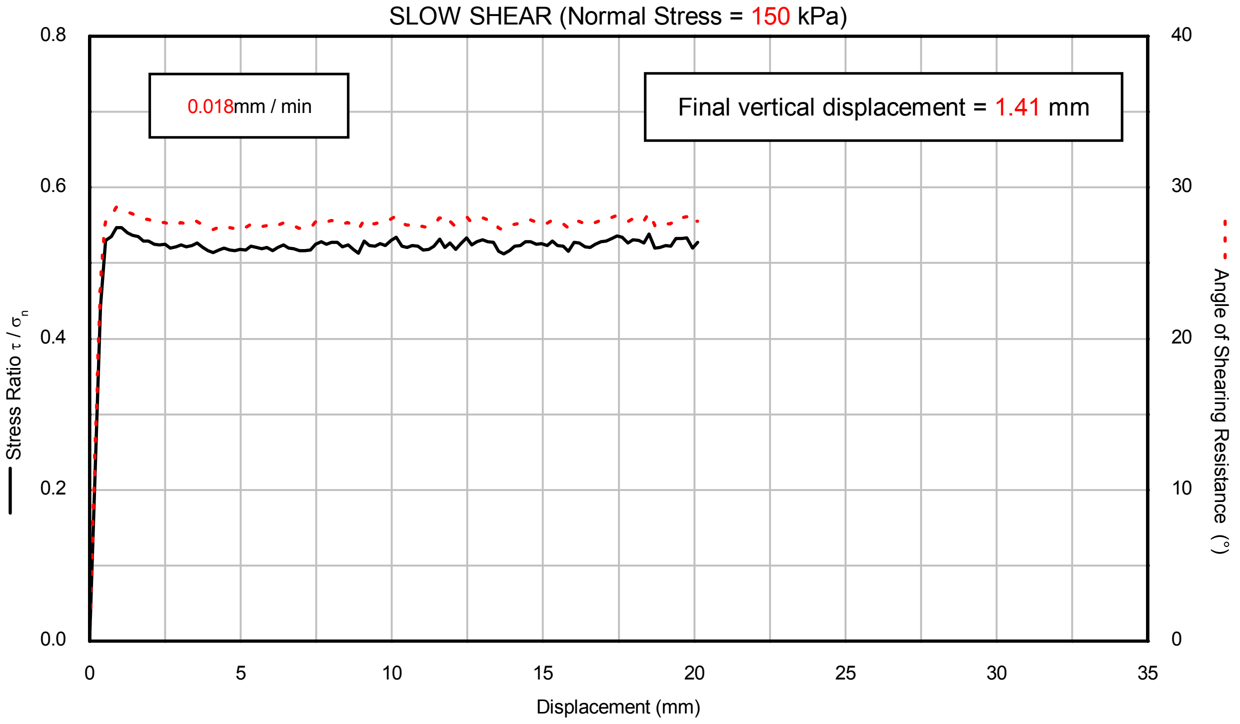
Date: 09/09/2016

Date: 04/10/2016

Checked By : ALB

Approved By : PH





Interface Roughness (μm) : 11.27

Borehole : HKZ1-BH01-SA

Sample : 09BagA

Depth (m) : 7.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 26/09/2016

Drawn By : ALB

Template Issue: 2

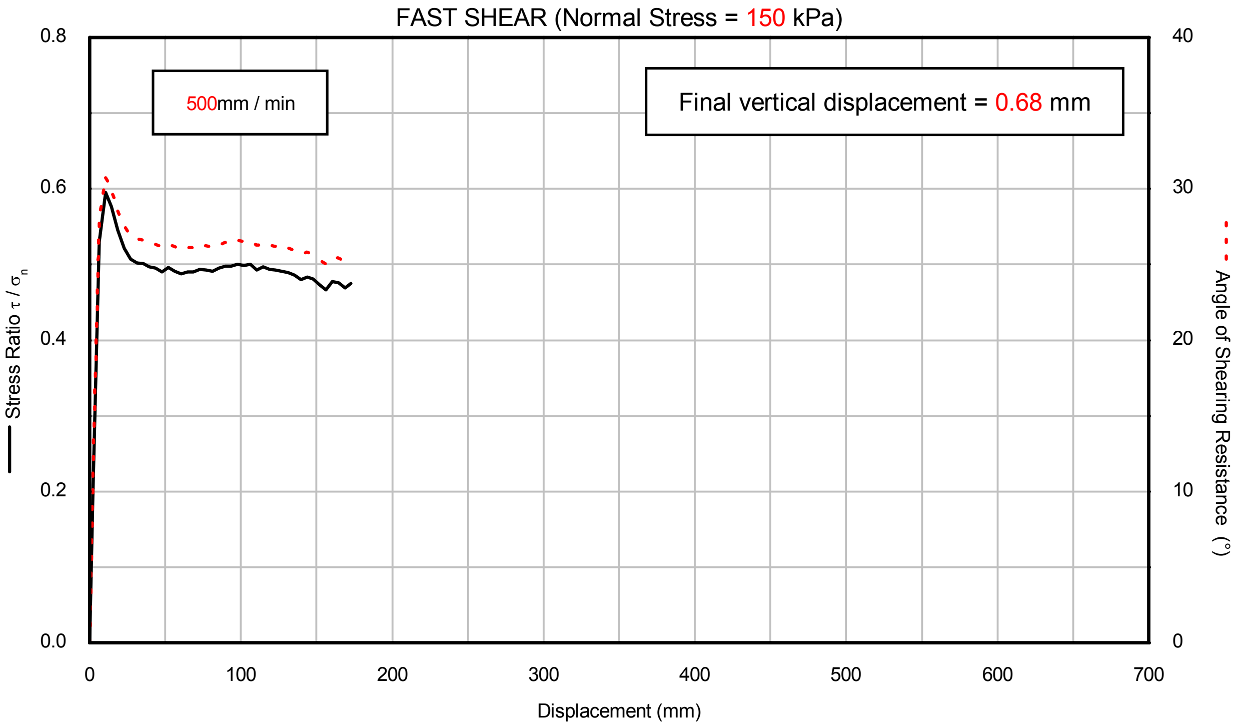
Filename: J11335 \ SHEAR \ HKZ1-BH01-SA_29BagA_RS.OPJ

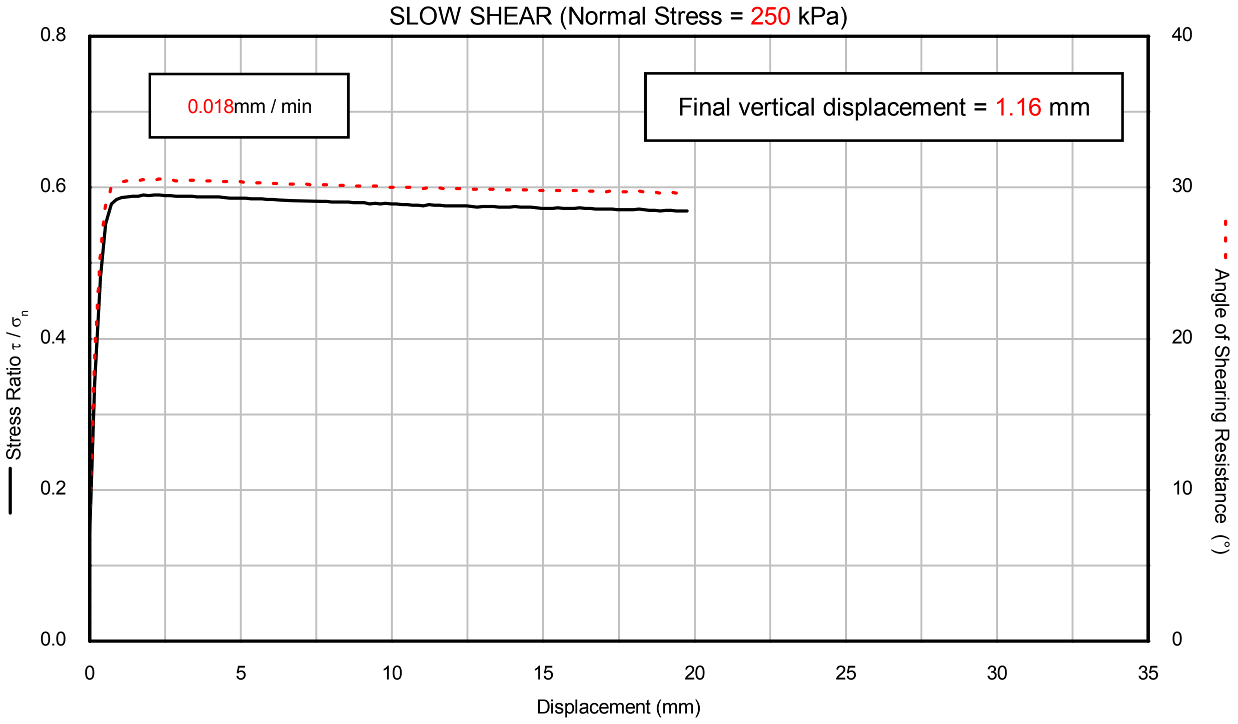
Date: 10/10/2016

Date: 10/10/2016

Checked By : PH

Approved By : PH





Interface Roughness (µm) : 9.81

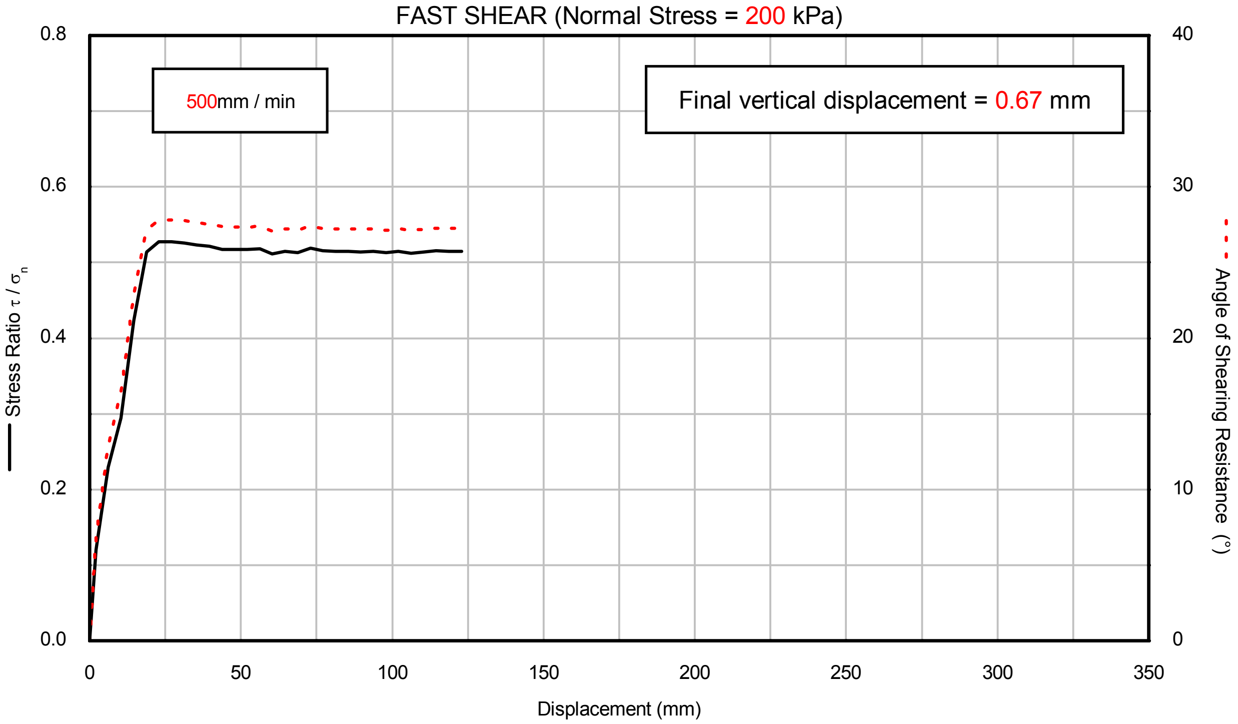
Borehole : HKZ1-BH01-SA

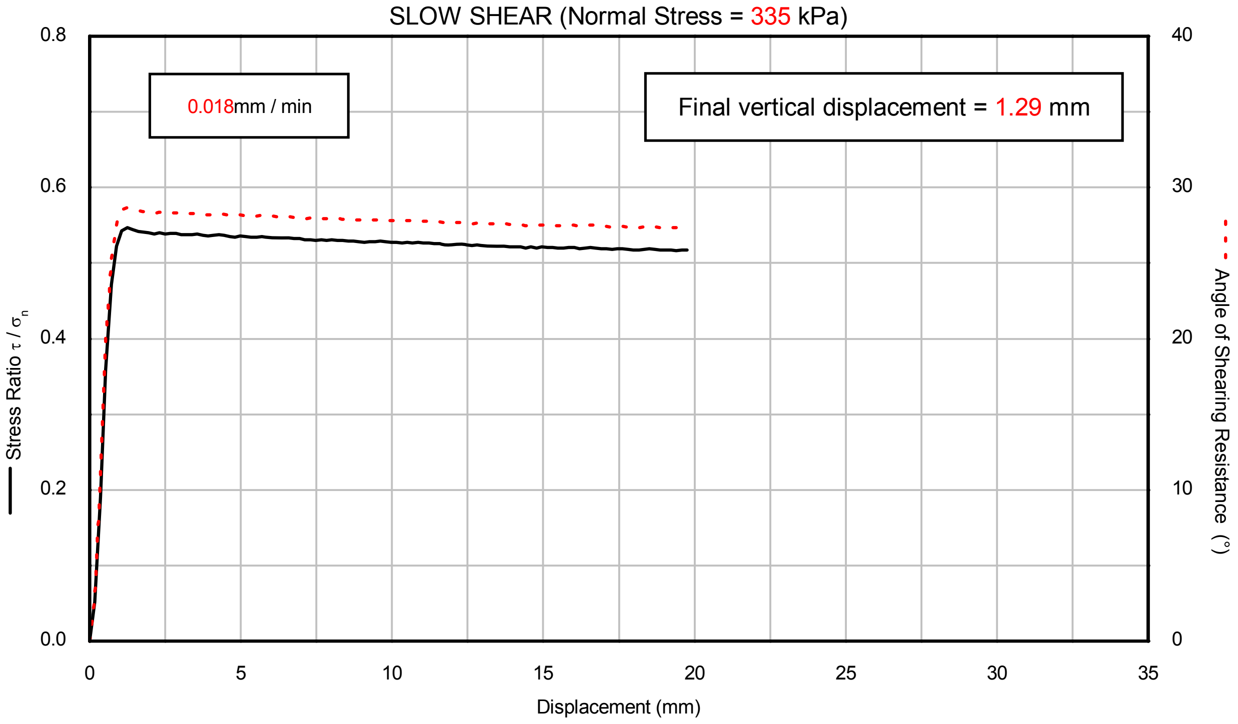
Sample : 29BagA

Depth (m) : 26.50

RING SHEAR TEST
SOIL / STEEL INTERFACE

Drawn By : MSR
Date: 08/09/2016
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH01-SA_46BagA_RS.OPJ
Date: 09/09/2016
Date: 04/10/2016
Checked By : ALB
Approved By : PH



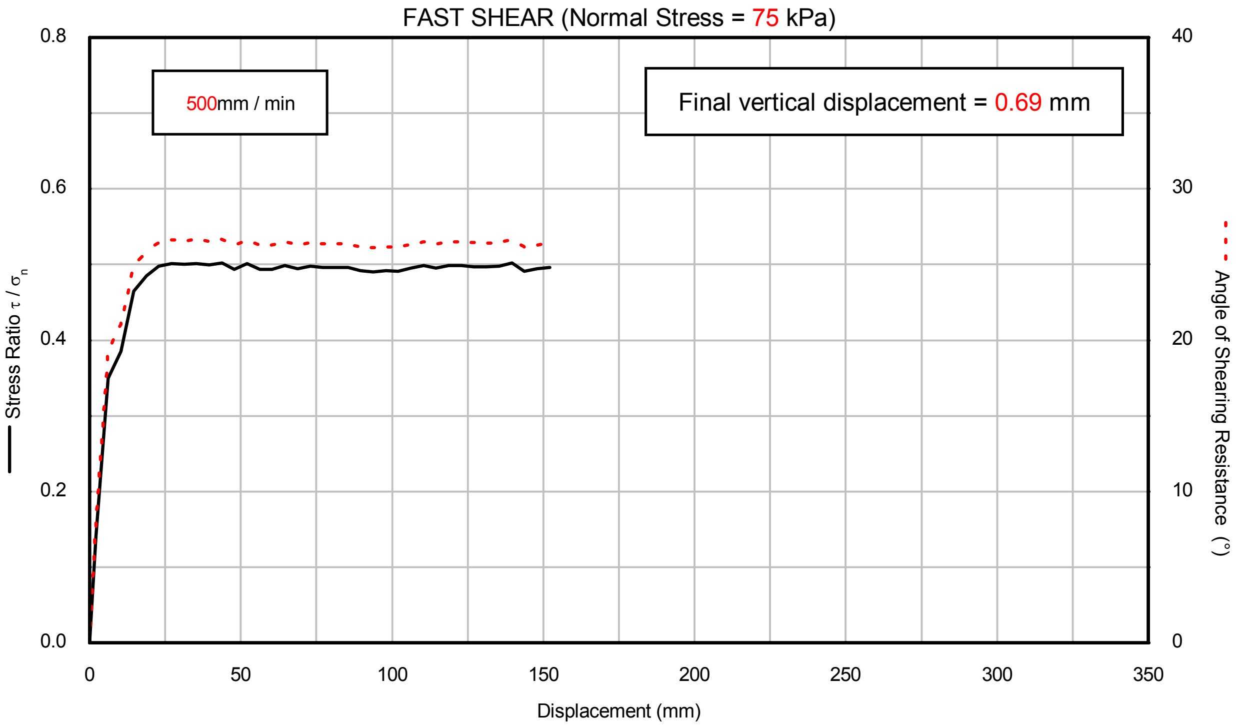


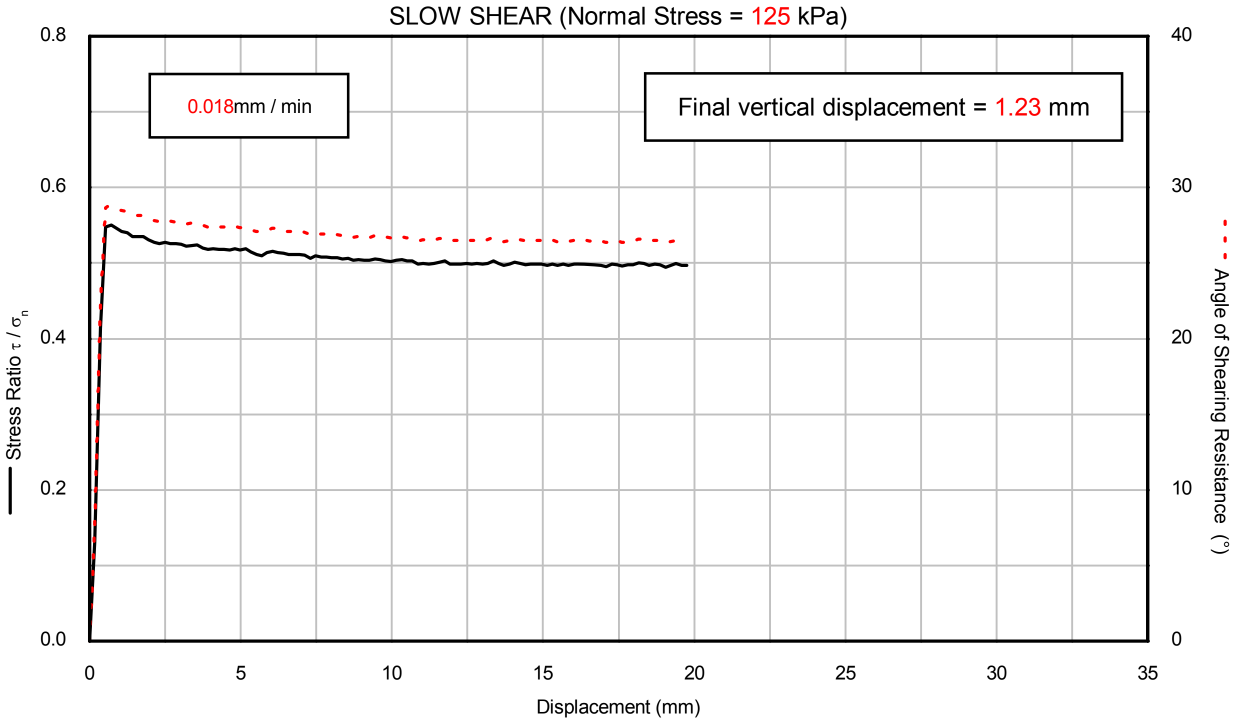
Interface Roughness (μm) : 8.04

Borehole : HKZ1-BH01-SA
Sample : 46BagA
Depth (m) : 43.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 05/09/2016
Drawn By : MSR
Template Issue: 2
Date: 06/09/2016
Checked By : ALB
Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_9BagA_RS.OPJ
Date: 04/10/2016
Approved By : PH





Interface Roughness (μm) : 9.58	Borehole	:	HKZ1-BH02-SA
	Sample	:	09BagA
	Depth (m)	:	7.50

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 08/09/2016

Drawn By : MSR

Template Issue: 2

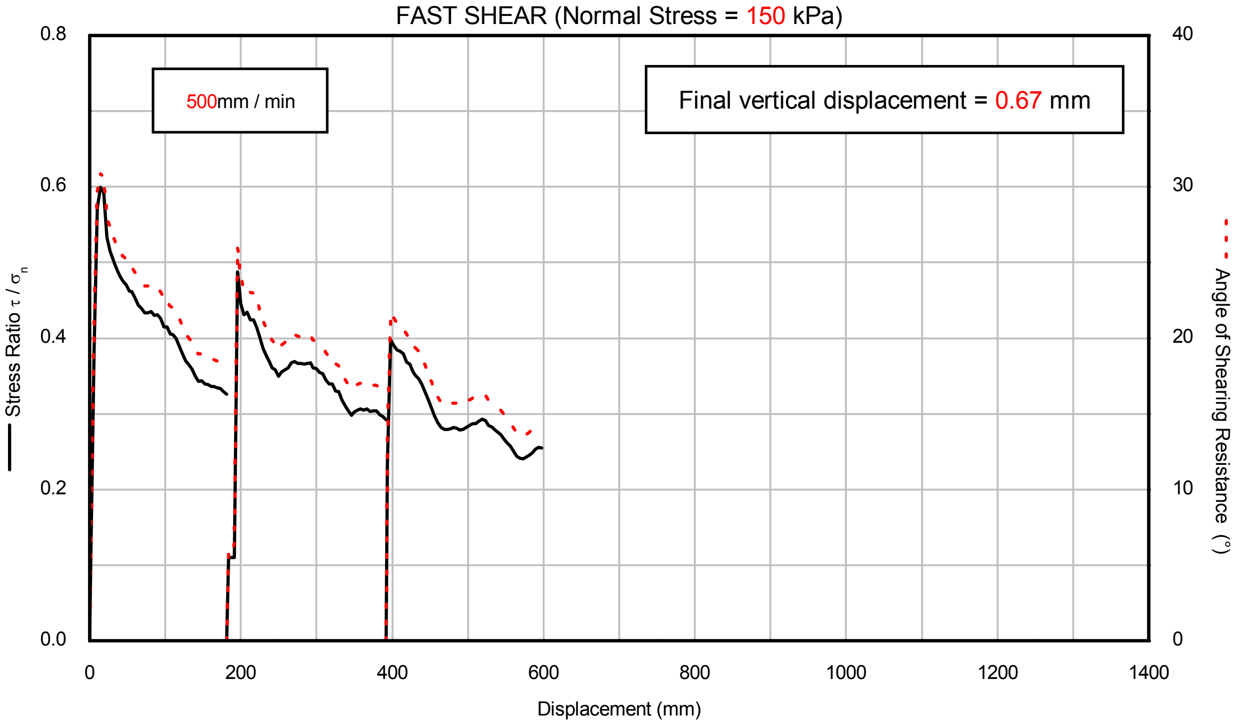
Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_16WaxD_RS.OPJ

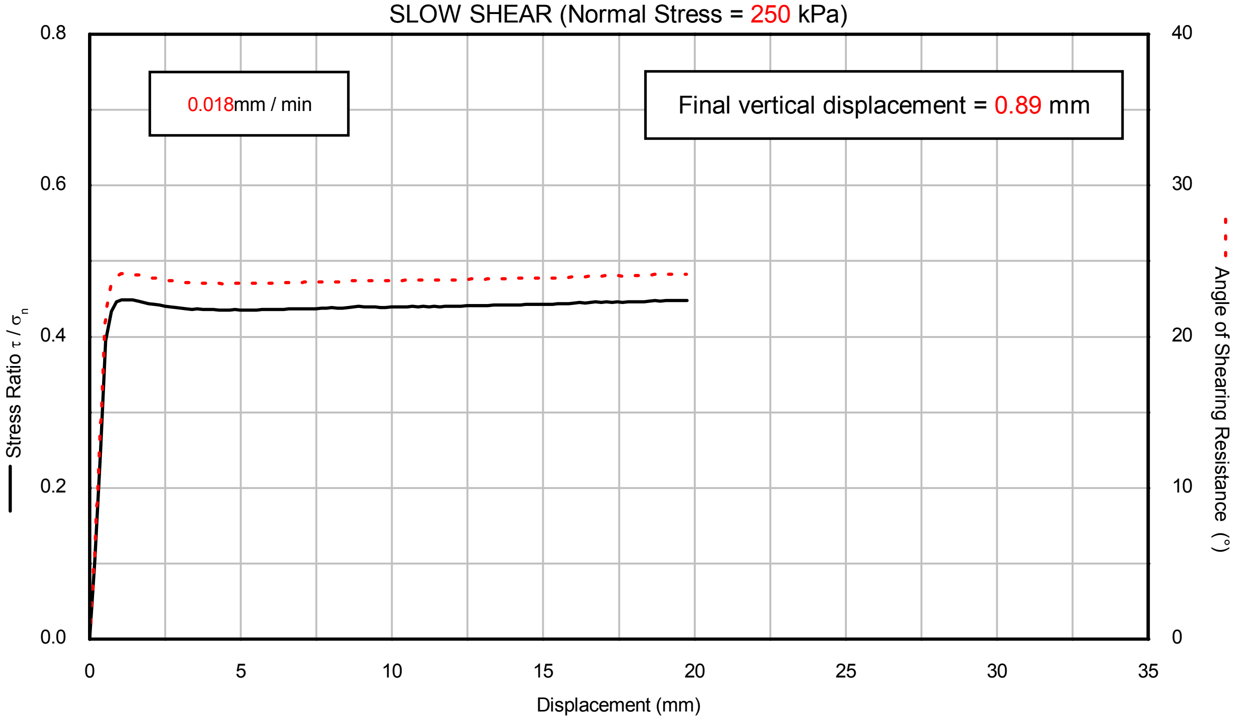
Date: 09/09/2016

Date: 04/10/2016

Checked By : ALB

Approved By : PH





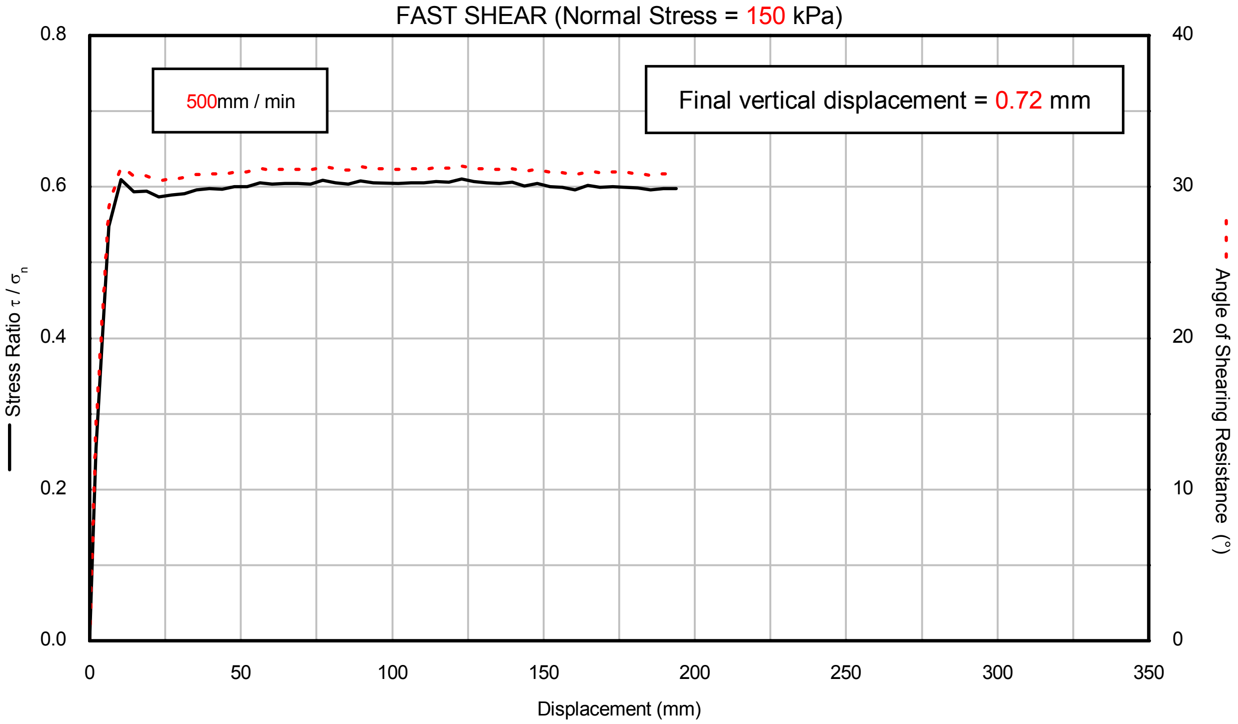
Interface Roughness (μm) : 9.81

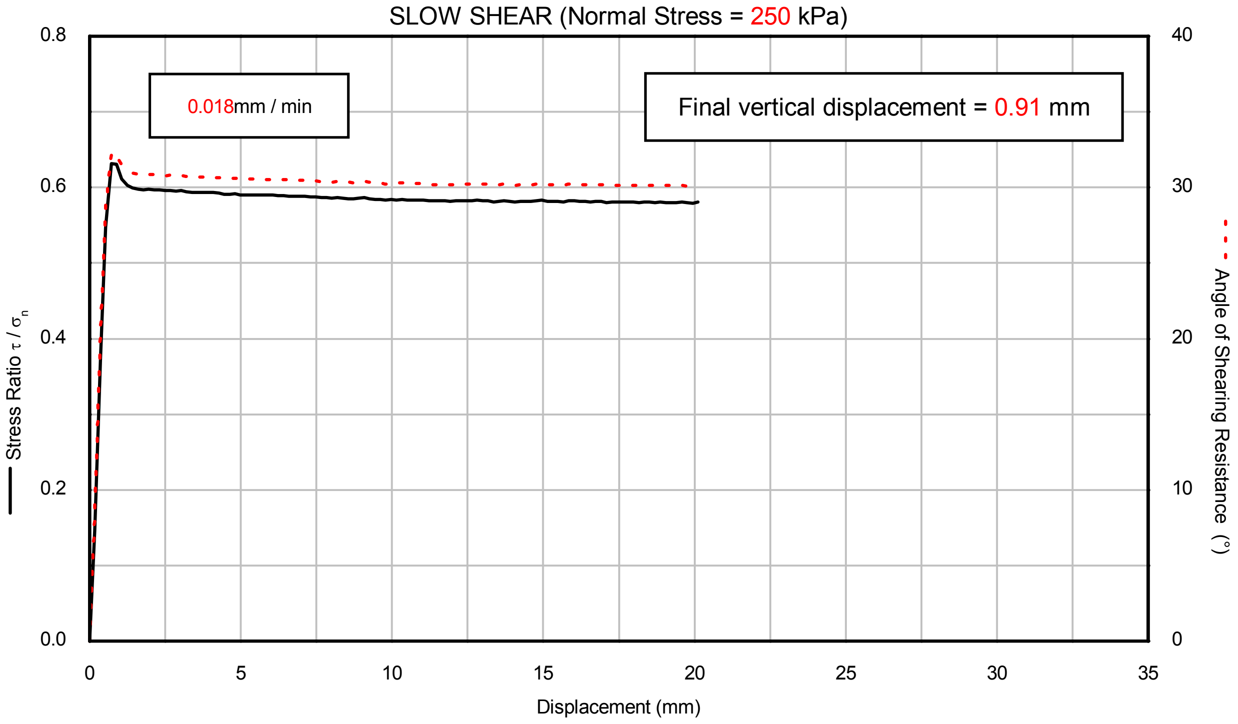
Borehole : HKZ1-BH02-SA

Sample : 16WaxD

Depth (m) : 14.10

RING SHEAR TEST
SOIL / STEEL INTERFACE





Interface Roughness (μm) : 8.64

Borehole : HKZ1-BH02-SA
Sample : 29BagB
Depth (m) : 26.30

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 10/10/2016
Drawn By : MSR
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH02-SA_29BagB_RS.OPJ
Date: 10/10/2016
Date: 10/10/2016
Checked By : PH
Approved By : PH

Date: 05/09/2016

Drawn By : MSR

Template Issue: 2

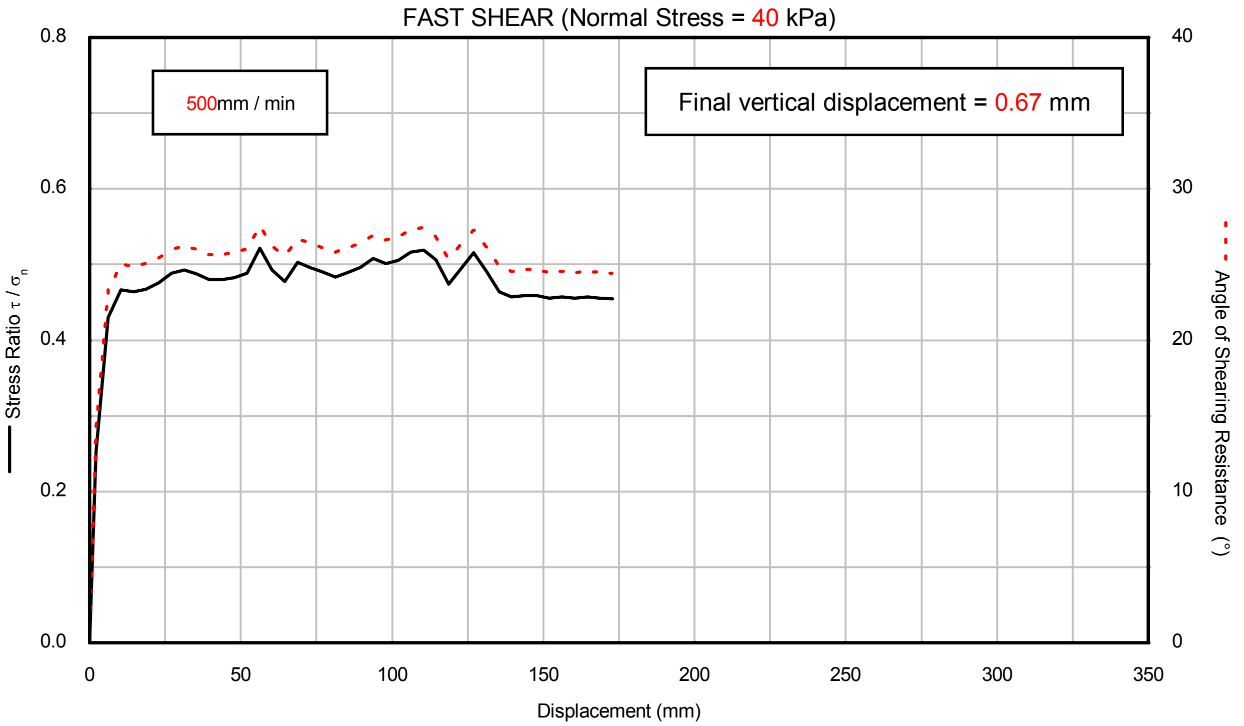
Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_07BagA_RS.OPJ

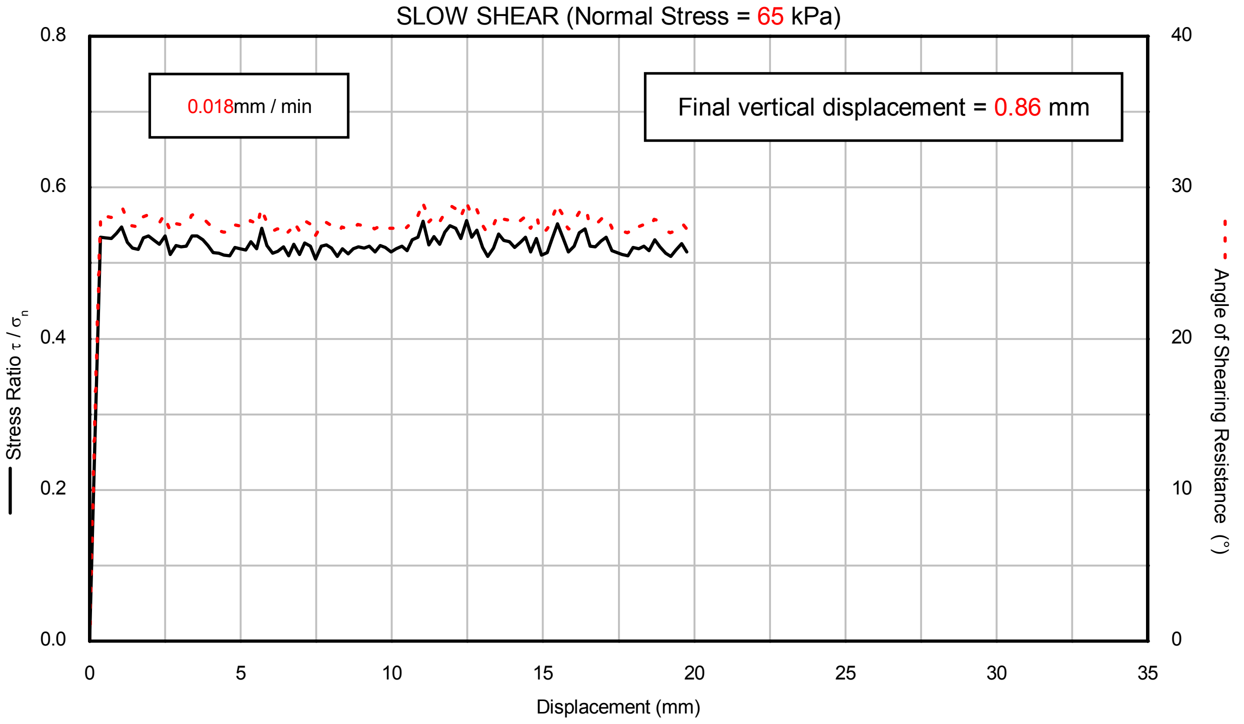
Date: 06/09/2016

Date: 04/10/2016

Checked By : ALB

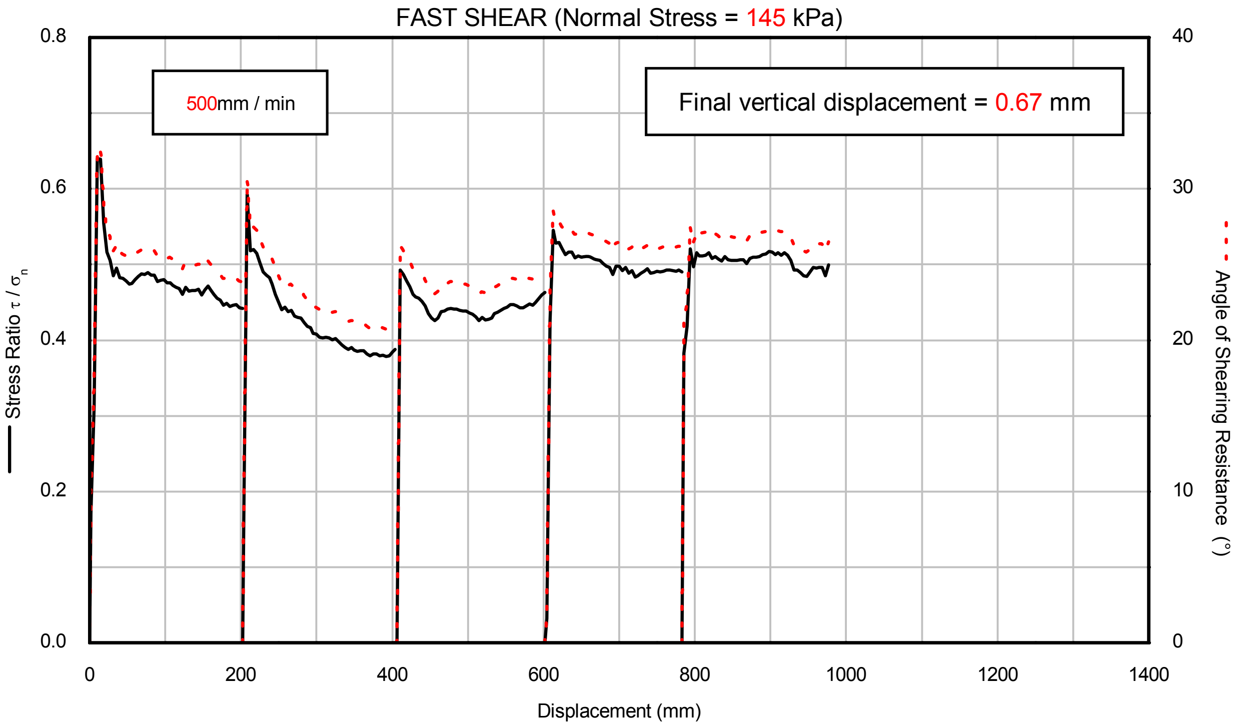
Approved By : PH

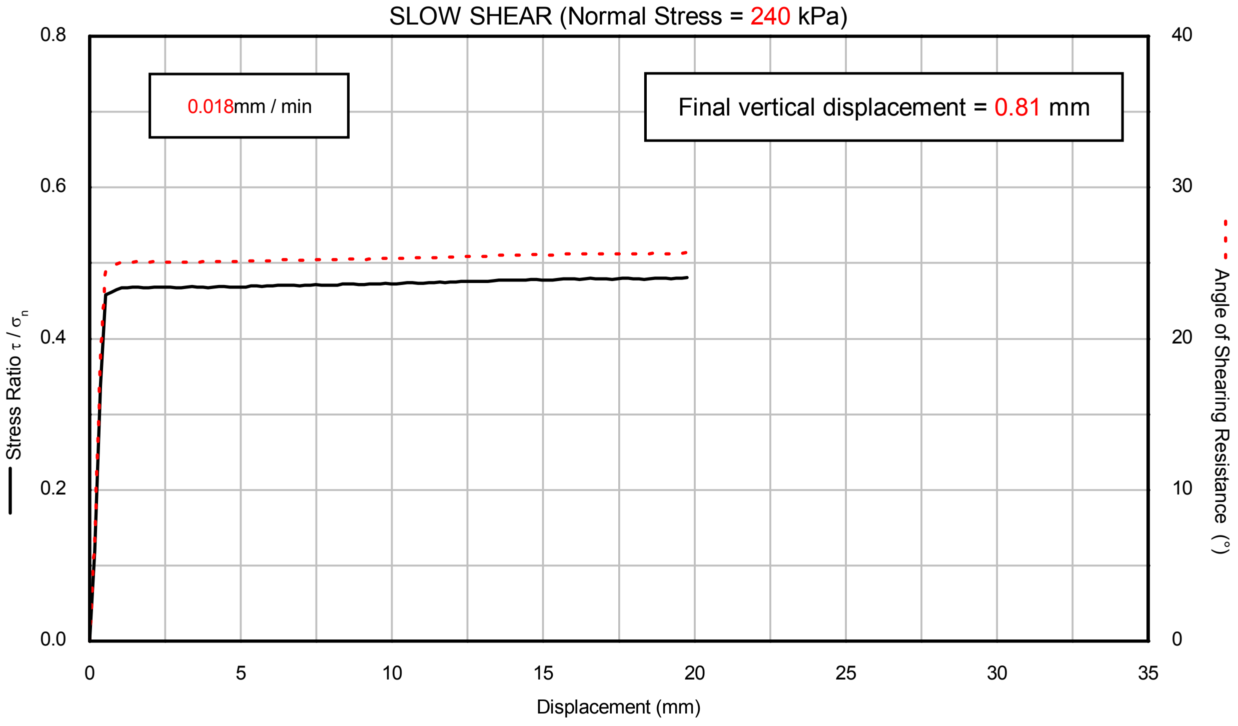




Interface Roughness (μm) :	8.77
Borehole	: HKZ1-BH03-SA
Sample	: 07BagA
Depth (m)	: 3.00

RING SHEAR TEST
SOIL / STEEL INTERFACE





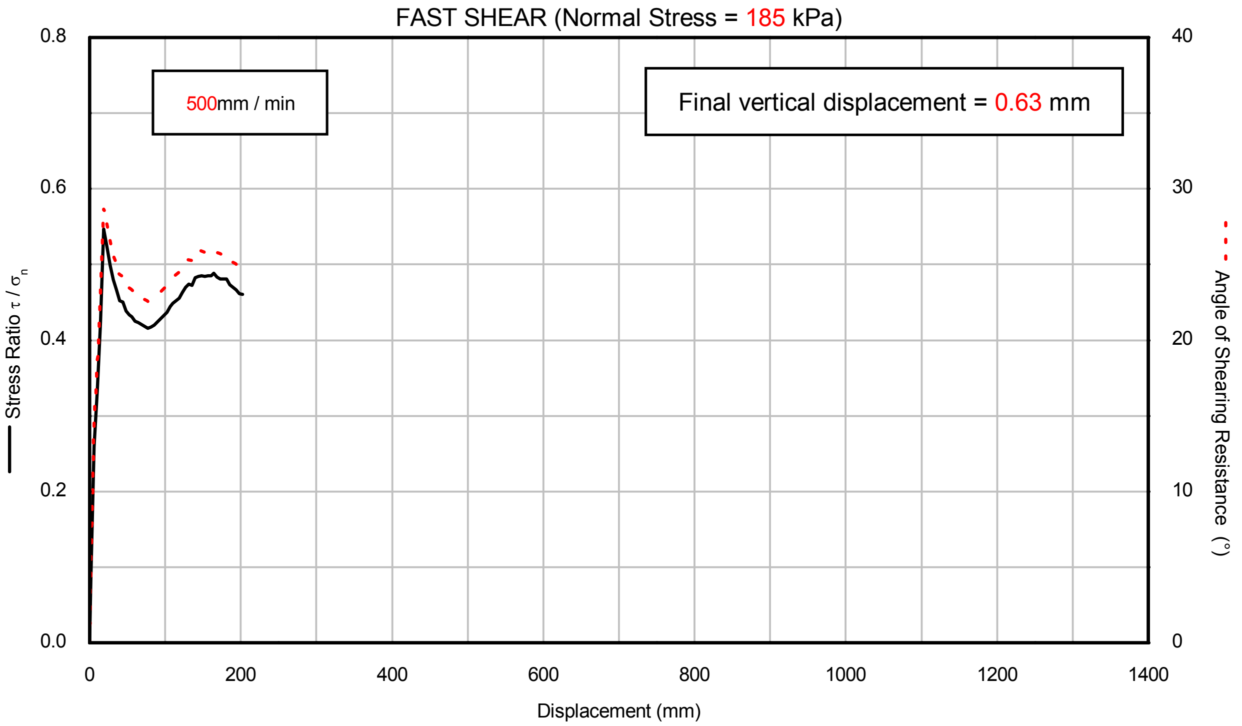
Interface Roughness (μm) : 10.41

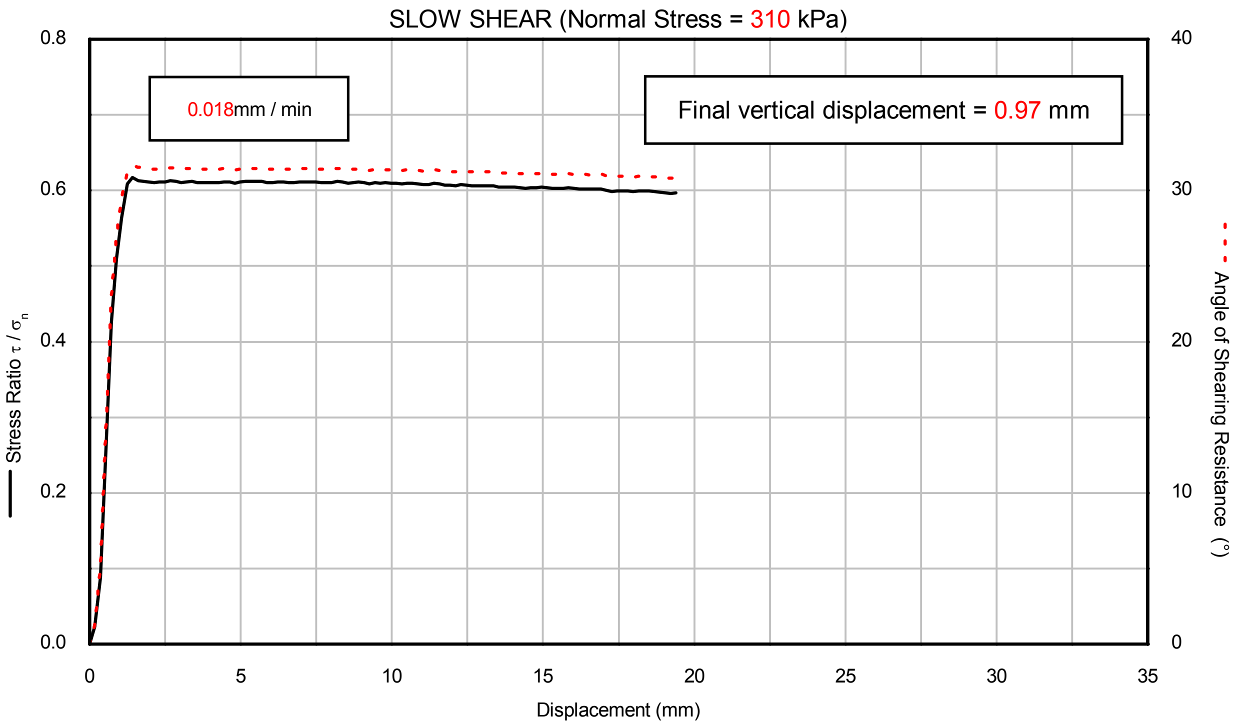
Borehole : HKZ1-BH03-SA
Sample : 24WaxA
Depth (m) : 15.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 08/09/2016
Drawn By : MSR
Filename: J11335 \ SHEAR \ HKZ1-BH03-SA_24WaxA_RS.OPJ
Template Issue: 2
Date: 09/09/2016
Date: 04/10/2016
Checked By : ALB
Approved By : PH

Date: 12/09/2016
Drawn By : MSR
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH04-SA_30BagA_RS.OPJ
Date: 13/09/2016
Date: 03/10/2016
Checked By : ALB
Approved By : PH





Interface Roughness (μm) : 8.02

Borehole : HKZ1-BH04-SA
Sample : 30BagA
Depth (m) : 26.50

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 02/09/2016

Drawn By : MSR

Template Issue: 2

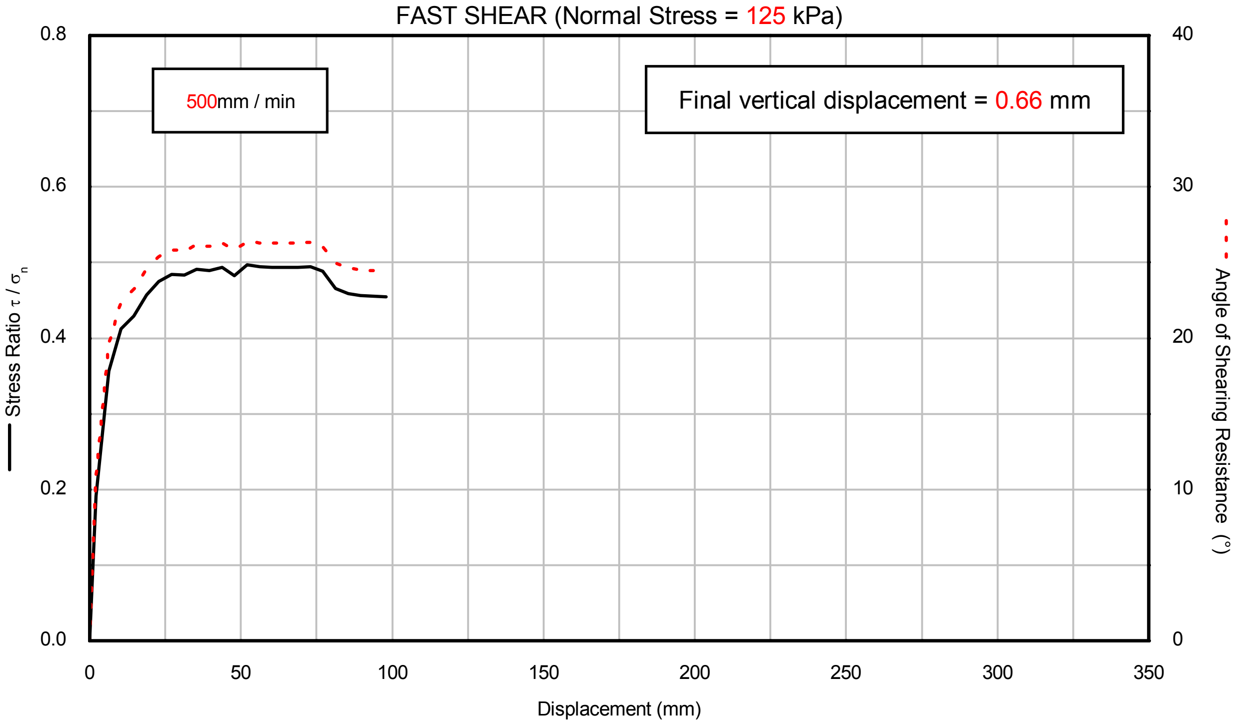
Filename: J11335 \ SHEAR \ HKZ1-BH04-SA_44BagA_RS.OPJ

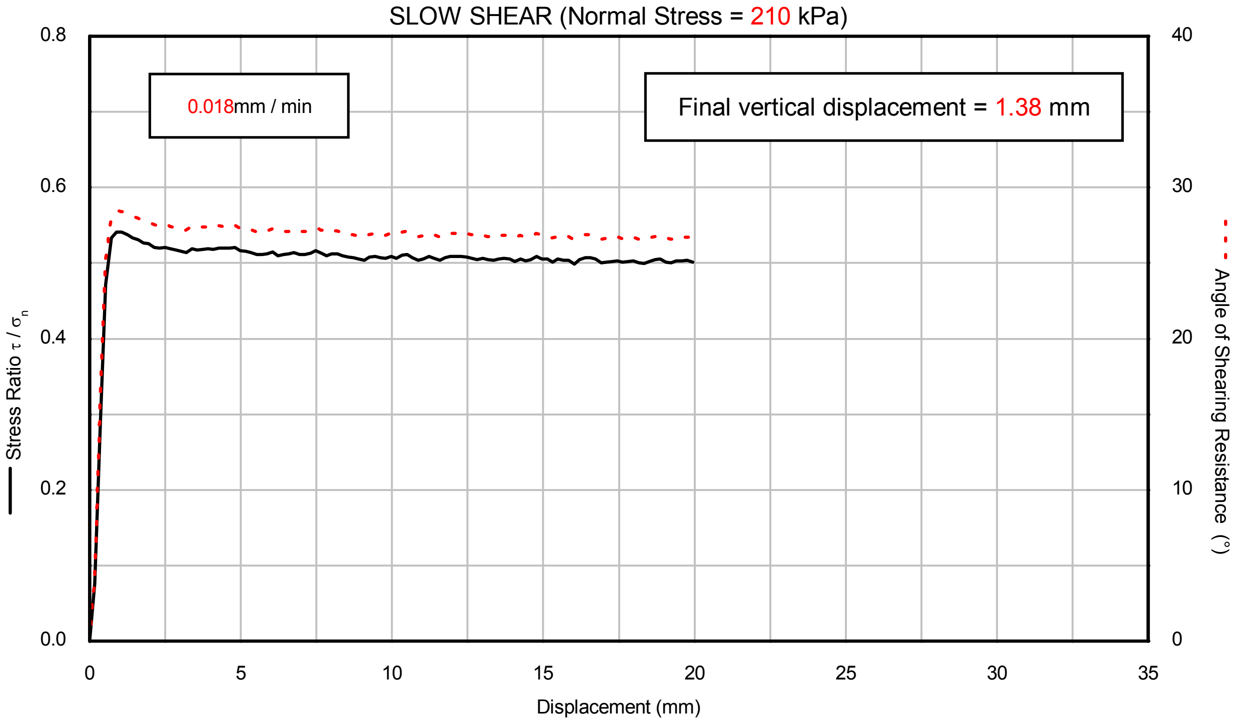
Date: 05/09/2016

Date: 03/10/2016

Checked By : ALB

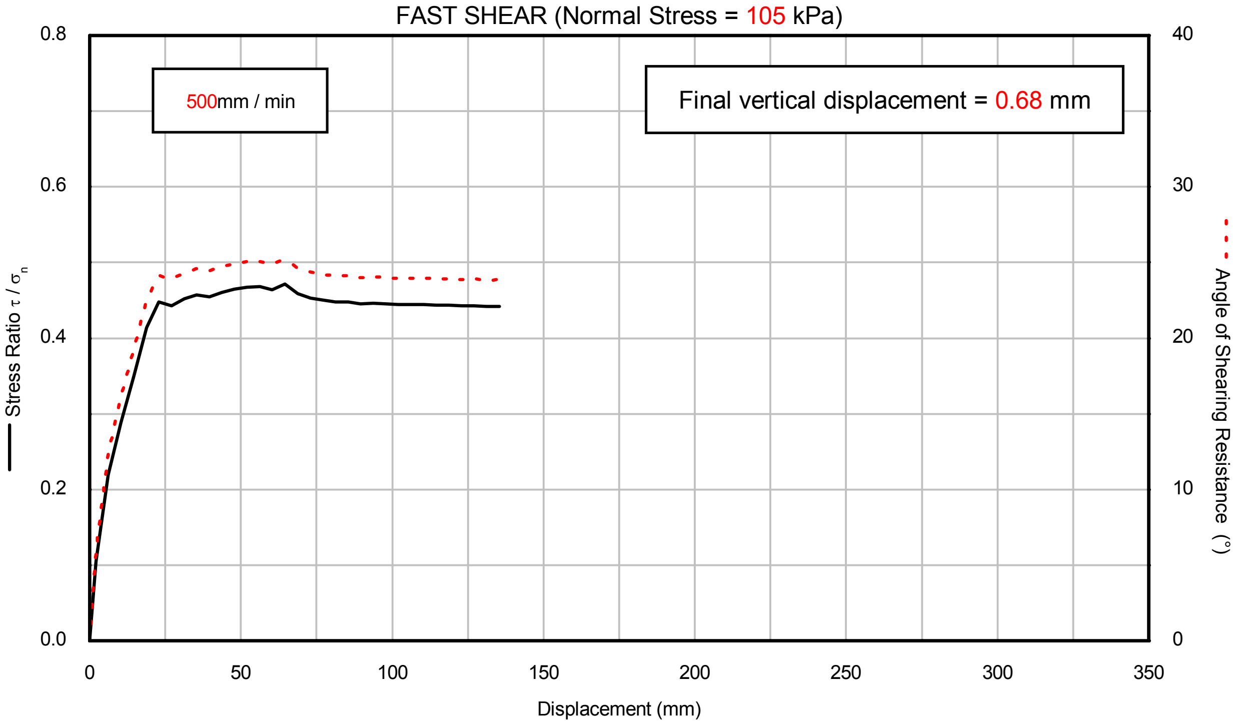
Approved By : PH

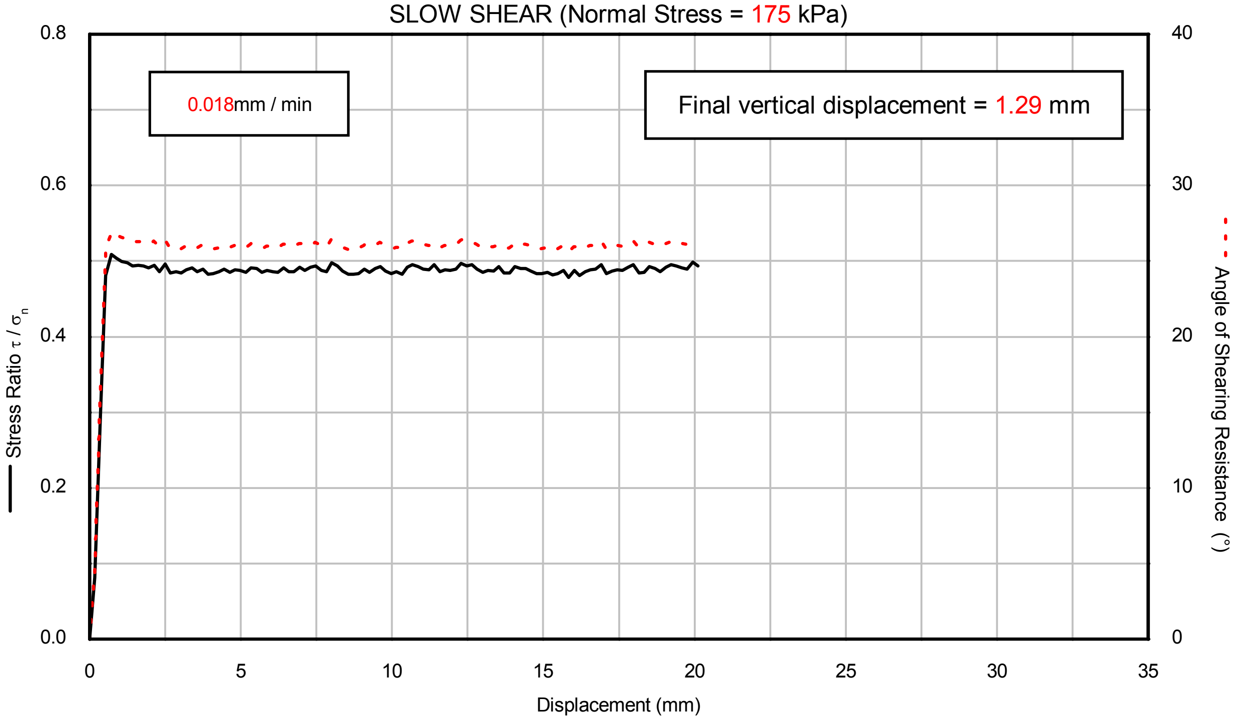




Interface Roughness (μm) : 9.13	Borehole	:	HKZ1-BH04-SA
	Sample	:	44BagA
	Depth (m)	:	40.00

RING SHEAR TEST
SOIL / STEEL INTERFACE





Interface Roughness (μm) : 10.24

Borehole : HKZ1-BH05-SA
Sample : 15BagA
Depth (m) : 12.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

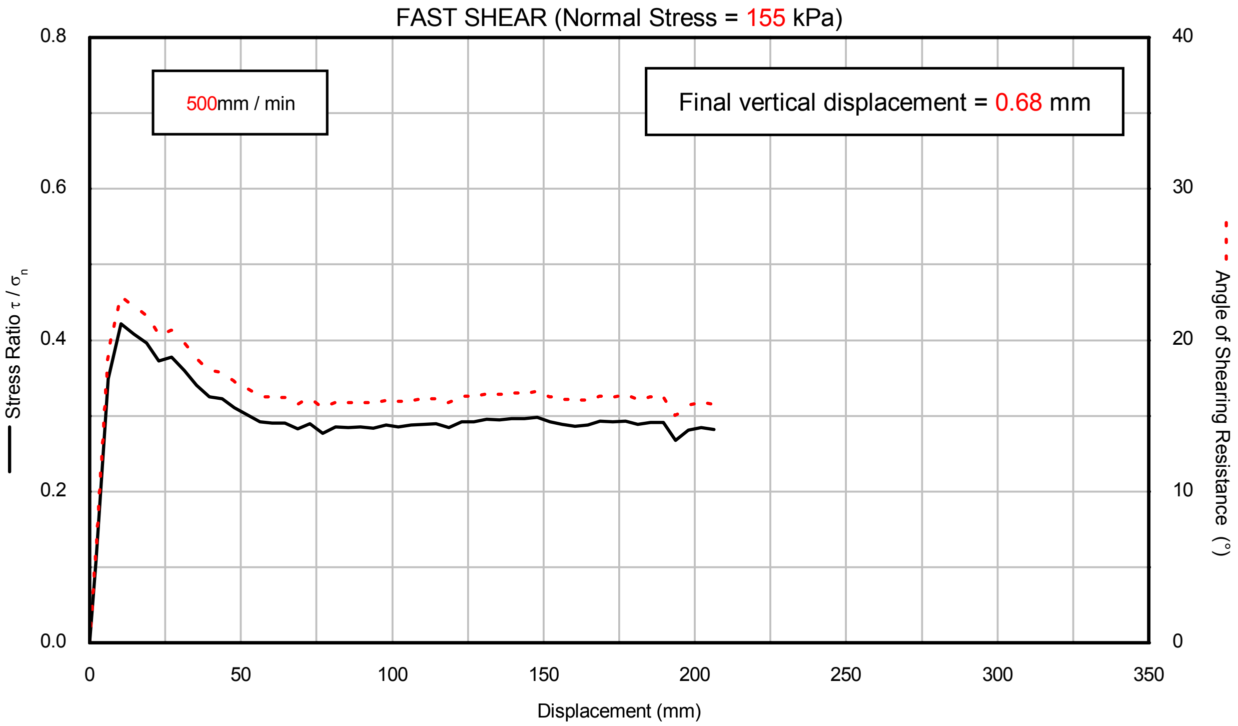
HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

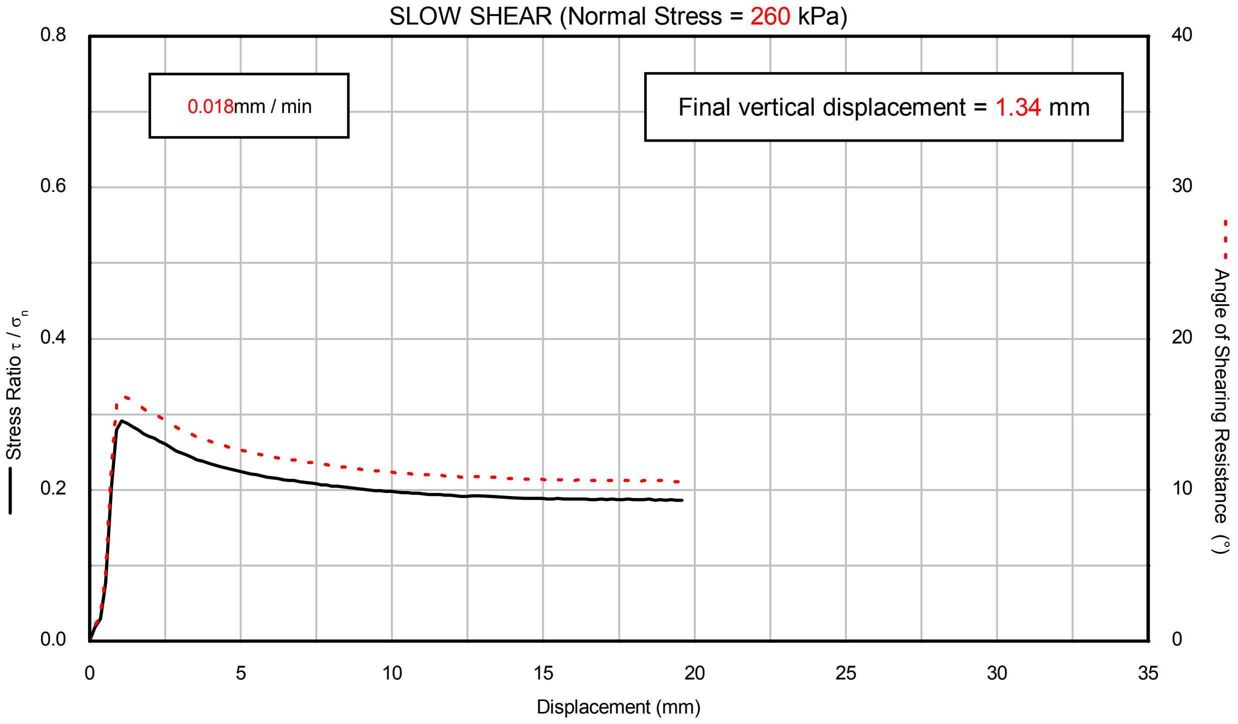
Drawn By : MSR
Date: 10/10/2016

Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH05-SA_24BagB_RS.OPJ

Date: 11/10/2016
Date: 11/10/2016

Checked By : PH
Approved By : PH



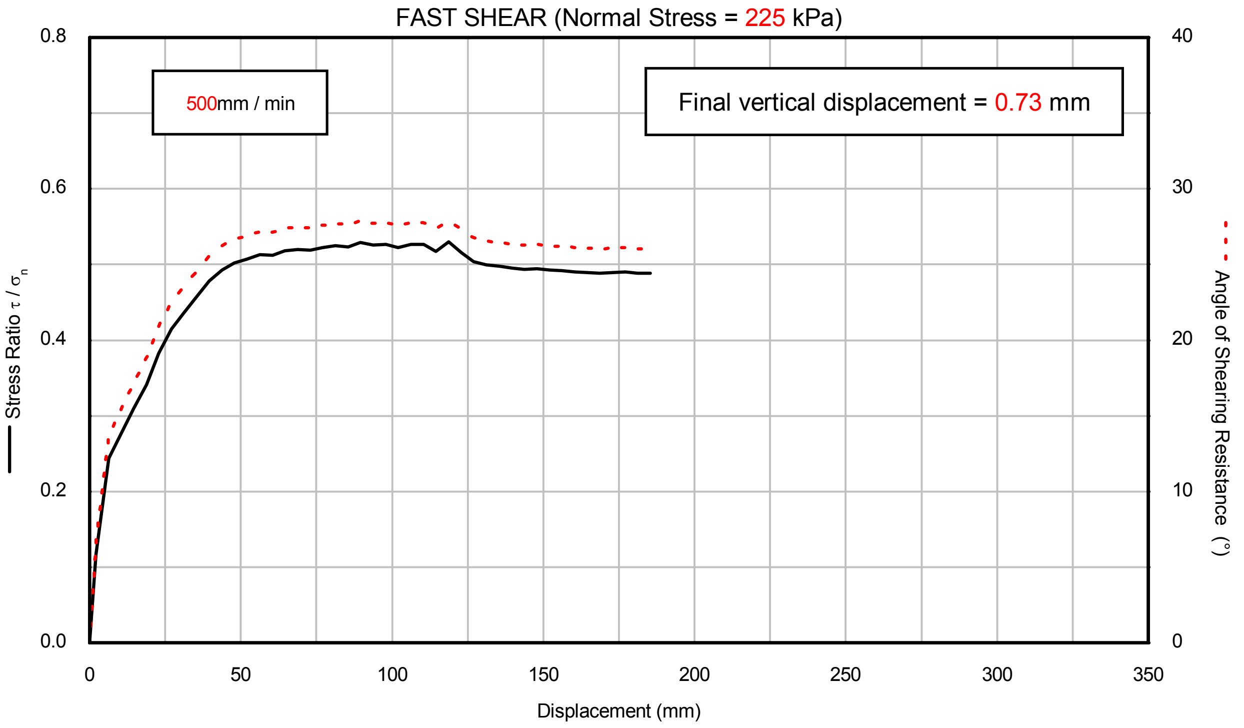


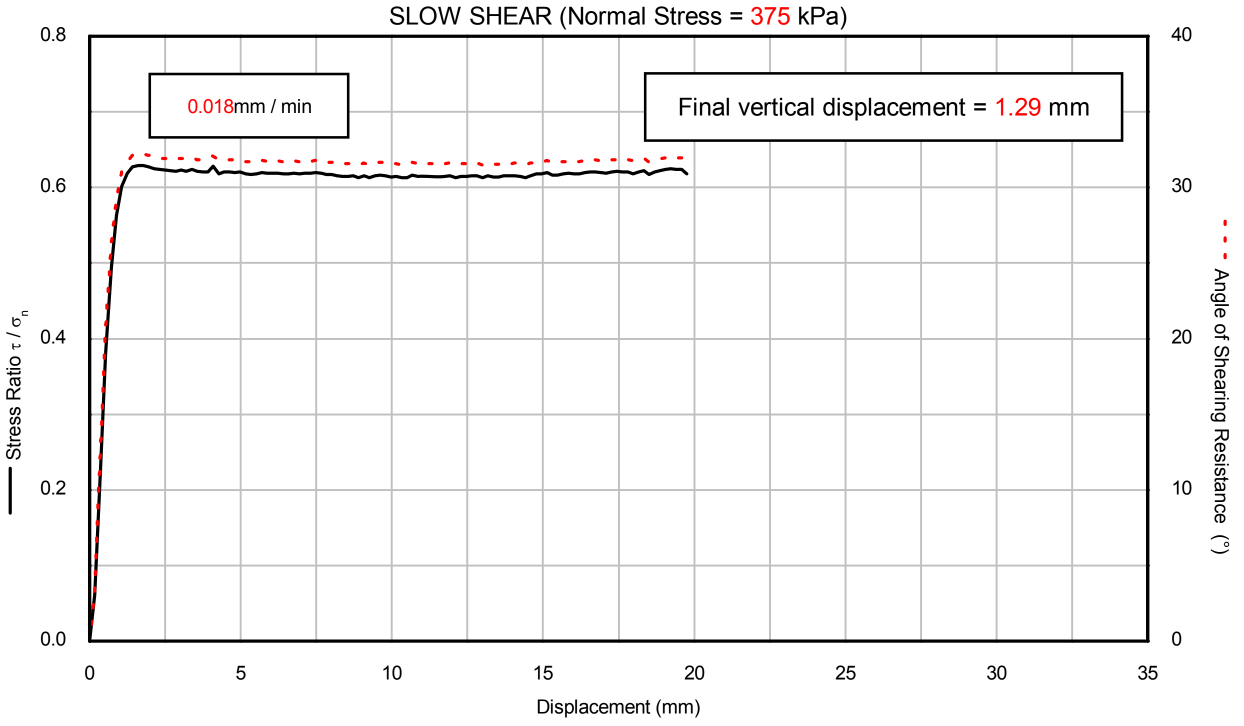
Interface Roughness (μm) : 9.59

Borehole : HKZ1-BH05-SA
Sample : 24BagB
Depth (m) : 20.20

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 05/09/2016
Drawn By : MSR
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH05-SA_50BagB_RS.OPJ
Date: 06/09/2016
Date: 04/10/2016
Checked By : ALB
Approved By : PH





Interface Roughness (μm) : 8.30	Borehole	:	HKZ1-BH05-SA
	Sample	:	50BagB
	Depth (m)	:	45.75

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 02/09/2016

Drawn By : MSR

Template Issue: 2

Filename: J11335 \ SHEAR \ HKZ1-BH06-SA_12BagA_RS.OPJ

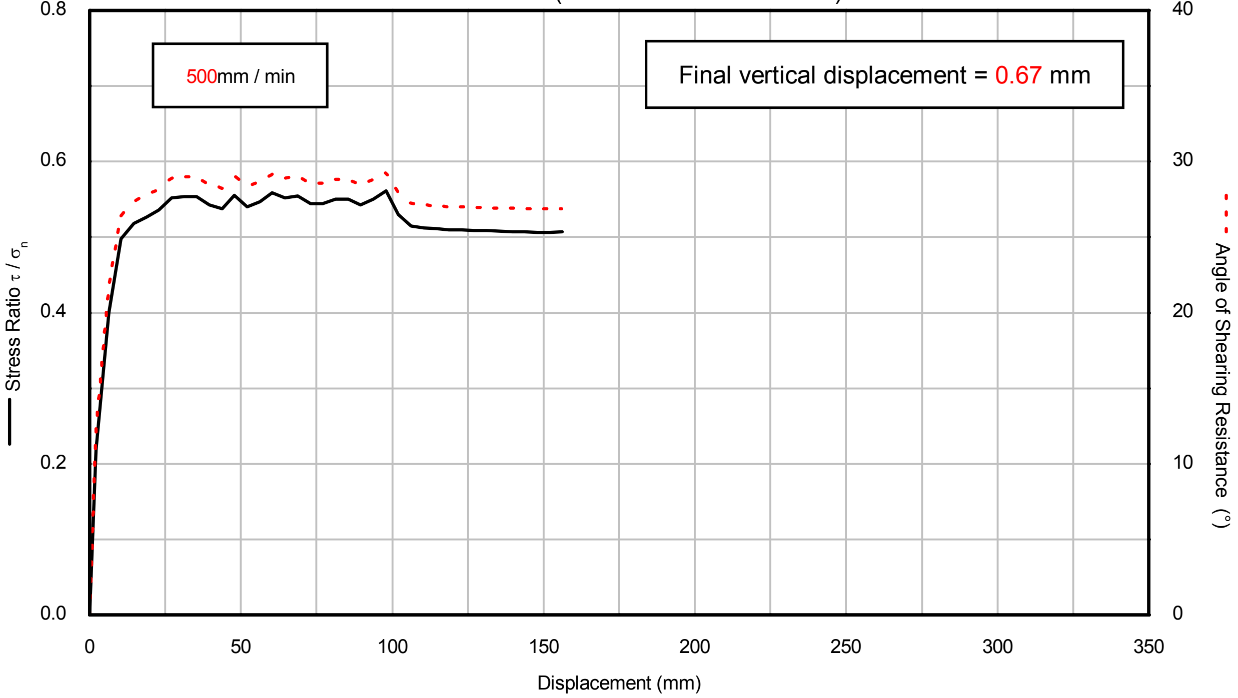
Date: 05/09/2016

Date: 03/10/2016

Checked By : ALB

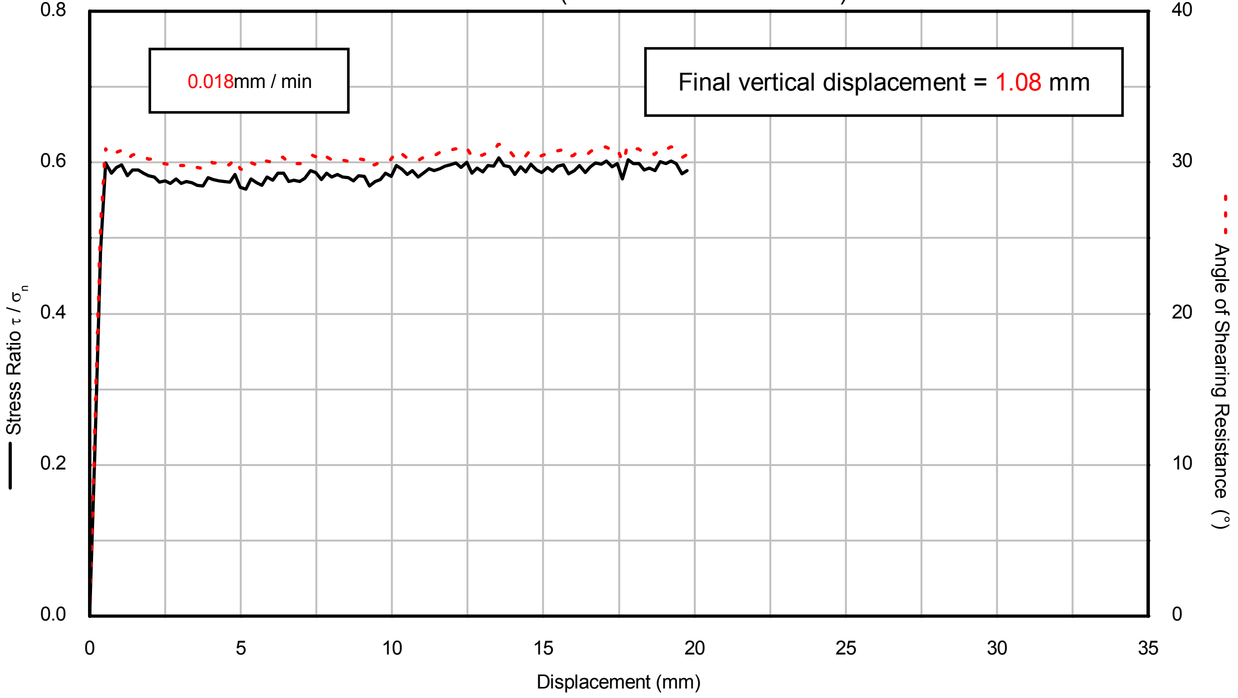
Approved By : PH

FAST SHEAR (Normal Stress = 105 kPa)



Final vertical displacement = 0.67 mm

SLOW SHEAR (Normal Stress = 175 kPa)



Final vertical displacement = 1.08 mm

Interface Roughness (μm) : 8.42

Borehole : HKZ1-BH06-SA

Sample : 12BagA

Depth (m) : 9.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 07/09/2016

Drawn By : MSR

Template Issue: 2

Filename: J11335 \ SHEAR \ HKZ1-BH06-SA_35BagB_RS.OPJ

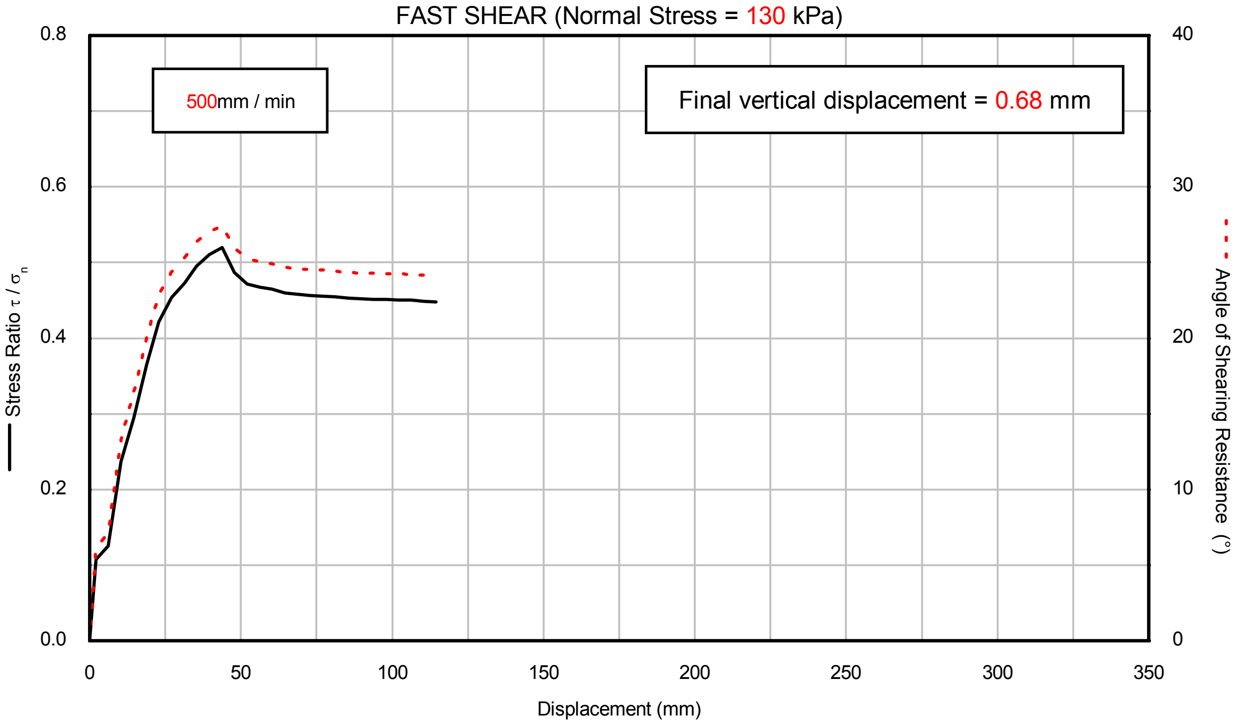
Date: 09/09/2016

Date: 04/10/2016

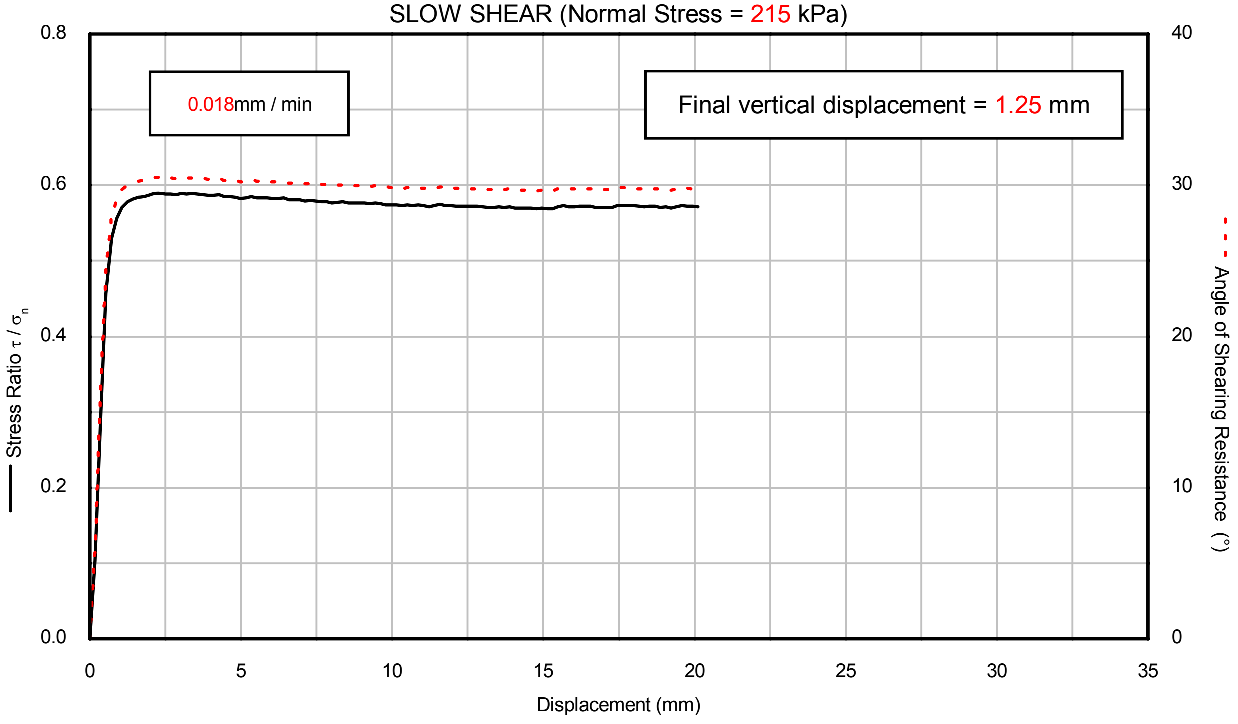
Checked By : ALB

Approved By : PH

FAST SHEAR (Normal Stress = 130 kPa)



SLOW SHEAR (Normal Stress = 215 kPa)



Interface Roughness (μm) : 10.97

Borehole : HKZ1-BH06-SA

Sample : 35BagB

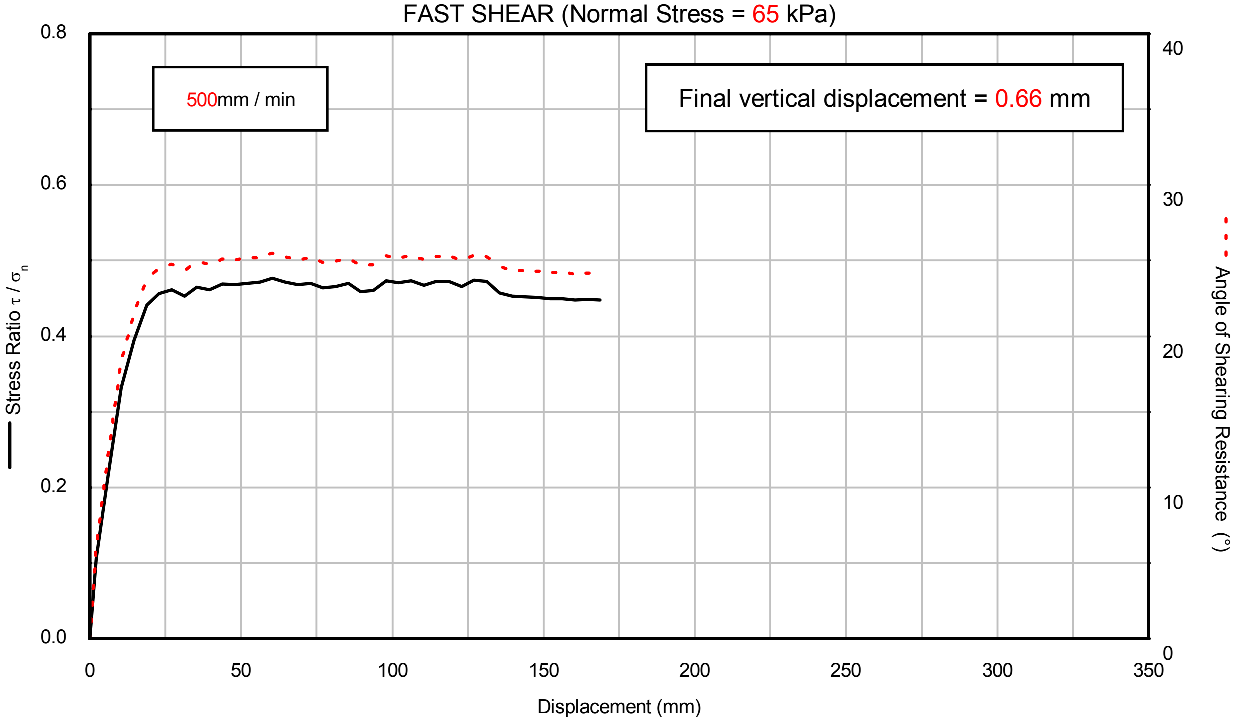
Depth (m) : 30.05

RING SHEAR TEST
SOIL / STEEL INTERFACE

HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA

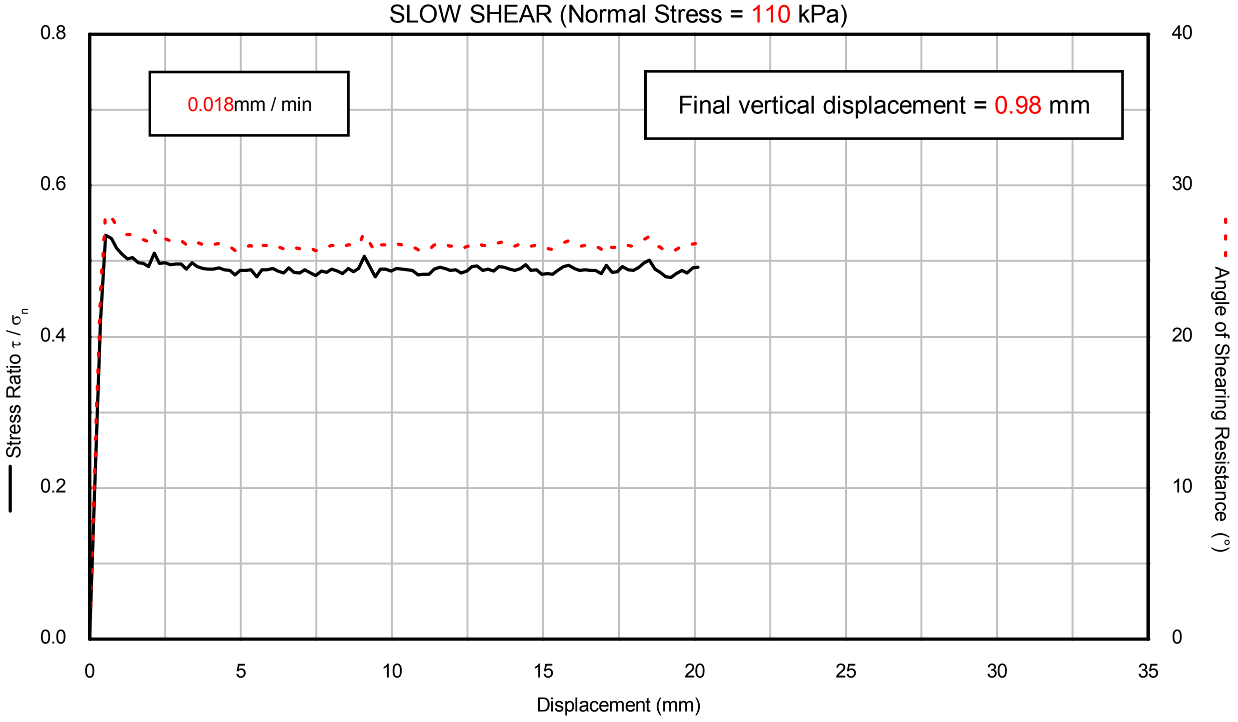
Date: 07/09/2016
Drawn By : MSr
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_07BagA_RS.OPJ
Date: 09/09/2016
Date: 03/10/2016
Checked By : ALB
Approved By : PH

FAST SHEAR (Normal Stress = 65 kPa)


500mm / min

Final vertical displacement = 0.66 mm

SLOW SHEAR (Normal Stress = 110 kPa)


0.018mm / min

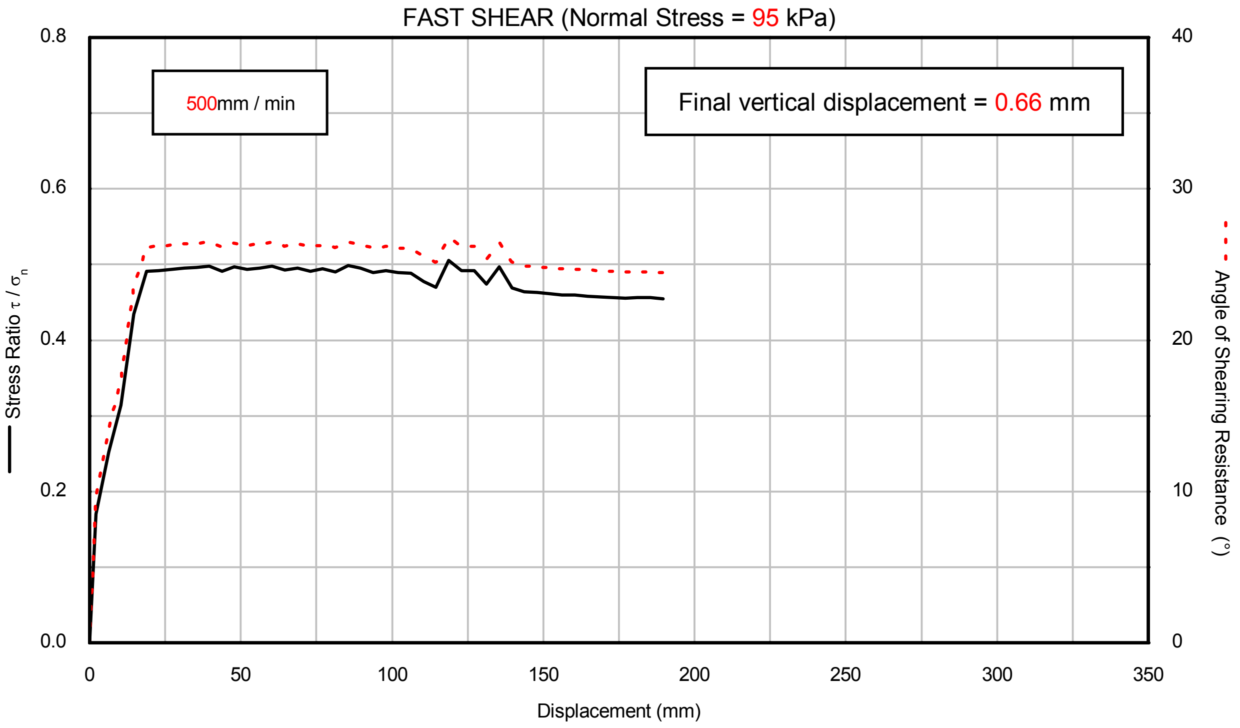
Final vertical displacement = 0.98 mm

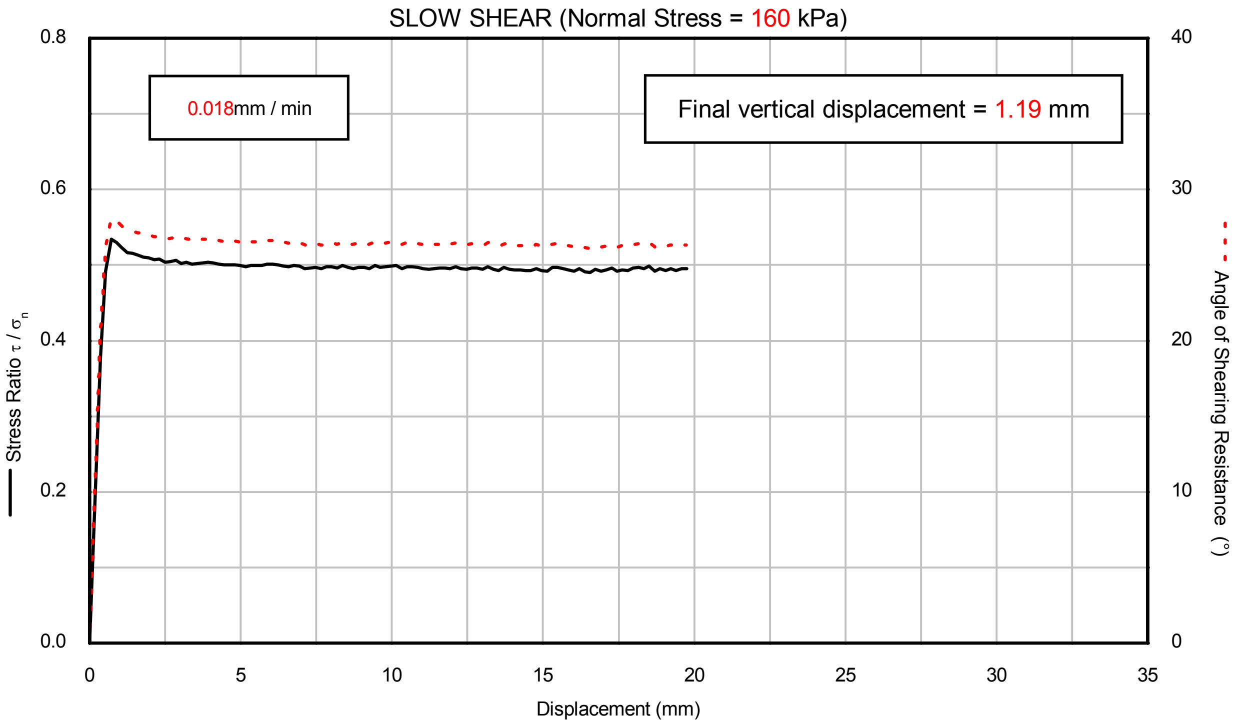
Interface Roughness (μm) : 10.62

Borehole : HKZ1-BH07-SA
Sample : 07BagA
Depth (m) : 5.50

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 05/09/2016
Drawn By : MSR
Template Issue: 2
Filename: J11335 \ SHEAR \ HKZ1-BH07-SA_27BagA_RS.OPJ
Date: 06/09/2016
Date: 03/10/2016
Checked By : ALB
Approved By : PH





Interface Roughness (μm) : 8.99

Borehole : HKZ1-BH07-SA
Sample : 27BagA
Depth (m) : 20.00

RING SHEAR TEST
SOIL / STEEL INTERFACE

Date: 05/09/2016

Drawn By : MSR

Template Issue: 2

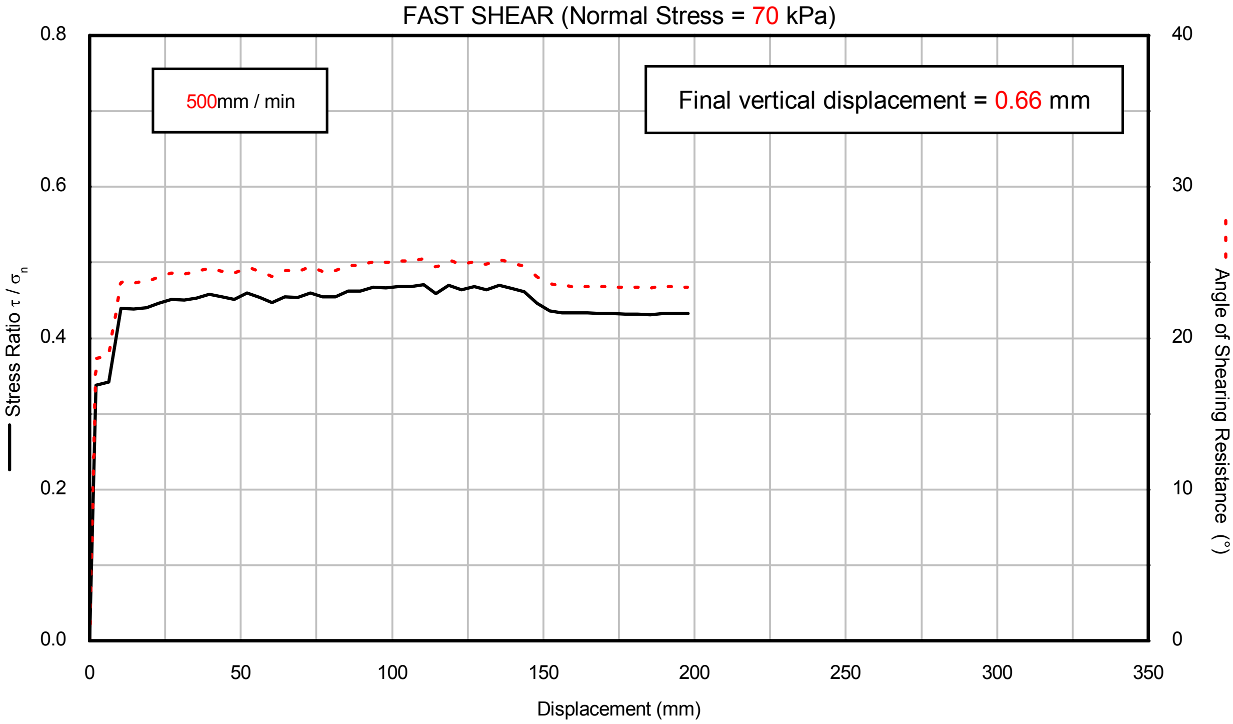
Filename: J11335 \ SHEAR \ HKZ1-BH08-SA_7BagA_RS.OPJ

Date: 06/09/2016

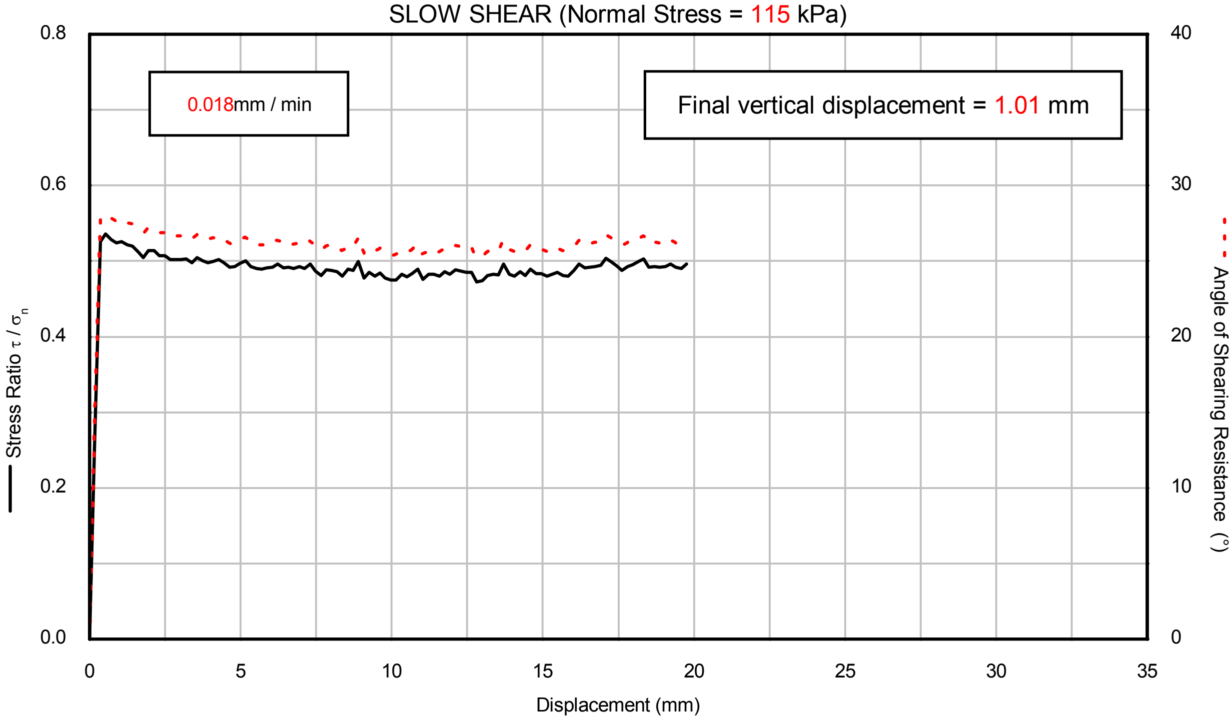
Date: 03/10/2016

Checked By : ALB

Approved By : PH



FAST SHEAR (Normal Stress = 70 kPa)



SLOW SHEAR (Normal Stress = 115 kPa)

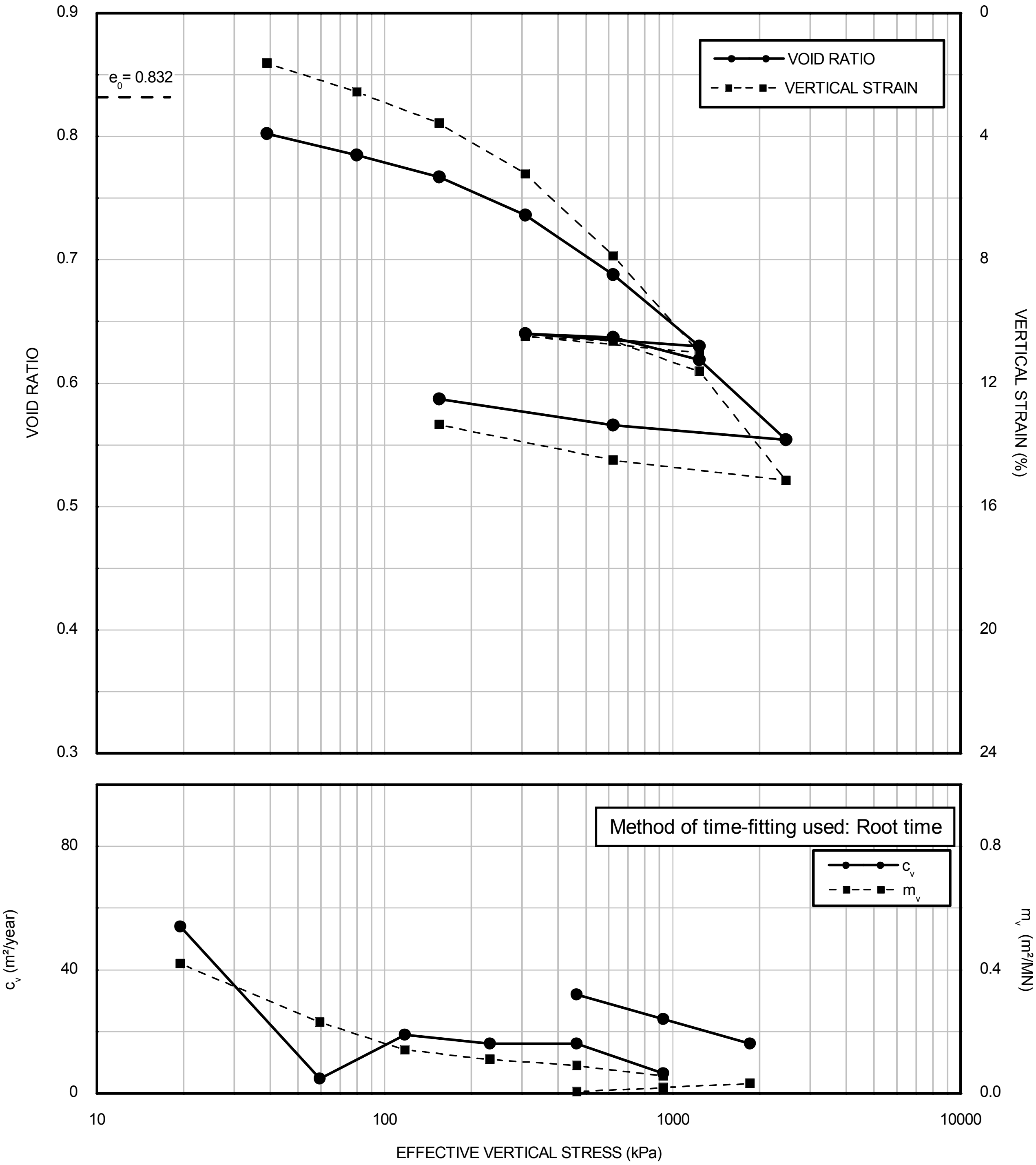
Interface Roughness (μm) : 11.08	Borehole	:	HKZ1-BH08-SA
	Sample	:	07BagA
	Depth (m)	:	5.50

RING SHEAR TEST
SOIL / STEEL INTERFACE

SECTION C6: COMPRESSIBILITY TESTS

LIST OF PLATES IN SECTION C6:

Drawn by: ALB Date: 20/09/2016
Template Issue: 3
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH01-SA_18WaxB_od.OPJ
Date : 27/09/2016
Date : 27/09/2016
Checked by: PH
Approved by: PH



Initial Conditions		
Specimen height : 18.4 mm Specimen diameter : 50.1 mm Degree of saturation : 92 % Particle density : 2.67 Mg/m³ (Measured) Specimen condition : Undisturbed Method of time fitting : Root Time Method	Bulk density : 1.88 Mg/m³ Dry density : 1.46 Mg/m³ Water content : 28.7 % Lab. temperature : 20 °C Swelling pressure : NA kPa	Borehole :HKZ1-BH01 -SA Sample :18WaxB Depth (m) :15.70

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL
CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

Template Issue: 3

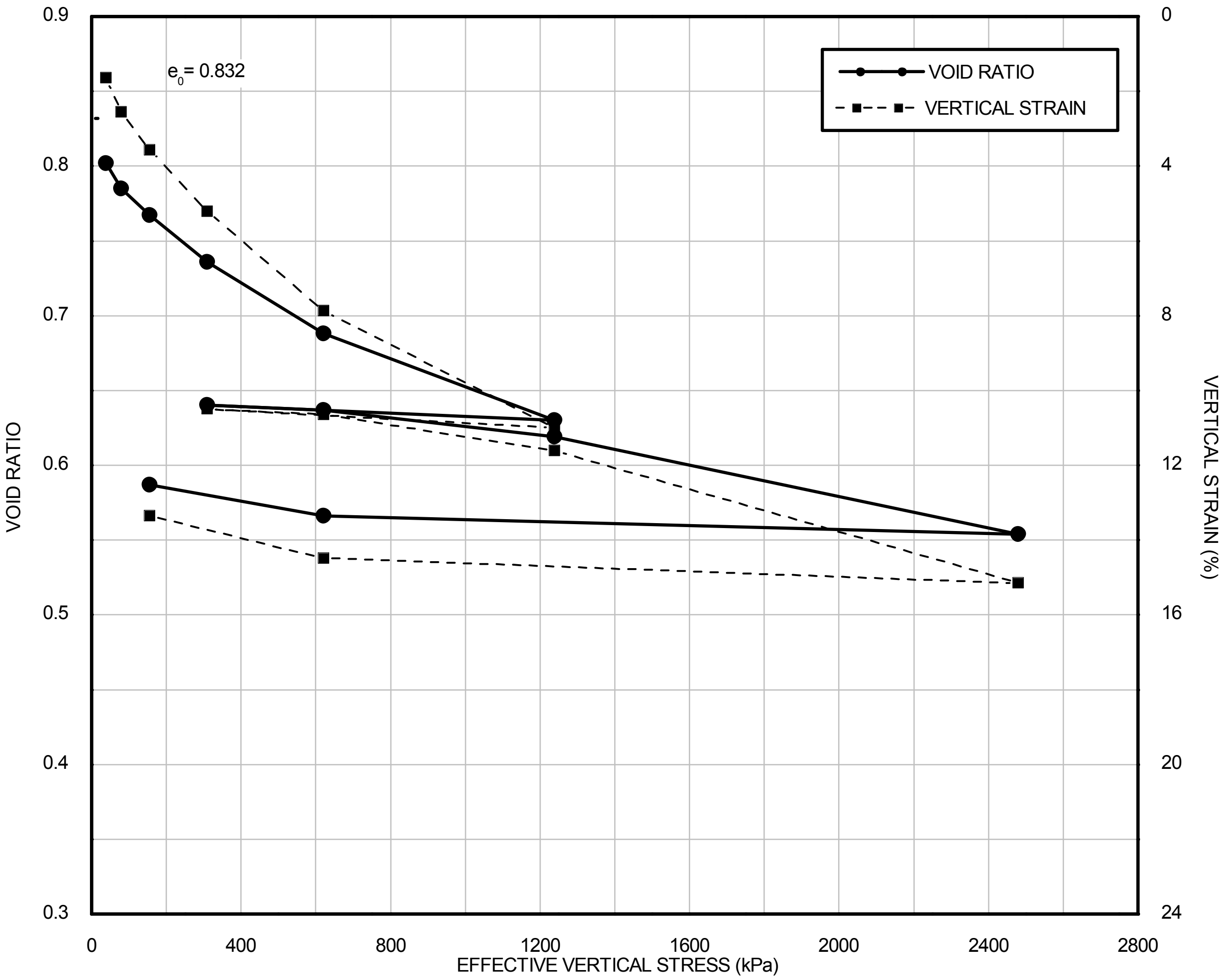
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH01-SA_18WaxB_od.OPJ

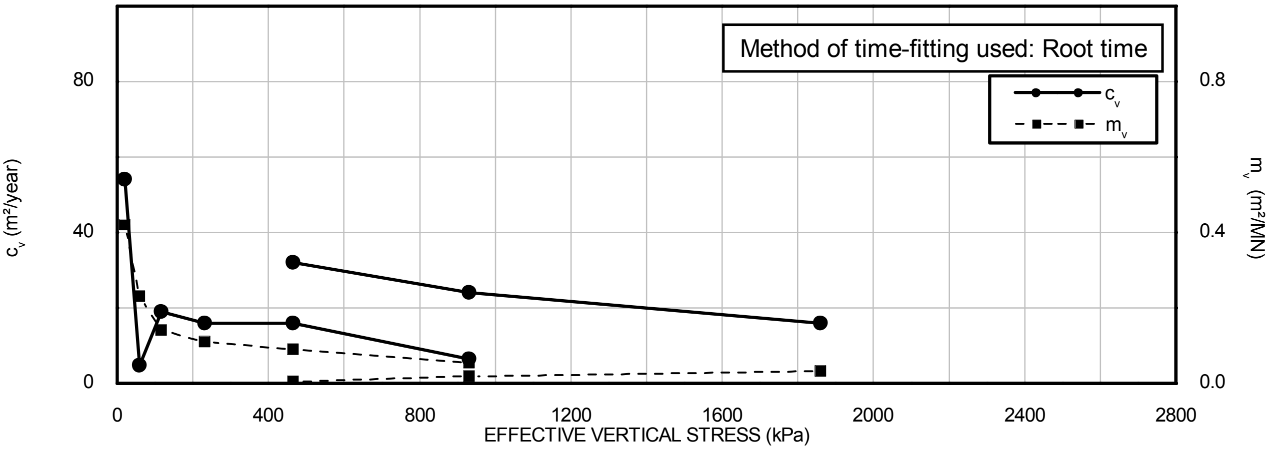
Date : 27/09/2016

Date : 27/09/2016

Checked by: PH

Approved by: PH



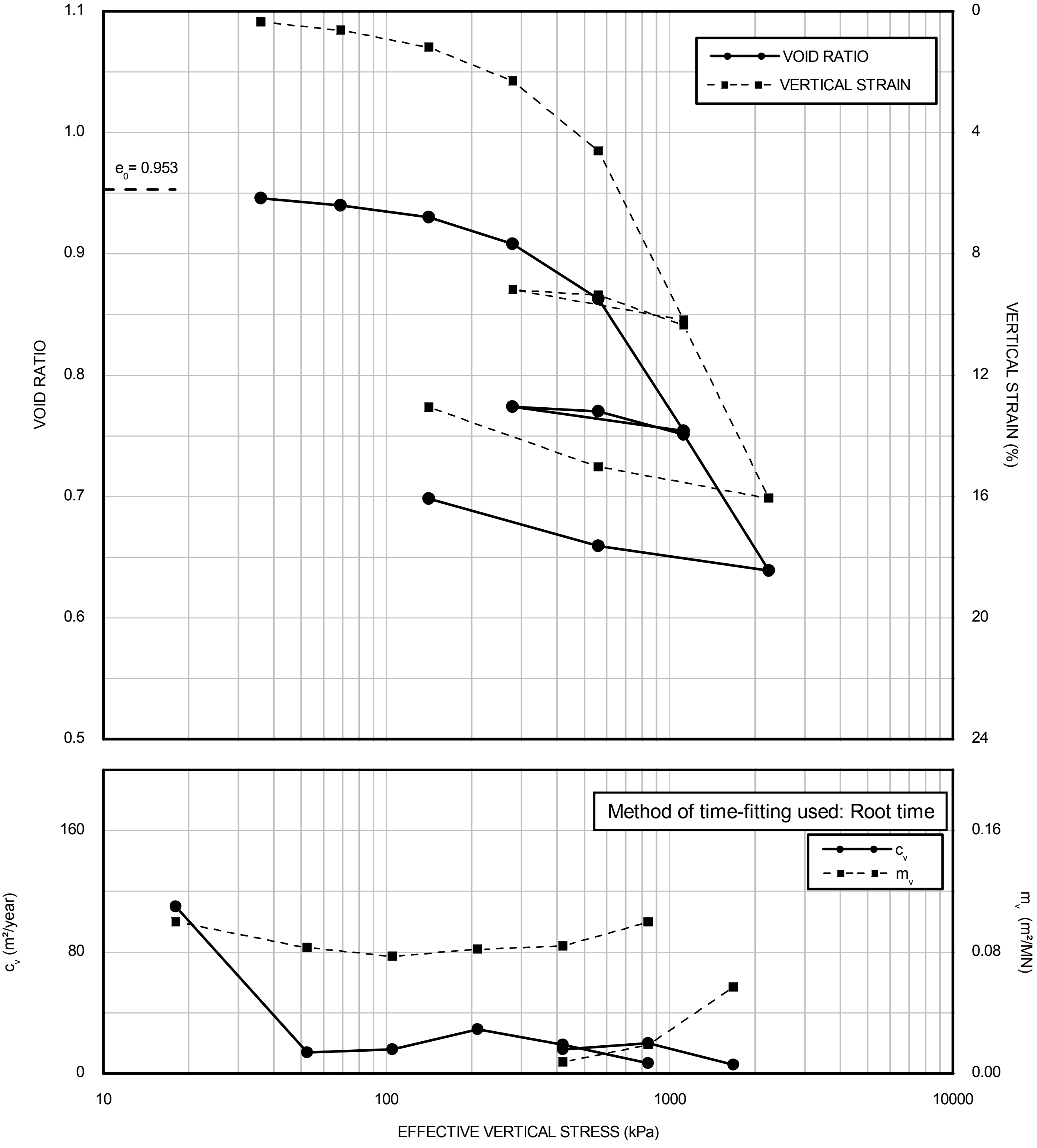


Initial Conditions

Specimen height	: 18.4 mm	Bulk density	: 1.88 Mg/m^3	Borehole	:HKZ1-BH01 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.46 Mg/m^3	Sample	:18WaxB
Degree of saturation	: 92 %	Water content	: 28.7 %	Depth (m)	:15.70
Particle density	: 2.67 Mg/m^3 (Measured)	Lab. temperature	: 20 °C		
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa		
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)



Initial Conditions

Specimen height	: 18.4 mm	Bulk density	: 1.85 Mg/m^3	Borehole :HKZ1-BH02 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.38 Mg/m^3	Sample :16WaxD
Degree of saturation	: 95 %	Water content	: 33.5 %	Depth (m) :14.10
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C	
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa	
Method of time fitting	: Root Time Method			

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

Template Issue: 3

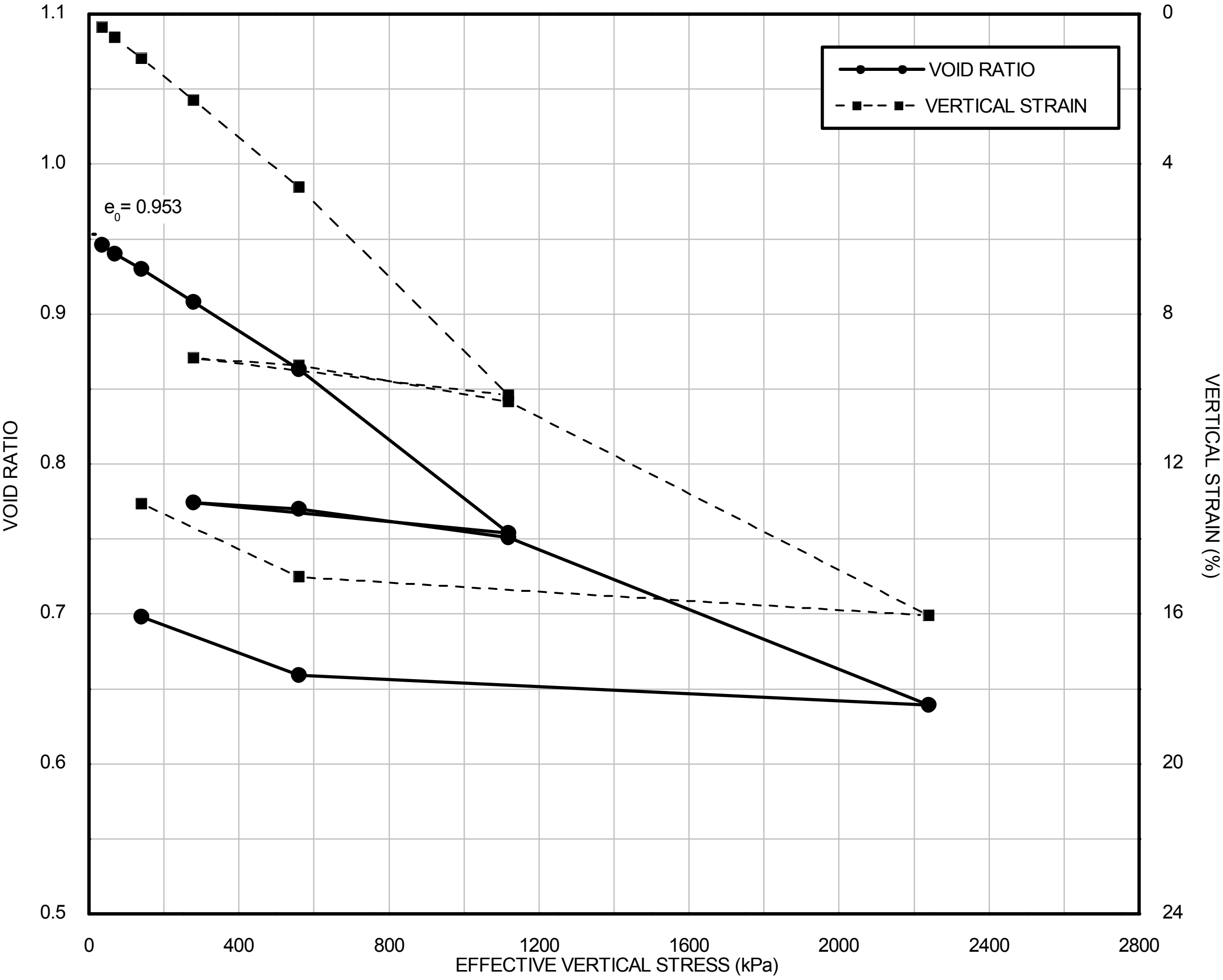
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH02-SA_16WaxD_od.OPJ

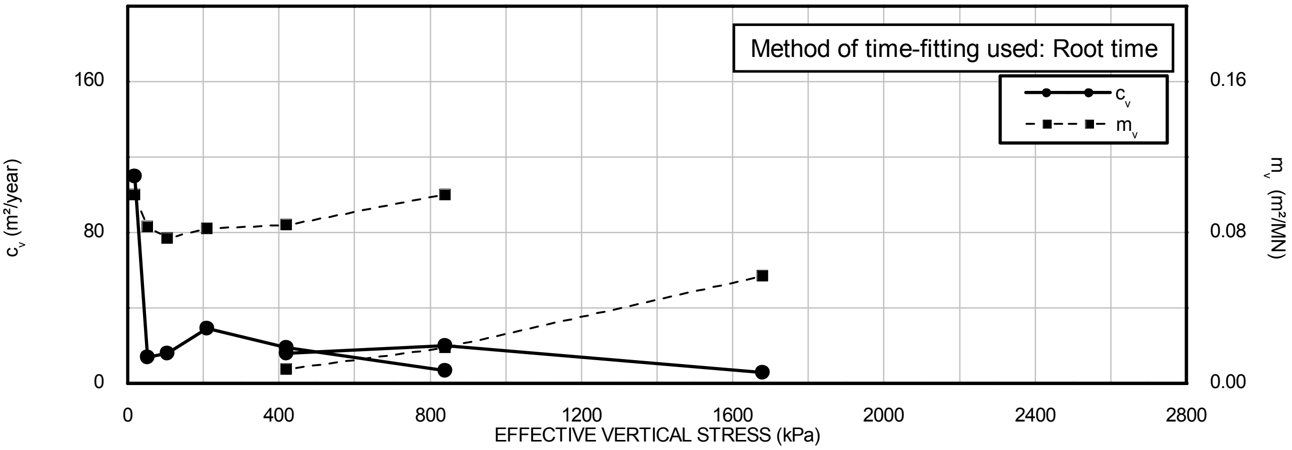
Date : 27/09/2016

Date : 27/09/2016

Checked by: PH

Approved by: PH





Initial Conditions

Specimen height Specimen diameter Degree of saturation Particle density Specimen condition Method of time fitting	: 18.4 mm : 50.1 mm : 95 % : 2.70 Mg/m³ (Assumed) : Undisturbed : Root Time Method	Bulk density Dry density Water content Lab. temperature Swelling pressure	: 1.85 Mg/m³ : 1.38 Mg/m³ : 33.5 % : 20 °C : NA kPa	Borehole :HKZ1-BH02 -SA Sample :16WaxD Depth (m) :14.10

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL
CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

Template Issue: 3

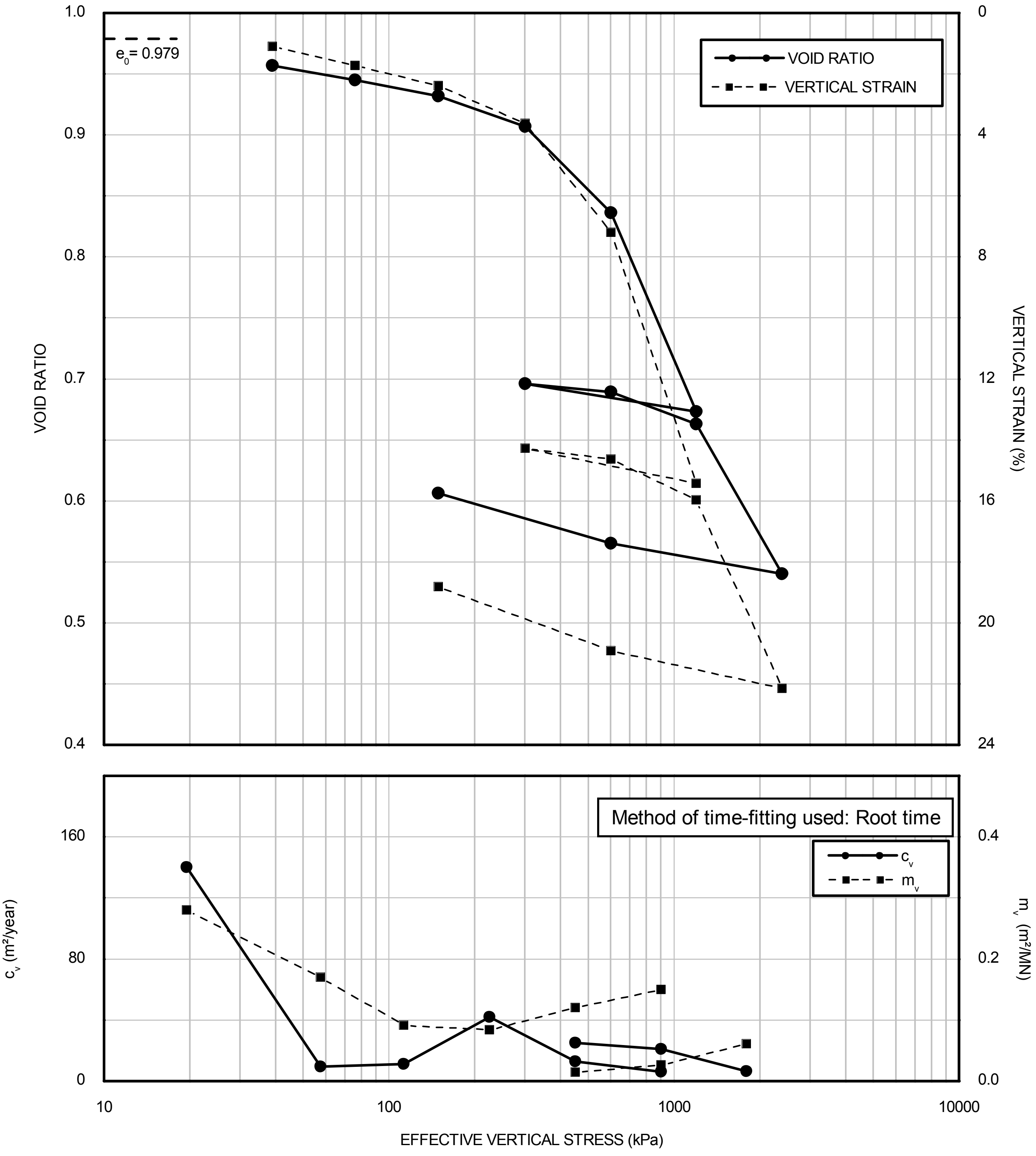
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH03-SA_24WaxA_od.OPJ

Date : 27/09/2016

Date : 27/09/2016

Checked by: PH

Approved by: PH



Initial Conditions			
Specimen height	: 19.5 mm	Bulk density	: 1.83 Mg/m^3
Specimen diameter	: 50.1 mm	Dry density	: 1.36 Mg/m^3
Degree of saturation	: 95 %	Water content	: 34.3 %
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa
Method of time fitting	: Root Time Method		

Borehole :HKZ1-BH03 -SA
Sample :24WaxA
Depth (m) :15.00

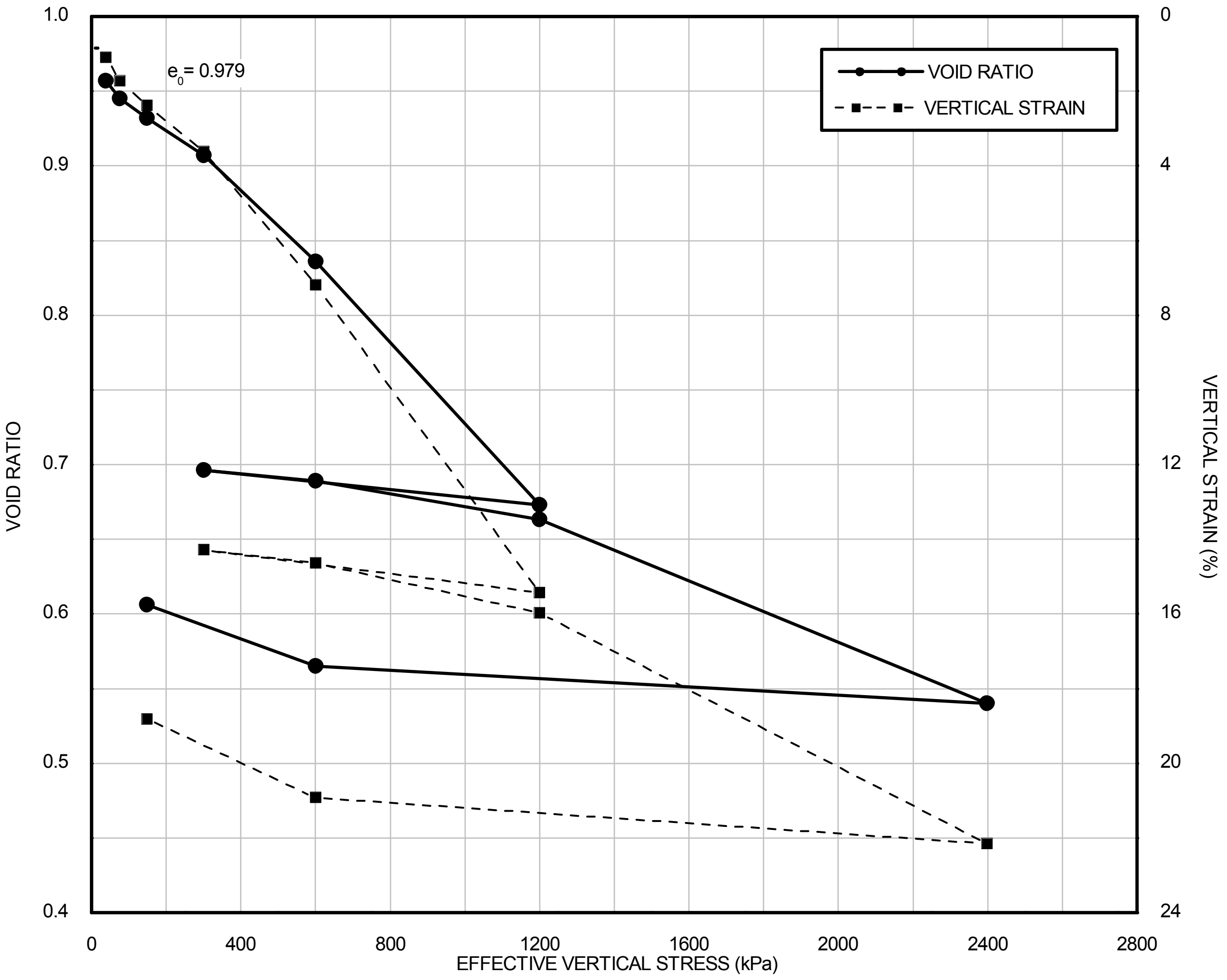
Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

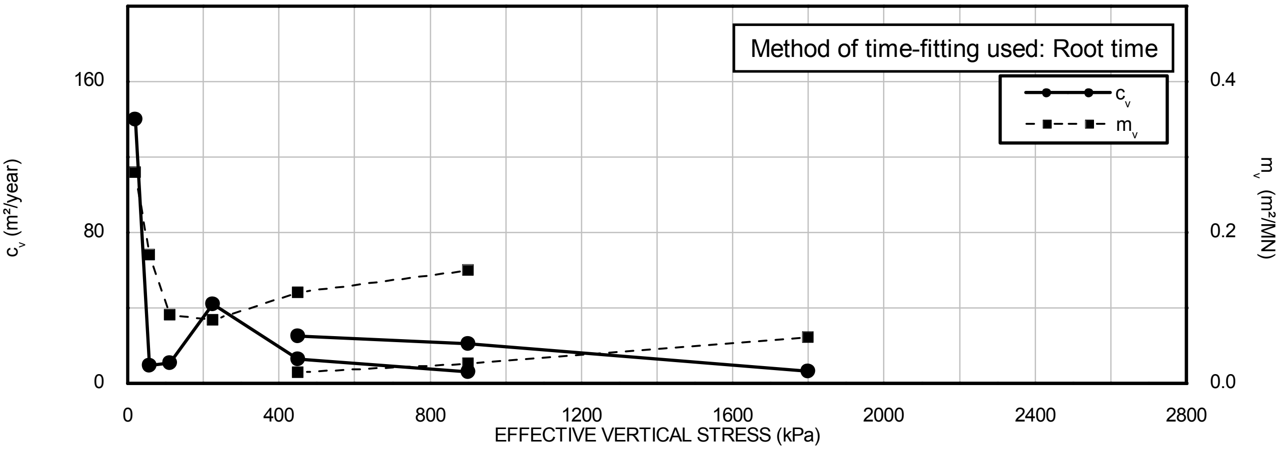
Template Issue: 3

Filename: J11335 \ Labdata \ Compress \ HKZ1-BH03-SA_24WaxA_od.OPJ



Date : 27/09/2016

Date : 27/09/2016



Checked by: PH

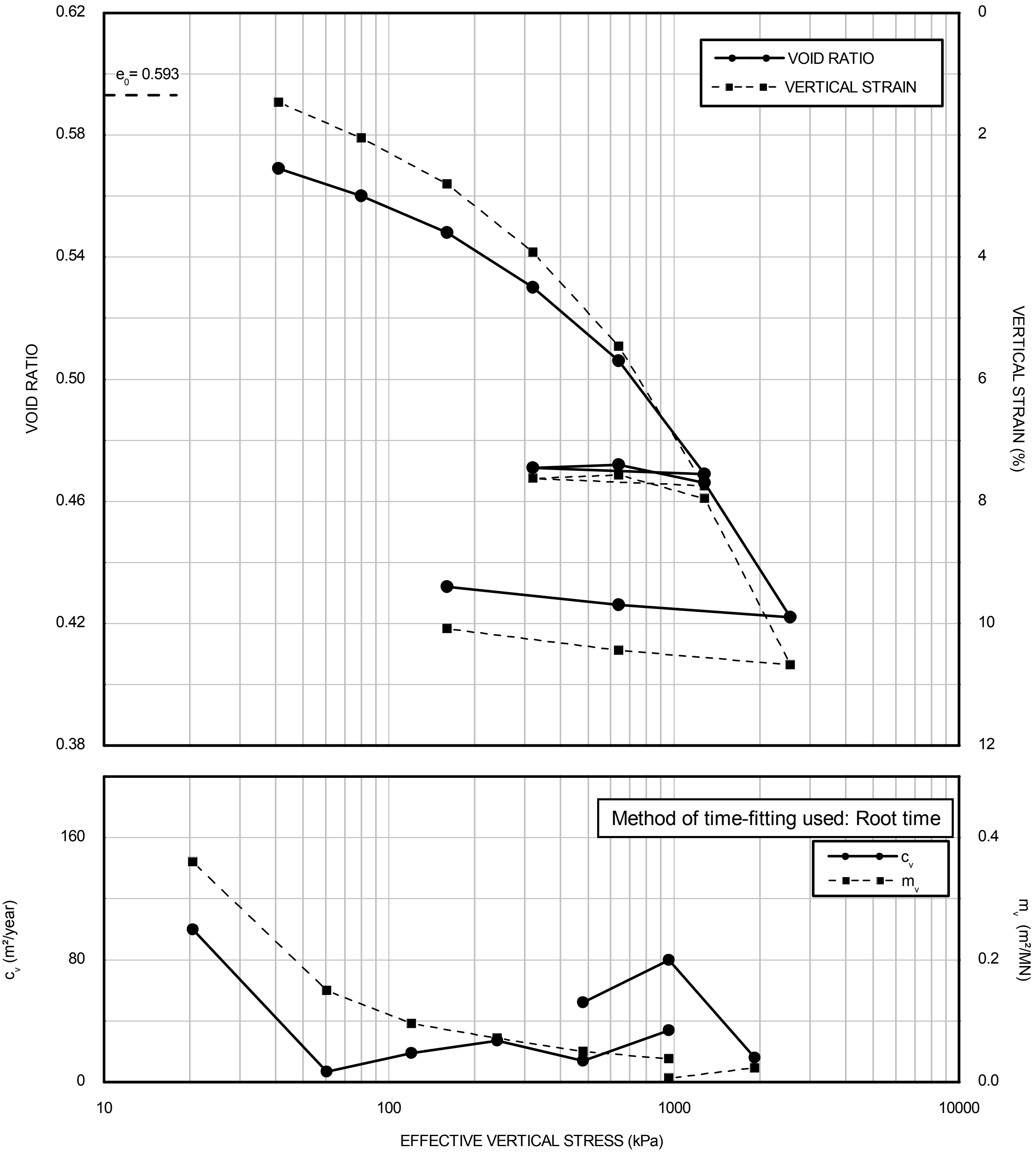
Approved by: PH

Initial Conditions					
Specimen height	: 19.5 mm	Bulk density	: 1.83 Mg/m^3		
Specimen diameter	: 50.1 mm	Dry density	: 1.36 Mg/m^3	Borehole	:HKZ1-BH03 -SA
Degree of saturation	: 95 %	Water content	: 34.3 %		
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C	Sample	:24WaxA
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa	Depth (m)	:15.00
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL
CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016
Template Issue: 3
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH04-SA_19WaxD_od.OPJ
Date : 27/09/2016
Date : 27/09/2016
Checked by: PH
Approved by: PH

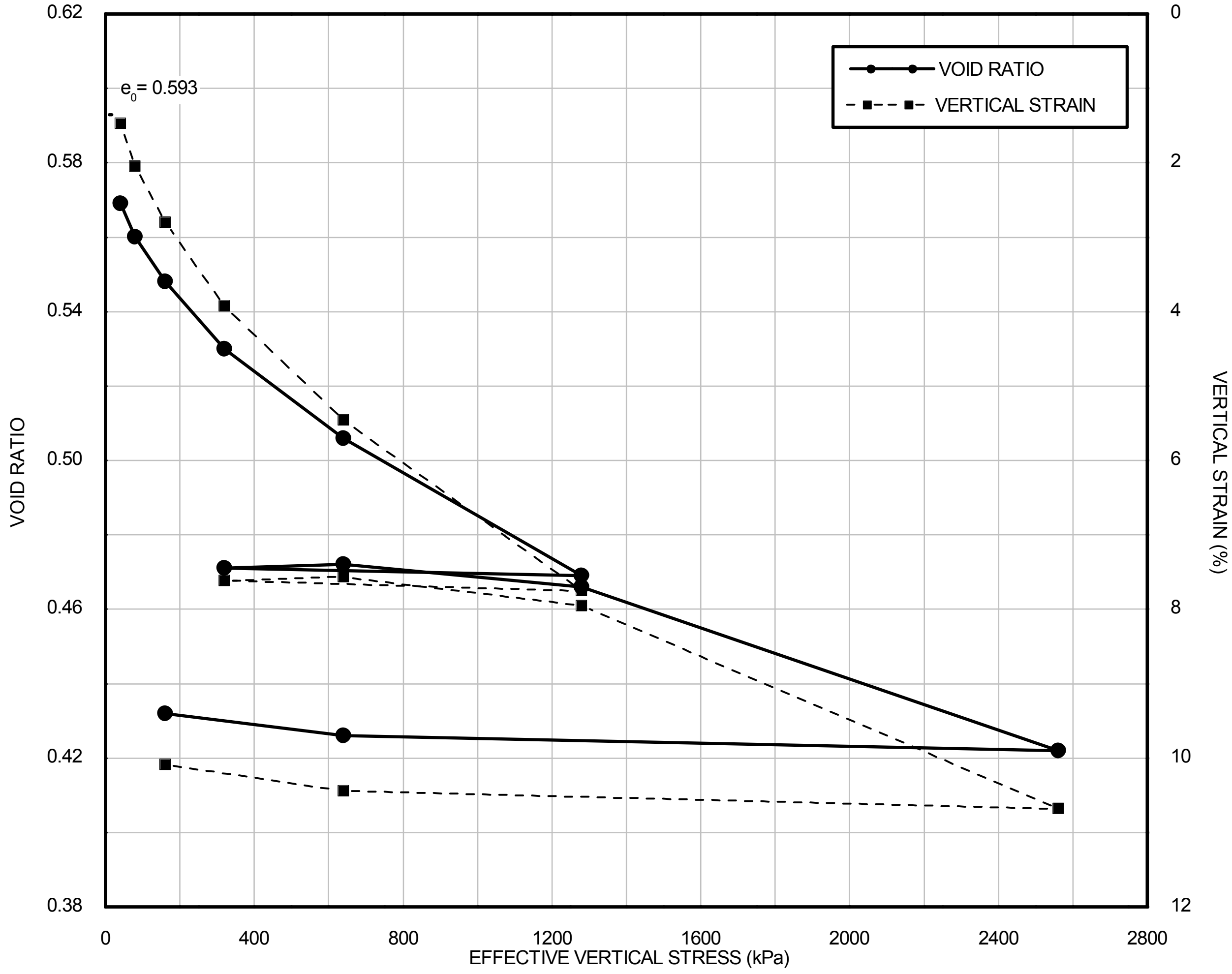


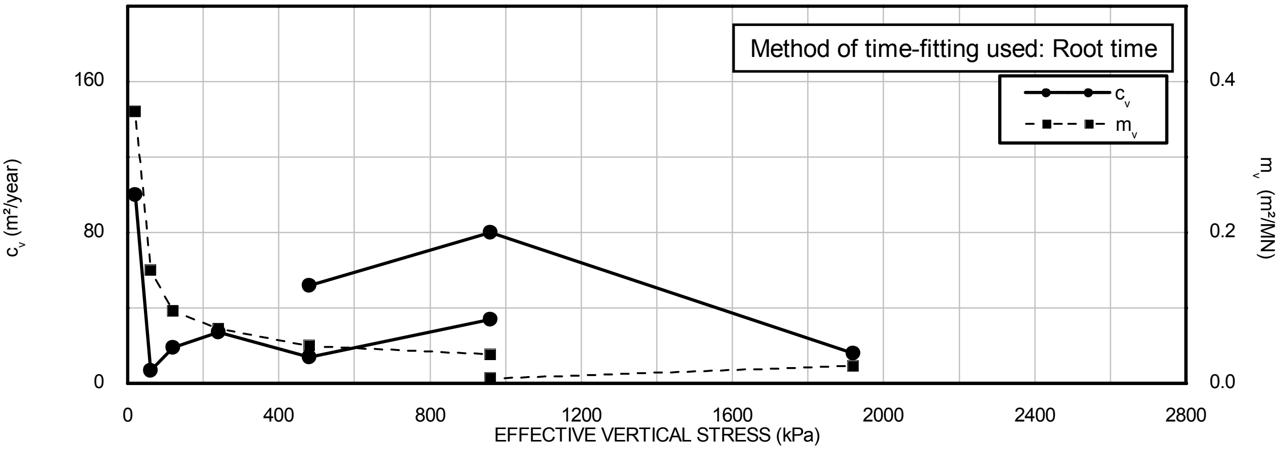
Initial Conditions			
Specimen height Specimen diameter Degree of saturation Particle density Specimen condition Method of time fitting	: 18.3 mm : 50.0 mm : 92 % : 2.70 Mg/m^3 (Measured) : Undisturbed : Root Time Method	Bulk density Dry density Water content Lab. temperature Swelling pressure	: 2.04 Mg/m^3 : 1.70 Mg/m^3 : 20.3 % : 20 °C : NA kPa

Borehole :HKZ1-BH04 -SA
Sample :19WaxD
Depth (m) :16.15

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)





Initial Conditions				
Specimen height	: 18.3 mm	Bulk density	: 2.04 Mg/m^3	Borehole :HKZ1-BH04-SA
Specimen diameter	: 50.0 mm	Dry density	: 1.70 Mg/m^3	Sample :19WaxD
Degree of saturation	: 92 %	Water content	: 20.3 %	Depth (m) :16.15
Particle density	: 2.70 Mg/m^3 (Measured)	Lab. temperature	: 20 °C	
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa	
Method of time fitting	: Root Time Method			

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL
CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

Template Issue: 3

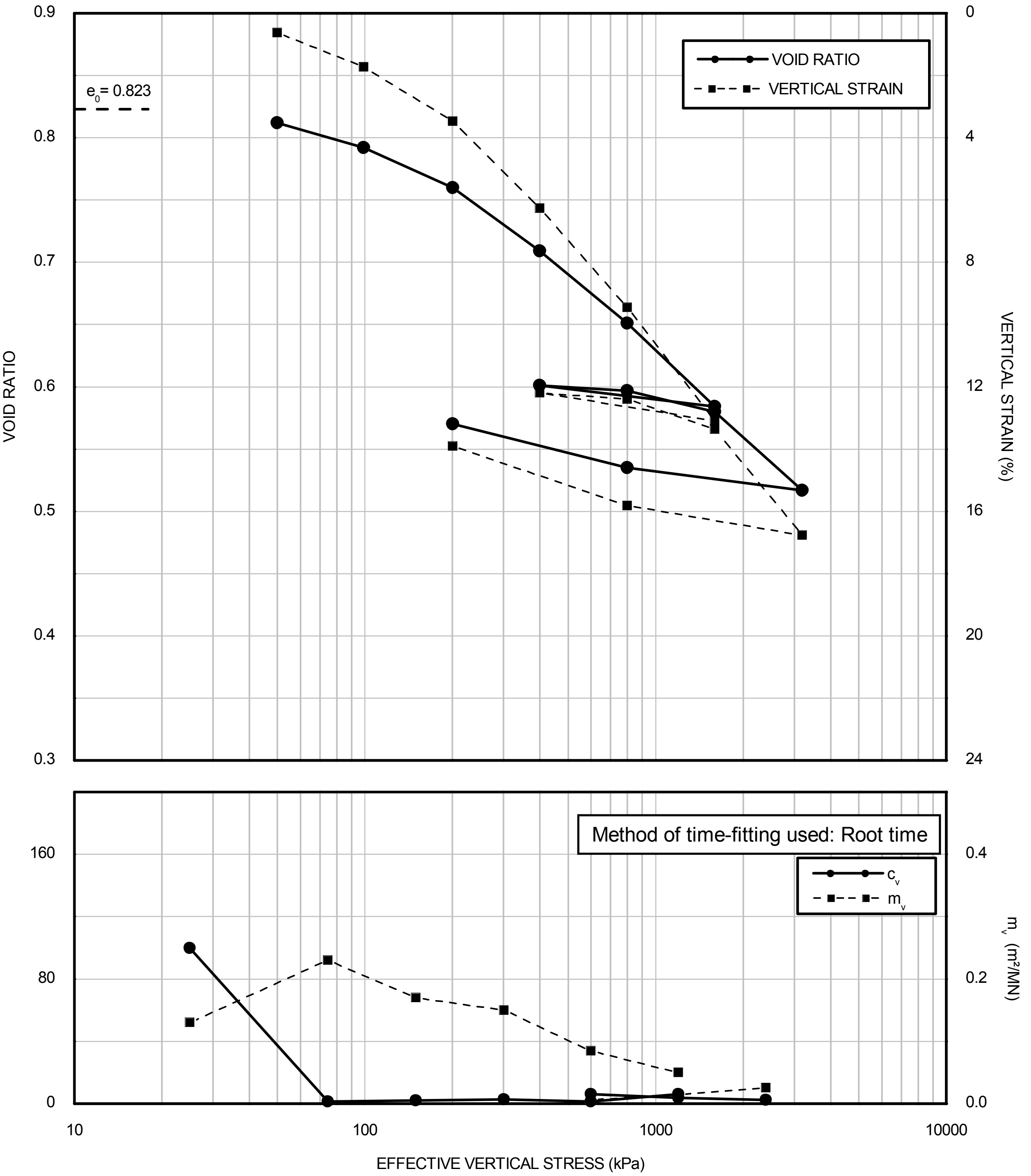
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH05-SA_23WaxD_od.OPJ

Date : 27/09/2016

Date : 27/09/2016

Checked by: PH

Approved by: PH



Initial Conditions

Specimen height : 18.3 mm
Specimen diameter : 50.1 mm
Degree of saturation : 100 %
Particle density : 2.70 Mg/m^3 (Assumed)
Specimen condition : Undisturbed
Method of time fitting : Root Time Method

Bulk density : 1.94 Mg/m^3
Dry density : 1.48 Mg/m^3
Water content : 30.7 %
Lab. temperature : 20 °C
Swelling pressure : NA kPa

Borehole :HKZ1-BH05 -SA
Sample :23WaxD
Depth (m) :19.60

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Drawn by: ALB Date: 20/09/2016

Template Issue: 3

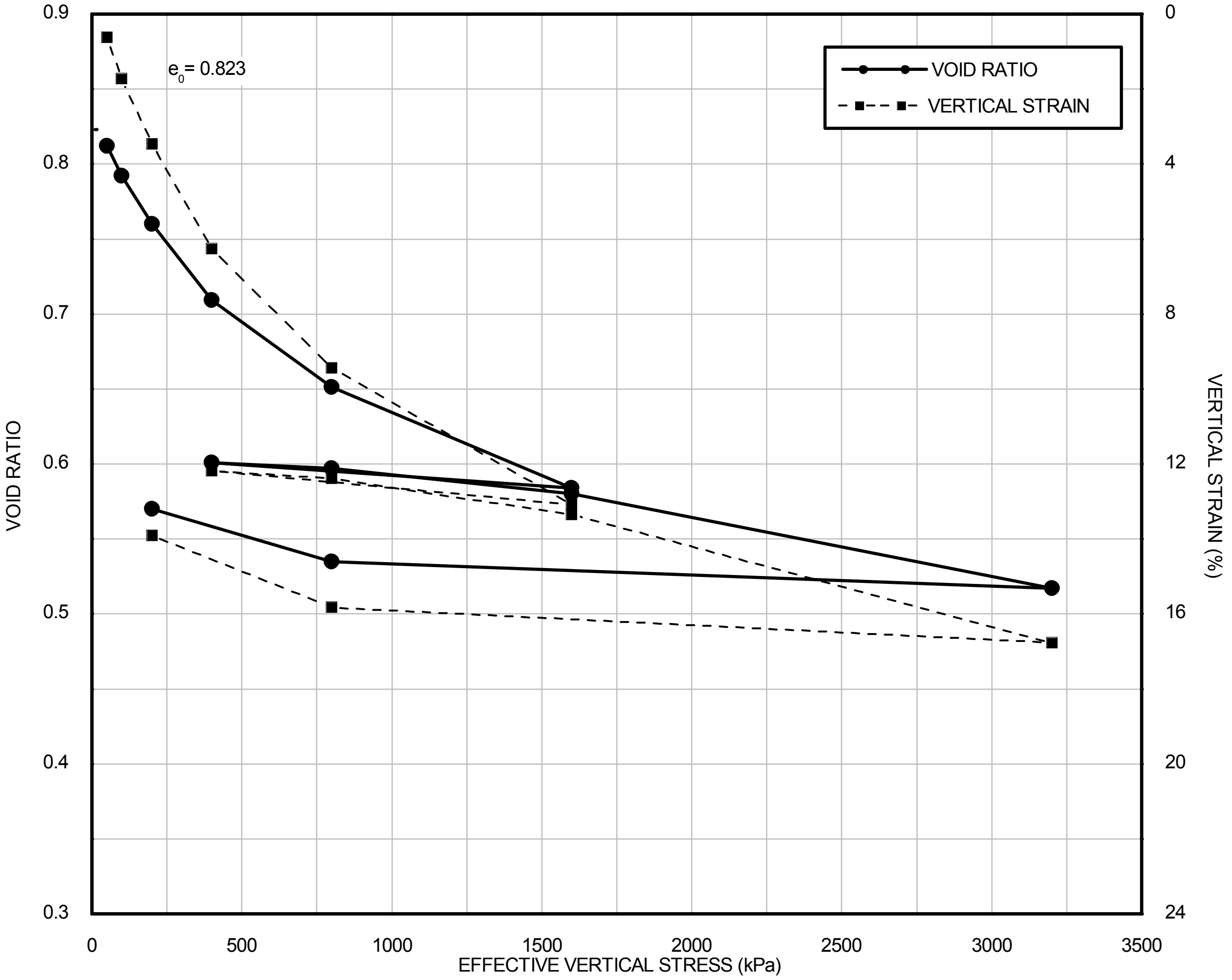
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH05-SA_23WaxD_od.OPJ

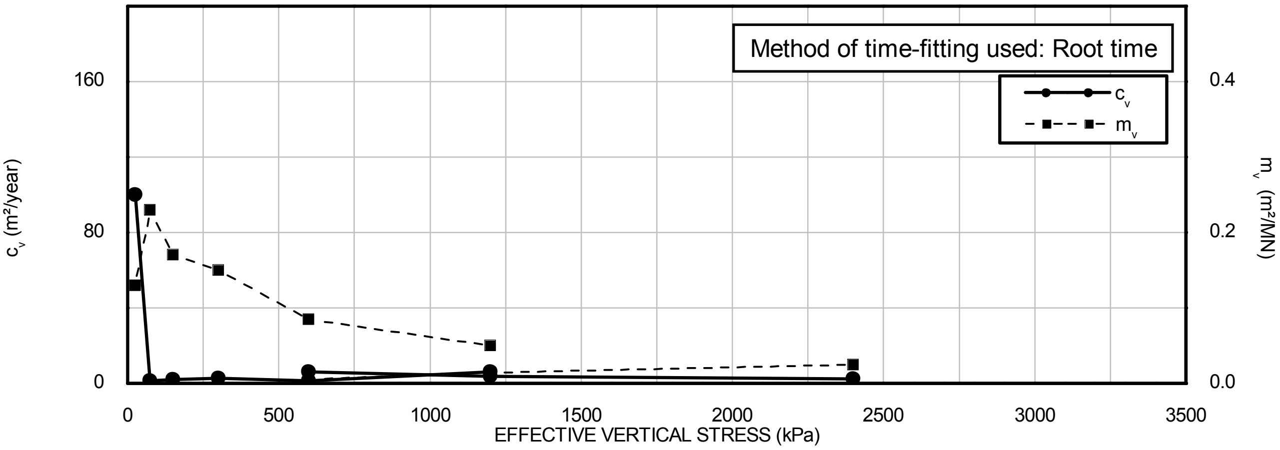
Date : 27/09/2016

Date : 27/09/2016

Checked by: PH

Approved by: PH



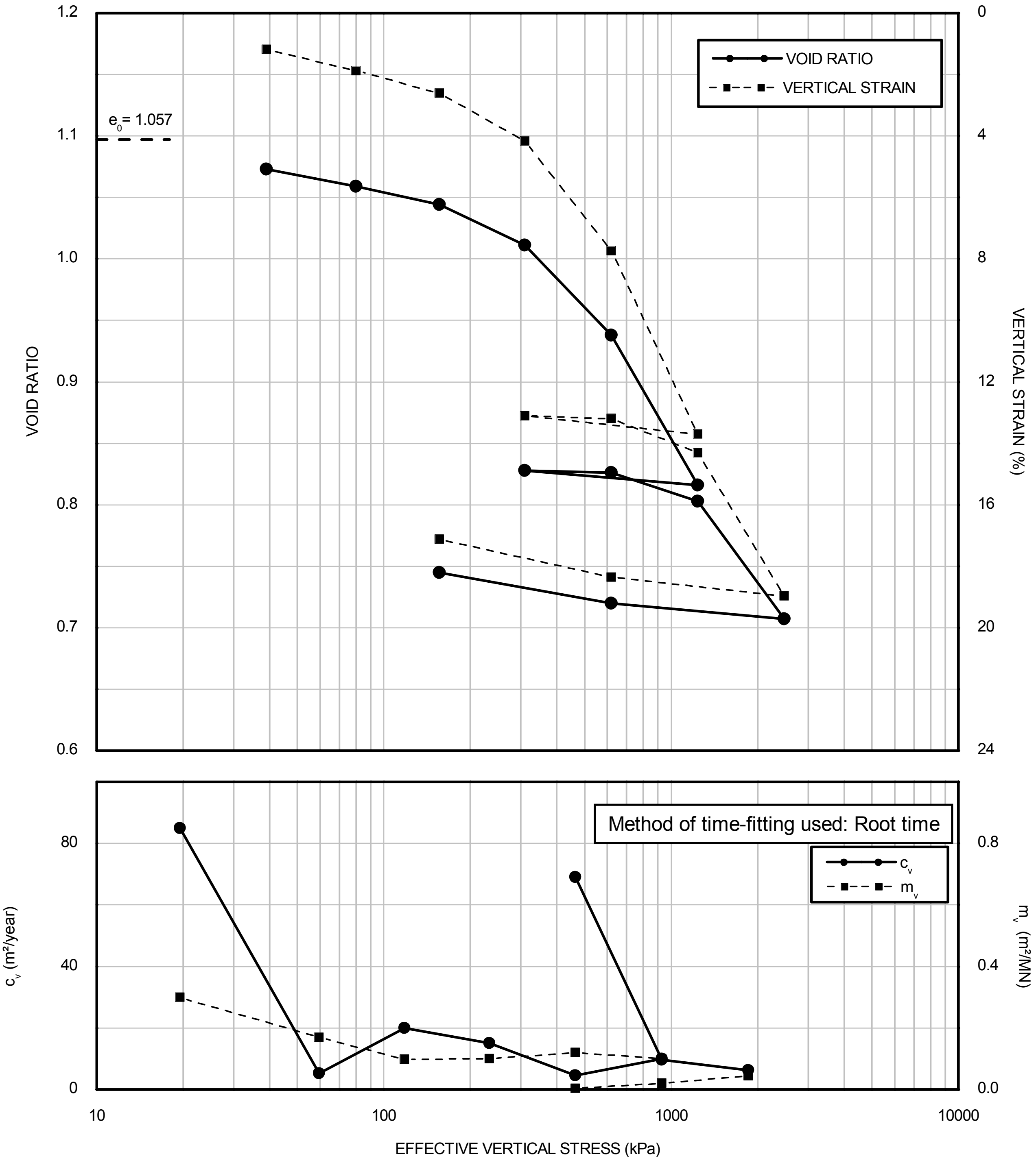


Initial Conditions					
Specimen height	: 18.3 mm	Bulk density	: 1.94 Mg/m^3	Borehole	:HKZ1-BH05 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.48 Mg/m^3	Sample	:23WaxD
Degree of saturation	: 100 %	Water content	: 30.7 %	Depth (m)	:19.60
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C		
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa		
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL
CONSOLIDATION TEST (OEDOMETER)

Date: 12/09/2016
Drawn by: MSR
Template Issue: 3
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH06-SA_20WaxB_od.OPJ
Date : 13/09/2016
Date : 27/09/2016
Checked by: ALB
Approved by: PH



Initial Conditions

Specimen height : 18.4 mm
Specimen diameter : 50.1 mm
Degree of saturation : 93 %
Particle density : 2.70 Mg/m^3 (Assumed)
Specimen condition : Undisturbed
Method of time fitting : Root Time Method

Bulk density : 1.79 Mg/m^3
Dry density : 1.31 Mg/m^3
Water content : 36.3 %
Lab. temperature : 20 °C
Swelling pressure : NA kPa

Borehole :HKZ1-BH06-SA
Sample :20WaxB
Depth (m) :15.70

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Date: 12/09/2016

Drawn by: MSR

Template Issue: 3

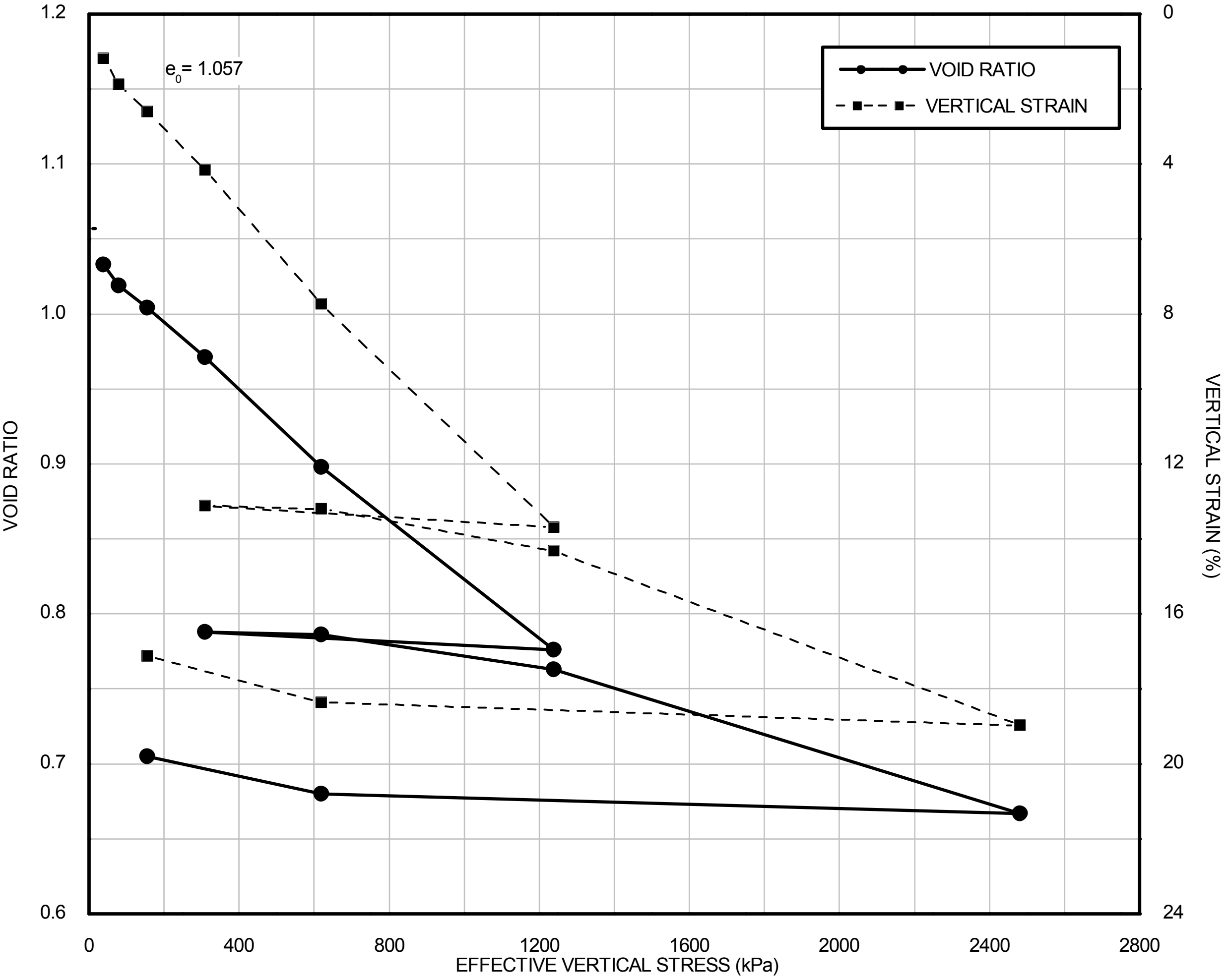
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH06-SA_20WaxB_od.OPJ

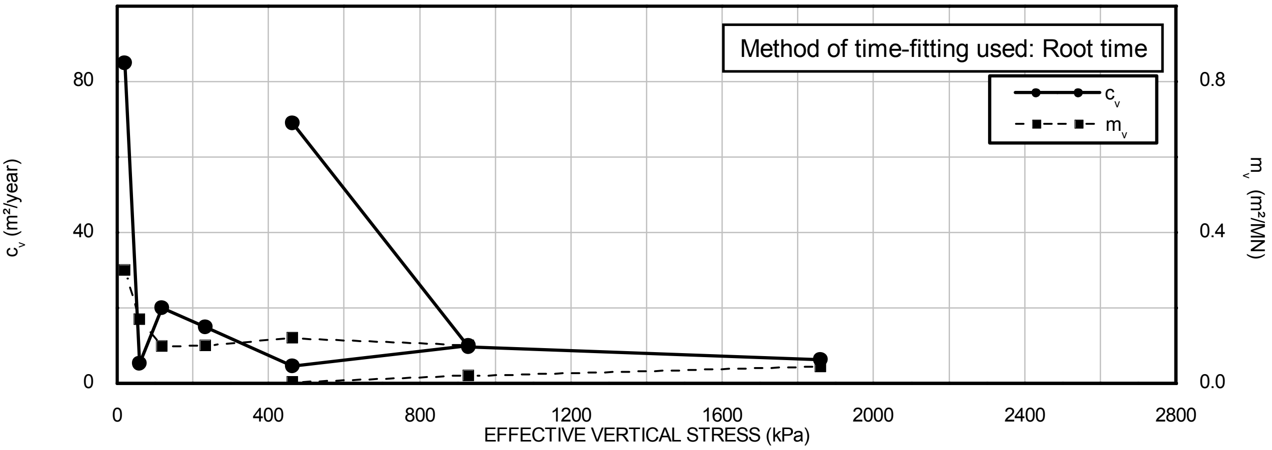
Date : 13/09/2016

Date : 27/09/2016

Checked by: ALB

Approved by: PH



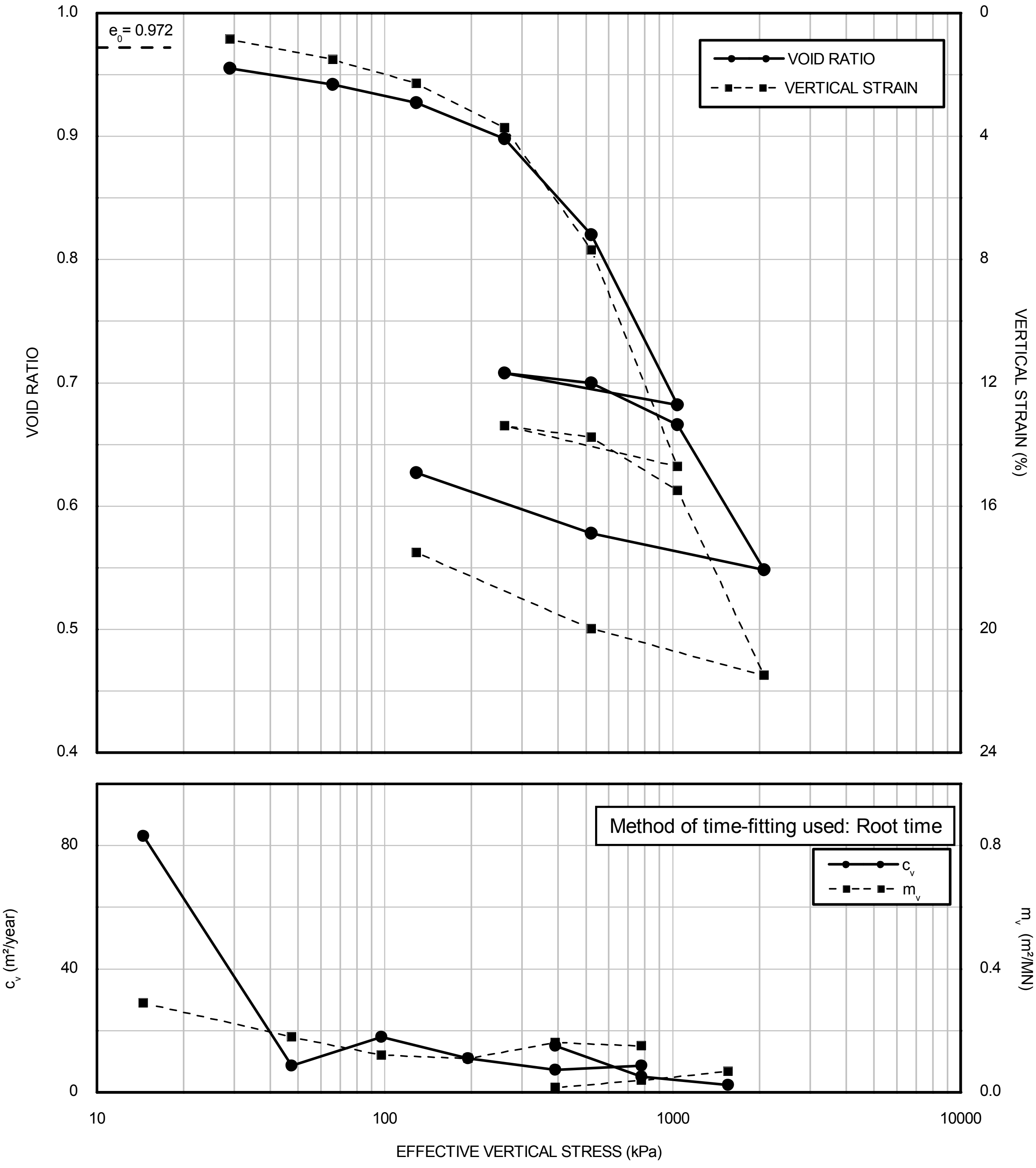


Initial Conditions					
Specimen height	: 18.4 mm	Bulk density	: 1.79 Mg/m^3	Borehole	:HKZ1-BH06 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.31 Mg/m^3	Sample	:20WaxB
Degree of saturation	: 93 %	Water content	: 36.3 %	Depth (m)	:15.70
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C		
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa		
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Date: 12/19/16
Drawn by: MSR
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH08-SA_15WaxB_od.OPJ
Template Issue: 3
Date : 13/09/2016
Date : 27/09/2016
Checked by: ALB
Approved by: PH



Initial Conditions					
Specimen height	: 19.2 mm	Bulk density	: 1.84 Mg/m^3	Borehole	:HKZ1-BH08 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.37 Mg/m^3	Sample	:15WaxB
Degree of saturation	: 96 %	Water content	: 34.7 %	Depth (m)	:13.20
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C		
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa		
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

Date: 12/19/16

Drawn by: MSR

Template Issue: 3

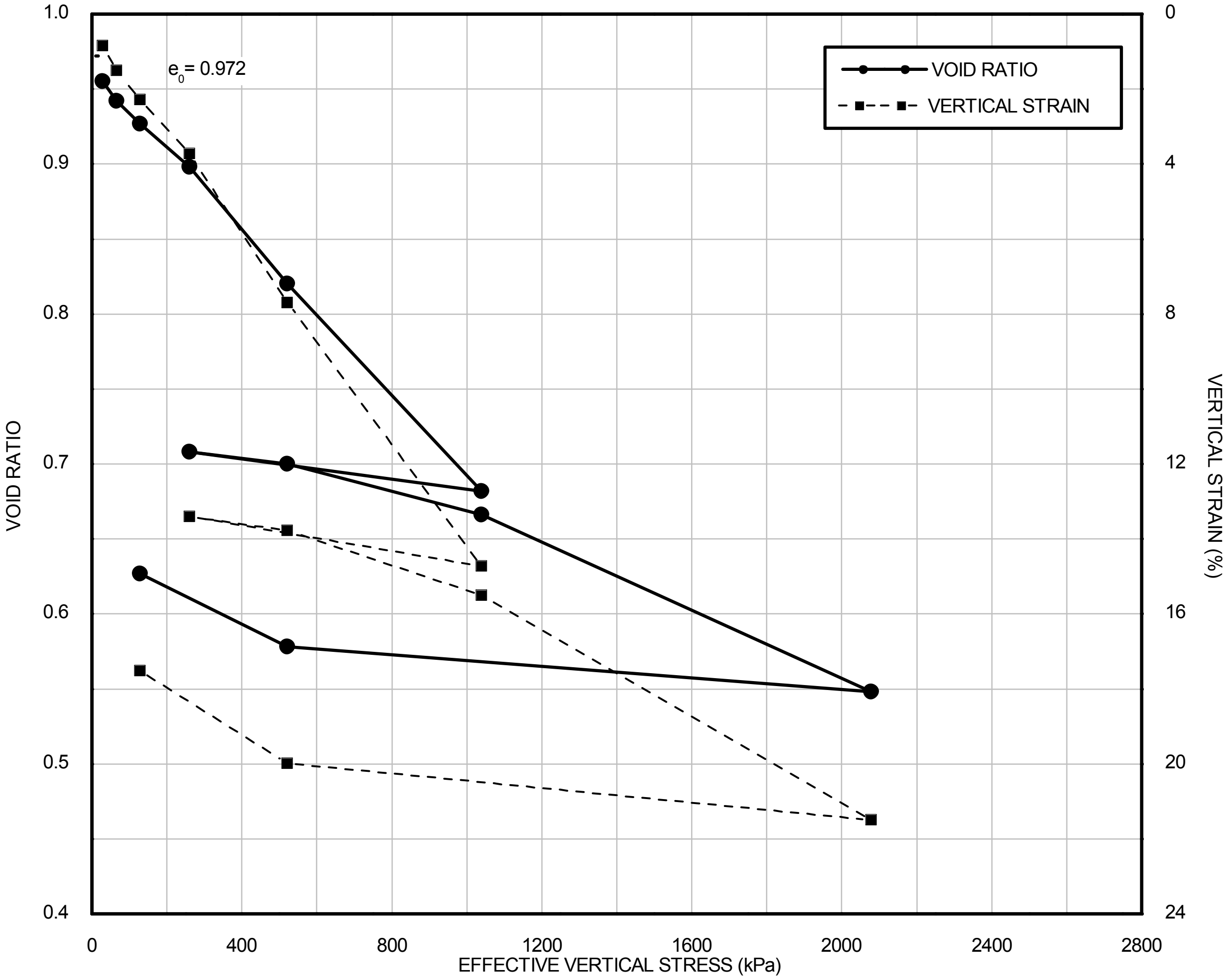
Filename: J11335 \ Labdata \ Compress \ HKZ1-BH08-SA_15WaxB_od.OPJ

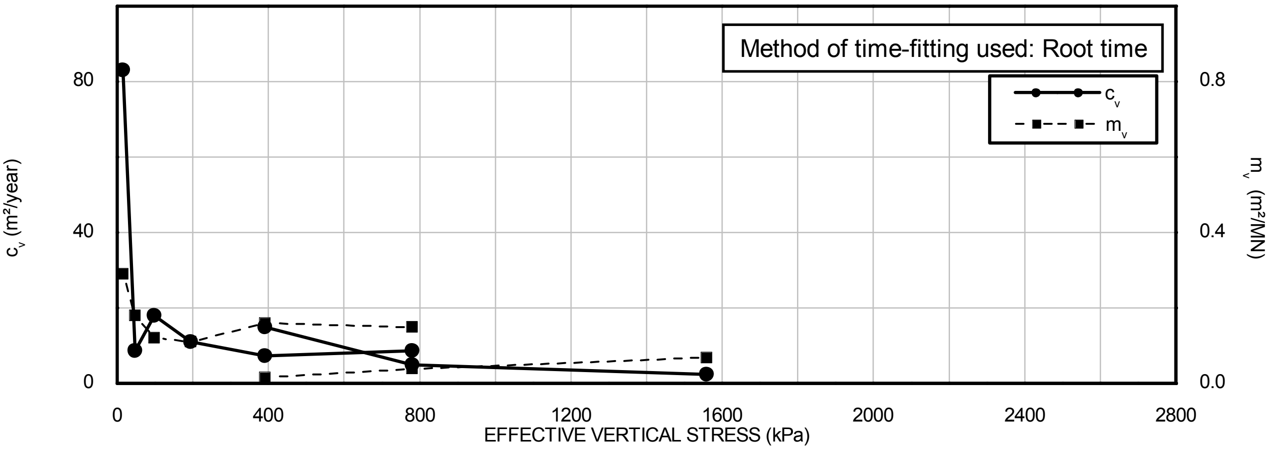
Date : 13/09/2016

Date : 27/09/2016

Checked by: ALB

Approved by: PH





Initial Conditions

Specimen height	: 19.2 mm	Bulk density	: 1.84 Mg/m^3	Borehole	:HKZ1-BH08 -SA
Specimen diameter	: 50.1 mm	Dry density	: 1.37 Mg/m^3		
Degree of saturation	: 96 %	Water content	: 34.7 %	Sample	:15WaxB
Particle density	: 2.70 Mg/m^3 (Assumed)	Lab. temperature	: 20 °C		
Specimen condition	: Undisturbed	Swelling pressure	: NA kPa	Depth (m)	:13.20
Method of time fitting	: Root Time Method				

Tested in accordance with BS1377: Part 5: 1990: Clause 3

ONE - DIMENSIONAL CONSOLIDATION TEST (OEDOMETER)

VISUAL DESCRIPTION
Very dark grey silty SAND

GENERAL	
Date test started	13/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	49.9
Length	[mm]	20.7
Water content	[%]	29.2
Bulk density	[Mg/m³]	1.95
Dry density	[Mg/m³]	1.51
Void ratio	[-]	0.773
Degree of saturation	[%]	100
Measured particle density	[Mg/m³]	2.67
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.

Note:
Fugro testing procedures are available upon request

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH01-SA_18WaxB_crs
Template issue	9.0
Processed by Date	ALB 20/09/2016
Checked by Date	MSR 26/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH01-SA
Sample	18WaxB
Depth [m]	15.81
Test Number	165

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

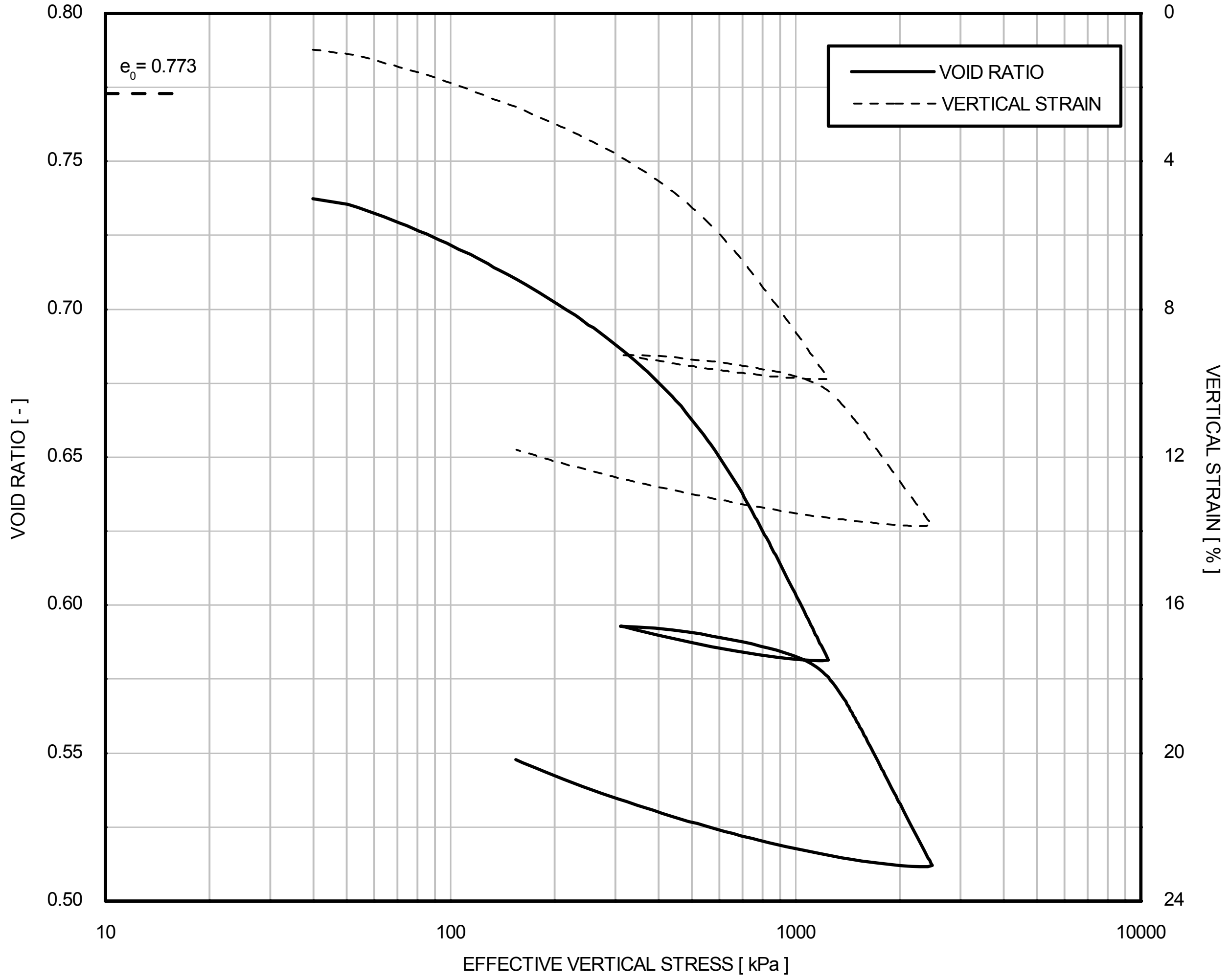
SPECIMEN PHOTOGRAPH

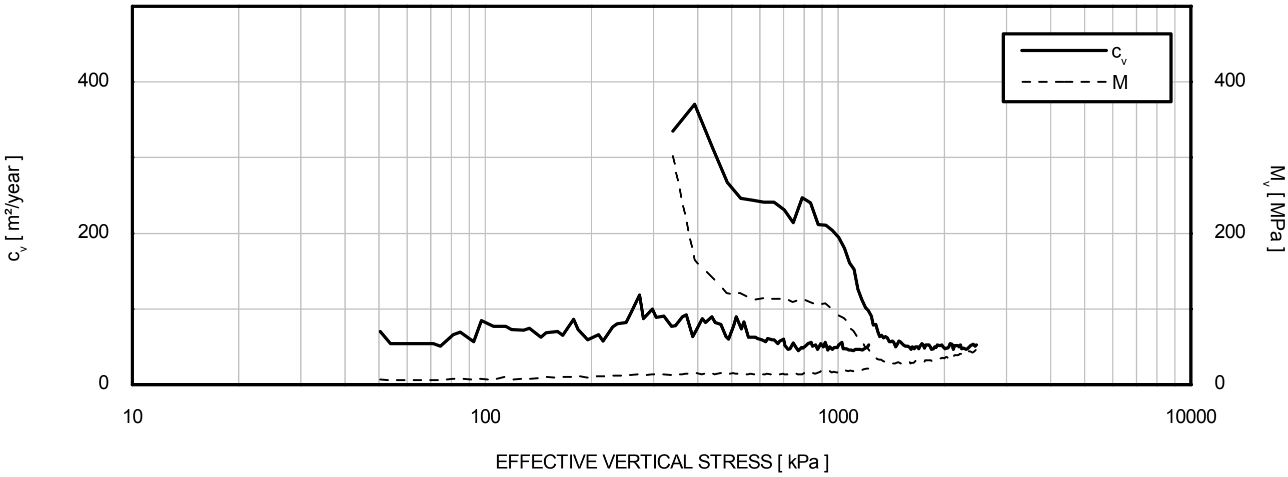
FUGRO 165

PROJECT No.	J11335
BORE HOLE	HKZ1-BH01-SA
SAMPLE	18WaxB
DEPTH (m)	15.70

TEST IDENTIFICATION	
Borehole	HKZ1-BH01-SA
Sample	18WaxB
Depth [m]	15.81
Test Number	165

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





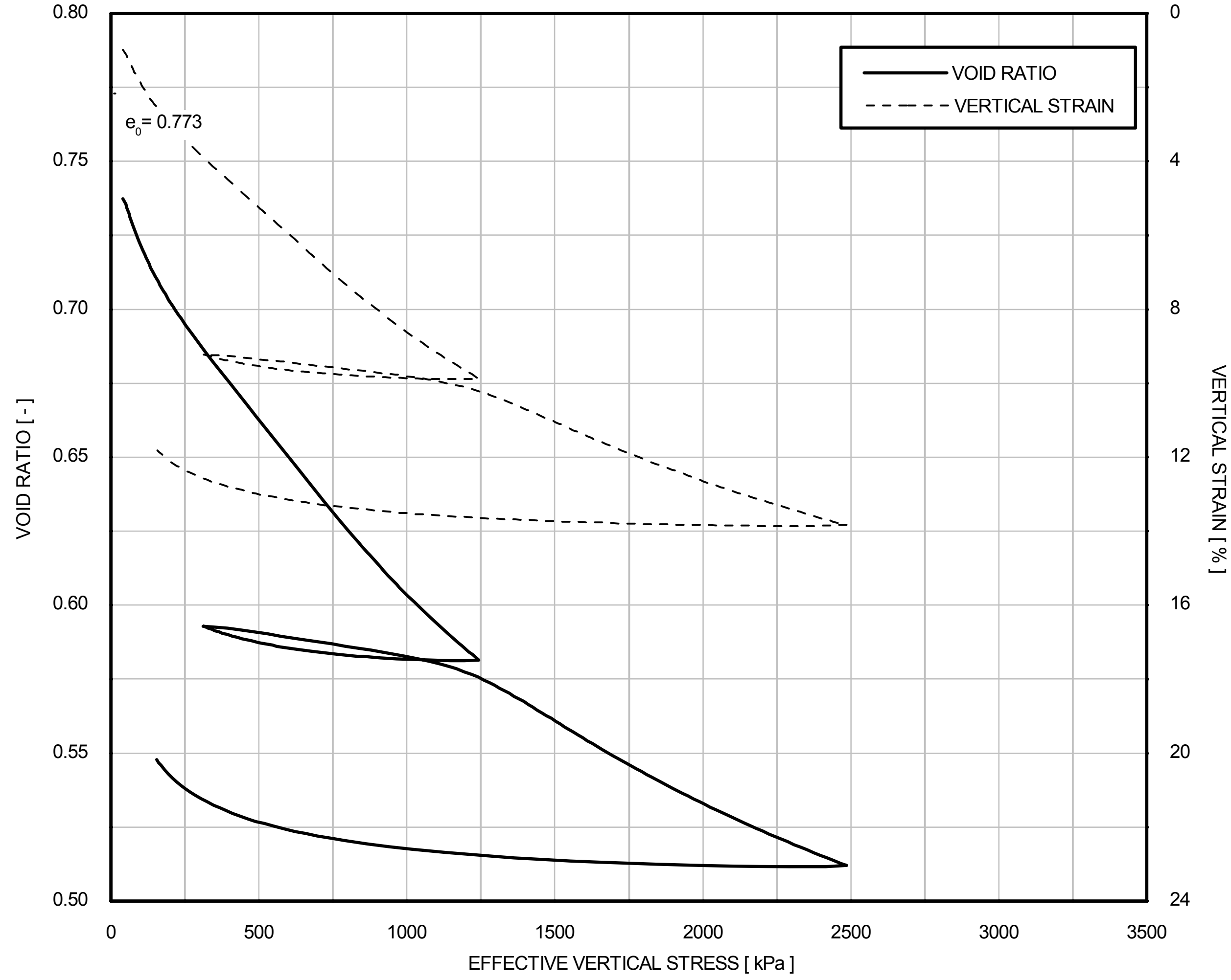
Borehole	Sample	Depth [m]
HKZ1-BH01-SA	18WaxB	15.81

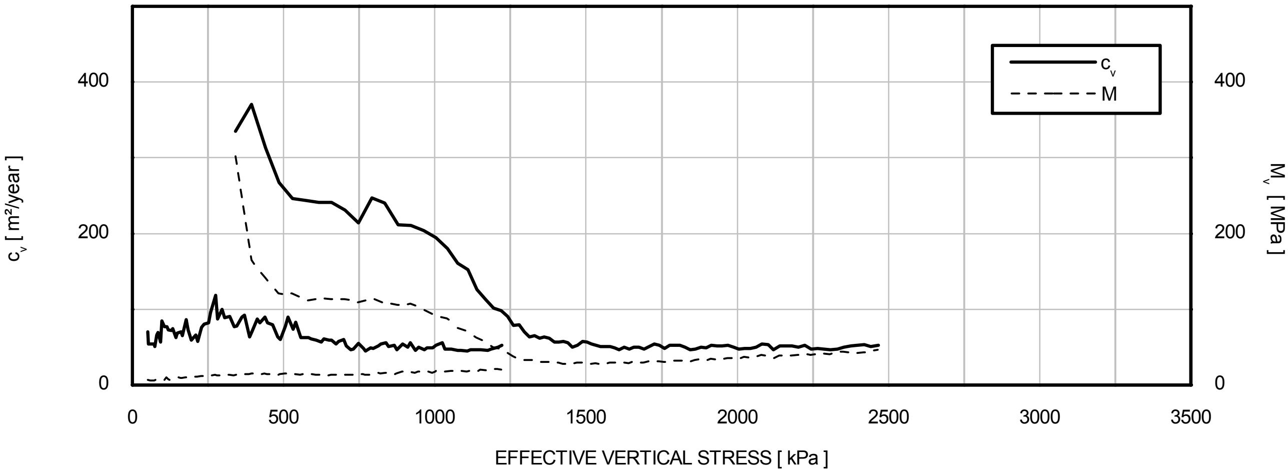
Initial void ratio : 0.773

Particle Density : 2.67 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





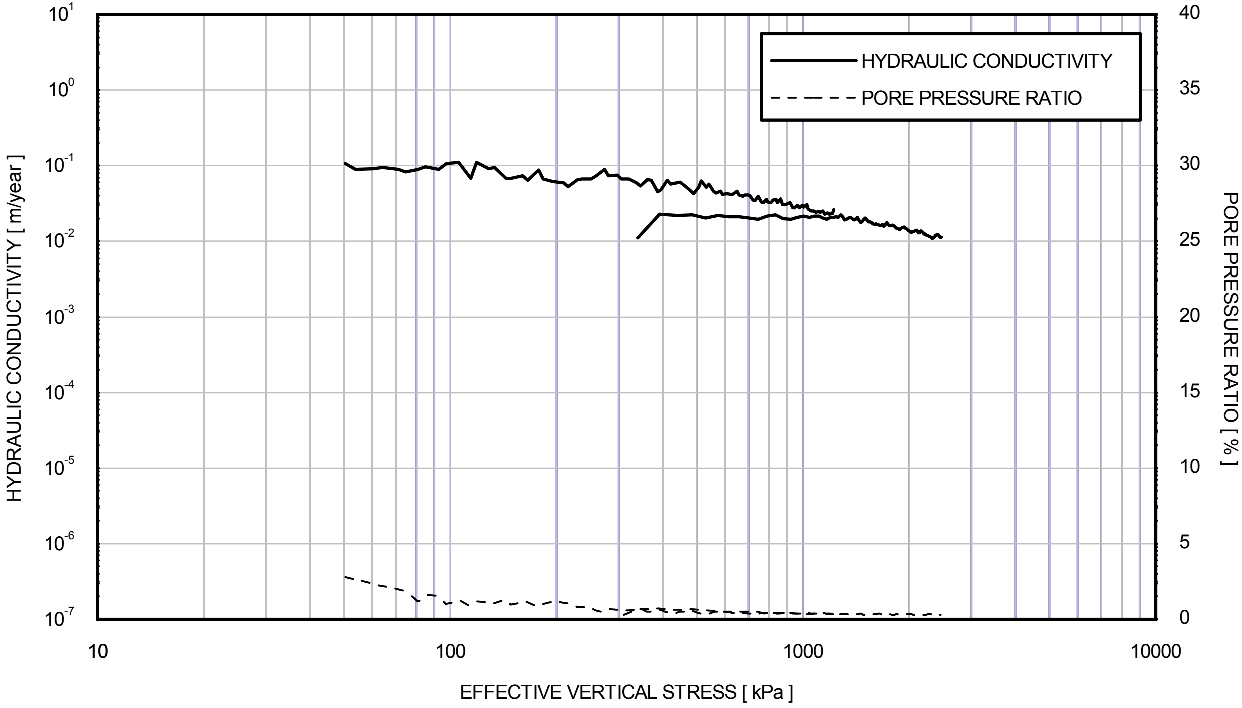
Borehole	Sample	Depth [m]
HKZ1-BH01-SA	18WaxB	15.81

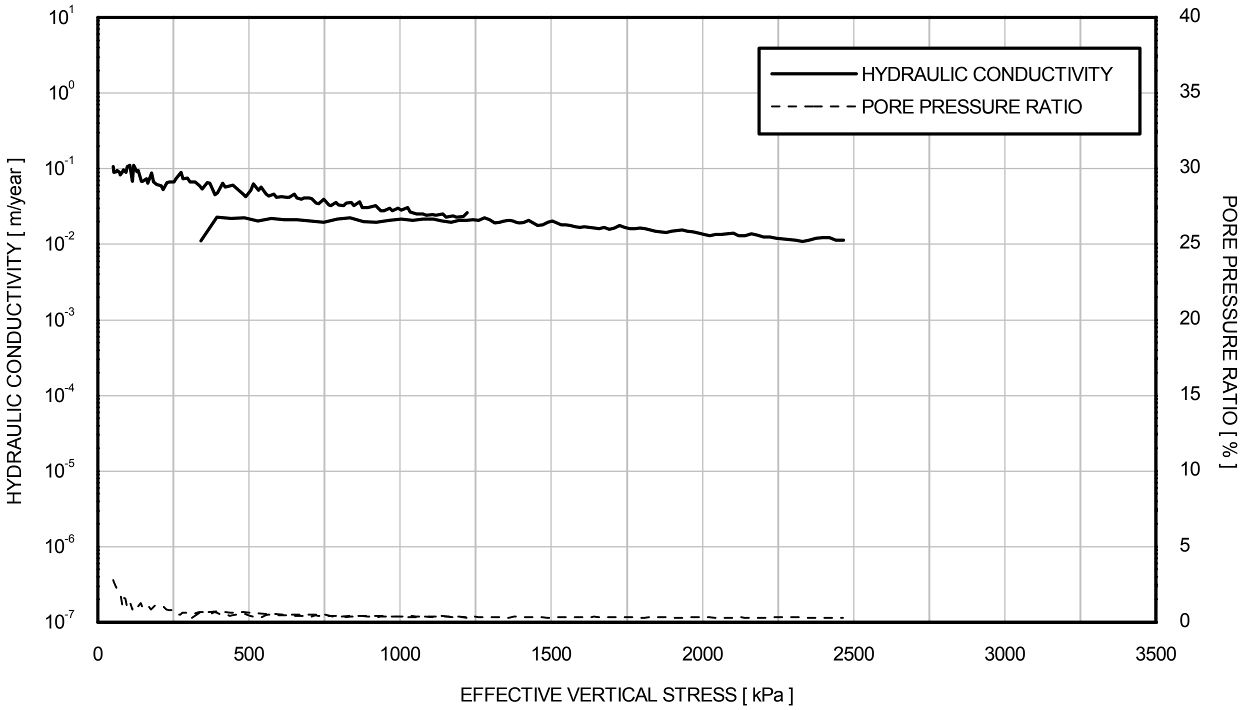
Initial void ratio : 0.773

Particle Density : 2.67 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





<u>Borehole</u>	<u>Sample</u>	<u>Depth [m]</u>
HKZ1-BH01-SA	18WaxB	15.81

Initial void ratio : 0.773

Particle Density : 2.67 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark grey silty CLAY

GENERAL	
Date test started	05/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.8
Water content	[%]	30.2
Bulk density	[Mg/m³]	1.95
Dry density	[Mg/m³]	1.50
Void ratio	[-]	0.806
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH01-SA_24WaxB_crs
Template issue	9.0
Processed by Date	ALB 13/09/2016
Checked by Date	MSR 15/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH01-SA
Sample	24WaxB
Depth [m]	21.62
Test Number	166

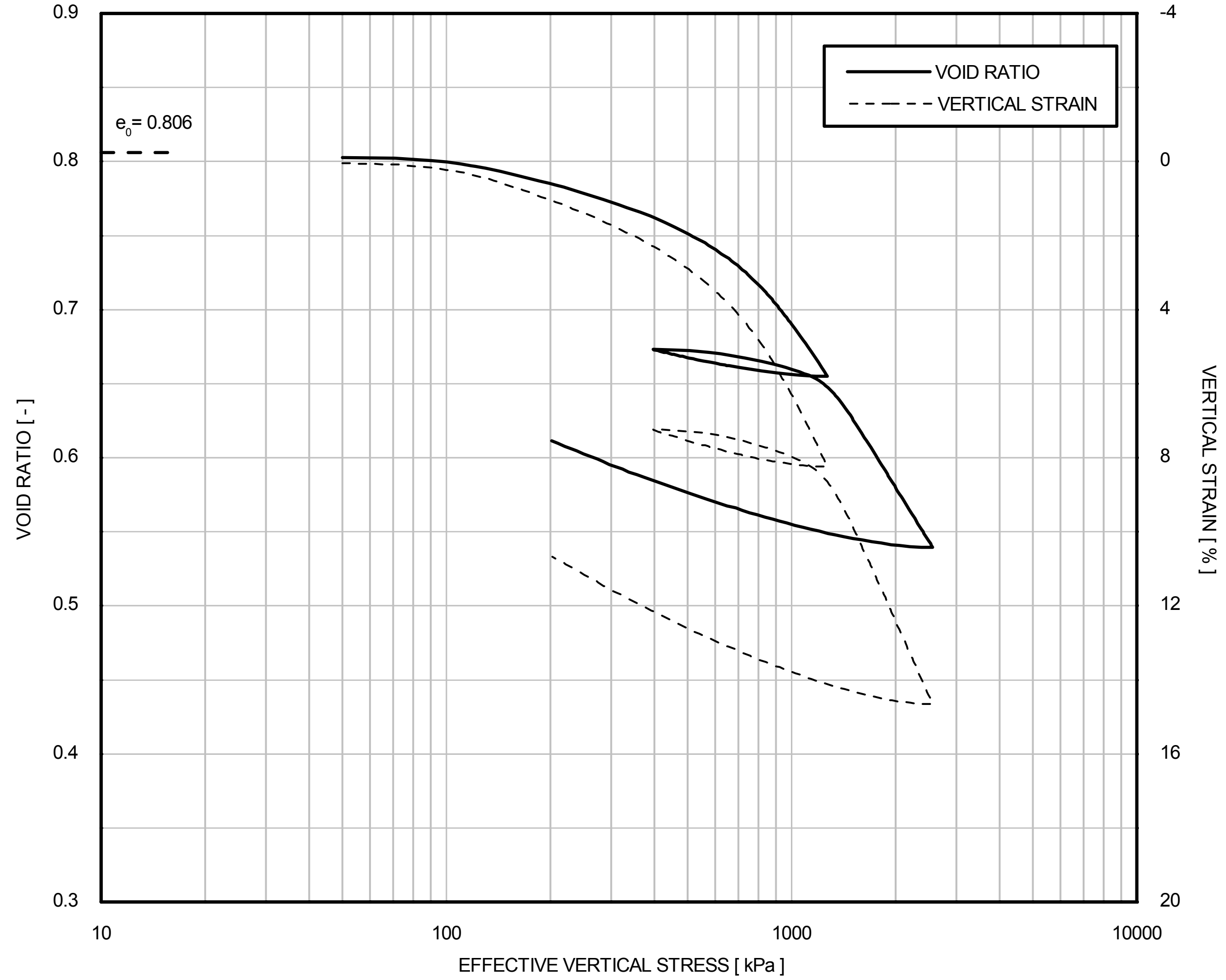
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

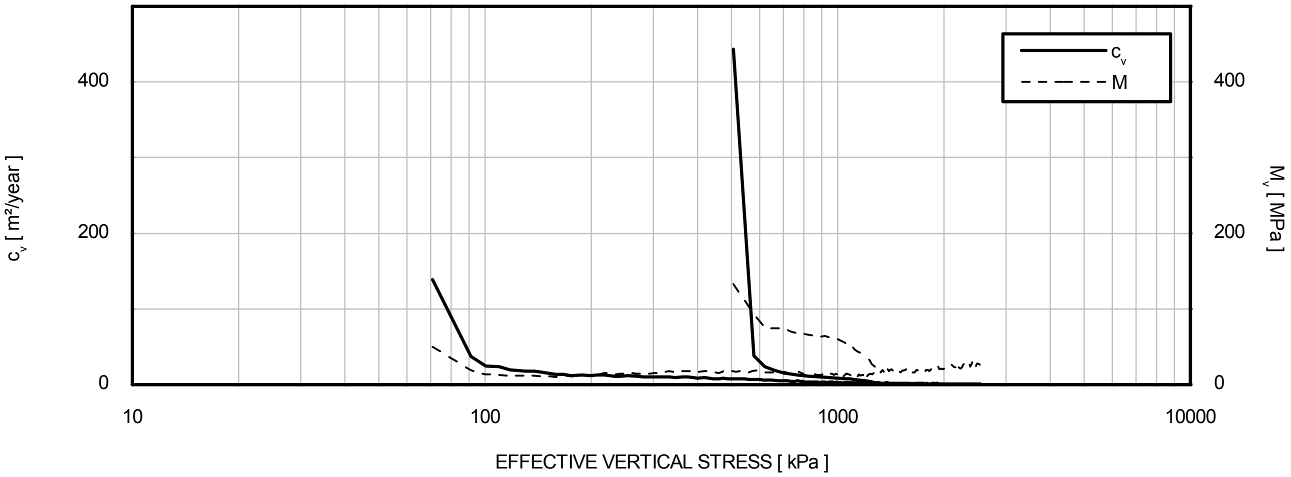
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION

Borehole	HKZ1-BH01-SA
Sample	24WaxB
Depth [m]	21.62
Test Number	166

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





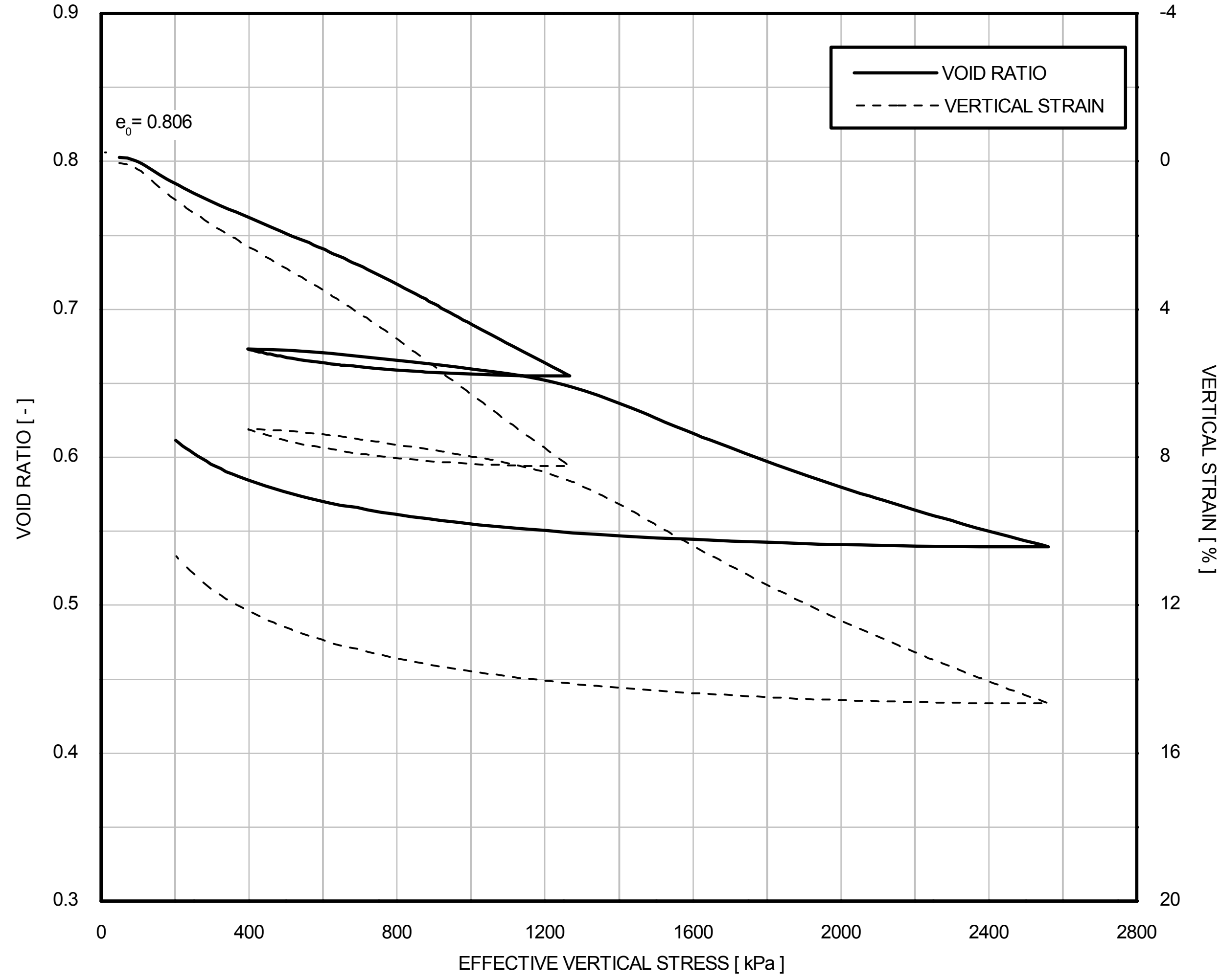
Borehole	Sample	Depth [m]
HKZ1-BH01-SA	24WaxB	21.62

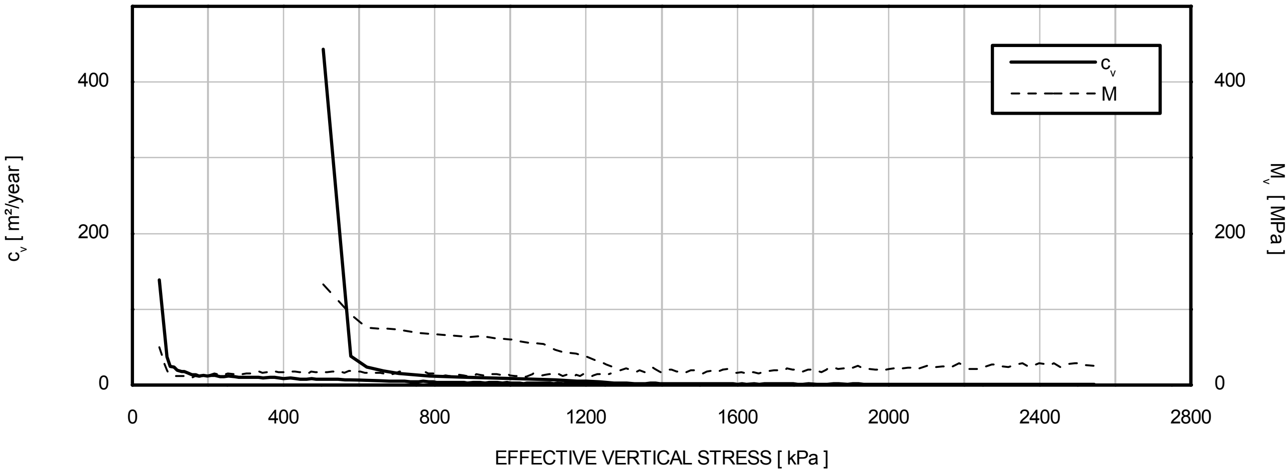
Initial void ratio : 0.806

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





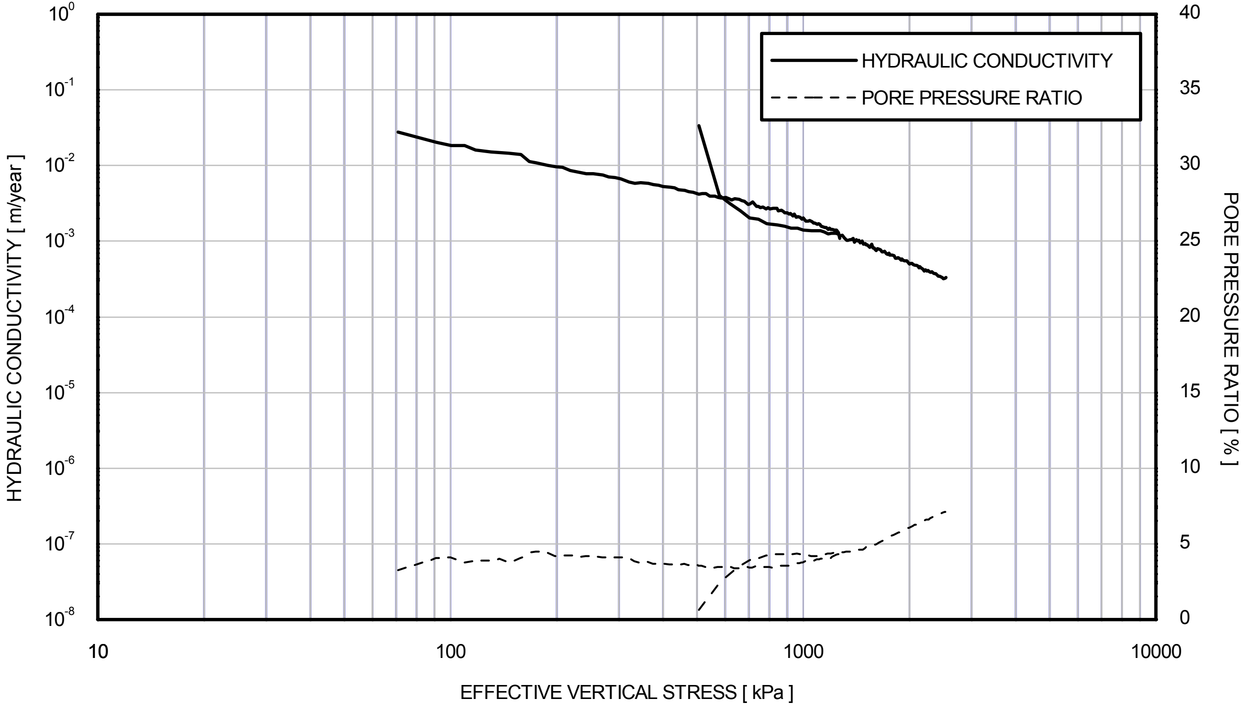
Borehole	Sample	Depth [m]
HKZ1-BH01-SA	24WaxB	21.62

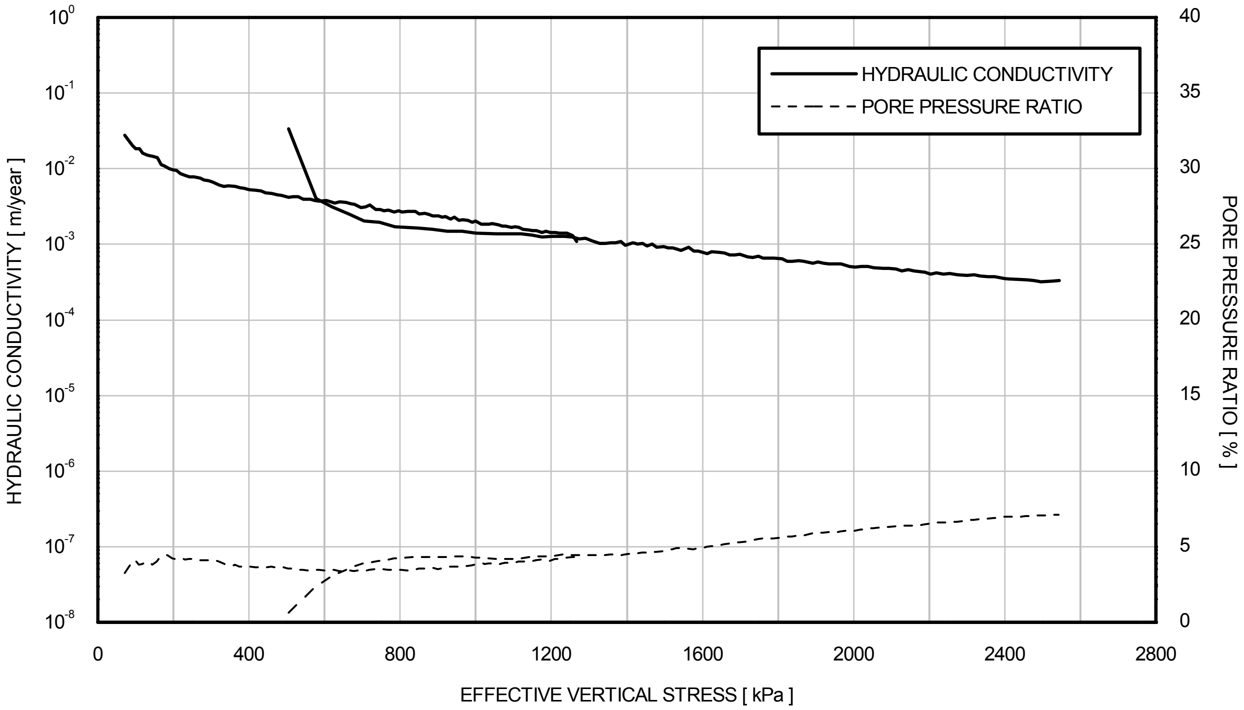
Initial void ratio : 0.806

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH01-SA	24WaxB	21.62

Initial void ratio : 0.806

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Very dark grey silty CLAY

GENERAL	
Date test started	16/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.6
Water content	[%]	32.4
Bulk density	[Mg/m³]	1.89
Dry density	[Mg/m³]	1.42
Void ratio	[-]	0.895
Degree of saturation	[%]	98
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH02-SA_17BagA_psm
Template issue	9.0
Processed by Date	ALB 30/09/2016
Checked by Date	PH 04/10/2016
Approved by Date	PH 04/10/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH02-SA
Sample	16WaxD
Depth [m]	14.19
Test Number	167

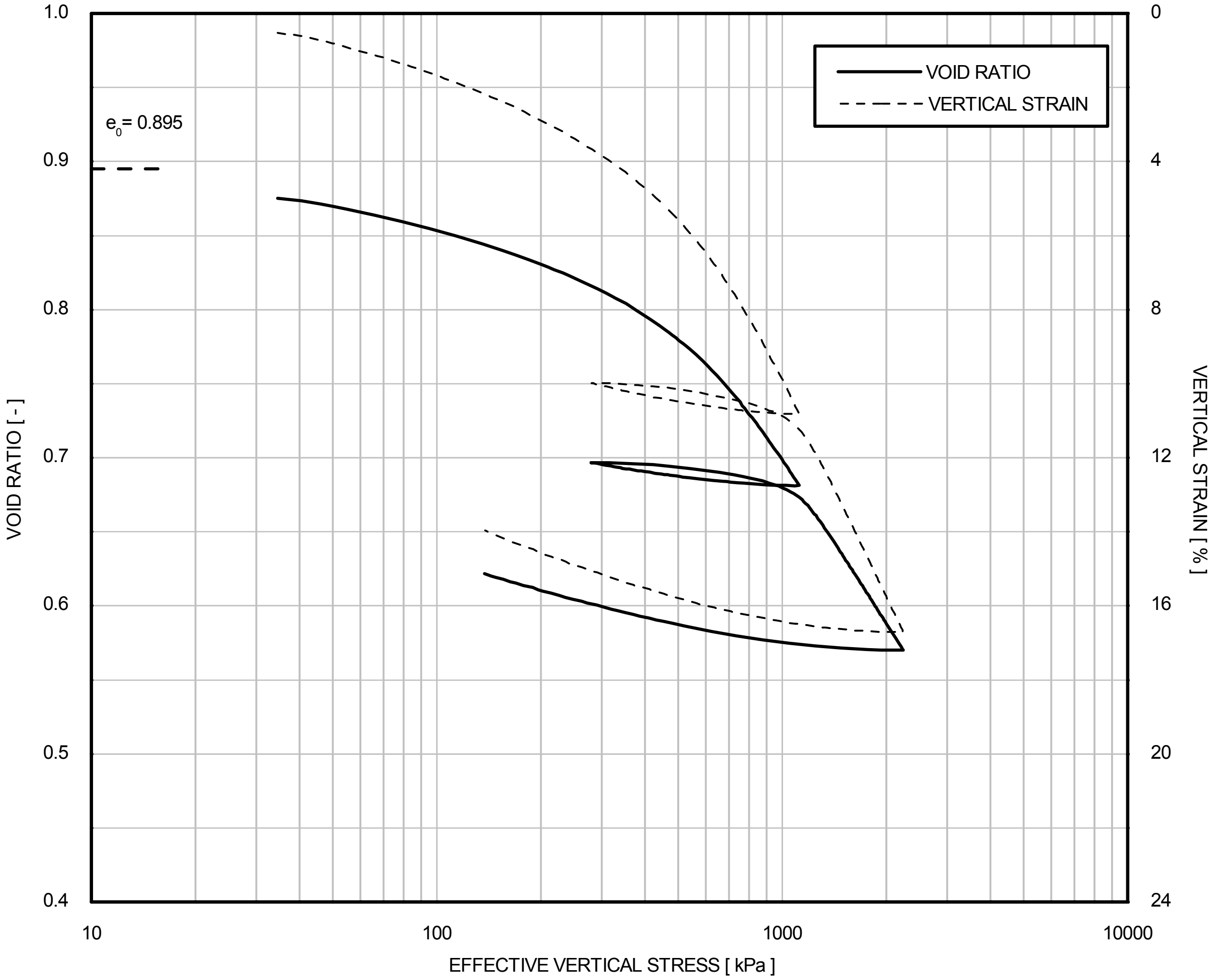
ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

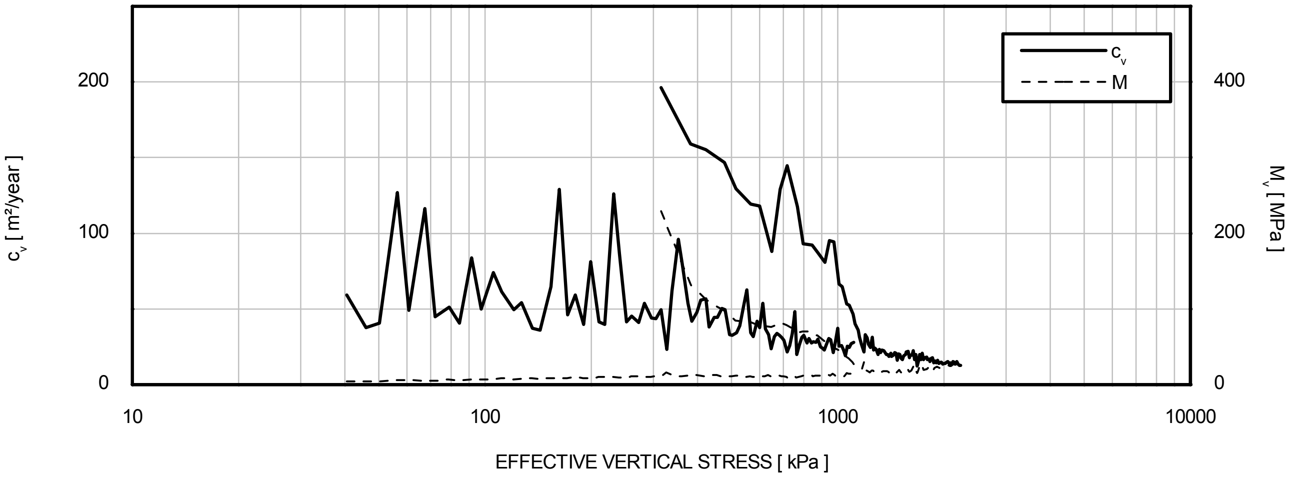
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION

Borehole	HKZ1-BH02-SA
Sample	16WaxD
Depth [m]	14.19
Test Number	167

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





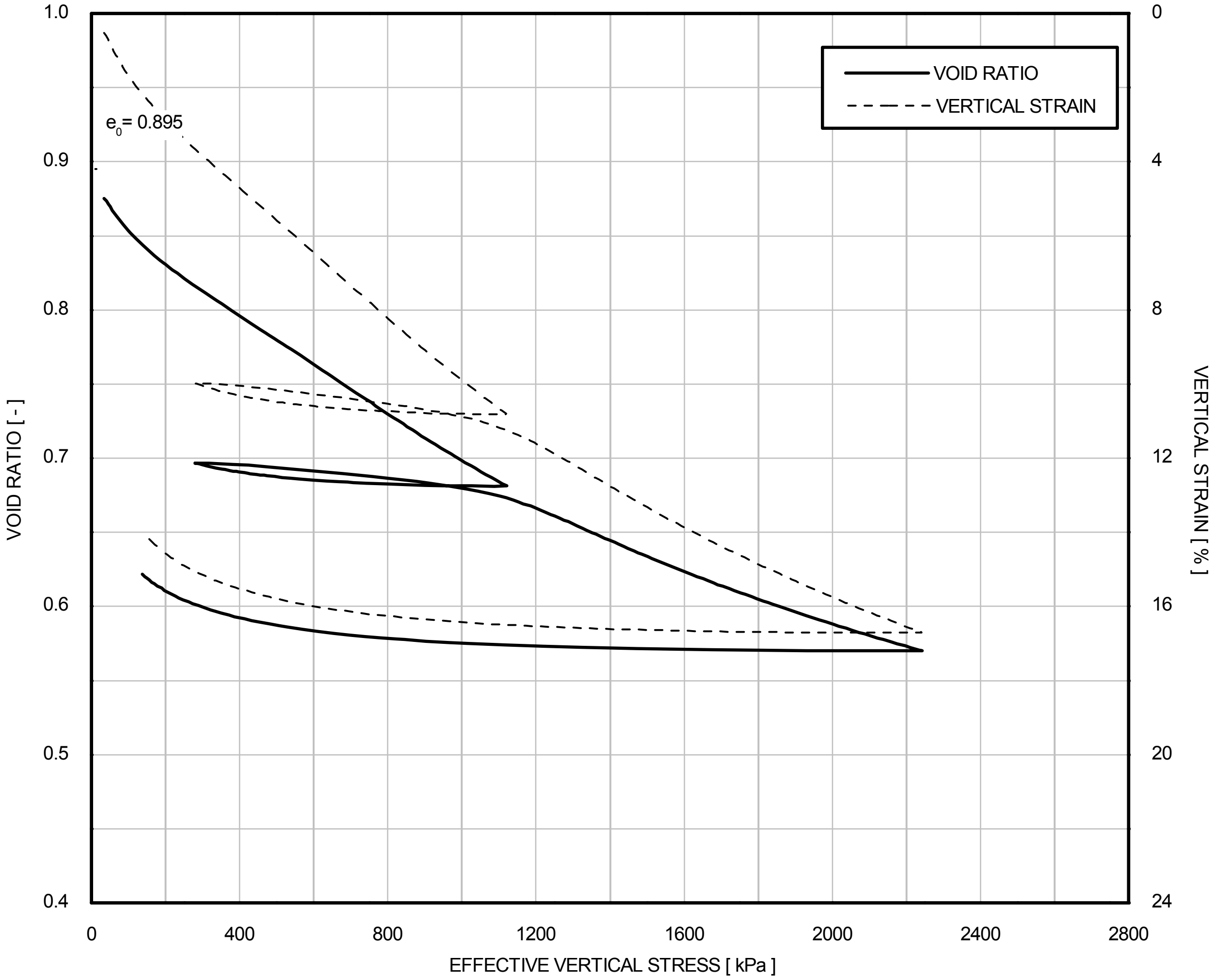
Borehole	Sample	Depth [m]
HKZ1-BH02-SA	16WaxD	14.19

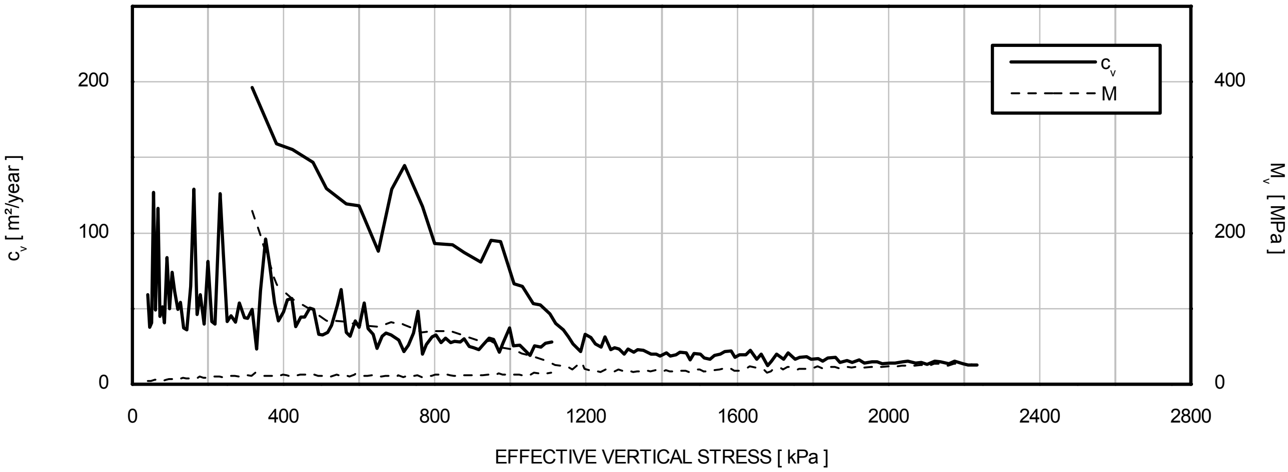
Initial void ratio : 0.895

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





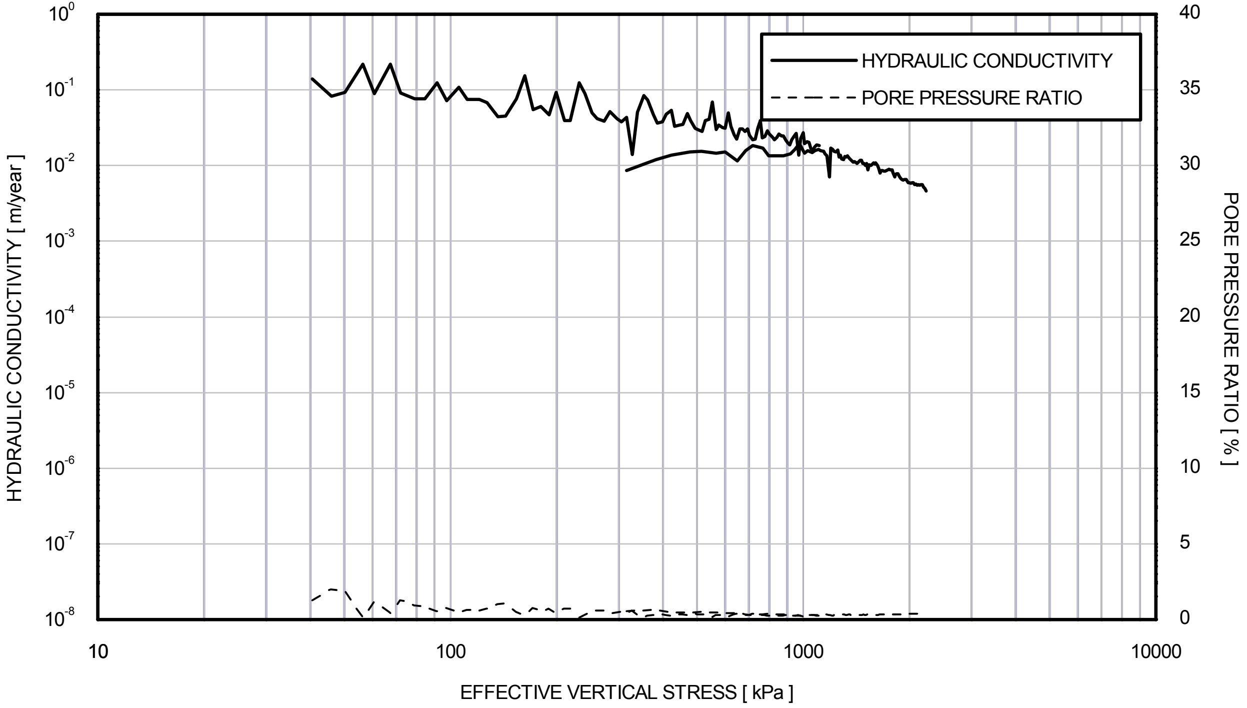
Borehole	Sample	Depth [m]
HKZ1-BH02-SA	16WaxD	14.19

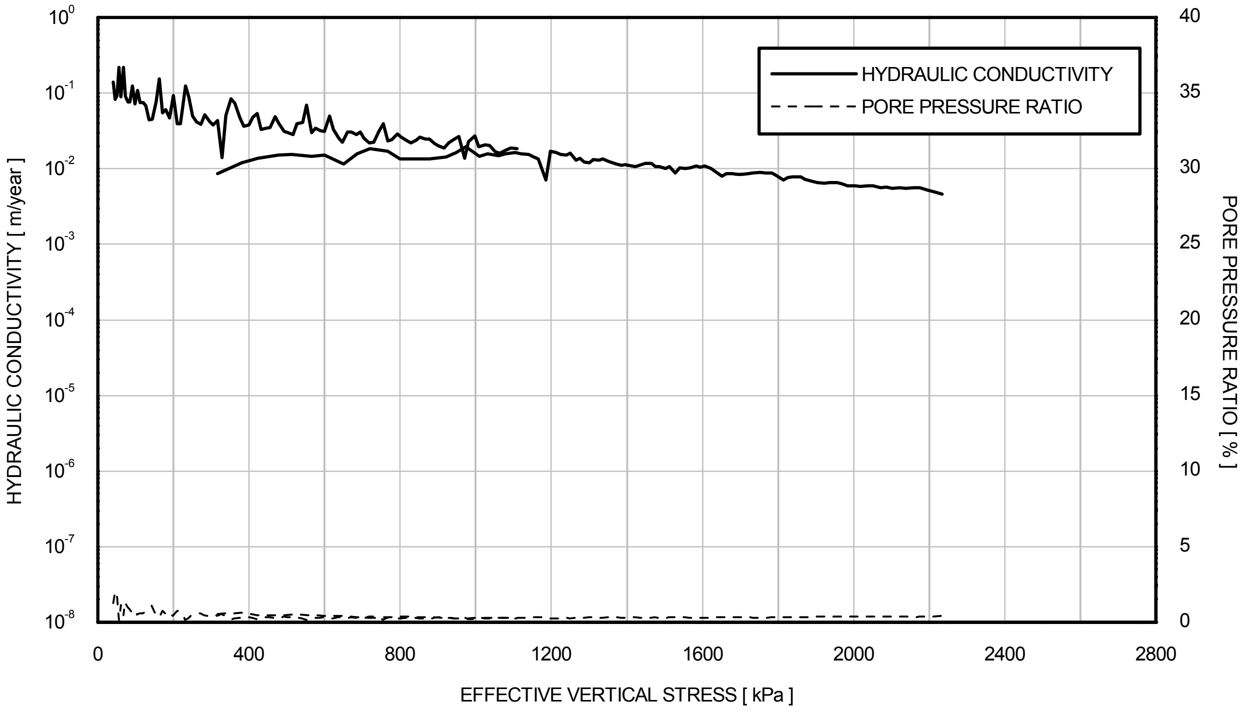
Initial void ratio : 0.895

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH02-SA	16WaxD	14.19

Initial void ratio : 0.895

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Greenish grey silty CLAY with traces of fine sand

GENERAL	
Date test started	10/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.8
Water content	[%]	14.5
Bulk density	[Mg/m³]	2.18
Dry density	[Mg/m³]	1.91
Void ratio	[-]	0.416
Degree of saturation	[%]	94
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

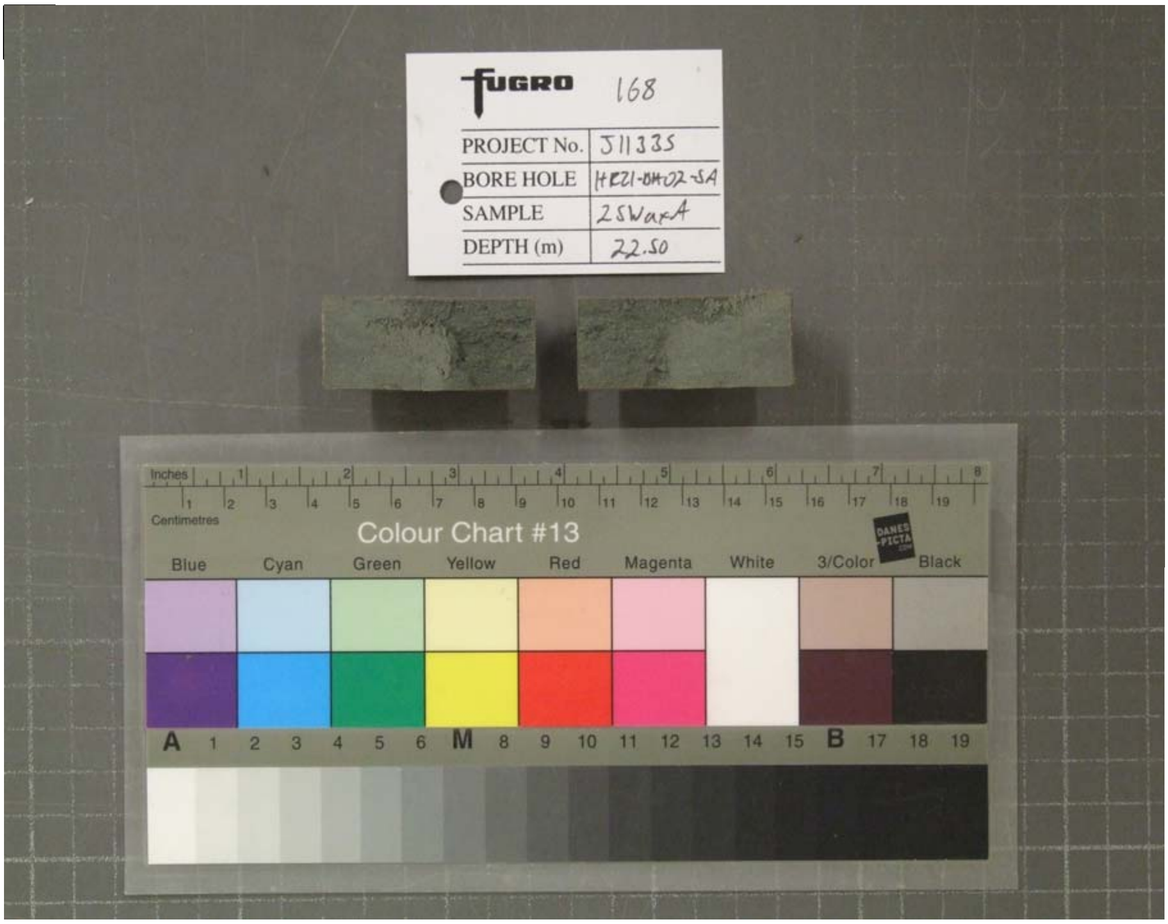
TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH02-SA_25WaxA_crs
Template issue	9.0
Processed by Date	MSR 19/09/2016
Checked by Date	ALB 21/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH02-SA
Sample	25WaxA
Depth [m]	22.52
Test Number	168

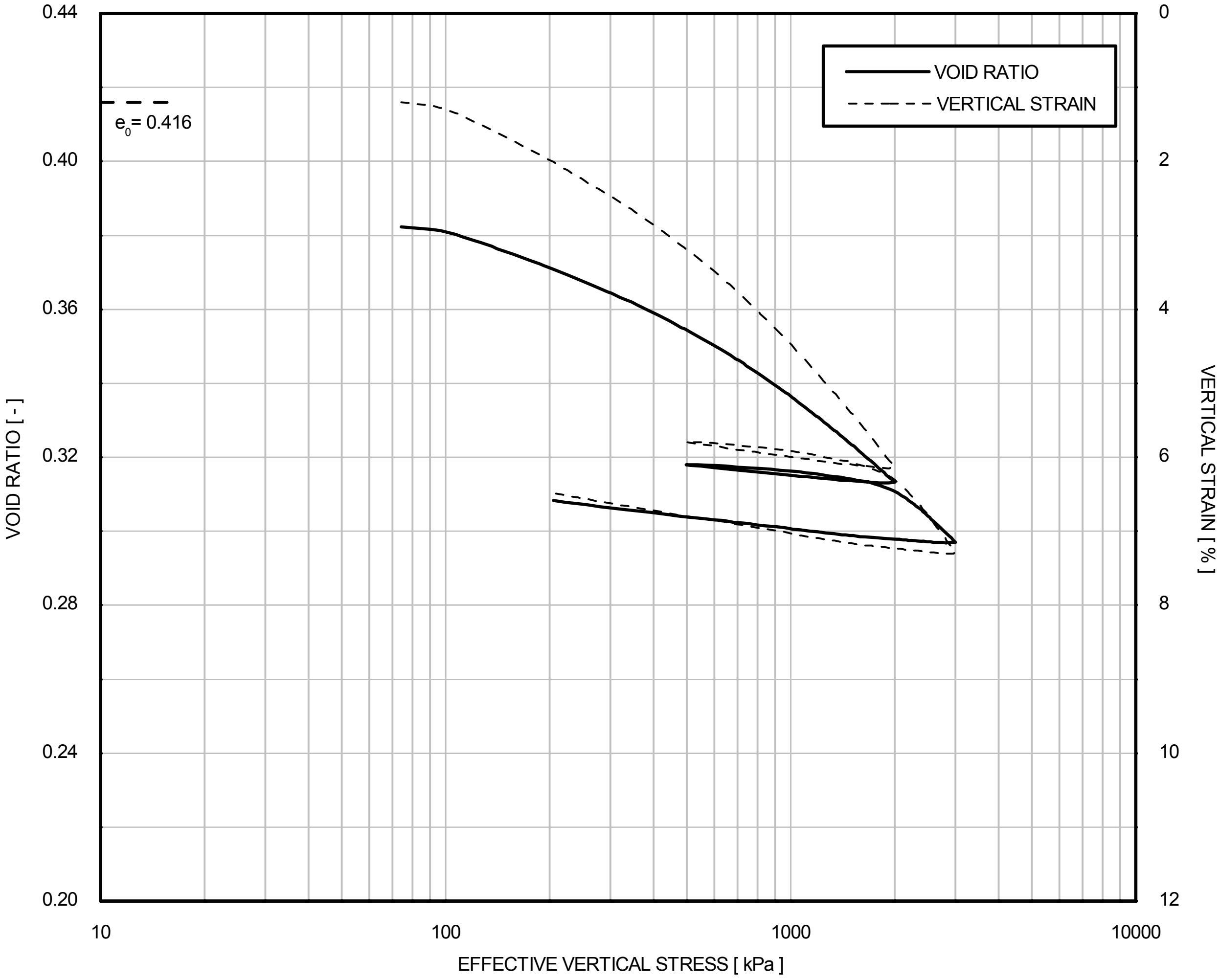
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

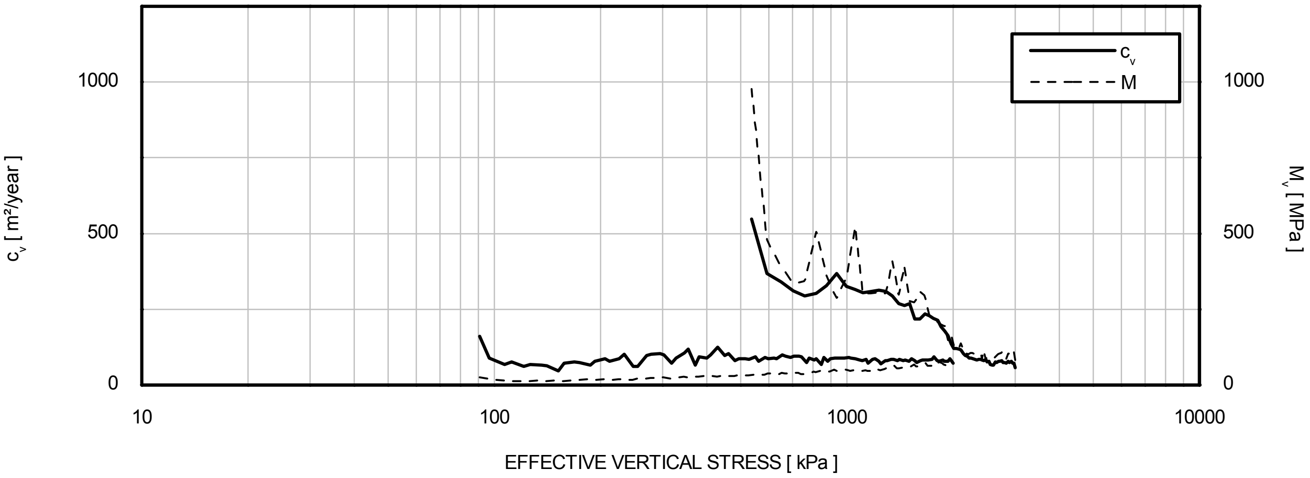
SPECIMEN PHOTOGRAPH



TEST IDENTIFICATION	
Borehole	HKZ1-BH02-SA
Sample	25WaxA
Depth [m]	22.52
Test Number	168

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





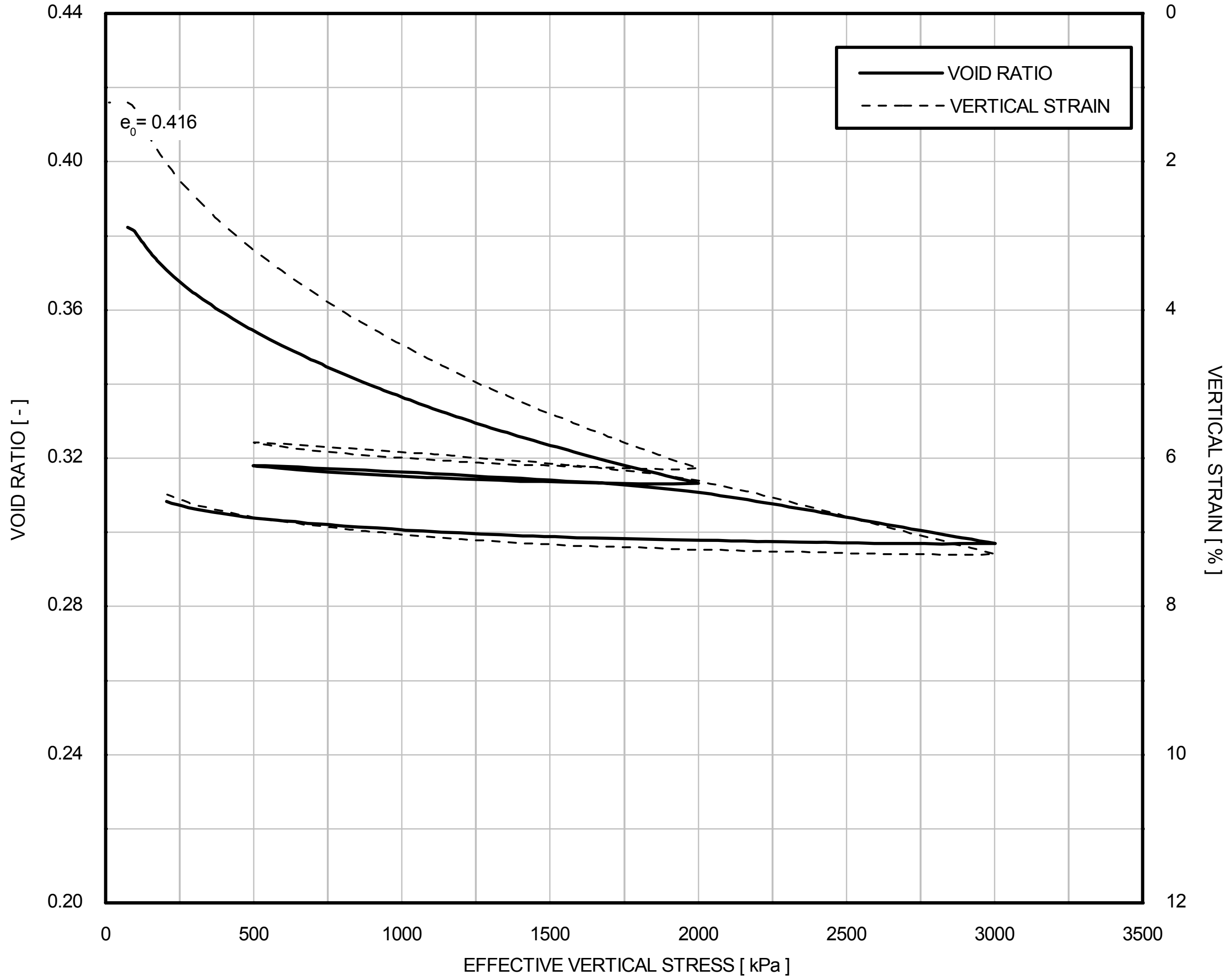
Borehole	Sample	Depth [m]
HKZ1-BH02-SA	25WaxA	22.52

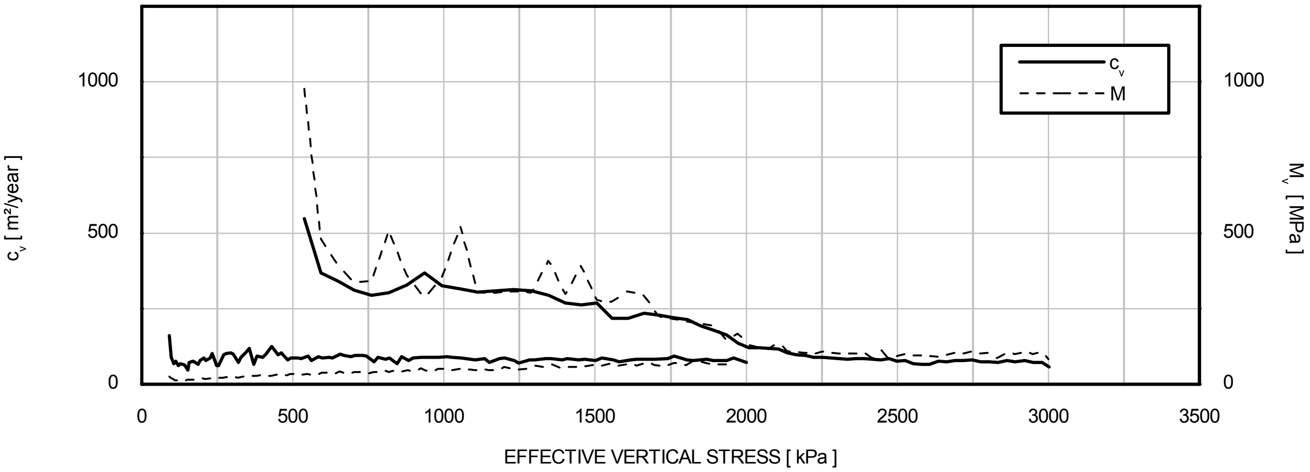
Initial void ratio : 0.416

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





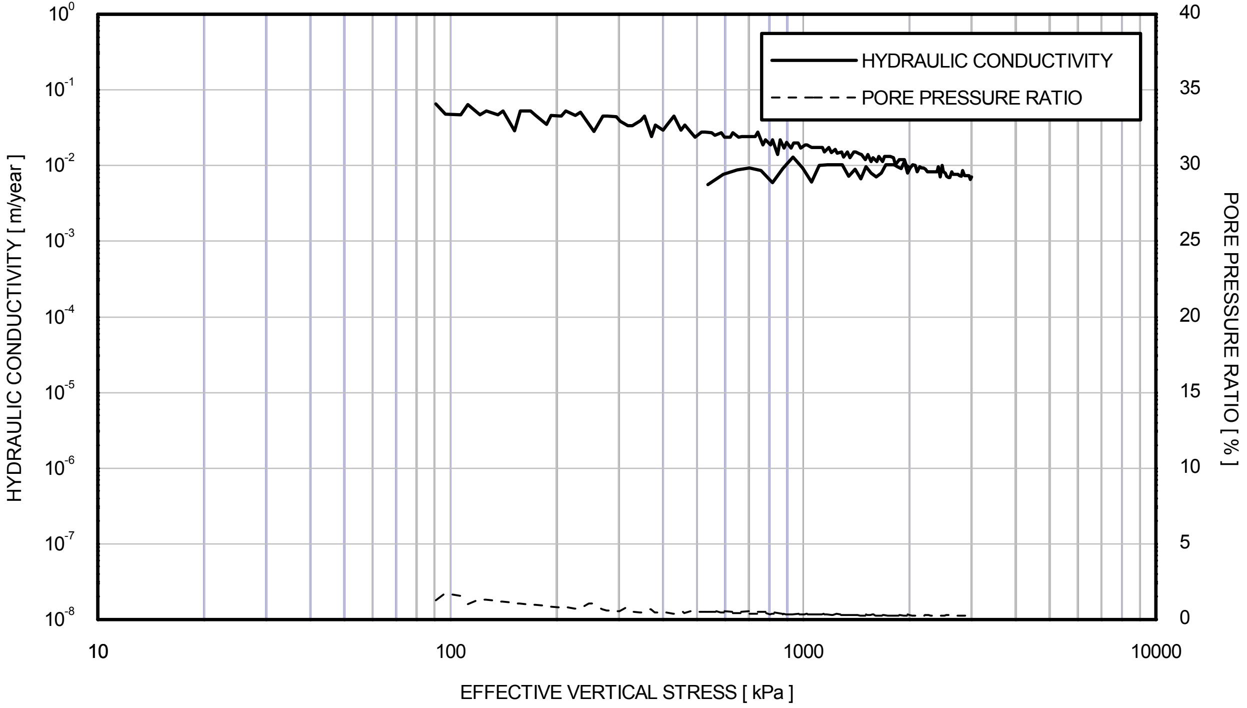
Borehole	Sample	Depth [m]
HKZ1-BH02-SA	25WaxA	22.52

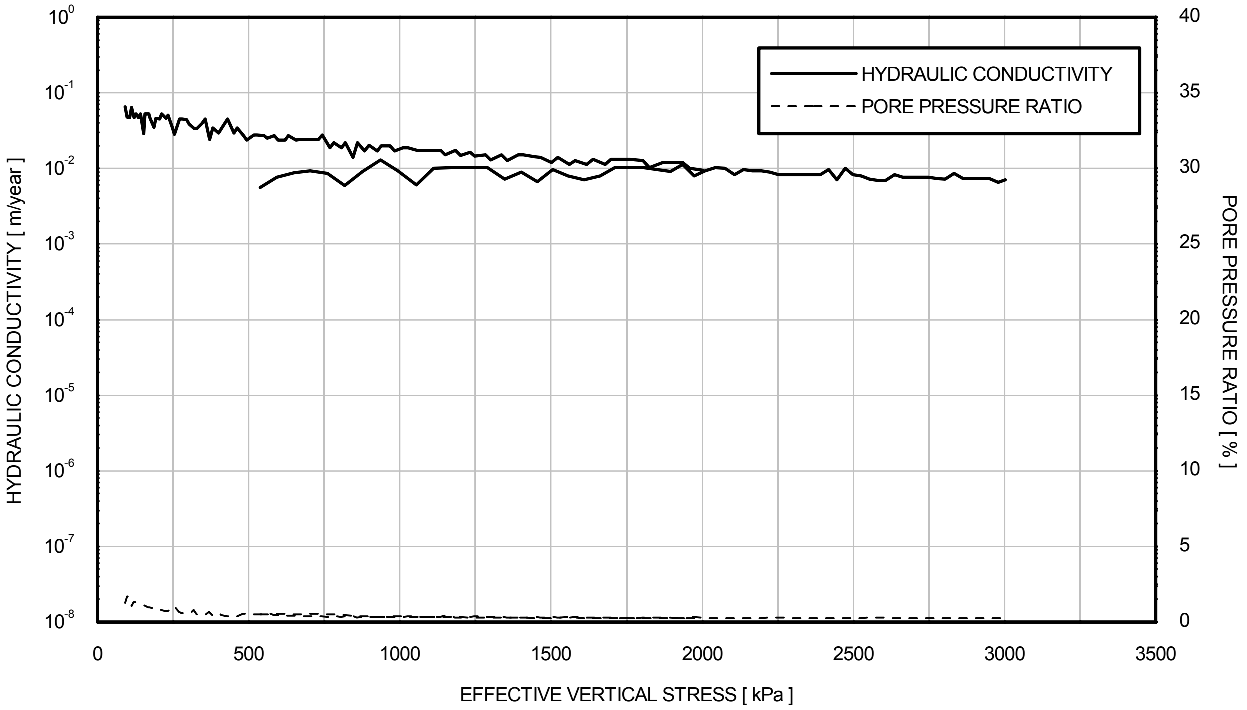
Initial void ratio : 0.416

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH02-SA	25WaxA	22.52

Initial void ratio : 0.416

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark olive grey silty CLAY

GENERAL	
Date test started	16/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.7
Water content	[%]	32.1
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.42
Void ratio	[-]	0.903
Degree of saturation	[%]	96
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH03-SA_24WaxA_crs
Template issue	9.0
Processed by Date	ALB 30/09/2016
Checked by Date	PH 04/10/2016
Approved by Date	PH 04/10/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH03-SA
Sample	24WaxA
Depth [m]	15.04
Test Number	5

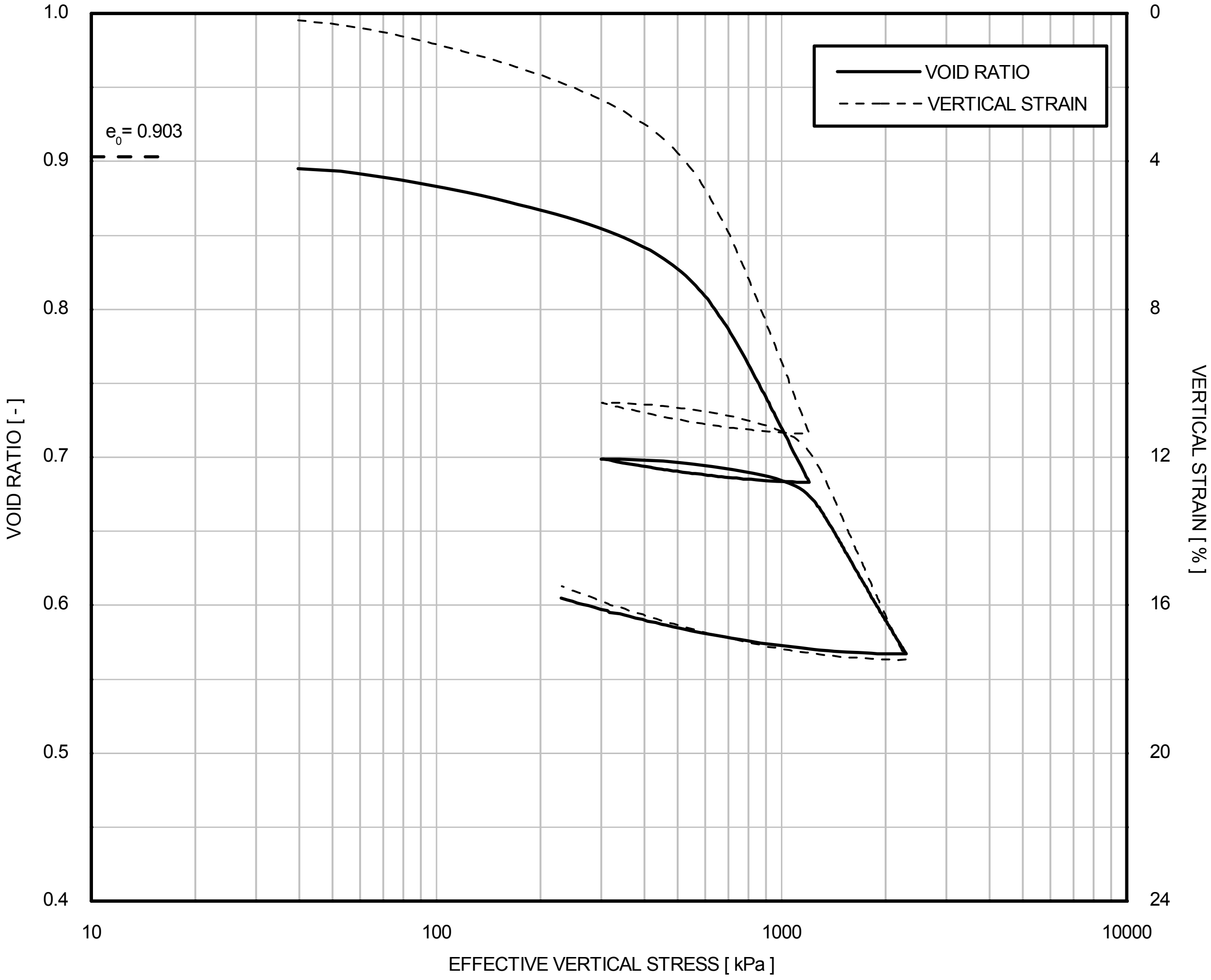
ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

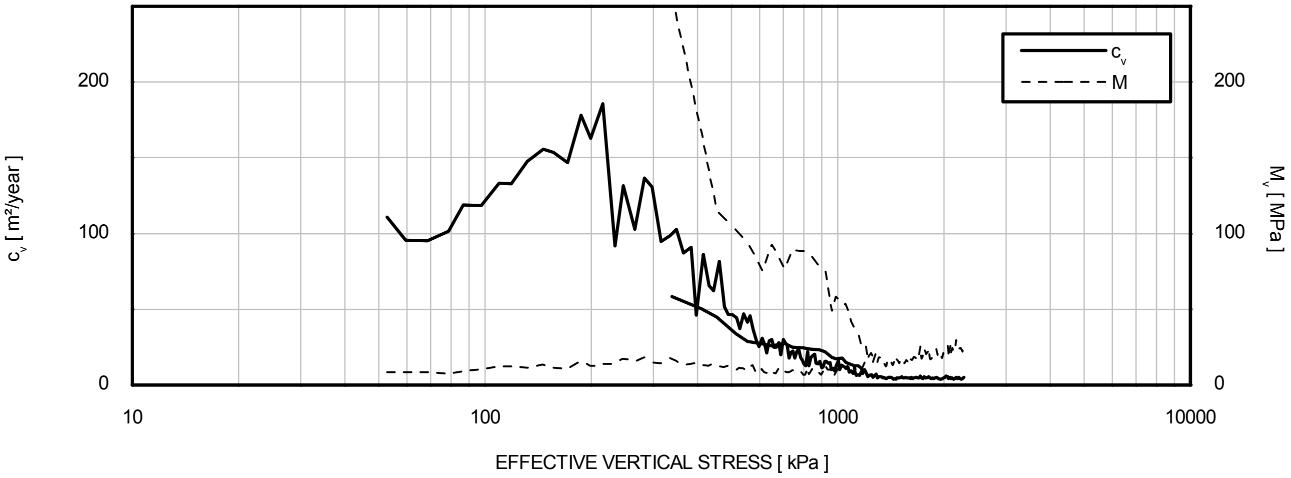
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION

Borehole	HKZ1-BH03-SA
Sample	24WaxA
Depth [m]	15.04
Test Number	5

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





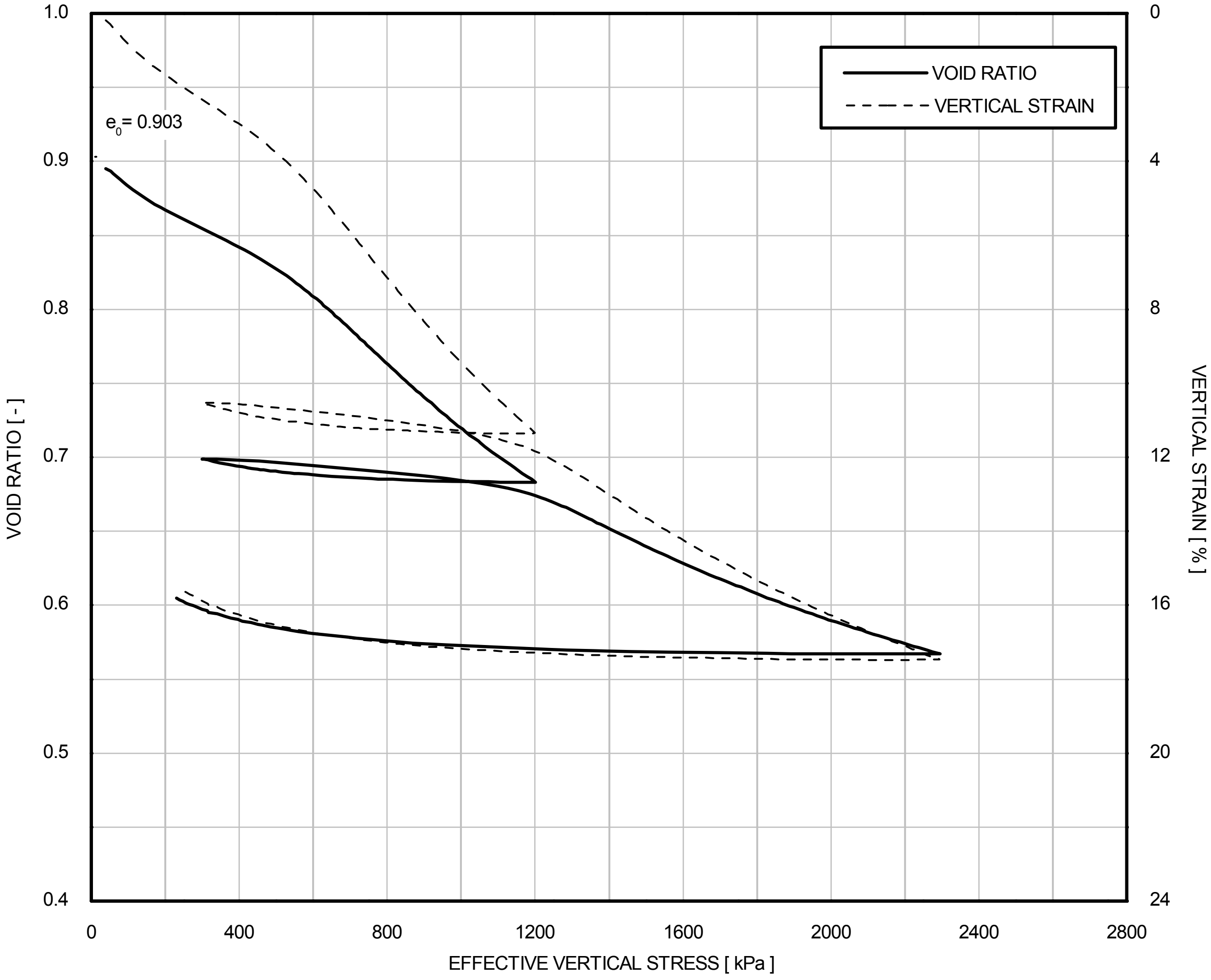
Borehole	Sample	Depth [m]
HKZ1-BH03-SA	24WaxA	15.04

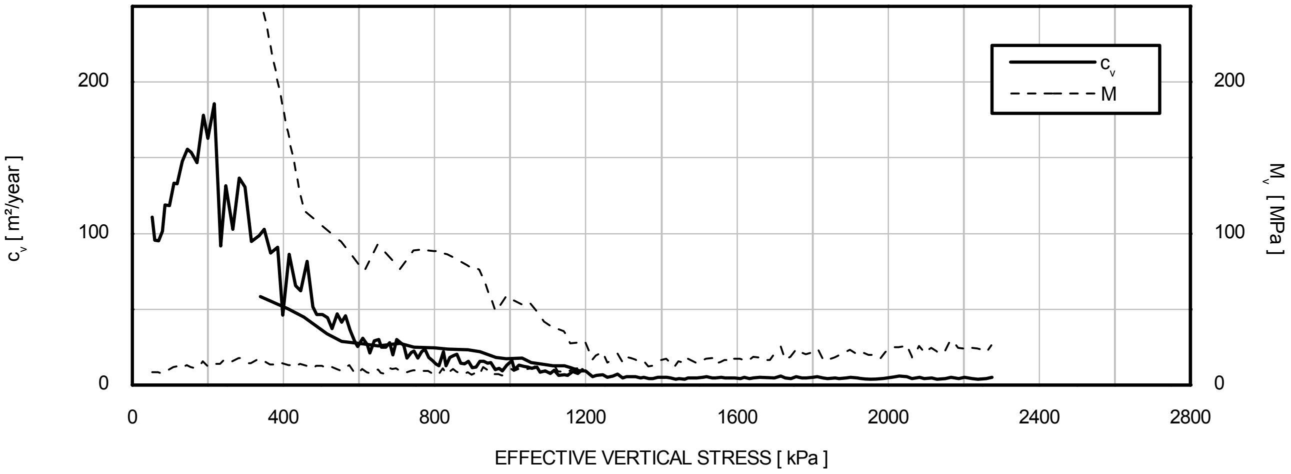
Initial void ratio : 0.903

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





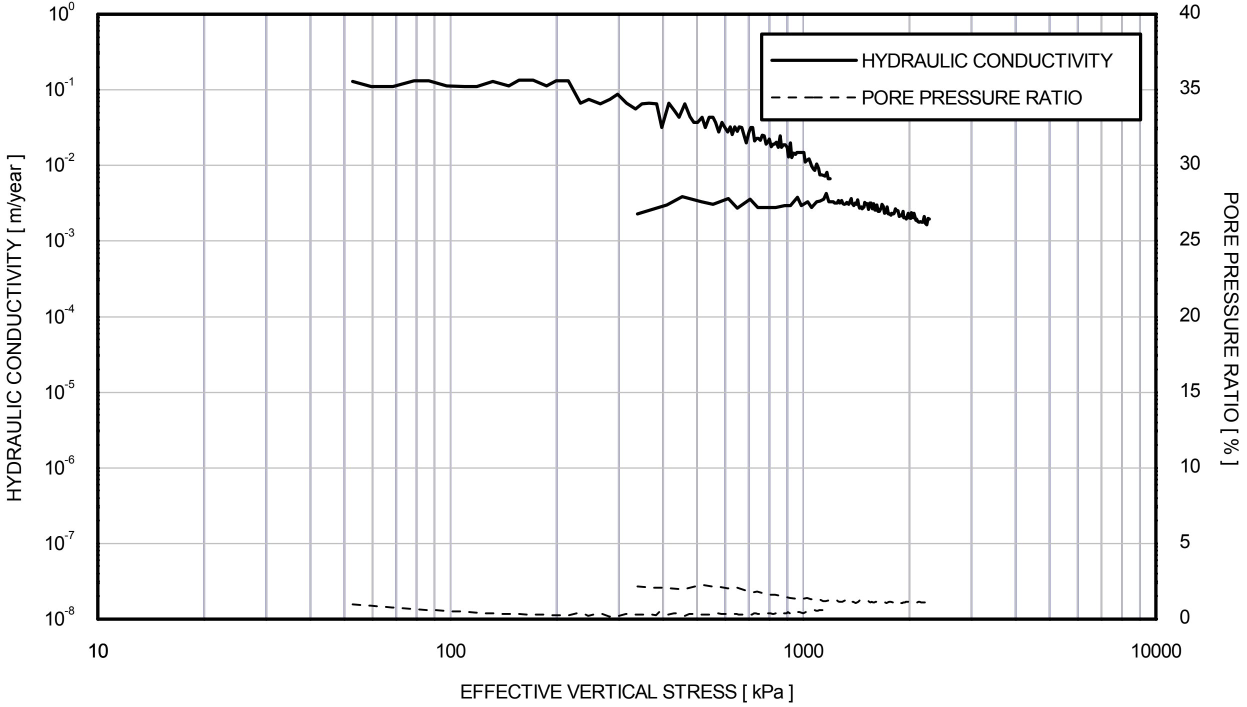
Borehole	Sample	Depth [m]
HKZ1-BH03-SA	24WaxA	15.04

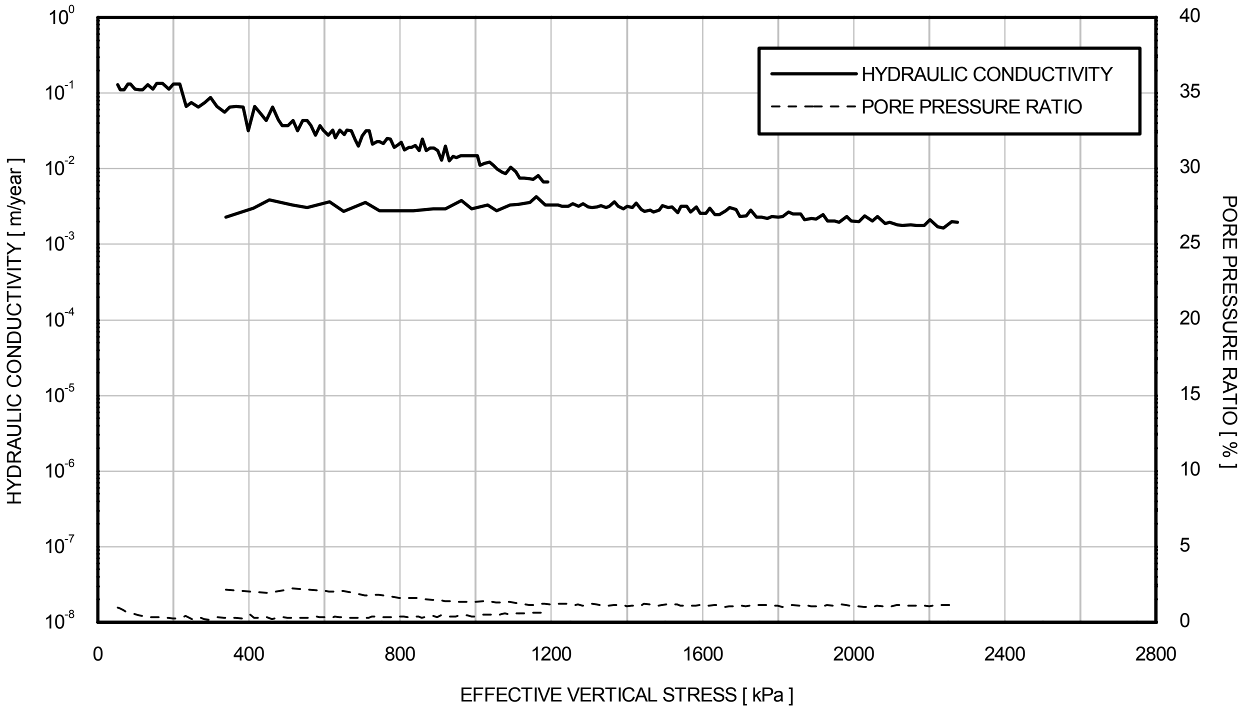
Initial void ratio : 0.903

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH03-SA	24WaxA	15.04

Initial void ratio : 0.903

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark grey CLAY

GENERAL	
Date test started	10/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.8
Water content	[%]	29.8
Bulk density	[Mg/m³]	1.91
Dry density	[Mg/m³]	1.47
Void ratio	[-]	0.838
Degree of saturation	[%]	96
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH03-SA_27WaxB_crs
Template issue	9.0
Processed by Date	ALB 20/09/2016
Checked by Date	MSR 26/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH03-SA
Sample	27WaxB
Depth [m]	18.12
Test Number	170

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SPECIMEN PHOTOGRAPH

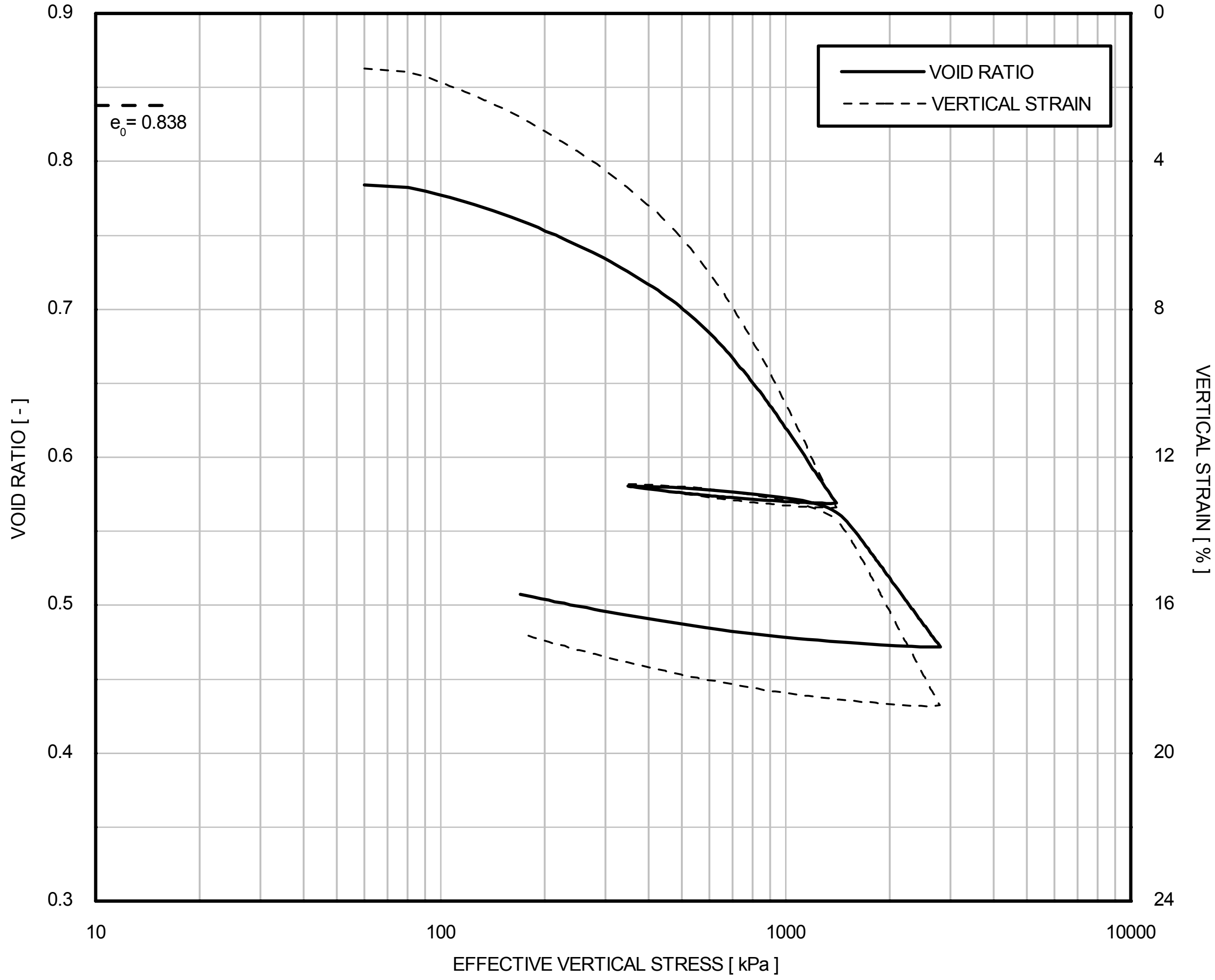
170

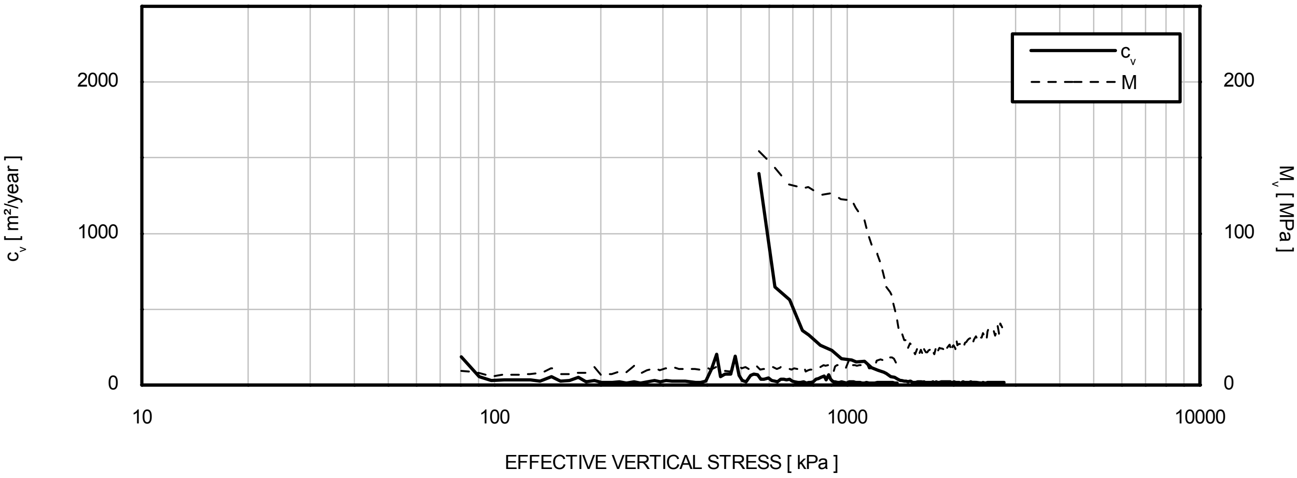
PROJECT No.	J11335
BORE HOLE	HKZ1-BH03-SA
SAMPLE	27Wax B
DEPTH (m)	18.10

TEST IDENTIFICATION

Borehole	HKZ1-BH03-SA
Sample	27WaxB
Depth [m]	18.12
Test Number	170

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





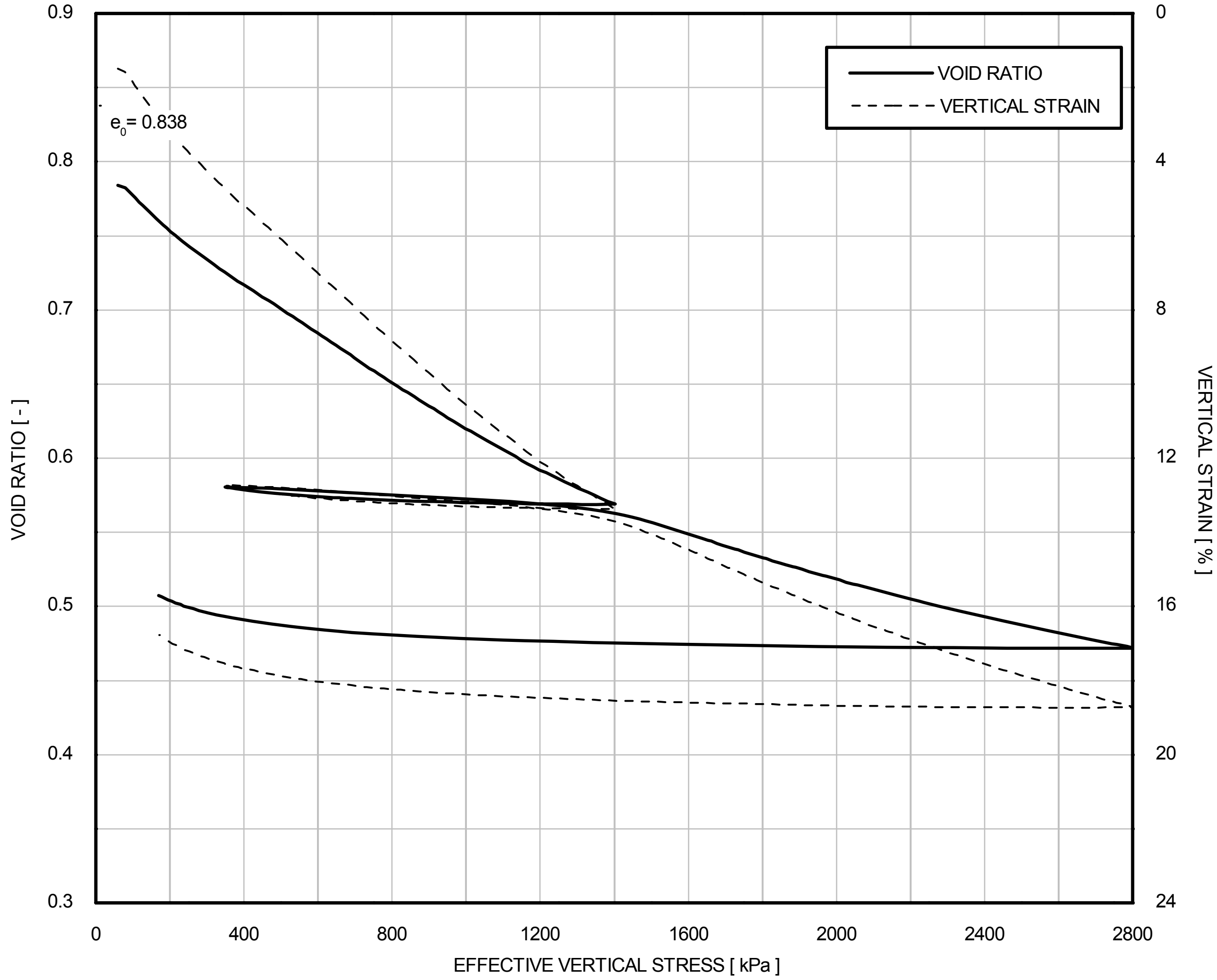
Borehole	Sample	Depth [m]
HKZ1-BH03-SA	27WaxB	18.12

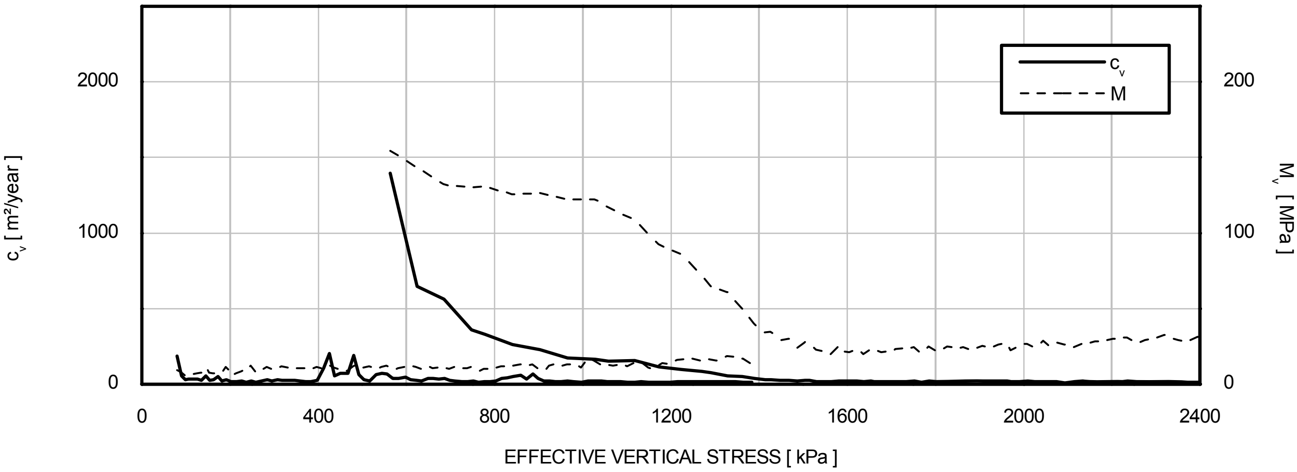
Initial void ratio : 0.838

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





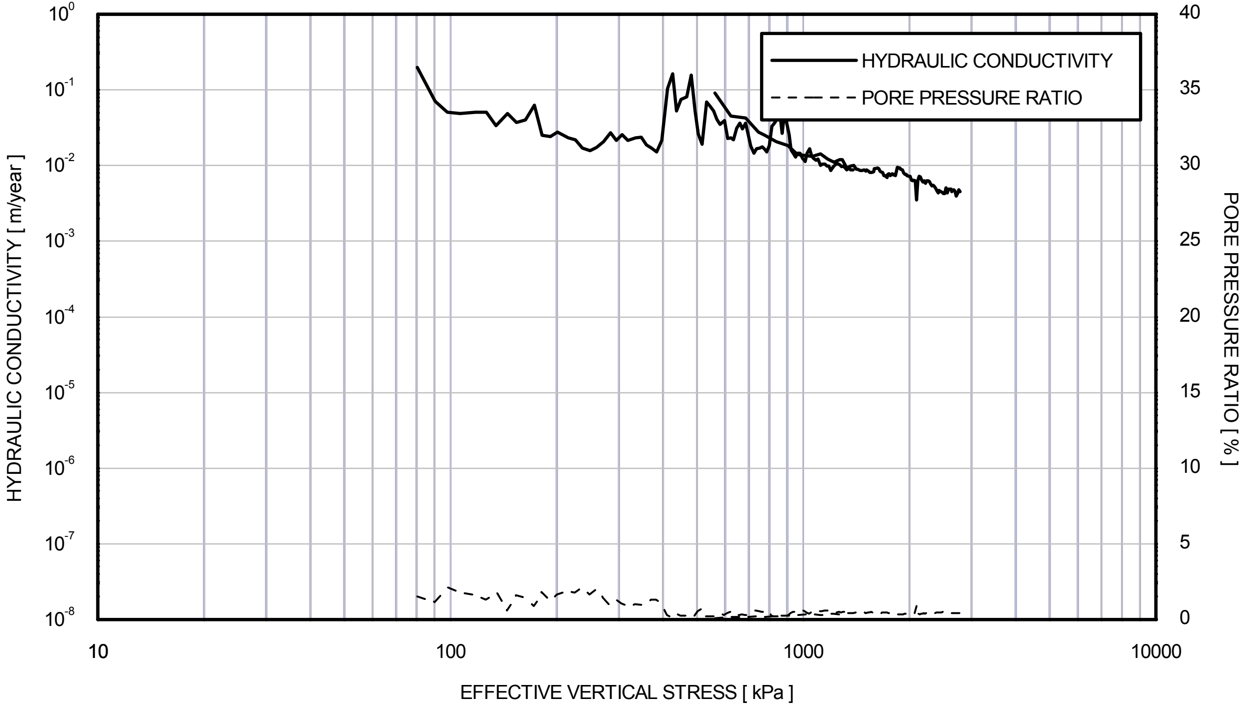
Borehole	Sample	Depth [m]
HKZ1-BH03-SA	27WaxB	18.12

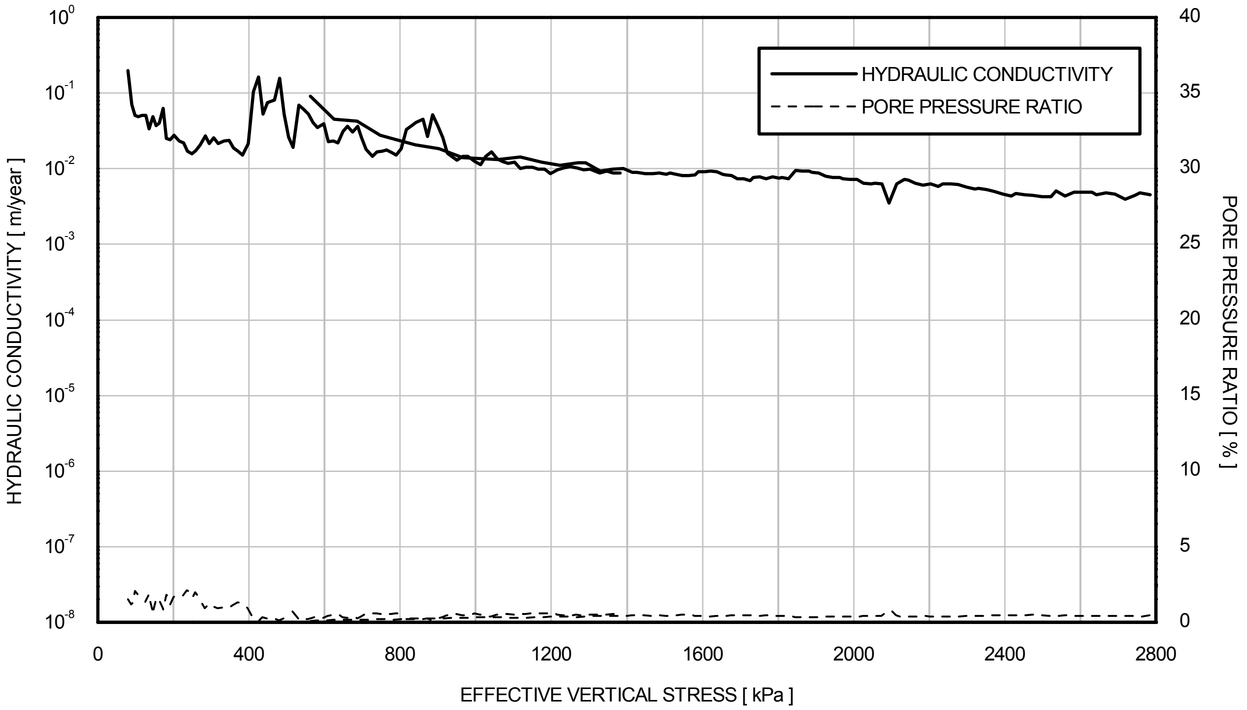
Initial void ratio : 0.838

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH03-SA	27WaxB	18.12

Initial void ratio : 0.838
Particle Density : 2.70 Mg/m^3
Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark grey slightly silty CLAY

GENERAL	
Date test started	10/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.7
Water content	[%]	23.2
Bulk density	[Mg/m³]	2.05
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.625
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH03-SA_51WaxA_crs
Template issue	9.0
Processed by Date	MSR 19/09/2016
Checked by Date	PH 27/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH03-SA
Sample	51WaxA
Depth [m]	42.01
Test Number	171

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SPECIMEN PHOTOGRAPH

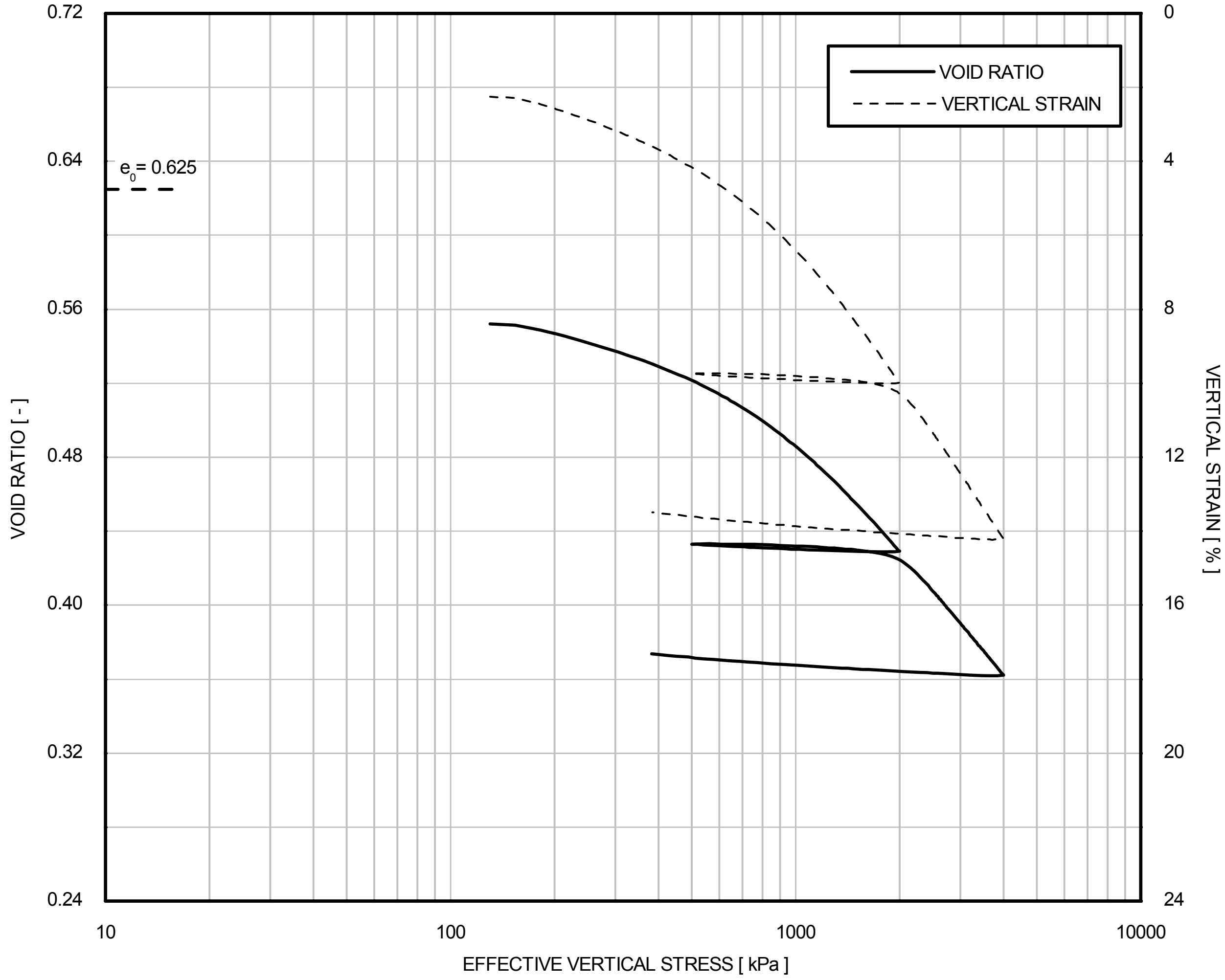
FUGRO 171

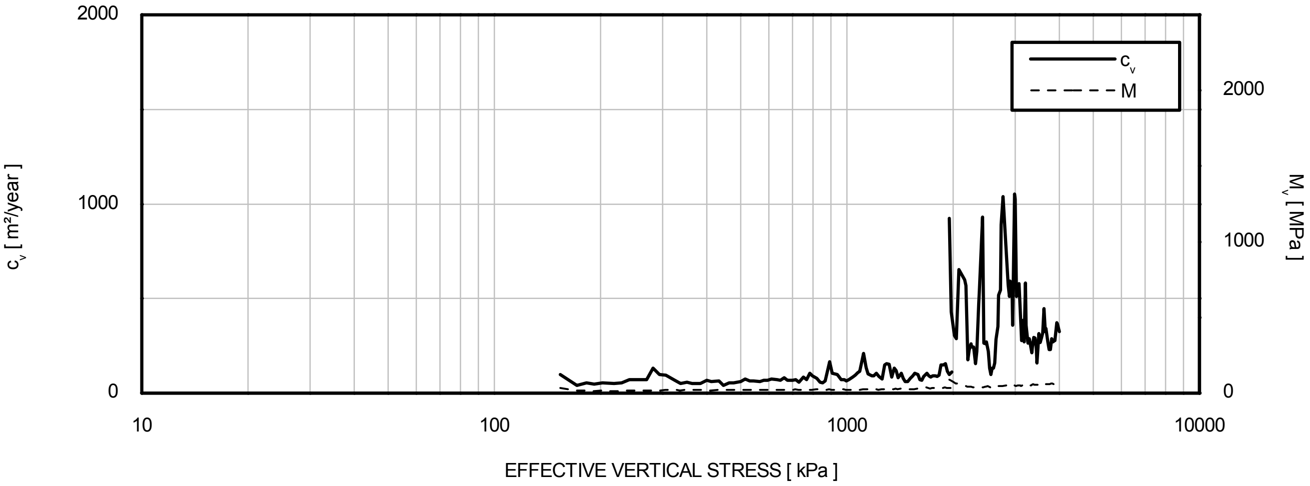
PROJECT No.	J11335
BORE HOLE	HKZ1-BH03-SA
SAMPLE	51WaxA
DEPTH (m)	42.00

TEST IDENTIFICATION

Borehole	HKZ1-BH03-SA
Sample	51WaxA
Depth [m]	42.01
Test Number	171

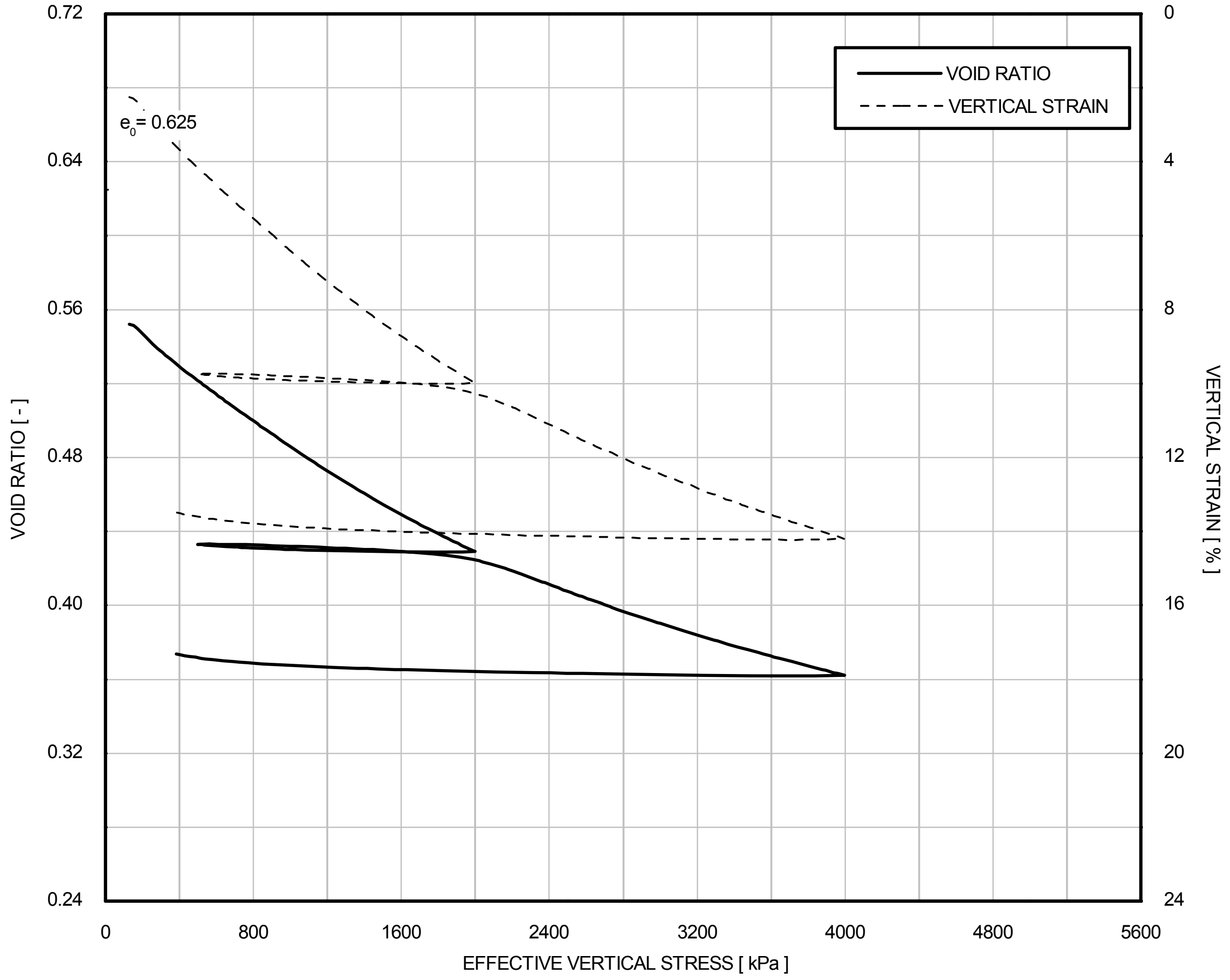
ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

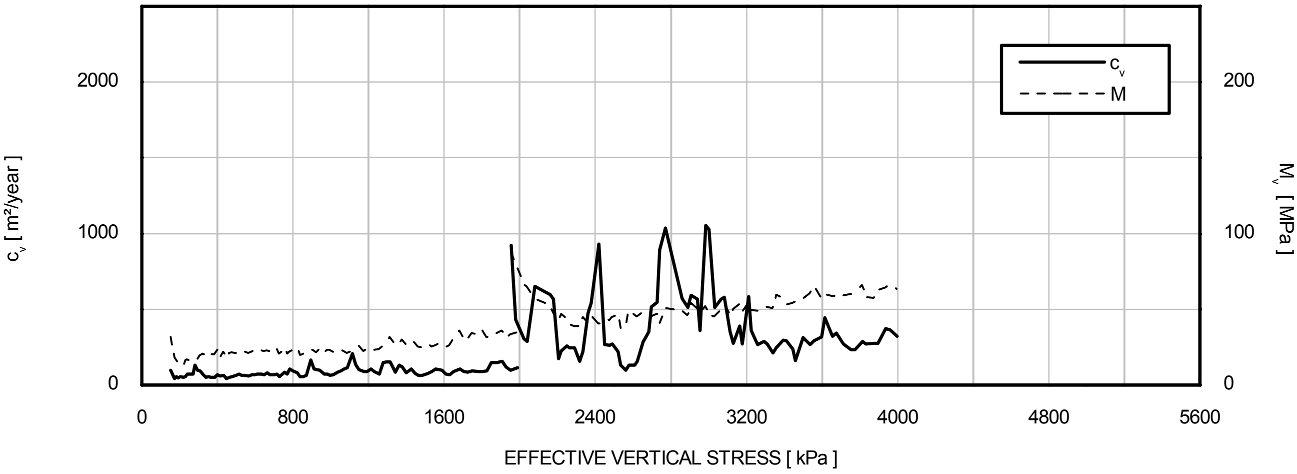




Borehole	Sample	Depth [m]	
HKZ1-BH03-SA	51WaxA	42.01	Initial void ratio : 0.625 Particle Density : 2.70 Mg/m^3 Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





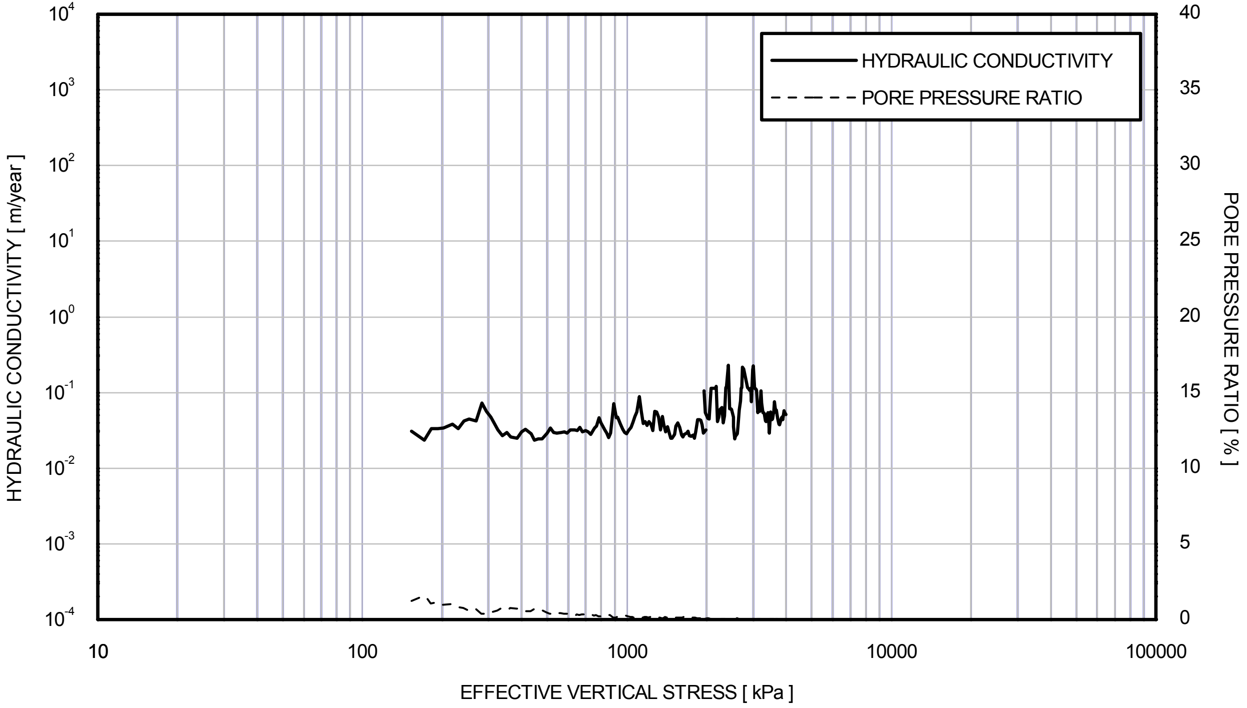
Borehole	Sample	Depth [m]
HKZ1-BH03-SA	51WaxA	42.01

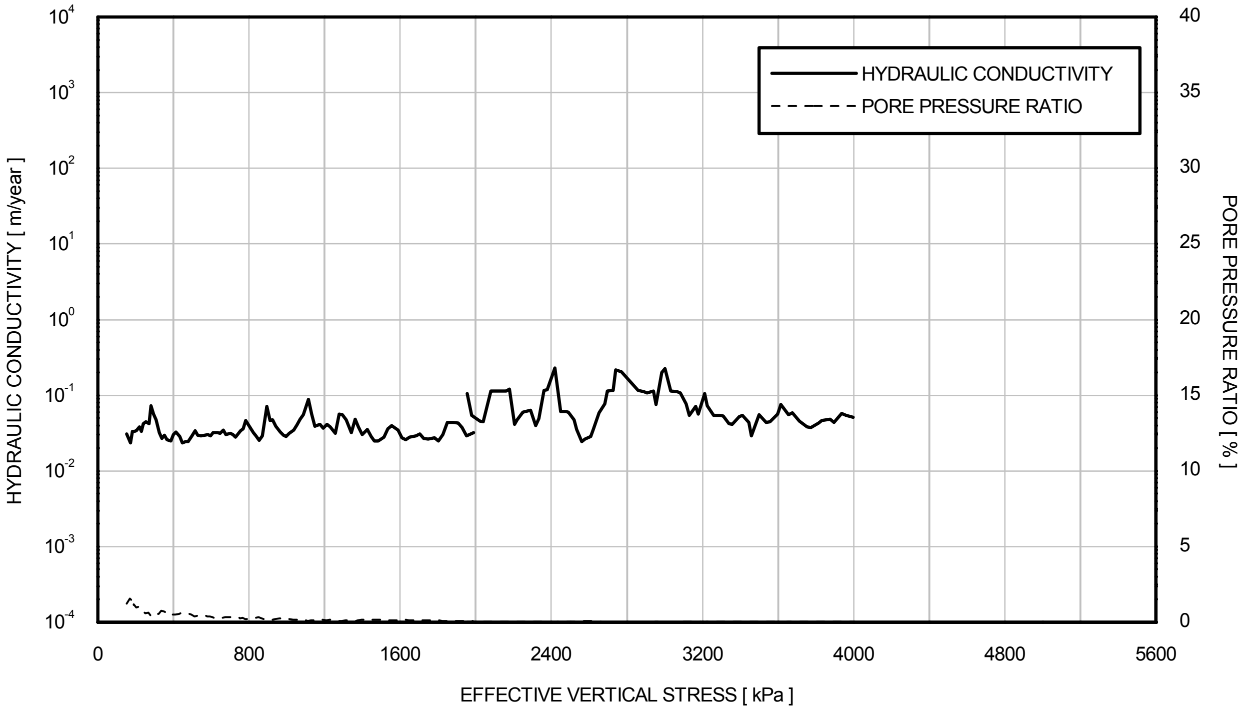
Initial void ratio : 0.625

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH03-SA	51WaxA	42.01

Initial void ratio : 0.625

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark grey slightly silty SAND

GENERAL	
Date test started	13/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.7
Water content	[%]	19.3
Bulk density	[Mg/m³]	2.09
Dry density	[Mg/m³]	1.76
Void ratio	[-]	0.537
Degree of saturation	[%]	97
Measured particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH04-SA_19WaxD_crs
Template issue	9.0
Processed by Date	ALB 20/09/2016
Checked by Date	MSR 26/09/2016
Approved by Date	PH 27/09/2016

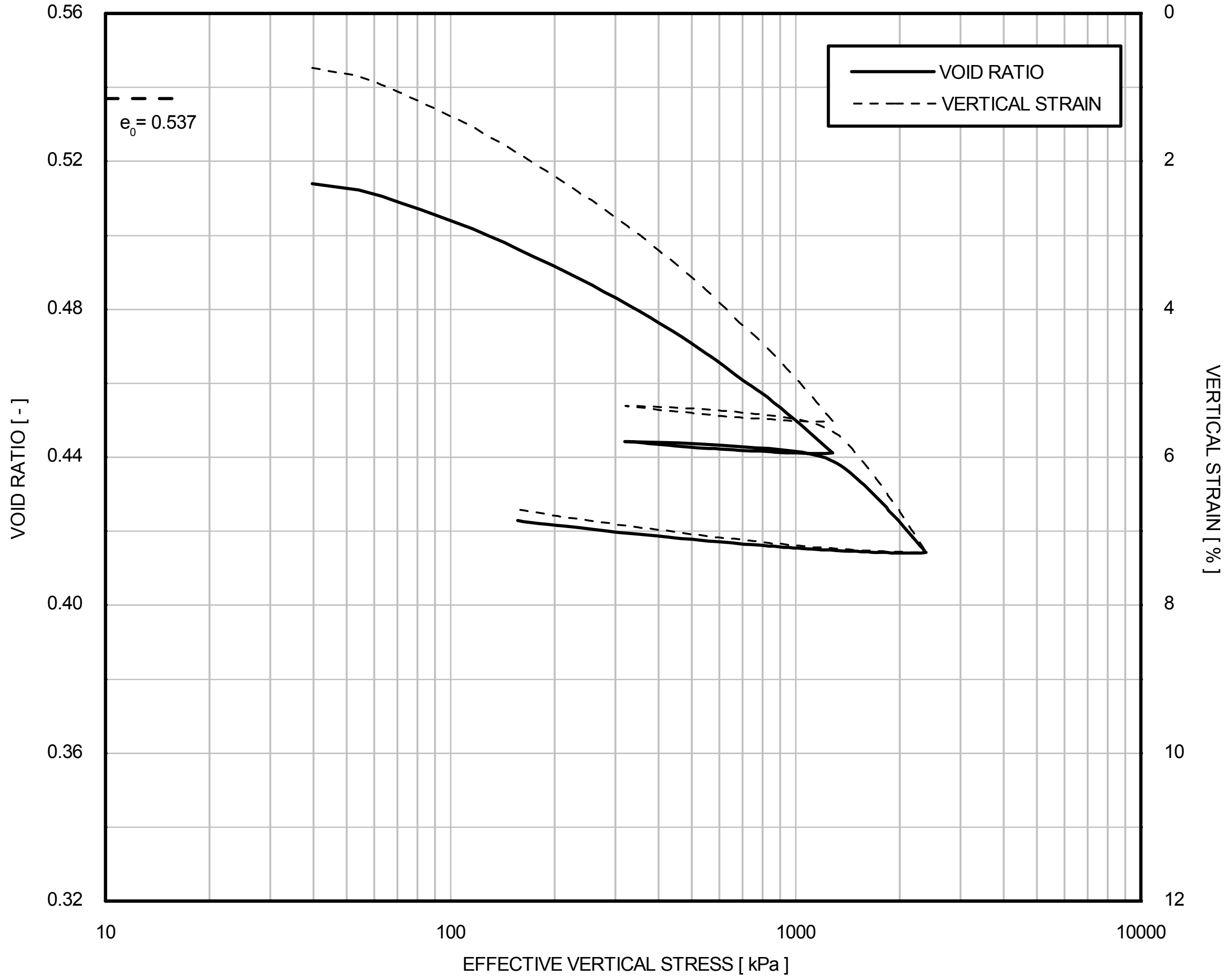
TEST IDENTIFICATION	
Borehole	HKZ1-BH04-SA
Sample	19WaxD
Depth [m]	16.21
Test Number	160

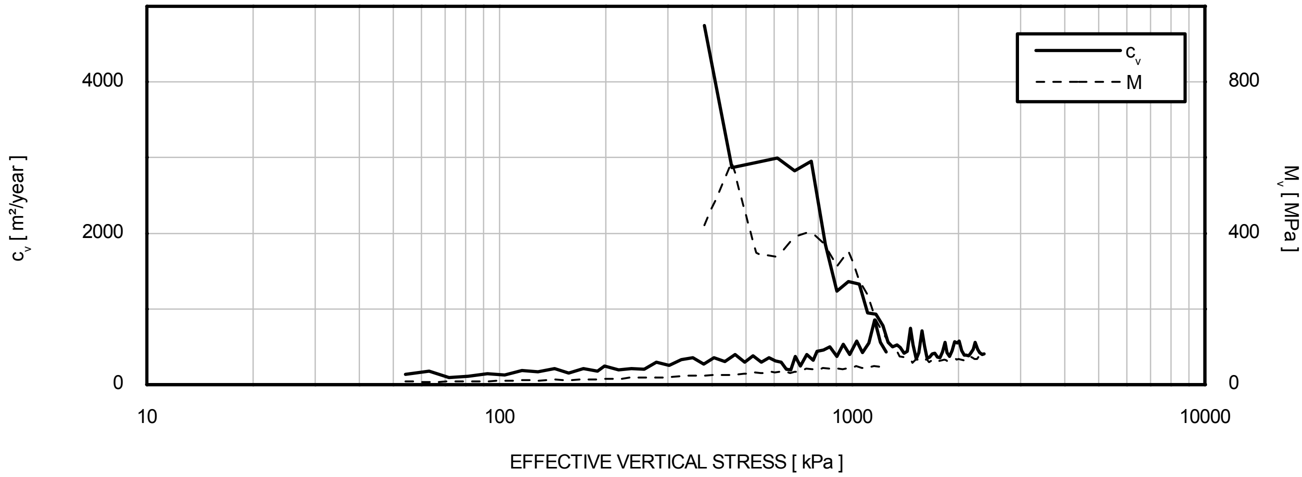
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	HKZ1-BH04-SA
Sample	19WaxD
Depth [m]	16.21
Test Number	160

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





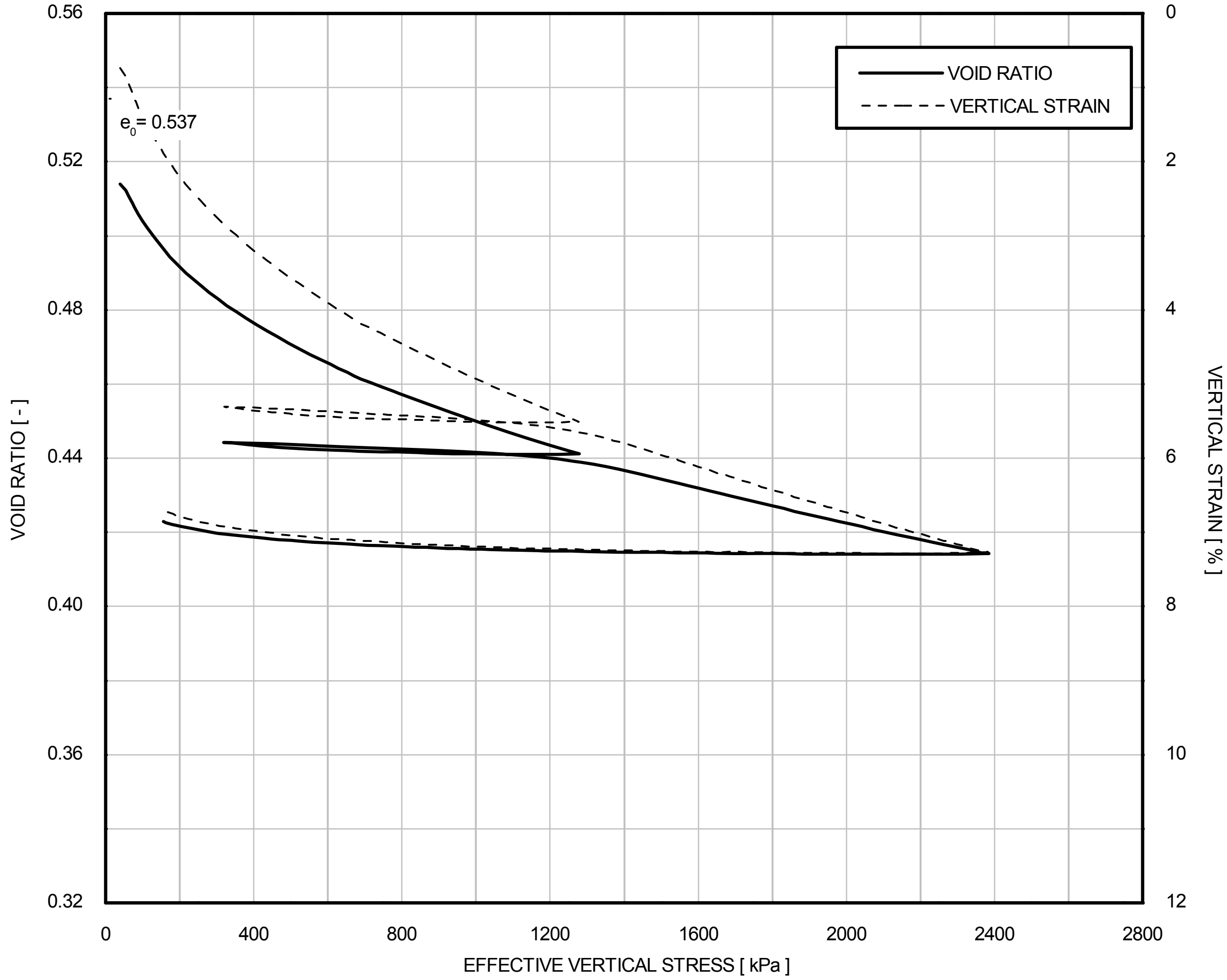
Borehole	Sample	Depth [m]
HKZ1-BH04-SA	19WaxD	16.21

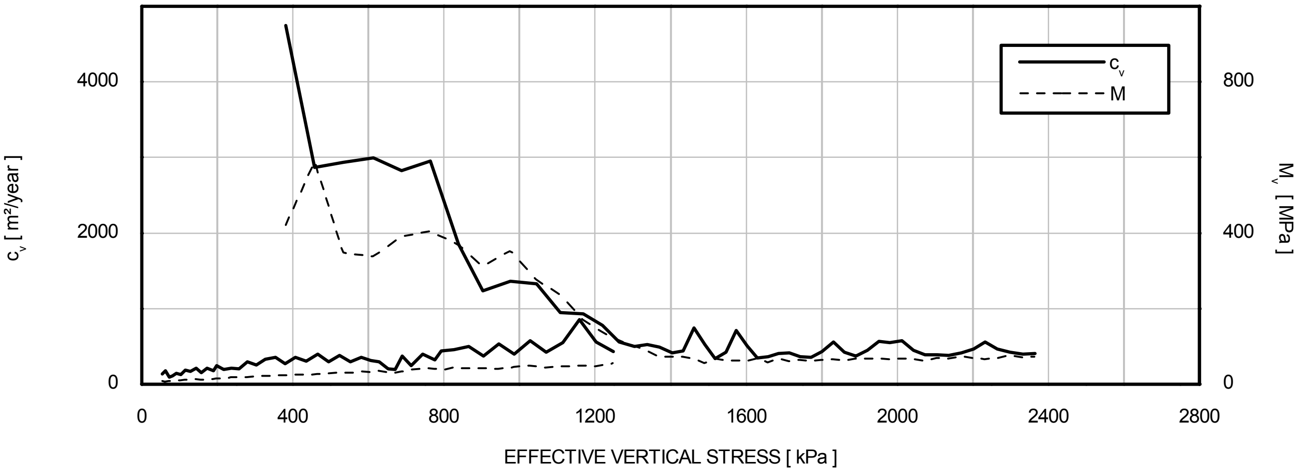
Initial void ratio : 0.537

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





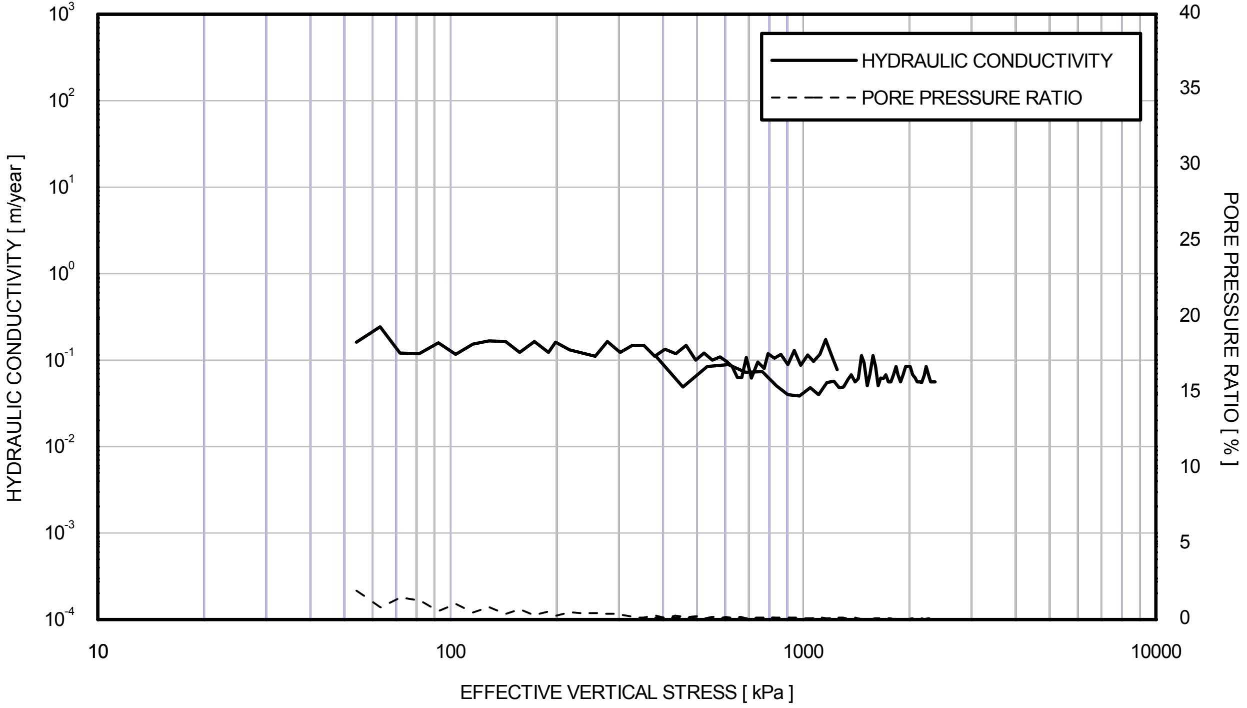
Borehole	Sample	Depth [m]
HKZ1-BH04-SA	19WaxD	16.21

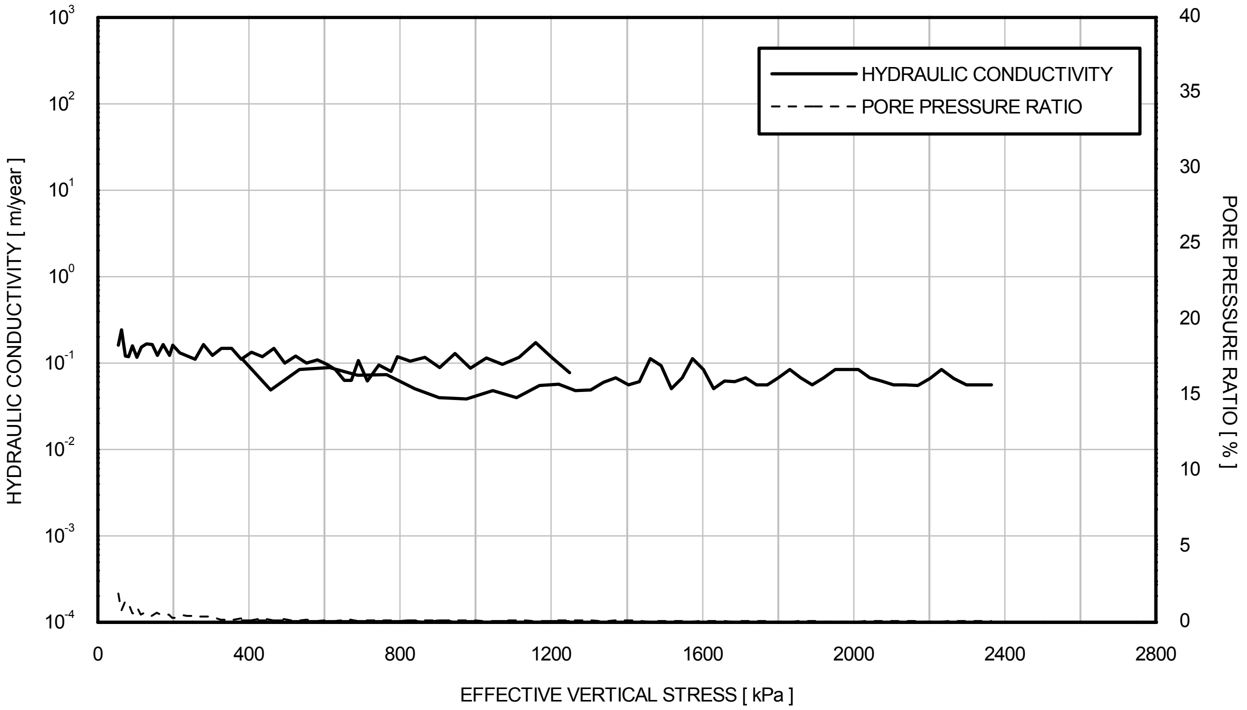
Initial void ratio : 0.537

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH04-SA	19WaxD	16.21

Initial void ratio : 0.537

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Grey CLAY

GENERAL	
Date test started	13/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.9
Water content	[%]	29.8
Bulk density	[Mg/m³]	2.00
Dry density	[Mg/m³]	1.54
Void ratio	[-]	0.753
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

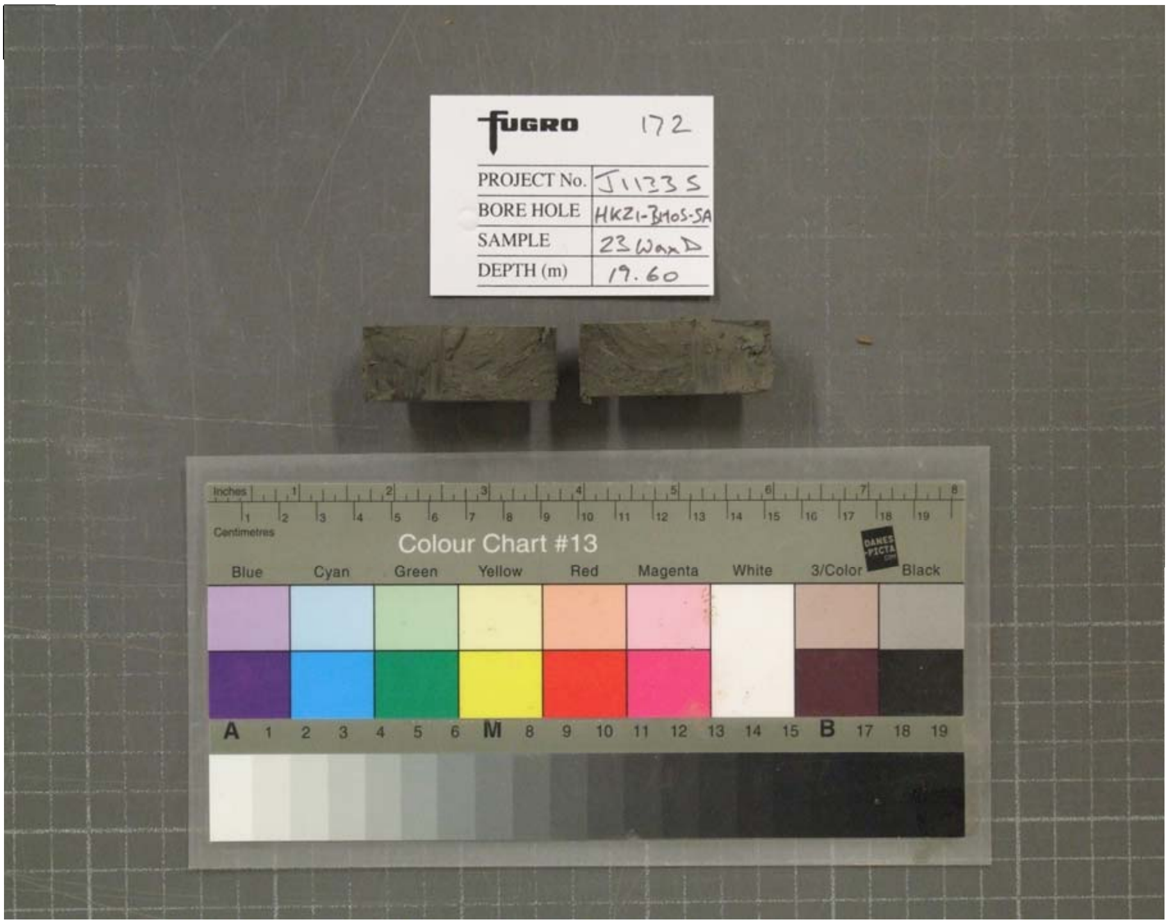
TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH05-SA_23WaxD_crs
Template issue	9.0
Processed by Date	ALB 29/09/2016
Checked by Date	MSR 30/09/2016
Approved by Date	PH 03/10/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH05-SA
Sample	23WaxD
Depth [m]	19.66
Test Number	172

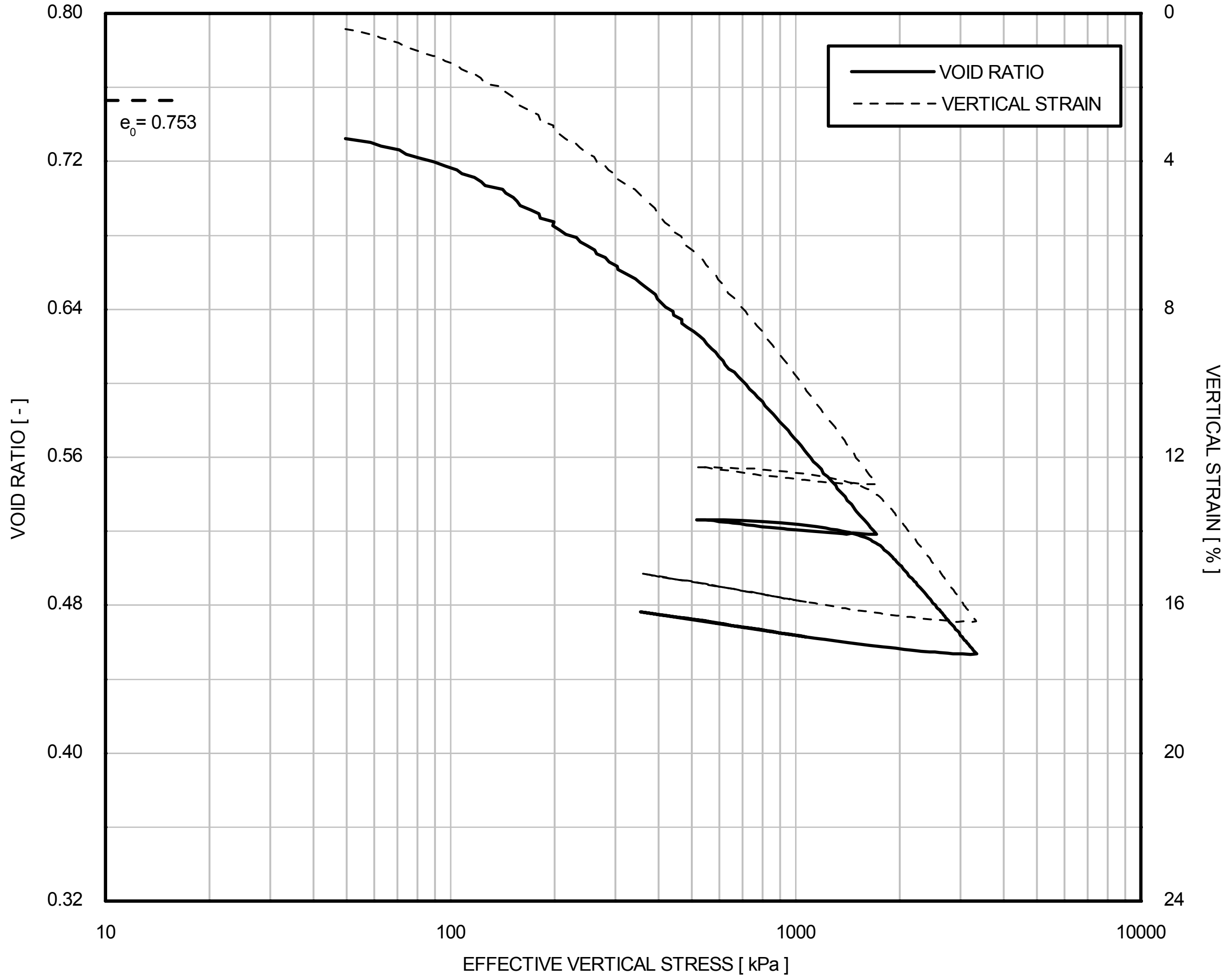
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

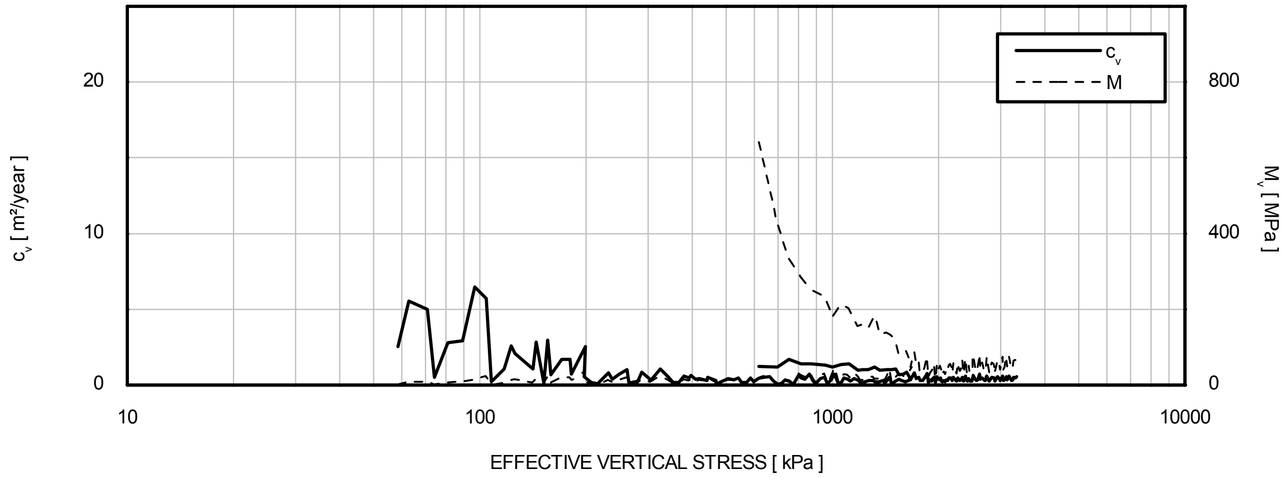
SPECIMEN PHOTOGRAPH



TEST IDENTIFICATION	
Borehole	HKZ1-BH05-SA
Sample	23WaxD
Depth [m]	19.66
Test Number	172

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





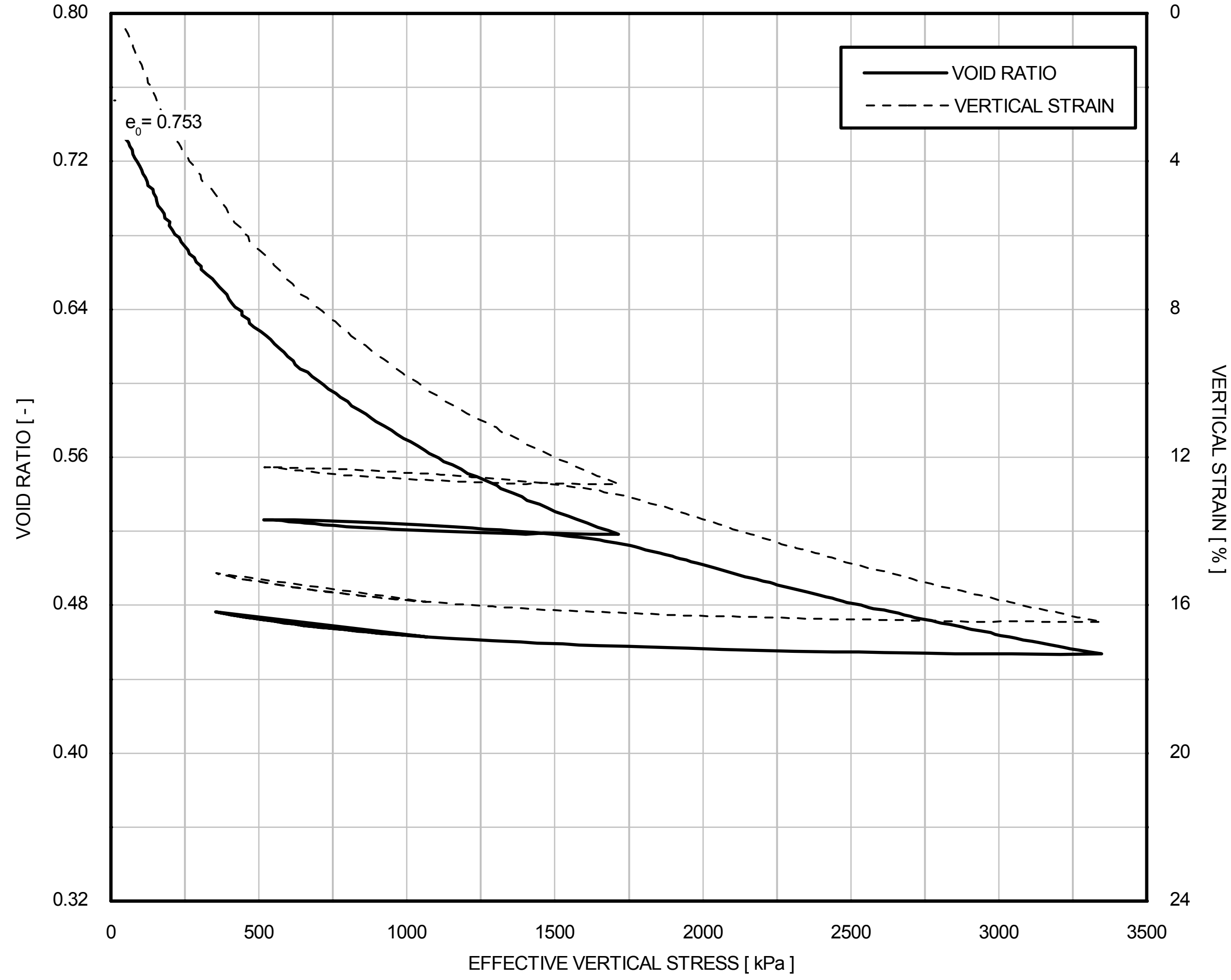
Borehole	Sample	Depth [m]
HKZ1-BH05-SA	23WaxD	19.66

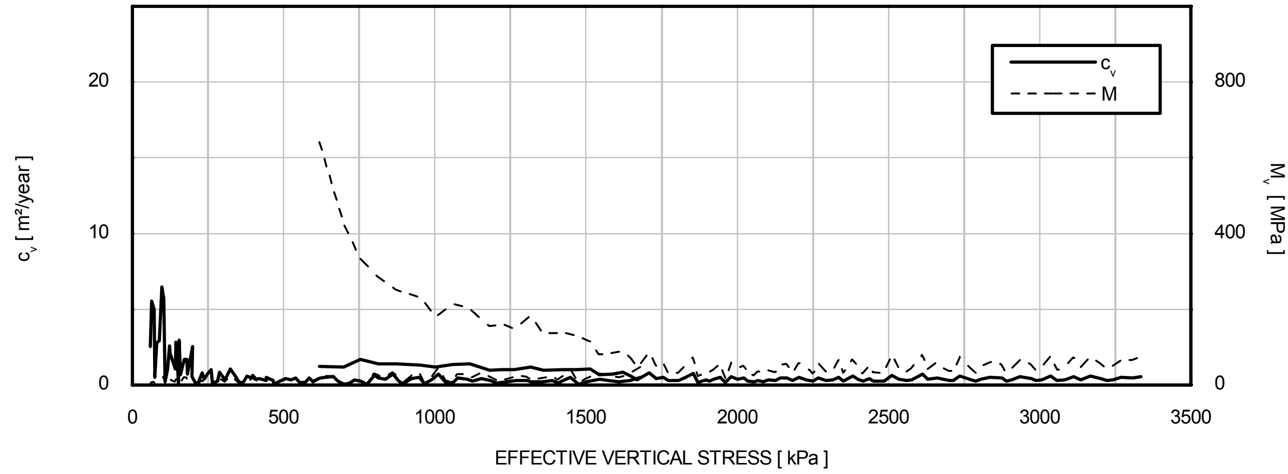
Initial void ratio : 0.753

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

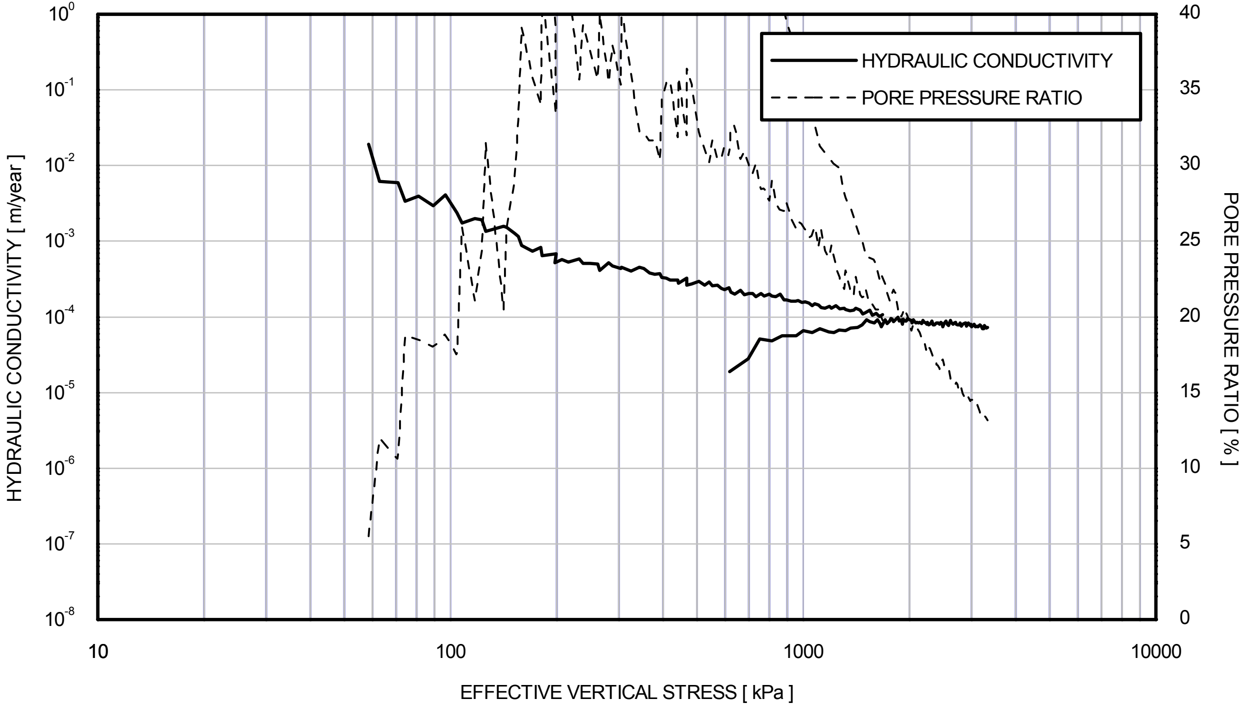
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

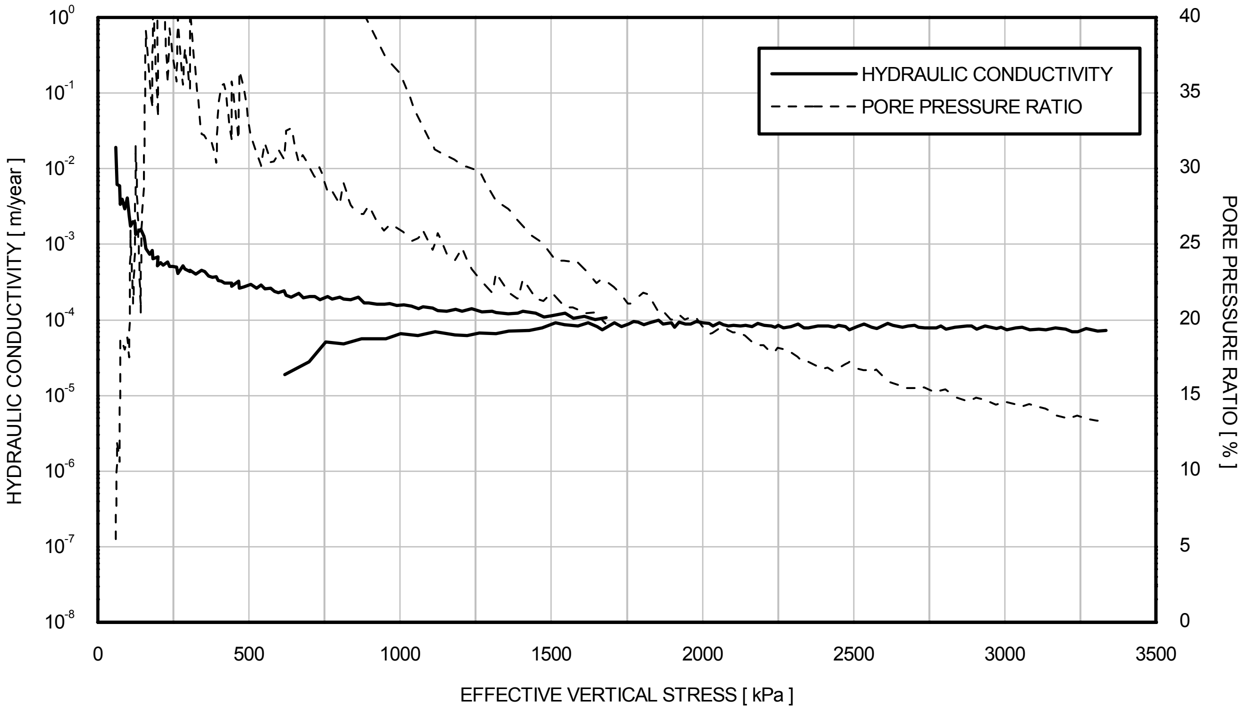




Borehole	Sample	Depth [m]		
HKZ1-BH05-SA	23WaxD	19.66	Initial void ratio	: 0.753
			Particle Density	: 2.70 Mg/m^3
			Strain rate (constant)	: 0.40 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH05-SA	23WaxD	19.66

Initial void ratio : 0.753

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.40 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Mottled black dark grey fine sandy CLAY with pockets of silt

GENERAL	
Date test started	05/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.7
Water content	[%]	40.3
Bulk density	[Mg/m³]	1.74
Dry density	[Mg/m³]	1.24
Void ratio	[-]	1.179
Degree of saturation	[%]	92
Assumed particle density	[Mg/m³]	2.70
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.

Note:
Fugro testing procedures are available upon request

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH06-SA_20WaxB_crs
Template issue	9.0
Processed by Date	ALB 13/09/2016
Checked by Date	MSR 15/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH06-SA
Sample	20WaxB
Depth [m]	15.72
Test Number	162

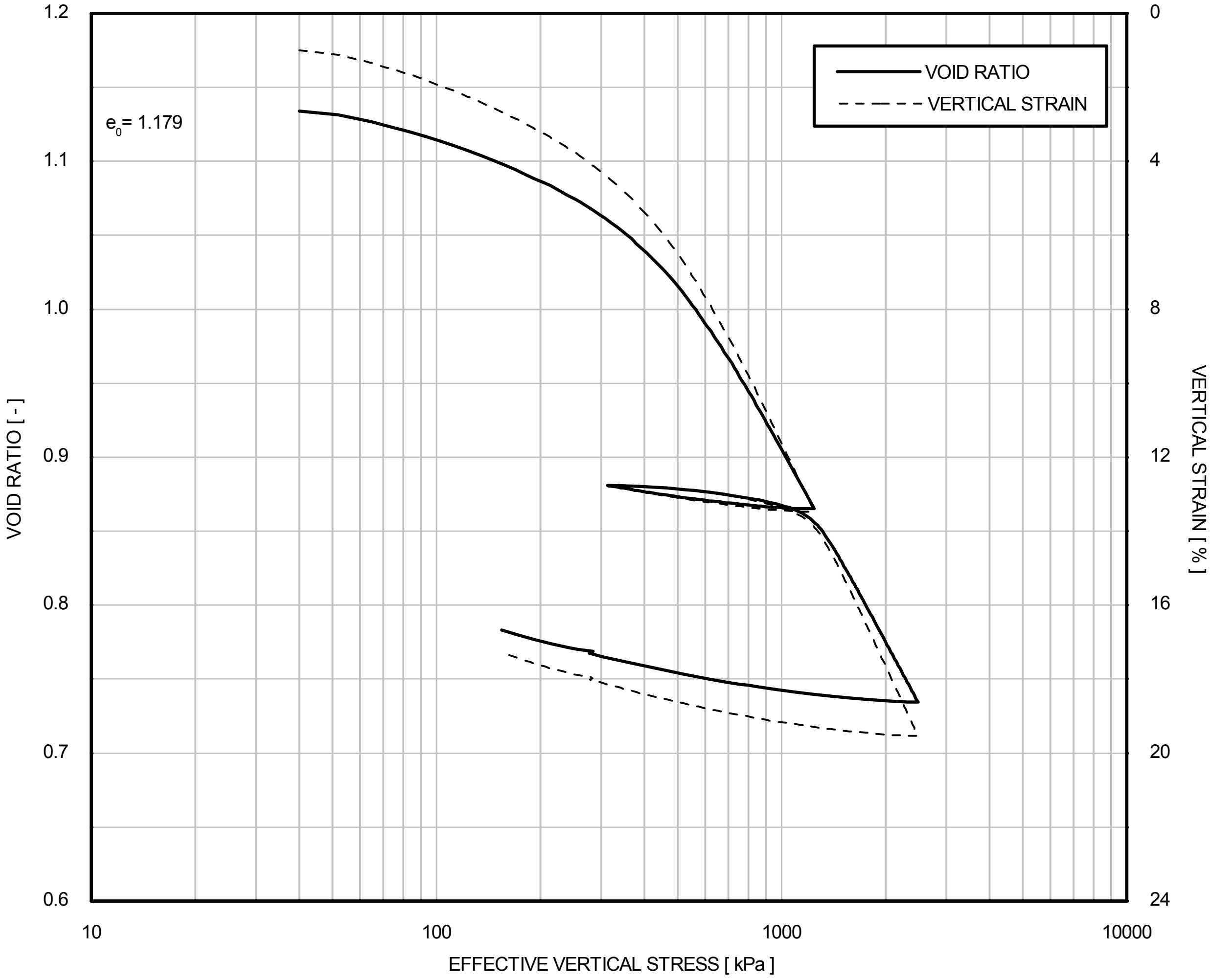
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

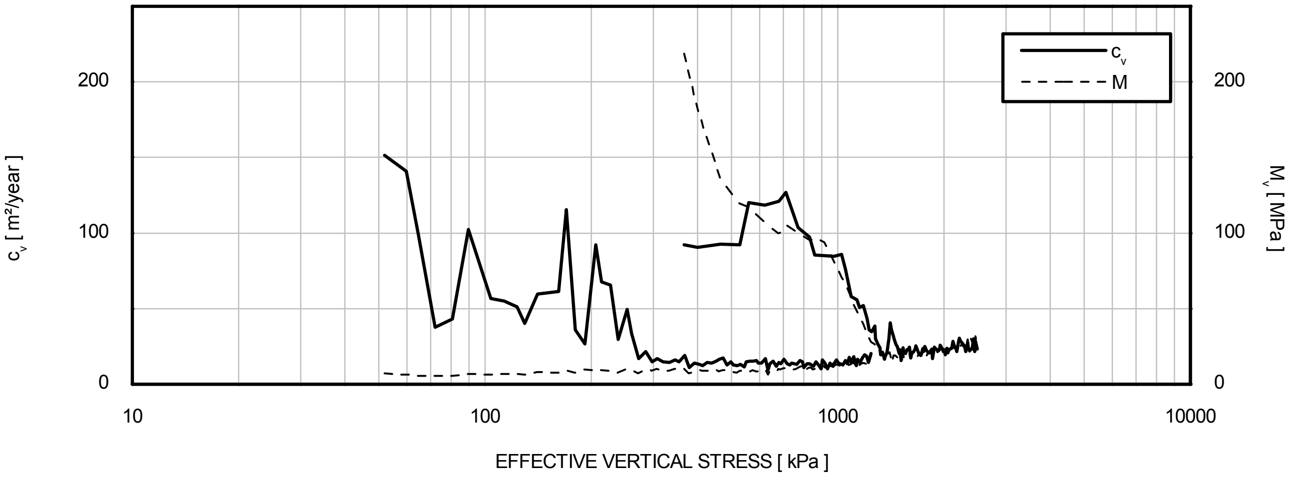
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION

Borehole	HKZ1-BH06-SA
Sample	20WaxB
Depth [m]	15.72
Test Number	162

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





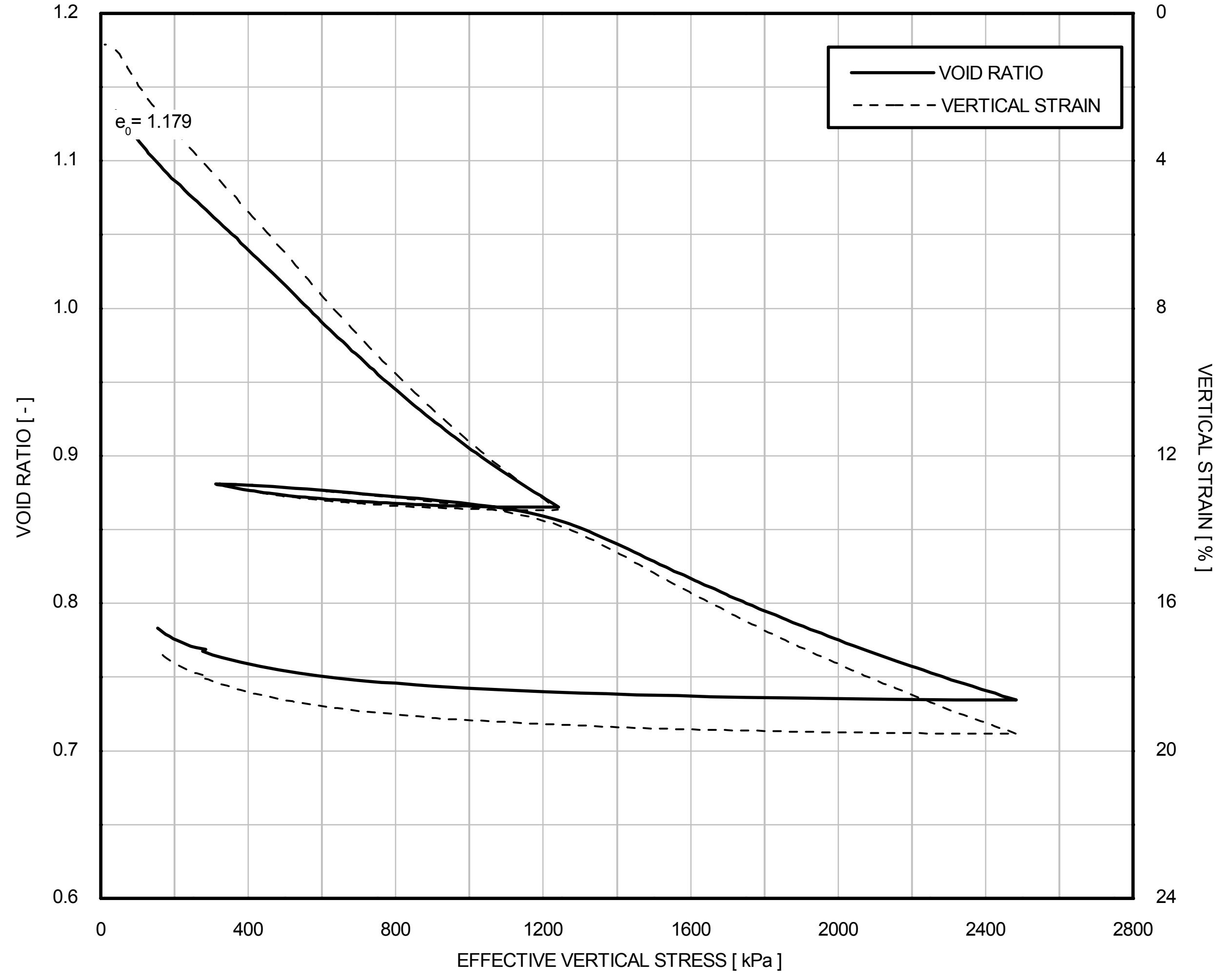
Borehole	Sample	Depth [m]
HKZ1-BH06-SA	20WaxB	15.72

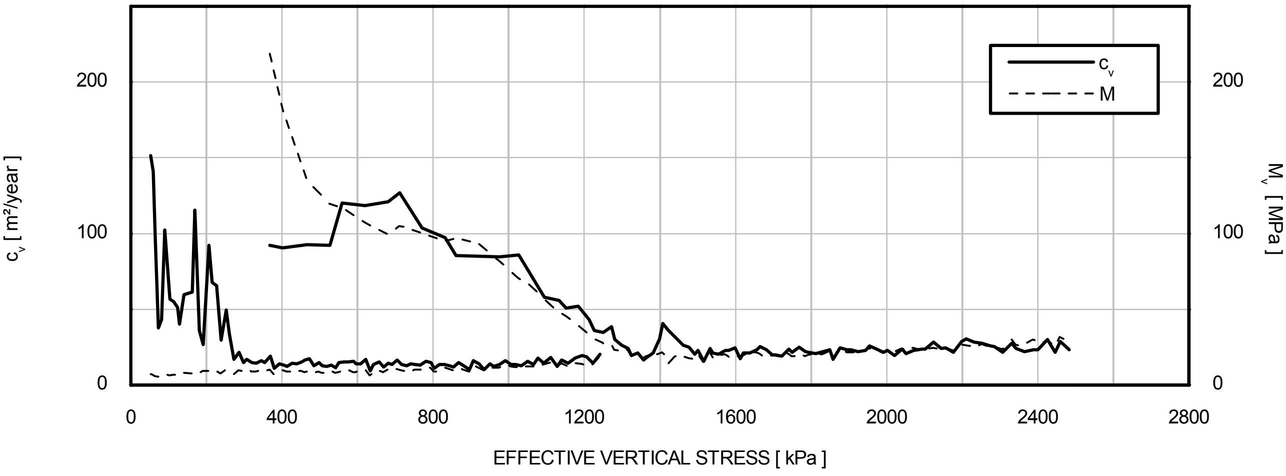
Initial void ratio : 1.179

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.60 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





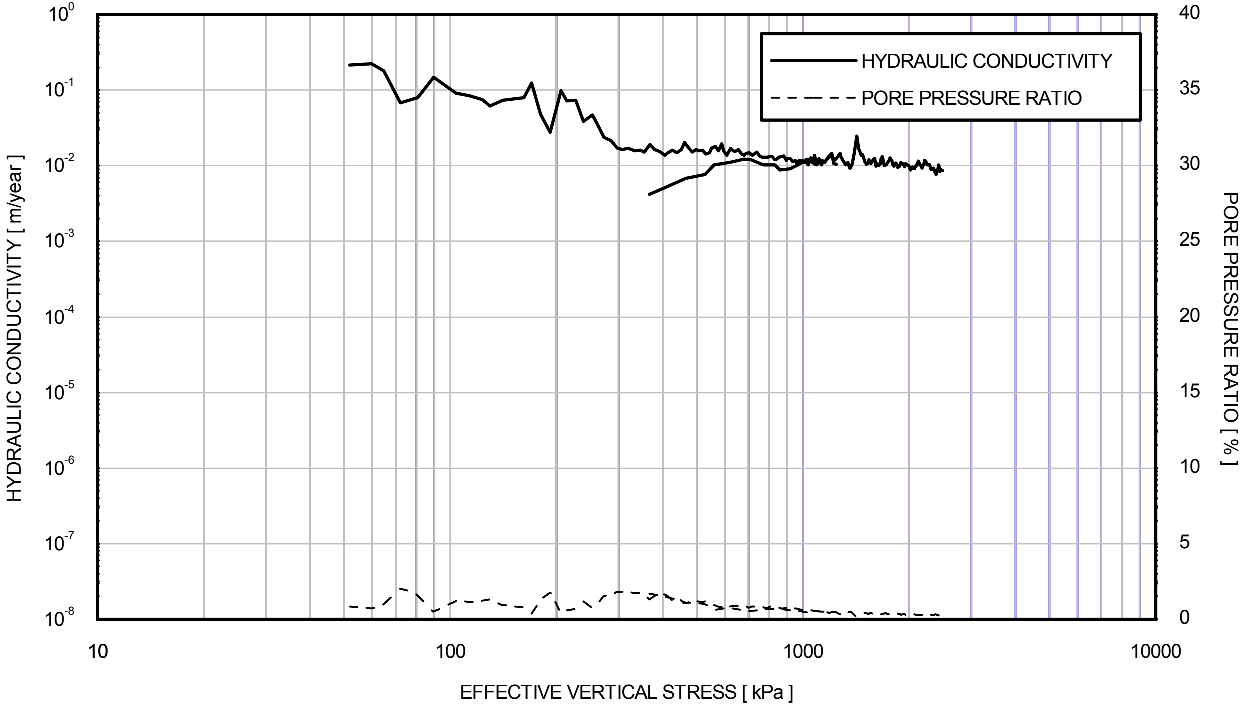
Borehole	Sample	Depth [m]
HKZ1-BH06-SA	20WaxB	15.72

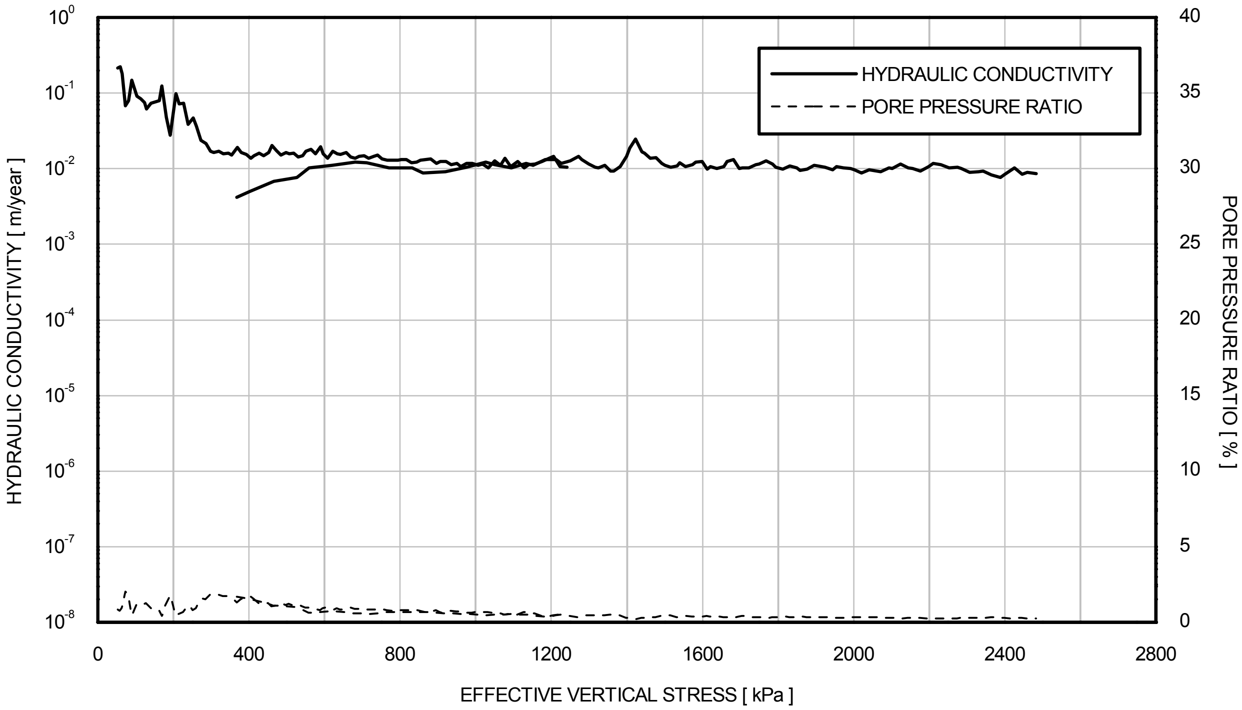
Initial void ratio : 1.179

Particle Density : 2.70 Mg/m^3

Strain rate (constant) : 0.60 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]	
HKZ1-BH06-SA	20WaxB	15.72	Initial void ratio : 1.179 Particle Density : 2.70 Mg/m^3 Strain rate (constant) : 0.60 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Dark grey sandy CLAY

GENERAL	
Date test started	06/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.4
Water content	[%]	27.6
Bulk density	[Mg/m³]	1.97
Dry density	[Mg/m³]	1.55
Void ratio	[-]	0.739
Degree of saturation	[%]	100
Measured particle density	[Mg/m³]	2.69
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.

Note:
Fugro testing procedures are available upon request

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH06-SA_32WaxD_crs
Template issue	9.0
Processed by Date	ALB 13/09/2016
Checked by Date	MSR 26/09/2016
Approved by Date	PH 27/09/2016

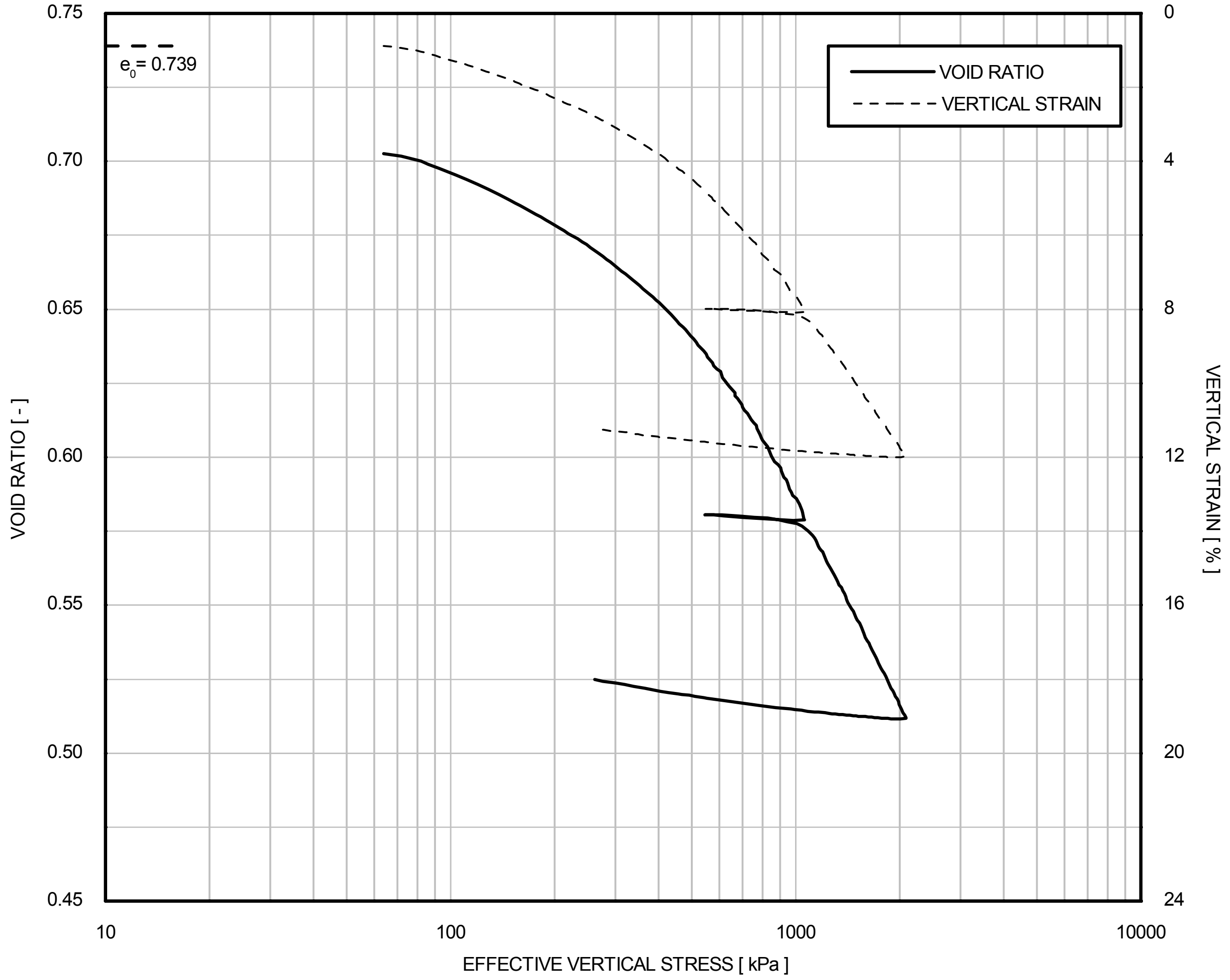
TEST IDENTIFICATION	
Borehole	HKZ1-BH06-SA
Sample	32WaxD
Depth [m]	27.62
Test Number	163

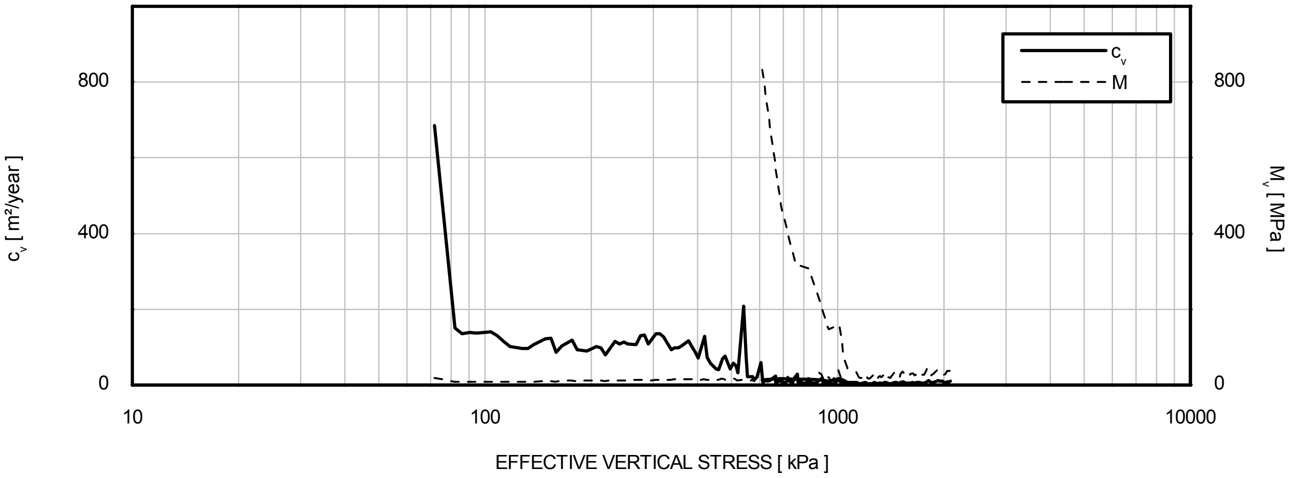
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	HKZ1-BH06-SA
Sample	32WaxD
Depth [m]	27.62
Test Number	163

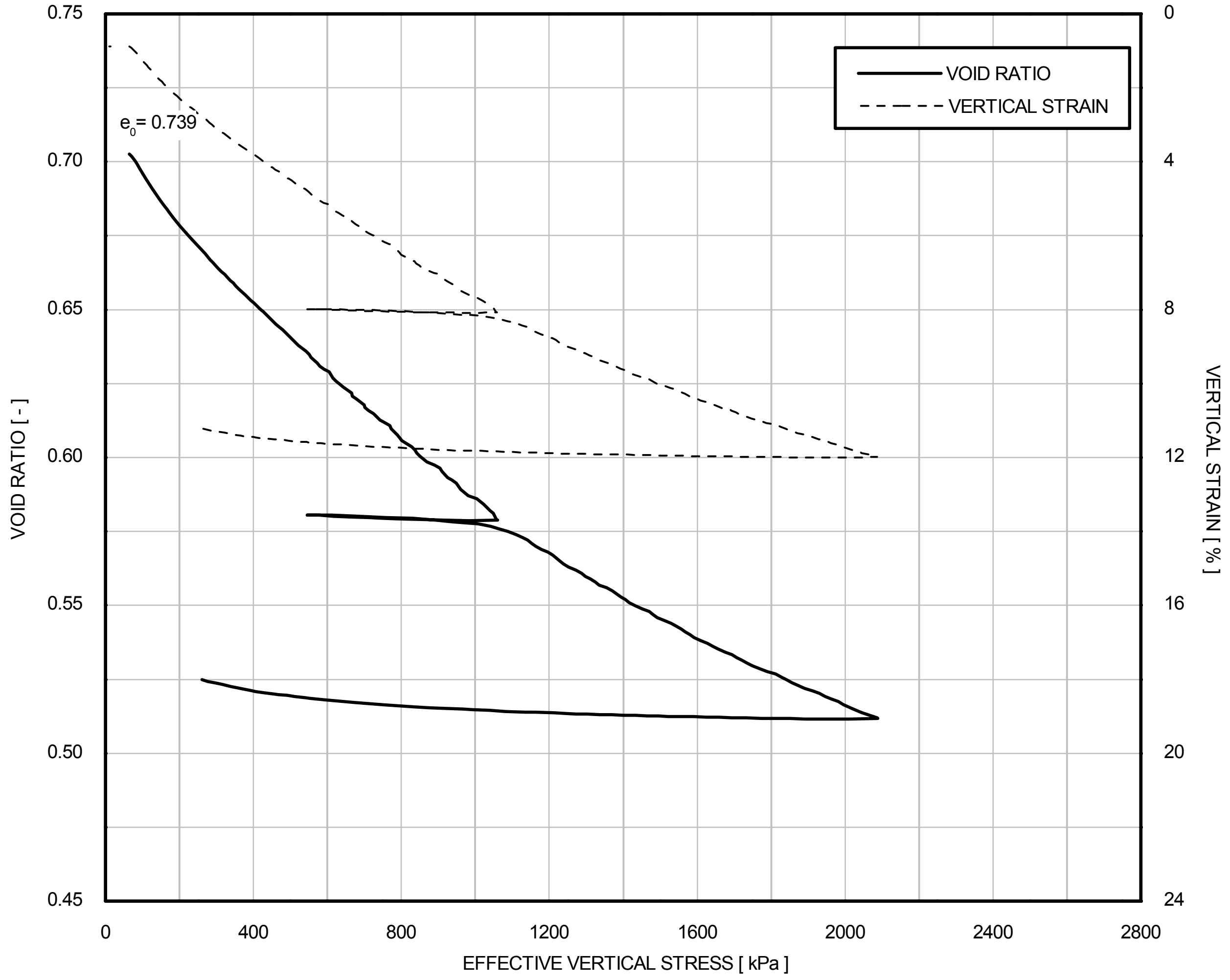
ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

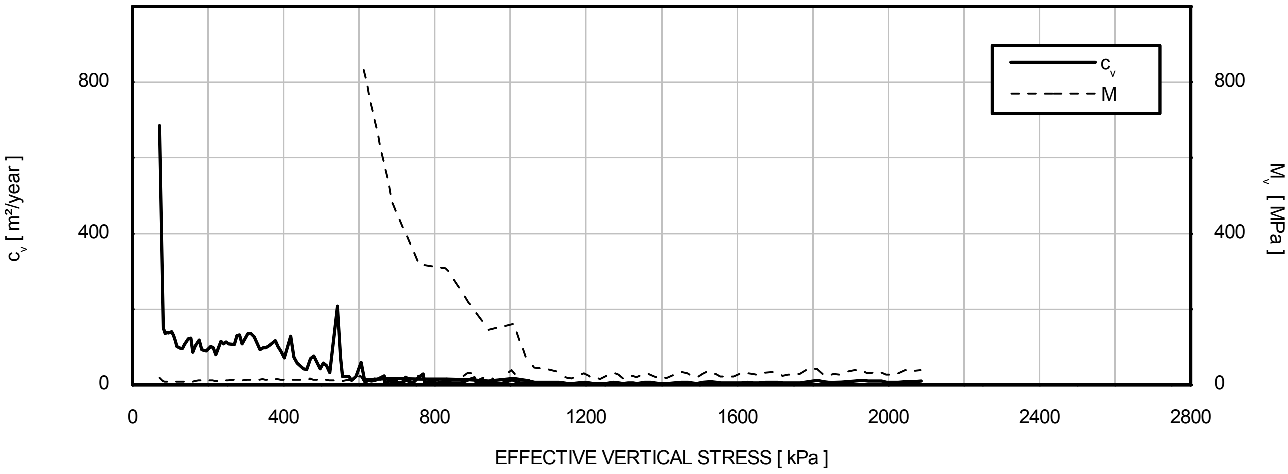




Borehole	Sample	Depth [m]	
HKZ1-BH06-SA	32WaxD	27.62	Initial void ratio : 0.739 Particle Density : 2.69 Mg/m^3 Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





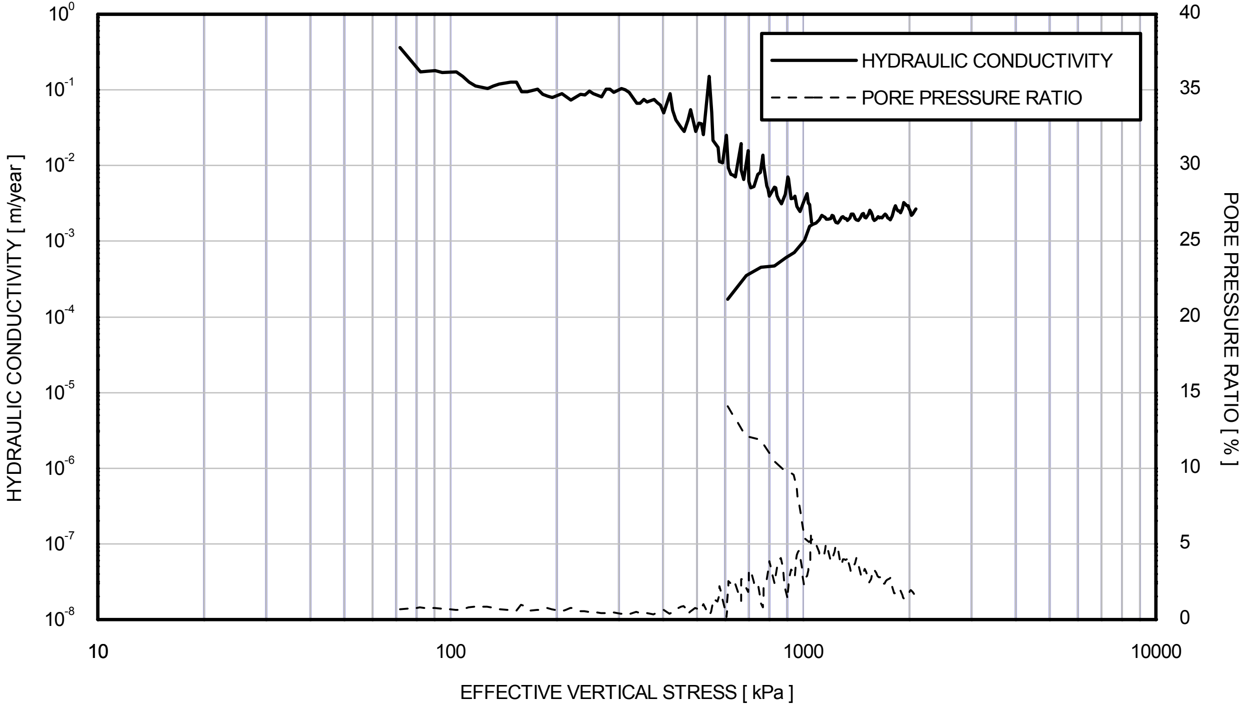
Borehole	Sample	Depth [m]
HKZ1-BH06-SA	32WaxD	27.62

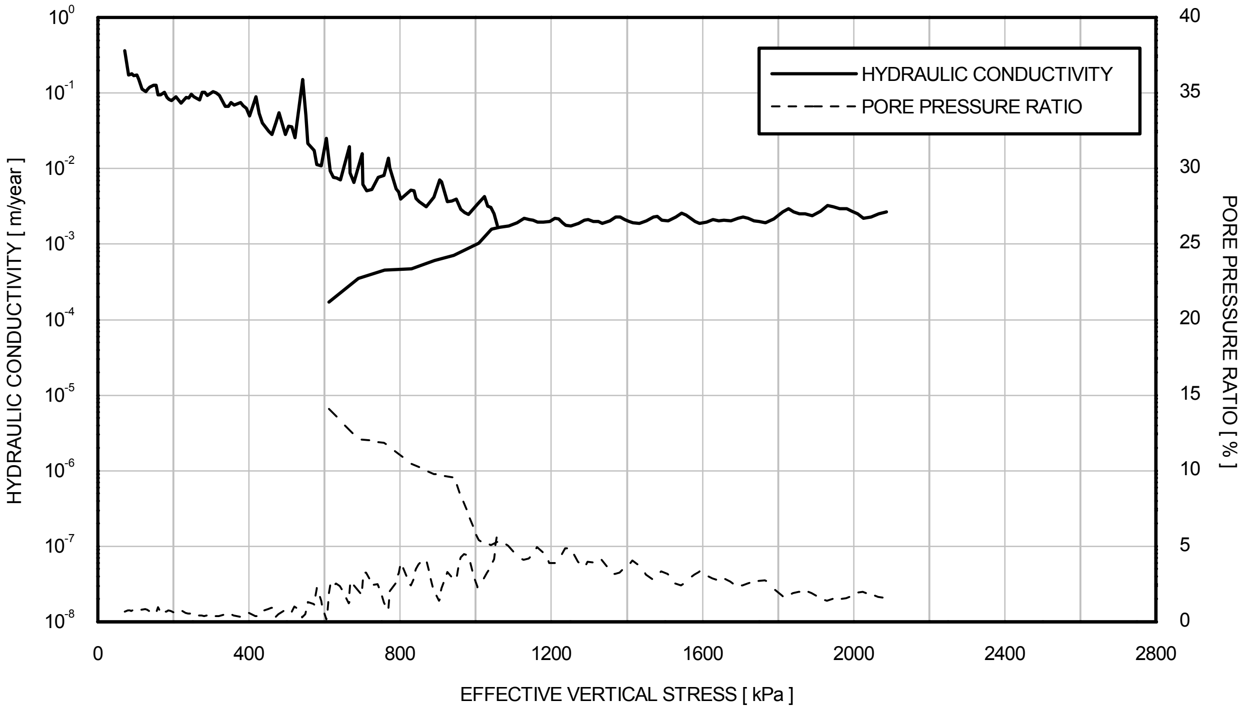
Initial void ratio : 0.739

Particle Density : 2.69 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH06-SA	32WaxD	27.62

Initial void ratio : 0.739

Particle Density : 2.69 Mg/m^3

Strain rate (constant) : 0.80 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Very dark grey fine to sandy CLAY

GENERAL	
Date test started	05/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.9
Water content	[%]	25.7
Bulk density	[Mg/m³]	1.96
Dry density	[Mg/m³]	1.56
Void ratio	[-]	0.693
Degree of saturation	[%]	98
Measured particle density	[Mg/m³]	2.64
Laboratory Temperature	[°C]	20

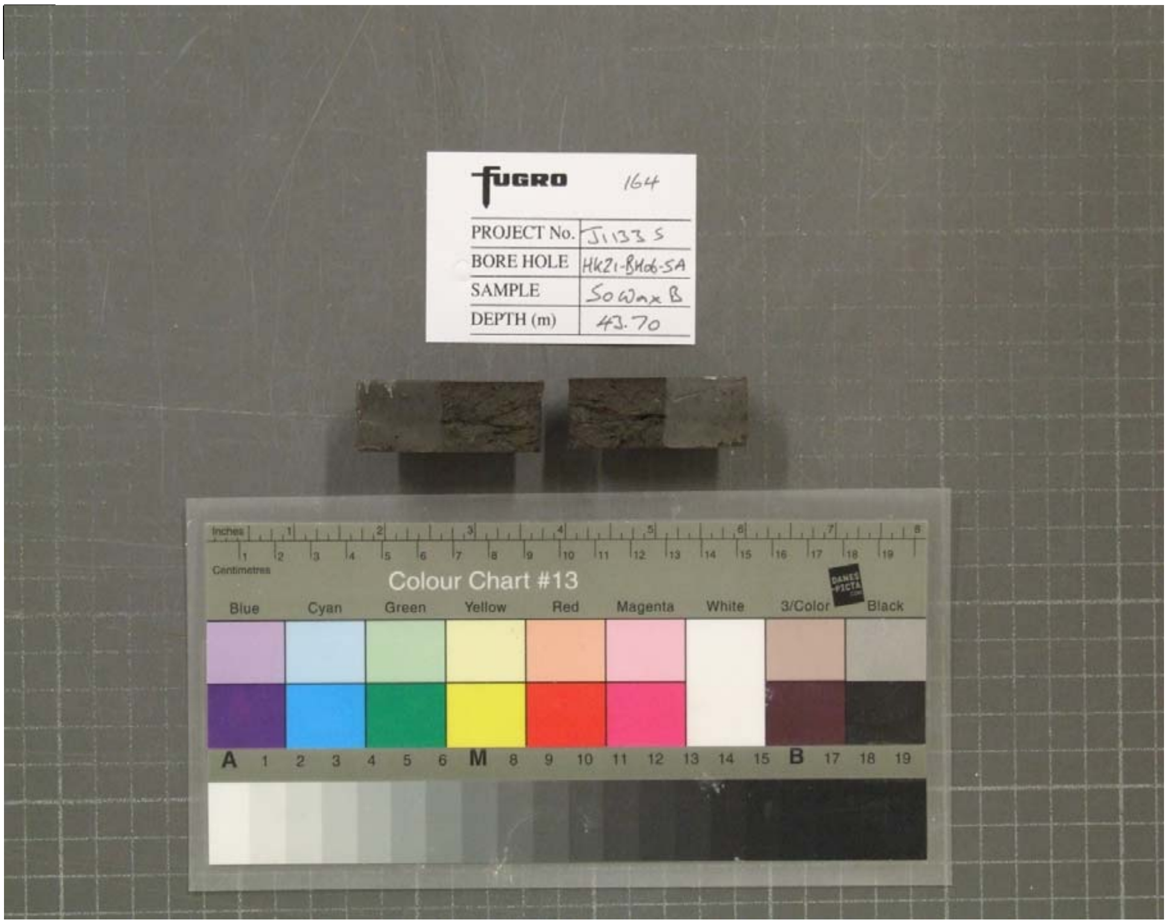
TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH08-SA_50WaxB_crs
Template issue	9.0
Processed by Date	ALB 13/09/2016
Checked by Date	MSR 15/09/2016
Approved by Date	PH 27/09/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH06-SA
Sample	50WaxB
Depth [m]	43.72
Test Number	164

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SPECIMEN PHOTOGRAPH

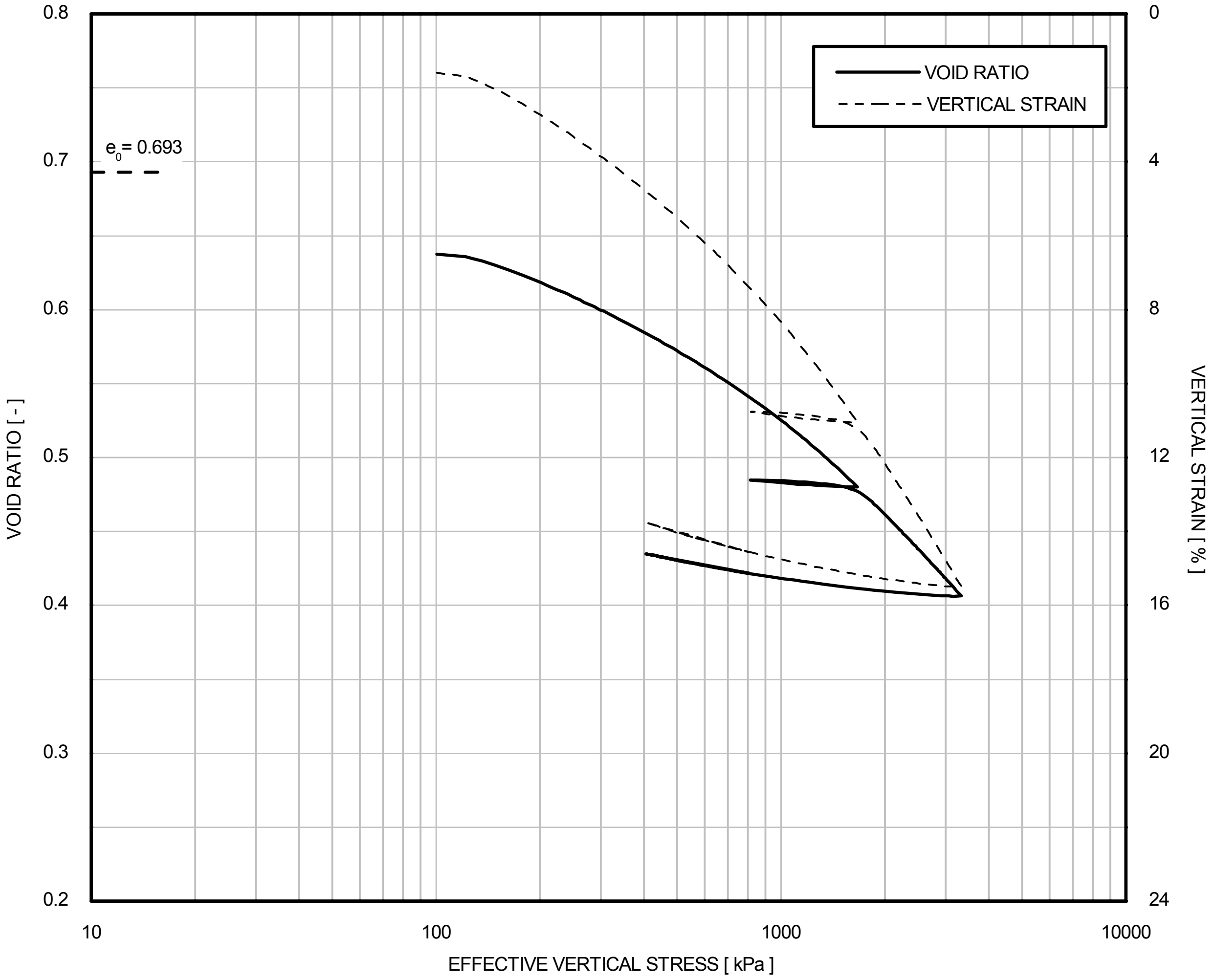


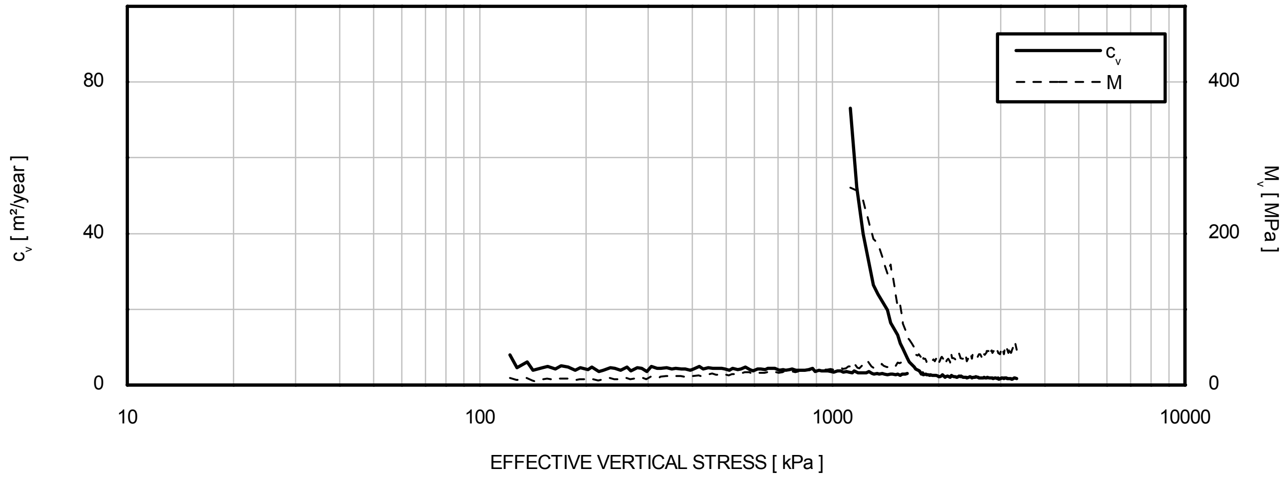
FUGRO 164

PROJECT No. J1133 S
BORE HOLE HKZ1-BH06-SA
SAMPLE 50 Wax B
DEPTH (m) 43.70

TEST IDENTIFICATION	
Borehole	HKZ1-BH06-SA
Sample	50WaxB
Depth [m]	43.72
Test Number	164

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

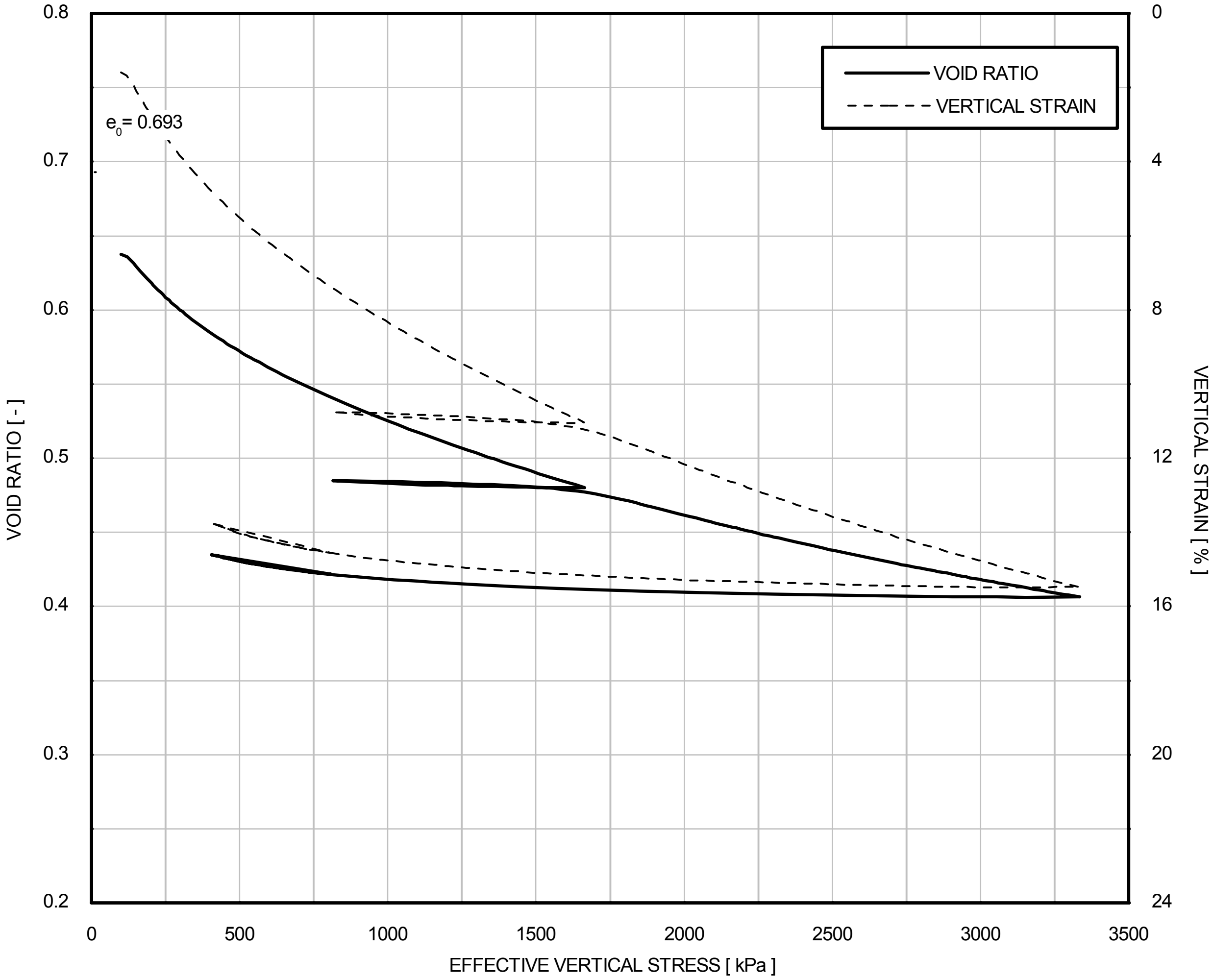


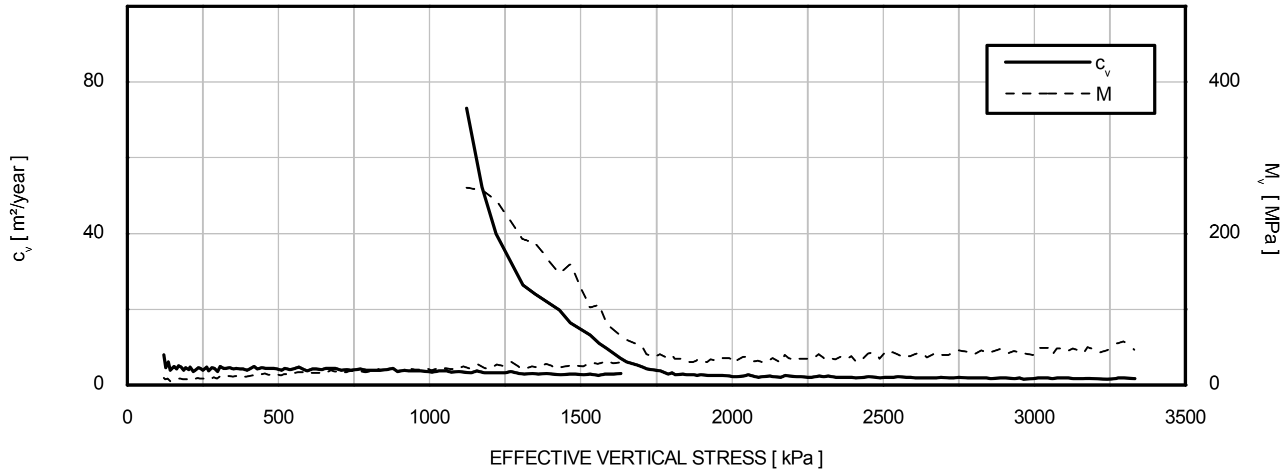


Borehole	Sample	Depth [m]
HKZ1-BH06-SA	50WaxB	43.72

Initial void ratio : 0.693
Particle Density : 2.64 Mg/m^3
Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





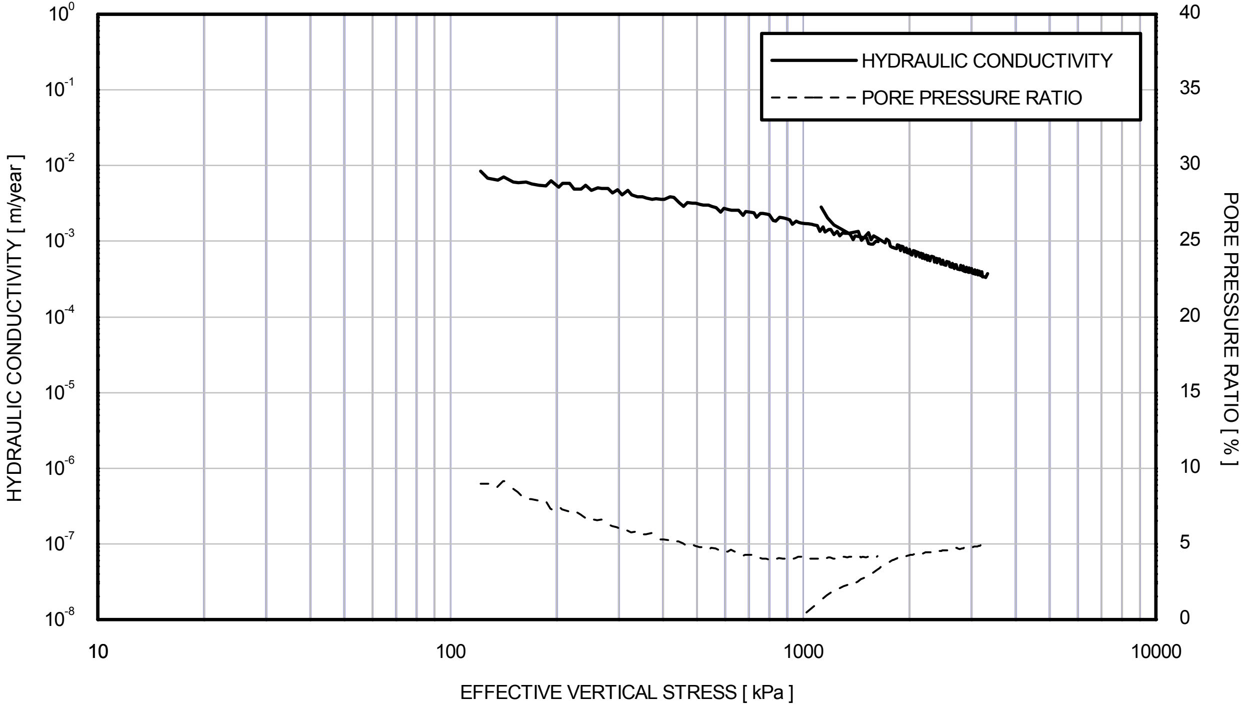
Borehole	Sample	Depth [m]
HKZ1-BH06-SA	50WaxB	43.72

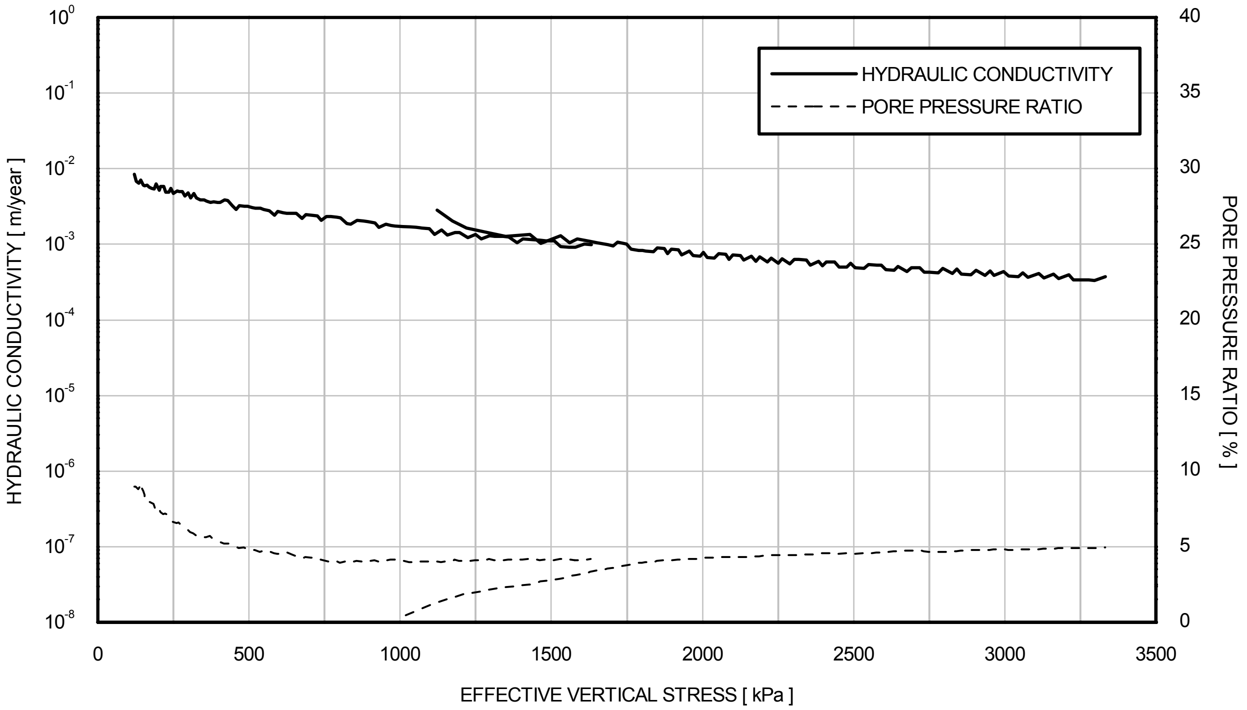
Initial void ratio : 0.693

Particle Density : 2.64 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH06-SA	50WaxB	43.72

Initial void ratio : 0.693

Particle Density : 2.64 Mg/m^3

Strain rate (constant) : 0.50 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)

VISUAL DESCRIPTION
Very dark grey silty CLAY

GENERAL	
Date test started	30/09/2016
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	50.0
Length	[mm]	20.7
Water content	[%]	34.7
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.39
Void ratio	[-]	0.916
Degree of saturation	[%]	100
Measured particle density	[Mg/m³]	2.66
Laboratory Temperature	[°C]	20

TESTING PROCEDURES USED	
Specimen set-up	Fugro procedure L-T-027 based on ASTM D4186-12.
Compression	Fugro procedure L-T-027 based on ASTM D4186-12.

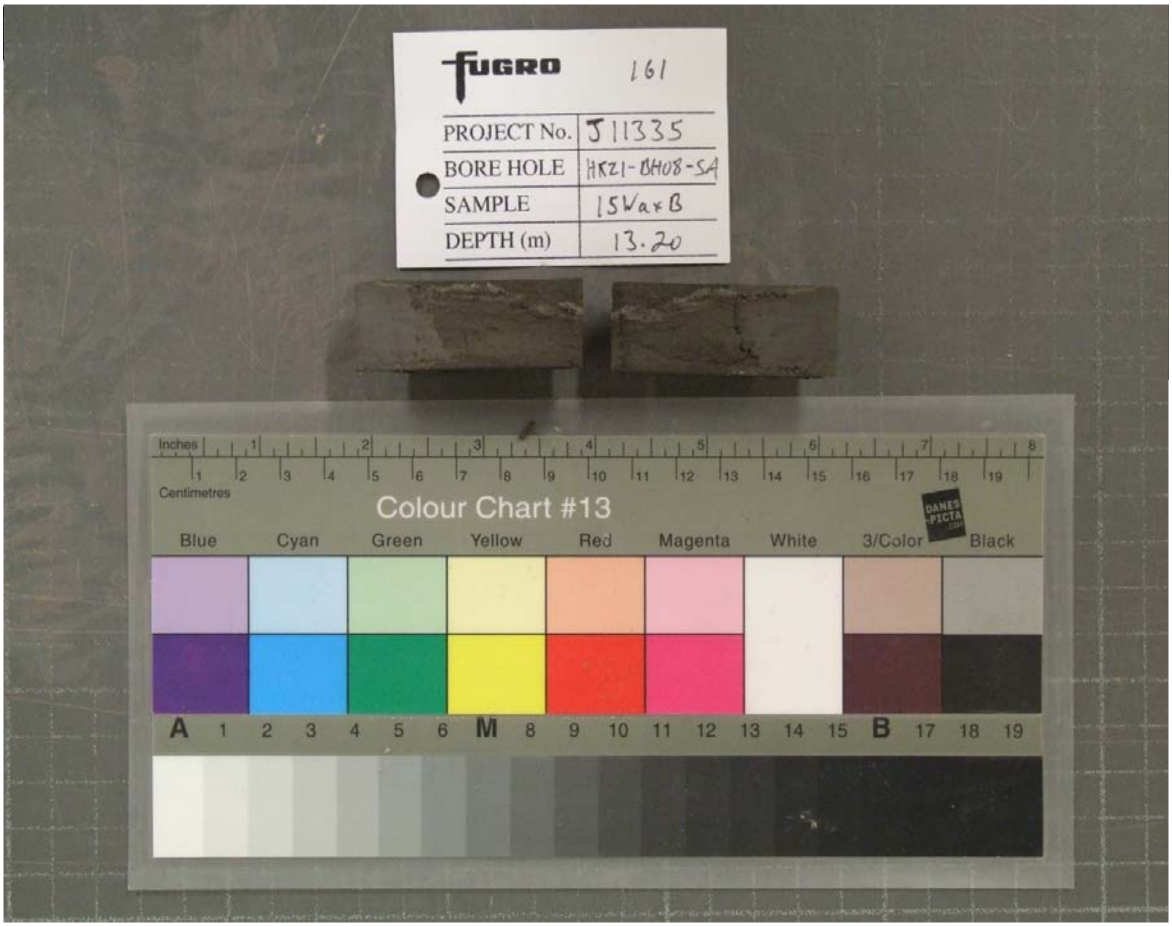
Note:
Fugro testing procedures are available upon request

QUALITY ASSURANCE	
Filename	J11335 \ HKZ1-BH08-SA_15WaxB_crs
Template issue	9.0
Processed by Date	MSR 07/10/2016
Checked by Date	PH 10/10/2016
Approved by Date	PH 10/10/2016

TEST IDENTIFICATION	
Borehole	HKZ1-BH08-SA
Sample	15WaxB
Depth [m]	13.30
Test Number	161R

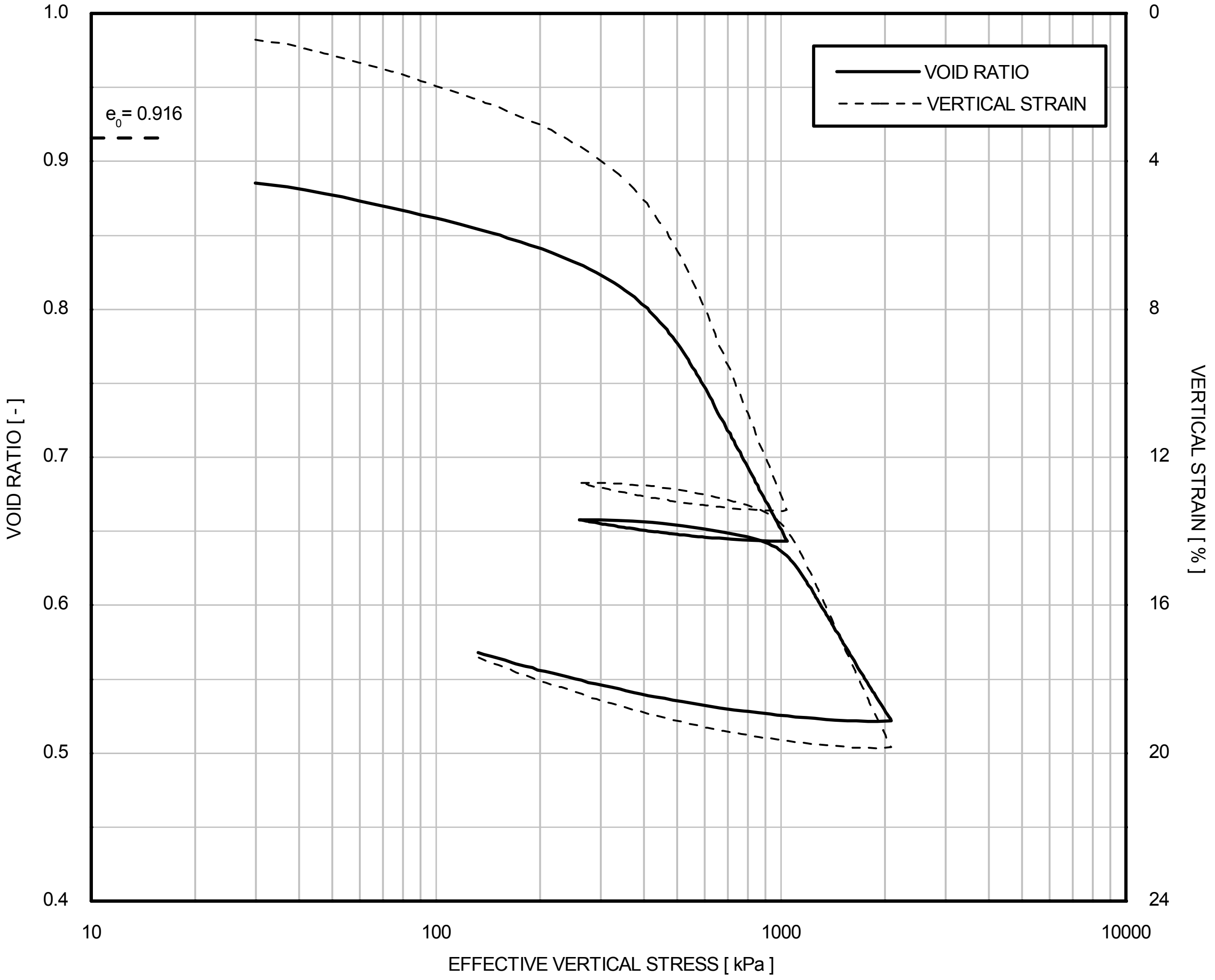
ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

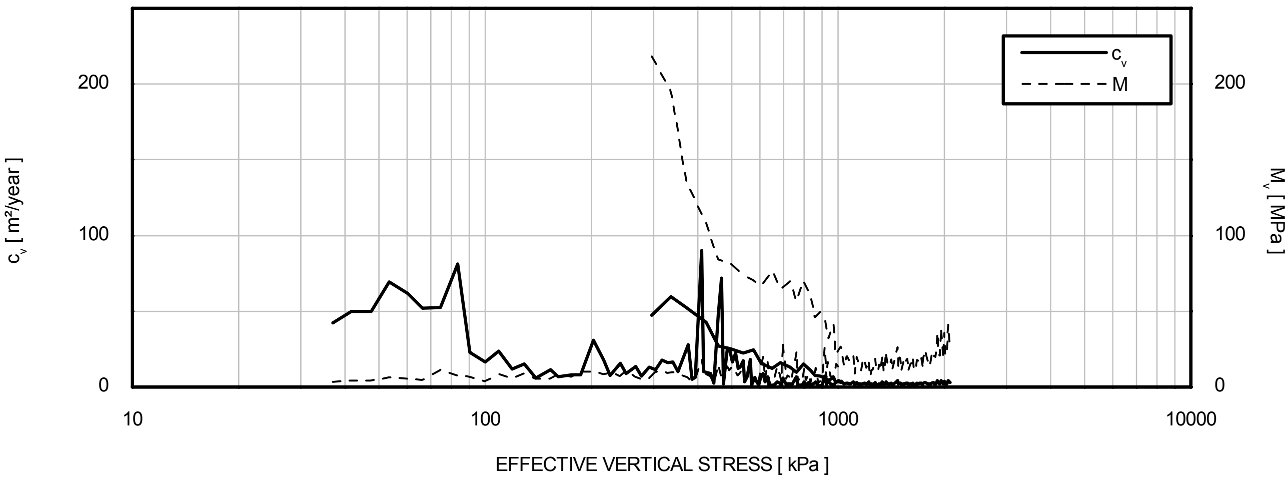
SPECIMEN PHOTOGRAPH



TEST IDENTIFICATION	
Borehole	HKZ1-BH08-SA
Sample	15WaxB
Depth [m]	13.30
Test Number	161R

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





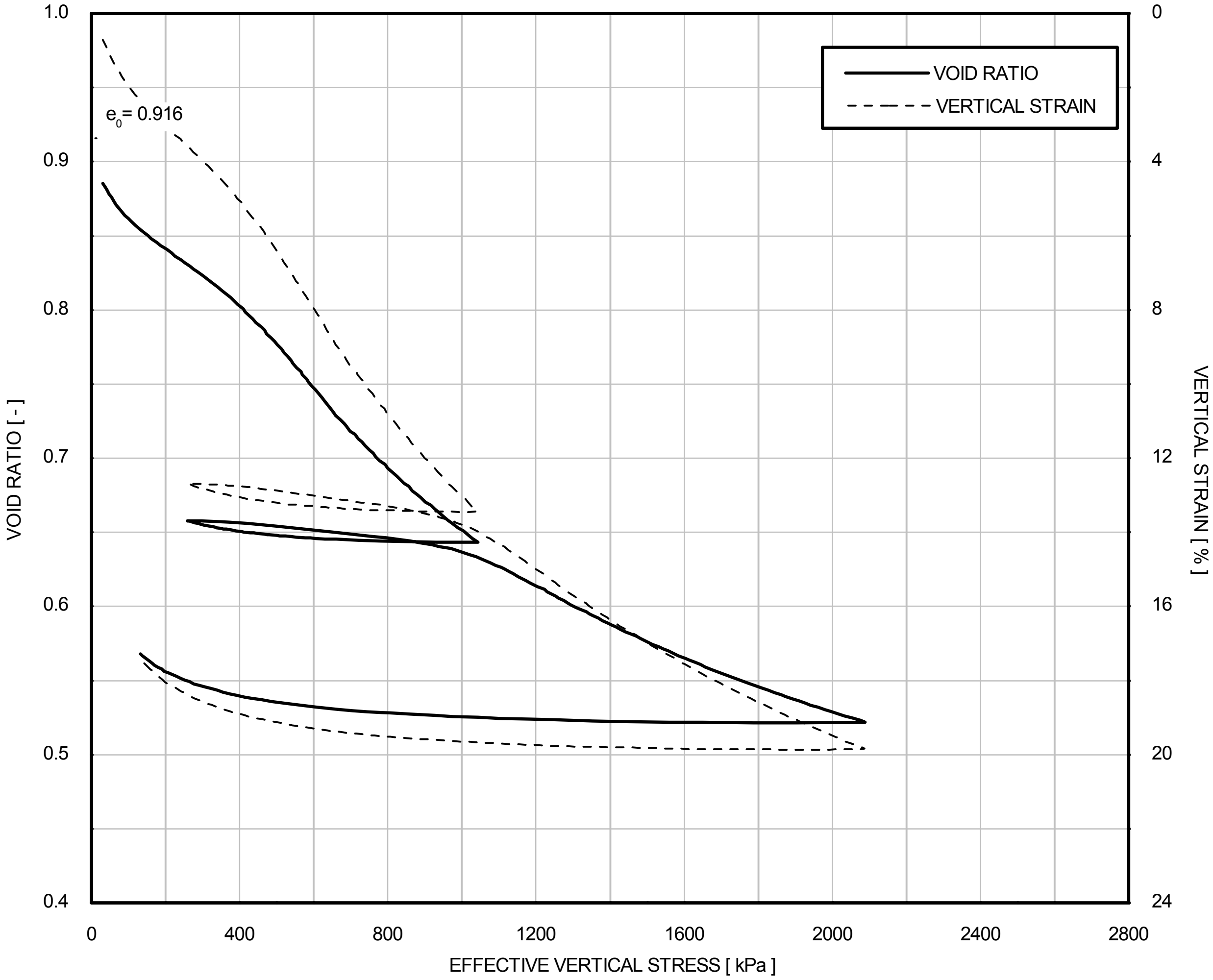
Borehole	Sample	Depth [m]
HKZ1-BH08-SA	15WaxB	13.30

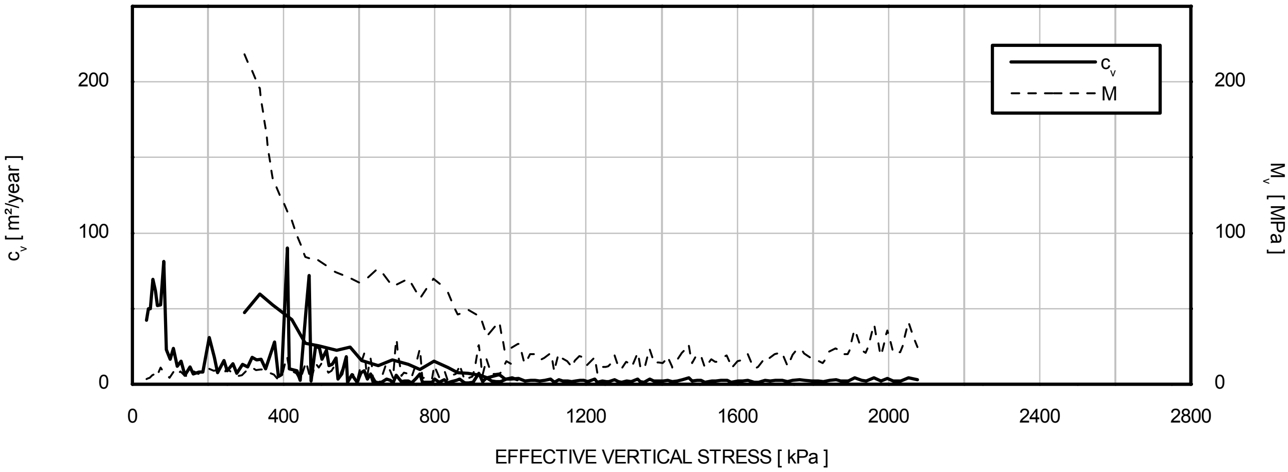
Initial void ratio : 0.916

Particle Density : 2.66 Mg/m^3

Strain rate (constant) : 0.30 %/hour

ONE DIMENSIONAL - VERTICAL CONTINUOUS LOADING OEDOMETER TEST (CRS)





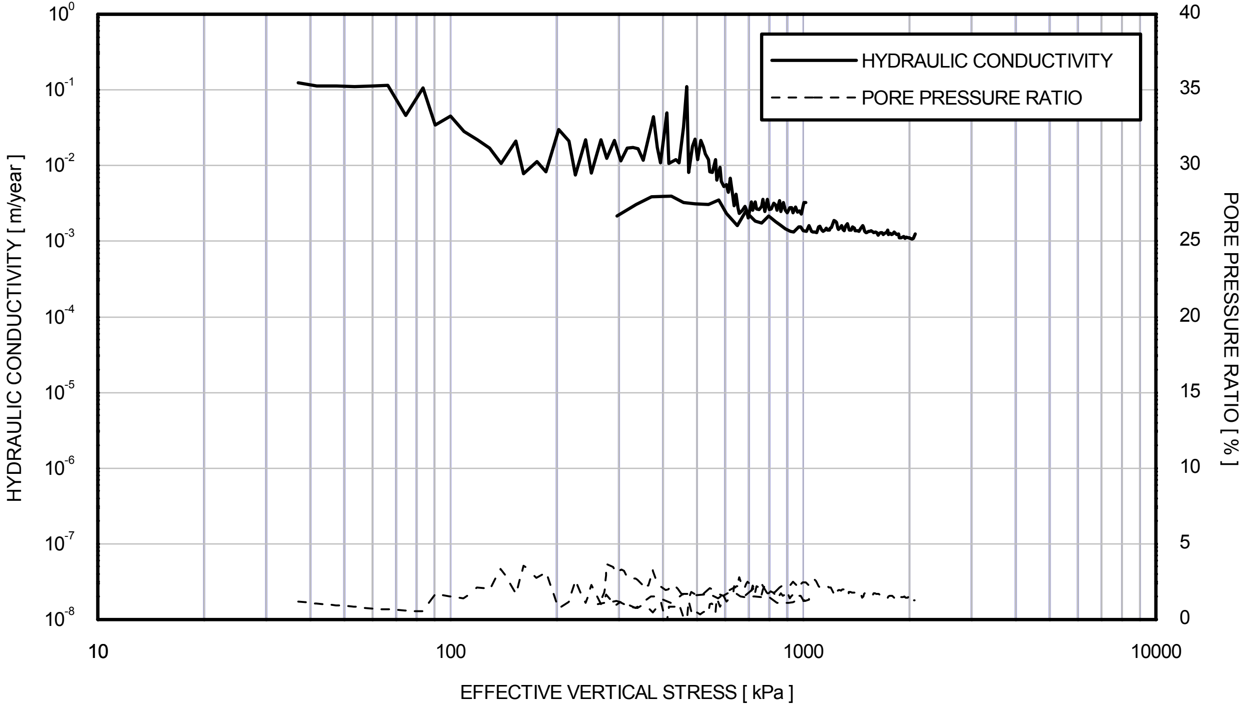
Borehole	Sample	Depth [m]
HKZ1-BH08-SA	15WaxB	13.30

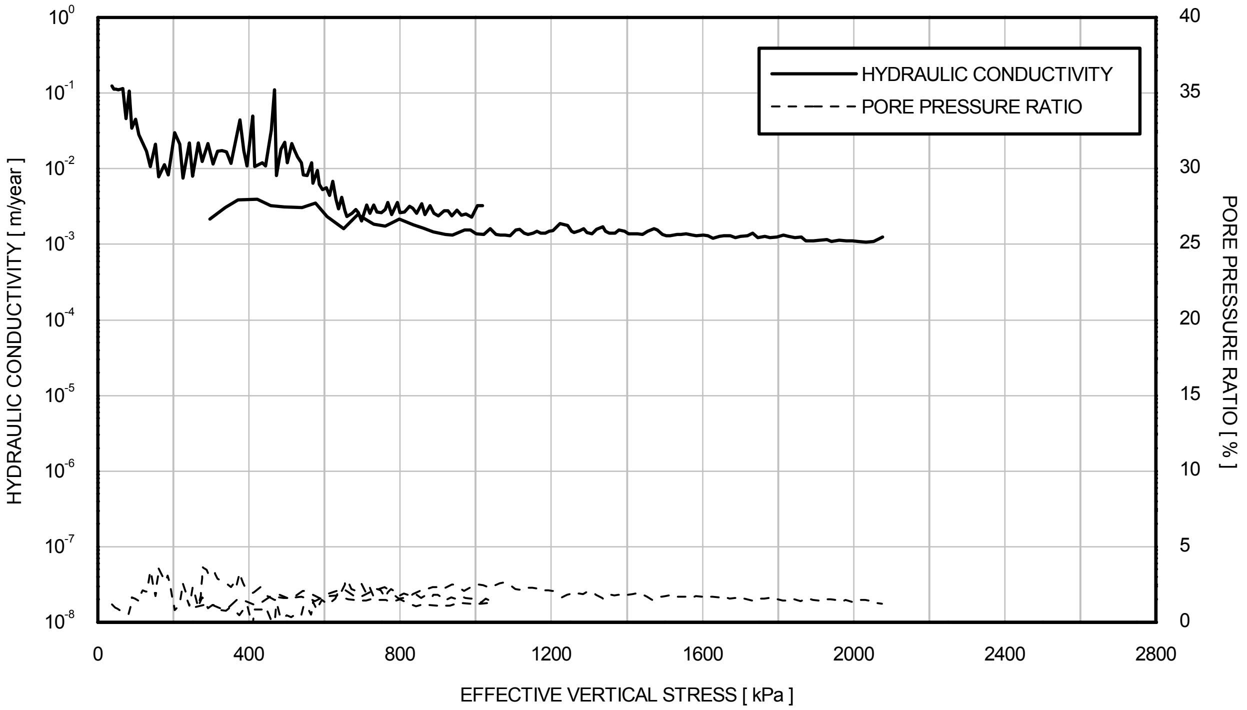
Initial void ratio : 0.916

Particle Density : 2.66 Mg/m^3

Strain rate (constant) : 0.30 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)





Borehole	Sample	Depth [m]
HKZ1-BH08-SA	15WaxB	13.30

Initial void ratio : 0.916

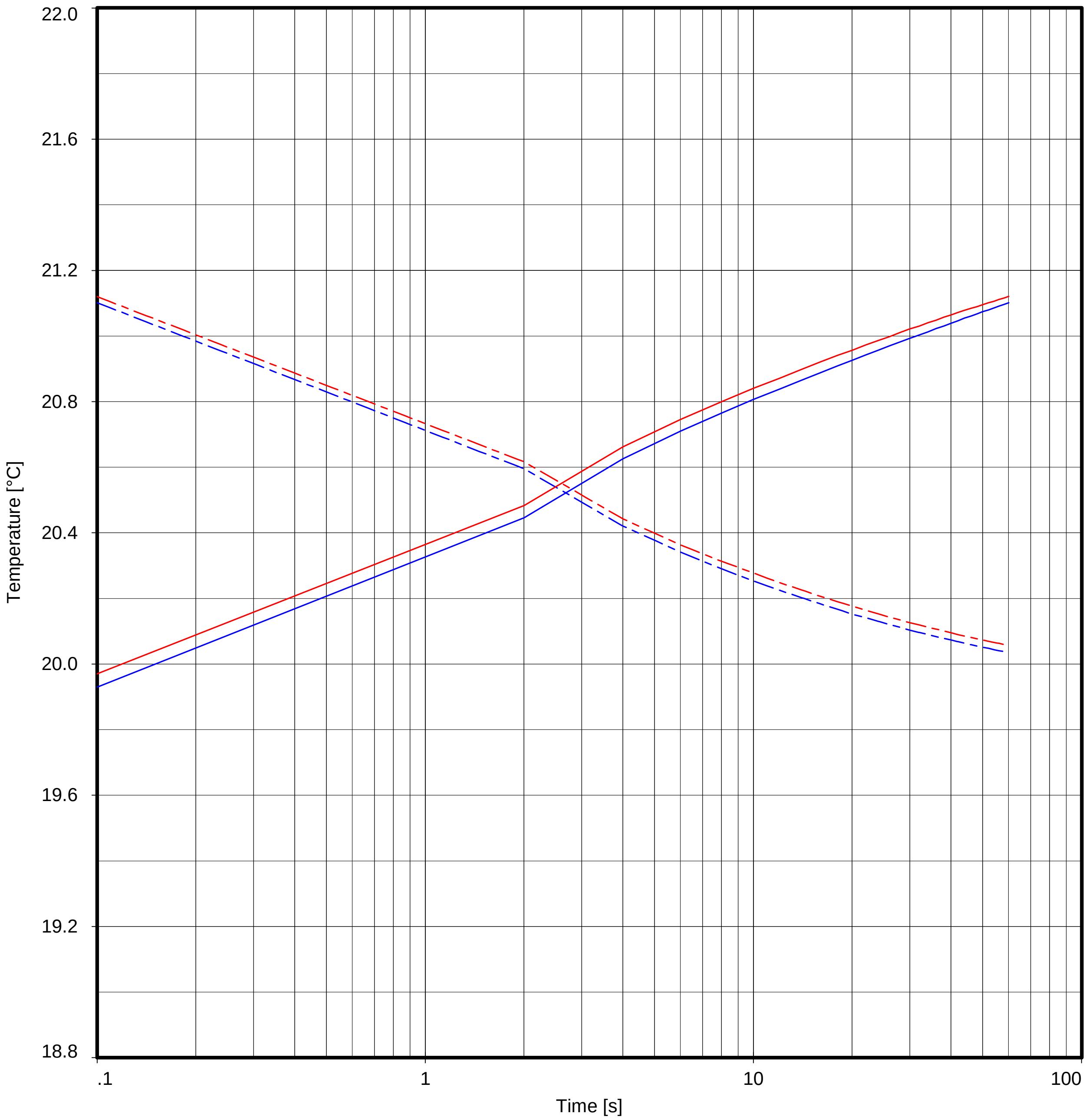
Particle Density : 2.66 Mg/m^3

Strain rate (constant) : 0.30 %/hour

ONE DIMENSIONAL - VERTICAL
CONTINUOUS LOADING OEDOMETER TEST (CRS)

SECTION C7: THERMAL CONDUCTIVITY TESTS

LIST OF PLATES IN SECTION C7:



Measurement 1
Applied power : 3.93 W/m ——— Heating phase measurement 1
Thermal conductivity : 1.925 W/(m.K) –·–·– Cooling phase measurement 1

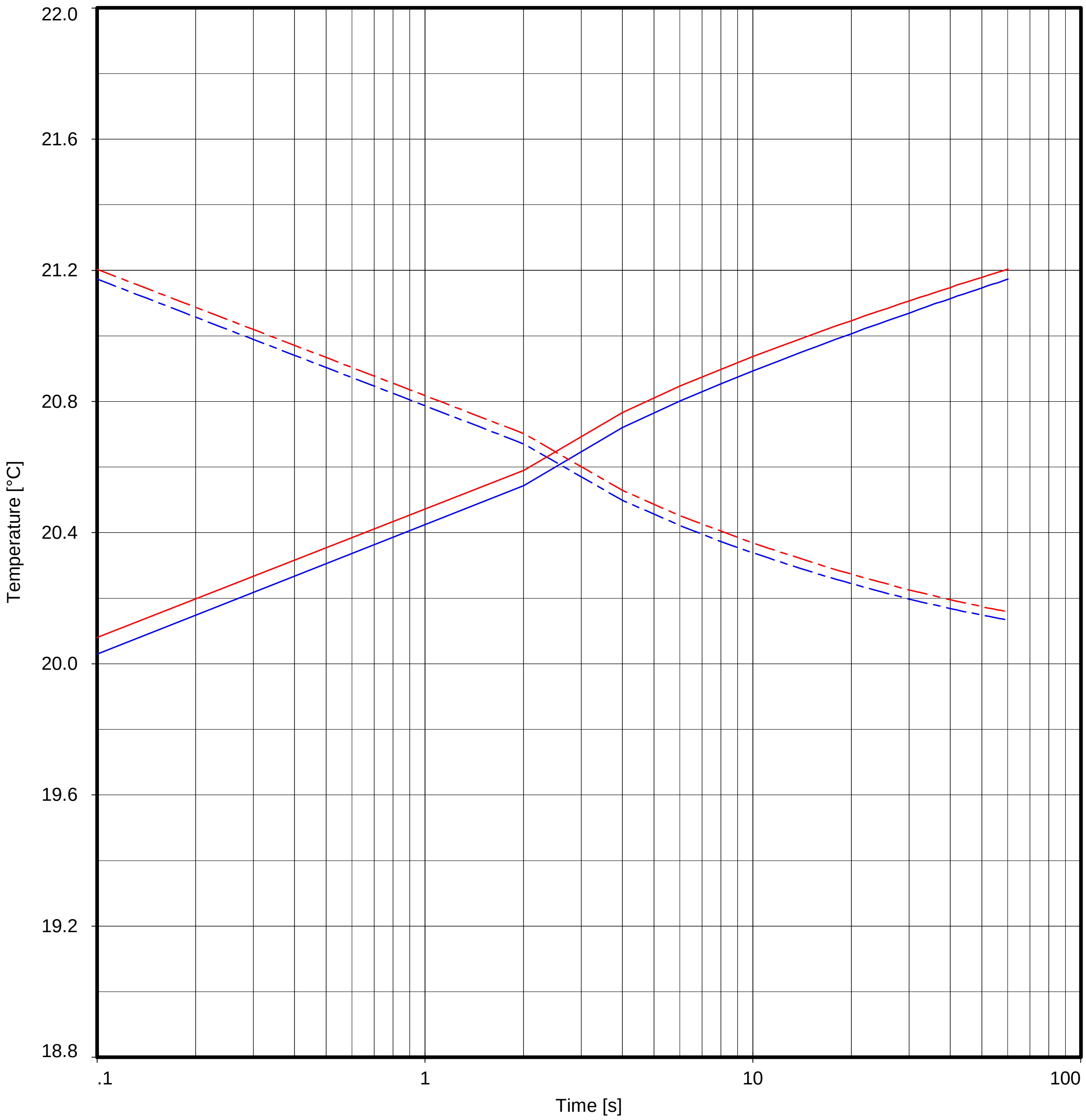
Measurement 2
Applied power : 3.91 W/m ——— Heating phase measurement 2
Thermal conductivity : 1.988 W/(m.K) –·–·– Cooling phase measurement 2

Test ID : TC01
Borehole : HKZ1-BH01-SA
Soil type : SAND
Dry density : 1.36 Mg/m^3
Test Date : 11/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 17:39:41

THERMAL CONDUCTIVITY TEST RESULTS



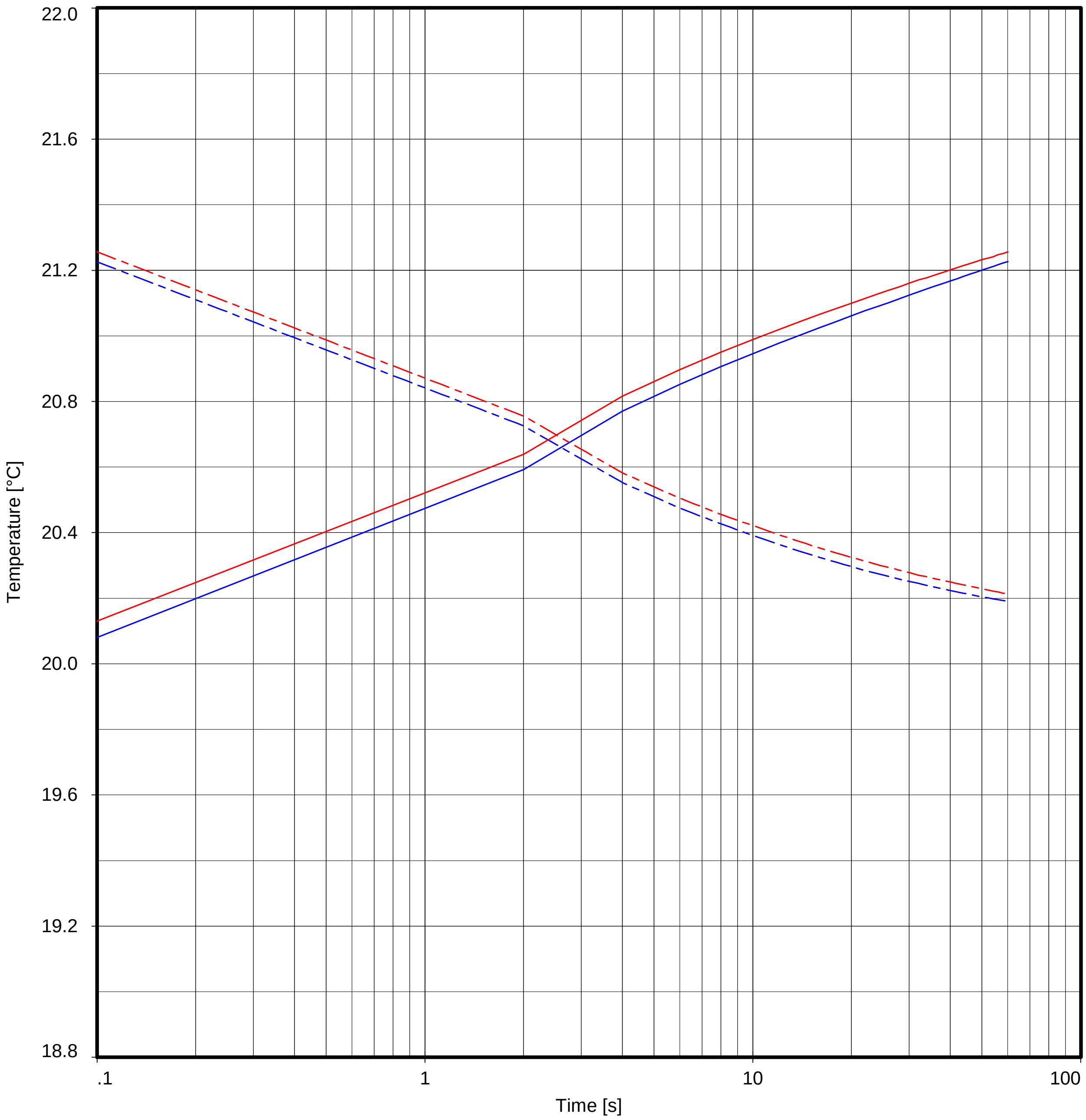
Measurement 1				
Applied power	: 3.91 W/m	━━━━	Heating phase measurement 1	
Thermal conductivity	: 2.023 W/(m.K)	— - — - —	Cooling phase measurement 1	
Measurement 2				
Applied power	: 3.89 W/m	━━━━	Heating phase measurement 2	
Thermal conductivity	: 2.058 W/(m.K)	— - — - —	Cooling phase measurement 2	

Test ID : TC01
Borehole : HKZ1-BH01-SA
Soil type : SAND
Dry density : 1.47 Mg/m^3
Test Date : 11/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 17:43:36

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.89 W/m ——— Heating phase measurement 1

Thermal conductivity : 2.058 W/(m.K) — - — - Cooling phase measurement 1

Measurement 2

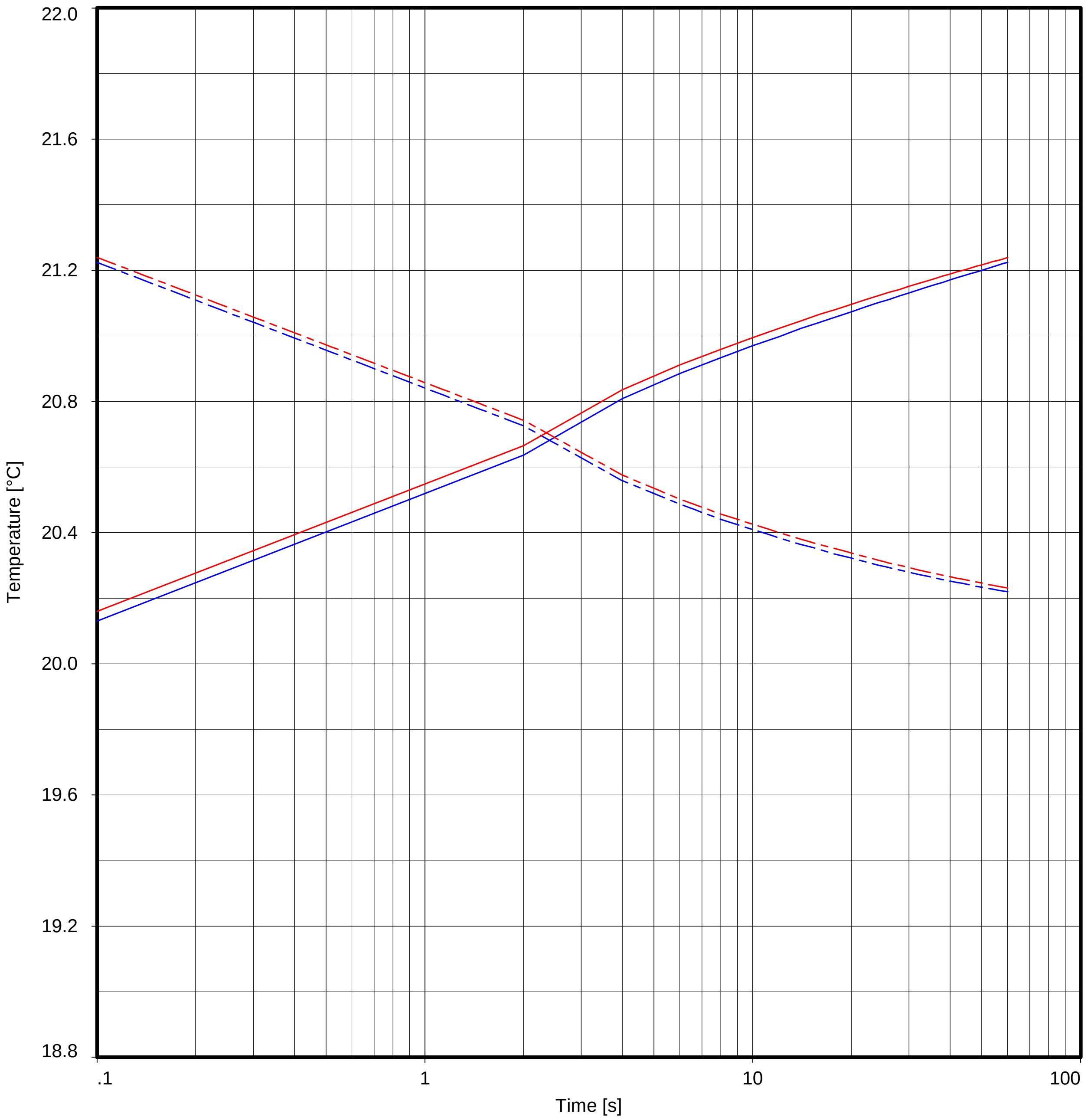
Applied power : 3.87 W/m ——— Heating phase measurement 2

Thermal conductivity : 2.082 W/(m.K) — - — - Cooling phase measurement 2

Test ID : TC01
Borehole : HKZ1-BH01-SA
Soil type : SAND
Dry density : 1.50 Mg/m^3
Test Date : 11/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.87 W/m		——	Heating phase measurement 1
Thermal conductivity	: 2.199 W/(m.K)		— - — -	Cooling phase measurement 1

Measurement 2

Applied power	: 3.87 W/m		——	Heating phase measurement 2
Thermal conductivity	: 2.23 W/(m.K)		— - — -	Cooling phase measurement 2

Test ID : TC01
Borehole : HKZ1-BH01-SA
Soil type : SAND
Dry density : 1.55 Mg/m^3
Test Date : 11/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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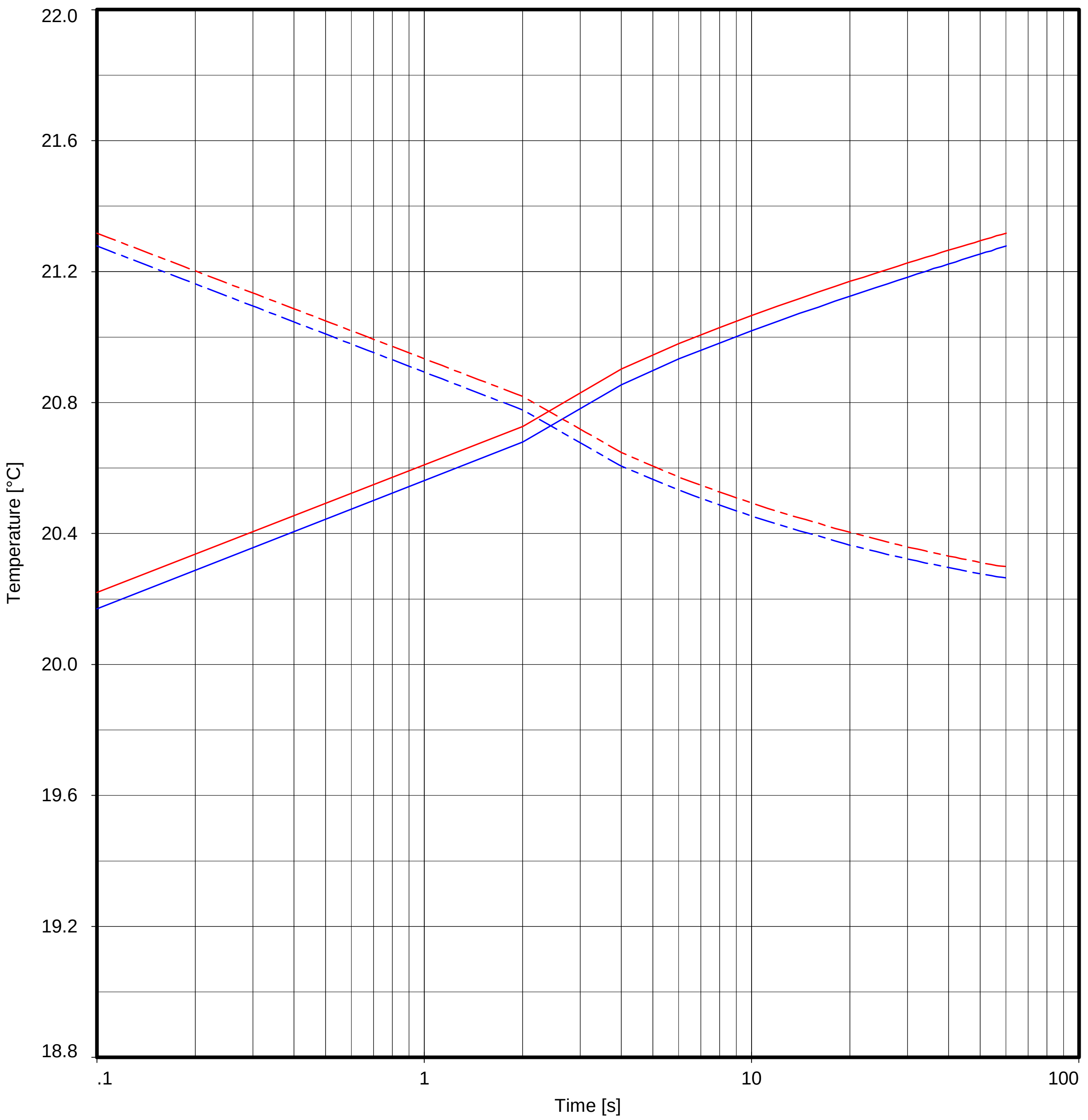
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.86 W/m — Heating phase measurement 1

Thermal conductivity : 2.175 W/(m.K) - · — · - Cooling phase measurement 1

Measurement 2

Applied power : 3.85 W/m — Heating phase measurement 2

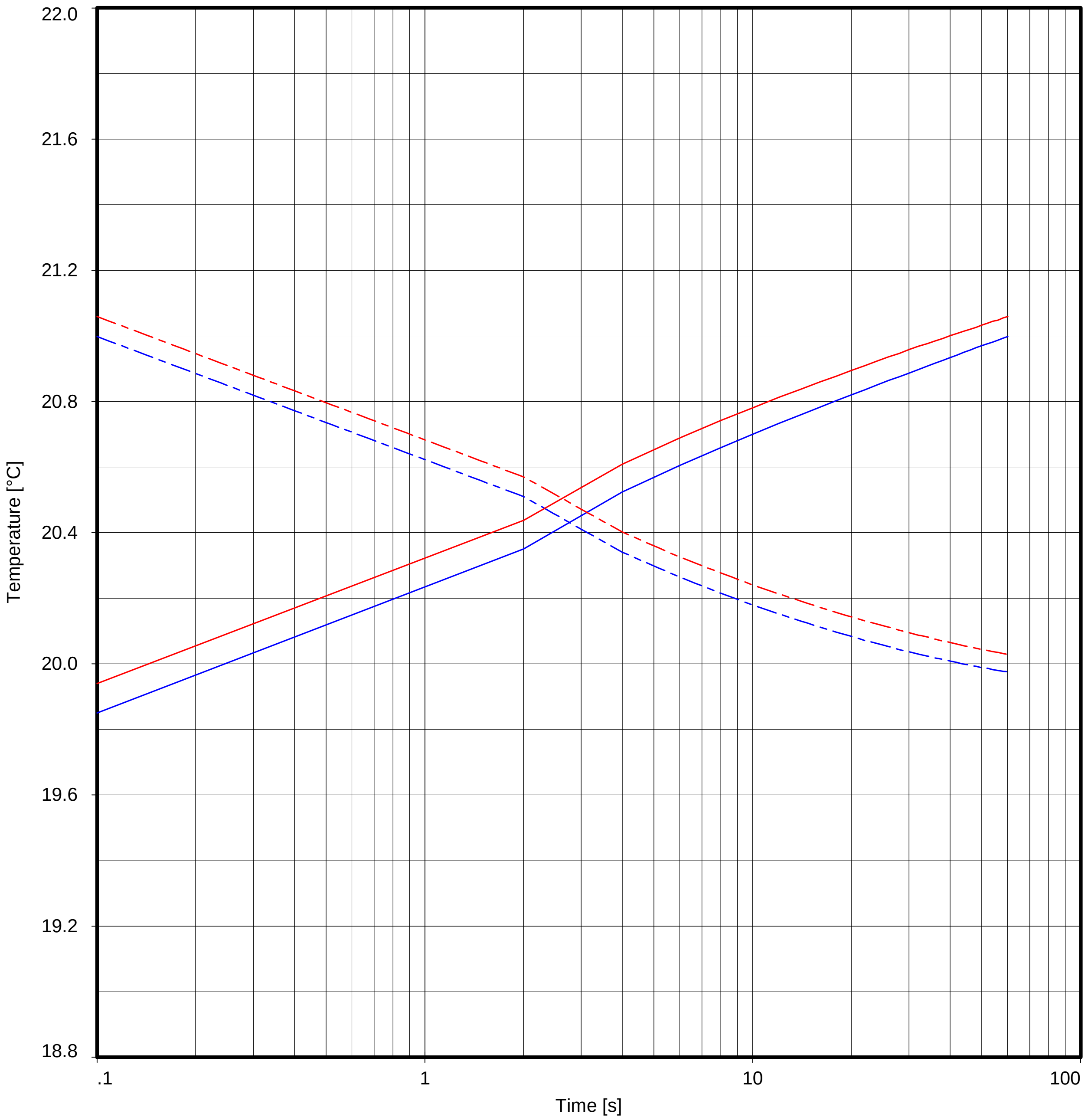
Thermal conductivity : 2.172 W/(m.K) - · — · - Cooling phase measurement 2

Test ID : TC01
Borehole : HKZ1-BH01-SA
Soil type : SAND
Dry density : 1.61 Mg/m^3
Test Date : 11/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 17:53:37

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.81 W/m
Thermal conductivity : 1.904 W/(m.K)

—— Heating phase measurement 1
– · – · Cooling phase measurement 1

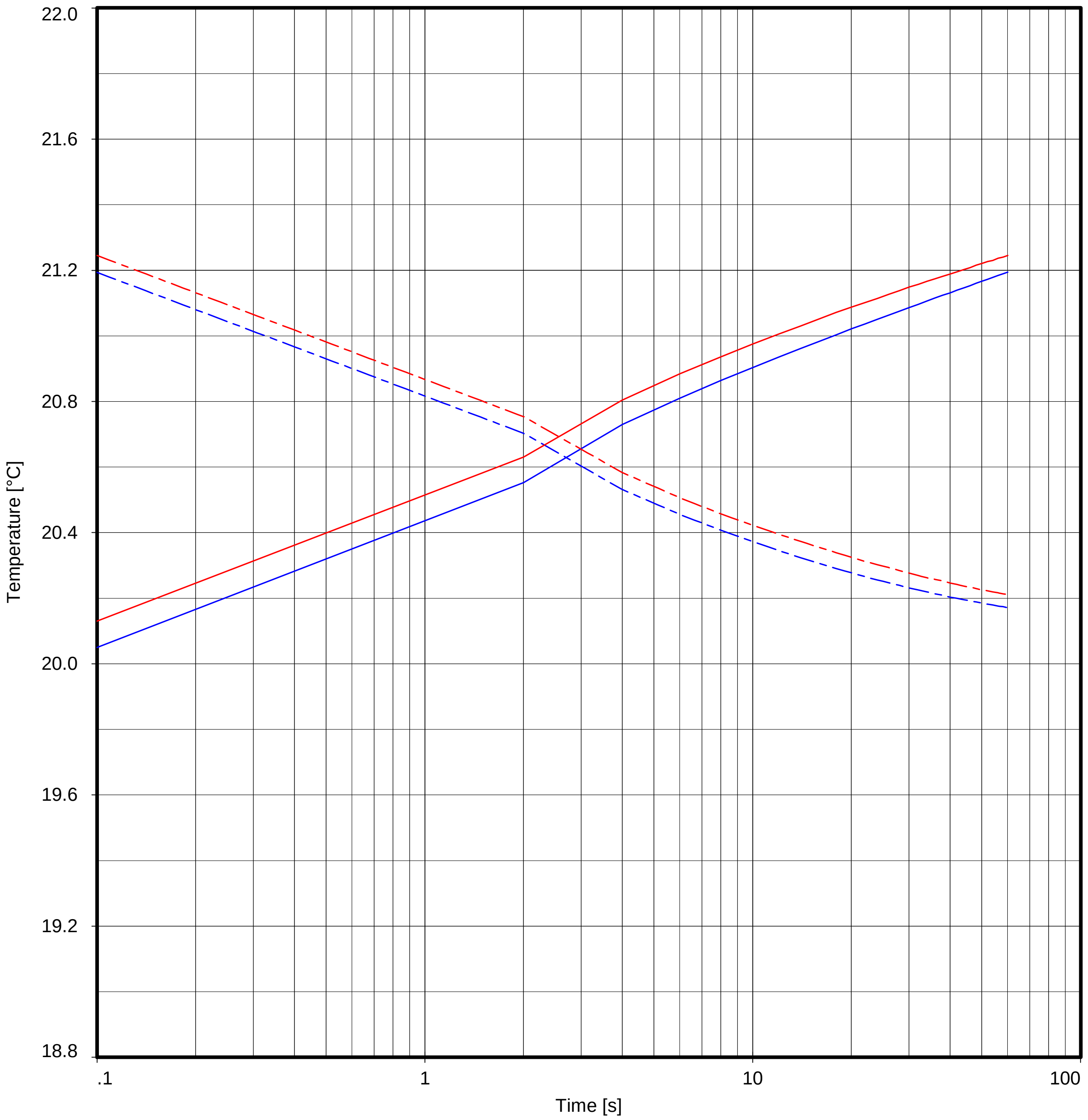
Measurement 2
Applied power : 3.8 W/m
Thermal conductivity : 1.957 W/(m.K)

—— Heating phase measurement 2
– · – · Cooling phase measurement 2

Test ID : TC02
Borehole : HKZ1-BH02-SA
Soil type : SAND
Dry density : 1.35 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.80 W/m	———	Heating phase measurement 1
Thermal conductivity	: 1.951 W/(m.K)	— - — -	Cooling phase measurement 1

Measurement 2

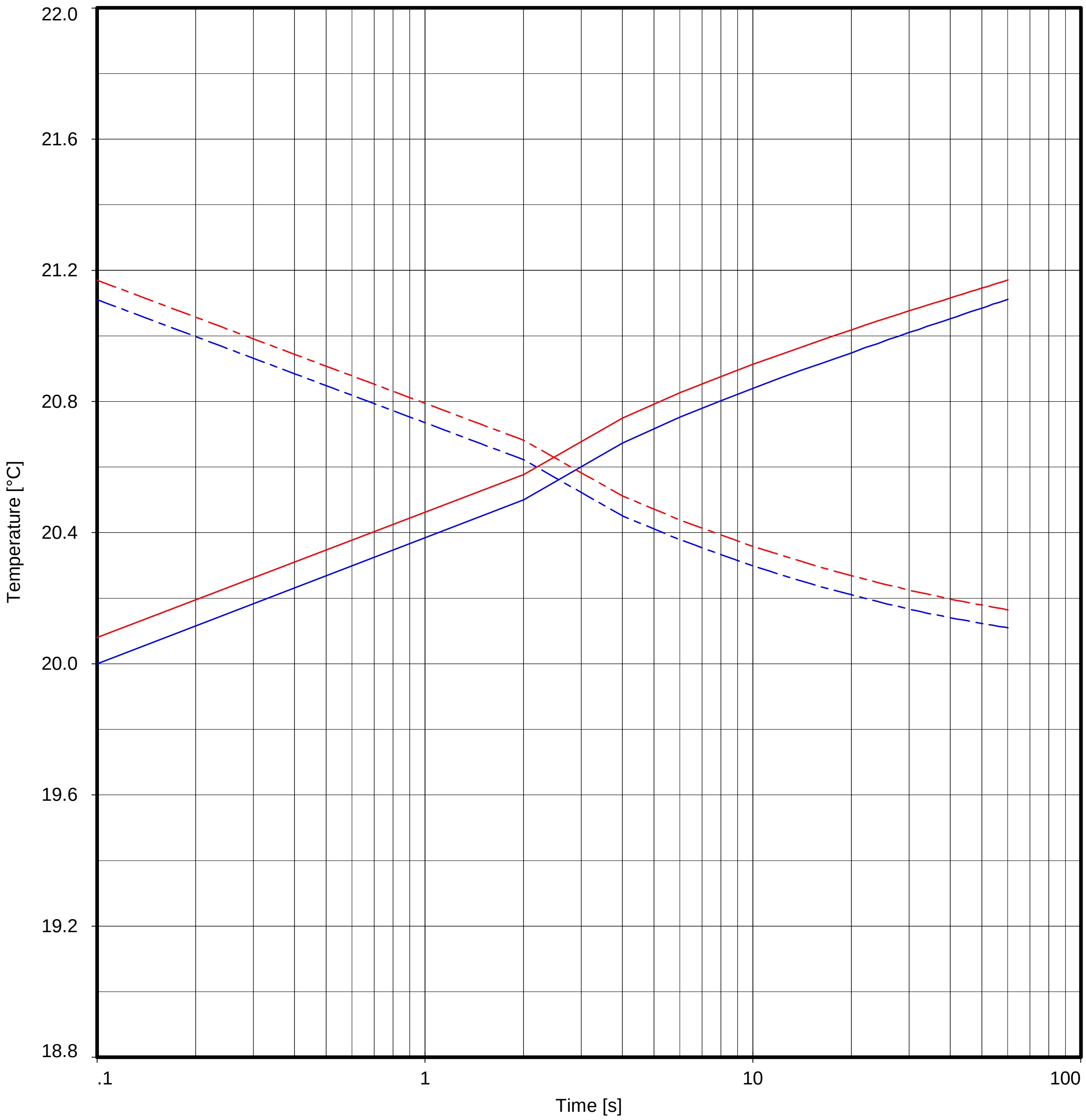
Applied power	: 3.79 W/m	———	Heating phase measurement 2
Thermal conductivity	: 1.991 W/(m.K)	— - — -	Cooling phase measurement 2

Test ID	: TC02
Borehole	: HKZ1-BH02-SA
Soil type	: SAND
Dry density	: 1.43 Mg/m^3
Test Date	: 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 18:02:15

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.79 W/m	———	Heating phase measurement 1
Thermal conductivity	: 2.073 W/(m.K)	— - — - —	Cooling phase measurement 1

Measurement 2

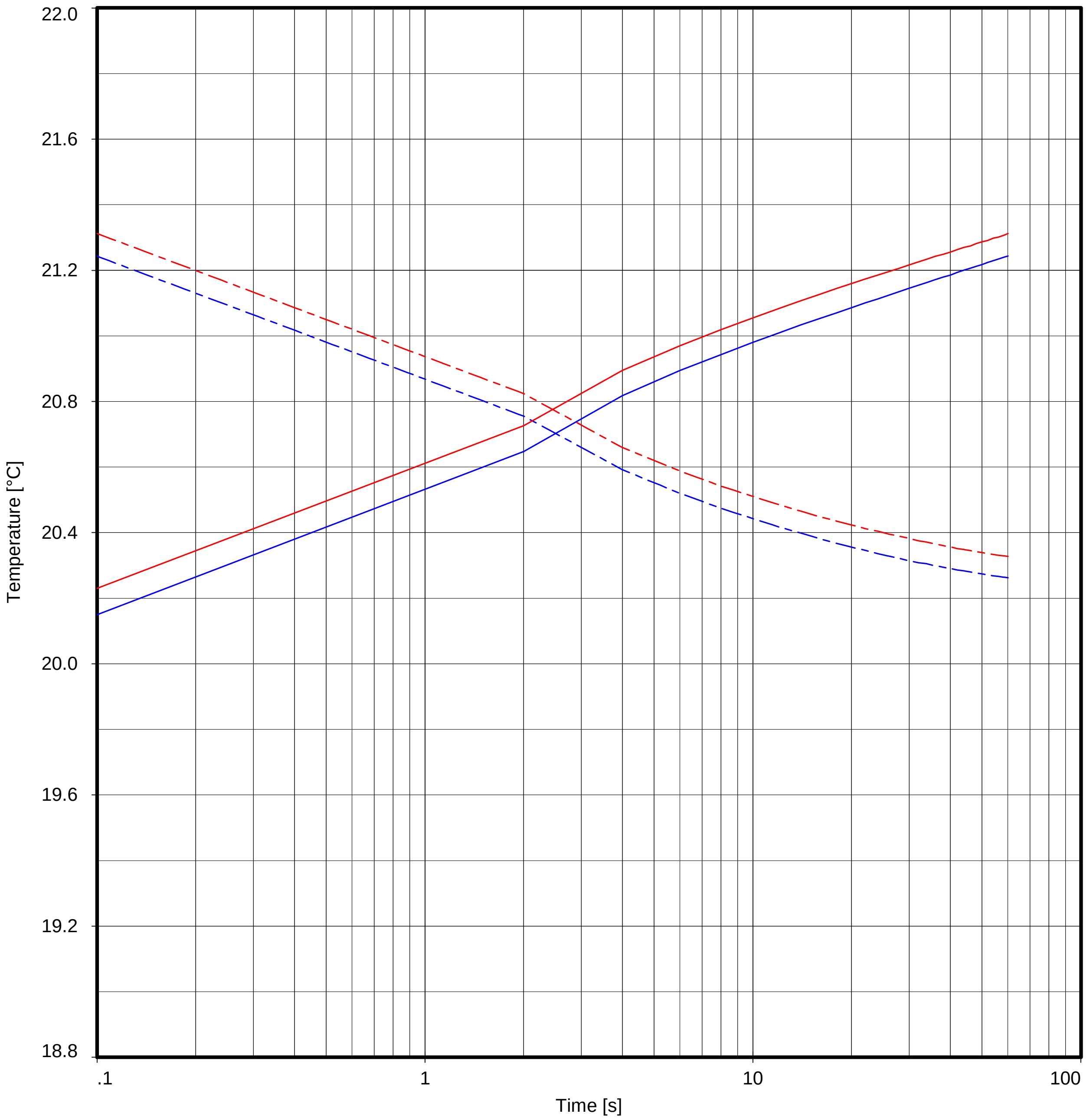
Applied power	: 3.77 W/m	———	Heating phase measurement 2
Thermal conductivity	: 2.123 W/(m.K)	— - — - —	Cooling phase measurement 2

Test ID	: TC02
Borehole	: HKZ1-BH02-SA
Soil type	: SAND
Dry density	: 1.51 Mg/m^3
Test Date	: 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 18:04:06

THERMAL CONDUCTIVITY TEST RESULTS



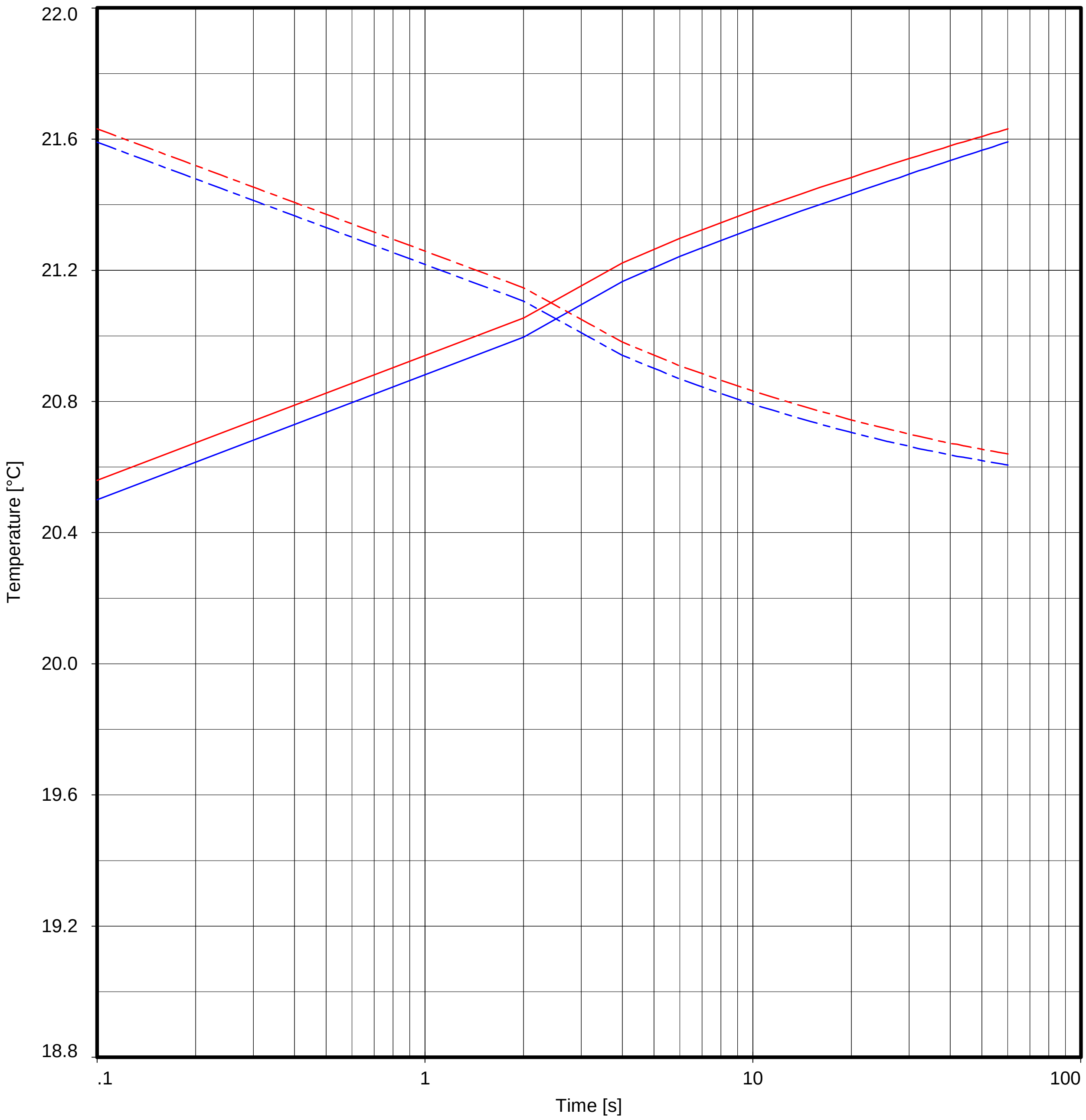
Measurement 1				
Applied power	: 3.77 W/m	───	Heating phase measurement 1	
Thermal conductivity	: 2.148 W/(m.K)	— - — - —	Cooling phase measurement 1	
Measurement 2				
Applied power	: 3.76 W/m	───	Heating phase measurement 2	
Thermal conductivity	: 2.172 W/(m.K)	— - — - —	Cooling phase measurement 2	

Test ID : TC02
Borehole : HKZ1-BH02-SA
Soil type : SAND
Dry density : 1.60 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 18:06:19

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1			
Applied power	: 3.76 W/m	─────	Heating phase measurement 1
Thermal conductivity	: 2.088 W/(m.K)	─ · ─ · ─	Cooling phase measurement 1
Measurement 2			
Applied power	: 3.75 W/m	─────	Heating phase measurement 2
Thermal conductivity	: 2.13 W/(m.K)	─ · ─ · ─	Cooling phase measurement 2

Test ID : TC02
Borehole : HKZ1-BH02-SA
Soil type : SAND
Dry density : 1.68 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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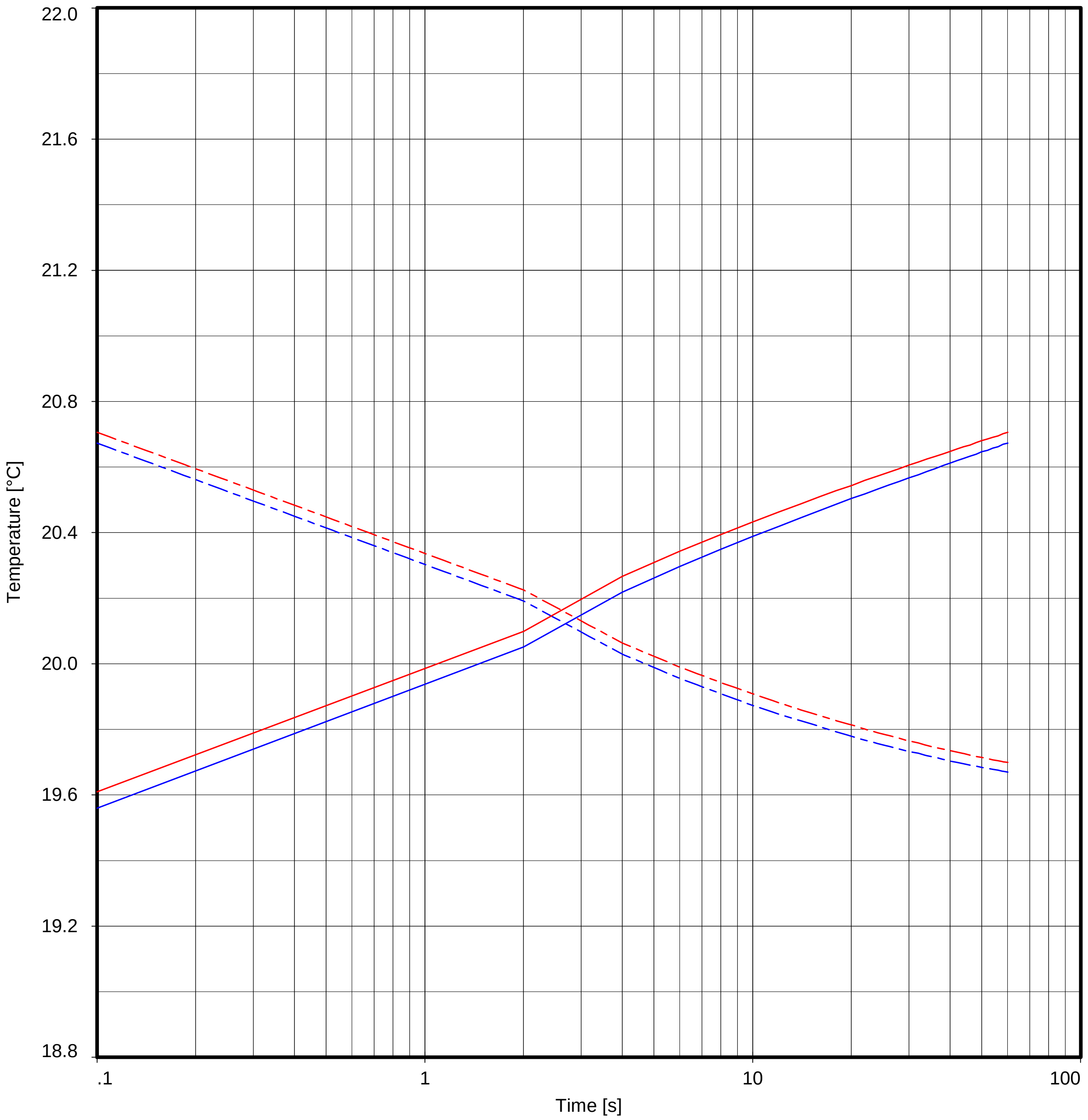
THERMAL CONDUCTIVITY TEST RESULTS



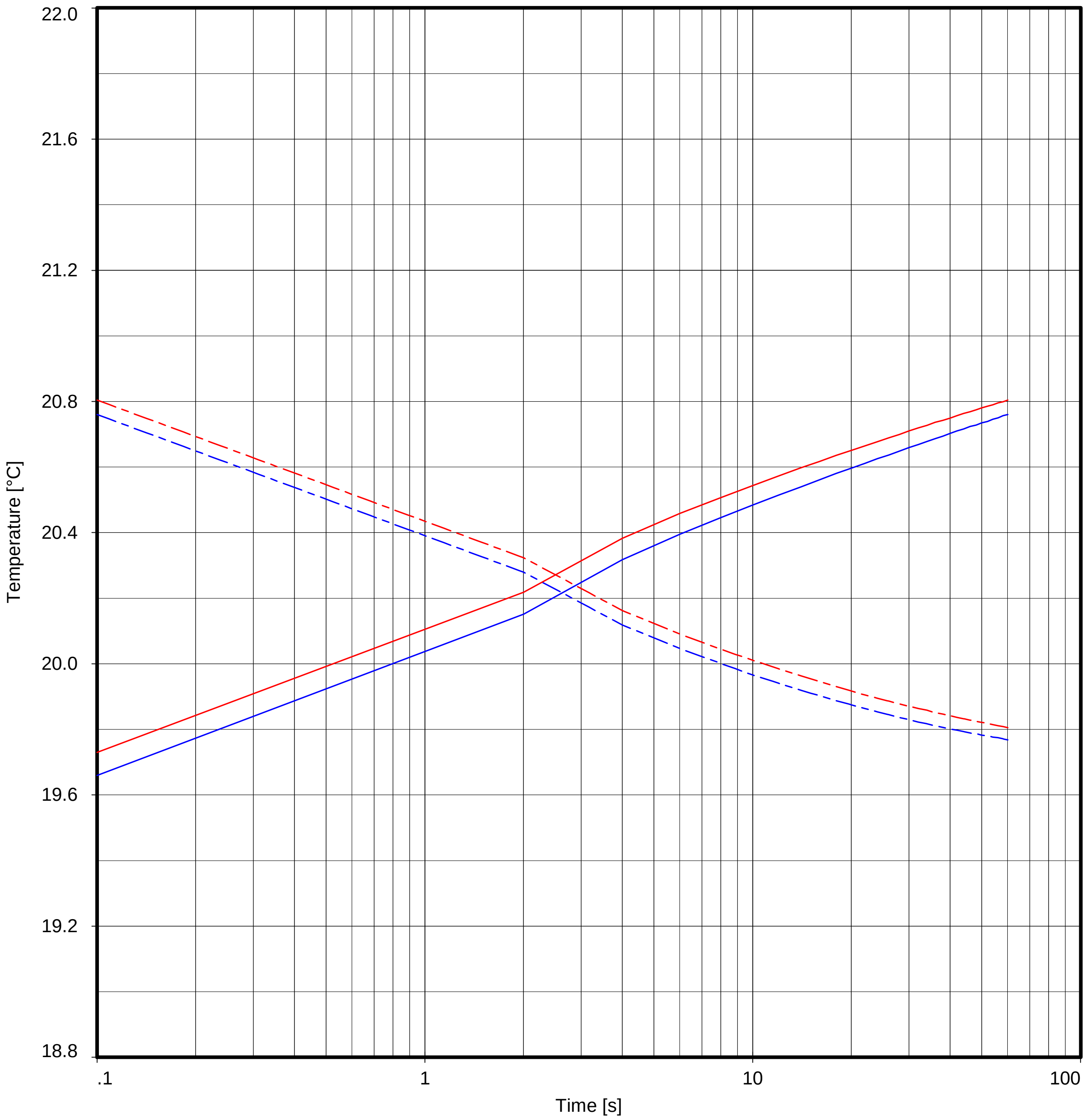
Measurement 1
Applied power : 3.79 W/m — Heating phase measurement 1
Thermal conductivity : 1.936 W/(m.K) – · – Cooling phase measurement 1

Measurement 2
Applied power : 3.77 W/m — Heating phase measurement 2
Thermal conductivity : 1.965 W/(m.K) – · – Cooling phase measurement 2

Test ID : TC03
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.34 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.77 W/m — Heating phase measurement 1

Thermal conductivity : 2.003 W/(m.K) – - – Cooling phase measurement 1

Measurement 2

Applied power : 3.75 W/m — Heating phase measurement 2

Thermal conductivity : 2.037 W/(m.K) – - – Cooling phase measurement 2

Test ID : TC03
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.39 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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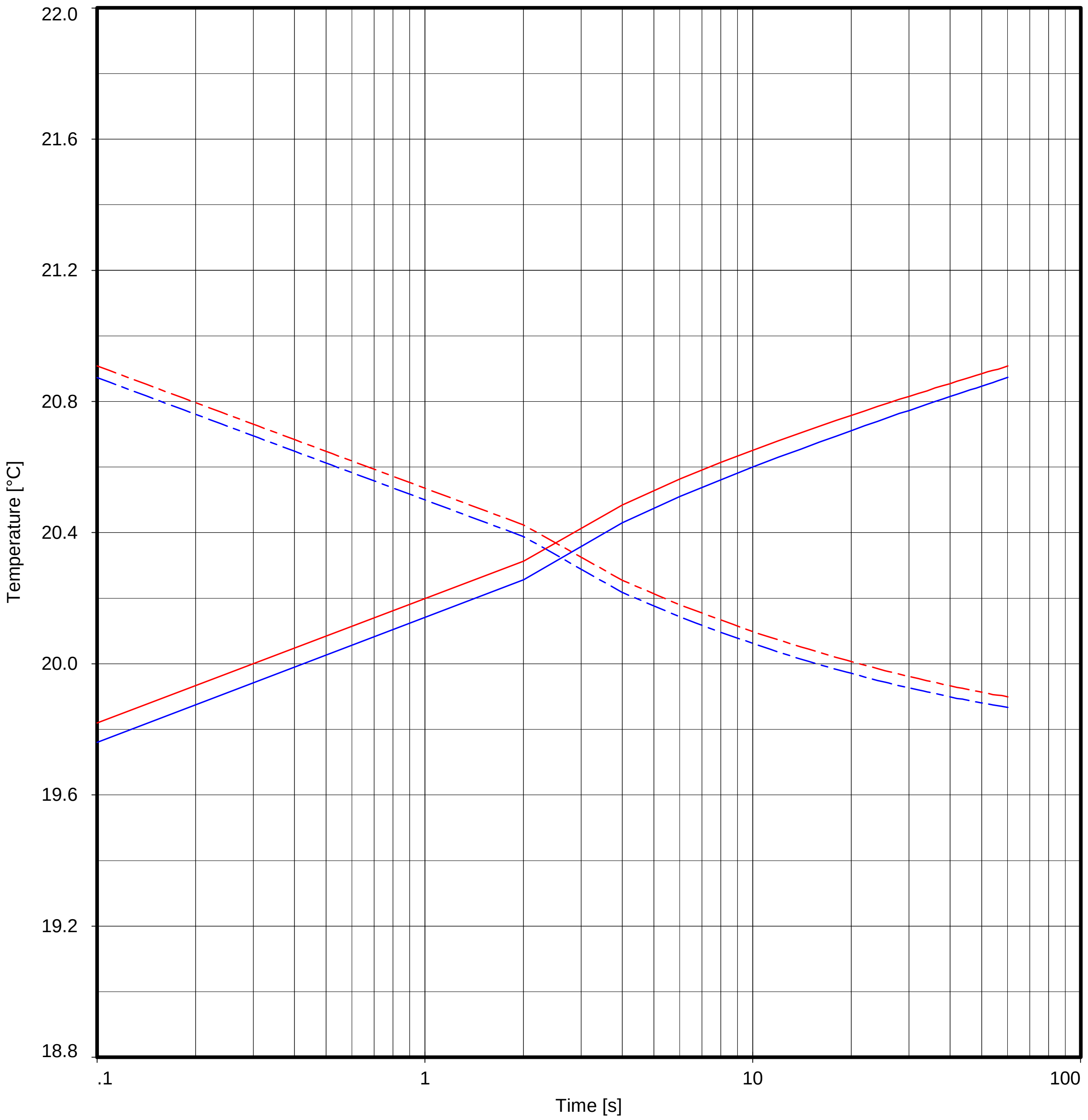
THERMAL CONDUCTIVITY TEST RESULTS



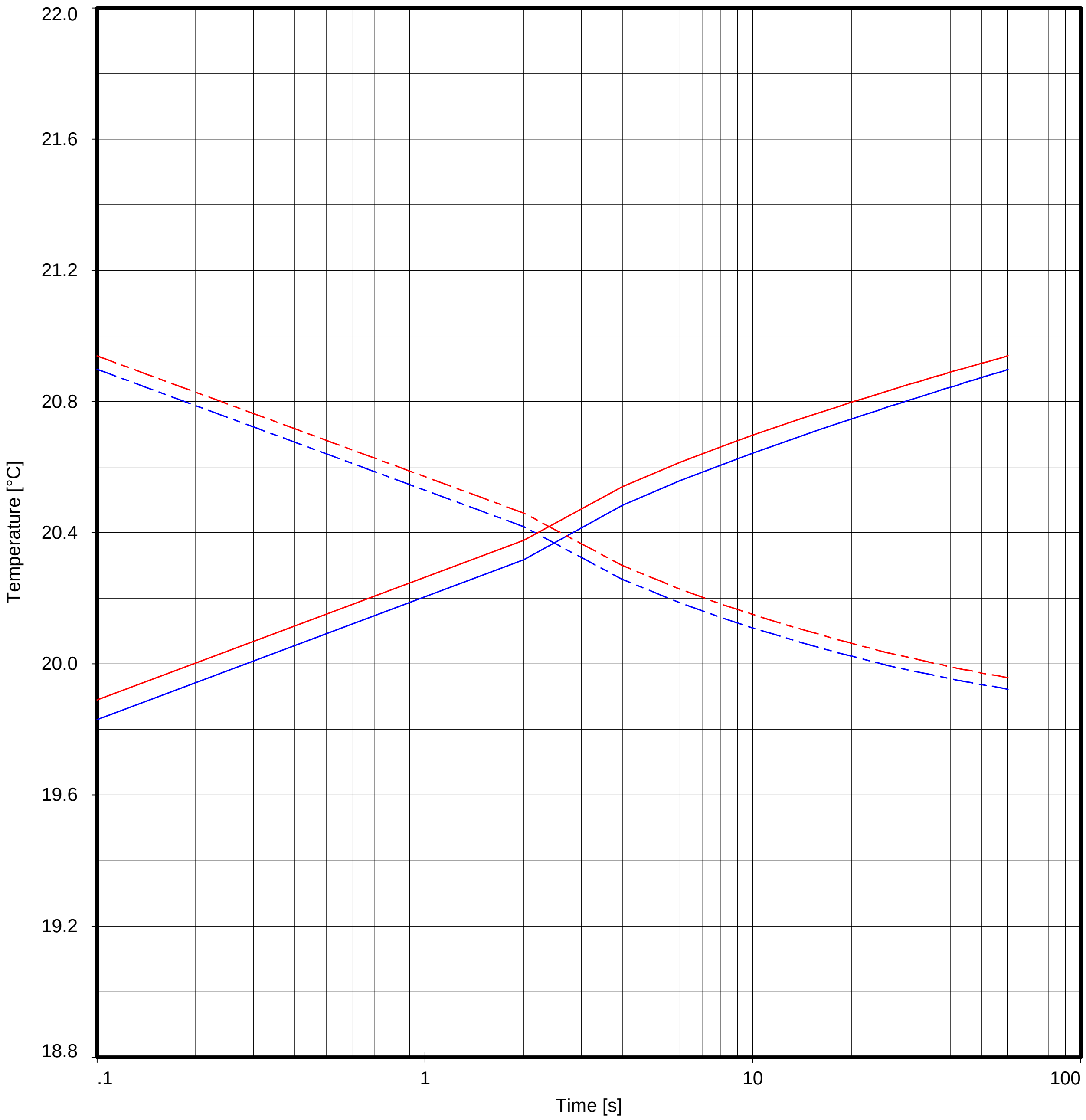
Measurement 1
Applied power : 3.75 W/m ——— Heating phase measurement 1
Thermal conductivity : 2.034 W/(m.K) — · — · — Cooling phase measurement 1

Measurement 2
Applied power : 3.74 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.085 W/(m.K) — · — · — Cooling phase measurement 2

Test ID : TC03
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.48 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.74 W/m	——	Heating phase measurement 1
Thermal conductivity	: 2.139 W/(m.K)	– - – -	Cooling phase measurement 1

Measurement 2

Applied power	: 3.73 W/m	——	Heating phase measurement 2
Thermal conductivity	: 2.186 W/(m.K)	– - – -	Cooling phase measurement 2

Test ID : TC03
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.60 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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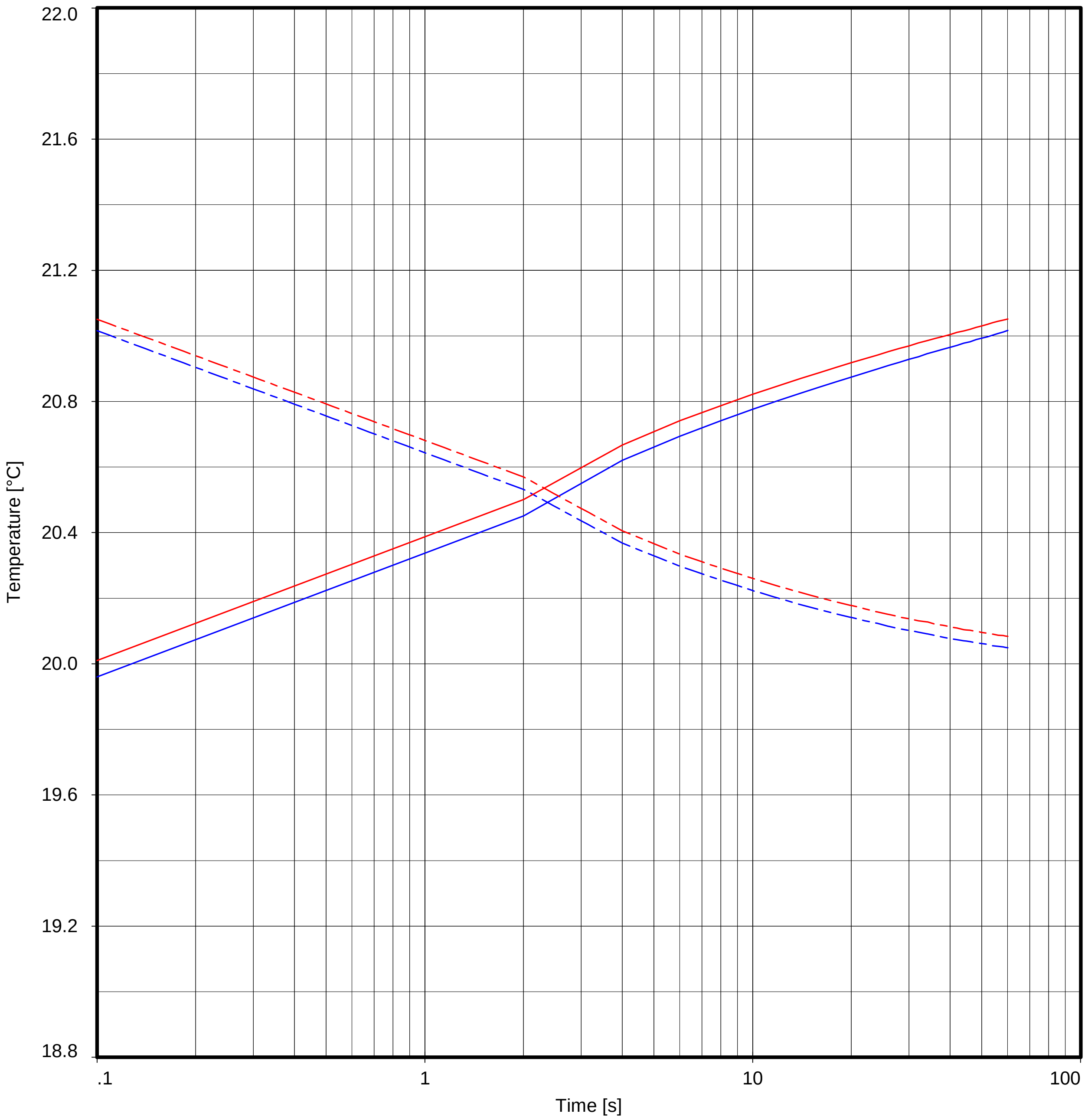
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.73 W/m — Heating phase measurement 1
Thermal conductivity : 2.308 W/(m.K) — - — - Cooling phase measurement 1

Measurement 2
Applied power : 3.73 W/m — Heating phase measurement 2
Thermal conductivity : 2.355 W/(m.K) — - — - Cooling phase measurement 2

Test ID : TC03
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.69 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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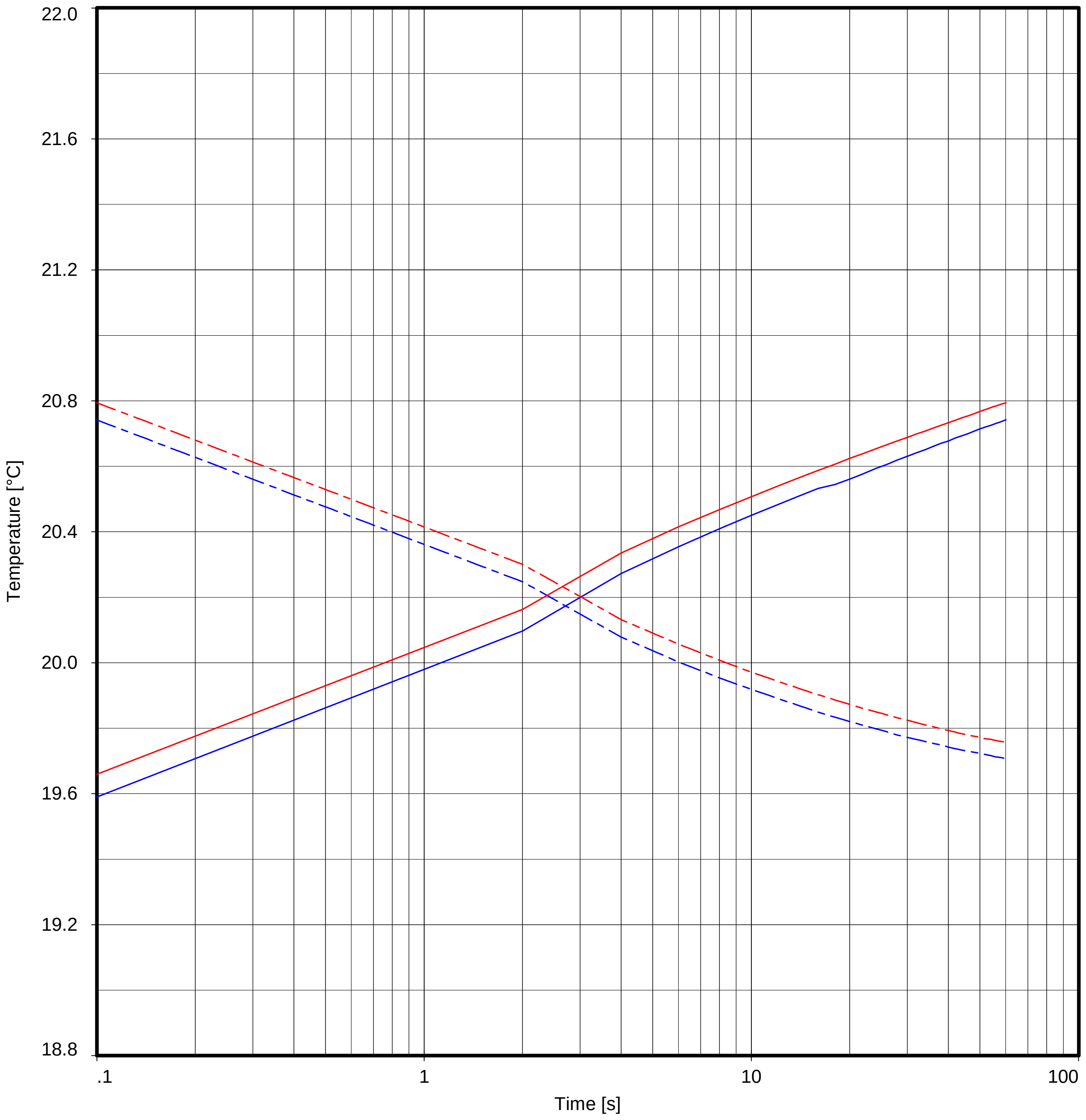
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.86 W/m — Heating phase measurement 1
Thermal conductivity : 1.883 W/(m.K) – · – · Cooling phase measurement 1

Measurement 2
Applied power : 3.85 W/m — Heating phase measurement 2
Thermal conductivity : 1.928 W/(m.K) – · – · Cooling phase measurement 2

Test ID : TC04
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.38 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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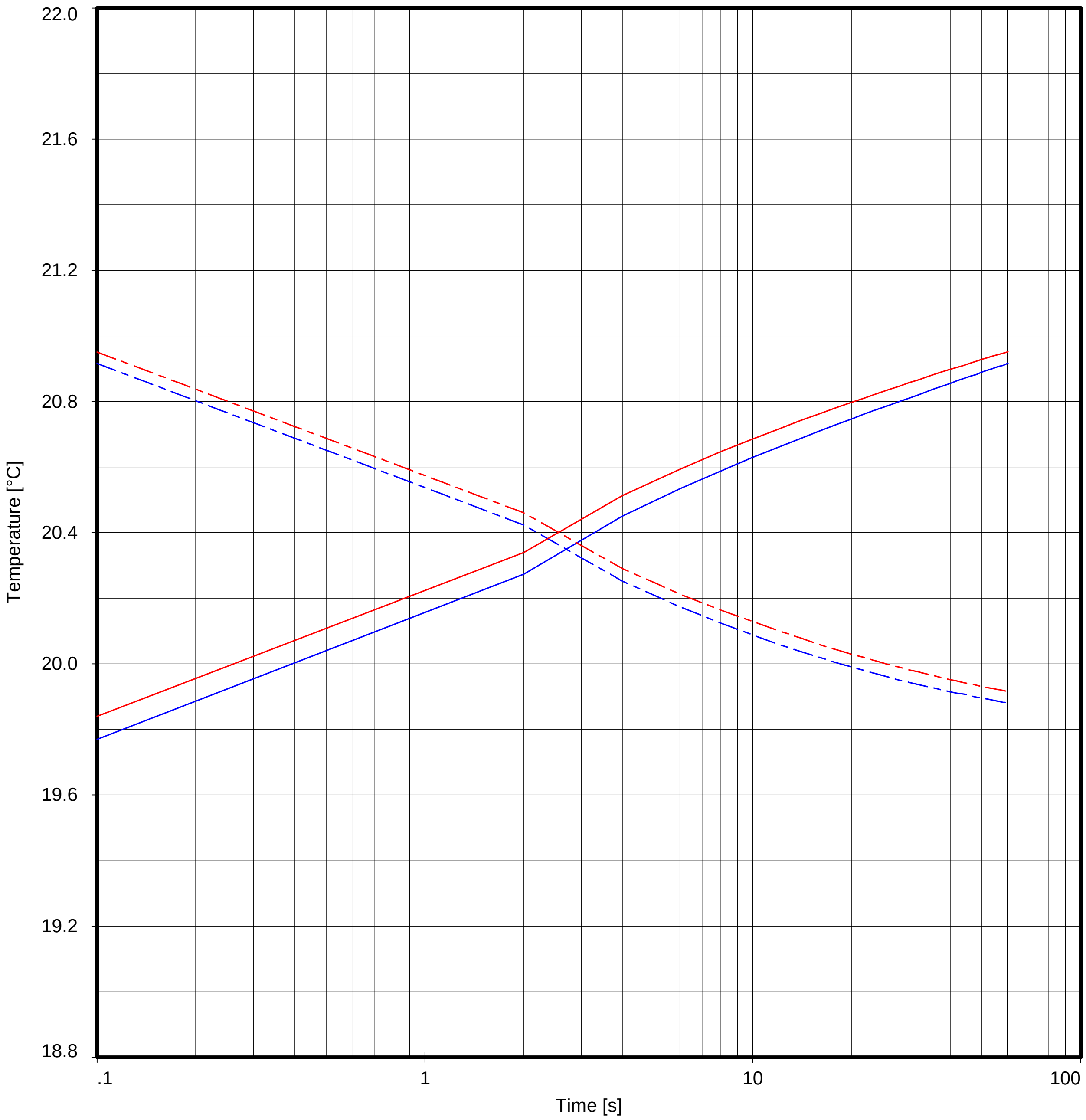
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.84 W/m

Thermal conductivity : 1.98 W/(m.K)

— Heating phase measurement 1

– · – Cooling phase measurement 1

Measurement 2

Applied power : 3.83 W/m

Thermal conductivity : 2.046 W/(m.K)

— Heating phase measurement 2

– · – Cooling phase measurement 2

Test ID : TC04
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.44 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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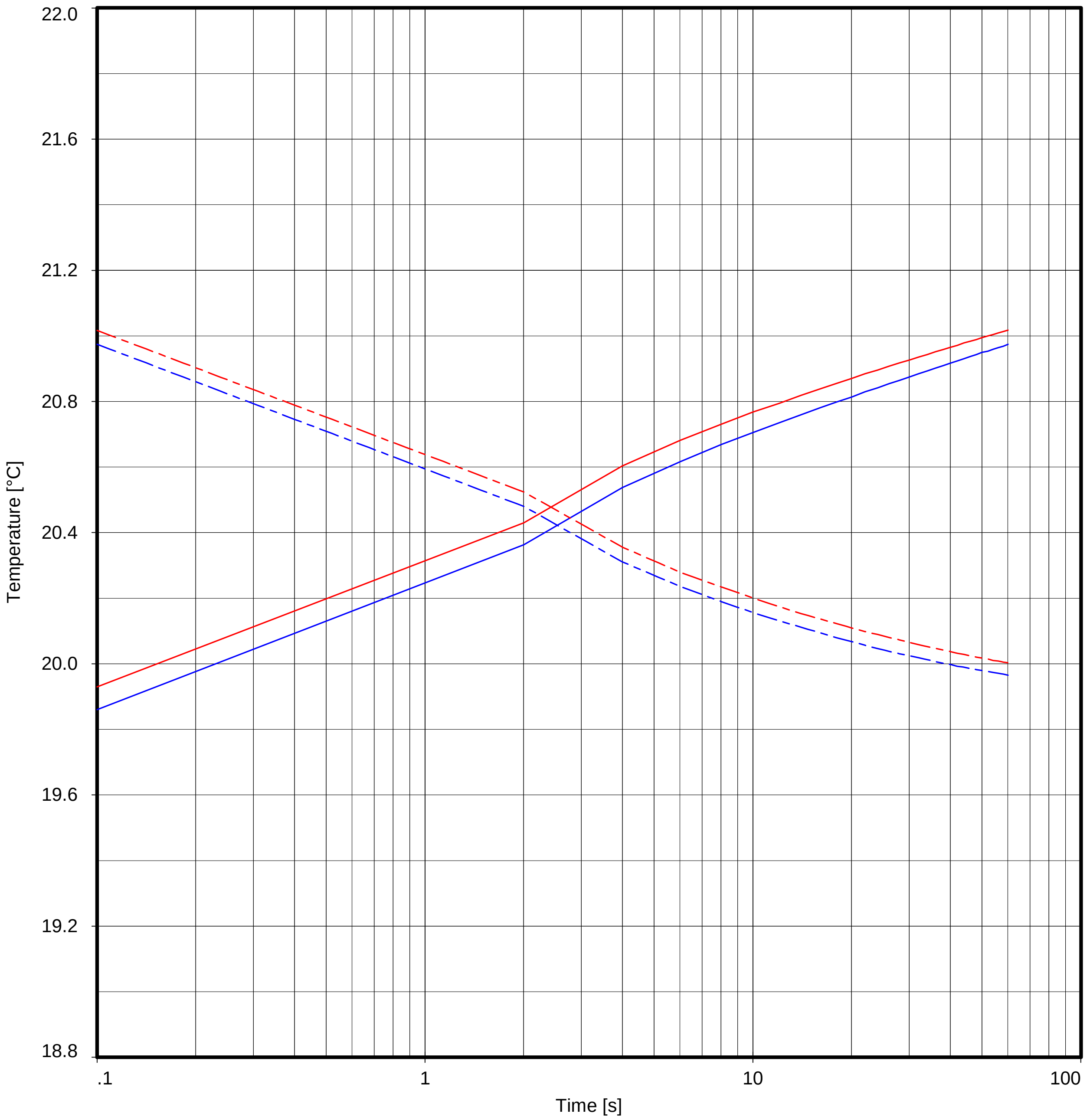
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.83 W/m	———	Heating phase measurement 1
Thermal conductivity	: 2.103 W/(m.K)	— · — · —	Cooling phase measurement 1

Measurement 2

Applied power	: 3.82 W/m	———	Heating phase measurement 2
Thermal conductivity	: 2.158 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID	: TC04
Borehole	: HKZ1-BH03-SA
Soil type	: SAND
Dry density	: 1.52 Mg/m^3
Test Date	: 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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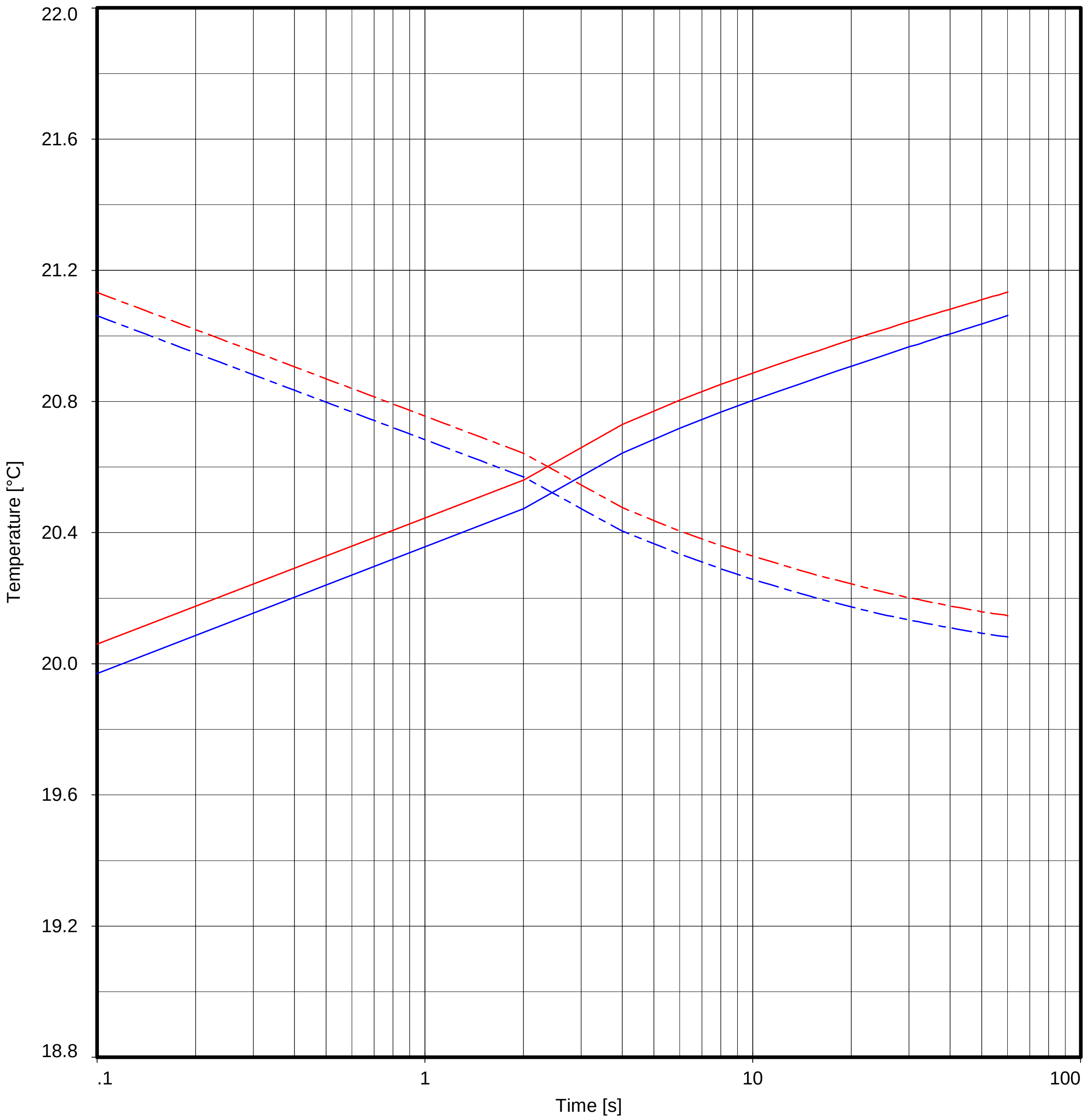
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.81 W/m ——— Heating phase measurement 1
Thermal conductivity : 2.22 W/(m.K) — - — - Cooling phase measurement 1

Measurement 2
Applied power : 3.80 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.265 W/(m.K) — - — - Cooling phase measurement 2

Test ID : TC04
Borehole : HKZ1-BH03-SA
Soil type : SAND
Dry density : 1.61 Mg/m^3
Test Date : 12/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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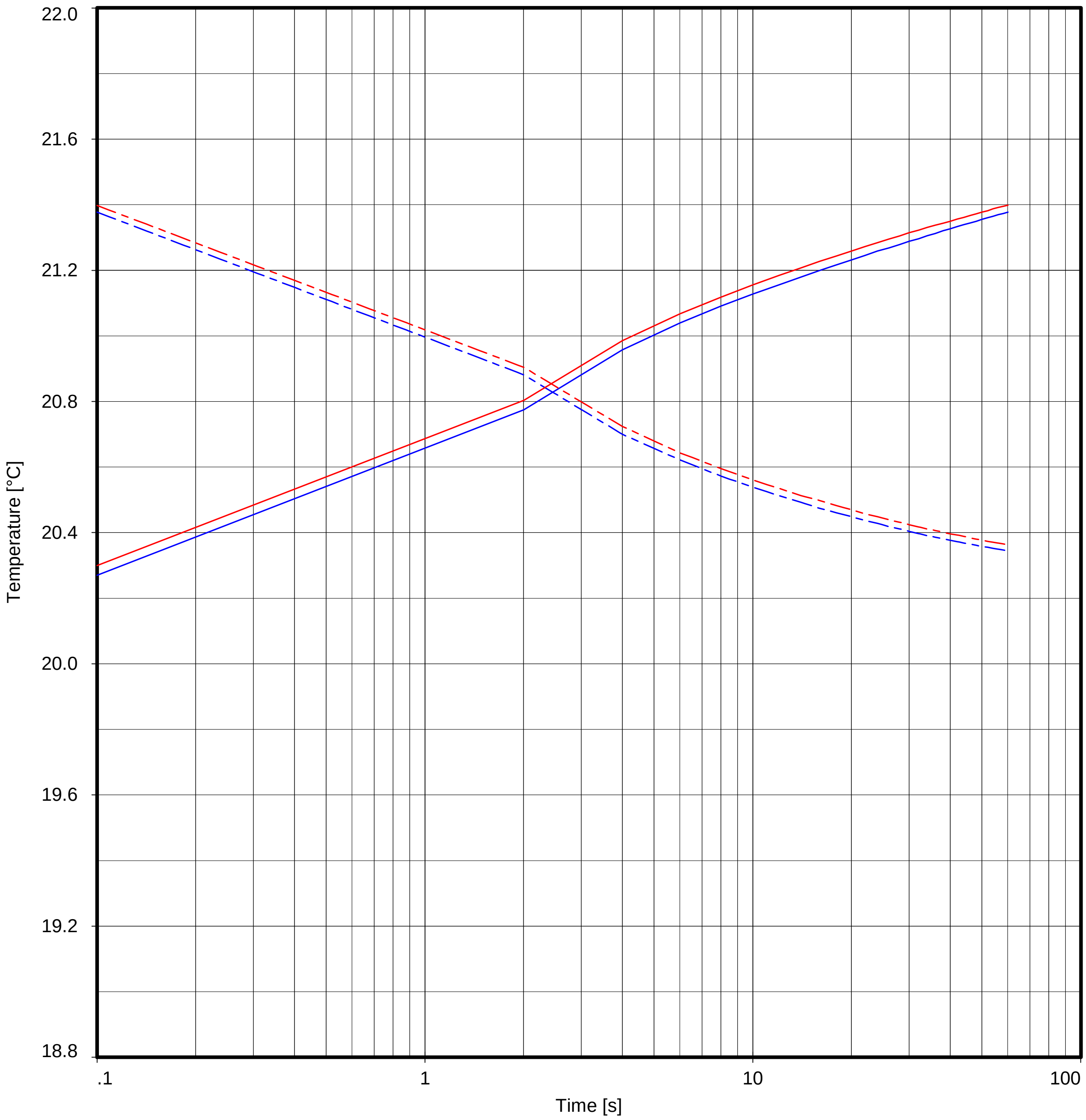
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.80 W/m — Heating phase measurement 1

Thermal conductivity : 2.197 W/(m.K) – - – - Cooling phase measurement 1

Measurement 2

Applied power : 3.79 W/m — Heating phase measurement 2

Thermal conductivity : 2.22 W/(m.K) – - – - Cooling phase measurement 2

Test ID	: TC04
Borehole	: HKZ1-BH03-SA
Soil type	: SAND
Dry density	: 1.73 Mg/m^3
Test Date	: 12/10/2016

Note(s):

- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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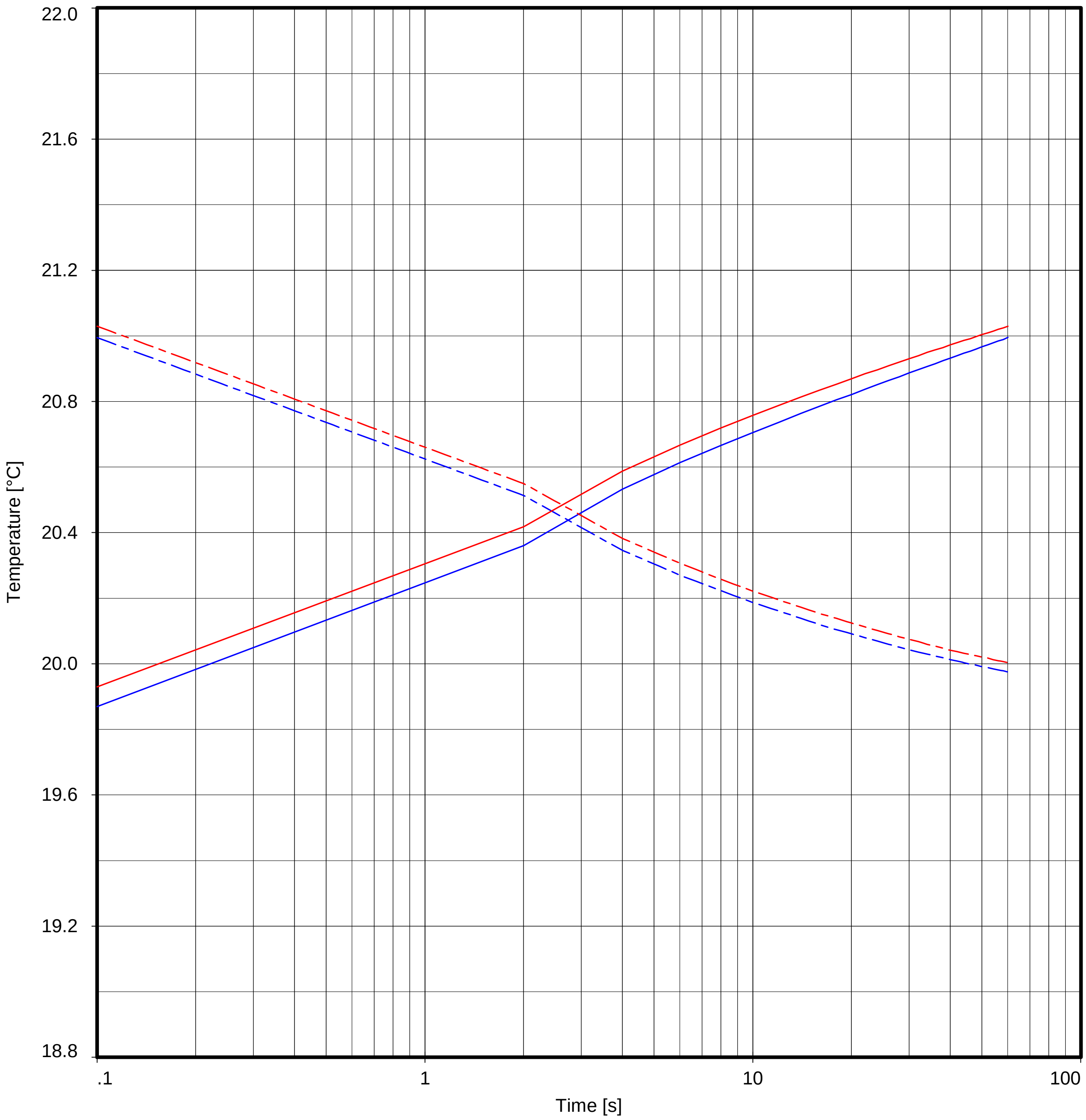
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1			
Applied power	: 3.74 W/m	————	Heating phase measurement 1
Thermal conductivity	: 1.855 W/(m.K)	— · — · —	Cooling phase measurement 1
Measurement 2			
Applied power	: 3.73 W/m	————	Heating phase measurement 2
Thermal conductivity	: 1.902 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID : TC05
Borehole : HKZ1-BH04-SA
Soil type : SAND
Dry density : 1.35 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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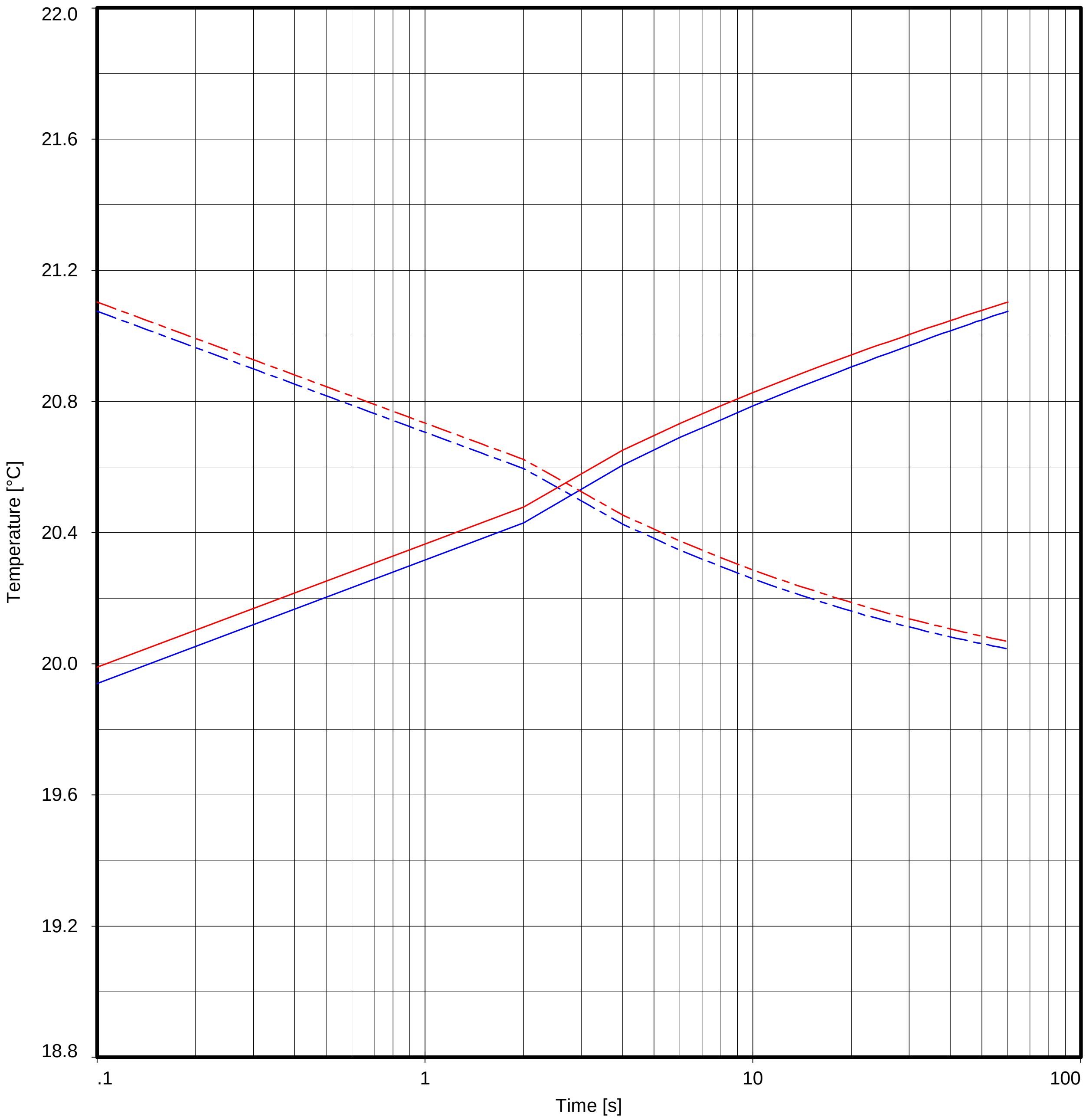
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.72 W/m ——— Heating phase measurement 1
Thermal conductivity : 1.872 W/(m.K) — · — · — Cooling phase measurement 1

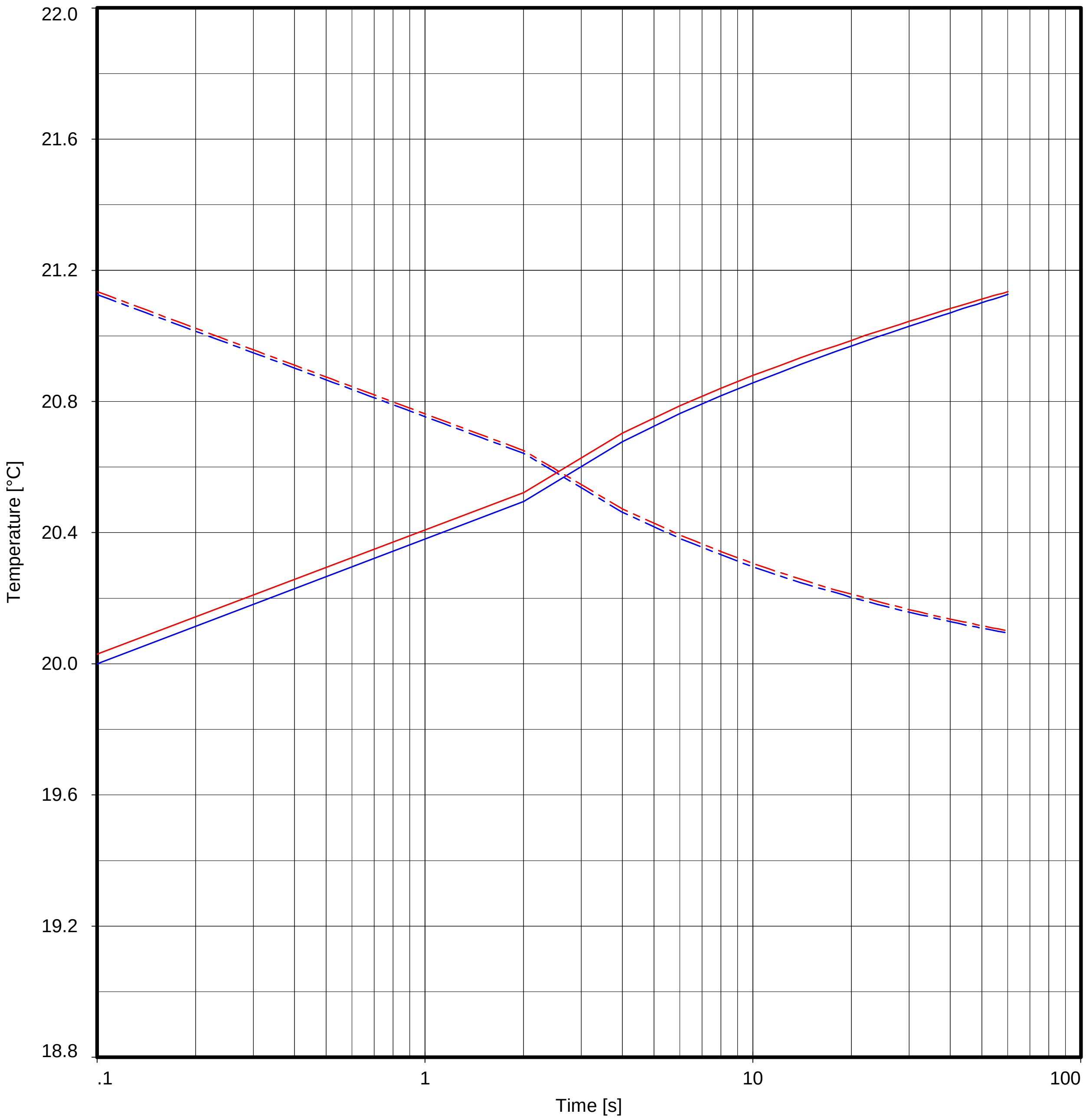
Measurement 2
Applied power : 3.71 W/m ——— Heating phase measurement 2
Thermal conductivity : 1.912 W/(m.K) — · — · — Cooling phase measurement 2

Test ID : TC05
Borehole : HKZ1-BH04-SA
Soil type : SAND
Dry density : 1.41 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 18:36:49



Measurement 1
Applied power : 3.71 W/m — Heating phase measurement 1
Thermal conductivity : 2.008 W/(m.K) — — · — — Cooling phase measurement 1

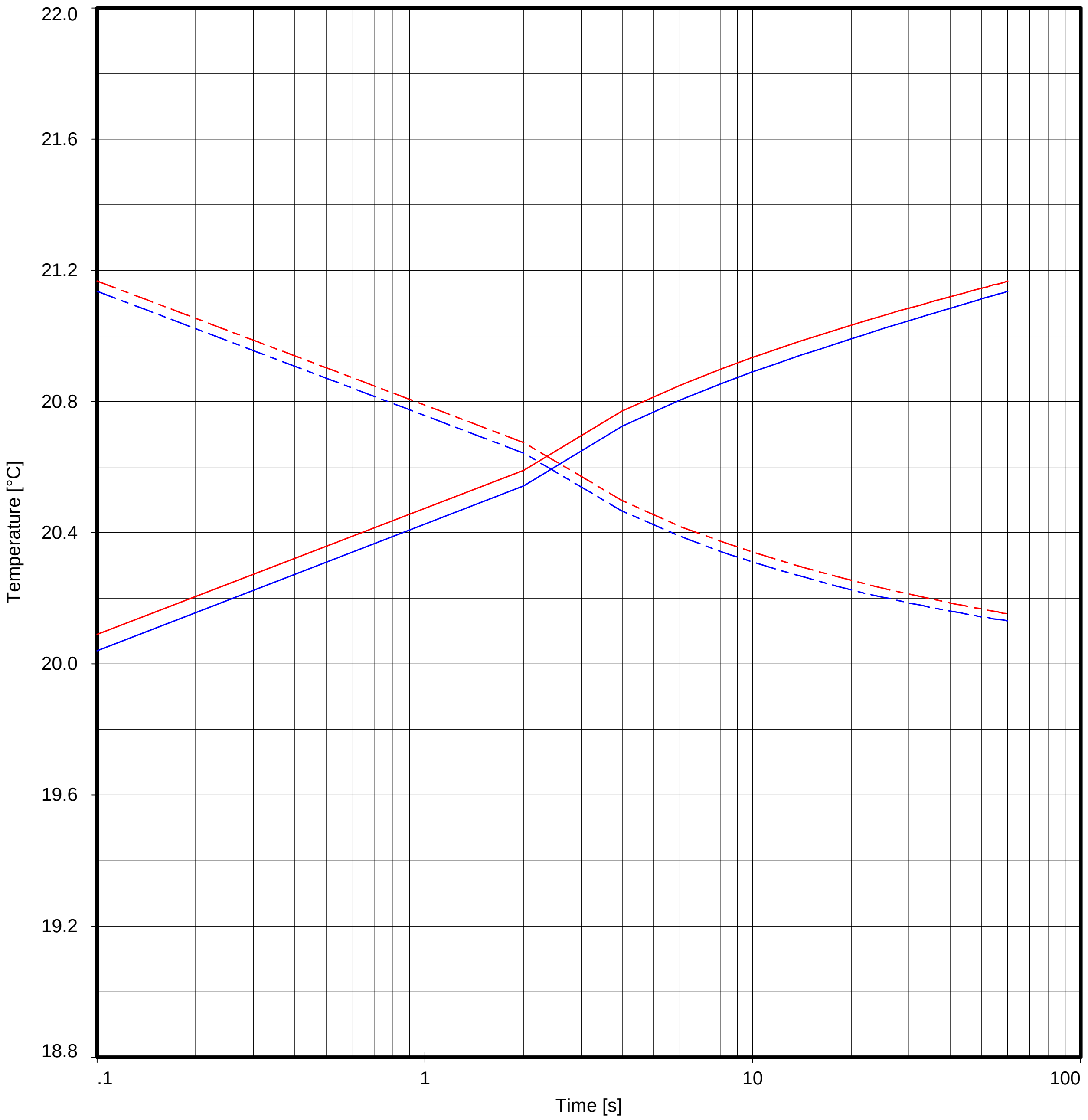
Measurement 2
Applied power : 3.7 W/m — Heating phase measurement 2
Thermal conductivity : 2.052 W/(m.K) — — · — — Cooling phase measurement 2

Test ID : TC05
Borehole : HKZ1-BH04-SA
Soil type : SAND
Dry density : 1.50 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 18:47:01

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.7 W/m
Thermal conductivity : 2.221 W/(m.K)

Heating phase measurement 1
Cooling phase measurement 1

Measurement 2
Applied power : 3.69 W/m
Thermal conductivity : 2.254 W/(m.K)

Heating phase measurement 2
Cooling phase measurement 2

Test ID : TC05
Borehole : HKZ1-BH04-SA
Soil type : SAND
Dry density : 1.60 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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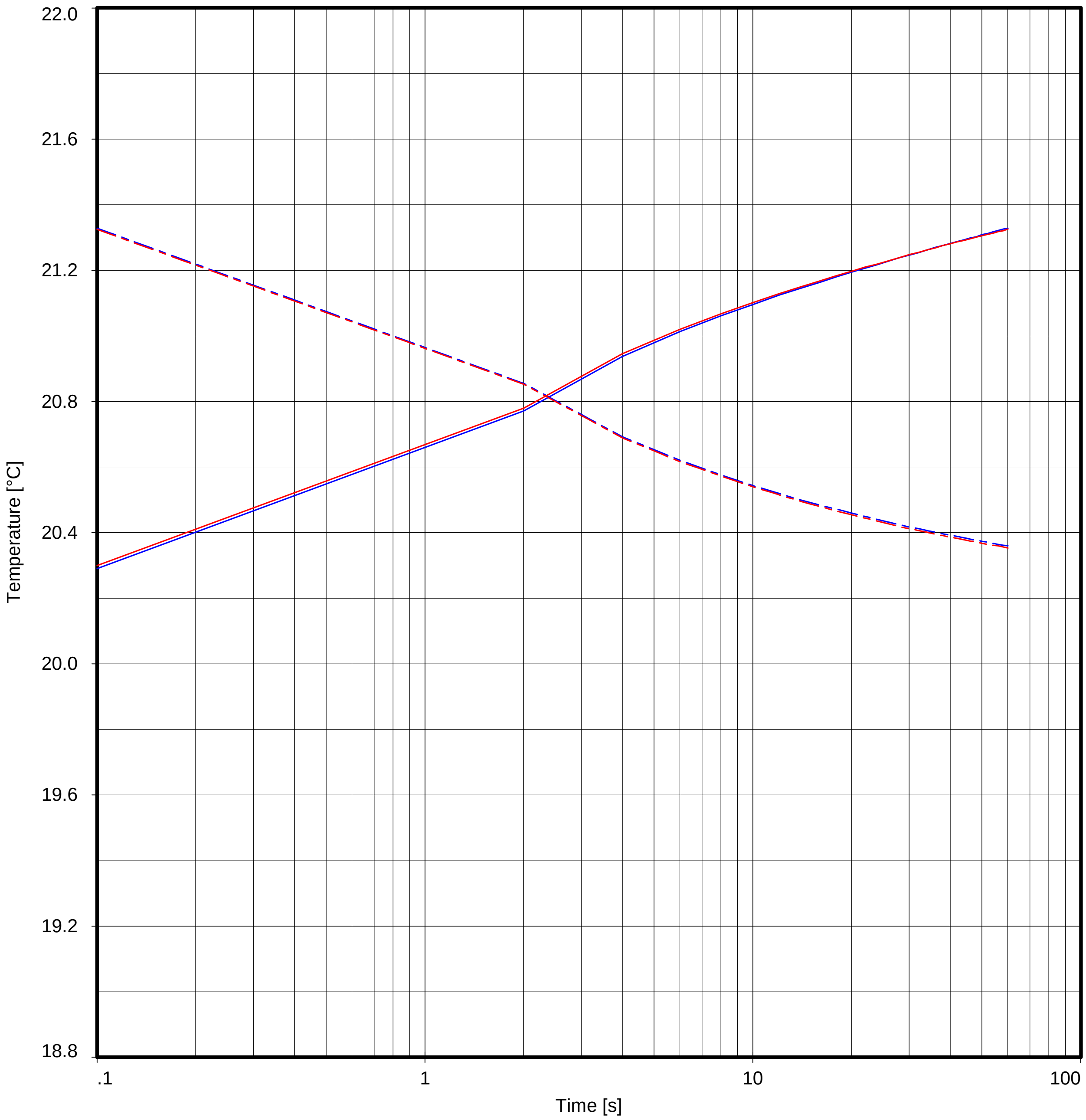
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.7 W/m
Thermal conductivity : 2.265 W/(m.K)

——— Heating phase measurement 1
— - — - Cooling phase measurement 1

Measurement 2
Applied power : 3.69 W/m
Thermal conductivity : 2.32 W/(m.K)

——— Heating phase measurement 2
— - — - Cooling phase measurement 2

Test ID : TC05
Borehole : HKZ1-BH04-SA
Soil type : SAND
Dry density : 1.68 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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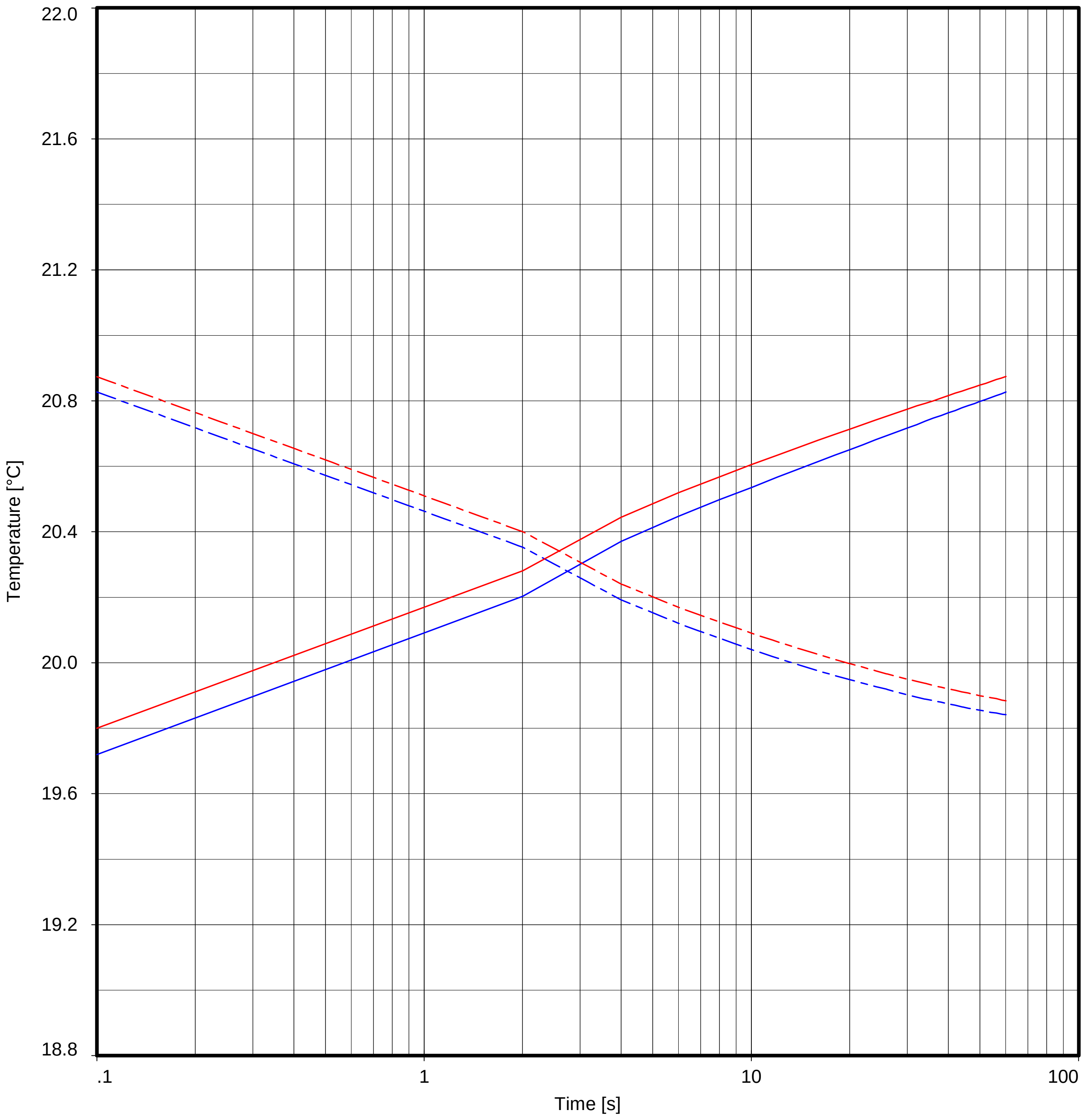
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.70 W/m ——— Heating phase measurement 1

Thermal conductivity : 1.872 W/(m.K) — · — · — Cooling phase measurement 1

Measurement 2

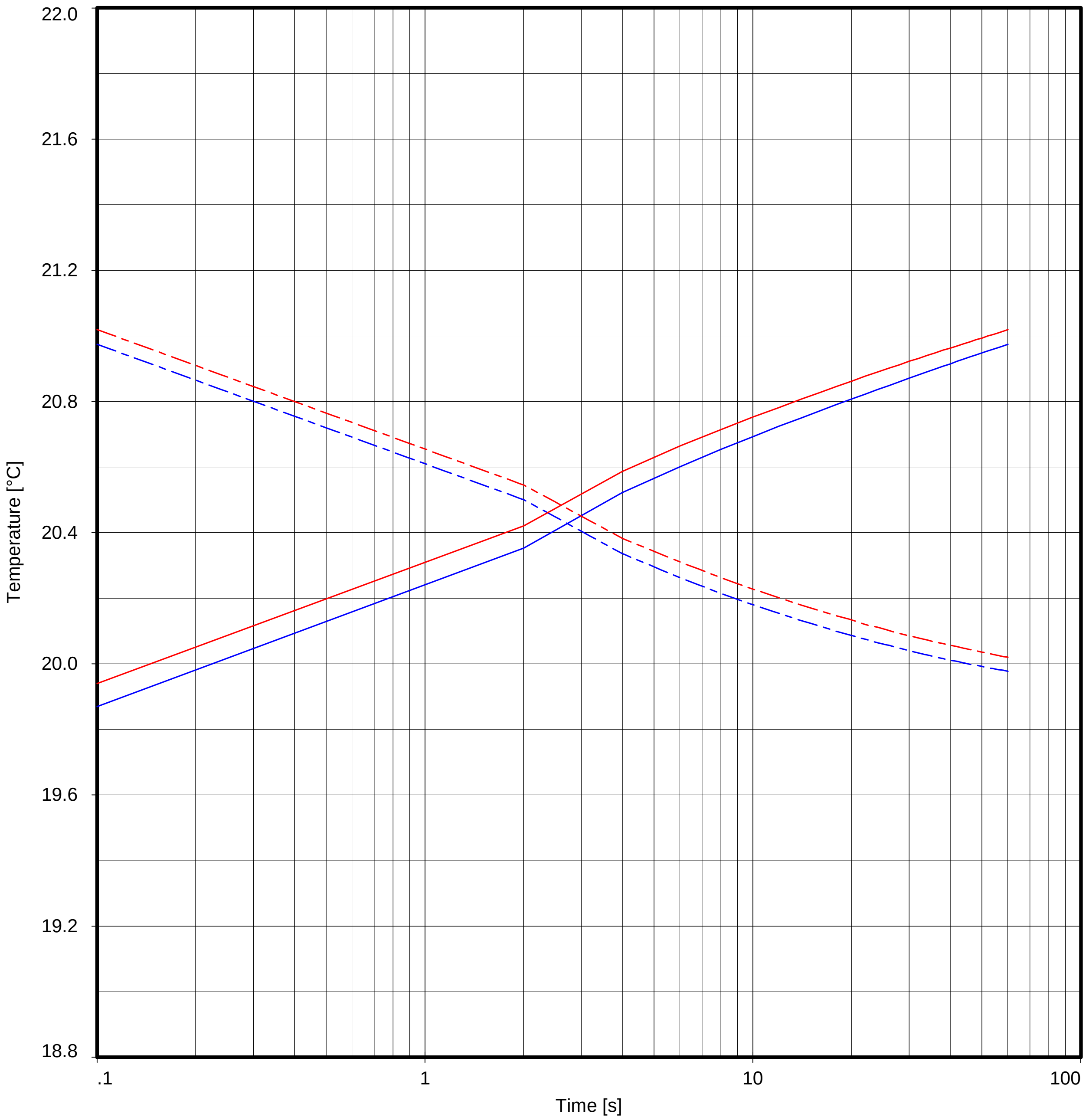
Applied power : 3.70 W/m ——— Heating phase measurement 2

Thermal conductivity : 1.936 W/(m.K) — · — · — Cooling phase measurement 2

Test ID : TC06
Borehole : HKZ1-BH05-SA
Soil type : SAND
Dry density : 1.33 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.69 W/m
Thermal conductivity : 1.912 W/(m.K)

――――	Heating phase measurement 1
— · — · —	Cooling phase measurement 1

Measurement 2
Applied power : 3.68 W/m
Thermal conductivity : 1.963 W/(m.K)

――――	Heating phase measurement 2
— · — · —	Cooling phase measurement 2

Test ID : TC06
Borehole : HKZ1-BH05-SA
Soil type : SAND
Dry density : 1.41 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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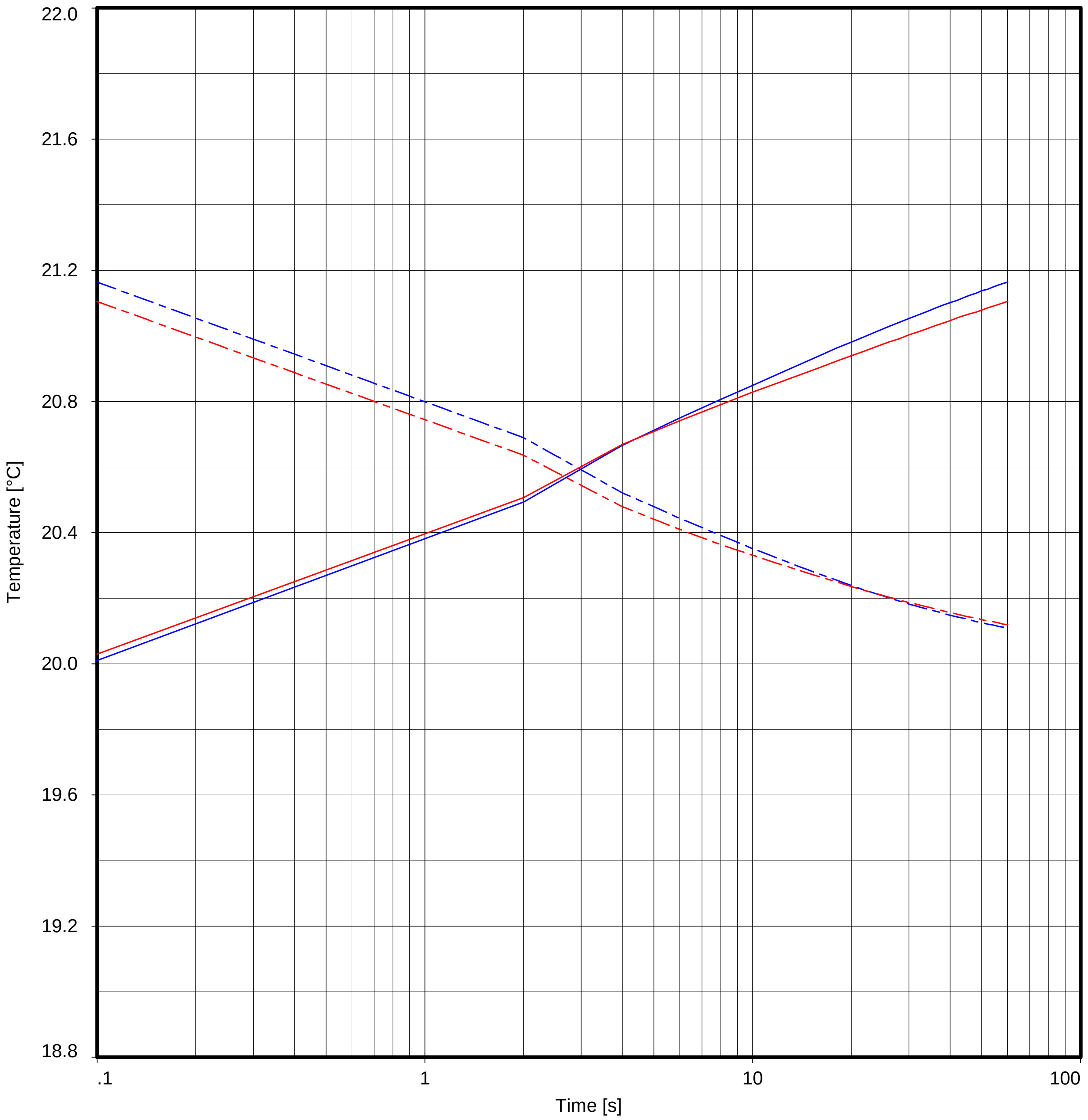
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1			
Applied power	: 3.68 W/m	———	Heating phase measurement 1
Thermal conductivity	: 1.695 W/(m.K)	— - — - —	Cooling phase measurement 1
Measurement 2			
Applied power	: 3.67 W/m	———	Heating phase measurement 2
Thermal conductivity	: 1.866 W/(m.K)	— - — - —	Cooling phase measurement 2

Test ID : TC06
Borehole : HKZ1-BH05-SA
Soil type : SAND
Dry density : 1.50 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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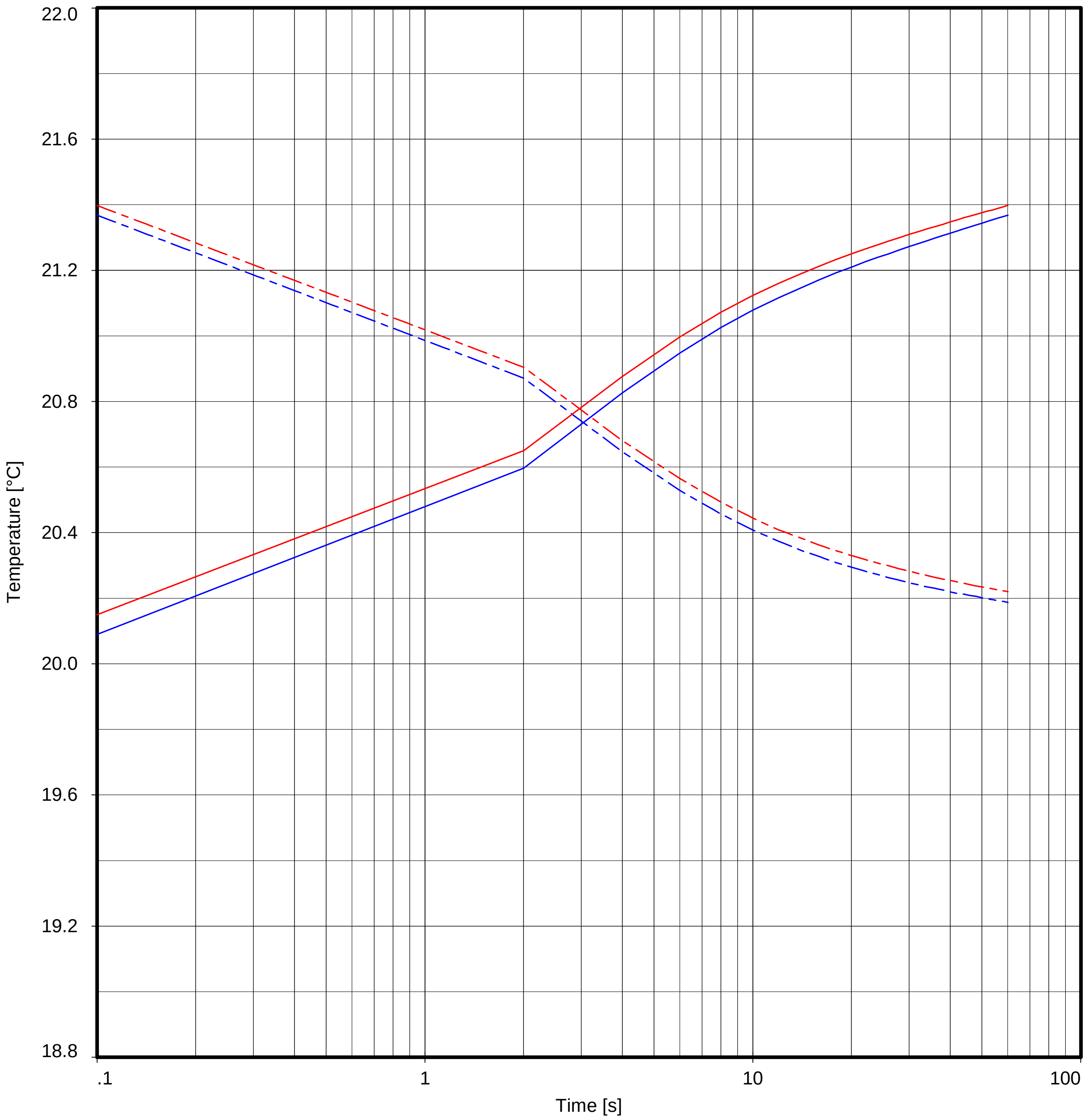
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.67 W/m	——	Heating phase measurement 1
Thermal conductivity	: 2.013 W/(m.K)	— · — · —	Cooling phase measurement 1

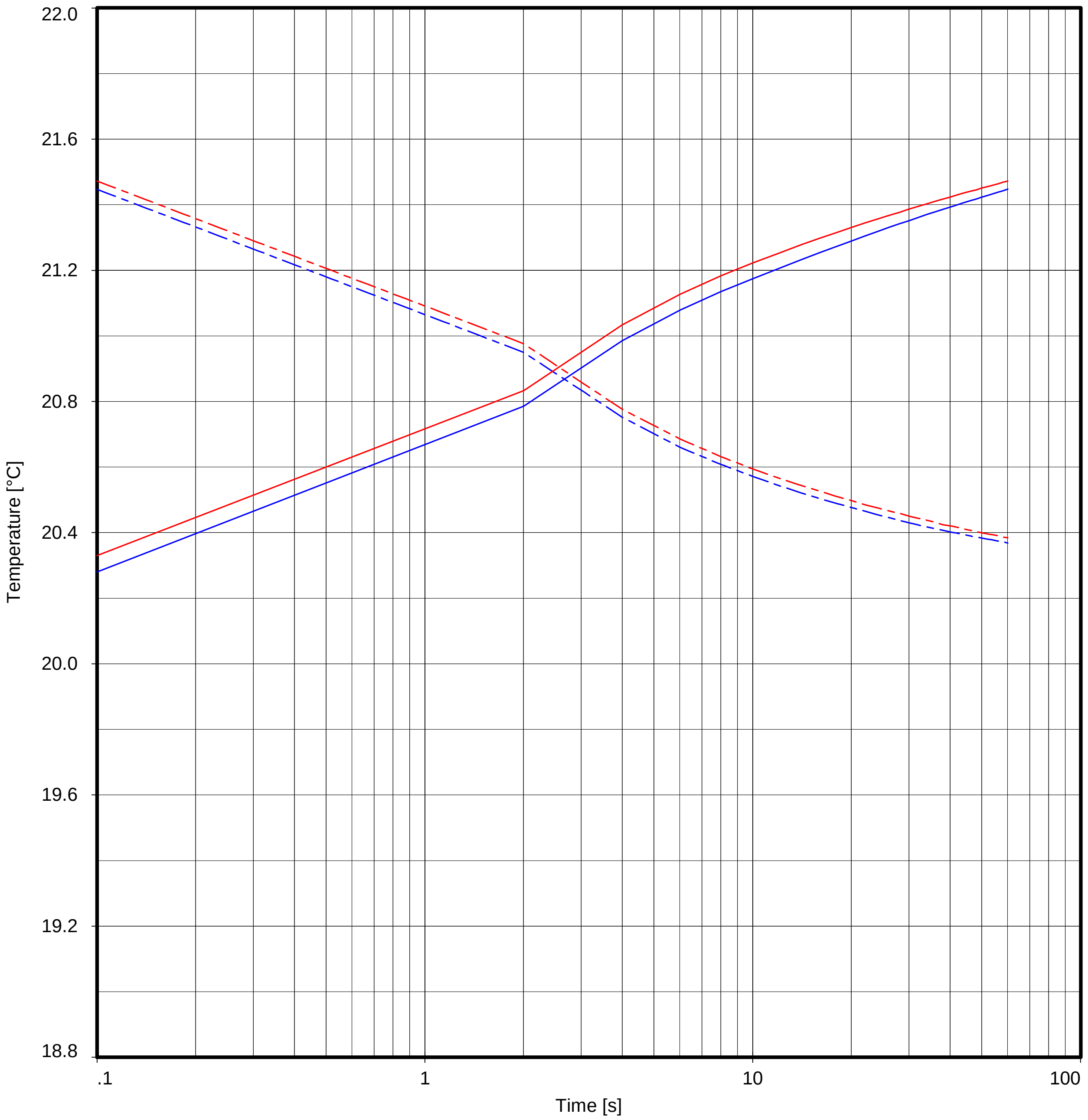
Measurement 2

Applied power	: 3.66 W/m	——	Heating phase measurement 2
Thermal conductivity	: 2.065 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID	: TC06
Borehole	: HKZ1-BH05-SA
Soil type	: SAND
Dry density	: 1.59 Mg/m^3
Test Date	: 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.67 W/m ——— Heating phase measurement 1
Thermal conductivity : 2.004 W/(m.K) — · — · — Cooling phase measurement 1

Measurement 2
Applied power : 3.66 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.067 W/(m.K) — · — · — Cooling phase measurement 2

Test ID : TC06
Borehole : HKZ1-BH05-SA
Soil type : SAND
Dry density : 1.68 Mg/m^3
Test Date : 13/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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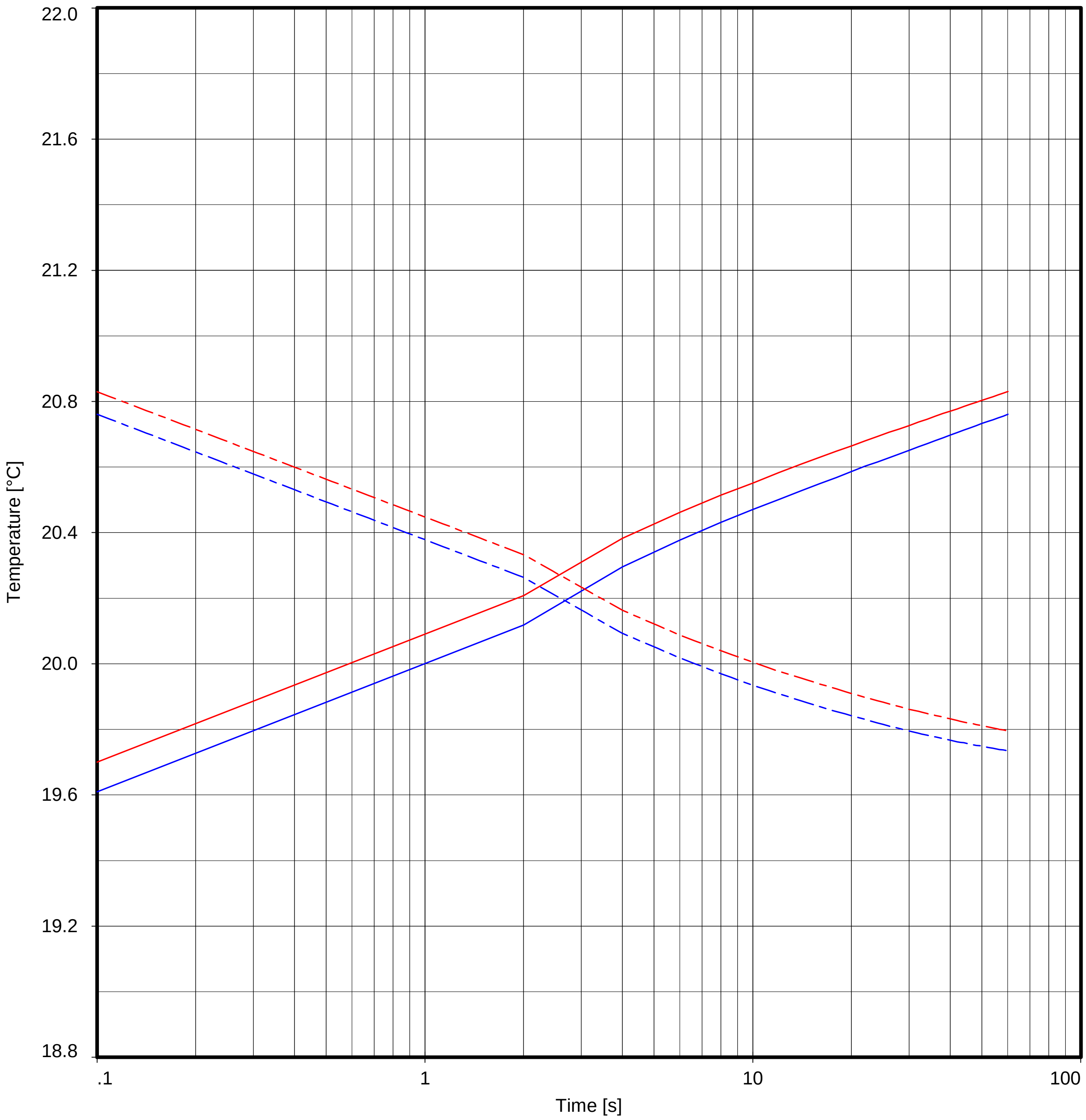
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.88 W/m	――――	Heating phase measurement 1
Thermal conductivity	: 1.972 W/(m.K)	– · – · –	Cooling phase measurement 1

Measurement 2

Applied power	: 3.86 W/m	――――	Heating phase measurement 2
Thermal conductivity	: 1.983 W/(m.K)	– · – · –	Cooling phase measurement 2

Test ID	: TC07
Borehole	: HKZ1-BH06-SA
Soil type	: SAND
Dry density	: 1.35 Mg/m^3
Test Date	: 14/10/2016

Note(s):

- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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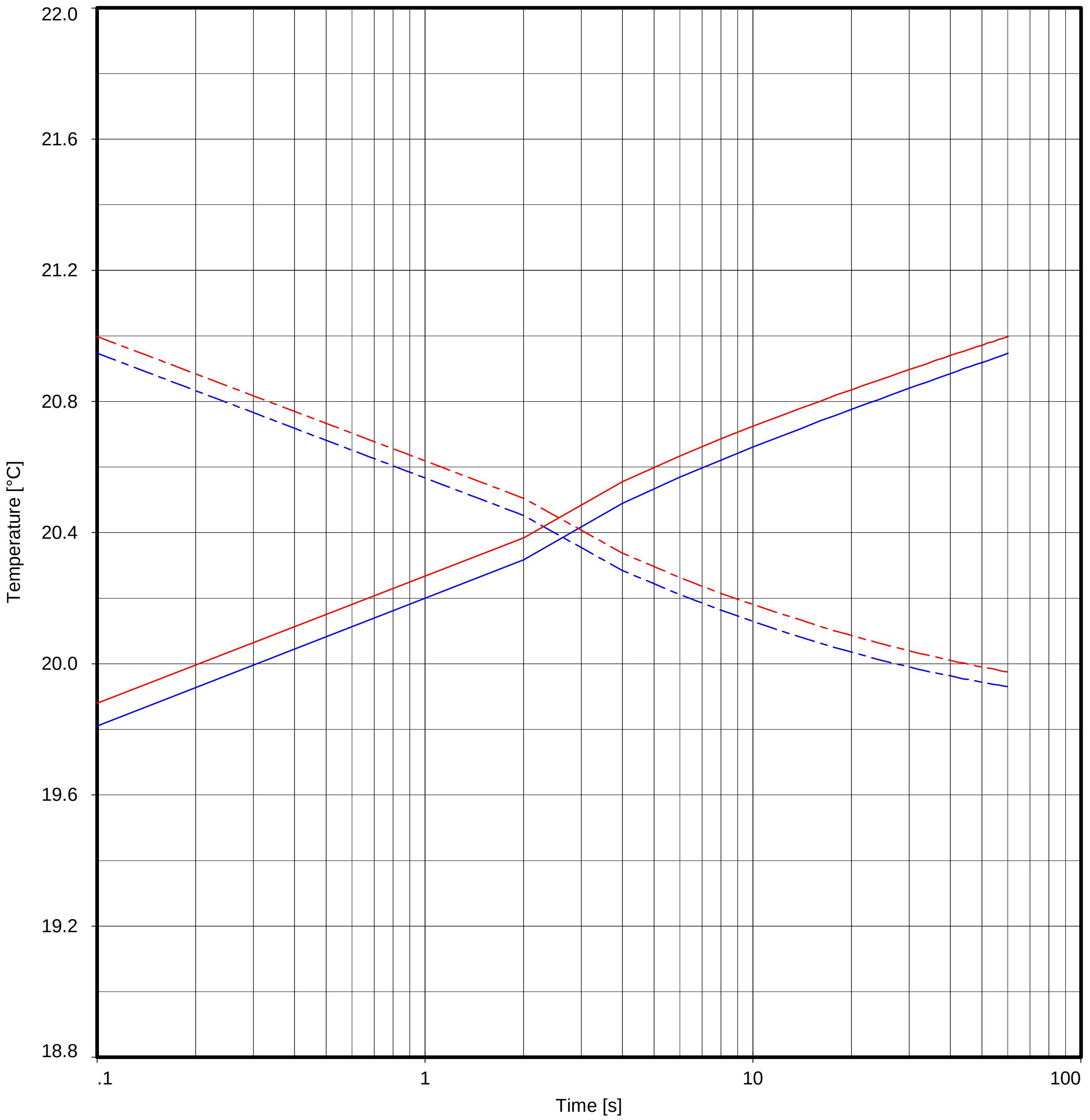
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.86 W/m
Thermal conductivity : 2.002 W/(m.K)

——— Heating phase measurement 1
— · — · — Cooling phase measurement 1

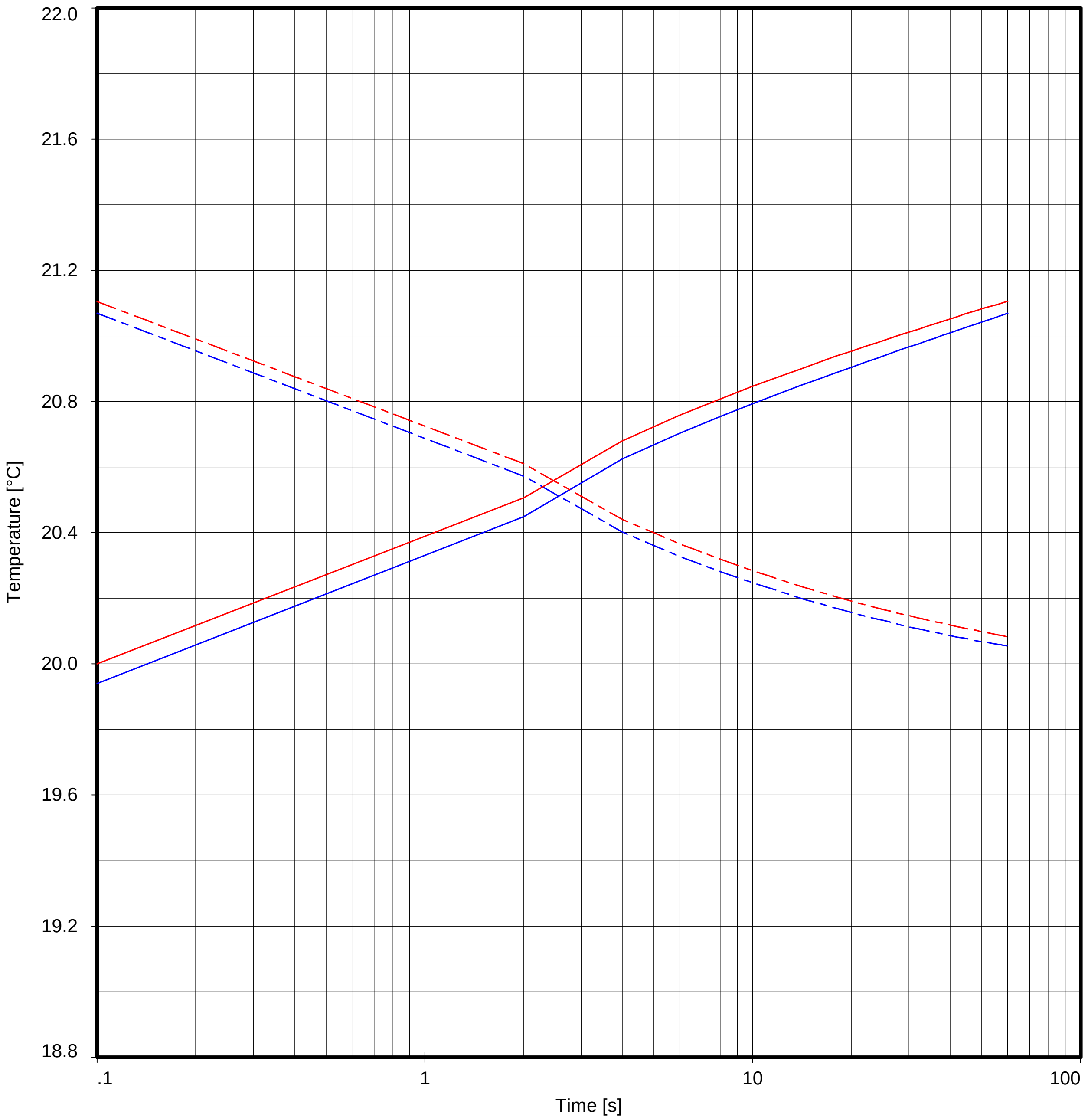
Measurement 2
Applied power : 3.85 W/m
Thermal conductivity : 2.019 W/(m.K)

——— Heating phase measurement 2
— · — · — Cooling phase measurement 2

Test ID : TC07
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.42 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.84 W/m —— Heating phase measurement 1
Thermal conductivity : 2.064 W/(m.K) — · — Cooling phase measurement 1

Measurement 2
Applied power : 3.83 W/m —— Heating phase measurement 2
Thermal conductivity : 2.104 W/(m.K) — · — Cooling phase measurement 2

Test ID : TC07
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.50 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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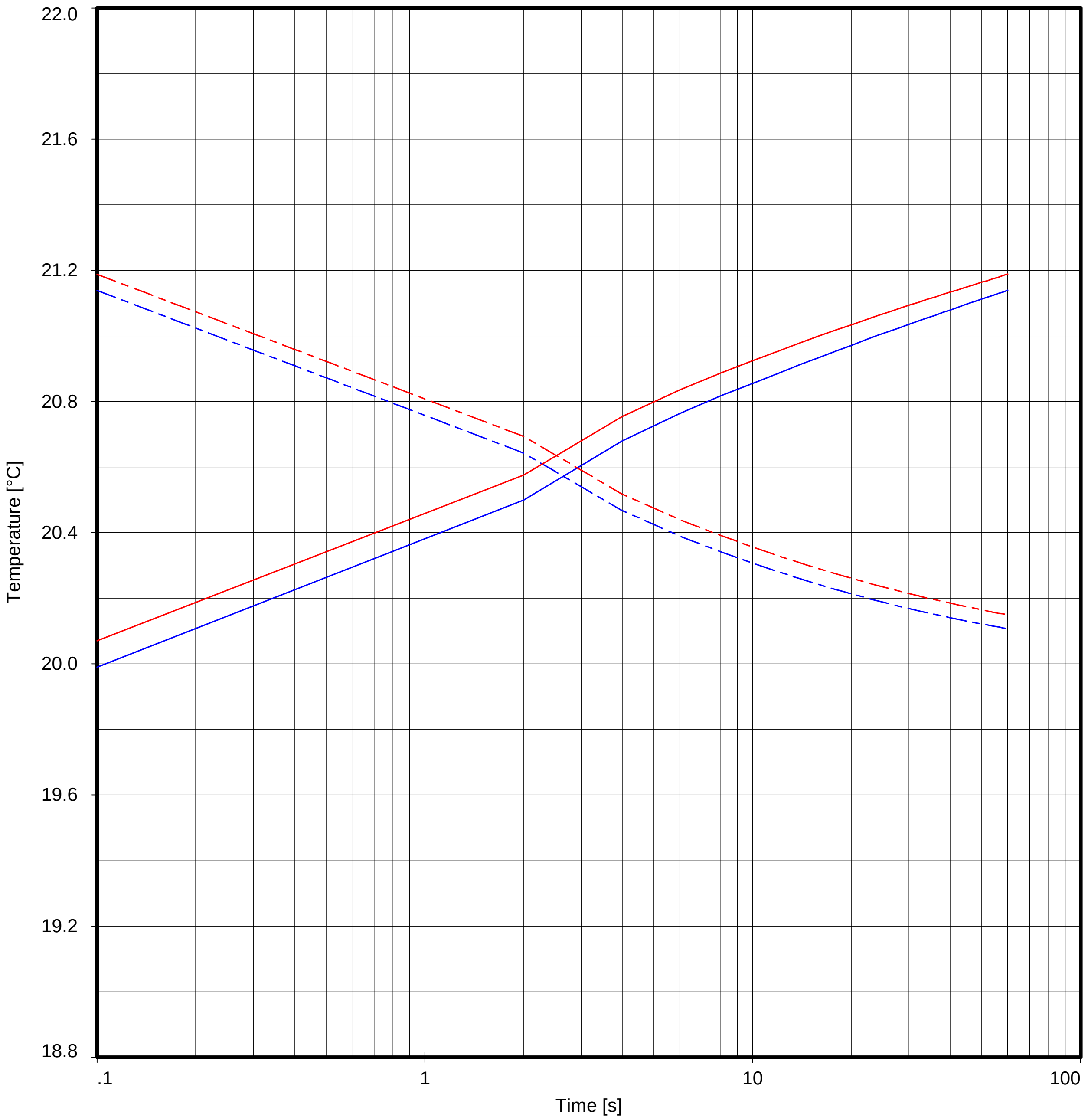
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.83 W/m
Thermal conductivity : 2.004 W/(m.K)

—— Heating phase measurement 1
– - – Cooling phase measurement 1

Measurement 2
Applied power : 3.81 W/m
Thermal conductivity : 2.058 W/(m.K)

—— Heating phase measurement 2
– - – Cooling phase measurement 2

Test ID : TC07
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.57 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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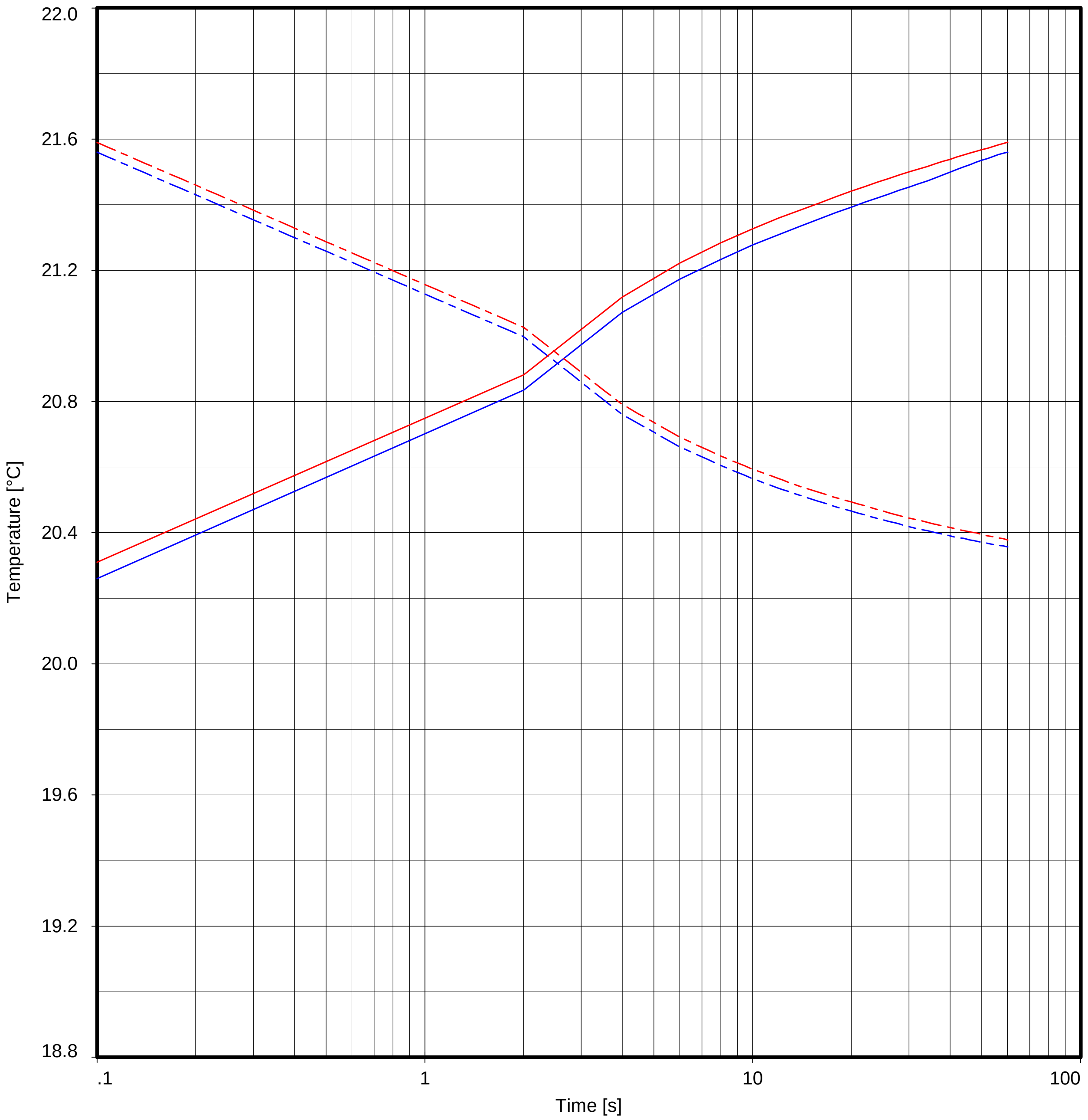
THERMAL CONDUCTIVITY TEST RESULTS



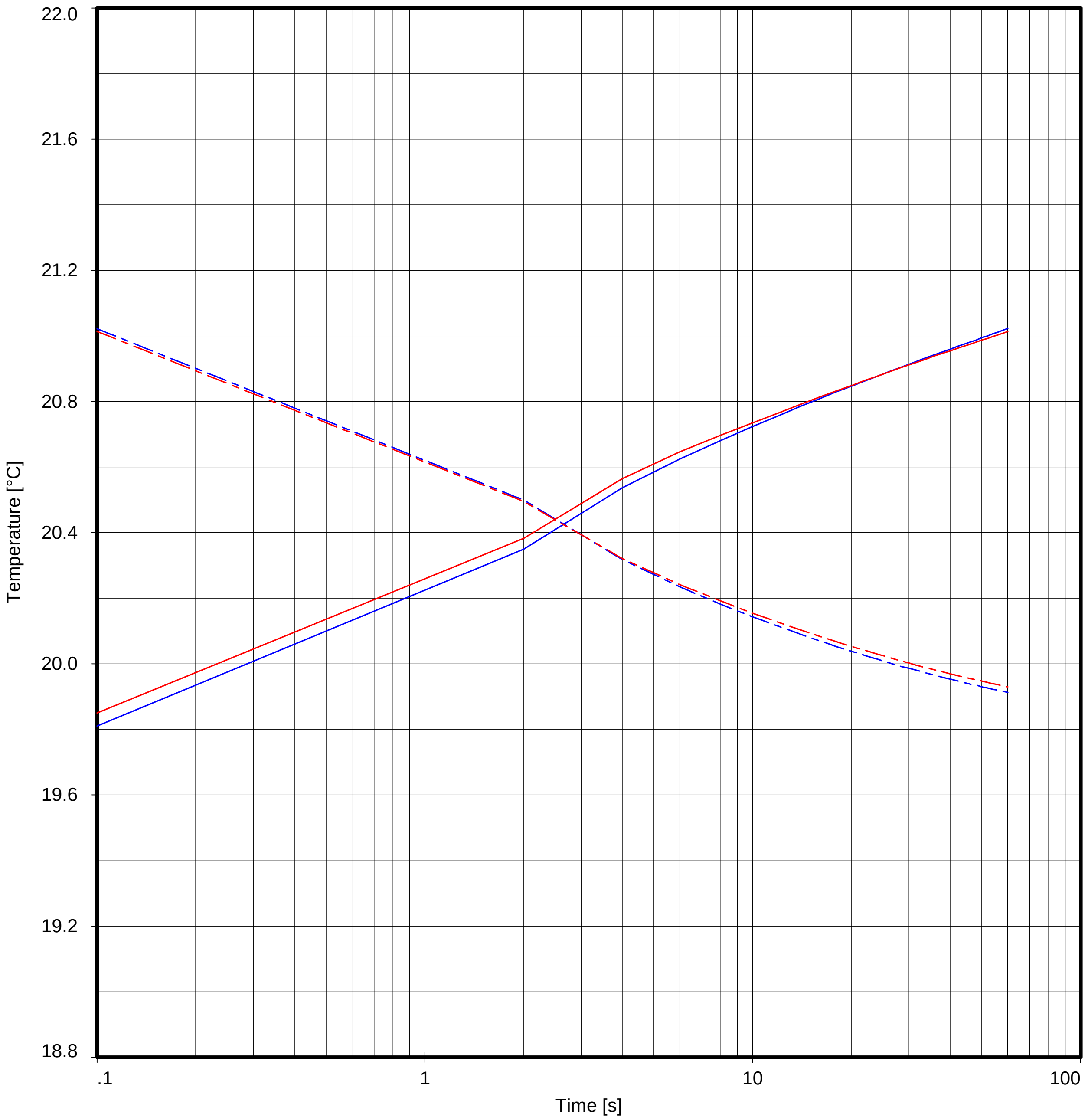
Measurement 1
Applied power : 3.81 W/m ——— Heating phase measurement 1
Thermal conductivity : 1.945 W/(m.K) — - — - — Cooling phase measurement 1

Measurement 2
Applied power : 3.8 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.082 W/(m.K) — - — - — Cooling phase measurement 2

Test ID : TC07
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.64 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 4.08 W/m — Heating phase measurement 1
Thermal conductivity : 1.943 W/(m.K) – · – Cooling phase measurement 1

Measurement 2
Applied power : 4.05 W/m — Heating phase measurement 2
Thermal conductivity : 2.016 W/(m.K) – · – Cooling phase measurement 2

Test ID : TC08
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.36 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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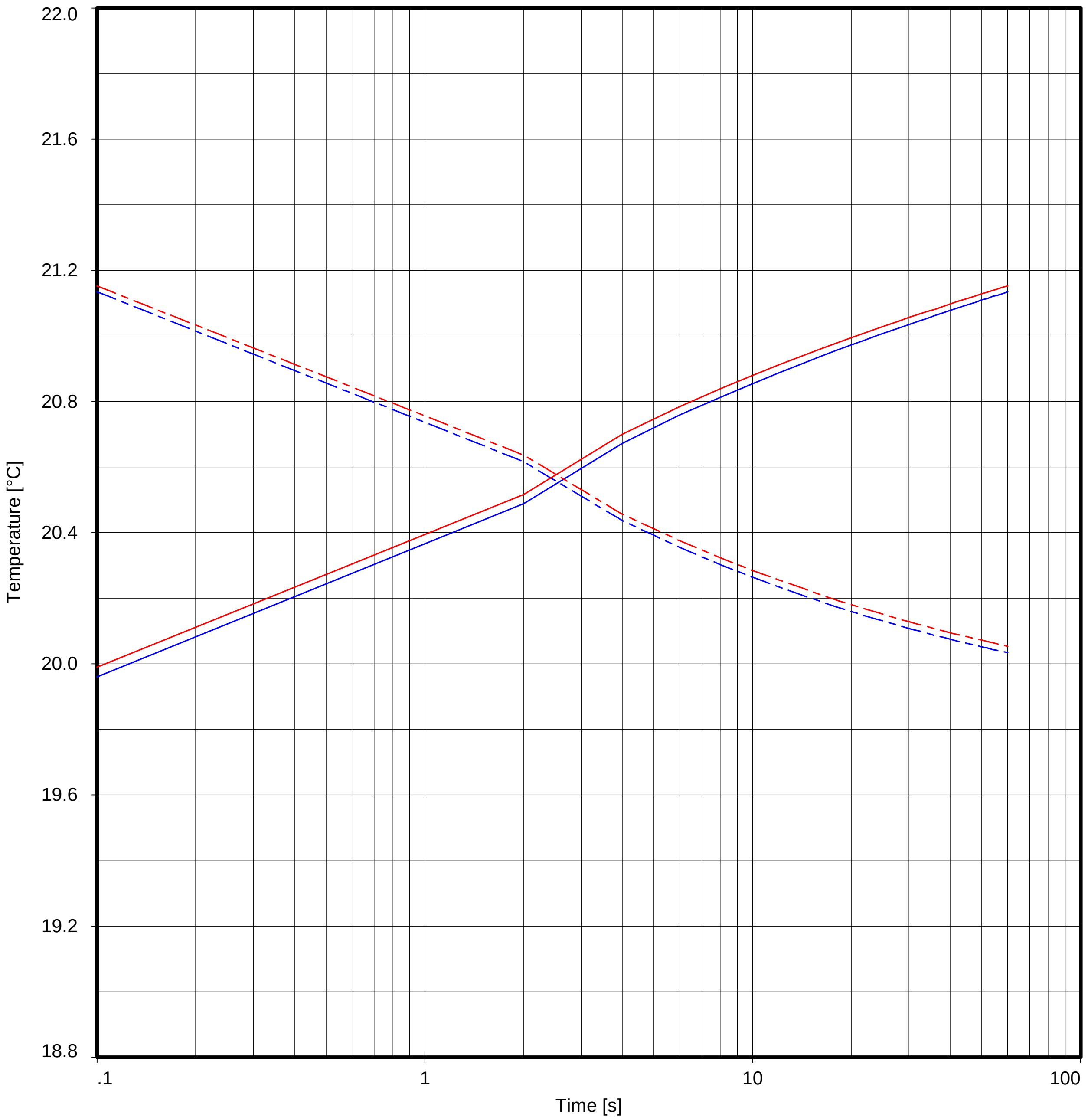
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 4.01 W/m	———	Heating phase measurement 1
Thermal conductivity	: 2.008 W/(m.K)	— · — · —	Cooling phase measurement 1

Measurement 2

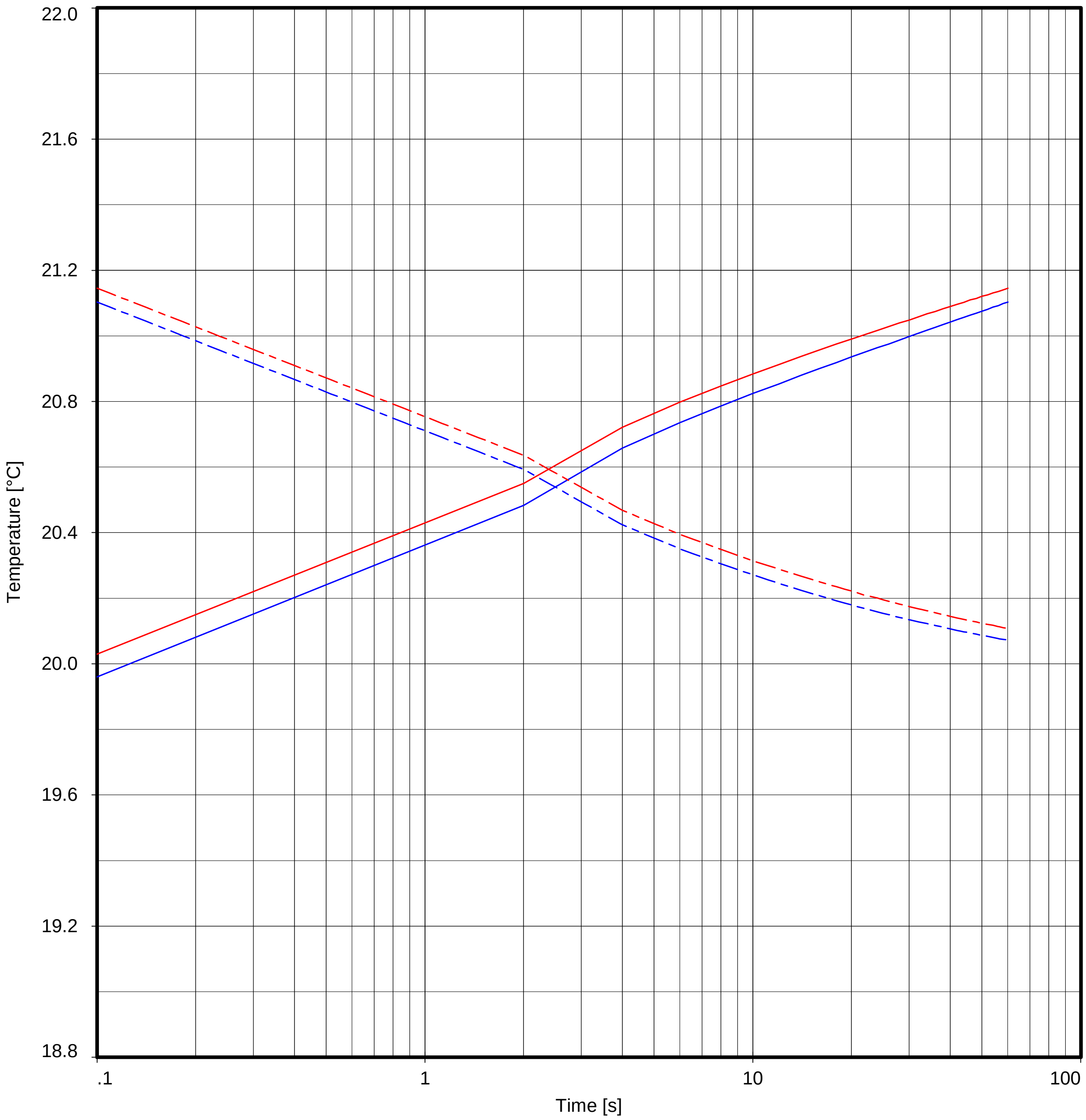
Applied power	: 4.00 W/m	———	Heating phase measurement 2
Thermal conductivity	: 2.022 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID : TC08
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.43 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:22:47

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.99 W/m

Thermal conductivity : 2.077 W/(m.K)

Heating phase measurement 1

Cooling phase measurement 1

Measurement 2

Applied power : 3.98 W/m

Thermal conductivity : 2.124 W/(m.K)

Heating phase measurement 2

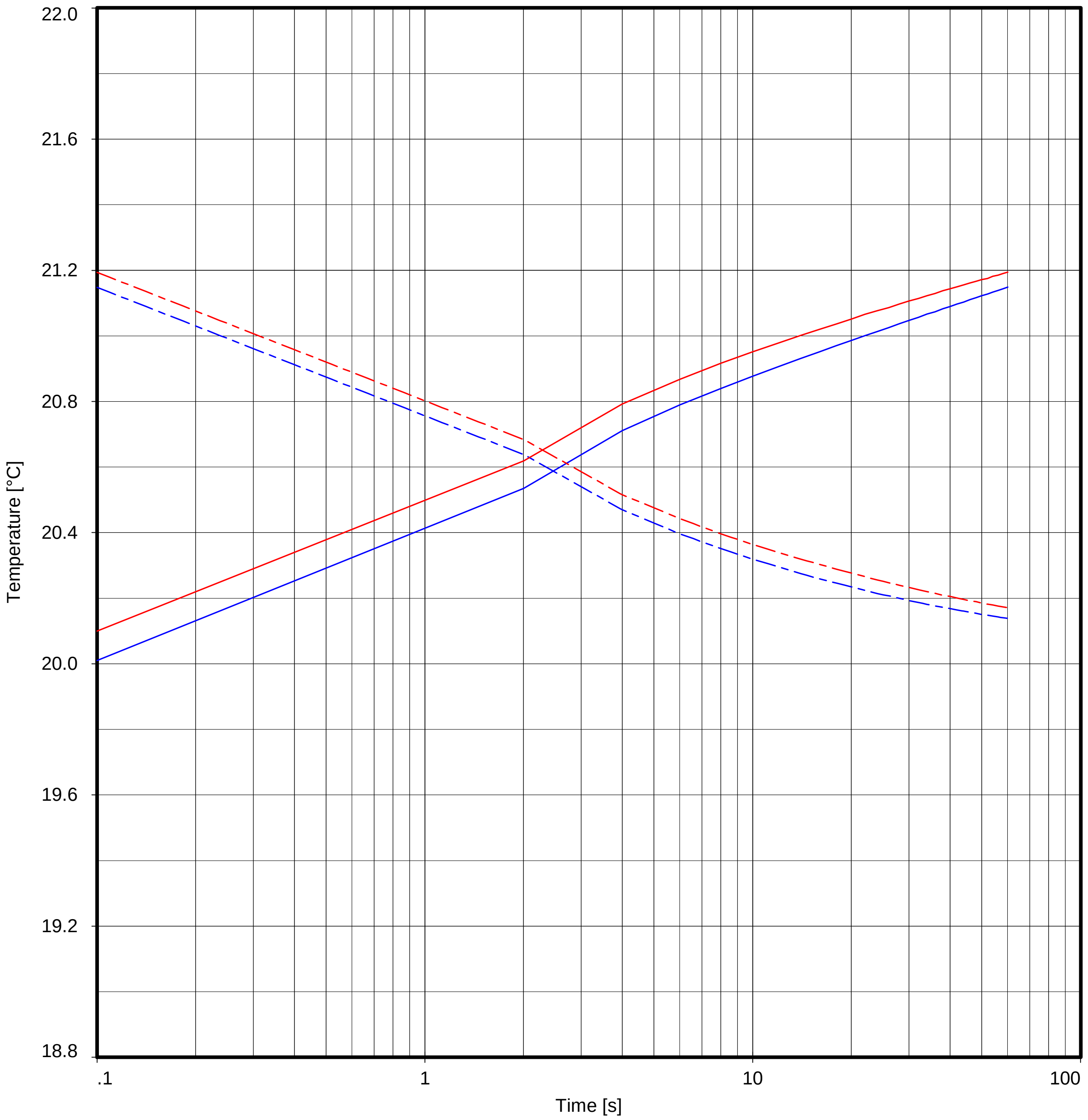
Cooling phase measurement 2

Test ID : TC08
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.51 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:28:45

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.97 W/m ——— Heating phase measurement 1
Thermal conductivity : 2.203 W/(m.K) — - — - — Cooling phase measurement 1

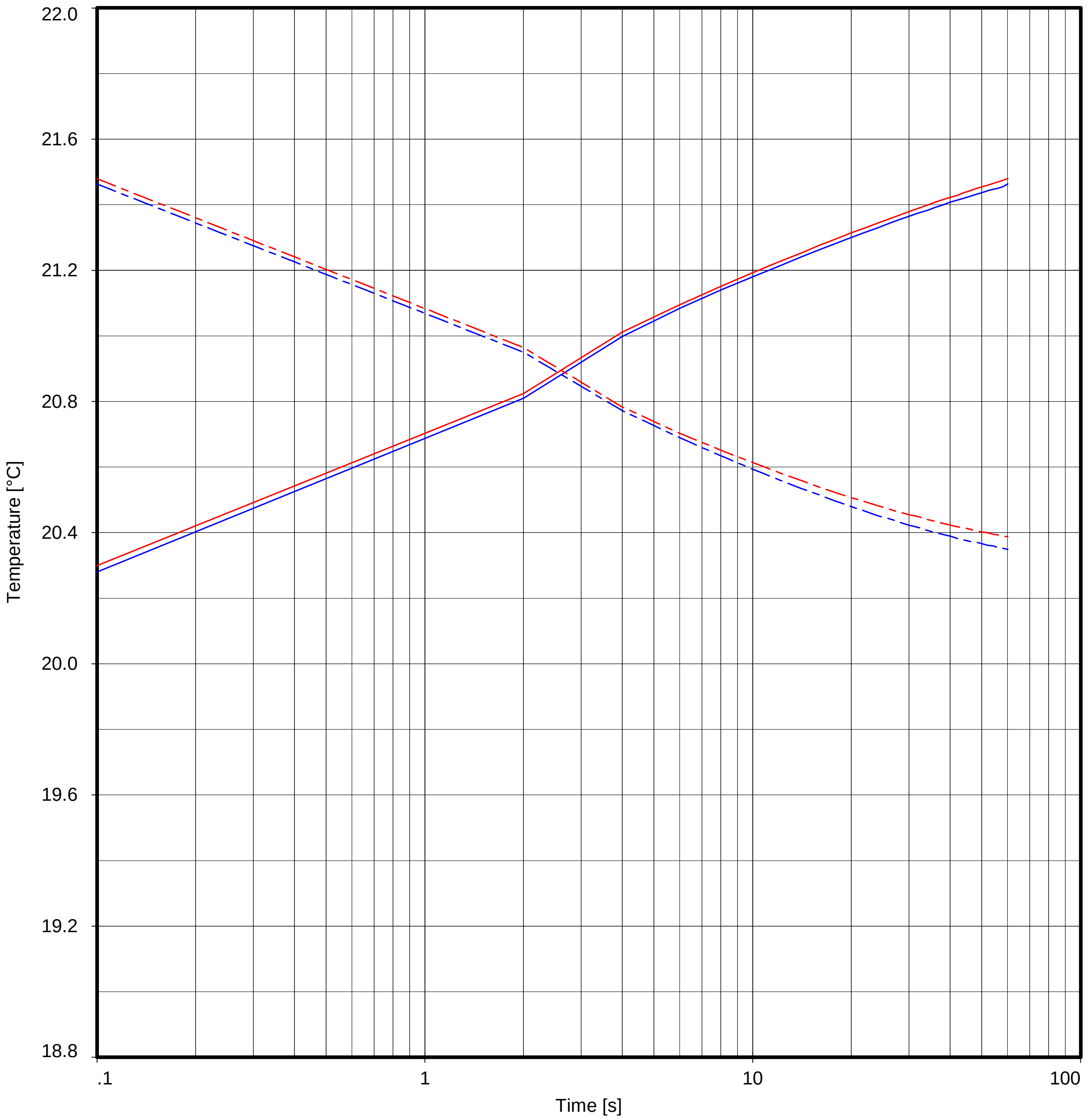
Measurement 2
Applied power : 3.96 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.295 W/(m.K) — - — - — Cooling phase measurement 2

Test ID : TC08
Borehole : HKZ1-BH06-SA
Soil type : SAND
Dry density : 1.60 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:30:43

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.95 W/m	———	Heating phase measurement 1	
Thermal conductivity	: 1.966 W/(m.K)	— · —	Cooling phase measurement 1	

Measurement 2

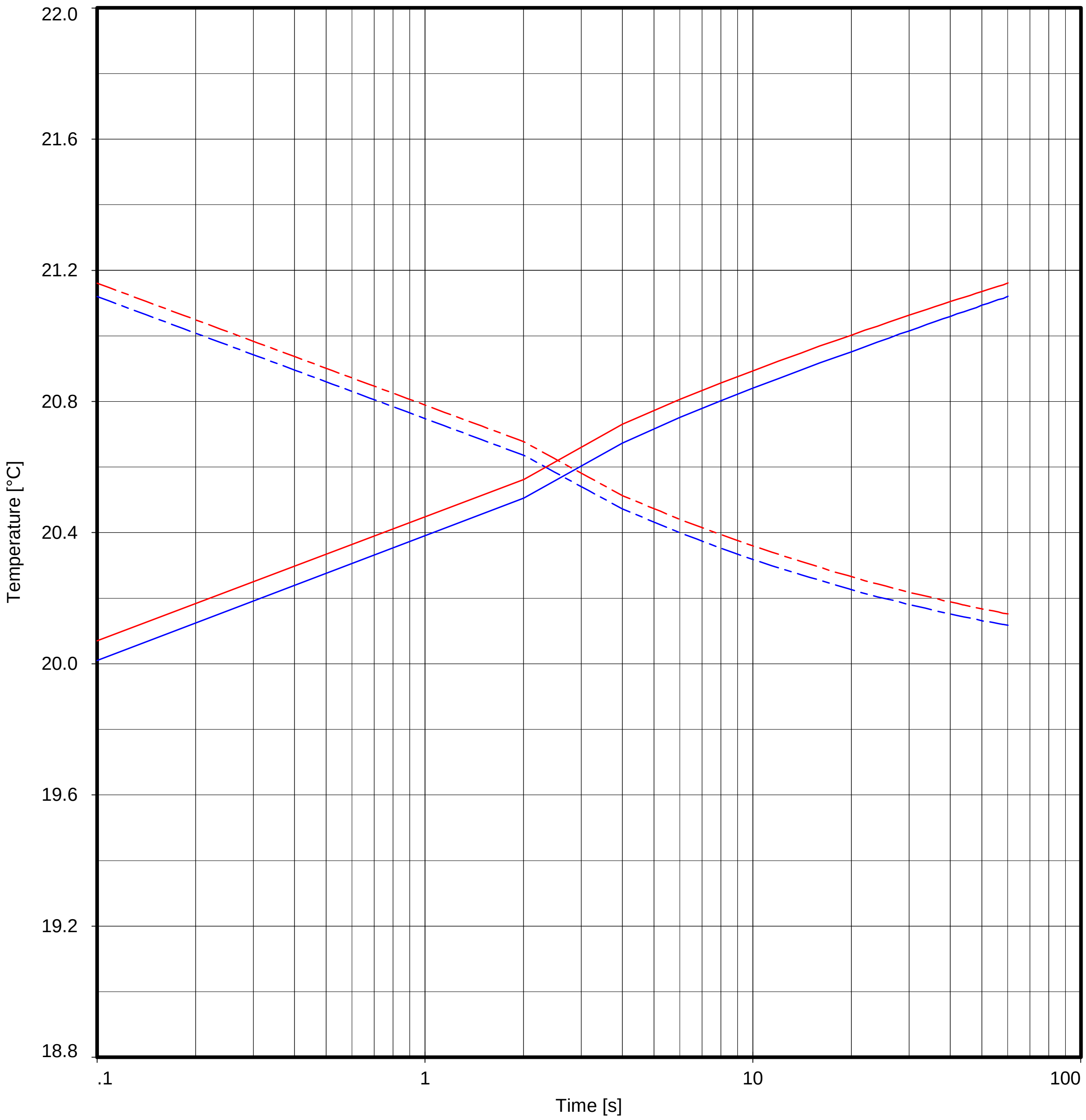
Applied power	: 3.93 W/m	———	Heating phase measurement 2
Thermal conductivity	: 1.997 W/(m.K)	— · —	Cooling phase measurement 2

Test ID	: TC08
Borehole	: HKZ1-BH06-SA
Soil type	: SAND
Dry density	: 1.67 Mg/m^3
Test Date	: 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:32:12

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.78 W/m	———	Heating phase measurement 1
Thermal conductivity	: 1.958 W/(m.K)	— · — · —	Cooling phase measurement 1

Measurement 2

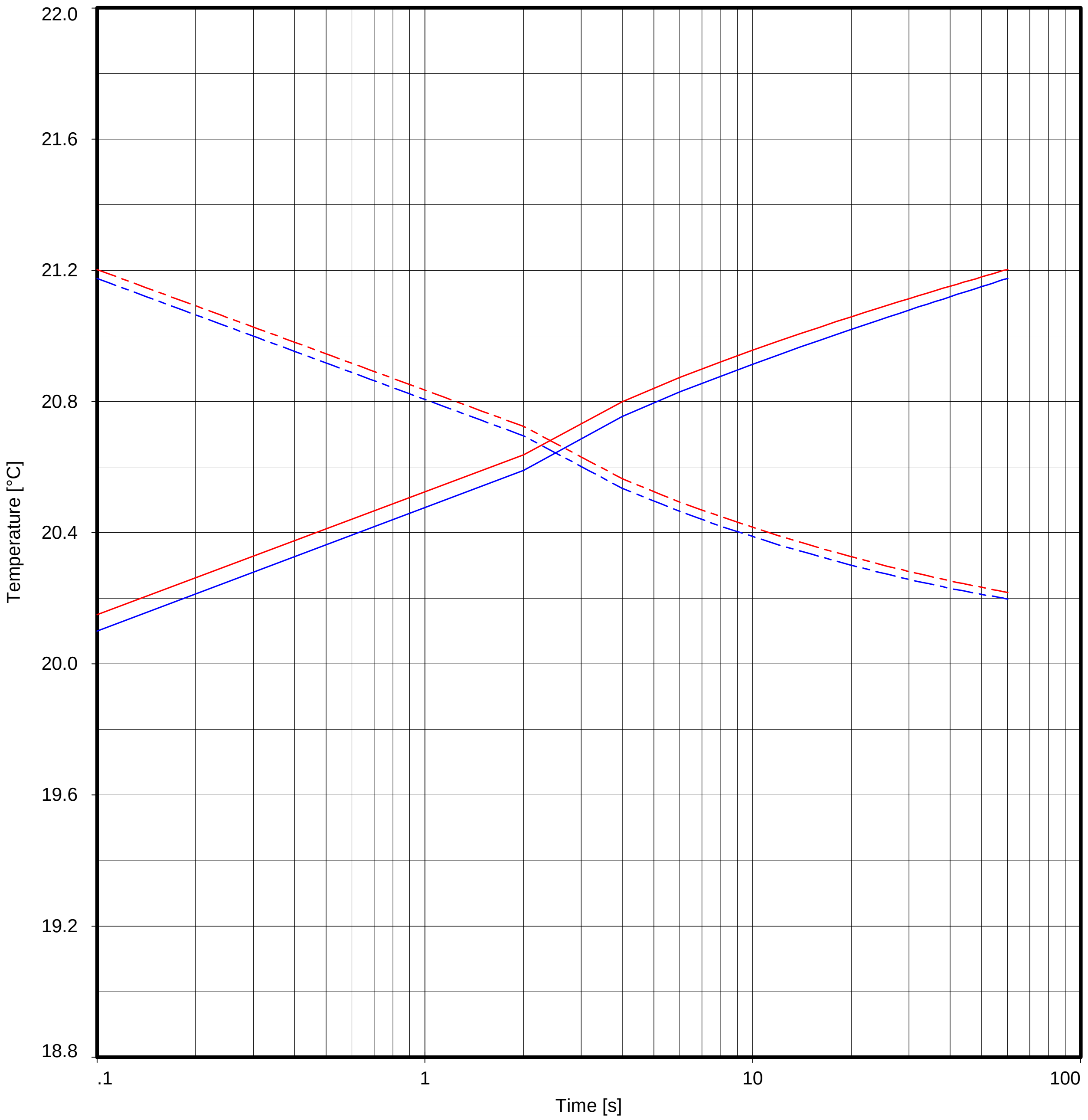
Applied power	: 3.76 W/m	———	Heating phase measurement 2
Thermal conductivity	: 1.989 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID	: TC09
Borehole	: HKZ1-BH07-SA
Soil type	: SAND
Dry density	: 1.38 Mg/m^3
Test Date	: 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:37:58

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.76 W/m ——— Heating phase measurement 1
Thermal conductivity : 2.083 W/(m.K) — - — - Cooling phase measurement 1

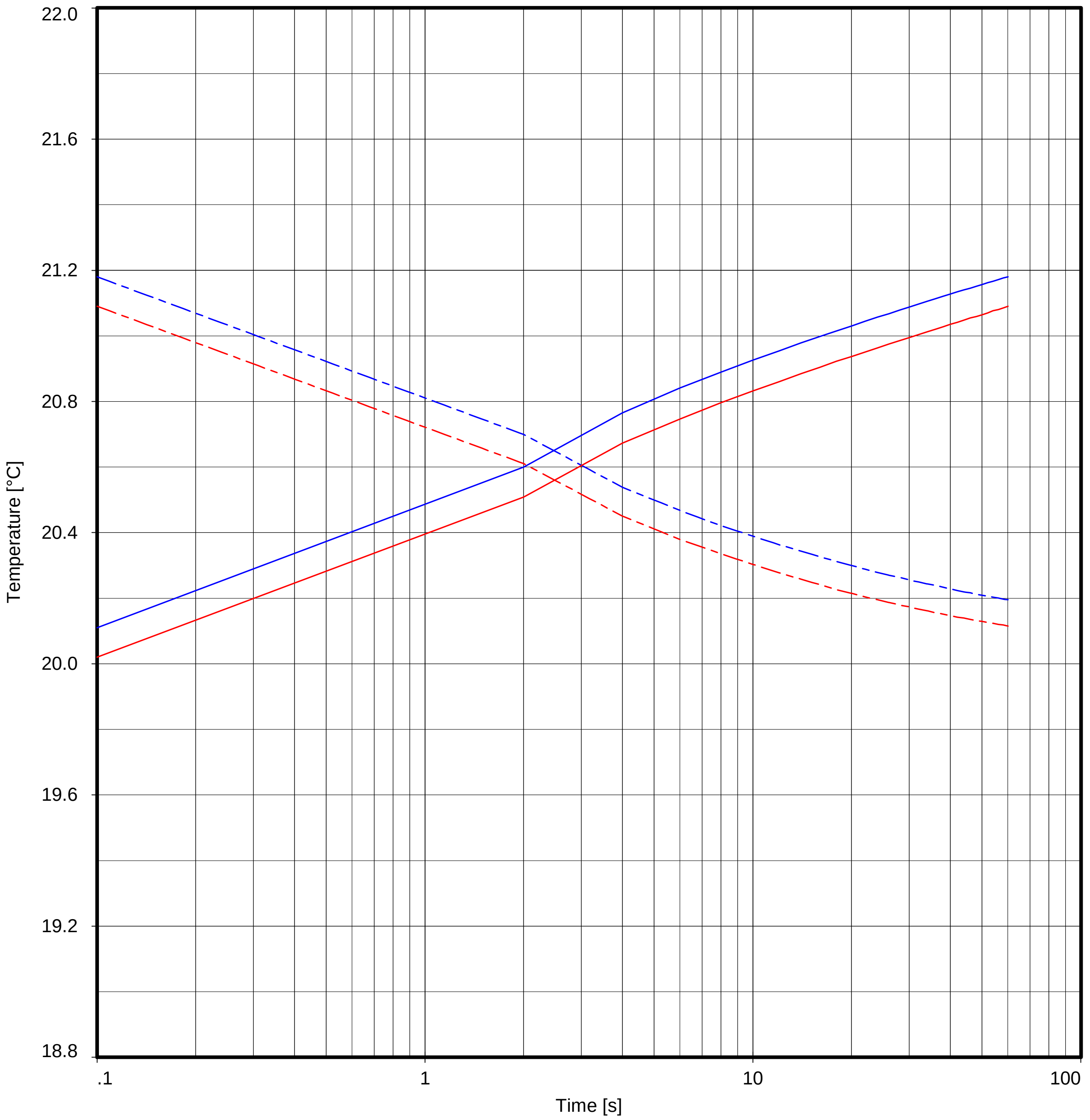
Measurement 2
Applied power : 3.75 W/m ——— Heating phase measurement 2
Thermal conductivity : 2.122 W/(m.K) — - — - Cooling phase measurement 2

Test ID : TC09
Borehole : HKZ1-BH07-SA
Soil type : SAND
Dry density : 1.44 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:40:36

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.74 W/m	———	Heating phase measurement 1
Thermal conductivity	: 2.109 W/(m.K)	— · — · —	Cooling phase measurement 1

Measurement 2

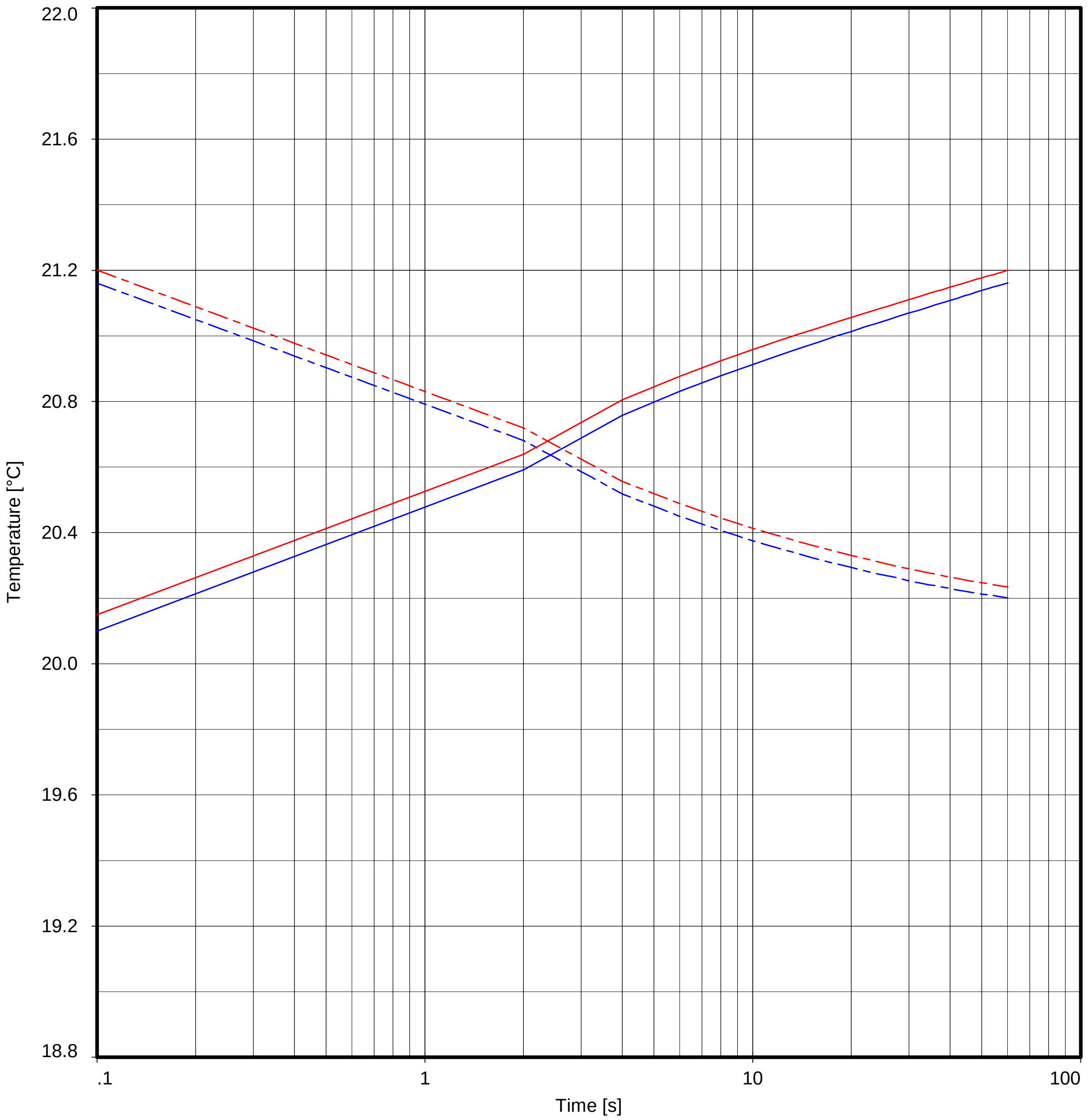
Applied power	: 3.74 W/m	———	Heating phase measurement 2
Thermal conductivity	: 2.124 W/(m.K)	— · — · —	Cooling phase measurement 2

Test ID	: TC09
Borehole	: HKZ1-BH07-SA
Soil type	: SAND
Dry density	: 1.50 Mg/m^3
Test Date	: 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:41:45

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.73 W/m ——— Heating phase measurement 1

Thermal conductivity : 2.219 W/(m.K) — · — · — Cooling phase measurement 1

Measurement 2

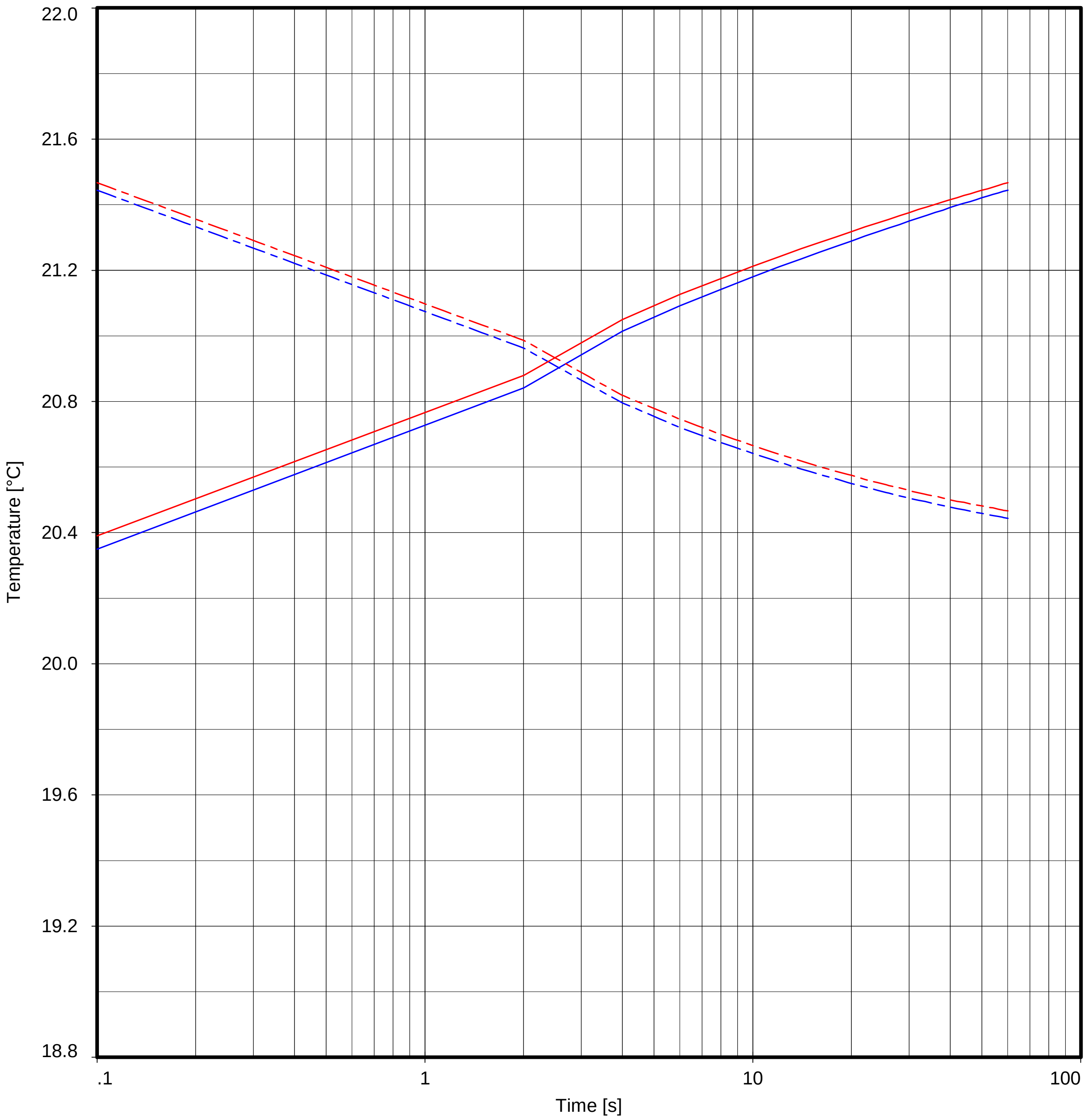
Applied power : 3.73 W/m ——— Heating phase measurement 2

Thermal conductivity : 2.228 W/(m.K) — · — · — Cooling phase measurement 2

Test ID : TC09
Borehole : HKZ1-BH07-SA
Soil type : SAND
Dry density : 1.57 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS

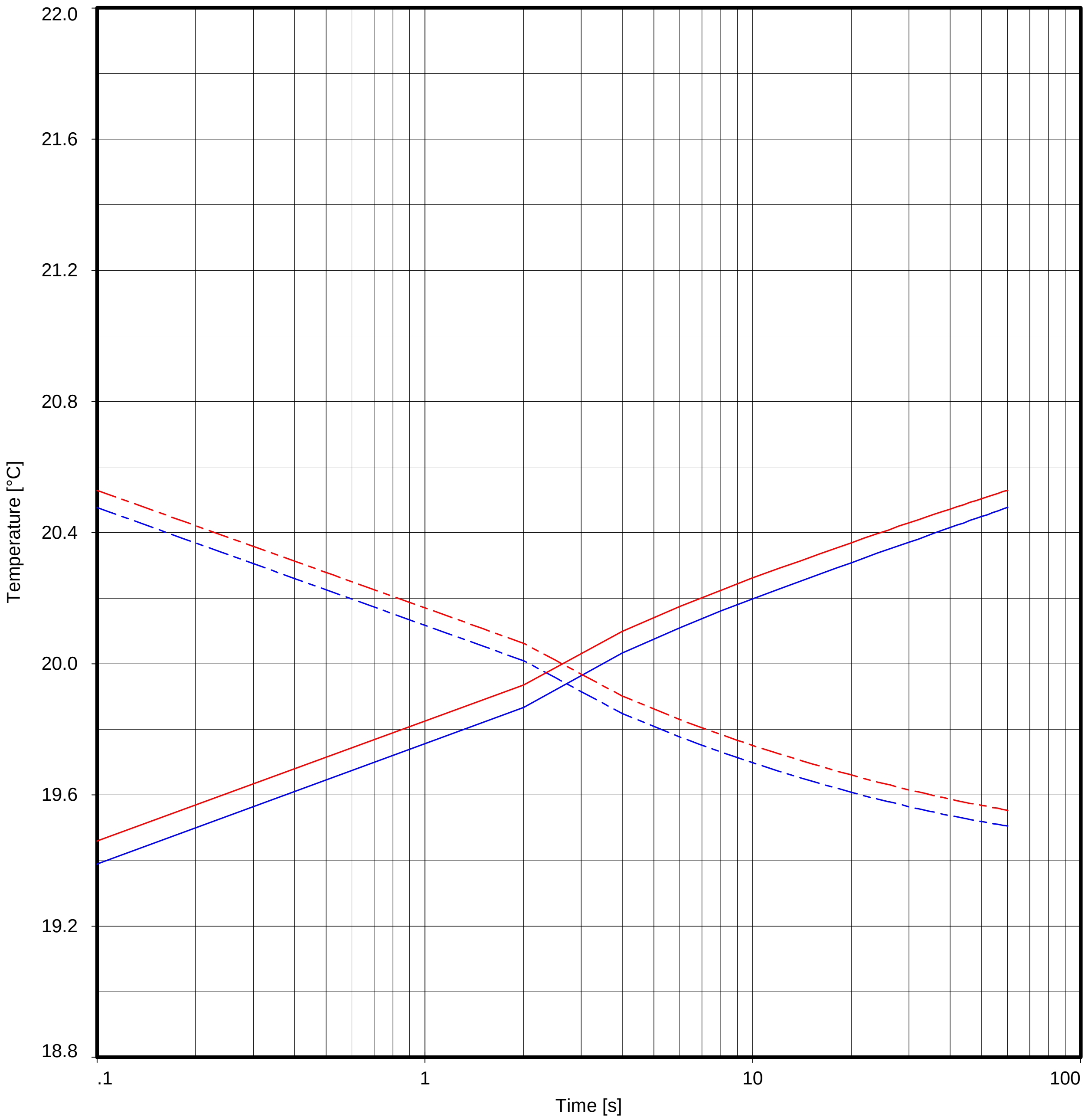


Measurement 1			
Applied power	: 3.72 W/m	───	Heating phase measurement 1
Thermal conductivity	: 2.047 W/(m.K)	─ · ─ ·	Cooling phase measurement 1
Measurement 2			
Applied power	: 3.71 W/m	───	Heating phase measurement 2
Thermal conductivity	: 2.085 W/(m.K)	─ · ─ ·	Cooling phase measurement 2

Test ID : TC09
Borehole : HKZ1-BH07-SA
Soil type : SAND
Dry density : 1.66 Mg/m^3
Test Date : 14/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS

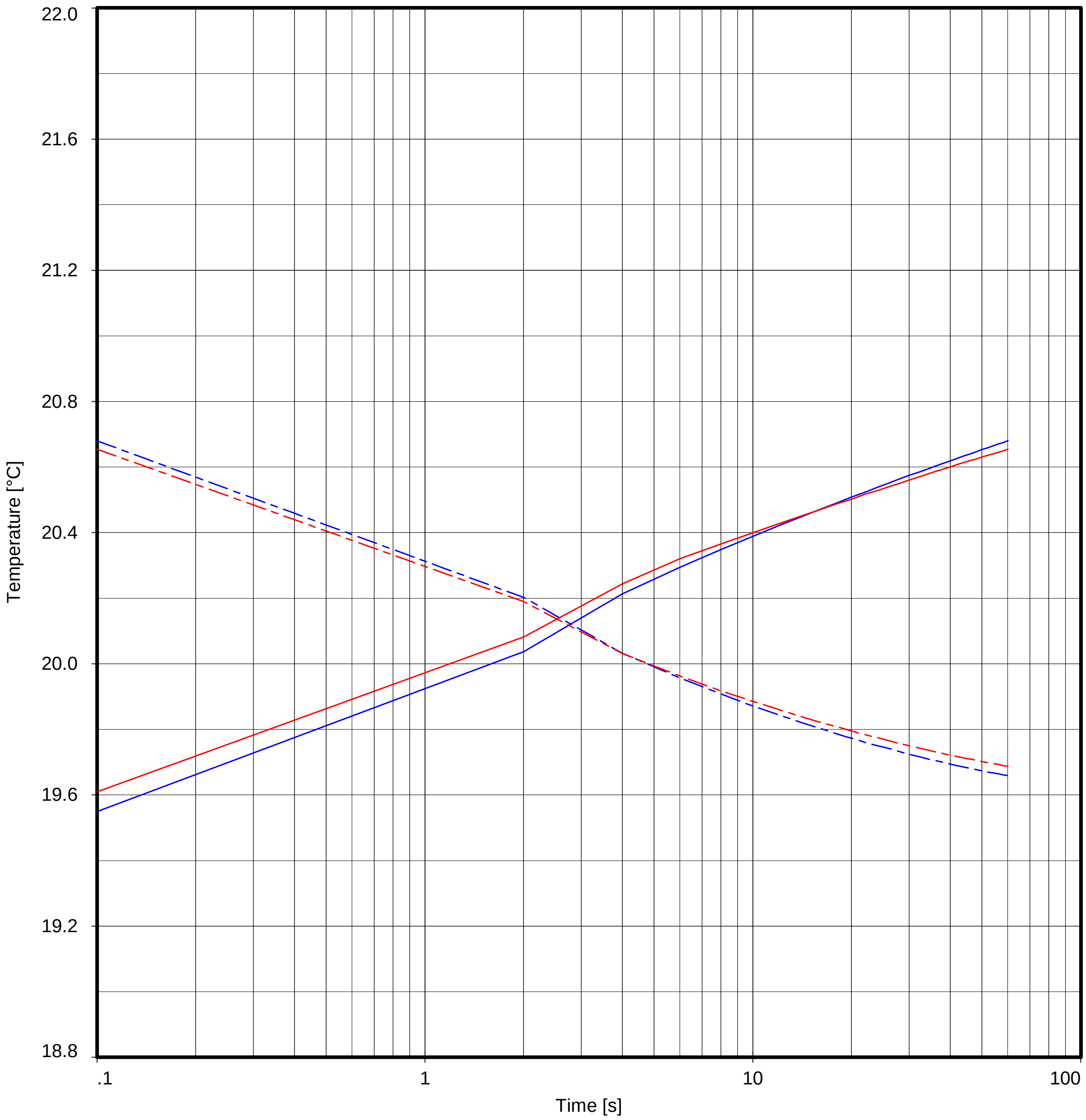


Measurement 1			
Applied power	: 3.63 W/m	———	Heating phase measurement 1
Thermal conductivity	: 1.913 W/(m.K)	— - — - —	Cooling phase measurement 1
Measurement 2			
Applied power	: 3.62 W/m	———	Heating phase measurement 2
Thermal conductivity	: 1.937 W/(m.K)	— - — - —	Cooling phase measurement 2

Test ID	: TC10
Borehole	: HKZ1-BH08-SA
Soil type	: SAND
Dry density	: 1.33 Mg/m^3
Test Date	: 15/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1
Applied power : 3.61 W/m — Heating phase measurement 1
Thermal conductivity : 1.808 W/(m.K) — — Cooling phase measurement 1

Measurement 2
Applied power : 3.61 W/m — Heating phase measurement 2
Thermal conductivity : 1.999 W/(m.K) — — Cooling phase measurement 2

Test ID : TC10
Borehole : HKZ1-BH08-SA
Soil type : SAND
Dry density : 1.43 Mg/m^3
Test Date : 15/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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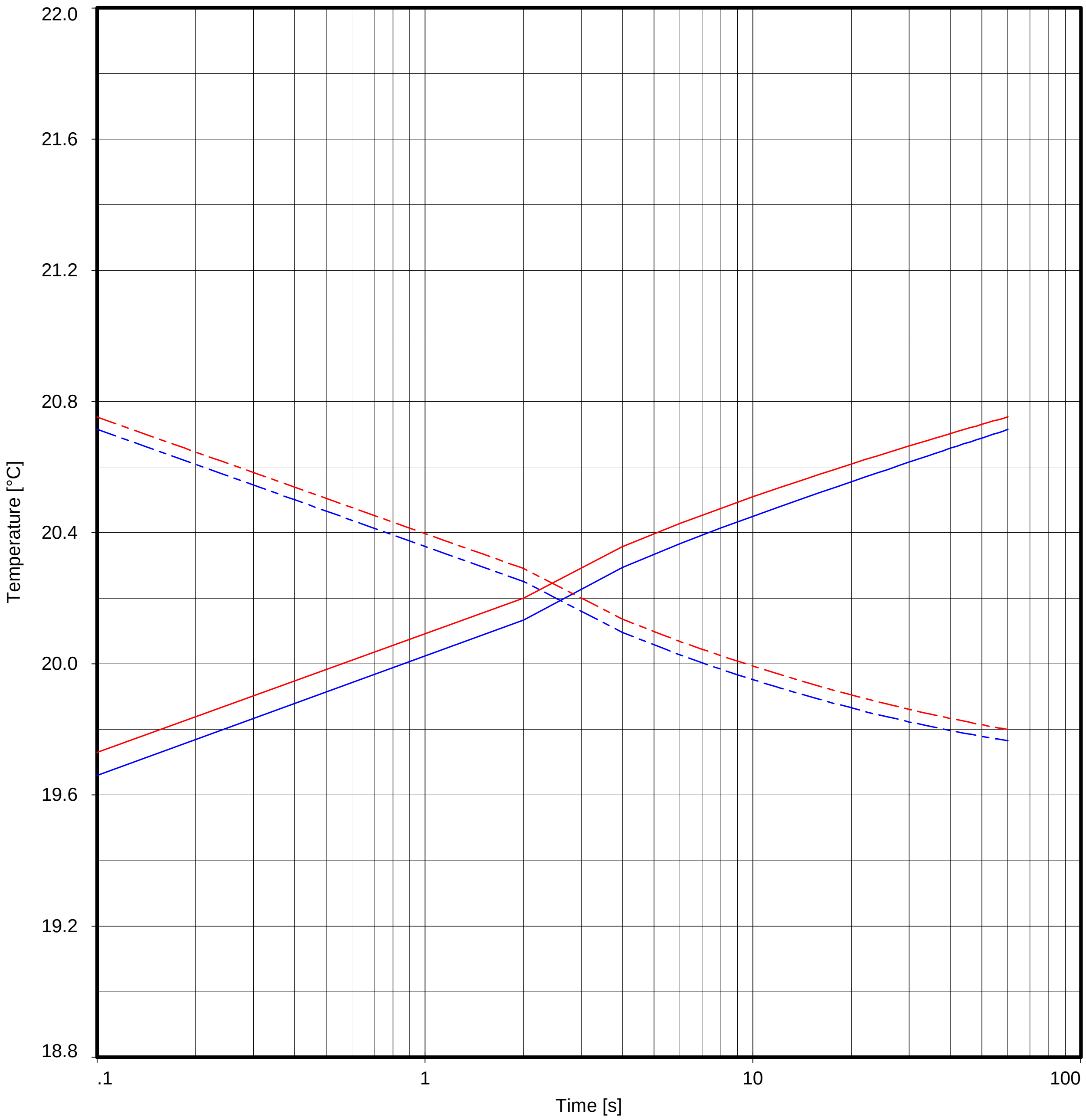
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power : 3.61 W/m

Thermal conductivity : 1.993 W/(m.K)

——— Heating phase measurement 1

— - — - Cooling phase measurement 1

Measurement 2

Applied power : 3.6 W/m

Thermal conductivity : 2.071 W/(m.K)

——— Heating phase measurement 2

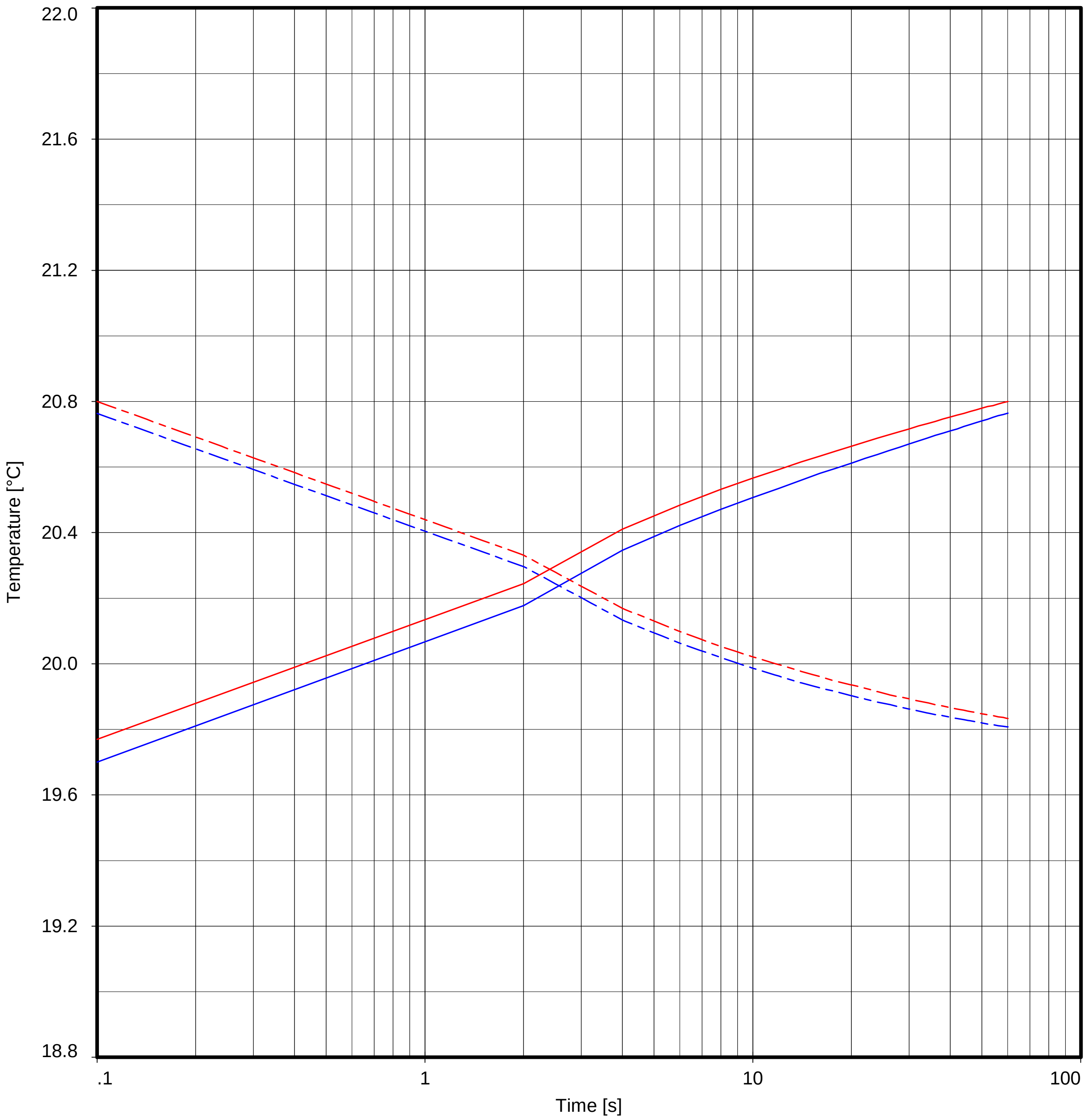
— - — - Cooling phase measurement 2

Test ID : TC10
Borehole : HKZ1-BH08-SA
Soil type : SAND
Dry density : 1.51 Mg/m^3
Test Date : 15/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:49:31

THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.6	W/m	———	Heating phase measurement 1
Thermal conductivity	: 2.08	W/(m.K)	— - — - —	Cooling phase measurement 1

Measurement 2

Applied power	: 3.59	W/m	———	Heating phase measurement 2
Thermal conductivity	: 2.17	W/(m.K)	— - — - —	Cooling phase measurement 2

Test ID	: TC10
Borehole	: HKZ1-BH08-SA
Soil type	: SAND
Dry density	: 1.60 Mg/m^3
Test Date	: 15/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

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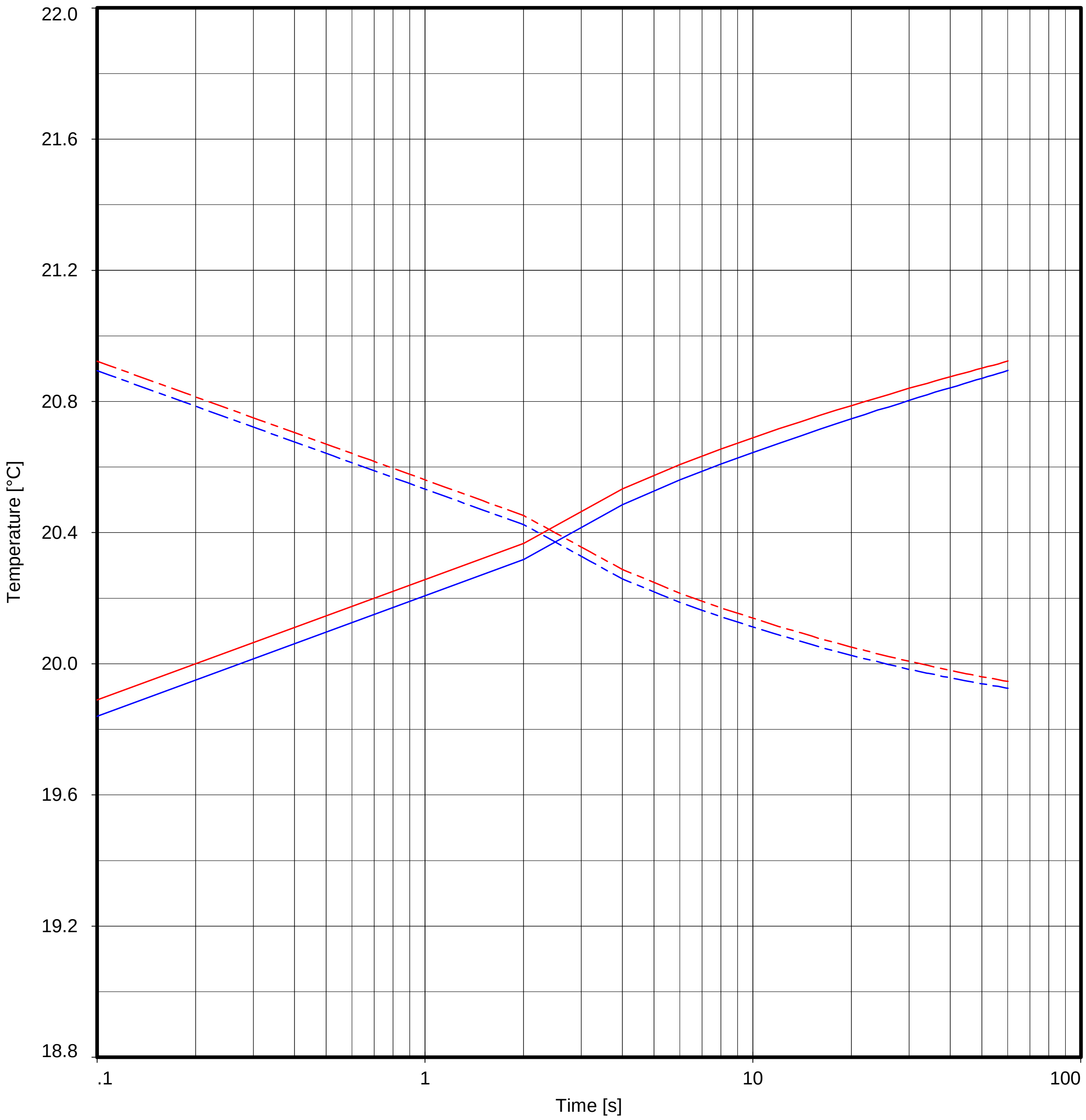
THERMAL CONDUCTIVITY TEST RESULTS



Measurement 1

Applied power	: 3.58 W/m	──	Heating phase measurement 1
Thermal conductivity	: 2.078 W/(m.K)	– · –	Cooling phase measurement 1

Measurement 2

Applied power	: 3.58 W/m	──	Heating phase measurement 2
Thermal conductivity	: 2.146 W/(m.K)	– · –	Cooling phase measurement 2

Test ID	: TC10
Borehole	: HKZ1-BH08-SA
Soil type	: SAND
Dry density	: 1.66 Mg/m^3
Test Date	: 15/10/2016

Note(s):
- Results calculated from final 1/3 of heating phase (measurements between 40 and 60 seconds)
- Measurements performed on a reconstituted batch sample. Refer to Main Text Section C for details.

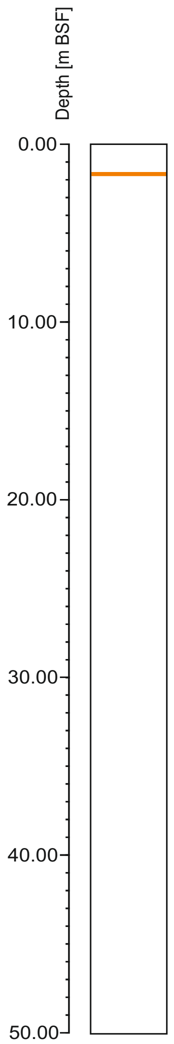
PPPWIN 03.26.nl/Template_2 tests_HKZ1.ppp/2016-10-24 21:52:22

THERMAL CONDUCTIVITY TEST RESULTS

SECTION C8: SAMPLE MICRO PHOTOGRAPHS

LIST OF PLATES IN SECTION C8:

Sample Microscope Description



Sample Description

Hand-Specimen Description
Very dark greyish brown (10YR–3/2) subangular to subrounded (rK = 0.4 to 0.6) medium to high sphericity (rK = 0.6 to 0.9) fine SAND

Colour:
Unwashed: Very dark grayish brown (10YR–3/2)
Washed: Light grey (10YR–7/1)

Sand is very well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

75 % Fine to medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) QUARTZ
- ~ 80 % clear, translucent
- ~ 27 % clear, glassy
- ~ 3 % Orange to reddish brown

10 % - Fine to medium sand-sized subrounded (rK = 0.6) low to medium sphericity (rK = 0.4 to 0.6) pink to orange FELDSPAR

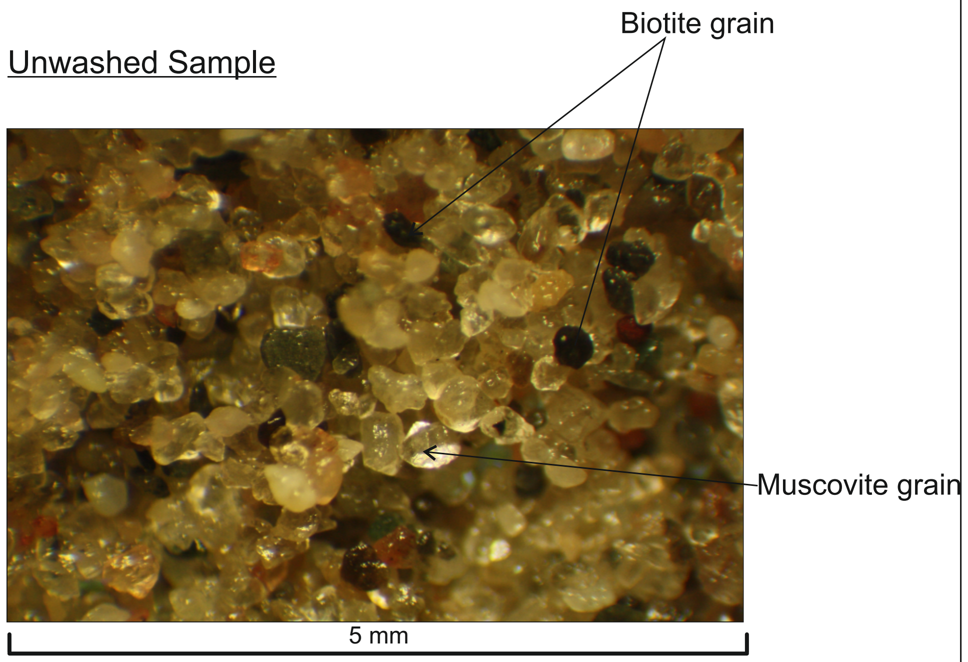
10 % - Fine to medium sand-sized subangular to rounded (rK = 0.3 to 0.7) low to medium sphericity (rK = 0.4 to 0.6) green to brown LITHIC FRAGMENTS

5 % - Fine sand-sized subangular (rK = 0.4) medium sphericity (rK = 0.6) black BIOTITE

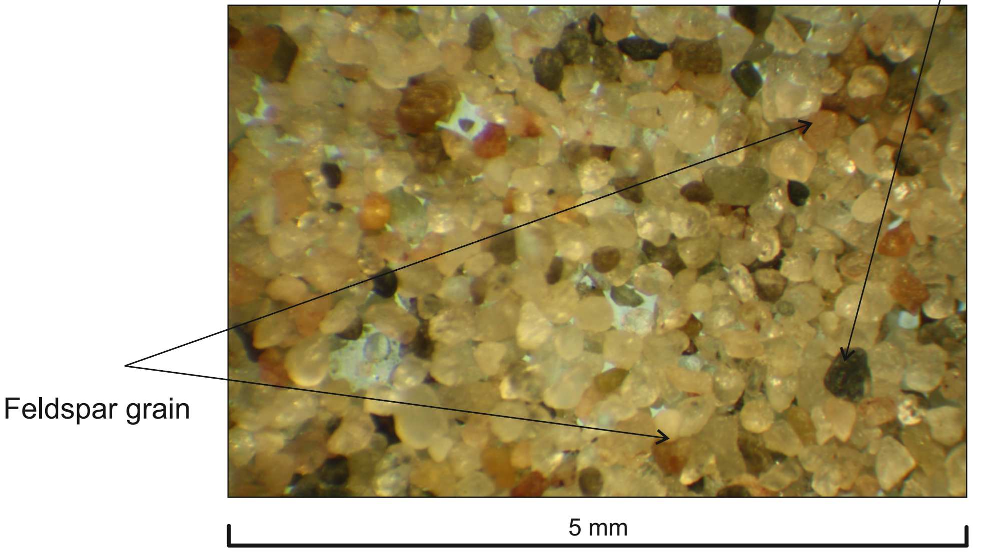
Trace: bioclastic fragments, glauconite

Reflected Light Microphotographs

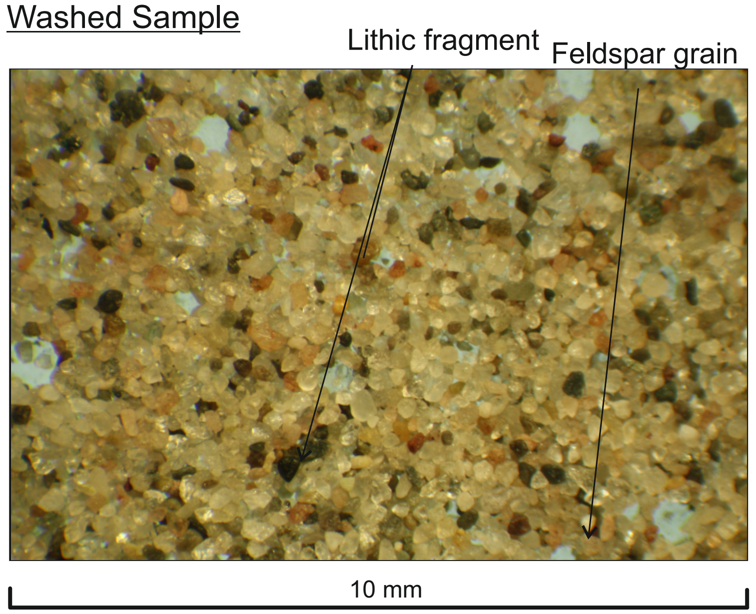
Unwashed Sample



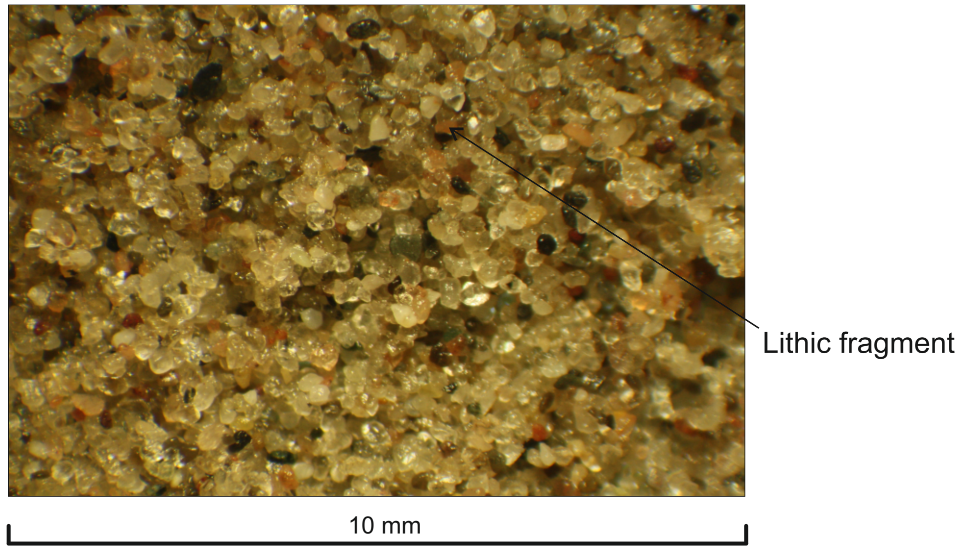
Washed Sample



Washed Sample



Unwashed Sample



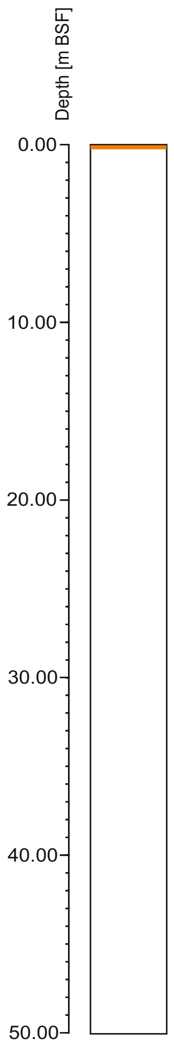
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH01-SA
Sample Name: 4BagA
Depth: 3.00 m BSF

Plate C8.1-1

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Dark Yellowish brown (10YR–4/4) subangular to subrounded (rK = 0.3 to 0.6) medium to high sphericity (rK = 0.6 to 0.8) fine SAND

Colour:
Unwashed: Yellowish brown (10YR–4/4)
Washed: Light grey (2.5Y–7/2)

Sand is moderately sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

80 % - Fine sand-sized subangular to subrounded (rK = 0.4 to 0.6) low to medium sphericity (rK = 0.4 to 0.6) QUARTZ
  ~ 60 % clear, translucent
  ~ 40 % clear, glassy

7 % - Fine to medium sand-sized subangular (rK = 0.3) low to medium sphericity (rK = 0.3 to 0.6) white to orange FELDSPAR

5 % - Fine sand-sized subangular to subrounded (rK = 0.3 to 0.6) low to high sphericity (rK = 0.4 to 0.9) black BIOTITE

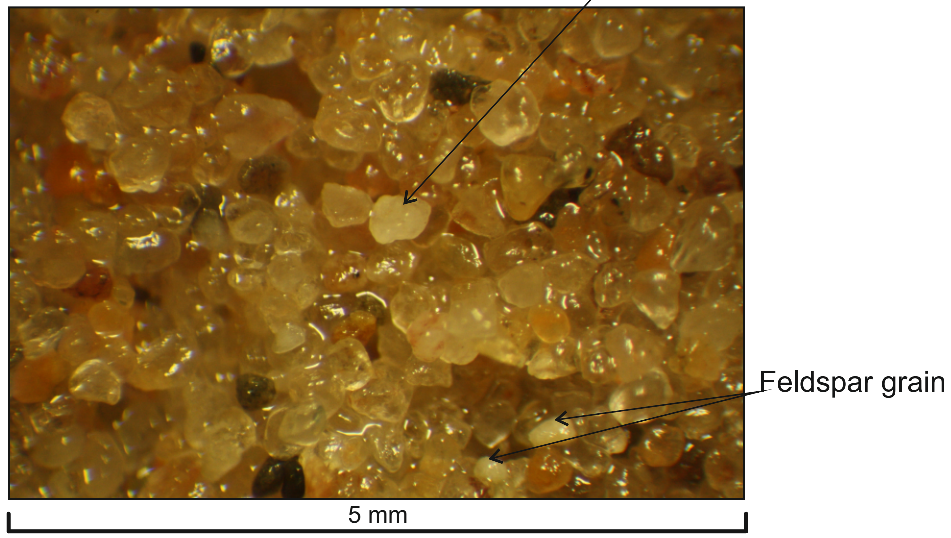
5 % - Fine to medium sand-sized angular to subrounded (rK = 0.2 to 0.5) low to medium sphericity (rK = 0.3 to 0.6)brown to black LITHIC FRAGMENTS

3 % - Medium sand-sized angular (rK = 0.2) low sphericity (rK = 0.3)white BIOCLASTIC FRAGMENTS

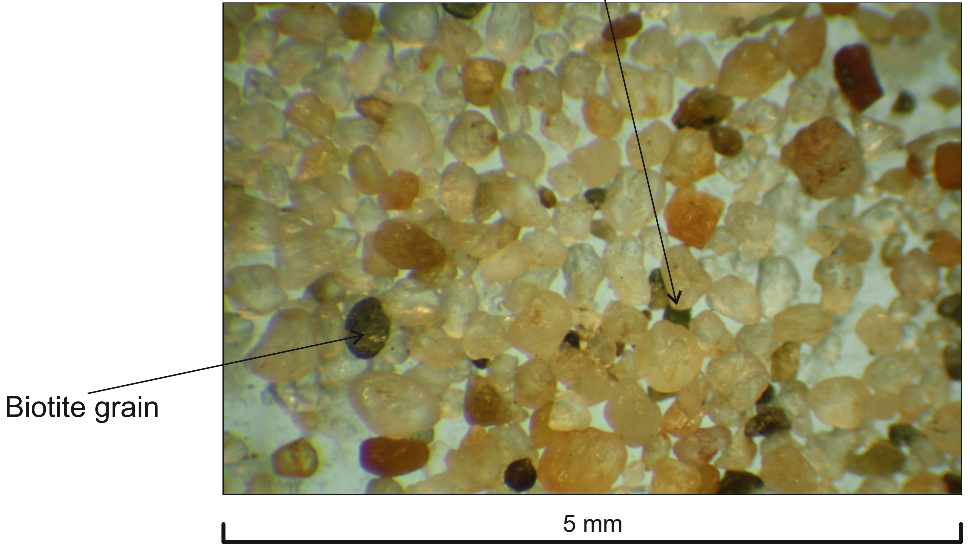
Trace: Glauconite

Reflected Light Microphotographs

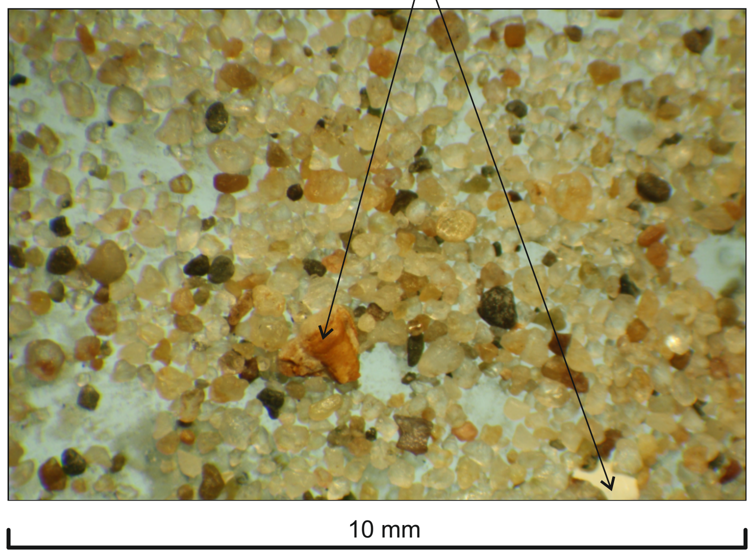
Unwashed Sample



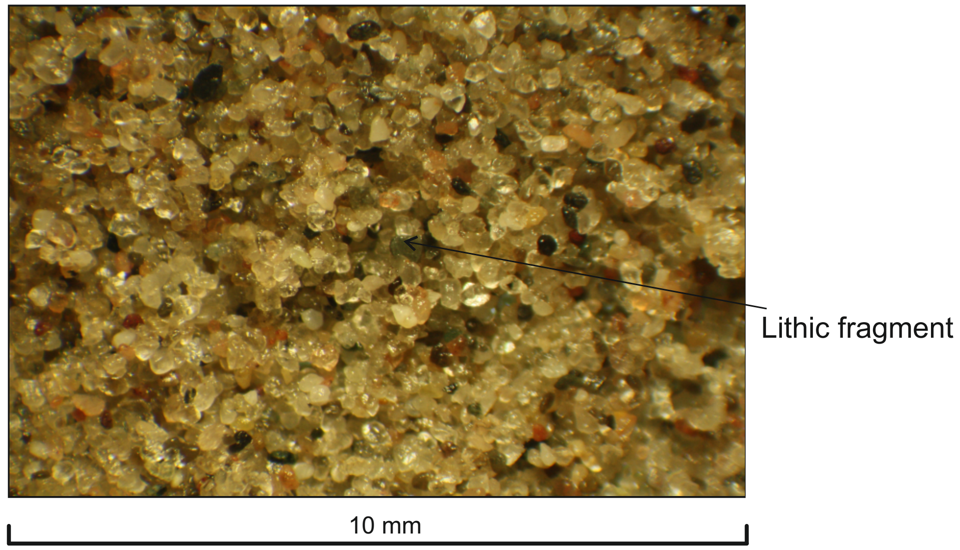
Washed Sample



Washed Sample



Unwashed Sample



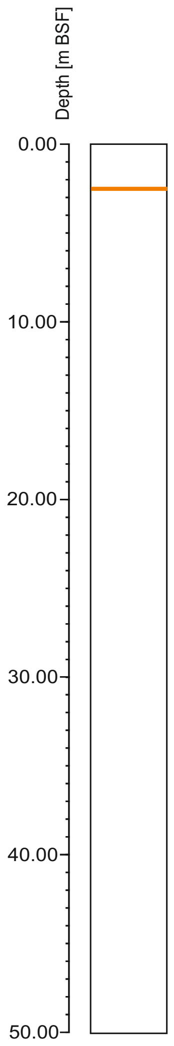
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH02-SA
Sample Name: 1BagA
Depth: 0.00 m BSF

Plate C8.1-2

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Grey (2.5Y–5/1) subangular to rounded (rK = 0.3 to 0.7) low to medium sphericity (rK = 0.3 to 0.6) medium SAND

Colour:
Unwashed: Grey (2.5Y – 5/1)
Washed: Light grey (2.5Y – 7/1)

Sand is moderately to well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

85 % - Fine to medium sand-sized subangular to rounded (rK = 0.4 to 0.8) medium to high sphericity (rK = 0.6 to 0.9) QUARTZ
- ~ 70 % clear, glassy
- ~ 30 % clear, translucent

5 % - Fine to medium sand-sized subangular (rK = 0.4) medium sphericity (rK = 0.5) black BIOTITE

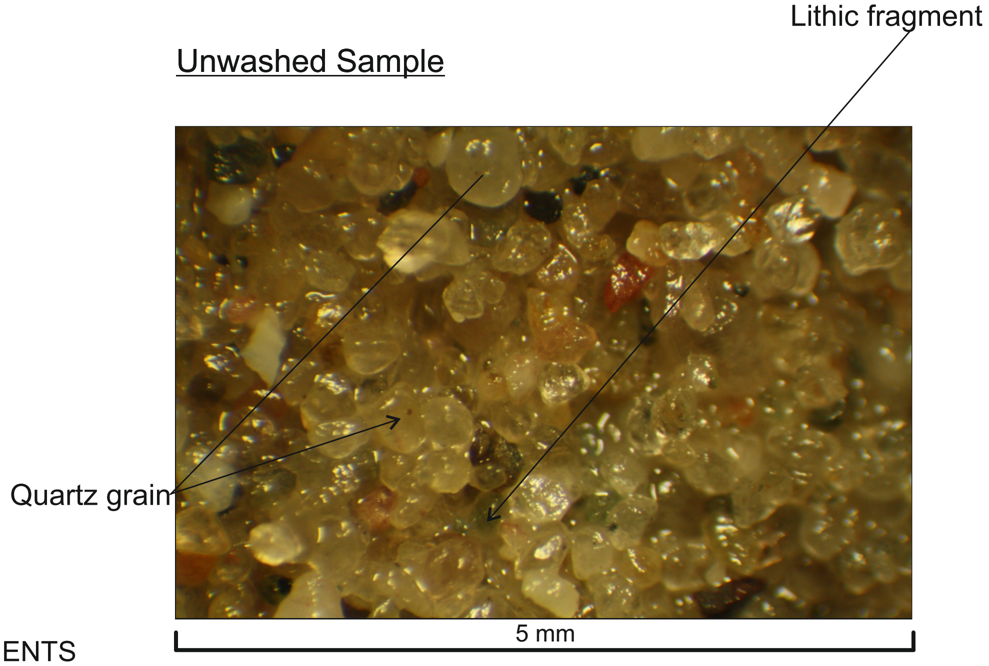
4 % - Fine to medium sand-sized rounded (rK = 0.7) medium to high sphericity (rK = 0.5 to 0.9)red to brown LITHIC FRAGMENTS

3 % - Fine to medium sand-sized subrounded (rK = 0.5) medium to high sphericity (rK = 0.6 to 0.8) white/translucent FELDSPAR

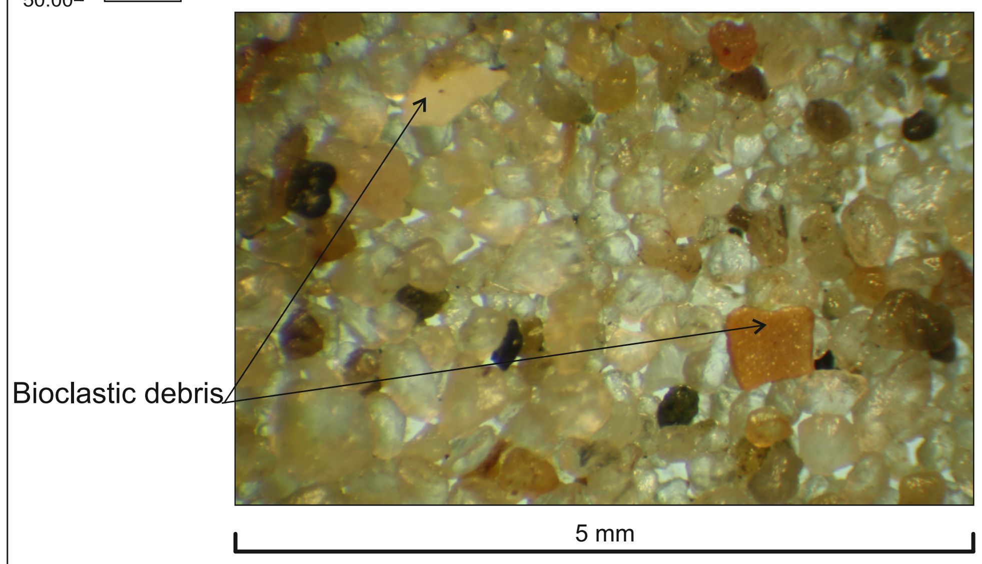
3 % - Medium sand-sized angular to subangular (rK = 0.2 to 0.4) low sphericity (rK = 0.3) white BIOCLASTIC FRAGMENTS

Reflected Light Microphotographs

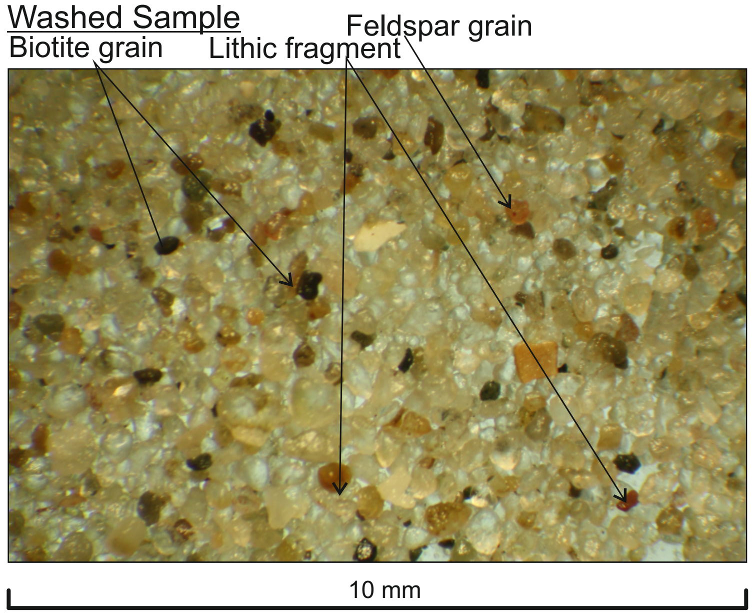
Unwashed Sample



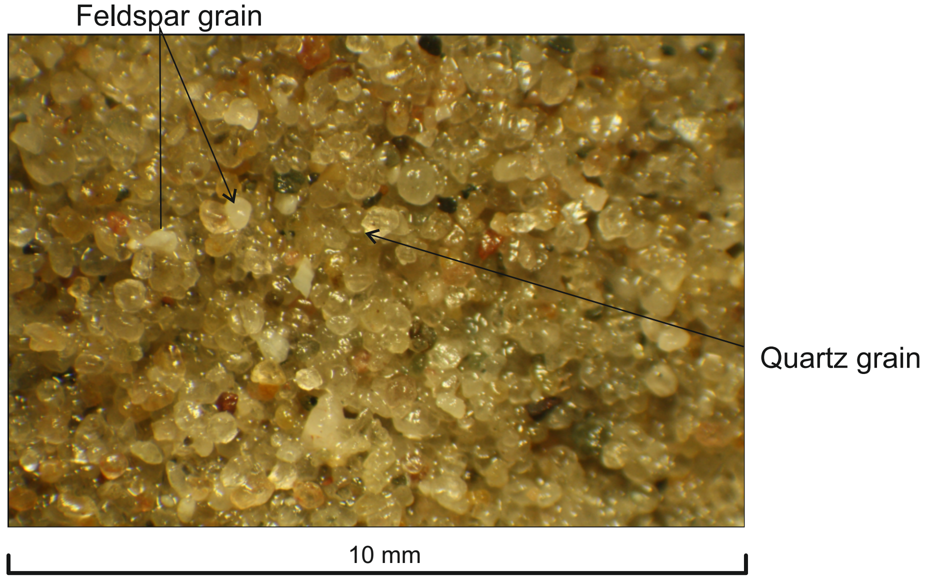
Washed Sample



Washed Sample



Unwashed Sample



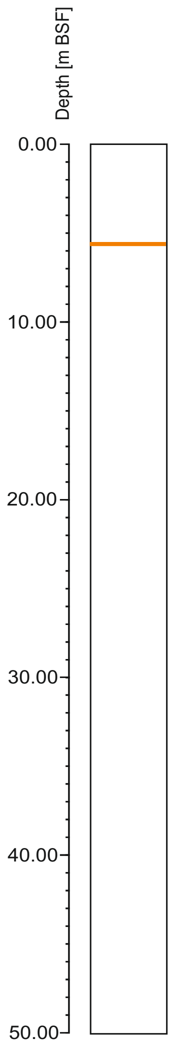
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH03-SA
Sample Name: 6BagA
Depth: 2.50 m BSF

Plate C8.1-3

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Dark greyish brown (2.5Y–4/2) subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) medium SAND with shell fragments

Colour:
Unwashed: Dark greyish brown (2.5Y-4/2)
Washed: Light grey (2.5Y-7/1)

Sand is well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

85 % - Medium sand-sized subangular to rounded (rK = 0.4 to 0.8) medium to high sphericity (rK = 0.6 to 0.9) QUARTZ
- ~ 23 % clear, translucent
- ~ 75 % clear, glassy
- ~ 2 % light pink

5 % - Fine to medium sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium sphericity (rK = 0.5) black BIOTITE

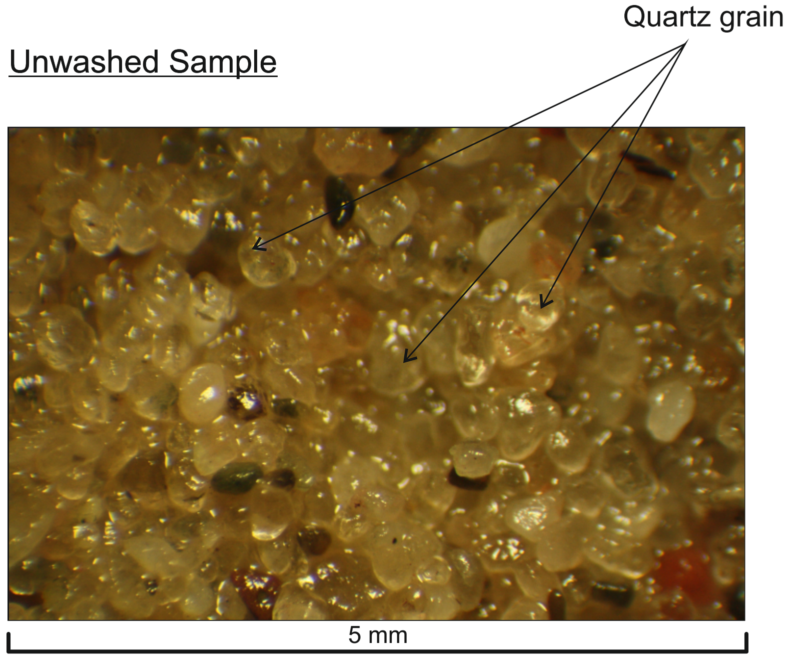
5 % - Medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.6) orange FELDSPAR

5 % - Fine to medium sand-sized subangular (rK = 0.4) low to medium sphericity (rK = 0.4 to 0.6) red to black LITHIC FRAGMENTS

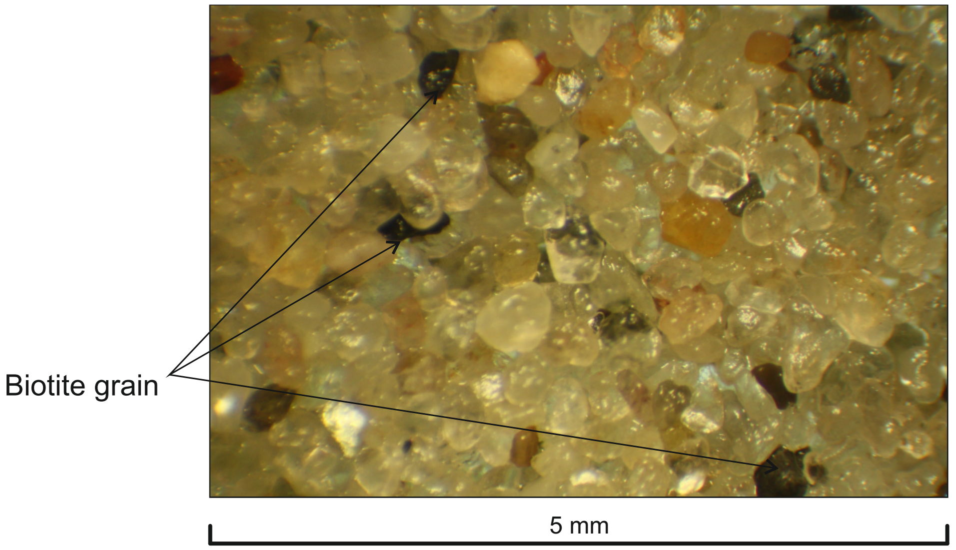
Trace: glauconite

Reflected Light Microphotographs

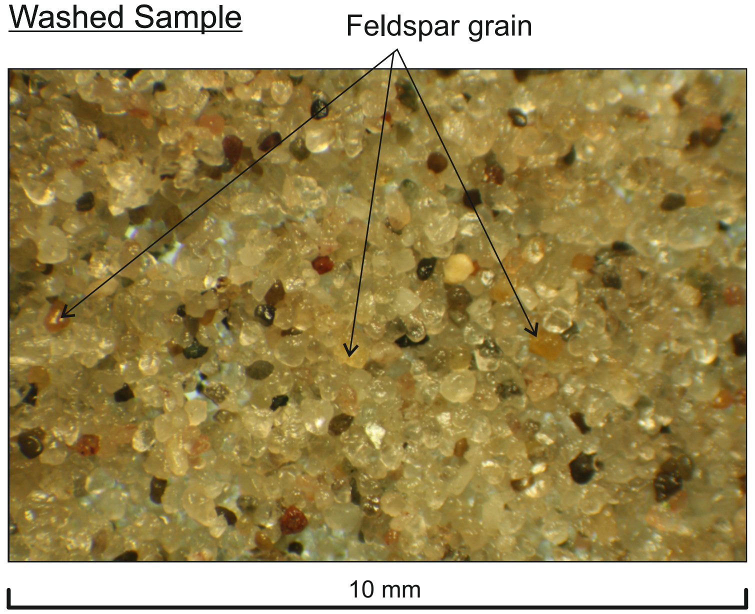
Unwashed Sample



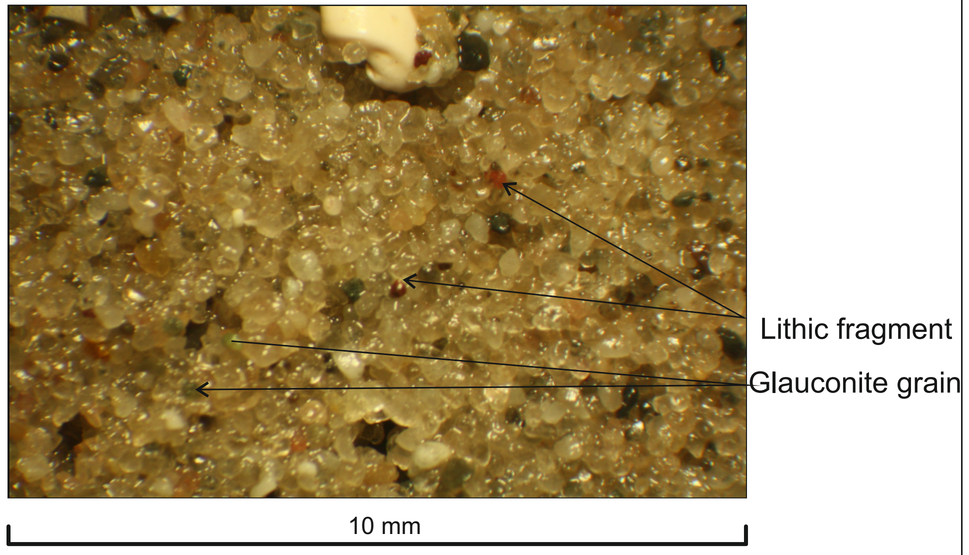
Washed Sample



Washed Sample



Unwashed Sample



N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH03-SA
Sample Name: 10BagA
Depth: 5.50 m BSF

Plate C8.1-4

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description

Sample Description

Hand-Specimen Description
Olive brown (2.5Y–4/3) subangular to subrounded (rK = 0.3 to 0.5) low to medium sphericity (rK = 0.4 to 0.6) fine to medium grained SAND with shell fragments

Colour:
Unwashed: Olive brown (2.5Y-4/3)
Washed: Light yellowish brown (2.5Y–6/3)

Sand is moderately sorted
Strong reaction to HCL

Microscope Description
Unwashed sample shows some coating of clay/silt

75 % - Medium sand-sized rounded (rK = 0.7) medium to high (rK = 0.6 to 0.8) sphericity QUARTZ
- ~ 85 % clear, glassy
- ~ 15% clear, translucent

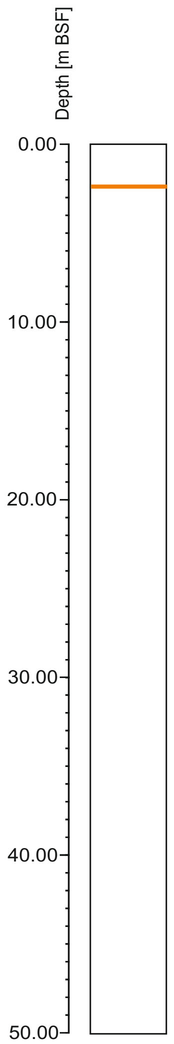
10 % - Medium to coarse sand sized angular (rK = 0.1) low sphericity (rK = 0.3) white BIOCLASTIC FRAGMENTS

7 % - Fine to coarse sand-sized subangular to rounded (rK = 0.3 to 0.8) low to high sphericity (rK = 0.4 to 0.9) white to brown LITHIC FRAGMENTS

5 % - Fine to medium sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium to high sphericity (rK = 0.6 to 0.9) black BIOTITE

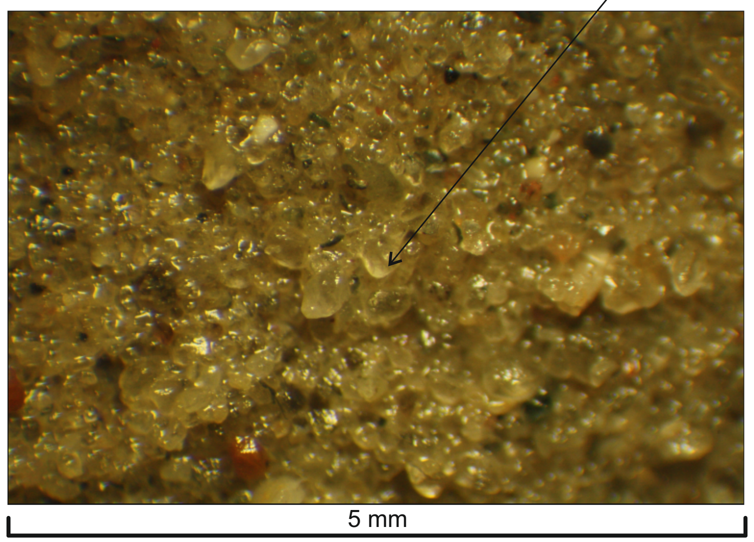
3 % - Fine to medium sand-sized subrounded (rK = 0.5) medium sphericity (rK = 0.5) pink to red FELDSPAR

Trace: Glauconite

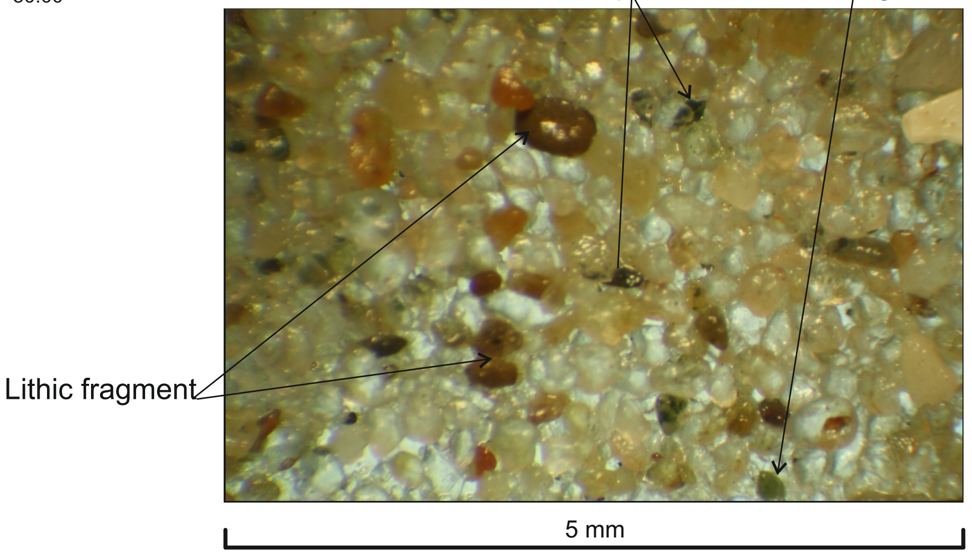


Reflected Light Microphotographs

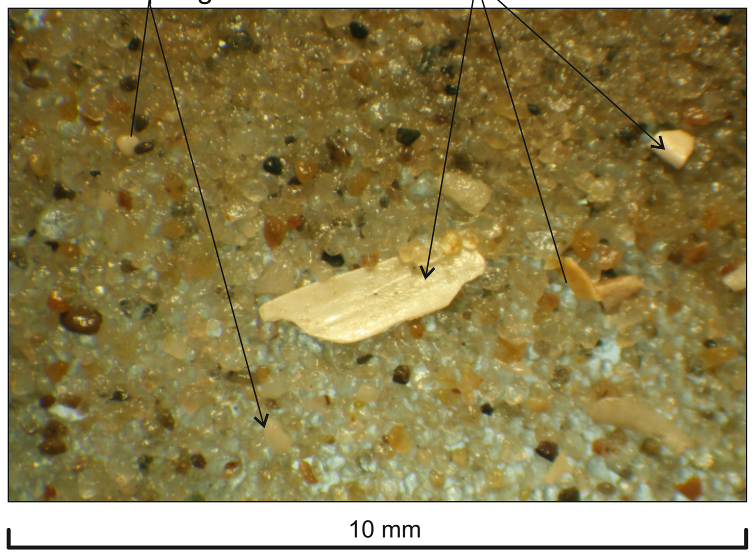
Unwashed Sample



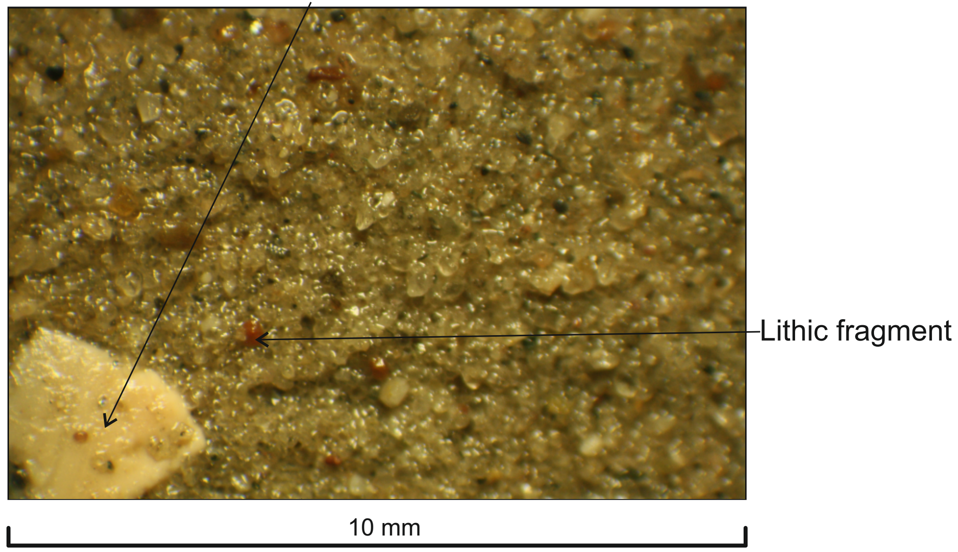
Washed Sample



Washed Sample



Unwashed Sample



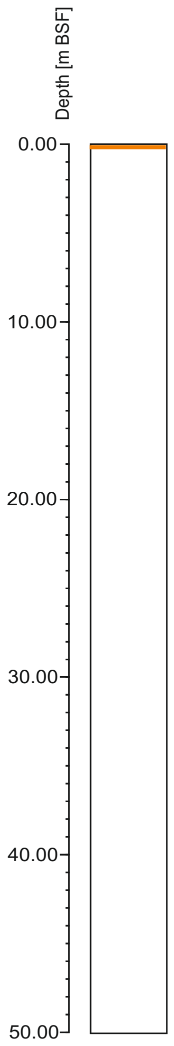
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH04-SA
Sample Name: 3BagB
Depth: 2.30 m BSF

Plate C8.1-5

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Olive brown (2.5Y–4/6) subrounded to rounded (rK = 0.5 to 0.8) medium to high sphericity (rK = 0.6 to 0.9) fine to medium grained SAND

Colour:
Unwashed: Olive brown (2.5Y–4/6)
Washed: White (2.5Y–8/1)

Sand is very well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

85 % - Fine to medium sand-sized subangular to subrounded (rK = 0.4 to 0.6) medium to high sphericity (rK = 0.6 to 0.9) QUARTZ
- ~ 70 % clear, translucent
- ~ 30 % clear, glassy

7 % - Fine sand-sized subrounded medium sphericity black BIOTITE

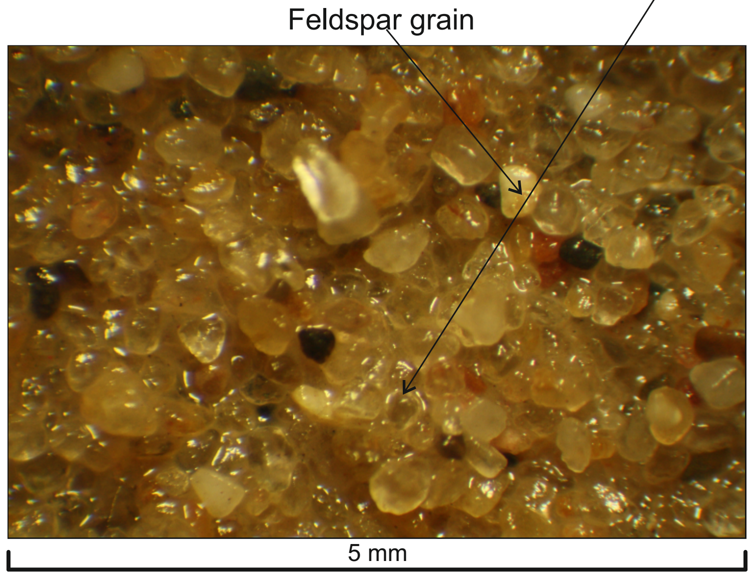
5 % - Fine to medium sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium to high sphericity (rK = 0.5 to 0.9) orange to white FELDSPAR

3 % - Fine sand-sized subrounded (rK = 0.5) medium to high (rK = 0.6 to 0.8) sphericity brown to dark green LITHIC FRAGMENTS

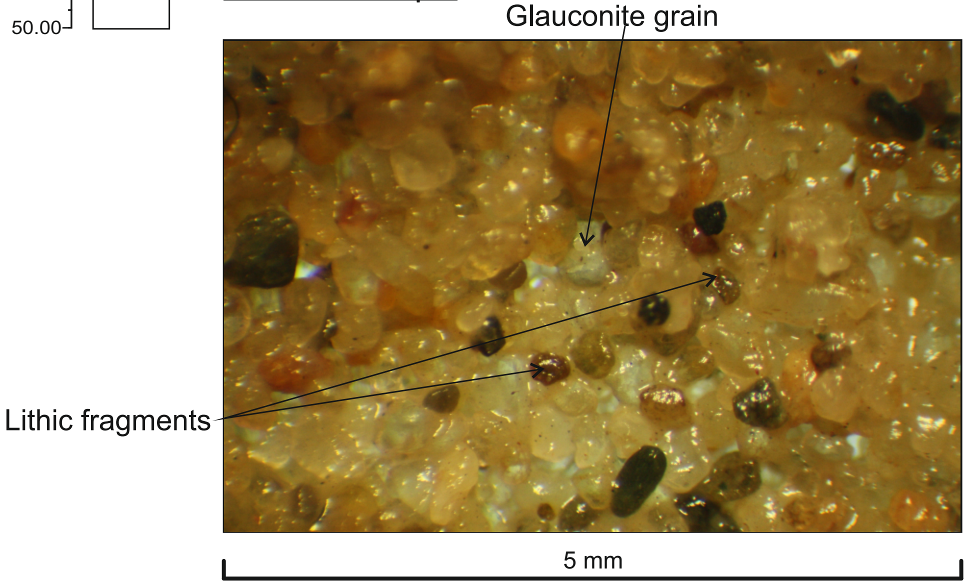
Trace: bioclastic fragments, glauconite, muscovite

Reflected Light Microphotographs

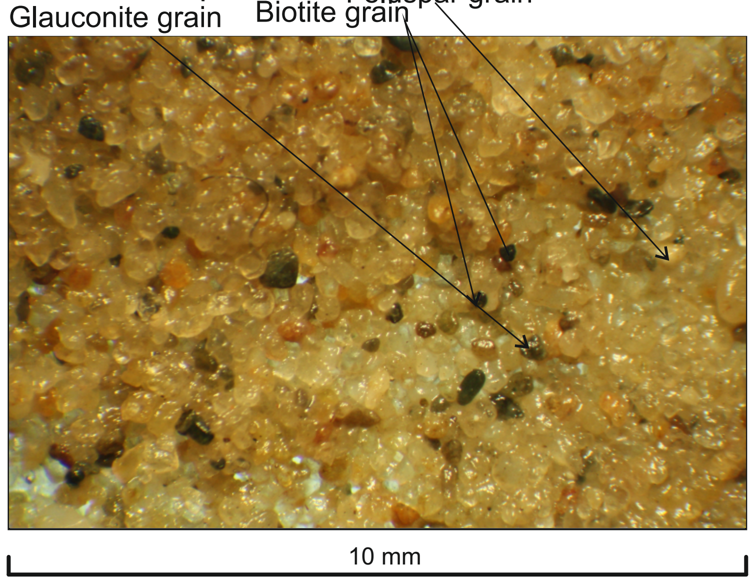
Unwashed Sample



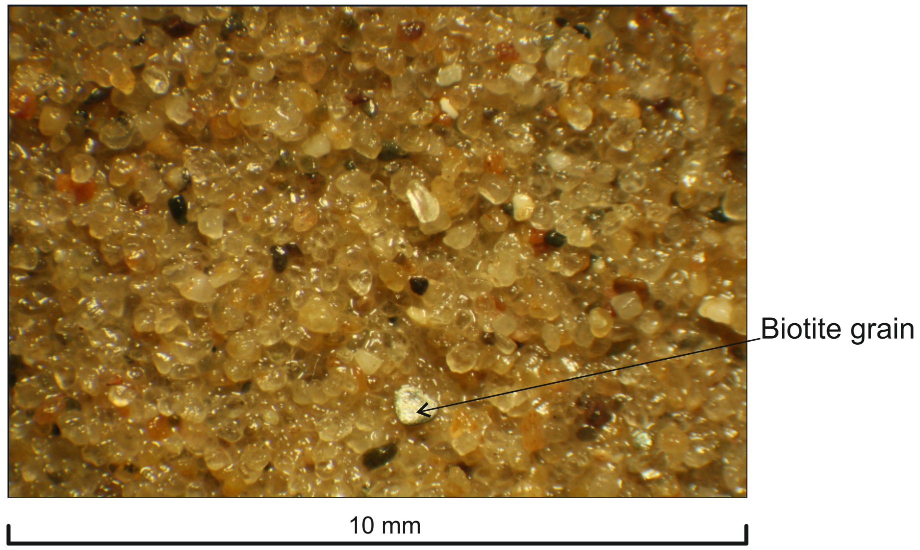
Washed Sample



Washed Sample



Unwashed Sample



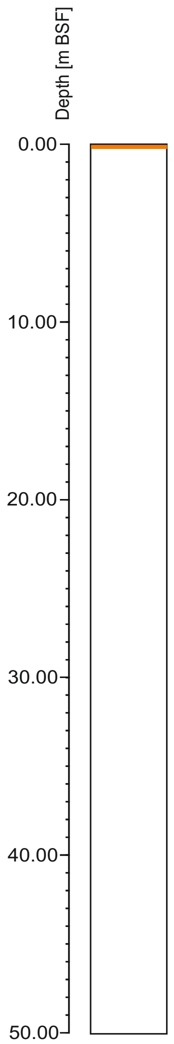
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH05-SA
Sample Name: 1BagA
Depth: 0.00 m BSF

Plate C8.1-6

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Olive yellow (2.5Y–6/8) subangular to rounded (rK = 0.4 to 0.7) with medium to high sphericity (rK = 0.6 to 0.9) fine to medium SAND

Colour:
Unwashed: Olive yellow (2.5Y–6/8)
Washed: Light yellowish brown (2.5Y–6/3)

Sand is very well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

95 % - Medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) QUARTZ
- ~ 85 % clear, glassy
- ~ 8 % orange to reddish brown
- ~ 7 % clear, translucent

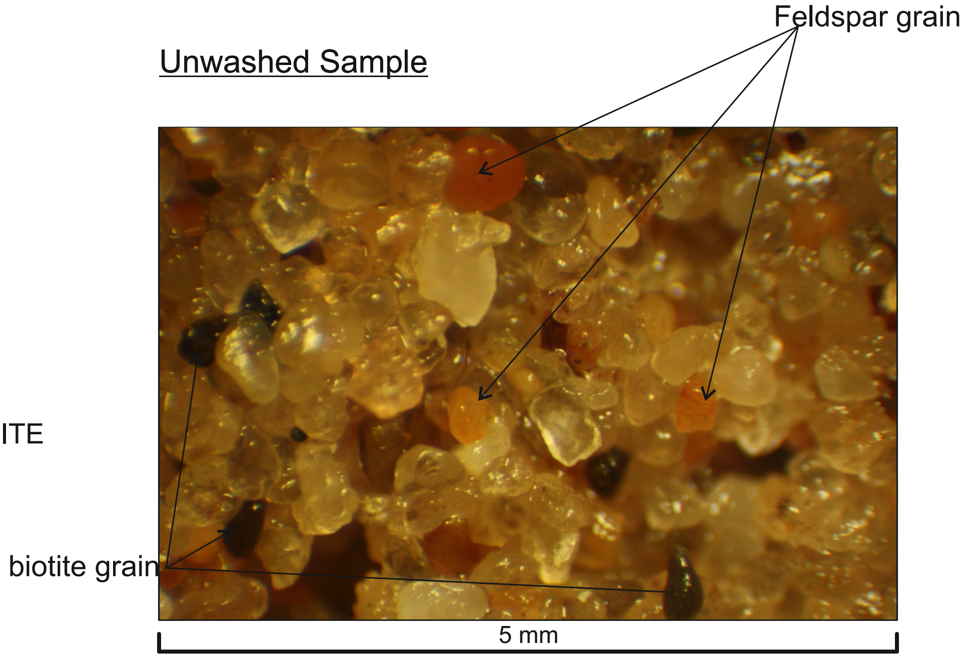
3 % - Fine sand-sized subangular to subrounded (rK = 0.4 to 0.6) low to medium (rK = 0.3 to 0.6) sphericity black BIOTITE

2 % - Fine to medium sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium sphericity (rK = 0.6) orange to red FELDSPAR

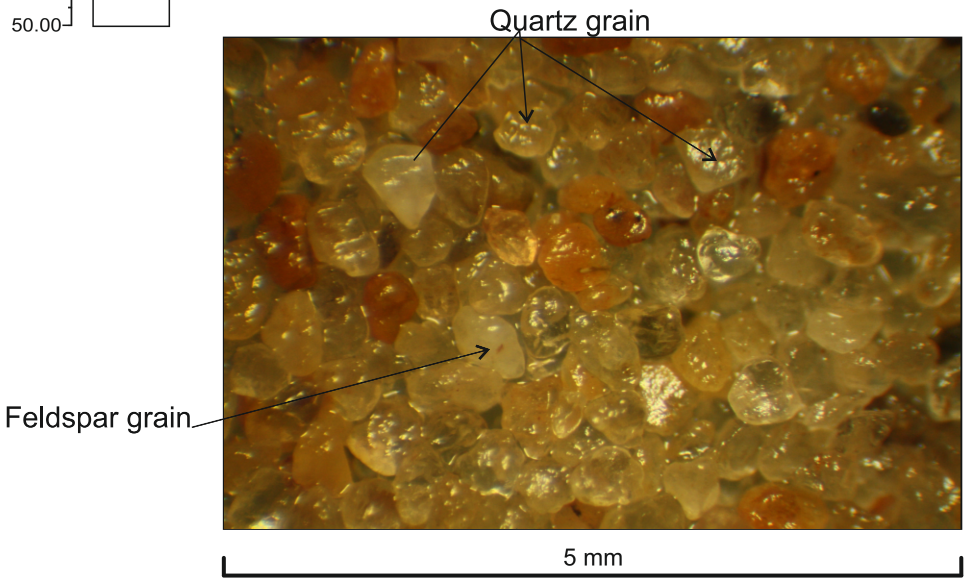
Trace: lithic fragments, bioclastic fragments

Reflected Light Microphotographs

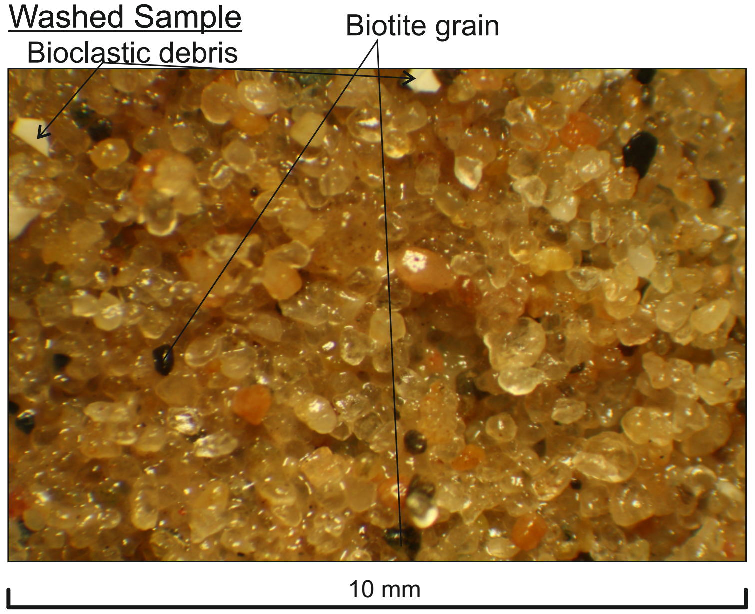
Unwashed Sample



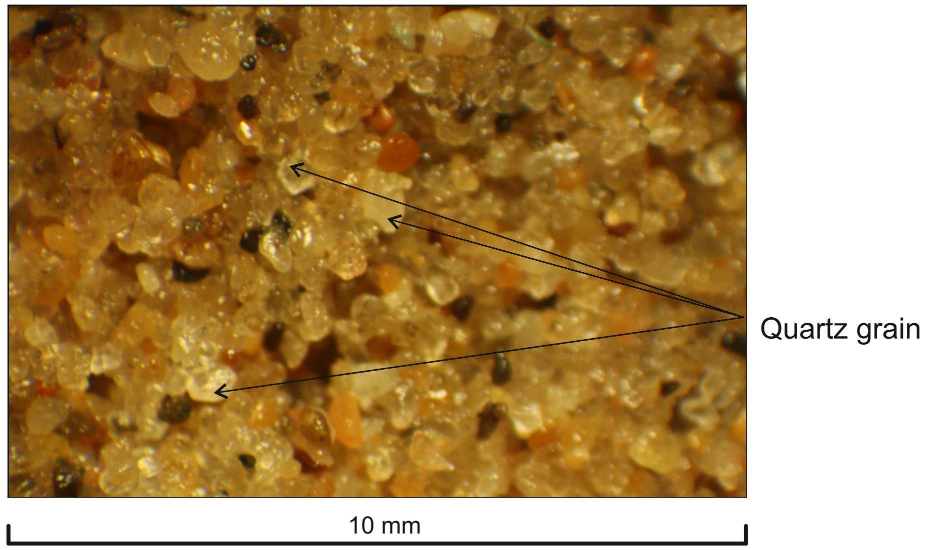
Washed Sample



Washed Sample



Unwashed Sample



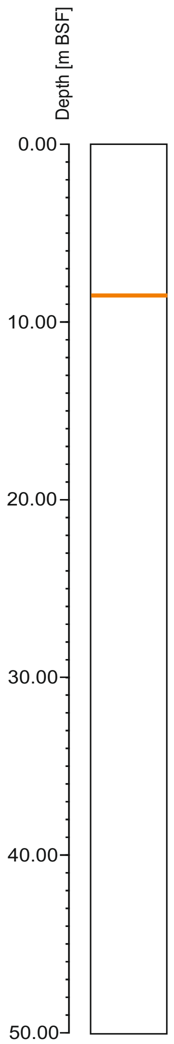
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH06-SA
Sample Name: 1BagA
Depth: 0.00 m BSF

Plate C8.1-7

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Olive brown (2.5Y–4/3) rounded (rK = 0.7) high sphericity (rK = 0.9) fine to medium SAND

Colour:
Unwashed: Olive yellow (2.5Y–6/8)
Washed: Light yellowish brown (2.5Y–6/3)

Sand is very well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

90% - Medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) QUARTZ
- ~ 85 % clear, glassy
- ~ 15 % clear, translucent

4 % - Fine to medium sand-sized subangular to subrounded (rK = 0.4 to 0.6) low to medium sphericity (rK = 0.4 to 0.6) green to brown LITHIC FRAGMENTS

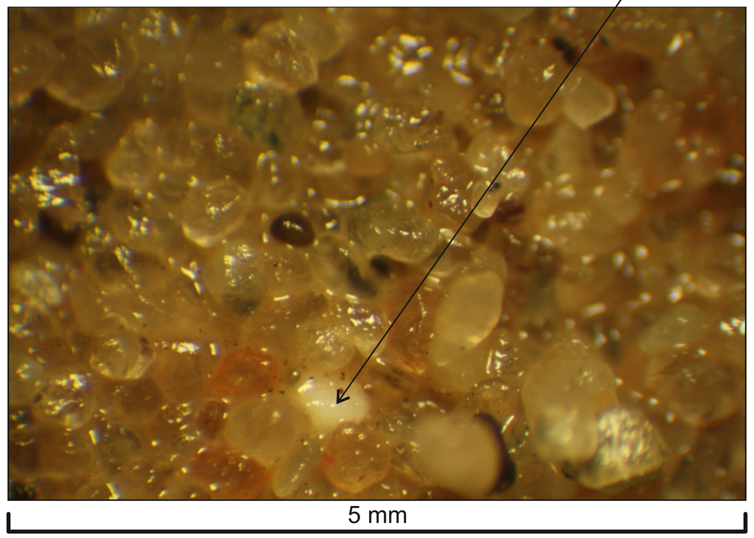
3 % - Fine sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium sphericity (rK = 0.6) black BIOTITE

3 % - Fine sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium sphericity (rK = 0.5) orange FELDSPAR

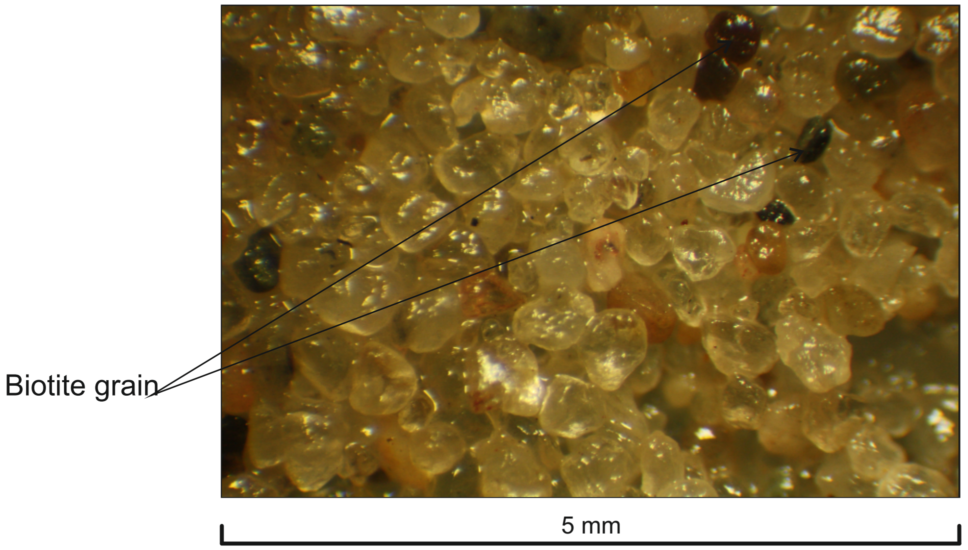
Trace: glauconite

Reflected Light Microphotographs

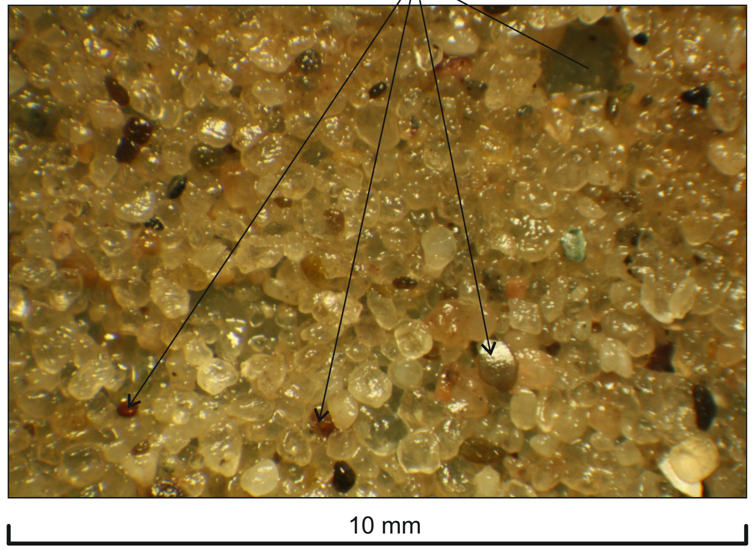
Unwashed Sample



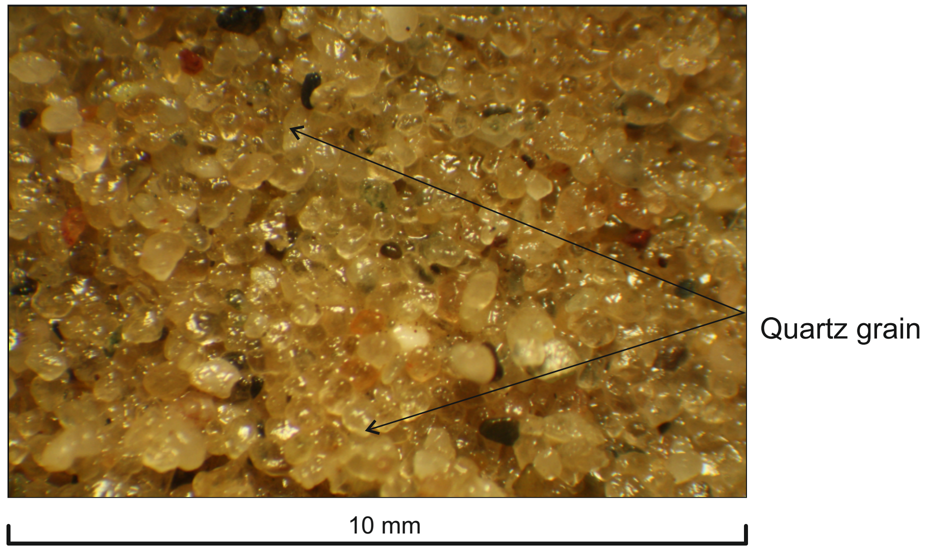
Washed Sample



Washed Sample



Unwashed Sample



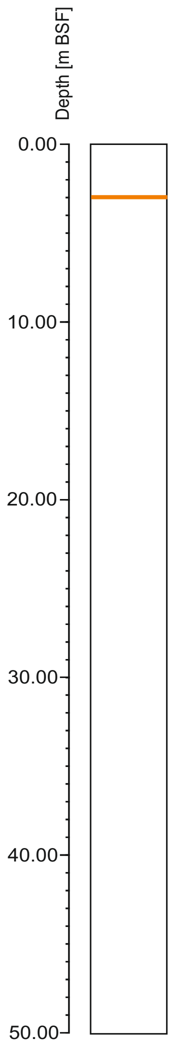
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH06-SA
Sample Name: 11BagA
Depth: 8.50 m BSF

Plate C8.1-8

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Very dark greyish brown (2.5Y–3/2) subrounded (rK = 0.6) high sphericity (rK = 0.9) fine to medium SAND

Colour:
Unwashed: Very dark greyish brown (2.5Y–3/2)
Washed: White (2.5Y–8/1)

Sand is very well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows no coating of clay/silt

90 % - Fine to medium sand-sized subrounded to rounded (rK = 0.6 to 0.8) medium to high sphericity (rK =0.6 to 0.9) QUARTZ
~ 80 % clear, glassy
~ 20 % clear, translucent

5 % - Fine sand-sized subangular (rK = 0.4) low to medium sphericity (rK = 0.4 to 0.6) black BIOTITE

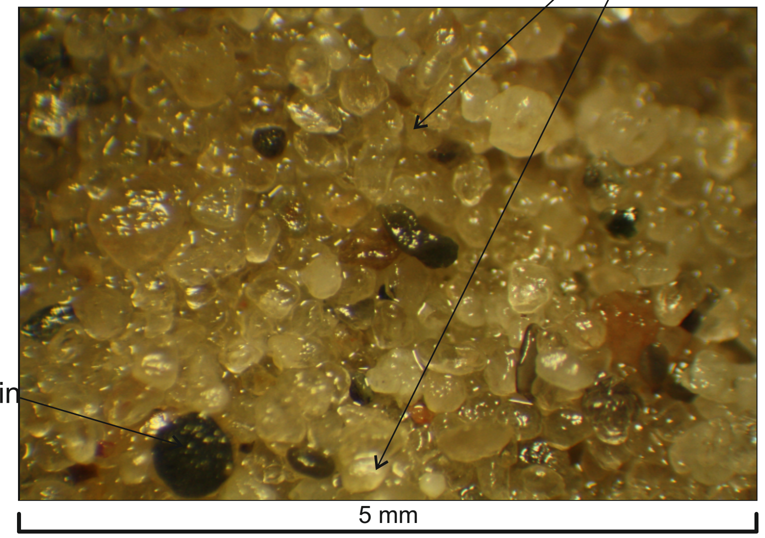
3 % - Fine sand-sized angular to subangular (rK = 0.2 to 0.4) low to medium sphericity (rK = 0.4 to 0.6) orange to white FELDSPAR

2 % - Fine to medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) low sphericity (rK = 0.3) green to black LITHIC FRAGMENTS

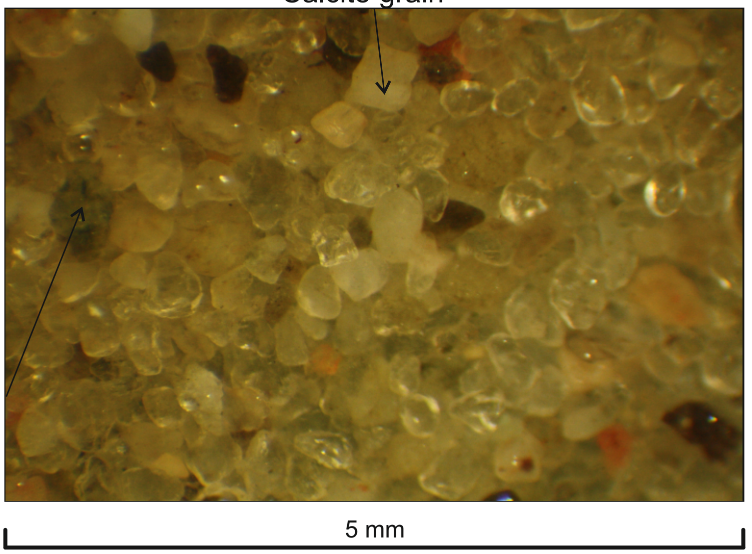
Trace: calcite, glauconite

Reflected Light Microphotographs

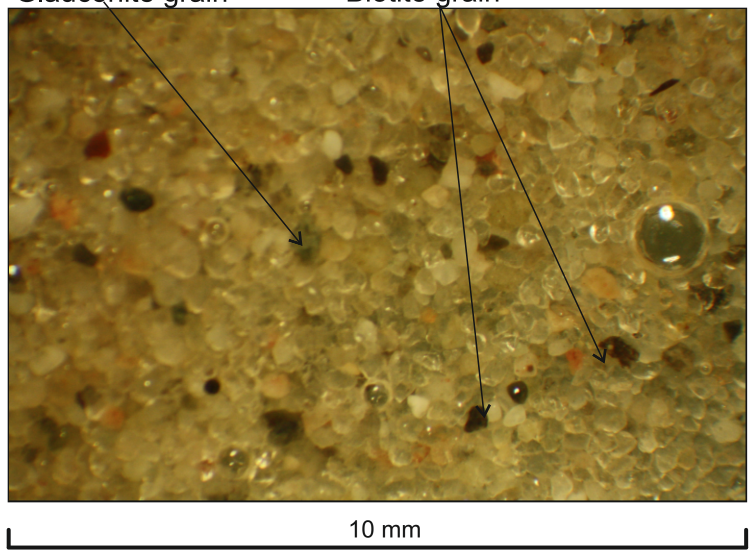
Unwashed Sample



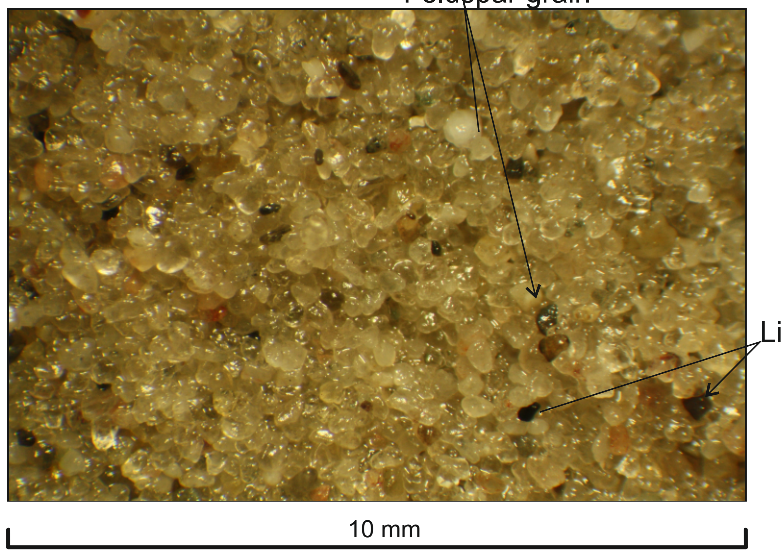
Washed Sample



Washed Sample



Unwashed Sample



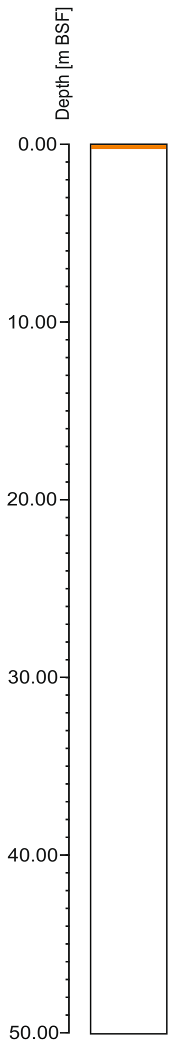
N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH07-SA
Sample Name: 4BagA
Depth: 3.00 m BSF

Plate C8.1-9

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

Sample Microscope Description



Sample Description

Hand-Specimen Description
Greyish brown (2.5Y–5/2) subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) fine to medium SAND

Colour:
Unwashed: Greyish brown (2.5Y–5/2)
Washed: Light grey (2.5Y–7/1)

Sand is well sorted
Limited reaction to HCL

Microscope Description
Unwashed sample shows minor coating of clay/silt

80 % - Medium sand-sized subangular to rounded (rK = 0.3 to 0.7) medium to high sphericity (rK = 0.6 to 0.9) QUARTZ
- ~ 75 % clear, translucent
- ~ 20 % clear, glassy
- ~ 5 % orange to reddish brown

7 % - Fine to medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.5) milky white to red FELDSPAR

5 % - Fine to medium sand-sized subangular to subrounded (rK = 0.3 to 0.6) medium sphericity (rK = 0.6) black BIOTITE

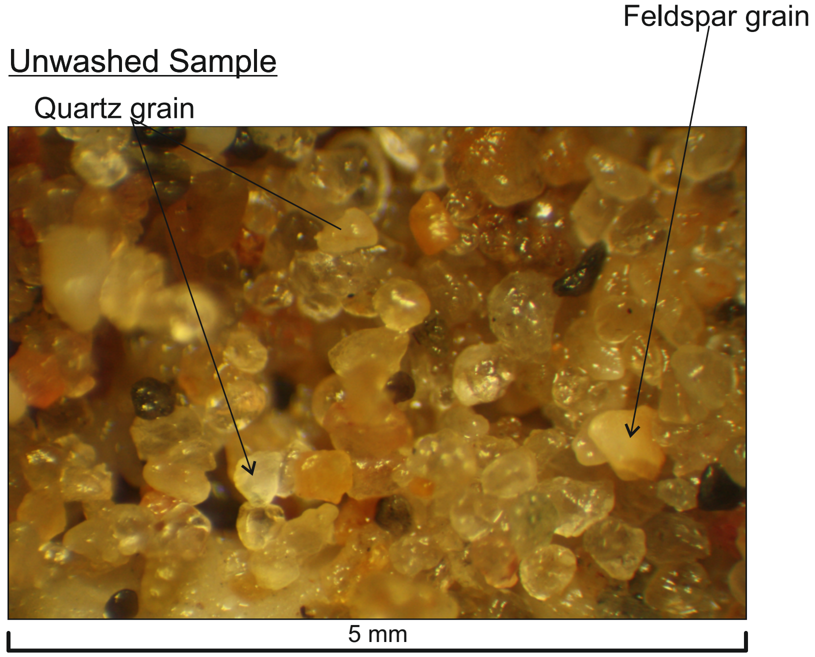
5 % - Medium sand-sized subangular to subrounded (rK = 0.4 to 0.6) medium sphericity (rK = 0.6)green to brown LITHIC FRAGMENTS

3 % - Medium sand-sized subangular to subrounded (rK = 0.3 to 0.5) medium sphericity (rK = 0.5) green GLAUCONITE

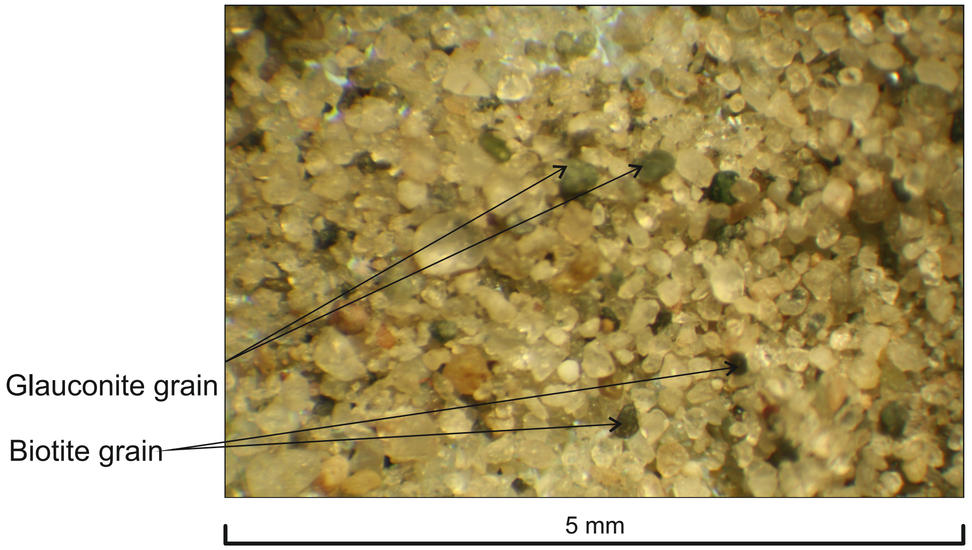
Trace: bioclastic fragments

Reflected Light Microphotographs

Unwashed Sample



Washed Sample



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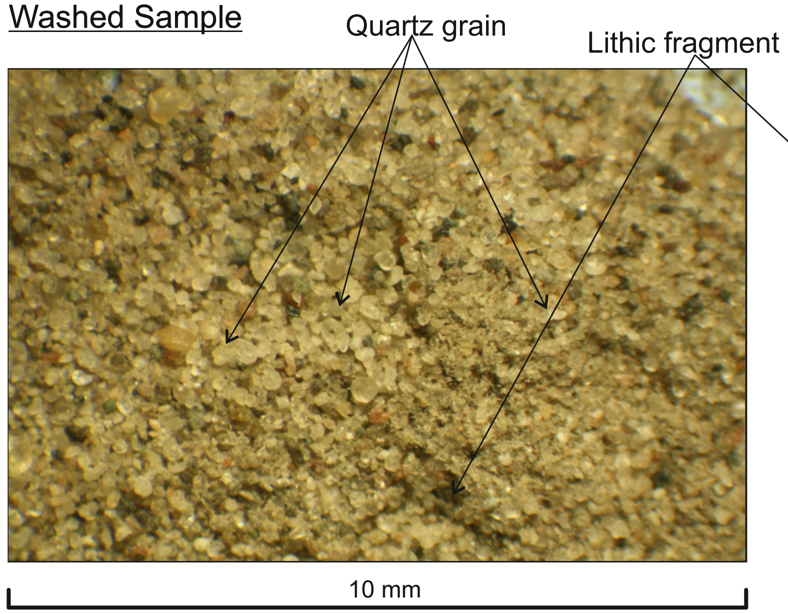
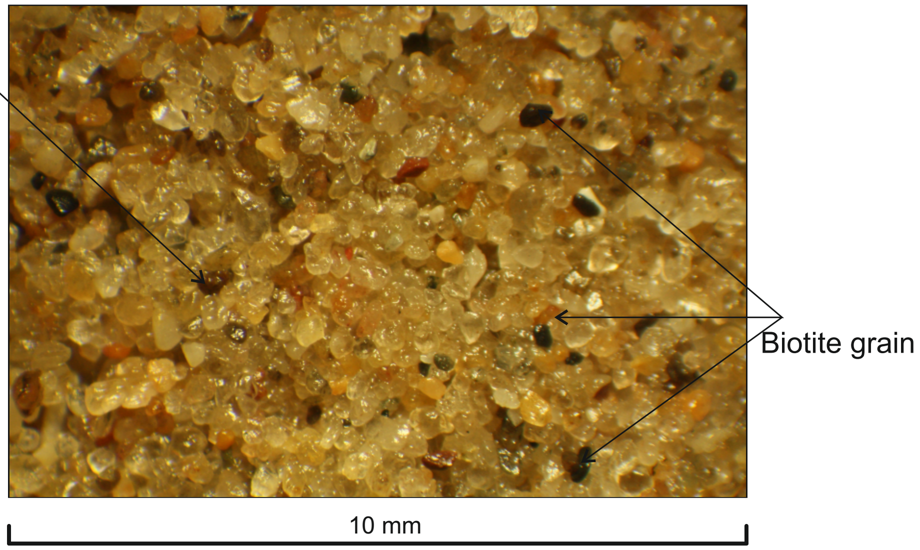


Unwashed Sample



N6196 - Hollandse Kust (zuid) WFZ - Wind Farm Site I
Detailed Microscopy Description
Fugro Report No. N6196/01 (3)

Sample Location: HKZ1-BH08-SA
Sample Name: 1BagA
Depth: 0.00 m BSF

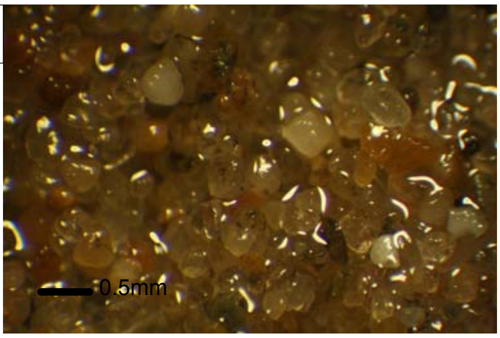
Plate C8.1-10

Made:	WH	26/08/2016
Checked:	GML	02/09/2016
Approved:	CAS	02/09/2016

A - HKZ1-BH01-SA
1BAGA (0.00m)
FOV 5mm
washed

B - HKZ1-BH01-SA
1BAGA (0.00m)
FOV 10mm
unwashed

A



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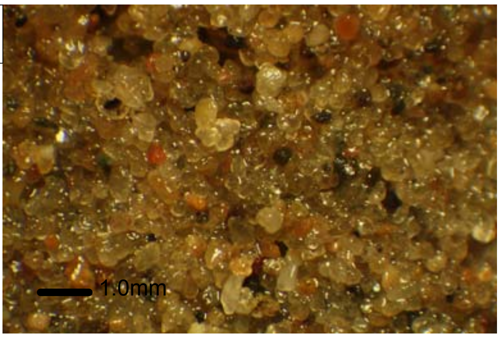
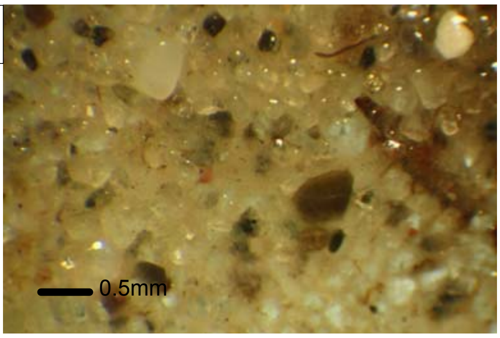


C - HKZ1-BH02-SA
4BAGA (2.50m)
FOV 5mm
washed

D - HKZ1-BH02-SA
4BAGA (2.50m)
FOV 10mm
unwashed

C

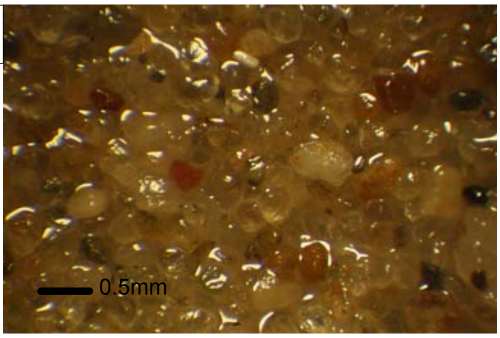


D

E - HKZ1-BH03-SA
1BAGA1 (0.00m)
FOV 5mm
washed

F - HKZ1-BH03-SA
1BAGA1 (0.00m)
FOV 10mm
unwashed

E



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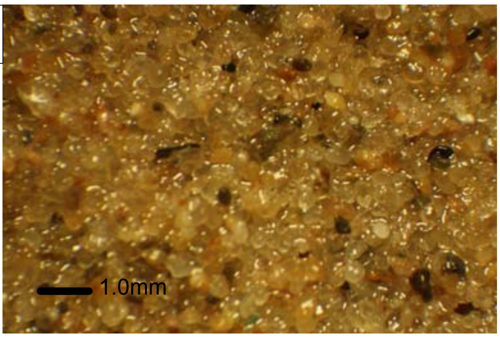
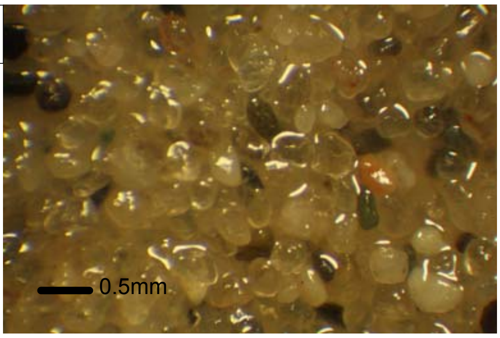


G - HKZ1-BH03-SA
1BAGA2 (0.15m)
FOV 5mm
washed

H - HKZ1-BH03-SA
1BAGA2 (0.15m)
FOV 10mm
unwashed

G



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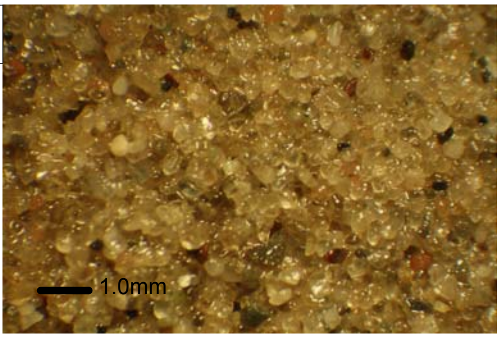
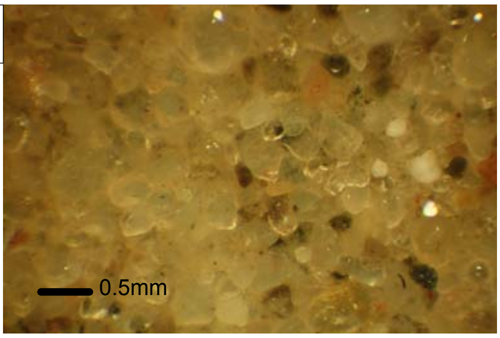


I - HKZ1-BH03-SA
15BAGA (8.00m)
FOV 5mm
washed

J - HKZ1-BH03-SA
15BAGA (8.00m)
FOV 10mm
unwashed

I



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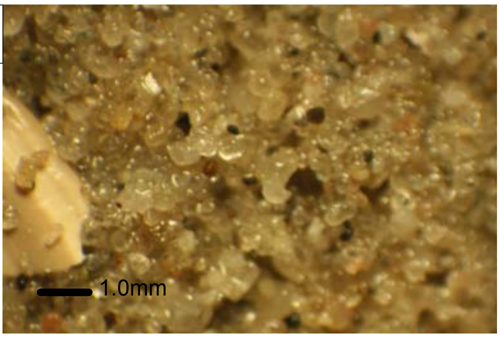
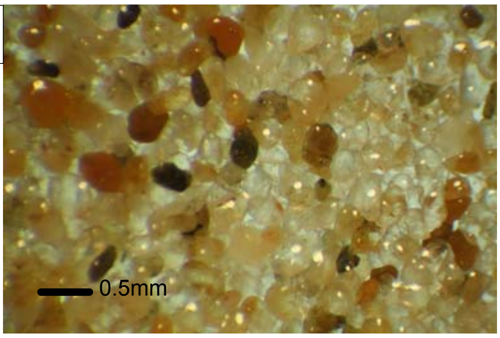


K - HKZ1-BH04-SA
1BAGA (0.0m)
FOV 5mm
washed

L - HKZ1-BH04-SA
1BAGA (0.00m)
FOV 10mm
unwashed

K



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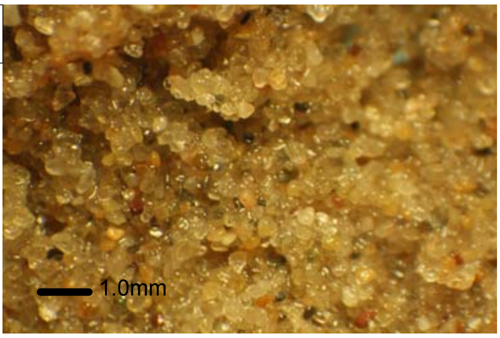
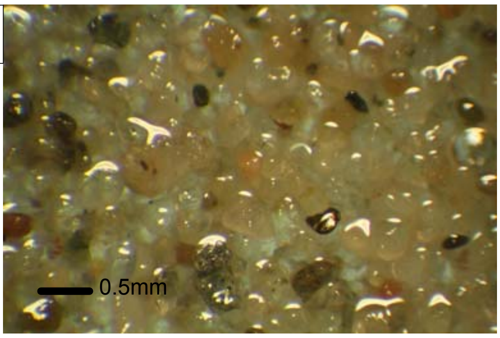


M - HKZ1-BH05-SA
3BAGA (2.00m)
FOV 5mm
washed

N - HKZ1-BH05-SA
3BAGA (2.00m)
FOV 10mm
unwashed

M



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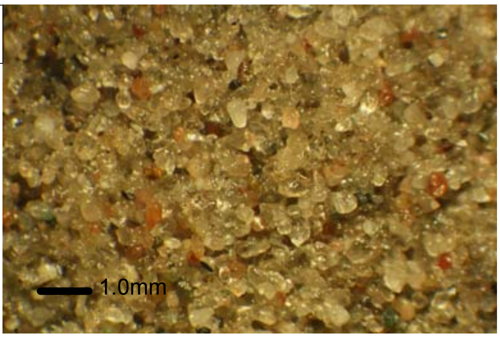
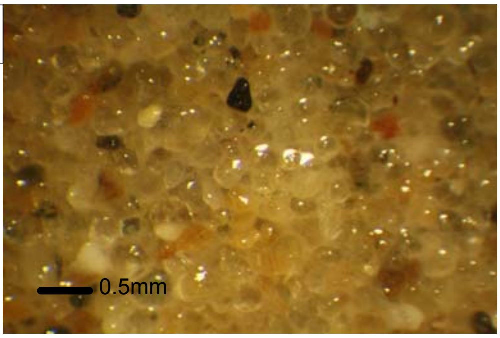


O - HKZ1-BH06-SA
4BAGB (3.30m)
FOV 5mm
washed

P - HKZ1-BH06-SA
4BAGB (3.30m)
FOV 10mm
unwashed

O



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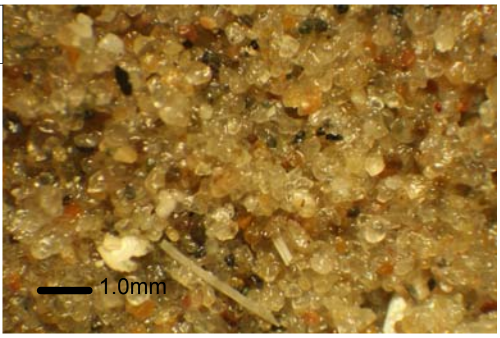
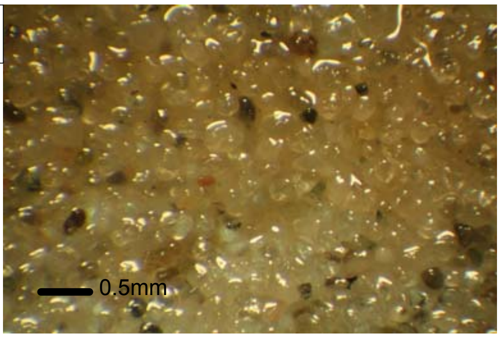


Q - HKZ1-BH06-SA
6BAGB (5.25m)
FOV 5mm
washed

R - HKZ1-BH06-SA
6BAGB (5.25m)
FOV 10mm
unwashed

Q



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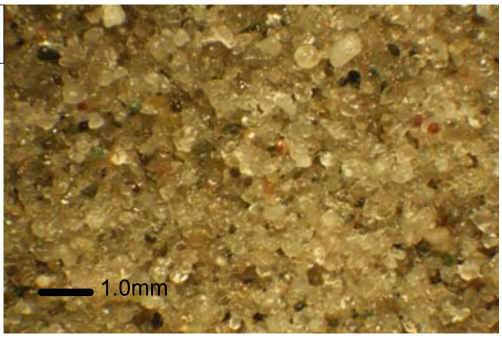
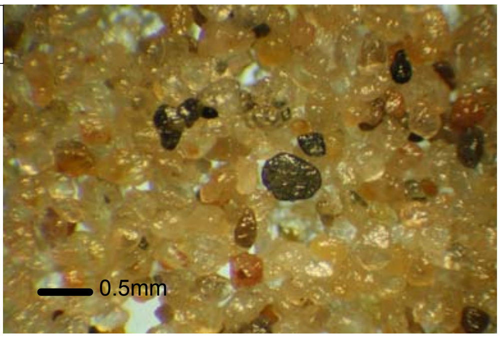


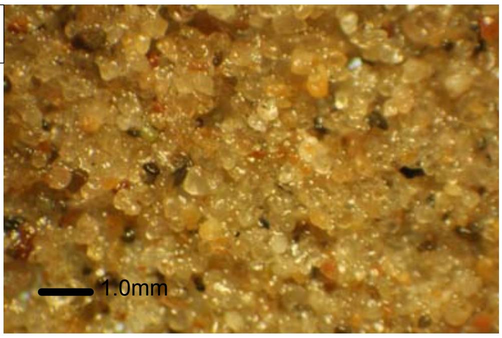
S - HKZ1-BH07-SA
1BAGA (0.00m)
FOV 5mm
washed

T - HKZ1-BH07-SA
1BAGA (0.00m)
FOV 10mm
unwashed

S



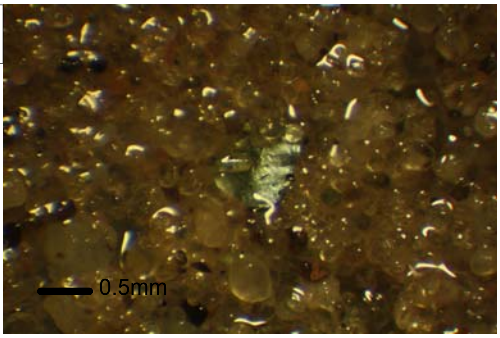
T



U - HKZ1-BH08-SA
3BAGA (2.00m)
FOV 5mm
washed

V - HKZ1-BH08-SA
3BAGA (2.00m)
FOV 10mm
unwashed

U



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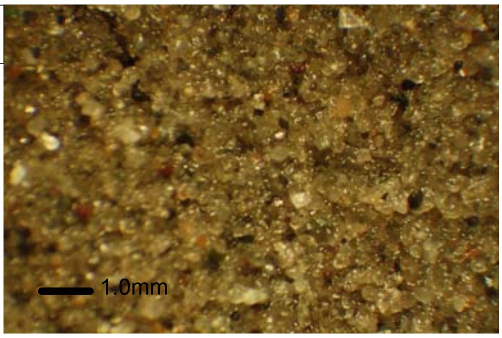


SECTION D: USE OF REPORT

CONTENTS

REPORT ISSUE CONTROL

Section	Page No.	Plate No.	Issue No.	Revision
Section A	A3	-	4	Editorial corrections and additions
Section A	-	All	4	Geotechnical Logs updated
Section C1	C1-5	-	4	Editorial corrections and additions
Section C1	-	Various	4	Summary table for UU triaxial tests, ring shear tests, compressibility tests and thermal conductivity tests updated
Section C2	-	Various	4	Summary of Atterberg Limits added
Summary	i-vi	-	3	Summary text reduced and page numbers/references updated; editorial corrections
Main Text	All	-	3	Editorial corrections and additions
Illustrations	-	All	3	Editorial corrections and additions to Vicinity Map, Detailed Location, Geodetic Parameters, and List of Project Reports, bathymetry chart depths in Coordinates and Water Depth plates revised
Section A	All	-	3	Editorial corrections and additions
Section A	-	All	3	Geotechnical Logs updated
Section B1	Various	-	3	Editorial corrections and additions
Section B2	Various	-	3	Editorial corrections and additions
Section C1	All	-	3	Section text expanded with comments on laboratory test results; editorial corrections and additions; Table C1.1 updated
Section C1	-	All	3	Summary tables added and updated
Section C2	-	All	3	LCTRs updated; PSD plates added; Plasticity Chart updated
Section C4	-	All	3	CIU and CID Triaxial Test results added; UU Triaxial Test results updated and added
Section C5	-	All	3	Ring Shear Test results added
Section C6	-	All	3	Compressibility Test results added
Section C7	-	All	3	Thermal Conductivity Test results added
Section C8	-	All	3	Sample Micro Photographs added
Main Text	All	-	2	Editorial corrections and additions
Main Text	v-viii	-	2	Vicinity Map, Detailed Location Plan and List of Project Reports updated
Illustrations	-	Various	2	Vicinity Map and Detailed Location Plan updated; Geodetic Parameters updated; Coordinates and Water Depth plates updated
Section A	All	-	2	Editorial corrections and additions
Section A	-	All	2	Geotechnical Logs updated
Section B1	All	-	2	Editorial corrections and additions
Section B1	-	All	2	Coordinates and water depths updated
Section B2	All	-	2	Editorial corrections
Section B2	-	Various	2	Shear wave velocity versus Depth plates updated to present Robertson and Cabal correlation
Section C1	All	-	2	Section text expanded with comments on laboratory test results; Table C1.1 added; editorial corrections and additions
Section C1	-	C1-1	2	Summary Table for UU triaxial tests expanded
Section C2	-	Various	2	Editorial corrections to LCTR; Plasticity Chart added
Section C3	-	All	2	Editorial corrections to sample photograph plates; pages for liner samples (no photographs) added
Section C4	-	Various	2	UU triaxial test result plates added (in-office test results)
Appendix 2	-	All	2	Location and Depth Reports replaced by FSBV Positioning Report
Appendix 4	-	Various	2	Calibration certificates of unused cones removed

1) The definitive copy of this report is held in Fugro's information system
2) Report distribution is restricted to project participants approved by the Client
3) The *report* issue number is the same as the highest issue number of any individual page
4) Pages of this report are at Issue 1, except those pages listed above
5) The reference at the bottom left-hand corner of each page shows the Fugro report ID and the page issue number (between brackets)

QUALITY MANAGEMENT RECORD

Fugro Project Lead:	E. Schoute Senior Project Engineer	Signed:
Report Review and Approval:	M. Klein Principal Geotechnical Engineer	Signed:

Report Section	Prepared By	Checked By
Main Text	JLI/ESE	JMO
Plates following Main Text	HHG/SS/LHT	JMO
A Geotechnical Logs	JLI/LBH/JLK	JMO
B In Situ Test Results		
– Cone Penetration Tests	PLI/ESE	JMO
– Seismic Cone Penetration Tests	PLI/ESE	JMO
C Geotechnical Laboratory Test Results		
– Laboratory Testing Overview	ESE	JMO
– Index Laboratory Tests	PH/ESE	JMO
– Sample Photographs	MKL/ESE	JMO
– Triaxial Tests	RMK/ESE	JMO
– Ring Shear Tests	PH/ESE	JMO
– Compressibility Tests	PH/ESE	JMO
– Thermal Conductivity Tests	PH/JLK/MKL/ESE	JMO
– Sample Micro Photographs	WH/JLR/ESE	JMO

Person(s):

ESE:	E. Schoute
HHG:	H. Hagen
JLI:	J. Marques Marçal Liça
JLK:	J. Lakeman
JLR:	J. Leadbeater
JMO:	J. Molle
LBH:	L. Both
LHT:	L. van der Horst
MKL	M. Klein
PH:	P. Holley
PLI:	P. Li
RMK:	R. Klasen
SS:	S. Soekhoe
WH:	W. Healy

INTRODUCTION

This document provides guidelines, recommendations and limitations regarding the use of information in this report.

The cost of geotechnical data acquisition, interpretation and monitoring is a small portion of the total cost of a construction project. By contrast, the costs of correcting a wrongly designed programme or mobilising alternative construction methods are often far greater than the cost of the original investigation. Attention and adherence to the guidelines and recommendations presented in this guide and in the geotechnical report can reduce delays and cost overruns related to geotechnical factors.

This guide applies equally to the use of geotechnical and multi-disciplinary project information and advice.

REQUIREMENTS FOR QUALITY GEOTECHNICAL INFORMATION

Fugro follows ISO 9001 quality principles for project management and ISO 2394 for general principles on reliability for structures. Project activities usually comprise part of specific phases of a construction project. The quality plan for the entire construction project should incorporate geotechnical input in every phase - from the feasibility planning stages to project completion. The parties involved should do the following:

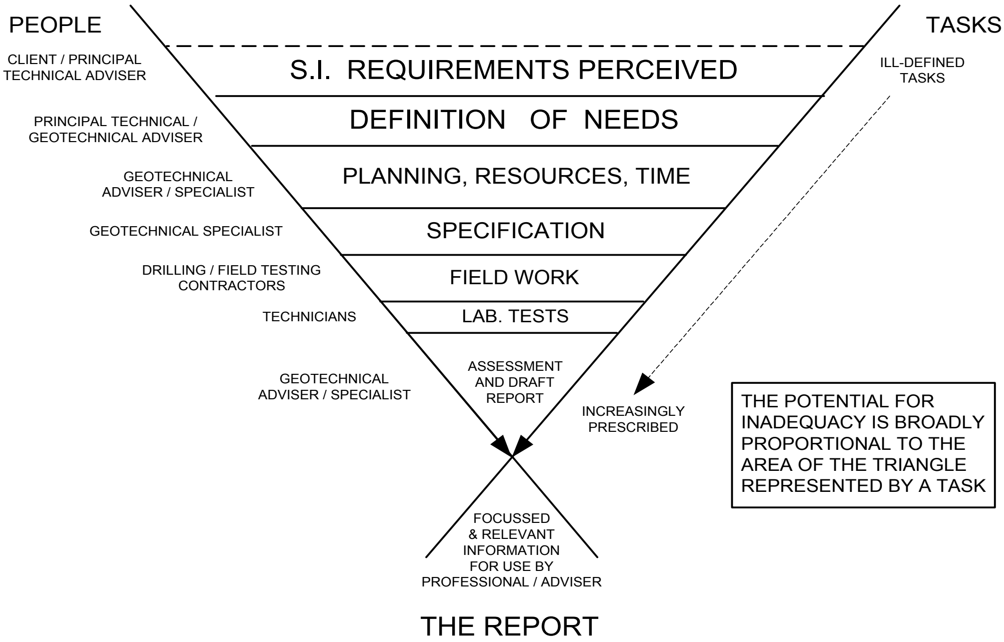
- Provide complete and accurate information necessary to plan an appropriate geotechnical site investigation.
- Describe the purpose(s), type(s) and construction methods of planned structures in detail.
- Provide the time, financial, personnel and other resources necessary for the planning, execution and follow-up of a site investigation programme.
- Understand the limitations and degree of accuracy inherent in the geotechnical data and engineering advice based upon these data.
- During all design and construction activities, be aware of the limitations of geotechnical data and geotechnical engineering analyses/advice, and use appropriate preventative measures.
- Incorporate all geotechnical input in the design, planning, construction and other activities involving the site and structures. Provide the entire geotechnical report to parties involved in design and construction.
- Use the geotechnical data and engineering advice for only the structures, site and activities which were described to Fugro prior to and for the purpose of planning the geotechnical site investigation or geotechnical engineering analysis programme.

AUTHORITY, TIME AND RESOURCES NECESSARY FOR GEOTECHNICAL INVESTIGATIONS

Adequate designation of authority and accountability for geotechnical aspects of construction projects is necessary. This way, an appropriate investigation can be performed, and the use of the results by project design and construction professionals can be optimised.

Figure 1 illustrates the importance of the initial project phases for gathering adequate geotechnical information for a project. The initial phases, when site investigation requirements are defined and resources are allocated, are represented by more than 50% of the Quality Triangle (Figure 1). Decisions and actions made during these phases have a large impact of the outcome and thus the potential of the investigation to meet project requirements.

Figure 1: Quality of Geotechnical Site Investigation (adapted from SISG[1]).



DATA ACQUISITION AND MONITORING PROGRAMMES

Geotechnical investigations are operations of discovery. Investigation should proceed in logical stages. Planning should allow operational adjustments deemed necessary by newly available information. This observational approach permits the development of a sound engineering strategy and reduces the risk of discovering unexpected hazards during or after construction.

GEOTECHNICAL INFORMATION – DATA TYPES AND LIMITATIONS

1. RELIABILITY OF SUPPLIED INFORMATION

Geotechnical engineering can involve the use of information and physical material that is publicly available or supplied by the Client. Examples are geodetic data, geological maps, geophysical records, earthquake data, earlier geotechnical logs and soil samples. Fugro endeavours to identify potential anomalies, but does not independently verify the accuracy or completeness of public or Client-supplied information unless indicated otherwise. This information, therefore, can limit the accuracy of the report.

2. COMPLEXITY OF GROUND CONDITIONS

There are hazards associated with the ground. An adequate understanding of these hazards can help to minimize risks to a project and the site. The ground is a vital element of all structures which rest on or in the ground. Information about ground behaviour is necessary to achieve a safe and economical structure. Often less is known about the ground than for any other element of a structure.

3. GEOTECHNICAL INVESTIGATION - SPATIAL COVERAGE LIMITATIONS

Geotechnical investigations collect data at specific test locations. Interpretation of ground conditions away from test locations is a matter of extrapolation and judgement based on geotechnical knowledge and experience, but actual conditions in untested areas may differ from predictions. For example, the interface between ground materials may be far more gradual or abrupt than a report indicates. It is not realistic to expect a geotechnical investigation to reveal or anticipate every detail of ground conditions. Nevertheless, an investigation can reduce the residual risk associated with unforeseen conditions to a tolerable level. If ground problems do arise, it is important to have geotechnical expertise available to help reduce and mitigate safety and financial risks.

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[1] Site Investigation Steering Group SISG 1993. *Site Investigation in Construction 2: Planning, Procurement and Quality Management*. London: Thomas Telford.

4. ROLE OF JUDGEMENT AND OPINION IN GEOTECHNICAL ENGINEERING

Geotechnical engineering is less exact than most other design disciplines, and requires extensive judgement and opinion. Therefore, a geotechnical report may contain definitive statements that identify where the responsibility of Fugro begins and ends. These are not exculpatory clauses designed to transfer liabilities to another party, but they are statements that can help all parties involved to recognise their individual responsibilities and take appropriate actions.

COMPLETE GEOTECHNICAL REPORT SHOULD BE AVAILABILE TO ALL PARTIES INVOLVED

To prevent costly construction problems, construction contractors should have access to the best available information. They should have access to the complete original report to prevent or minimize any misinterpretation of site conditions and engineering advice. To prevent errors or omissions that could lead to misinterpretation, geotechnical logs and illustrations should not be redrawn, and users of geotechnical engineering information and advice should confer with the authors when applying the report information and/or recommendations.

GEOTECHNICAL INFORMATION IS PROJECT-SPECIFIC

Fugro’s investigative programmes and engineering assessments are designed and conducted specifically for the Client described project and conditions. Thus this report presents data and/or recommendations for a unique construction project. Project-specific factors for a structure include but are not limited to:

- location
- size and configuration of structure
- type and purpose or use of structure
- other facilities or structures in the area.

Any factor that changes subsequent to the preparation of this report may affect its applicability. A specialised review of the impact of changes would be necessary. Fugro is not responsible for conditions which develop after any factor in site investigation programming or report development changes.

For purposes or parties other than the original project or Client, the report may not be adequate and should not be used.

CHANGES IN SUBSURFACE CONDITIONS AFFECT THE ACCURACY / SUITABILITY OF THE DATA

Ground is complex and can be changed by natural phenomena such as earthquakes, floods, seabed scour and groundwater fluctuations. Construction operations at or near the site can also change ground conditions. This report considers conditions at the time of investigation. Construction decisions should consider any changes in site conditions, regulatory provisions, technology or economic conditions subsequent to the investigation. In general, two years after the report date, the information may be considered inaccurate or unreliable. A specialist should be consulted regarding the adequacy of this geotechnical report for use after any passage of time.

APPENDIX 1: DESCRIPTIONS OF METHODS AND PRACTICES

CONTENTS

This appendix presents method statements and terminology that are generally familiar to expert users of the information.

INTRODUCTION

This document describes borehole activities for a geotechnical project. The activities comprise borehole drilling and, optionally (1) borehole geophysical logging, (2) in situ testing in borehole and/or (3) sampling and sample handling.

The common drilling techniques for onshore and nearshore projects are:
- Open hole drilling: a drilling method whereby all material within the diameter of the borehole is cut, such as open hole rotary drilling, cable percussion drilling and auger drilling.
- Open hole rotary drilling: an open hole drilling method whereby ground at the bottom of the borehole is cut by a drill bit rotated on the bottom of a borehole, and drill fluid is pumped down to the drill bit through the hollow drill pipe.
- Cable percussion drilling: an open hole drilling method whereby ground at the bottom of the borehole is broken up by percussive action of a bailer, clay cutter or chisel, and brought to the surface by the bailer or clay cutter.
- Auger drilling: an open hole drilling method whereby ground at the bottom of the borehole is cut and brought to the surface by auger flights.
- Core drilling: a rotary drilling method that cuts out cylindrical ground samples.

The common drilling techniques for an offshore project are open hole rotary drilling and core drilling. Offshore core drilling is by either piggyback or by downhole system. Piggyback core drilling uses drilling techniques whereby the drill pipe for open hole rotary drilling acts as drill casing and as support for the drill rig. Downhole core drilling uses a core barrel that latches in a bottom-hole assembly for open hole rotary drilling.

Borehole geophysical logging tools are available for in-pipe measurements and for open hole measurements, including:
- P-S logger: measures S-wave and P-wave velocities.
- Calliper tool: measures borehole diameter by a mechanical calliper.
- Natural gamma radiation tool: measures the concentration of radioactive isotopes, which provides information on soil type and variation in particle size distribution.
- Neutron tool: uses a radioactive source to estimate the porosity of the formation, and can also measure natural gamma radiation and formation resistivity.
- Sonic tool: measures sound velocity within the surrounding soil body, which can provide indications on soil type and changes in soil character.
- Density tool: uses a radioactive source to measure soil density, and can also be used to measure natural gamma radiation and formation resistivity.

A wide range of in situ tests is available for boreholes. Examples are the pore pressure dissipation test (PPDT), vane shear test (VST), thermal conductivity test (TCT) and cone penetration test (CPT).

This document describes borehole geophysical logging and in situ tests as an integral part of borehole activities, but gives no details. Separate descriptions apply, if appropriate.

The common sampling techniques are drive sampling and/or push sampling of an open-tube sampler, and push sampling in case of a piston sampler. Sampling of cuttings from drilling may be feasible for some types of drilling techniques.

Borehole activities are based on ISO, CEN, BSI and ASTM standards.

DRILLING APPARATUS

GENERAL

Descriptions of common borehole drilling apparatus are as follows:
- Drilling Equipment: any equipment that provides a suitably clean open hole before insertion of downhole sampling and/or testing apparatus and ensures that sampling and/or testing is performed in undisturbed ground.

- Drill Rig: machine capable of providing:
  - rotation, feed and retraction to drill pipe, casing and/or auger,
  - drill fluid pumping capacity, as required,
  - sampler or test apparatus insertion.
- Drill Casing: cylindrical pipe with one or more of the following purposes:
  - to support the sides of a borehole,
  - to support drill pipe above ground surface in case of over-water drilling,
  - to promote return of drilling fluid.
- Drill Pipe: cylindrical pipe connecting drill rig and drill bit.
- Drill Collar: thick-walled drill pipe providing self-weight thrust for the drill bit.
- Drill Bit: device attached to drill pipe and used as a cutting tool to drill into the ground.
- Core Bit: device attached to a rotary core sampler and used as a cutting tool to drill into the ground.
- Core Catcher: device that assists retention of core in the core barrel.
- Core Box: box with longitudinal separators for the protection and storage of (core) sample.
- Bottom Hole Assembly: lower section of offshore drill pipe and drill bit, shaped to permit latching of downhole in situ testing and sampling apparatus.

An optional activity for rotary drilling is manual or digital recording of drilling parameters, such as penetration rate, torque and drill fluid pressure.

CORING

Core drilling is a ground investigation technique comprising simultaneous drilling and sampling. Descriptions of apparatus are as follows:

- Single Tube Core Barrel: hollow steel tube with a head at the upper end threaded for drill pipe, and a threaded connection for the core bit at the lower end.
- Double Tube Core Barrel: assembly of two concentric steel tubes joined at the upper end by means of a swivel arranged to permit rotation of the outer tube without causing rotation of the inner tube; the upper end of the outer tube is threaded for drill pipe and the lower end is threaded for the core bit.
- Double Tube Core Barrel with Retrievable Inner Tube: double tube core barrel that permits retrieval of the core-laden inner tube assembly to the surface through matching drill pipe without the need for withdrawal of the drill pipe.

OFFSHORE OPERATIONS

Offshore drilling can require additional apparatus, in particular when drilling from a vessel:

- Seabed Reaction Frame: seafloor-based apparatus capable of providing one or more of the following:
  - improved horizontal and vertical control of the drill pipe
  - re-entry of a borehole by drill pipe after earlier retraction
  - vertical reaction for hard-tie rigging
  - vertical reaction for the drill pipe during downhole testing and sampling
  - vertical control of the drill pipe during drilling, downhole testing and sampling (hybrid seafloor/ vessel drilling).
- Heave Compensator: apparatus to compensate the drill pipe or logging tools for vertical motion of a vessel.
- Hard-tie Rigging: special rigging system incorporating a seabed reaction frame and a heave compensator, for heave-compensated drilling with low drill bit load and/or increased depth control of the drill bit.

SAMPLING APPARATUS

DRIVE SAMPLING

- Drive-Weight Assembly: Device consisting of hammer, hammer fall guide, anvil and hammer drop system.
- Hammer: impact mass, which is successively lifted and dropped to provide the energy that accomplishes sampler penetration.
- Hammer Fall Guide: guide arrangement for the fall of the hammer.
- Anvil: drive-head which the hammer strikes and through which the hammer energy passes into the sampling rods.

- Hammer Drop System: pick-up and release mechanism by which lifting and dropping of the hammer is accomplished.
- Cathead: rotating drum in a rope-cathead hammer drop system around which a rope is wrapped to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.
- Self-Tripping Release: hammer drop system that ensures a free fall of the hammer after lifting by a cable or rope.
- Free-Fall Winch: hammer drop system that permits a free release of the rotating drum of the winch around which a cable is wrapped to lift and drop the hammer.
- Hydraulic Percussion: hammer drop system that provides rapid impact hammer blows by fluid flow.
- Sampling Rods: rods that connect the drive-weight assembly to the sampler head.

PUSH SAMPLING APPARATUS

- Sampler Insertion Equipment: apparatus providing relatively rapid continuous penetration force.
- Reaction Equipment: reaction for the sampler insertion equipment.
- Sampling Rods: rods that connect the sampler insertion equipment to the sampler head.

SAMPLER

- Open-Tube Sampler: sampler with tube that is open at one end and fitted to the sampler head at the other end.
- Piston Sampler: sampler with close-fitting sliding piston that is held stationary during penetration of a sample tube into the ground.
- Rotary Core Sampler:
  - Single Tube Core Barrel: hollow steel tube with a head at the upper end threaded for drill pipe, and a threaded connection for the core bit at the lower end.
  - Double Tube Core Barrel: assembly of two concentric steel tubes joined at the upper end by means of a swivel arranged to permit rotation of the outer tube without causing rotation of the inner tube; the upper end of the outer tube is threaded for drill pipe and the lower end is threaded for the core bit.
  - Double Tube Core Barrel with Retrievable Inner Tube: double tube core barrel that permits retrieval of the core-laden inner tube assembly to the surface through matching drill pipe without the need for withdrawal of the drill pipe.
- Sampler Head: coupling between sampling rods and sample tube, and containing a non-return valve to allow free exit of water and air above sample.
- Sample Tube: cylindrical tube with cutting edge or cylindrical tube fitted with separate cutting shoe.
- Liner: cylindrical plastic tube inserted in a sampler to preserve sample and reduce friction.
- Thin-Walled Sample Tube: sample tube with area ratio of less than 15% and inside clearance ratio of less than 1%.
- Thick-Walled Sample Tube: sample tube not meeting the requirements of a thin-walled sample tube.
- Core Catcher: device that assists retention of the sample in the sampler.
- Cutting Shoe: replaceable tapered cutting edge of sample tube to allow use of core catcher and the selection of inside clearance ratio and/or area ratio.
- Stroke length: maximum achievable sample length.

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Table 1 shows dimensions of common samplers.

Table 1 - Dimensions of Samplers

Sampler type	Inside diameter D_1 [mm]	Outside diameter D_2 [mm]	Inside diameter D_3 [mm]	Wall thickness [mm]	Area ratio A_r [%]	Inside clearance ratio C_r [%]	Stroke length(1) [mm]
Thin-walled 3 inch tube	72.0	76.0	72.0	2.0	10.2	0.0	950
Thin-walled 5° – 10° tube(2)	72.0	76.0	72.0	2.0	10.2	0.0	950
Thick-walled 3 inch tube	72.0	80.0	72.0	4.0	19.0	0.0	950
Thin-walled 2 inch tube	54.0	57.0	54.0	1.5	10.2	0.0	950 and 570

Sampler type	Inside diameter D_1 [mm]	Outside diameter D_2 [mm]	Inside diameter D_3 [mm]	Wall thickness [mm]	Area ratio A_r [%]	Inside clearance ratio C_r [%]	Stroke length(1) [mm]
Thick-walled 2 inch tube	53.0	60.3	53.1	3.6	22.7	0.2	570
Piston Sampler(3)	72.0	76.0	72.0	2.0	10.2	0.0	845
3 metre EP Piston Sampler(3)	66.0	80.0	67.0	2.6	31.3	1.5	3000
Hammer Sampler 2 inch splitspoon	40.0	51.0	41.0	5.0	38.5	2.5	600
Rotary Core Sampler(4)	62.5	85.0	63.6	4.1	44.0	1.8	3000

Notes
1. "Length" dimension considers manufactured length. Re-use of a sampler may lead to shortening, for example to reshape the cutting edge.
2. Thin walled 5° - 10° tube is equivalent to conventional thin-walled 3 inch tube except for specially machined cutting edge with 5° and 10° taper to reduce sampling disturbance.
3. Tool can be assembled with liners and a range of cutting shoes; D_1, D_2, D_3, A_r and C_r can be varied.
4. Fugro Marine Core Barrel.

The definitions of area ratio and inside clearance ratio are as follows:

Area Ratio: Indication of volume of ground displaced by the sample tube, calculated as follows:

$$A_r = [(D_2^2 - D_1^2)/D_2^2] \times 100$$

where:
A_r = area ratio expressed as percentage
D_2 = outside diameter of the sample tube and/or cutting shoe
D_1 = inside diameter of the cutting shoe.

Inside Clearance Ratio: Indication of clearance of sample inside the sample tube, calculated as follows:

$$C_r = [(D_3 - D_1)/D_1] \times 100$$

where:
C_r = inside clearance ratio expressed as percentage
D_3 = inside diameter of the flush portion of the sample tube or liner
D_1 = inside diameter of the cutting shoe.
The worst case of manufacturing tolerances applies for calculation of C_r.

PROCEDURE

Figure 1 summarises the procedure for boreholes. The procedure includes several stages, as follows:

BOREHOLE SET-UP STAGE

- assignment of borehole details such as location, target borehole depth, types of apparatus, sequence of sampling
- positioning of drill rig at assigned location
- selection of drilling, sampling or in situ testing stage.

The subsequent stage is one of the following:

DRILLING

- open hole or core drilling
- borehole logging, such as drill bits and drill fluids used, borehole size and depth, drilling observations
- borehole water level, where practicable
- selection of subsequent drilling, sampling or in situ testing stage.

BOREHOLE GEOPHYSICAL LOGGING

- tool deployment in-pipe or open hole
- logging of depth and geophysical parameters
- selection of subsequent drilling stage.

IN SITU TESTING

- in situ test
- logging, such as test depth and test parameters
- selection of subsequent drilling stage.

SAMPLING

- sampling
- logging, such as sample depth and sample inspection at the time of sampling
- sample handling
- selection of subsequent drilling stage.

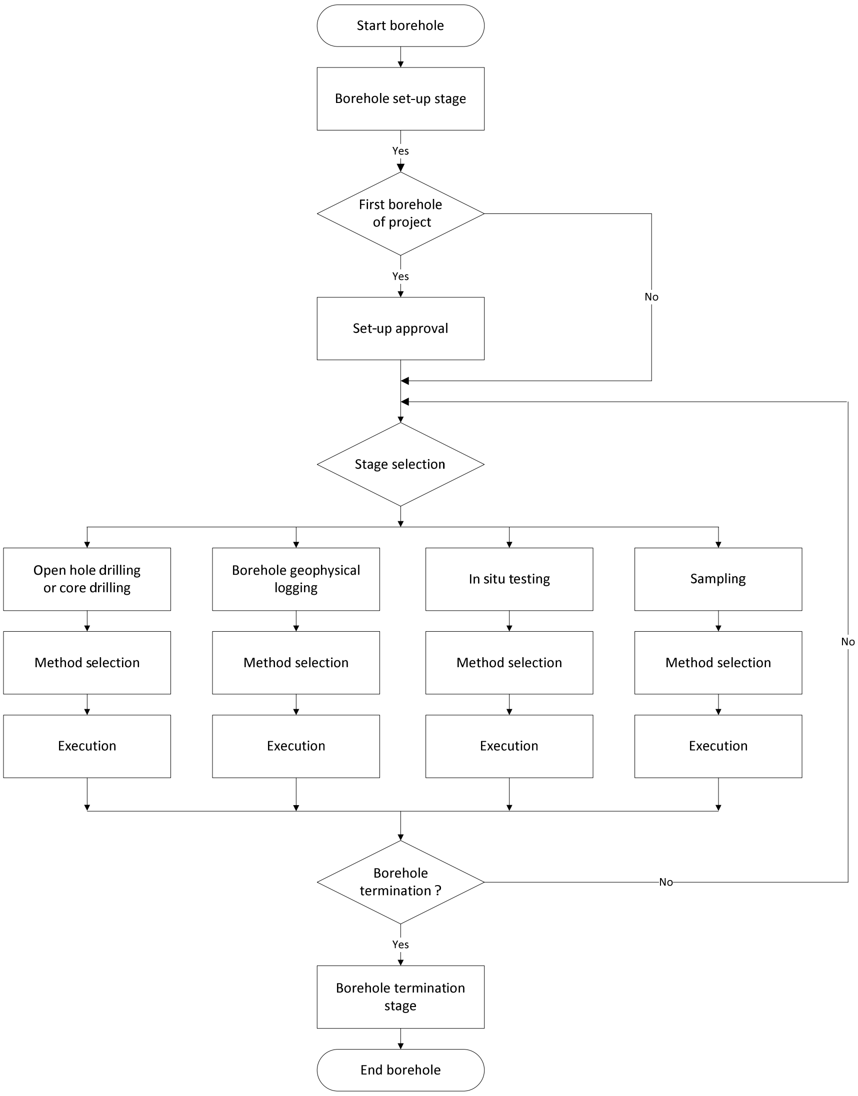

Figure 1 - Flow chart

BOREHOLE TERMINATION STAGE

- termination of borehole
- backfilling of borehole, if appropriate
- data processing.

Set-up requires a reasonably flat, accessible, ground surface with a slope of 5^o or less. In other cases, set-up is at discretion of equipment operator, considering risks such as damage to apparatus or safety of personnel. Most onshore drilling systems have levelling facilities allowing a vertical start of drilling. Seabed reaction frames used for offshore drilling activities typically have no levelling facilities. Drill pipe passage through a seabed reaction frame must be (near-)vertical.

The sampling stage may result in no-recovery or partial recovery of a sample due to unfavourable conditions for the deployment of a particular sampler. A subsequent sampling event at the same depth or immediately below the initial sampling depth is a separate sampling activity, unless specifically agreed otherwise or unless no specific evidence shows departure from the agreed procedure for the earlier activity.

Criteria for borehole termination are as follows, unless specifically agreed otherwise:
- as instructed by Client
- reaching target penetration
- drilling progress rate of less than 1 m/hour based on half-hourly observation
- circumstances at discretion of system operator, such as risk of damage to apparatus or safety of personnel

whichever occurs first and as applicable.

SAMPLE QUALITY

Sampling techniques and samplers can be important for the evaluation of the results of laboratory tests.

Table 2 presents an assessment of typical sample class and Table 3 summarises the corresponding classification system for sample quality. The classification system recognises 5 classes on the basis of feasibility of specific geotechnical identification and laboratory tests (CEN, 2007; ISO, 2014).

Table 2 – Sampling Technique and Sample Class

Sampler type	Sample class					
	Very soft to soft clay	Stiff to very stiff clay	Hard boulder clay	Loose to medium dense silt/sand	Dense silt/ sand	Weakly cemented soils and rock
Thin-walled 3 inch tube	2 (1)	2 (1)	2 (1)	3 (2)	n/a (2)	n/a (2)
Thin-walled 5^o – 10^o tube	1	1	n/a	3 (2)	n/a (2)	n/a (2)
Thick-walled 3 inch tube	2	2	2	3 (2)	3 (2)	n/a (3)
Thin-walled 2 inch tube	2 (1)	2 (1)	2 (1)	3 (2)	2	n/a (3)
Thick-walled 2 inch tube	2	2	2	3 (2)	3 (2)	n/a (3)
Piston Sampler	1	1	n/a	3 (2)	n/a	n/a
3 metre EP Piston Sampler	2 (1)	2 (1)	2 (1)	3 (2)	n/a	n/a
Hammer Sampler 2 inch splitspoon	2	3 (2)	3 (2)	3	3	3
Rotary Core Sampler	n/a	3 (2)	3 (2)	n/a	n/a (3)	n/a (2)

Notes
1. Sampler type is according to Table 1 and sample class is according to Table 3.
2. Ground descriptions (e.g. stiff to very stiff clay) are according to ISO (2014) for applicability rating.
3. Sample class between brackets may be feasible under favourable conditions.
4. n/a means not applicable or very low applicability.

Table 3 – Sample Application (Quality) Classes

Application (quality) class	Designation	Laboratory test feasibility
Class 1	undisturbed	strength, stiffness and consolidation
Class 2	undisturbed	layering, permeability, unit weight
Class 3	disturbed	water content
Class 4	disturbed	particle size analysis, Atterberg limits, soil type
Class 5	disturbed	stratigraphy
Notes 1. The higher class includes the laboratory tests of the lower classes.		

Comments on Class 1 and Class 2 fine-grained soil samples are as follows:

- Some sample disturbance is inevitable because of the required sampling process and subsequent on-site and laboratory sample handling.
- Silt soil is more sensitive to disturbance than clay soil.
- Sample disturbance typically increases with increasing total stress conditions applicable to the in situ soil. Negative pore pressures develop after sampling, upon reduction of total stresses. The resulting effective stresses within the sample cause sample disturbance. Sample disturbance may thus increase with sampling depth or with increasing water depth for offshore boreholes.
- Reduction in water pressure occurring after sampling causes a change in equilibrium between dissolved gasses, gas bubbles and gas hydrates, where present. The amount of gas release increases with water pressure. This may result in increased sample disturbance, in particular for deep-water sites.

In principle, sampling is continuous from bottom of borehole to maximum penetration. However, recovery ratios (ratio of recovered sample length to penetration) can differ from unity. Reasons include:

- Loss of ground from the bottom end of the sampler during retrieval.
- Compaction of ground due to vibration (hammer sampler), and/or handling.
- Settling of soil due to an inside clearance ratio C_r of the sampler of greater than zero.
- Soil expansion due to swelling-soil minerals, gas and/or stress release.
- Loss and/or segregation of very soft soil due to fluidisation.
- Plugging type behaviour during penetration (missing sample).

Sample quality may change with time and storage conditions. The type of soil or rock will influence the degree of change. For example, exposure to air may initiate chemical processes, such as rapid oxidisation of organic soil.

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GEOTECHNICAL LOG

INTRODUCTION

A geotechnical log presents a one-dimensional, typically vertical, profile of ground strata and water level measurements, where applicable. In addition, it may include the principal details of operational activities for acquisition of the information shown on the geotechnical log. Other terms for geotechnical log used in practice include core log, borehole log, sample log, geohazard core log, geological log.

The format and detail of a geotechnical log depends on an agreed project specification. This means that the geotechnical log considers a specific purpose, for example presentation of geotechnical information for design of a pile foundation. The geotechnical log should not be used for another purpose without appropriate verification. A minimal geotechnical log can consist of descriptions limited to e.g. “soil” and “rock” or a value such as soil behaviour type index, in combination with corresponding depths below ground surface or seafloor. A comprehensive geotechnical log can include mm-scale geological descriptions, geotechnical strata, data points of laboratory test results and multiple profiles of geophysical borehole logging and interpretive results of in situ testing.

The level of detail and accuracy of a geotechnical log also depend on factors such as sample size, quality, coverage of samples and test data and availability of supplementary information.

Preparation of geotechnical logs is based on ISO, CEN, BSI and ASTM standards.

EXAMPLE INFORMATION - GEOTECHNICAL LOGS

OPERATIONAL ACTIVITIES

Additional documentation of operational activities can include further details on drilling, sampling and in situ testing. In particular, details of sampling techniques and samplers can be important for the evaluation of the results of laboratory tests. Figure 1 shows examples for presentation of operational information.

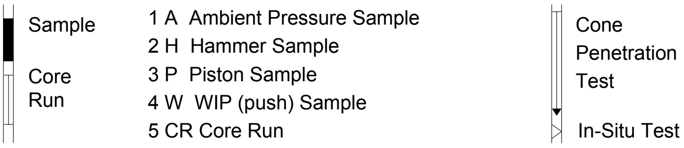

Figure 1 - Symbols for identification of samples and in situ tests

The penetration depth shown on a (vertical) geotechnical log is defined as the deepest point reached by drilling, sampling or in situ testing. The recovery depth is the deepest point for which logging, sample or test data are presented.

Unless indicated otherwise, recovery of a borehole tube sample or a core sample is assumed and shown to be continuous from the starting depth of sampling. Similarly, sample recovery for a seafloor sampler is assumed to be continuous from seafloor to recovery depth. In other words, the geotechnical log ignores possible plugging, flow-in and/or wash-out.

MWD PARAMETERS

Measurement while drilling (MWD) parameters for rotary drilling can help characterisation of ground conditions such as cemented strata, weak rock and formations with cavities apply. Presentation of factual and/or interpreted results is usually in graphical format.

ROCK CORING PARAMETERS

ASTM International (2008) provides descriptions for rock core quality as follows:

TCR	Total Core Recovery: the total core length divided by the core run length
SCR	Solid Core Recovery: the total length of the pieces of solid core that have a complete circumference divided by the core run length
RQD	Rock Quality Designation: the total length of the pieces of sound core over 100 mm long along the centreline divided by the core run lengths per stratum or core run; sound core includes core with obvious drilling breaks
I_F	Fracture Index: spacing of natural discontinuities.

Table 1 shows a classification of rock quality according to ASTM International (2002).

TABLE 1 CLASSIFICATION OF ROCK QUALITY

RQD	Classification of Rock Quality
0 to 25%	Very poor
25 to 50%	Poor
50 to 75%	Fair
75 to 90%	Good
90 to 100%	Excellent

GEOTECHNICAL DESCRIPTION

Geotechnical description, including strata boundaries, is an interpretation of the processed data available at the time of the preparation of a geotechnical log. Subsequent processing and integration of supplementary ground investigation data can allow improved accuracy or confidence. Supplementary information can include:

- geological information
- 2D/ 3D geophysical data
- results of nearby geotechnical investigation locations
- borehole geophysical data
- in situ test data
- laboratory test results
- analysis of drilling parameters such as torque, feed, drill fluid pressure and drilling time.

Any graphical presentation of test results considers values within the scale limits only. No automatic scaling applies, unless indicated otherwise.

GRAPHIC LOG

A geotechnical log can include a graphic log of ground conditions. Figures 2 through 4 present details for soils, cementation degrees and rocks.

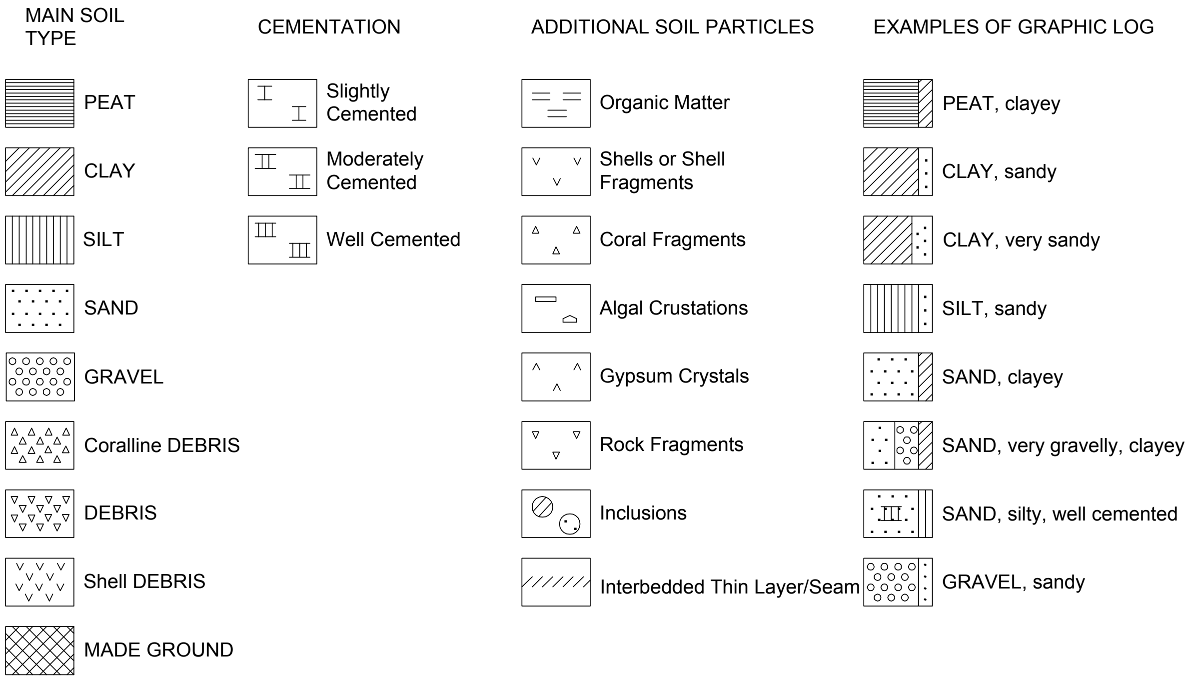

Figure 2 - Symbols for soils

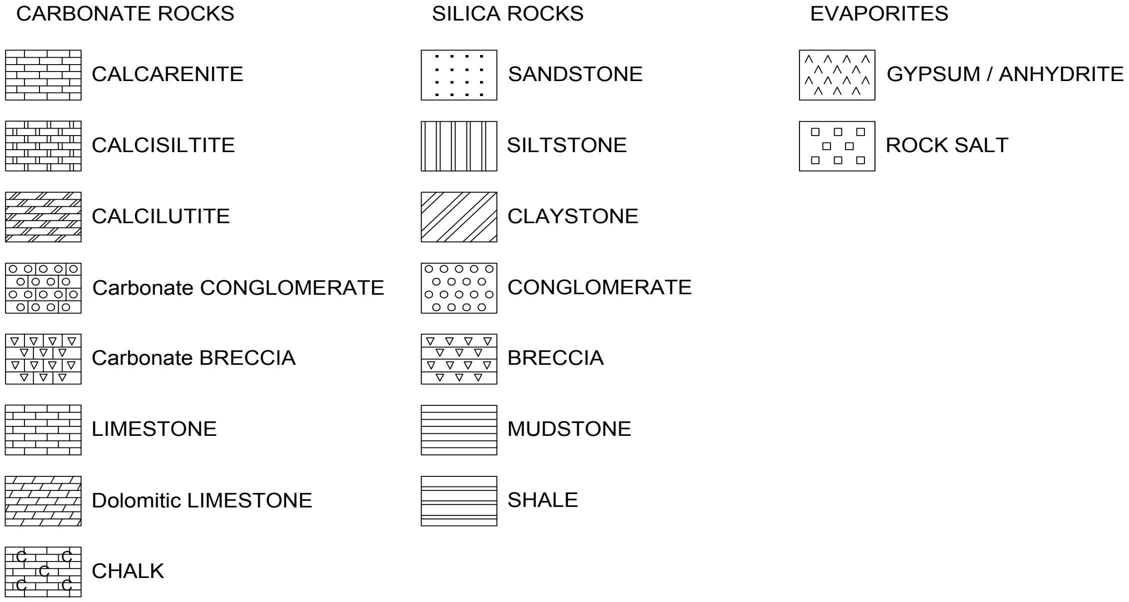

Figure 3 - Symbols for sedimentary rocks

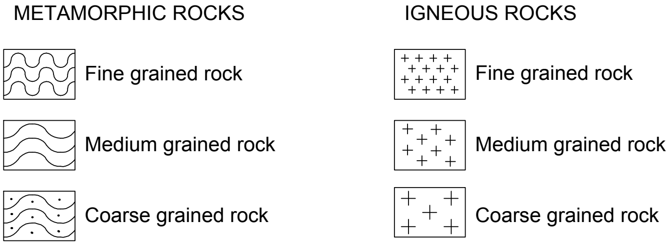

Figure 4 - Symbols for metamorphic and igneous rocks

WATER LEVEL

Water level measurements taken in boreholes can be valuable. Interpretation of water levels requires due caution. They may or may not be representative of the ground water levels. In any case, water levels apply to the time and date of the measurements only. They will vary due to seasonal and other environmental influences, including construction activities.

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INTRODUCTION

Fugro employs a range of industry-standard systems for soil description, with additional refinements. The more important systems are:

- British Standard 5930 (ground investigations).
- American Society for Testing and Materials (ASTM) Standards D 2487-11 (Classification of soils for Engineering Purposes) and D 2488-09a (Description and Identification of Soils – Visual-Manual Procedure).
- International Standard ISO 14688-1:2002 (Geotechnical Investigation and Testing - Identification and Classification of Soil: Identification and Description) and International Standard ISO 14688-2:2004 (Principles for a Classification).
- International Standard ISO 19901-8:2014 (Marine Soil Investigations).

The standards are similar, as they are (1) based on the Unified Classification System (Casagrande, 1947), (2) rely on a range of relatively simple visual and manual observations and (3) classify soils according to particle-size distribution and plasticity. Laboratory particle-size distribution and Atterberg limits tests are used to confirm the observations. In addition, the standards include organic soils characterization under soil particle type description.

Significant differences between the standards include the particle-size boundaries and the degree to which plasticity is used as a basis for description. Other differences include the format and order of the soil description.

This document describes a convention that is consistent with either the BS or ASTM standard, and that produces soil descriptions, which can be converted to the other standard. In addition, to describe calcareous soils, Fugro has integrated the carbonate classification system outlined by Clark and Walker (1977) with both British Standard and ASTM systems (Landva et al., 2007). No further information is given about the ISO standards.

British Standard and ASTM systems apply primarily to common terrestrial soils in temperate climates. However, construction activities in coastal areas and offshore can also encounter major carbonate soil deposits. The engineering characteristics of carbonate soil deposits can differ substantially from those of silica-based soil deposits, primarily because of cementation and differences in void ratios.

Appropriate description is necessary. A commonly accepted procedure for calcareous soil deposits is the Clark and walker system, originally developed for the Middle East. This considers particle size, carbonate content and material strength. The particle size classification fits both BS and ASTM system. The carbonate content is an additional feature and the material strength classification relates to common post-depositional alteration of calcareous soil.

This document does not include rock description or specific engineering geological classification systems, such as those for the detailed identification of peat, chalk or micaceous sand.

The main steps of the soil description system are:

1. Measure or estimate particle type as silica-based, organic, or calcareous.
2. For soils that are predominantly silica-based and organic, select BS 5930:1999 or ASTM D 2487 based on local geotechnical practice or project requirements, and follow the appropriate descriptive procedure. For calcareous soils, use the process described by Peuchen et al. (1999).
3. Measure or estimate the particle-size distribution and Atterberg limits (plasticity) for use in defining the principal and secondary soil fractions.
4. Measure or estimate soil strength according to one of the following: (1) relative density of coarse-grained soil, (2) consistency of fine-grained soil, (3) cementation of cemented soil, or (4) lithification of soil undergoing diagenesis.
5. Complete the description using the additional terms for the soil mass characteristics and other features such as bedding, colour, and particle shape.

CALCAREOUS SOIL DESCRIPTION

The procedure considers particle size, carbonate content and material strength. The particle-size classification follows the Unified Soil Classification System. The carbonate content is an additional feature and the material strength classification relates to common post-depositional alteration of calcareous soil.

PARTICLE TYPE

The first determinant for soil description is particle type using Table 1. It mainly differentiates between silica and carbonate soil compositions with organic content of less than 1% of the dry weight. Organic soils are further described in the soil description procedures for BS and ASTM (Table 4).

TABLE 1 - PARTICLE TYPE

Clay soil	Other Soils	Carbonate Content (by dry weight)	Reaction with HCl (10%)
--	Silica	< 10 %	In clays: no bubbles, or slowly forming bubbles. In sands: reaction often limited to some individual particles, or particle surface Residue - Nearly all soil remaining
Calcareous	Calcareous silica	10 to 50	In clays: clearly visible, prolonged reaction and foaming. In sand: violent reaction Residue - Large part of soil remaining
Carbonate	Siliceous carbonate	50 to 90	Violent reaction Residue - Only small part of soil remaining
Carbonate	Carbonate	> 90	Violent reaction Residue - Hardly any soil remaining

The description method does not distinguish between types of carbonate material, and assumes that non-carbonate particles are siliceous.

CEMENTATION AND LITHIFICATION

Cementation is the process by which a binding material precipitates in the voids between the grains or minerals. Lithification is the process by which a soil is hardened due to pressure solution and transformation or new grain or mineral growth. Both processes contribute to the formation of rock.

The descriptions for cementation follow rock strength classification (Table 2) expressed as uniaxial compressive strength σ_c:

TABLE 2 – CEMENTATION

Cementation	σ_c [MPa]
Slightly cemented	0.3 to 1.25
Moderately cemented	1.25 to 5.0
Well cemented	5.0 to 12.5

The term "well cemented" in Table 2 applies to soil, which also shows sublayers with little or no cementation. In case of further lithification, the soil description becomes a rock description using Table 3. The rock strength is only indicative.

TABLE 3 - LITHIFICATION

Carbonate content	Dominant fraction						σ_c
[%]	Clay	Silt	Sand	Gravel	Cobbles	Boulders	[MPa]
incomplete lithification							
< 10	CLAYSTONE	SILTSTONE	SANDSTONE	CONGLOMERATE	CONGLOMERATE or BRECCIA		0.3 to 12.5
10 to 50	Calcareous CLAYSTONE	Calcareous SILTSTONE	Calcareous SANDSTONE	Calcareous CONGLOMERATE			
50 to 90	Clayey CALCILUTITE	Siliceous CALCISILTITE	Siliceous CALCARENITE	Conglomeratic CALCIRUDITE			
> 90	CALCILUTITE	CALCISILTITE	CALCARENITE	CALCIRUDITE			
complete lithification							
< 50	CLAYSTONE	SILTSTONE	SANDSTONE	GRAVEL CONGLOMERATE	CONGLOMERATE or BRECCIA		>12.5
> 50	Fine-grained Argillaceous LIMESTONE	Fine-grained Siliceous LIMESTONE	Medium grained LIMESTONE	Conglomeratic LIMESTONE			

The Clark and Walker system does not include reef limestone (biolithite). **Reef limestone** represents an in situ accumulation of biological origin (e.g. coral reef) and consists largely of carbonate skeletal material of colonising organisms. The carbonate content normally exceeds 90%. Classification of strength follows rock description procedures.

SOIL DESCRIPTION USING BS 5930:1999

In the following sections, each of the main characteristics is described in the order most commonly used for soil identification, with some portions of the text quoted (shown within quotation marks) or paraphrased from the BS 5930.

SOIL GROUP (BS)

The soil group subdivides the soils into very coarse, coarse, fine, and organic soils.

<u>Very coarse</u> soils consist of cobbles and boulders, with particles larger than 60 mm in diameter. These soil particles are rarely sampled using standard soil sampling techniques. They are described separately, and not included when determining the proportions of the other soil components.

The initial classification of silica soils as <u>coarse</u> or <u>fine</u> is based on the percentage of fine particles after the very coarse particles are removed. In BS 5930, the boundary between coarse (i.e. sands and gravels) and fines (i.e. silts and clays) is 0.060 mm (60 µm). When the soil contains approximately 35% or more fines, it is described as a fine soil; further classification of the fine soil as a clay or silt depends on the plasticity of the soil. When the soil contains less than about 35% fine material, it is usually described as a coarse soil. “The boundary between fine and coarse soils is approximate, as it depends on the plasticity of the fine fraction and the grading of the coarse fraction.”

<u>Organic soils</u> contain usually small quantities of dispersed organic matter that can have a significant effect on soil plasticity. Organic soil descriptions in BS 5930 are based on an organic content by weight determined by loss on ignition. Where organic matter is present as a secondary constituent, the following terms are used:

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TABLE 4 - ORGANIC SOIL DESCRIPTIONS

Term	Organic content [% by weight]	Typical colour
Slightly organic clay or silt	2 to 5	Grey
Slightly organic sand	1 to 3	Same as mineral
Organic clay or silt	5 to 10	Dark grey
Organic sand	3 to 5	Dark grey
Very organic clay or silt	> 10	Black
Very organic sand	> 5	Black

Soils with organic contents up to approximately 30% by weight and water contents up to about 250% behave as mineral soils and are described using the terms given in the lower portion of Table 4.

Peat consists predominantly of plant remains, is usually dark brown or black, and has a distinctive smell. It is generally classified according to the degree of decomposition (fibrous, pseudo-fibrous, or amorphous) and strength (firm, spongy, or plastic). When encountered, reference can also be made to the classification given in ASTM Standard Procedure D 4427.

PRINCIPAL SOIL TYPE AND PARTICLE SIZE (BS)

Coarse-Grained Soils

The principal soil type in coarse-grained soils is sand if the dry weight of the sand fraction (0.06 mm to 2 mm particle sizes) exceeds that of the gravel fraction (2 mm to 60 mm particle sizes), and vice versa for gravel.

As an addition to the BS 5930 classification, coarse-grained soils are described as well-graded or poorly-graded based on the grain-size distribution curve, using the coefficient of uniformity (C_U) and, to a lesser extent, the coefficient of curvature (C_C), as follows:
- Sands with ≤12% fines are well-graded when $C_U \geq 6$ and C_C is between 1 and 3.
- Sands are poorly-graded for other values of C_U and C_C.
- Gravels with ≤12% fines are well-graded when $C_U \geq 4$ and C_C is between 1 and 3.
- Gravels are poorly-graded for other values of C_U and C_C.

For coarse-grained soils with fines contents > 12%, these terms are not used.

Sands and gravels are sub-divided into coarse, medium, and fine, as defined in Table 5.

TABLE 5 - SIZE FRACTION DESCRIPTIONS FOR COARSE-GRAINED SOILS

Soil	**Particle diameter range [mm]**		
	Coarse	**Medium**	**Fine**
Gravel	60 to 20	20 to 6	6 to 2
Sand	2 to 0.6	0.6 to 0.2	0.2 to 0.06

Fine-Grained Soils

Fine-grained soils are classified as clay or silt according to the results of Atterberg limits tests. A fine-grained soil is classified as clay if:

$$I_P \geq 6 \text{ and } I_P \geq 0.73\,(w_L-20)$$

where:
I_P = plasticity index [%]
w_L = liquid limit [%]

Otherwise the dominant soil fraction is silt. The equation $I_P = 0.73\,(w_L-20)$ represents the "A-line" in a plasticity chart. The plasticity chart may also show a “U-line” defined as $I_P = 0.9\,(w_L-8)$ and $w_L \geq 16$, according to Casagrande (1948). The U-line represents an approximate upper limit of correlation between plasticity index and liquid limit for natural soils.

The following additional descriptors (as used in the ASTM soil description procedure) are added:
- Clays with liquid limits of 50% or higher are described as “fat.”
- Clays with liquid limits below 50% are described as “lean.”
- Silts with liquid limits of 50% or higher are termed “elastic silt.”
- Silts with liquid limits below 50% are simply “silts.”

The term “silty clay” is not used, since BS 5930 explicitly states that silt and clay “are to be mutually exclusive.”

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Particle Shape

The description of particle shape includes terms for form, angularity, and surface texture. These terms are the same for BS 5930 as for ASTM D 2488. Reference should be made to the corresponding ASTM section of this document.

COMPOSITE (SECONDARY) SOIL TYPES (BS)

BS 5930 defines procedures for assigning secondary soil fractions to coarse-grained soils that are identical for sand and gravel, except that the secondary soil type is sandy when the principal soil type is gravel and vice versa. For fine-grained soils (silt and clay) there is a single procedure for assigning secondary soil fractions. The ranges for the percentages of the secondary constituents are similar to, though different from, those defined by ASTM.

If the principal soil type is sand, secondary soil fractions may be gravelly and silty or clayey (e.g. silty sand). Similarly, if the principal soil type is clay, secondary soil fractions may be sandy or gravelly. Table 6 (from BS 5930) gives the terms to be used for ranges of secondary constituents.

TABLE 6 - DESCRIPTIVE TERMS AND RANGES FOR SECONDARY CONSTITUENTS

Term	Principal soil type	Approximate proportion of secondary constituent	
		Coarse soil	Fine soil
Slightly clayey or silty	SAND and/or GRAVEL		< 5%
Clayey or silty			5% to 20%
Very clayey or silty			> 20% (1)
Slightly sandy or gravelly		< 5%	
Sandy or gravelly		5% to 20%	
Very sandy or gravelly		> 20%	
Slightly sandy and/or gravelly	SILT or CLAY	< 35%	
Sandy and/or gravelly		35% to 65%	
Very sandy and/or gravelly		> 65% (2)	

Notes: (1) or can be described as fine soil depending on engineering behaviour
(2) or can be described as coarse soil depending on engineering behaviour.

COLOUR (BS)

Soil colours are described using the Munsell Soil Colour Charts (Gretag-Macbeth, 2000).

The Munsell colour is arranged according to three variables known as Hue, Value and Chroma. The Hue notation of a colour indicates its relation to red, yellow, green, blue and purple. The Value notation indicates the relative lightness. The Chroma notation indicates the intensity of the colour.

BEDDING/STRATIGRAPHY (BS)

Layers of different soil types within a stratum are called bedding units, and are described in terms of the unit thickness. In an otherwise homogeneous soil, these can be identified as bedding planes or as colour changes, and not necessarily as discontinuities.

Table 7 (from BS 5930) gives terms for bedding/stratigraphy.

TABLE 7 - DESCRIPTIVE TERMS FOR BEDDING/STRATIGRAPHY

Stratified	Bedding	Interbedded	Thickness [mm]
Very thick beds	Very thick bedded	Very thickly interbedded	>2000
Thick beds	Thickly bedded	Thickly interbedded	600 to 2000
Medium beds	Medium bedded	Medium interbedded	200 to 600
Thin beds	Thinly bedded	Thinly interbedded	60 to 200
Very thin beds	Very thinly bedded	Very thinly interbedded	20 to 60
Thick laminae	Thickly laminated	Thickly interlaminated	6 to 20
Thin laminae	Thinly laminated	Thinly interlaminated	<6

Strata with alternating or different beds or laminations can be described as interbedded or interlaminated. Where the soil types are approximately equal, both terms can be used (e.g. thinly interlaminated SAND and CLAY).

Partings are bedding surfaces that separate easily, and typically are laminae of no appreciable thickness. The spacing between partings is described in the same terms as for spacing of discontinuities (Table 8).

DISCONTINUITIES/STRUCTURE (BS)

Discontinuities include fissures and shear planes, and the descriptor refers to the mean spacing between such discontinuities in a soil mass. A soil is “fissured” when it breaks into blocks along unpolished discontinuities, and “sheared” when it breaks into blocks along polished discontinuities (which is equivalent to a slickensided soil). The spacing description ranges from extremely closely spaced (less than 20 mm) to very widely spaced (over 2000 mm). No other descriptive terms are used. An example would be: Firm grey very closely fissured fine sandy calcareous CLAY with many silt partings.

The spacing terms are also used for distances between partings, isolated beds or laminae, desiccation cracks, rootlets, etc.

TABLE 8 - SPACING OF DISCONTINUITIES

Term	**Mean spacing range [mm]**
Very widely	Over 2000
Widely	600 to 2000
Medium	200 to 600
Closely	60 to 200
Very closely	20 to 60
Extremely closely	Under 20

DENSITY/COMPACTNESS OF GRANULAR SOILS (BS)

Usually, soil description offers little evidence about the density condition of coarse-grained cohesionless (granular) soil samples. The reason for this is the substantial sampling disturbance incurred during conventional sampling operations such as push sampling, percussion sampling, and vibrocoring. Complementary investigation techniques, such as Cone Penetration Tests (CPT), are usually necessary. The strength of a cohesionless soil is normally measured as a function of its relative density (also termed compactness or density index). Relative density is the ratio of the difference between the void ratios of a cohesionless soil in its loosest state and existing natural state to the difference between its void ratio in the loosest and densest states.

Relative density (compactness) is referred to in BS 5930:1999 only in terms of N-values obtained by the Standard Penetration Test (which is not conducted in offshore site investigations). Rather than using SPT-based values, it is common practice to interpret relative density on the basis of CPT results. Ranges of relative density are given in Table 9. These ranges are in common use in the industry. They were originally given in Lambe and Whitman (1979) and in the API RP 2A guidelines generally used for offshore pile design. These terms also apply to cohesionless fine-grained soils.

TABLE 9- RANGE OF RELATIVE DENSITY OF GRANULAR SOILS

Term	**Range of relative density [%]**
Very loose	Less than 15
Loose	15 to 35
Medium dense	35 to 65
Dense	65 to 85
Very dense	Greater than 85

STRENGTH OF COHESIVE SOILS (BS)

The strength of cohesive soils is given in terms of undrained shear strength, using the terms and ranges given in Table 10, with an additional level to cover “very hard” soils.

TABLE 10 - UNDRAINED SHEAR STRENGTH SCALE FOR COHESIVE SOILS (BS 5930:1999)

Term	**Undrained shear strength**	
	[kPa]	**[ksf]** (1)
Very soft	Less than 20	Less than 0.4
Soft	20 to 40	0.4 to 0.8
Firm	40 to 75	0.8 to 1.5
Stiff	75 to 150	1.5 to 3.0
Very stiff	150 to 300	3.0 to 6.0
Hard	300 to 600	6.0 to 12.0
Very hard (2)	Greater than 600	Greater than 12.0

Notes: (1) Unit conversion added to table
(2) Added for global practice.

MINOR CONSTITUENTS (BS)

Percentages of minor constituents within the soil, such as shell or wood fragments, or small soil inclusions (such as partings or pockets), can be quantified using the terms “with trace”, “with few”, “with” and “with many” (in increasing order). These terms are usually added at the end of the main soil description (e.g. with many shell fragments, with silt pockets, etc.); exceptions are terms such as “shelly”, which are more appropriate before the soil group name. For beds of material within a soil matrix, the terminology for spacing and thickness of beds is used. For individual particles of soil or material within a soil matrix, the terms “partings” and “pockets” are used.

SOIL ODOUR (BS)

Describing the odour from soil samples as they are retrieved or extruded on board ship can be useful. Terms used to describe the odour are H_2S, “musty”, “putrid” and “chemical”. It must be emphasised that soil odour descriptions are unlikely to be fully consistent, because of factors such as variations in sample handling, ambient conditions at time of sample description, and strong dependence on a person’s ability to detect and identify odour.

SOIL DESCRIPTION USING ASTM D 2487 AND D 2488

The identification and description of silica soils in the ASTM system consists primarily of a group name and symbol, which are based on the particle-size distribution and the Atterberg limits test results, and the results of other laboratory classification tests.

The main standard for soil description, D 2487 Classification of Soils for Engineering Purposes, is applicable to naturally-occurring soils passing a 3-in. (75-mm) sieve, and identifies three major soil types: coarse-grained, fine-grained, and highly organic soils. The major soil types are further subdivided into 15 specific basic soil groups.

An accompanying Standard, D 2488, outlines the Description and Identification of Soils using a Visual-Manual Procedure. This standard is used primarily in the field, where full particle-size distribution curves and Atterberg limits values are not available. It gives guidance for detailed descriptions of soil particles and soil conditions (e.g. colour, structure, strength, cementation, etc.), which are not included in D 2487.

Soil types with particles larger than 75 mm (i.e. cobbles and boulders) are not included in the Standards, but are identified.

SOIL TYPES (ASTM)

The initial classification of silica soils as coarse-grained or fine-grained is based on the percentage fines, expressed as the percentage of dry weight of the total sample after the very coarse particles are removed, as with BS 5930. However, ASTM has defined the coarse-fine boundary as 0.075 mm (75 µm).

The soil is coarse-grained (sand or gravel) if the percentage fines is 50% or less. Otherwise, the soil is fine-grained (silt or clay) – the classification is not based on plasticity.

Coarse-grained soils are classified further as either sand or gravel using the results of particle-size distribution tests.

Fine-grained soils are classified further as silt or clay on the basis of the liquid limit and plasticity index (from Atterberg limits tests).

The soil is an organic soil if it contains sufficient quantities of dispersed organic matter that it has an influence on the liquid limits of the fines component after oven-drying, as outlined in the BS Section. The definition of peat is similar to that in BS 5930 and it is generally classified according to the degree of decomposition and strength. When encountered, reference should be made to the classification given in ASTM D 4427.

SOIL GROUP NAME AND SYMBOL (ASTM)

Coarse-Grained Soils

For coarse-grained soils, the dominant soil fraction is sand if the dry weight of the sand fraction, i.e. particle sizes from 0.075 mm to 4.75 mm, exceeds that of the gravel fraction, i.e. particles ranging from 4.75 mm to 75 mm, and vice versa for gravel.

Coarse-grained soils with ≤12% fines are also described as well-graded or poorly-graded based on the particle-size distribution curve, using the coefficient of uniformity (C_U) and, to a lesser extent, the coefficient of curvature (C_C) as follows:

- Sands are well-graded when $C_U \geq 6$ and C_C is between 1 and 3.
- Sands are poorly-graded for other values of C_U and C_C.
- Gravels are well-graded when $C_U \geq 4$ and C_C is between 1 and 3.
- Gravels are poorly-graded for other values of C_U and C_C.

For coarse-grained soils with fines contents >12%, these terms are not used.

Sands and gravels are also sub-divided into coarse, medium, and fine, as defined in Table 11.

TABLE 11 - SIZE FRACTION DESCRIPTIONS FOR COARSE-GRAINED SOILS

Soil	**Particle diameter range [mm]**		
	Coarse	**Medium**	**Fine**
Gravel	75 to 19	-	19 to 4.75
Sand	4.75 to 2.0	2.0 to 0.425	0.425 to 0.075

The predominant size fractions present are identified, and the absence of size range descriptors means that fine, medium, and coarse fractions are all present in roughly equal proportions.

Fine-Grained Soils

Fine-grained soils are classified as clay or silt according to the results of Atterberg limits tests. A soil is inorganic clay if: $I_P \geq 6$ and $I_P \geq 0.73(w_L-20)$

where:
I_P = plasticity index [%]
w_L = liquid limit [%]

The A-line and U-line in a plasticity chart are as described in the BS section.

Clays with liquid limit $w_L < 50$ and plasticity index $I_P > 7$ are further classified as lean clay, and given the group symbol “CL”. Clays with liquid limits $w_L \geq 50$ are further classified as fat clay, and are given the group symbol “CH”.

A soil is classified as a silt when it plots below the A-line or the plasticity index $I_P < 4$. Silts with liquid limit $w_L < 50$ are given the group symbol "ML". Silts with liquid limits $w_L \geq 50$ are further classified as elastic silt, and are given the group symbol "MH".

Soils are classified as silty clay where the liquid limit versus plasticity index plots on or above the A-line but where the plasticity index falls within the range $4 \leq I_P \leq 7$, i.e. the hatched zone in the lower left-hand corner of the plasticity chart. Silty clays are given the Group Symbol "CL-ML".

Organic Soils

For both clay and silt, or the fines component of a coarse-grained soil, the additional term organic applies if the ratio of the liquid limit of a sample (or the fines portion of the sample) after oven drying at 105° C to the liquid limit without oven drying is less than 0.75.

Organic soils are classified in a manner similar to that for inorganic soils for plots of the liquid limit (not oven dried) versus plasticity index with respect to the A-line. Organic clays and silts with liquid limit $w_L < 50$ are given the same group symbol "OL". Organic clays and silts with liquid limits $w_L \geq 50$ are given the group symbol "OH".

Coarse-grained soils containing fine organic material are described using the term "with organic fines".

SECONDARY SOIL TYPE (ASTM)

Secondary soil type descriptions follow the ranges given in Table 12. No other terms are used, though combinations of these terms are.

TABLE 12 - DESCRIPTIVE TERMS AND RANGES FOR SECONDARY CONSTITUENTS

Term	Principal soil type	Term	Approximate proportion of secondary constituent	
			Coarse soil	Fine soil
	SAND and/or GRAVEL(1)			< 5%
	SAND and/or GRAVEL(1)	with clay or silt		5% to 12%
Clayey or Silty	SAND and/or GRAVEL(1)			> 12%
	SAND and/or GRAVEL(1)		<15% gravel or sand	
	SAND and/or GRAVEL(1)	with gravel or sand	≥15% gravel or sand	
	SILT or CLAY		< 15%	
	SILT or CLAY	with sand or gravel(1)	15% to 29%	
Sandy and/or gravelly(1)	SILT or CLAY		≥30%	

Note: (1) choice depends on which has higher percentage.

PARTICLE SHAPE (ASTM)

The description of particle shape includes references to form, angularity, and surface texture. These terms are normally used only for gravels, cobbles, and boulders, though in some cases for coarse sands.

The form (or shape) of coarse particles is described as flat, elongated, or both.

Flat: Width/Thickness > 3
Elongated: Length/Width > 3
Flat and elongated meets both criteria. These terms are not used if the criteria are not strictly met.

Angularity terms are usually only applied to particles gravel-size and larger (Table 13, from ASTM D 2488).

TABLE 13 - ANGULARITY OF COARSE-GRAINED PARTICLES

Term	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

The surface texture of coarse particles are described as rough or smooth.

COLOUR (ASTM)

As noted for BS 5930 (BS section), soil colours are described using the Munsell Soil Colour Charts (Gretag-Macbeth, 2000).

SOIL ODOUR (ASTM)

The same descriptive terms suggested for BS 5930 (BS Section) are used with the ASTM Standards. It must be emphasised that soil odour descriptions are unlikely to be fully consistent, because of factors such as variations in sample handling, ambient conditions at time of sample description, and strong dependence on a person's ability to detect and identify odour.

STRENGTH OF COHESIVE SOILS (ASTM)

Descriptions of cohesive soil strength are not part of the ASTM classification system; however soil strength is incorporated whenever available from laboratory or in situ test results and interpretation. The boundaries for undrained shear strength ranges in current use in North American practice are given in Table 14. These boundaries are lower than those used with BS 5930.

TABLE 14 - UNDRAINED SHEAR STRENGTH SCALE FOR COHESIVE SOILS (1)

Term	**Undrained shear strength**	
	[kPa]	**[ksf] (2)**
Very soft	Less than 12.5	Less than 0.25
Soft	12.5 to 25	0.25 to 0.50
Firm	25 to 50	0.50 to 1.0
Stiff	50 to 100	1.0 to 2.0
Very stiff	100 to 200	2.0 to 4.0
Hard	200 to 400	4.0 to 8.0
Very hard (3)	Greater than 400	Greater than 8.0

Notes: 1) from Terzaghi and Peck (1967)
2) ksf used primarily for US projects
3) the upper boundary for "Hard", and the "Very hard" range have been added

DENSITY/COMPACTNESS OF GRANULAR SOILS (ASTM)

Tables of recommended values and descriptors for relative density are not provided in the ASTM Standards, but in practice relative density is often interpreted on the basis of cone penetration test results. The same ranges of relative density (compactness) as those recommended for use with BS 5930 (see BS Section) are used.

DISCONTINUITIES/STRUCTURE (ASTM)

Criteria for describing soil structure are provided in ASTM D 2488, and in Table 15 along with additional terms in use in the geotechnical industry.

TABLE 15 - DESCRIPTIVE TERMS FOR SOIL STRUCTURE

Term	**Description**
Slickensided	Fracture or shear planes (or planes of weakness) that appears slick and glossy.
Fissured	Cohesive soil that breaks into blocks along unpolished planes (discontinuities), often filled with a different material. The fill material is noted.
Blocky	Cohesive soil that breaks into small angular lumps along polished planes (discontinuities) which resist further breakdown.
Gassy	Soil has a porous nature and there is evidence of gas, such as blisters.
Expansive	Visibly expands after sampling. Degree of expansion is estimated and noted.
Platy	A stratified appearance when the soil can be broken into thin horizontal plates.
Cemented	Material grains bound together forming an intact mass.

The distance between the fissures, shear planes and expansion cracks is noted using the terms in Table 8.

BEDDING/STRATIGRAPHY (ASTM)

The terminology for bedding thickness and stratigraphic description used in North American offshore practice is more detailed than outlined in ASTM D 2488, and is different from BS 5930. In Table 16, the descriptive terms have been further defined and integrated with BS 5930 terminology.

TABLE 16 - DESCRIPTIVE TERMS FOR BEDDING THICKNESS AND INCLUSIONS

Term	**Bedding thickness**	
	[mm]	**[inch]**
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample	
Parting	< 3	1/8
Lamina	3 to < 6	1/8 to < 0.25
Laminated(1)	Alternating partings or laminae of different soil types in equal proportion	
Lens	6 to < 20	0.25 to < 0.75
Seam	20 to < 76	0.75 to < 3
Layer	Greater than 76	Greater than 3
Stratified(2)	Alternating lenses, seams or layers of different soil types in equal proportion	
Intermixed	Soil sample composed of pockets of different soil types, and laminated or stratified structure is not evident	

Notes: (1) Equivalent to “Interlaminated” term used in BS 5930:1999
(2) Equivalent to “Interbedded” term used in BS 5930:1999.

MINOR CONSTITUENTS (ASTM)

Minor constituents within a soil, such as shell or wood fragments, or small quantities of soil particles (not secondary soil types), are typically more relevant to the site geology or to laboratory testing procedures than to soil behaviour. Since the terms and percentages are not defined in either BS 5930 or ASTM D 2487/8, the terms “with trace”, “with few”, “with”, “with many” are used as a guide.

WRITTEN SOIL DESCRIPTIONS

Although soils are classified in the order of the characteristics described in the preceding sections, written descriptions are given in a different order in both Standards. To bring as much consistency as possible to the soil descriptions, Fugro selected a single preferred order of terms, which most closely resembled the majority of the descriptions used in Fugro offices around the world.

In this description, the principal soil type is given last as the soil name, with most other terms written as adjectives. The principal soil type is given in upper-case.

The preferred order of terms for a soil description are:
1. Density/compactness/strength.
2. Discontinuities.
3. Bedding.
4. Colour.
5. Secondary (composite) soil types.
6. Particle shape.
7. Particle size.
8. PRINCIPAL SOIL TYPE.

with:
9. Minor constituents (can be inserted in front of the principal soil type, such as “shelly”).
10. Soil odour.

For example: Firm closely-fissured dark olive grey sandy calcareous CLAY with few silt pockets. Where used, the Group Symbol is part of the soil description, e.g. loose poorly-graded fine to medium SAND with silt (SP-SM).

PARTICULATE DEPOSITS

The geological origin of a single particle type allows the following descriptions (optional):

Clastic: sediment transported and deposited as grains of inorganic origin. Typical clastic particles are:
- quartz grains: clear or milky white and ranging from very angular to very rounded; commonly a frosted surface for wind-blown grains
- feldspar grains: varying in colour from milky white to light yellowish brown
- mica flakes: varying in colour from gold-coloured to dark brown
- dark mineral grains: usually of igneous or metamorphic origin with undetermined mineralogy
- silicate grains: undetermined mineralogy
- rock fragments: including fragments of carbonate rock
- debris: deposit of rock fragments of a variety of particle sizes which may include sand and finer fractions; typical examples are rock debris and coral debris.

Organic: remains of plants and animals that consists mainly of carbon compounds

Bioclastic: sediment transported and deposited as grains of organic origin. Examples of bioclastic particles are:
- Calcareous algae: crustal or nodular growths or erect and branching forms produced by lime-secreting algae; microstructures include layered, rectangular structures and internal fine tube-like structures.
- Foraminifera: hard sediment test (external skeleton) consisting of calcite or aragonite and produced by unicellular organisms; commonly less than 1 mm in diameter, multi-chambered and intact.
- Sponge spicules: spicules of siliceous sponges in a variety of rayed shapes; dimensions ranging from less than 1 mm to over 1 cm in length but usually less than 1 mm in width.
- Corals: commonly consisting of small fibres set perpendicular to the walls and septal surfaces; mainly aragonite composition for relatively recent forms; conversion of aragonite to calcite for earlier corals, usually with consequent loss of original structural details.
- Echinoids: hard part of echinoids consisting of a plate or skeletal element forming a single crystal of calcite; five-rayed internal symmetry for spines of echinoids; typical widths ranging from several mm to a few cm.
- Bryozoans: chambered cell-like structures that are considerably coarser than those of calcareous algae; either aragonite or calcite composition; possible cell in-fill consisting of clear calcite and/or micrite.
- Bivalves and Gastropods: Mollusk shells, chiefly of aragonite composition; inner layer of aragonite protected by an outer layer of calcite for some bivalve shells and gastropods.

Oolitic: sediment consisting of solid, round or oval, highly polished and smooth coated grains, which may or may not have a nucleus. The coating consists of chemically precipitated aragonite, possibly converted to calcite. Ooliths have concentric structures and may also have radial structures. The grains are generally less than 2 mm diameter.

Pelletal: sediment consisting of well-rounded grains of ellipsoidal shape and no specific internal structure. The composition is clay to silt-sized carbonate material, which is probably the excretion product of sediment eating organisms. Pellets may have an oolitic crust. The grains are generally less than 2 mm diameter.

STRUCTURE OF NON PARTICULATE DEPOSITS

Reef: soil or rock formed by in situ accumulation or build-up of carbonate material by colonial organisms such as polyps (coral), algae (algal mats or balls) and sponges.

Orthochemical: orthochemical components precipitated during or after deposition. These components can include: (1) pyrite spherulites and grains, (2) crystal euhedra of anhydride or gypsum, (3) replacement patches and nodular masses of anhydrite and gypsum. Single grains are rare.

GEOLOGICAL INFORMATION

Specific geological terms can assist the geotechnical soil description by providing information on stratigraphy, origin (genesis) or regional significance (optional). Examples are:

- time stratigraphy, such as Eemian and Pleistocene
- lithostratigraphy, such as Yarmouth Roads Formation
- depositional environment, such as Marine, Glacio-lacustrine and Residual Soil
- regional significance, such as Chalk and Mud.

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TESTING PRACTICE

GENERAL

This document summarises geotechnical laboratory test methods for soil.

Fugro strives to arrange testing in registered laboratories with formal accreditation. This document summarises test methods used by Fugro geotechnical laboratories in the Netherlands. Test methods used by on-site laboratories and other office laboratories are often identical or generally equivalent.

Laboratory tests are carried out in general accordance with standards published by ASTM International (ASTM), British Standards Institution (BSI) and International Organization for Standardization (ISO). Note that ISO (2014) refers mainly to test procedures published in other documents, with some additional recommendations. In-house test procedures adopted for some tests are generally based on published recommendations for which no standards are available. Detailed work instructions and calibration details are available for inspection at the laboratory.

Some of the laboratory tests allow various optional procedures. These procedures are not applicable, unless specifically agreed.

Soil parameter values can vary with temperature. Tests are generally conducted at laboratory temperatures of around 20^{o}C. Any tests conducted at specific temperatures and any corrections for temperature are explicitly reported.

Laboratory test results show depth defined as vertical distance between ground surface or seafloor and top of the laboratory test specimen, unless indicated otherwise.

SAMPLE REQUIREMENTS

The feasibility of a particular laboratory test relates to the sampling practice and sample handling for a particular soil and depends on factors such as soil type, available amount of sample material and sample quality. Usually, a reasonable estimate of test feasibility is possible at the time of sampling. A further refinement is possible in the laboratory prior to testing and, in some cases, only after testing. The limitations of feasibility estimates may lead to rejection of samples for testing upon inspection in the laboratory or may result in appropriate comments on test results after completion of testing.

The adopted classification system for sample quality is according to BSI (2015) and ISO (2006, 2014). The classification system recognises 5 classes on the basis of feasibility of specific geotechnical identification and laboratory tests. A summary of these classes is as follows:

Class 1: undisturbed:	strength, stiffness and consolidation
Class 2: undisturbed:	permeability, unit weight, boundaries of strata - fine
Class 3: disturbed:	water content
Class 4: disturbed:	particle size analysis, Atterberg limits, boundaries of strata - broad
Class 5: disturbed:	sequence of layers

The higher class includes the laboratory tests of the lower class.

An indication of intact (undisturbed) sample quality may be obtained from re-compression of a test specimen, for example in an oedometer or triaxial cell. Table 1 presents a method recommended by ISO (2014) based on $\Delta e/e_0$. Here, Δe represents the change in void ratio Δe from an initial laboratory value (e_0) at atmospheric conditions to the specimen void ratio upon re-compression to in situ stress conditions.

Table 1 - Intact Sample Quality - $\Delta e/e_0$

Overconsolidation Ratio	$\Delta e/e_0$			
	1 (very good to excellent)	**2** (good to fair)	**3** (poor)	**4** (very poor)
1 to 2	< 0.04	0.04 to 0.07	0.07 to 0.14	> 0.14
2 to 4	< 0.03	0.03 to 0.05	0.05 to 0.10	> 0.10

The presented criteria are based on tests on marine clays in the depth range 4 m to 25 m, with plasticity index in the range 6 % to 43 %, water content 20 % to 67 % and overconsolidation ratios of 1 to 4. The criteria must be used with caution for soils outside this range.

Table 2 presents an alternative indication of intact (undisturbed) sample quality according to Terzaghi et al. (1996). Here, volumetric strain is derived from an initial laboratory specimen volume and the specimen volume upon re-compression to in situ stress conditions. The criteria apply to clays with an overconsolidation ratio of less than about 3 to 5. Parameters such as effective preconsolidation pressure σ'_p and undrained shear strength c_u preferably require laboratory specimen with SQD equal to B or better (DeGroot et al., 2005).

Table 2 – Intact Sample Quality - SDQ

Volumetric Strain ε_v [%]	SDQ
< 1	A
1 to 2	B
2 to 4	C
4 to 8	D
> 8	E

Note: SDQ: Sample Quality Designation

The $\Delta e/e_0$ and ε_v criteria represent a simplification, as they ignore important soil changes during the process of sampling and sample handling up to specimen preparation in a geotechnical laboratory. This simplification avoids interpretation anomalies related to uncertainties in laboratory values for soil unit weights, water contents and density of solid particles.

The $\Delta e/e_0$ and ε_v criteria assume no-gas within the pore water. Gas can cause an increase in void ratio when recovering samples to surface. The result is a correspondingly larger change in void ratio when returning a specimen back to the estimated effective stress conditions in situ. In such case, it is likely that the undrained shear strength would be less affected than soil stiffness, as the void ratio in situ has been partially restored. Changes in soil fabric remain.

Values for $\Delta e/e_0$ and ε_v should exclude secondary consolidation. In practice, no correction for secondary consolidation will be applied. This practice underestimates undisturbed sample quality, particularly for incremental loading oedometer tests with 24 hour load increments and longer.

GEOTECHNICAL INDEX TESTING

WATER CONTENT

The water content is determined by drying selected moist/wet soil material for at least 18 hours to a constant mass in a 110°C drying oven. The difference in mass before and after drying is used as the mass of the water in the test material. The mass of material remaining after drying is used as the mass of the solid particles. The ratio of the mass of water to the measured mass of solid particles is the water content of the material. This ratio can exceed 1 (or 100 %).

Test references: ASTM D2216-10, BS 1377: Part 2: 1990, ISO/TS 17892-1:2014, ISO 19901-8:2014

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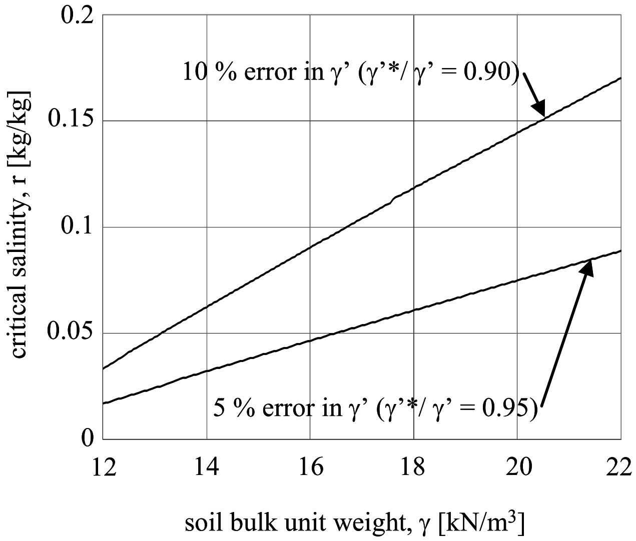
UNIT WEIGHT – VOLUME-MASS CALCULATION

Measurement of volume and mass of a soil sample allows calculation of unit weight. For fine-grained (cohesive) soils, a soil specimen is generally obtained from a standard steel cylinder with cutting edge, which is pushed manually into the extruded soil sample. Preference is given to a 100 ml cylinder (area ratio of 12 %), but a volume of 33.3 ml (area ratio of 21 %) may be used when insufficient homogeneous sample is available. If possible, a specimen of coarse-grained (non-cohesive) soil is obtained by selecting a part of a cylindrical soil sample, trimming the end surfaces, and measuring height and diameter. This method also applies to fine-grained specimens selected for strength and/or stiffness (e.g. triaxial and oedometer) tests.

Unit weight γ (kN/m^3) refers to unit weight of the soil specimen at the water content at the time of test.

The method excludes correction for pore water salinity r (contains dissolved solids), in situ pressure and temperature. The diagram below provides an indication of error in calculated submerged unit weight γ' versus submerged unit weight corrected for salinity, γ'^* (Kay et al., 2005). Typical seawater salinity is 35 g salt per kg seawater (r = 0.035). Correction for salinity is optional.

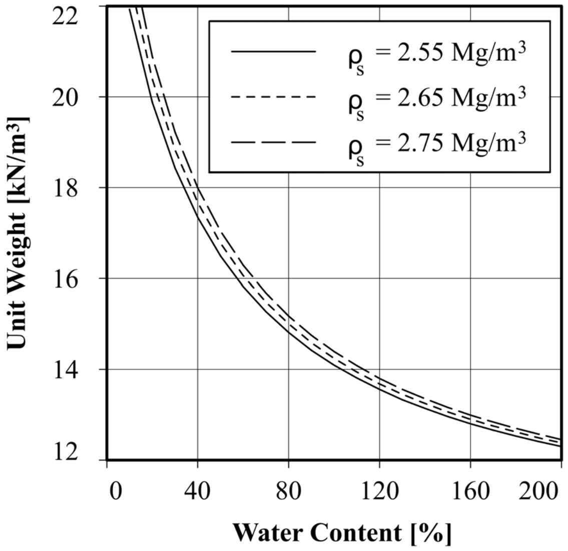


Optionally, dry unit weight γ_d, is calculated from the mass of oven-dried soil and the initial specimen volume.

Test references: BS 1377: Part 2: 1990, ASTM D7263-09, ISO 19901-8:2014

UNIT WEIGHT – DERIVED FROM WATER CONTENT

Water content (w) measurement allows estimation of soil unit weight (γ) on fully saturated samples. This practice requires input on density of solid particles (ρ_s) and presumes saturation of non-saline pore water.



Correction for (high) pore water salinity (contains dissolved solids) is optional.

Test reference: In-house

DENSITY OF SOLID PARTICLES – CONVENTIONAL PYCNOMETER

The density of the solid particles of an oven-dried soil sample is determined by means of a stoppered-bottle pycnometer, using distilled water. The method is considered applicable to solid particles that are not soluble in water. For soils with a high organic content, a different liquid may be selected. Soils with high pore water salinity (contain dissolved solids) require use of a gas pycnometer. This is optional.

Test references: BS 1377: Part 2: 1990, ASTM D854-14, ISO 19901-8:2014

GRAIN SHAPE

Grain shape is determined by microscopic comparison of both grain roundness and sphericity with standard grain shapes. The standard shapes are presented together with the test results.

Test reference: In-house

PARTICLE SIZE ANALYSIS

Particle size analysis can be performed by means of sieving and/or hydrometer readings. Sieving is carried out for particles that would be retained on a 0.063 mm (ISO and BS) or 0.075 mm (ASTM) sieve, while additional hydrometer readings may be carried out when a significant fraction of the material passes a 0.063 mm (0.075 mm) sieve.

In a sieve analysis, the mass of soil retained on each sieve is determined, and expressed as a percentage of the total mass of the sample. Prior to sieving, samples are treated with a dispersing agent (sodium hexametaphosphate), rinsed on a 0.063 mm (0.075 mm) sieve and dried.

The hydrometer method allows measurement of the density of a suspension consisting of fine-grained soil particles and distilled water, to which a dispersion agent is added. This suspension is mixed using a high speed stirrer. Testing is performed in a thermostatically controlled water bath (25° ± 0.5°). The particle size is calculated according to Stokes' Law for a single sphere, on the basis that particles of a particular diameter were at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. These calculations require a value for the density of solid particles. Generally, a value of 2.65 t/m^3 is assumed. When other values are used, this is included in the laboratory report. The hydrometer results for selected particle sizes are presented as a percentage of the total mass of the soil sample.

Particle size is presented on a logarithmic scale so that two soils having the same degree of uniformity are represented by curves of the same shape regardless of their positions on the particle size distribution plot. The general slope of the distribution curve may be described by the coefficient of uniformity C_u, where $C_u = D_{60}/D_{10}$, and the coefficient of curvature C_c, where $C_c = (D_{30})^2/D_{10} \times D_{60}$. D_{60}, D_{30}, and D_{10} are effective particle sizes indicating that 60 %, 30 %, and 10 % respectively of the particles (by weight) are smaller than the given effective size.

Combined presentation of results from hydrometer readings and sieving normally requires data harmonising in the area of overlap, i.e. near the 0.06 mm particle size.

Test references: ISO/TS 17892-4:2004, BS 1377: Part 2: 1990, ASTM D422-63 (2007)e2 (withdrawn, no replacement), ASTM D6913-04(2009)e1, ISO 19901-8:2014

PERCENTAGE FINES

The Percentage Fines test identifies the proportions of fine grained (< 0.06 mm for BS/ISO and < 0.075 mm for ASTM) and coarse-grained (> 0.06 mm) particle sizes of a soil sample by wet sieving through a 0.063 mm (0.075 mm) sieve. Prior to sieving, the sample is treated with a dispersing agent. The Percentage Fines is defined as the ratio of dry mass of soil passing the 0.063 mm (0.075 mm) sieve to the dry mass of the total soil sample, expressed as a percentage.

Test references: ISO/TS 17892-4:2004, BS 1377: Part 2: 1990, ASTM D6913-04(2009)e1, ISO 19901-8:2014

ATTERBERG LIMITS

Atterberg limits are determined on soil specimens with a particle size of less than 0.425 mm. If necessary, coarser material is removed by dry sieving. The Atterberg limits refer to arbitrarily defined boundaries between the liquid and plastic states (Liquid Limit, w_L), and between the plastic and brittle states (Plastic Limit, w_P) of fine grained soils. They are expressed as water content, in percent.

The liquid limit is defined as the water content at which a part of soil is placed in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove, when the cup is subjected to 25 standard shocks. The one-point liquid limit test is usually carried out. Distilled water may be added during soil mixing to achieve the required consistency.

The plastic limit is defined as the water content at which a soil can no longer be deformed by rolling into 3 mm diameter threads without crumbling.

The range of water contents over which a soil behaves plastically is the Plasticity Index, I_P. This is the difference between the liquid limit and the plastic limit (w_L-w_P).

Test references: BS 1377: Part 2: 1990, ASTM D4318-10e1, ISO 19901-8:2014

MINIMUM INDEX UNIT WEIGHT

The minimum index unit weight (γ_{dmin}) of cohesionless soil is determined from the mass of oven-dry material that is deposited by slowly withdrawing a soil-filled funnel from a standard mould of either 70 ml or 550 ml volume.

Test reference: In-house

MAXIMUM INDEX UNIT WEIGHT - IMPACT COMPACTION

The maximum index unit weight (γ_{dmax}) of cohesionless soil is determined from the mass of oven-dry, compacted soil in a standard mould. The soil is compacted in 5 layers, with each layer being subjected to respectively 5, 10, 20, 40 and 80 blows from a standard, hand-held hammer.

Equipment dimensions are as follows. Preference is given to the large mould, but application depends on size of sample.

		70.5 ml mould	**554 ml mould**
Hammer mass	[g]	185	750
Drop height	[mm]	300	390
Cross-sectional area	[mm^2]	1006	38,500

Reference: In-house, DGI Product Sheet #000 96-07-02

MAXIMUM INDEX UNIT WEIGHT – VIBRATING HAMMER

The maximum index unit weight (γ'_{dmax}) is obtained by compacting soil that has been passed through a 4 mm sieve into a mould at a range of water contents. The first sample is thoroughly mixed with water, to produce a soil with a 4 % water content, and then compacted in three equal layers using a vibrating hammer for a period of 10 seconds per layer. The top section of the mould is removed and the sample levelled in the bottom section of the mould. The unit weight of the sample is calculated and a representative portion of soil is removed for water content determination.

The test is repeated at four further water contents. By determining the dry unit weight achieved at each water content, a maximum dry unit weight may be estimated. There is evidence of breakdown of crushable particles during a test.

Equipment dimensions are as follows:

- Volume of mould: 96.4 ml
- Hammer: Milwaukee heavy duty 545S
  - 1300 W nominal / 650 W release
  - rotation/min: 300
  - hammer force: 8.5 J
  - mass: 6.7 kg

Test reference: In-house

GEOCHEMICAL TESTING

ORGANIC MATTER CONTENT – DICHROMATE OXIDATION METHOD

An oven-dried (50°C) soil sample is mixed with potassium dichromate solution and left for 30 min to allow the oxidation of organic matter to proceed. The solution is titrated with a ferrous sulphate solution (to determine the amount of excess potassium dichromate). The organic matter content is defined as the ratio of the total volume of potassium dichromate solution used to oxidize the organic matter in the soil sample to the mass of the initial dried soil sample (Walkley and Black's method). It is expressed as a percentage.

Note: soils containing sulphides or chlorides have been found to yield inaccurate (too high) organic matter content measurements using this procedure.

Test references: BS 1377: Part 3: 1990:3

ORGANIC MATTER CONTENT – LOSS ON IGNITION

An oven-dried (105°C) soil sample is heated to 550°C for 2 hours. The mass is measured before and after heating. The organic matter content is defined as the ratio of the mass loss due to heating to the original mass of the dried soil sample, and is expressed as a percentage.

Note: the mass loss on ignition test is reliable for (1) sandy soils that contain little or no clay and no carbonate and (2) peats and organic clays containing more than 10 % organic matter.

Test references: BS 1377: Part 3: 1990:4, ASTM D2974-14, NEN 5754, ISO 19901-8:2014

CARBONATE CONTENT – GAS VOLUME

The carbonate content is determined by drying selected soil material to a constant mass in a 110°C drying oven, and measuring the volume of dissipated carbon dioxide (CO_2) upon reaction of the soil with hydrochloric acid (HCl). The carbonate content is calculated from calibration values, and expressed as a percentage of dry mass of the original soil.

Test reference: ISO 10693:2004, ISO 19901-8:2014

CARBONATE CONTENT - GAS PRESSURE

The carbonate content is determined by using a dried or a natural soil specimen and measuring the pressure of dissipated carbon dioxide (CO_2) upon reaction of the soil with hydrochloric acid (HCl). The carbonate content is calculated from the mass of the specimen and the pressure increase after reaction by comparison with calibration values. For a natural soil, a correction factor is applied to correct for water content. Carbonate content is expressed as a percentage of dry mass of the original soil.

Test reference: ASTM D4373-14, ISO 19901-8:2014

WATER-SOLUBLE SULPHATE CONTENT – GRAVIMETRIC METHOD

The water-soluble sulphate content of a soil sample is determined on a test portion that has been sieved and crushed through a 2 mm sieve and oven dried to 110°C. The test portion is mixed with distilled water to prepare a 2:1 water:soil extract.

In the gravimetric method, barium chloride solution is added to the water:soil extract and the precipitated barium sulphate is collected, dried and weighted. The sulphate content is then calculated from the mass of the material used in the analysis and the mass of the barium sulphate precipitated. BS presents the results in SO_3 [g/l] and AASTHO in SO_4 [mg/kg].

If a 2:1 water:soil extract is prepared, one can convert sulphites (SO_3) into sulphates (SO_4) by multiplying SO_3 by a factor 1.2. For extractions other than a 2:1 the multiplying factor is different.

Test reference: BS 1377: Part 3:1990, AASHTO T290-95-UL (2007)

WATER-SOLUBLE CHLORIDE CONTENT – MOHR'S METHOD

The water-soluble chloride content of a soil sample is determined on a test portion that has been sieved and crushed through a 2 mm sieve and oven dried to 110°C. The test portion is mixed with distilled water to prepare a 2:1 water:soil extract.

In the Mohr's method chloride ion will precipitate with silver nitrate. The chloride reacts with the silver ion before any silver chromate forms, due to the lower solubility of silver nitrate. The potassium chromate indicator reacts with excess silver ion to form a red silver chromate precipitate. The end point is the appearance of the first permanent orange colour. The chloride content is expressed as a percentage by mass of dry soil.

This test method is suitable for analysing solutions with a pH between 6.0 and 8.5.

Test reference: BS 1377: Part 3: 1990, AASHTO T291-94-UL (2008)

PERMEABILITY TESTING

CONSTANT HEAD PERMEABILITY: TRIAXIAL CELL

The effect of stress level on the coefficient of permeability may be estimated from constant head tests in a triaxial cell – flexible wall permeameter. The specimen is compacted in a split mould by tamping of thin layers of moist soil to the required initial density, and subsequently mounted in the triaxial cell. Filter screens or porous disks are placed at both ends of the specimen. The required stress level is applied and saturation is achieved by flushing with CO_2 gas followed by controlled flow of de-aired water and the application of backpressure. The degree of saturation is checked by the pore water pressure response to small variations in cell pressure. A hydraulic gradient is applied and the rate of flow is recorded for various time steps. The permeability is calculated in accordance with Darcy's equation for laminar flow.

References: BS 1377: Part 6: 1990, ASTM D5084-10, ISO 19901-8:2014

COMPRESSIBILITY TESTING

OEDOMETER - INCREMENTAL LOADING

The oedometer test covers determination of the rate and magnitude of consolidation of a laterally restrained soil specimen, which is axially loaded in increments of constant stress until the excess pore water pressures have dissipated for each increment. Normally, each load increment is maintained for 24 hours.

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The test is generally carried out on undisturbed (intact) cohesive specimens using a consolidometer (oedometer) apparatus, which is placed in a thermostatically controlled room (10°C). Selection of mounting method depends on soil characteristics. Soils that show a tendency to swell, such as peat or overconsolidated clays, are mounted dry. Moist sponges are placed in the oedometer cell to retain sample moisture conditions. Other samples are usually mounted using the wet mounting method. Distilled water is added to the cell when loads are applied to the loading arm. When required, the initial load is increased to prevent swell.

Key parameters that can be obtained from this test are the preconsolidation pressure σ'_p and the coefficient of consolidation c_v. The preconsolidation pressure is estimated using the graphical Casagrande construction. The root time method or the log time method is used for determination of c_v. Other parameters that may be derived from this test are the compression index C_c, the coefficient of volume compressibility m_v and the vertical permeability k_v.

Test references: ASTM D2435/D2435M -11, BS 1377: Part 5: 1990, ISO 19901-8:2014

OEDOMETER - CONSTANT RATE OF STRAIN

The Constant Rate of Strain (CRS) oedometer test covers determination of the rate and magnitude of consolidation of a laterally restrained soil specimen when it is drained axially and subjected to controlled deformation loading. The rate of deformation is selected so that excess pore water pressures are between 3 % and 20 % of the applied axial stress. Drainage of pore water is permitted from the top of the specimen and pore water pressures are measured at the bottom of the specimen. The test is generally carried out on undisturbed (intact) cohesive specimens using a consolidometer, in a thermostatically controlled room (20°C).

Key parameters that can be obtained from this test are the preconsolidation pressure σ'_p and the coefficient of consolidation c_v as a function of axial stress. The preconsolidation pressure is estimated using the graphical Casagrande procedure, while the coefficient of consolidation is determined analytically from the measurements of axial stress, strain and excess pore water pressure. Other parameters that may be derived from this test are the compression index C_c, the coefficient of volume compressibility m_v and the coefficient of vertical permeability k_v.

Test reference: ASTM D4186/D4186M-12, ISO 19901-8:2014

STRENGTH INDEX TESTING

TORVANE AND POCKET PENETROMETER

The torvane and pocket penetrometer are small hand-held instruments for rapid strength index testing of fine grained (cohesive) soils. The torvane test is carried out by pressing a standard vane into the soil and measuring the minimum torque required to rotate the vane. The vane size can be selected to suit the expected torque up to an equivalent undrained shear strength of the soil of 250 kPa. The undrained shear strength is correlated to the measured torque by vane size and torvane spring constant.

The pocket penetrometer test consists of pressing a small solid cylinder into the soil, to a specified penetration. The maximum force required for penetration is correlated to the undrained shear strength. The size of the cylinder can be selected so that undrained shear strength readings of up to 900 kPa can be taken.

Test reference: ISO 22475-1:2006, ISO 19901-8:2014

NEEDLE PENETROMETER

The needle penetrometer is a small held-held instrument for rapid strength index testing of cemented soil and soft rock. The test consists of pressing a needle into a laboratory specimen or in situ outcrop. The needle is a thin truncated cone with a minimum diameter of 0.3 mm, a maximum diameter of 0.8 mm and a cone angle of 20°. The maximum penetration is 10 mm. Force and penetration are recorded. Results are expressed as NPR = F/D, where F is the axial force in N and D is the penetration in mm. The axial force is limited to 100 N. NPR can be correlated to uni-axial compressive strength σ_c. Ulusay and Erguler (2012) suggest $\sigma_c = 0.042\ \text{NPR}^{0.929}$, where σ_c is in MPa and NPR is in N/mm.

Test reference: Ulusay & Erguler (2012)

FALL CONE

The fall cone is a rapid index test for determining undrained shear strength of undisturbed or remoulded specimens of cohesive soil. The test consists of suspending a standard cone of a specified mass and apex angle vertically over and just touching the surface of the specimen. Subsequently, the cone is released and penetrates into the sample under its self-weight. The depth of penetration for the selected cone is correlated to the undrained shear strength of the soil. Several correlations exist. The cone size and shape can be selected to suit the expected undrained shear strength of the specimen.

Reference: ISO/TS 17892-6, ISO 19901-8:2014

HAND VANE

The hand vane allows index testing for undrained shear strength of cohesive soil. The tool is similar to the laboratory miniature vane except for reduced control: manual penetration and rotation of the vane.
Several different measurements of undrained shear strength are possible:

a) Intact: undisturbed undrained shear strength as measured on an intact specimen.
b) Intact–residual: measured post-peak during initial shearing of an intact specimen.
c) Intact–vane-remoulded: measured after multiple rotations of the hand vane after completion of the intact test.
d) Hand-remoulded: steady state (post-peak if exists) resistance of a hand-remoulded test specimen.
e) Hand-remoulded–cane-remoulded: steady state resistance of a hand-remoulded specimen measured after applying multiple vane rotations.

Different values of the remoulded shear strength are often obtained from the different measurement methods.

A specimen may be tested in the sample tube in which it was taken, in a block sample or in a mould after removal from a sampler. The test apparatus consists of a rectangular vane with a short push rod for penetration into the soil. The vane is then slowly rotated by hand and the maximum torsional moment is recorded. Various vane sizes can be selected depending on the consistency of the specimen. Calculation of undrained shear strength is based on a cylindrical failure surface for which uniform stress distributions are assumed. The equation for undrained shear strength is as follows:

$$c_U = \frac{T_{max}}{\pi D^2\left(\frac{1}{2}H + \frac{1}{6}D\right)}$$

where:

c_u	= peak undrained shear strength	[kPa]
T_{max}	= maximum torsional moment	[kNm]
D	= vane diameter	[m]
H	= vane height	[m]

Test reference: in-house

LABORATORY MINIATURE VANE

The laboratory miniature vane test allows determination of undrained shear strength of cohesive soil. CEN (2007) classifies the laboratory miniature vane as a strength index test.

Several different measurements of undrained shear strength are possible:
a) Intact: undisturbed undrained shear strength as measured on an intact specimen.
b) Intact–residual: measured post-peak during initial shearing of an intact specimen.
c) Intact–vane-remoulded: measured after multiple rotations of the vane after completion of the intact test.
d) Hand-remoulded: steady state (post-peak if exists) resistance of a hand-remoulded test specimen.
e) Hand-remoulded–vane-remoulded: steady state resistance of a hand-remoulded specimen measured after applying multiple vane rotations.

Different values of the remoulded shear strength are often obtained from the different measurement methods.

A specimen may be tested in the sample tube in which it was taken or in a mould after extrusion from the sample tube. The sample tube or mould is mounted in the test apparatus and a rectangular vane is lowered into the soil. The vane is then rotated at 10°/min (BS 1377) or at 60°/min to 90°/min (ASTM D4648) and the maximum torsional moment is recorded. A continuous record of rotation versus torsional moment can also be made if required (optional). Various vane sizes can be selected depending on the consistency of the specimen. Calculation of undrained shear strength is based on a cylindrical failure surface for which uniform stress distributions are assumed. The equation for undrained shear strength is as follows:

$$c_U = \frac{T_{max}}{\pi D^2\left(\frac{1}{2}H + \frac{1}{6}D\right)}$$

where:

c_u	= peak undrained shear strength	[kPa]
T_{max}	= maximum torsional moment	[kNm]
D	= vane diameter	[m]
H	= vane height	[m]

Test references: BS 1377: Part 7: 1990, ASTM D4648/D4648M-16, ISO 19901-8:2014

UNCONSOLIDATED UNDRAINED TRIAXIAL (UU)

This type of test is usually performed on undisturbed (intact) samples of cohesive soils. Depending on the consistency of the cohesive material, the test specimen is prepared by trimming the sample or by pushing a mould into the sample. A latex membrane with a thickness of approximately 0.2 mm is placed around the specimen. A lateral confining pressure of 600 kPa to 1000 kPa is maintained during axial compression loading of the specimen. Some test procedures consider lateral confining pressures that are equivalent to total in situ vertical stress. Consolidation and drainage of pore water during testing is not allowed. The test is deformation controlled (strain rate of 60 %/h), single stage, and stopped when an axial strain of 15 % or 20 % is achieved. The deviator stress is calculated from the measured load assuming that the specimen deforms as a right cylinder.

The presentation of test results includes a plot of deviator stress versus axial strain. The undrained shear strength, c_u, is taken as half the maximum deviator stress. The stress at 15 % or 20 % strain is used to calculate undrained shear strength if a maximum stress has not been reached earlier.

To determine strength sensitivity, the test may be repeated on remoulded (compacted) specimens. When possible, the tested undisturbed specimen is kneaded in the membrane, and then reshaped in a mould prior to testing. Stiff to hard specimens are cut into pieces, and reconstituted (compacted) by tamping the pieces in layers into a mould, until the original specimen dimensions are obtained. The sensitivity is the ratio of shear strength of undisturbed soil to shear strength of remoulded soil, $c_u/c_{u;r}$.

Test references: ASTM D2850-15 (2015), BS 1377: Part 7: 1990 (Clause 8), ISO 19901-8:2014

STRENGTH TESTING

RING SHEAR - SOIL/STEEL INTERFACE

Ring shear interface tests are performed on remoulded or reconstituted (compacted) soils to infer the residual friction angle, also called the constant volume friction angle (δ_{cv}), on a soil-steel interface.

The ring shear apparatus enables an annular specimen of soil, 5 mm thick with internal and external diameters of 70 mm and 100 mm, respectively, to be subjected to rotational shear.

First, the sample is consolidated to selected stress conditions. Then, it is sheared at a rate of 500 mm/min (fast shear), followed by 50 mm/min, up to a relative displacement of at least one metre. The sample is then resting for a period of 24h and after that is again consolidated to its selected stress conditions. Finally, the sample is sheared at a slower rate of 0.018 mm/min under drained conditions.

The presentation of the test results includes a plot of stress ratio and angle of shearing resistance versus displacement, both for fast and slow shear.

Test reference: BS 1377: Part 7: 1990, Jardine et al. (2005) (Appendix A), ISO 19901-8:2014

DIRECT SIMPLE SHEAR (DSS)

Simple shear tests provide a simulation of the plane strain mode of shearing for undisturbed (intact), remoulded or reconstituted (compacted) specimens. Key features of the DSS test are essentially constant horizontal dimensions of the specimen in the direction of shear, and a constant volume during shear to simulate undrained behaviour for a saturated test specimen. A constant volume is achieved by maintaining a constant specimen height. A constant specimen height is achieved by varying the normal load applied to the specimen or by fixing the vertical loading ram in place.

The direct simple shear test is carried out on a cylindrical specimen of 50 mm to 66 mm diameter and 16 mm to 30 mm height, depending on test apparatus. Lateral confinement of the specimen is provided by (1) a membrane in combination with a stack of brass shearing washers or by (2) a reinforced membrane. There are no facilities for applying back pressure and control of drainage.

The stress state within a test specimen is insufficiently uniform to allow fundamental processing of test results. Nevertheless, data are commonly presented by shear stresses and strains for the horizontal plane and by equivalent pore pressures.

The peak horizontal shear stress is inferred as the undrained shear strength.

Test reference: ASTM D6528-07, ISO 19901-8:2014

DIRECT SHEAR – SOIL/SOIL INTERFACE

Direct shear testing (or shear box testing) is a method for determining drained soil resistance (angle of internal friction, φ’) for cohesionless and cohesive soils.

The soil to be tested is placed in a split mould, with internal dimensions of 60 mm by 60 mm. A porous stone and loading plate are placed on top of the specimen and a normal load is applied to the specimen. The sample is then sheared, by displacing the top half of the split mould relative to the bottom half, at a rate of displacement preventing significant excess pore-water pressures to be generated. During the test, horizontal displacement, load and vertical displacement are recorded.

On completion of the first stage, the specimen is removed from the mould and the unit weight and water content are determined. Two further tests may then be performed, at the same unit weight, but with increased normal loads.

The test results are presented in the form of graphs of horizontal displacement versus shear stress and normal stress versus maximum shear stress.

Test reference: BS1377: Part 7: 1990, ISO 19901-8:2014

CONSOLIDATED UNDRAINED TRIAXIAL (CIU AND CAU)

The consolidated undrained triaxial test offers the opportunity to derive both undrained and drained strength parameters for undisturbed (intact) or remoulded (compacted) specimens. Specimens are generally prepared by trimming cohesive samples to the required dimensions. The wet mounting method is used, which includes use of wet porous disks and a water-filled drainage system.

Test procedures include specimen saturation, consolidation and compression loading. For cohesive soils, filter paper strips are attached to the specimen circumference to promote drainage during consolidation. Saturation is obtained by incrementing cell pressure and back pressure. The degree of saturation is checked by the pore water pressure response to small variations in cell pressure.

In case of isotropic consolidation (CIU) the specimen is usually consolidated to a stress level equivalent to the mean in situ stress estimated for the appropriate sample depth. For anisotropic consolidation (CAU), the specimen is consolidated to the estimated vertical and horizontal effective stresses. Various consolidation stages may be adopted to simulate the consolidation history and the effects of the expected loading sequence.

Specimen shearing is carried out under conditions of constant axial strain rate, while monitoring axial load and pore water pressure. A strain rate of 4 %/h is generally applied, except when consolidation was slow, in which case a smaller strain rate is applied. The deviator stress is calculated from the measured load assuming the specimen deforms as a right cylinder. The shearing stage is terminated on the basis of effective principal stress ratio (ratio of effective axial stress to effective lateral stress σ'_1/σ'_3), or when an axial strain of 15 % or 20 % is reached. The CIU test may consist of three consolidation and shearing stages of increasing stress level. These stages may be performed on a single specimen or on three separate specimens.

The presentation of test results includes stress-strain data, effective stress paths, pore water pressures and shear strength parameters. Stress paths may be presented in terms of a mean effective stress (p' or s') and the principal stress difference or deviator stress (q or t) as follows:

- Cambridge p'-q space and ASTM p'-q space, with p' defined as $(\sigma'_1+2\sigma'_3)/3$ and q as $\sigma_1-\sigma_3$;
- BSI (1990) s'-t space, with s' defined as $(\sigma'_1+\sigma'_3)/2$ and t as $(\sigma_1-\sigma_3)/2$.

The undrained shear strength is defined as half the deviator stress at failure, $c_u = q/2$ and is reported for the following failure criteria:

1) maximum deviator stress
2) maximum stress ratio q/p'.

The stress at 15 % or 20 % strain is used to calculate undrained shear strength when a maximum stress has not been reached. A secant angle of internal friction, φ', is determined from q = Mp' where $M = (6\sin\varphi')/(3-\sin\varphi')$ or $\sin\varphi' = 3M/(6+M)$ for compression conditions. This definition assumes a zero effective cohesion intercept and may be applied to M_{max} but also to other values of M and corresponding values of q and p'. Similarly, $\sin\varphi' = t/s'$. For tests with three shearing stages, angles of internal friction may be determined for each stage separately, and from a straight line approximation of the failure points of the three stages. The latter method also provides a value for effective cohesion intercept c'.

Test references: NEN 5117, ASTM D4767-11, BS 1377: Part 8: 1990 (Clause 4, 5, 6, 7), ISO 19901-8:2014

CONSOLIDATED DRAINED TRIAXIAL (CID AND CAD)

Consolidated drained triaxial compression tests are generally performed on samples of cohesionless soils. The specimen of dry soil is prepared in the rubber membrane on the base of the triaxial cell, without the use of side drains. Soil particles larger than 20 % of the diameter of the specimen are removed. Specimens are prepared by tamping thin layers of soil to a density approximating the estimated in situ dry density. To saturate the specimen, CO_2 gas is used to expel the air and subsequently de-aired water is used to expel the CO_2 gas. The specimen is further saturated by incrementing cell pressure and back pressure, until the pore pressure response to a cell pressure increment (B-factor) indicates saturation is complete. The specimen is then isotropically or anisotropically consolidated (CID and CAD respectively).

After consolidation the sample is sheared by applying axial load at a sufficiently slow rate to permit drainage (usually 6 %/h). The lateral confining pressure is kept constant during each loading stage. Pore pressure measurements are made at the bottom to check if the test is fully drained. The deviator stress is calculated from the measured load assuming the specimen deforms as a right cylinder. The CID test may have three consolidation and loading stages of increasing pressure performed on either a single specimen or on three separate specimens. The CAD test is limited to a single shearing stage. A shearing stage is terminated on the basis of effective stress ratio (ratio of effective axial stress to effective lateral stress, σ'_1/σ'_3), or when an axial strain of 15 % or 20 % is reached.

Results include stress-strain data, stress paths, and volumetric/shear strain of each loading stage. Stress paths may be presented in terms of a mean effective stress (p' or s') and the principal stress difference or deviator stress (q or t) as follows:

- Cambridge p'-q space and ASTM p'-q space, with p' defined as $(\sigma'_1+2\sigma'_3)/3$ and q as $\sigma_1-\sigma_3$;
- BSI (1990) s'-t space, with s' defined as $(\sigma'_1+\sigma'_3)/2$ and t as $(\sigma_1-\sigma_3)/2$.

A secant angle of internal friction, φ', is determined from q = Mp' where $M = (6\sin\varphi')/(3-\sin\varphi')$ or $\sin\varphi' = 3M/(6+M)$ for compression conditions. This definition assumes zero effective cohesion intercept and may be applied to M_{max} but also to other values of M and corresponding values of q and p'. Similarly, $\sin\varphi' = t/s'$. For tests with three shearing stages, angles of internal friction may be determined for each stage separately, and from a straight line approximation of the failure points of the three stages. The latter method also provides a value for effective cohesion intercept c'.

Test reference: ASTM D7181-11; BS 1377: Part 8: 1990 (Clause 4, 5, 6, 8), ISO 19901-8:2014

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INTRODUCTION

The Cone Penetration Test (CPT) involves the measurement of the resistance of ground to steady and continuous penetration of a cone penetrometer equipped with internal sensors. The measurements comprise penetration depth, cone resistance, sleeve friction and, optionally, pore pressure and inclination from vertical. These measurements permit interpretation of ground conditions.

CPT apparatus and procedures adopted by Fugro are in general accordance ISSMGE (1999), ASTM (2012), ISO (2012) and ISO (2014). BS 5930 (BSI, 2015) and NORSOK Standard G-CR-001 (NORSOK, 2004) refer to ISSMGE (1999). General agreement also applies to Eurocode 7 (CEN, 2007).

Fugro offers CPT systems operated from (1) ground surface and seafloor (non-drilling deployment mode) and (2) downhole in a borehole (drilling deployment mode).

CPT APPARATUS

GENERAL

CPT apparatus includes various parts as described below:
- Thrust machine: apparatus providing thrust to the push rods so that the required constant rate of penetration is controlled.
- Reaction equipment: reaction for the thrust machine.
- Push rod: thick-walled cylindrical tube used for advancing the penetrometer to the required test depth. Push rods may also consist of drill pipe.
- Friction-cone penetrometer (CPT): cylindrical terminal body mounted on the lower end of the push rods, including a cone, a friction sleeve and internal sensing devices for the measurement of cone resistance, sleeve friction and, optionally, inclination.
- Piezo-cone penetrometer (CPTU or PCPT): cylindrical terminal body mounted on the lower end of the push rods, including a cone, a friction sleeve, a filter and internal sensing devices for the measurement of cone resistance, sleeve friction, pressure and, optionally, inclination.
- Measuring system: apparatus and software, including sensors, data transmission apparatus, recording apparatus and data processing apparatus.

DEPLOYMENT FROM GROUND SURFACE OR SEAFLOOR

Specific additional apparatus for CPT deployment from ground surface and seafloor can include:
- Push rod casing: guide for the part of the push rods protruding above the soil, and for the push rod length exposed in water or soil, in order to prevent buckling when the required penetration pressure increases beyond the safe limit for the exposed upstanding length of push rods.
- Friction reducer: ring or special projections fixed on the outside of the push rods, with an outside diameter larger than the base of the cone, to reduce soil friction acting on the push rods.

DOWNHOLE BOREHOLE DEPLOYMENT

Downhole CPT systems latch into a bottom hole assembly at the lower end of a drill pipe. System options are:
1. Operation of a downhole thrust machine by applying mud pressure in the borehole.
2. Remote control of a downhole thrust machine by hydraulic pressure transmitted through an umbilical cable connected to a surface-based pump unit, together with.
3. Application of thrust to drill rods where CPT apparatus and a short push rod are latched in the bottom hole assembly; the thrust machine is at ground surface or seafloor.

Data recording can be surface-based and/or downhole.

Downhole CPTs require drilling apparatus for advancing the borehole. The maximum CPT stroke is generally 1.5 m or 3 m.

CONE PENETROMETER

Typical features of Fugro penetrometers (Figure 1) include:

- Cone base areas of 500 mm^2, 1000 mm^2 or 1500 mm^2; other sizes are also in use, e.g. 3300 mm^2
- Cone and friction sleeve sensors placed in series, i.e. subtraction-type penetrometers.
- Pore pressure measurements either at the face of the cone (u_1) or at the cylindrical extension of the cone (u_2). Multiple-sensor penetrometers (u_1, u_2 and u_3) are also available. The u_3 location is immediately above the friction sleeve.
- Inclinometer.
- Storage of signals from the penetrometer in digital form for subsequent computer-based processing and presentation.

PROCEDURE

Figure 2 summarises the test procedure. The procedure includes several stages. The stage of Additional Measurements is optional.

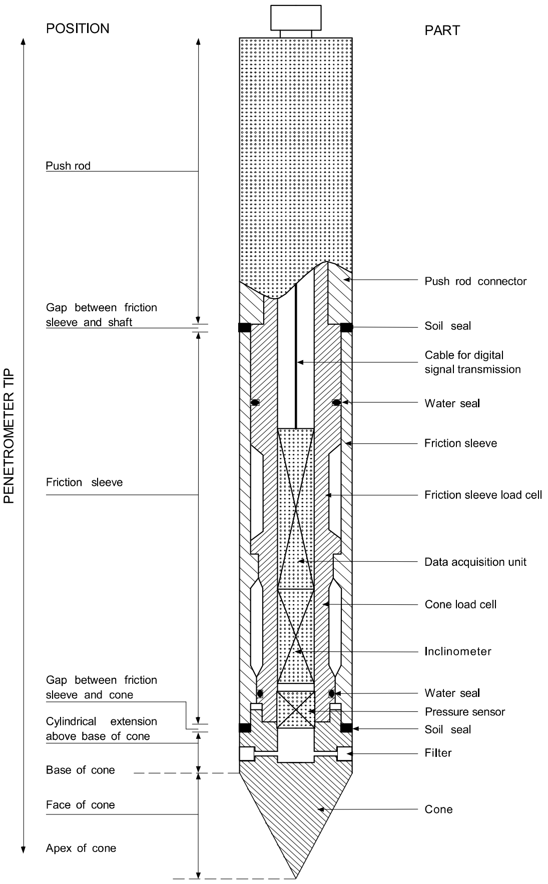

Figure 1 – Piezo-cone Penetrometer

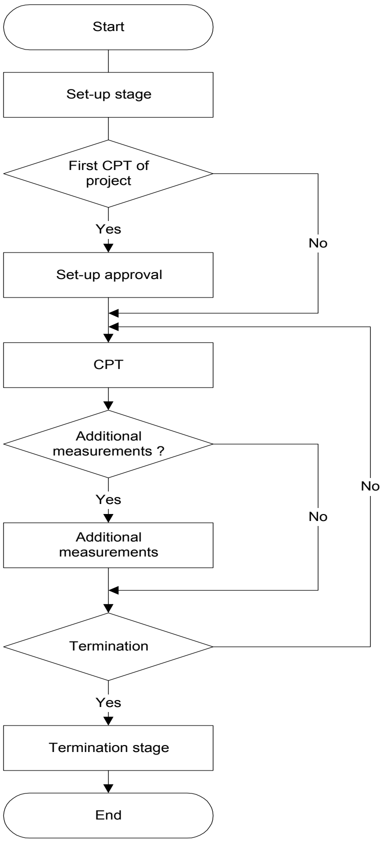

Figure 2 - Flow chart

Set-up requires a reasonably flat, accessible, ground surface with a slope of 5° or less. In other cases, set-up is at discretion of the equipment operator, considering risks such as damage to apparatus or safety of personnel. Most onshore thrust machines have levelling facilities allowing a vertical start of penetration. Seabed frames used for offshore CPT activities have no levelling facilities, i.e. start of penetration may not be vertical.

The set-up stage includes selection of equipment and procedures according to project-specific agreements, such as a required accuracy class or application class, penetration, type of cone penetrometer and data processing/ submission. Table 1 presents ISSMGE accuracy classes and Tables 2 and 3 summarise ISO application classes. The allowable minimum accuracy of a measured parameter is the larger value of the two quoted. A percentage value applies to the measured value and not to the measuring range. The concept of application classes considers intended soil conditions for selection of an application class. For example, Application Class 1 of ISO (2014) can be selected for “very soft to soft soil deposits”, which is approximately equivalent to q_c < 0.5 to q_c < 1 MPa. In other words, Application Class 1 should not apply to “mixed bedded soil profiles with weak to strong layers”.

The accuracy values apply to ground surface or seafloor as reference. They are uncoupled from uncertainty of spatial position below ground surface or seafloor.

TABLE 1 ACCURACY CLASSES (ISSMGE, 1999)

Accuracy Class	Measured Parameter	Allowable Minimum Accuracy	Maximum Length between Measurements
1	Cone resistance, q_c	50 kPa or 3%	20 mm
	Sleeve friction, f_s	10 kPa or 10%	
	Pore pressure, u	5 kPa or 2%	
	Inclination, i	2°	
	Penetration depth, z	0.1 m or 1%	
2	Cone resistance, q_c	200 kPa or 3%	20 mm
	Sleeve friction, f_s	25 kPa or 15%	
	Pore pressure, u	25 kPa or 3%	
	Inclination, i	2°	
	Penetration depth, z	0.2 m or 2%	
3	Cone resistance, q_c	400 kPa or 5%	50 mm
	Sleeve friction, f_s	50 kPa or 15%	
	Pore pressure, u	50 kPa or 5%	
	Inclination, i	5°	
	Penetration depth, z	0.2 m or 2%	
4	Cone resistance, q_c	500 kPa or 5%	50 mm
	Sleeve friction, f_s	50 kPa or 20%	
	Penetration length, l	0.1 m or 1%	

TABLE 2 APPLICATION CLASSES (ISO, 2012)

Appl. Class	Measured Parameter	Allowable Minimum Accuracy	Maximum Length between Measurements
1	Cone resistance, q_c	35 kPa or 5%	20 mm
	Sleeve friction, f_s	5 kPa or 10%	
	Pore pressure, u	10 kPa or 2%	
	Inclination, i	2°	
	Penetration length, l	0.1 m or 1%	
2	Cone resistance, q_c	100 kPa or 5%	20 mm
	Sleeve friction, f_s	15 kPa or 15%	
	Pore pressure, u	10 kPa or 3%	
	Inclination, i	2°	
	Penetration length, l	0.1 m or 1%	
3	Cone resistance, q_c	200 kPa or 5%	50 mm
	Sleeve friction, f_s	25 kPa or 15%	
	Pore pressure, u	50 kPa or 5%	
	Inclination, i	5°	
	Penetration length, l	0.2 m or 2%	
4	Cone resistance, q_c	500 kPa or 5%	50 mm
	Sleeve friction, f_s	50 kPa or 20%	
	Penetration length, l	0.2 m or 2%	

TABLE 3 APPLICATION CLASSES (ISO, 2014)

Application Class	Measured Parameter	Allowable Minimum Accuracy
1	Cone Resistance Sleeve friction Pore pressure	35 kPa or 5% 5 kPa or 10% 25 kPa or 5%
2	Cone resistance Sleeve friction Pore pressure	100 kPa or 5% 15 kPa or 15% 50 kPa or 5%
3	Cone Resistance Sleeve friction Pore pressure	200 kPa or 5% 25 kPa or 15% 100 kPa or 5 %

The set-up stage or the termination stage includes the location survey, i.e. the determination of the co-ordinates and the ground surface elevation (or the water depth).

The set-up stage and the termination stage for a downhole CPT include lowering of the CPT apparatus into the borehole and lifting respectively. Most projects require multiple downhole tests in a single borehole.

For piezo-cone testing, the set-up stage also includes the following steps:
- Office-based or site-based: de-airing of the filter in glycerine by application of 24-hour vacuum and storage in a glycerine-filled container.
- On-site: glycerine filling of hollow space in the cone penetrometer and subsequent mounting of the filter.
- On-site: application of a flexible membrane around the filter to prevent loss of saturating fluid prior to the start of a test.

Land-based tests may include specific measures to help retention of filter saturation during penetration of partially saturated zones. Relaxation of requirements typically applies to offshore tests where water pressures will force entrapped air into solution.

Criteria for test termination are as follows, unless specifically agreed otherwise:
- as instructed by Client
- reaching target penetration
- reaching maximum capacity of the thrust machine, reaction equipment, push rods and/or measuring sensors
- penetrometer inclination of greater than 15°
- sudden increase in penetrometer inclination
- circumstances at discretion of equipment operator, such as risk of damage to apparatus or safety of personnel,

whichever occurs first and as applicable.

A CPTU pore pressure measuring system is intended for use in water-saturated uncemented fine-grained soil. Results obtained for ground conditions such as partially saturated soils, very dense sands and cemented soils may not be reliable and/or repeatable. For example, stiffness differences between the steel components of the cone penetrometer and the piezo-cone filter can affect results for very dense sands. Also, loss of saturation of the pore pressure measuring system may occur during a test (Lunne et al. 1997; Peuchen and Terwindt 2014). Reasons can include:
- penetration of partially saturated ground, for example ground containing significant amounts of gas
- measurement of negative pore pressures such that cavitation occurs. For example, this is not uncommon for a piezo-cone filter located at the cylindrical extension above the base of the cone (u_2 location). Particularly, this may occur at the time of penetration of dense sand or overconsolidated clay layers. Loss of saturation usually causes a sluggish pore pressure response during penetration of ground below the zone causing desaturation of the pore pressure measuring system.

Special apparatus and procedures may apply to:
- specific additional measurements (for example shear wave velocity)
- specific applications (for example deepwater tests or measurements for application (accuracy) classes 1 and 2).

RESULTS

CPT PARAMETERS

Presentation of results from cone penetration tests typically includes:
- CPT parameters q_c, f_s and R_f versus depth below ground surface or versus elevation
- additional CPTU parameters u_1 or u_2 and, optionally, q_t, q_n, B_q, Q_t, Q_{tn}, F_r and I_c for tests with pore pressure measurements
- optionally, inclination i for tests with inclination measurements
- standard graphical format and optional ASCII and AGS formats.

Most standards specify scales for graphical presentation as follows:
- axis for penetration depth z: 1 scale unit = 1 m
- axis for cone resistance q_c, corrected cone resistance q_t and net cone resistance q_n: 1 scale unit = 2 MPa or 0.5 MPa
- axis for sleeve friction f_s: 1 scale unit = 50 kPa
- axis for friction ratio R_f: 1 scale unit = 2%
- axis for pore pressure u: 1 scale unit = 0.2 MPa or 0.02 MPa
- axis for pore pressure ratio B_q: 1 scale unit = 0.5.

Graphical presentation aims for these scale units and scale ratios, where suitable and practicable.

This reference level of a test is (1) the ground surface for onshore tests, (2) the seafloor for nearshore and offshore tests. Historically, the bottom of the borehole was used as the reference level of downhole tests. Data processing presumes a hydrostatic pore pressure profile relative to seafloor, unless specifically indicated otherwise. The definition of CPT parameters is as follows:

z = penetration depth relative to ground surface or seafloor, corrected for inclination from vertical (i) where a test includes inclination measurements, as follows:

$$z = \int_0^l \cos i \, . \, dl$$

where:
z = penetration depth for the conical base of the cone penetrometer
l = recorded penetration length
i = recorded inclination from vertical

q_c = cone resistance relative to the reference level of the test.

f_s = sleeve friction relative to the reference level of the test. A calculated depth correction applies so that the presented sleeve friction corresponds with the cone depth.

f_t = corrected sleeve friction relative to the reference level of the test. Sleeve friction is corrected for pore pressures acting on the end areas of the friction sleeve

$$f_t = f_s - \frac{(u_2 * A_{sb} - u_3 * A_{st})}{A_s}$$

or simplified to:

$$f_t = f_s - u_2 \frac{(A_{sb} - A_{st})}{A_s} \qquad \text{or}$$

$$f_t = f_s - (u_2 * a_{fs})$$

where:
A_{sb} = cross sectional area in the gap between the friction sleeve and the cone
A_{st} = cross sectional area in the gap above the friction sleeve
A_s = surface area of the friction sleeve
a_{fs} = net area ratio of the friction sleeve $(A_{sb} – A_{st})/A_s$

R_f = ratio of sleeve friction to cone resistance (f_s/q_c). This calculated ratio is for the cone depth.

R_{ft} = corrected friction ratio (f_s/q_t). The ratio f_t/q_t applies if f_t is known.

I_{SBT} = non-normalized soil behaviour type index (Robertson, 2010)

$$I_{SBT} = [(3.47 – \log(q_c/P_a))^2 + (\log R_f + 1.22)^2]^{0.5}$$

where:
P_a = atmospheric pressure

u_1 = pore pressure at the face of the cone, relative to the reference level of the test.

u_2 = pore pressure at the cylindrical extension above the base of the cone or in the gap between the friction sleeve and the cone, relative to the reference level of the test.

u_3 = pore pressure immediately above the friction sleeve or in the gap above the friction sleeve, relative to the reference level of the test.

q_t = corrected cone resistance (also called total cone resistance). This includes corrections for hydrostatic and transient pore pressures, and cone construction. The corrected cone resistance is relative to ground surface or seafloor:

Ground surface / seafloor:	Downhole (historic):
$q_t = q_c+(1-a)u_2$ or	$q_t = q_c+(1-a)u_2+u_{oi}$ or
$q_t = q_c+(1-a)\{K(u_1-u_o)+u_o\}$	$q_t = q_c+(1-a)\{K(u_1+u_{oi}-u_o)+u_o\}+au_{oi}$

where:

a = net area ratio of the cross-sectional steel area at the gap between cone and friction sleeve to the cone base area. This ratio is penetrometer-type dependent. The a-factor indicates the effect of pore pressure on unequal cross-sectional areas of the cone.

u_o = hydrostatic pore pressure at the cone, relative to the phreatic surface or the seafloor. This is a calculated value.

u_{oi} = hydrostatic pore pressure at the bottom of the borehole, relative to seafloor. This is a calculated value.

K = adjustment factor for the ratio of pore pressure at the cylindrical extension above the base of the cone to pore pressure on the cone face.

Ground surface / seafloor:	Downhole (historic):
$K = (u_2-u_o)/(u_1-u_o)$	$K = (u_2+u_{oi}-u_o)/(u_1+u_{oi}-u_o)$

The term u_2-u_o or $u_2+u_{oi}-u_o$ refers to excess pore pressure (with respect to hydrostatic pore pressure). Common symbols for excess pore pressure are du_2 or Δu_2. Similarly, du_1 or Δu_1 may represent the term u_1-u_o or $u_1+u_{oi}-u_o$.

The K-factor is only of interest for processing of CPTU results with pore pressure measurement at the cone face (u_1). The factor depends on soil characteristics as fabric, overconsolidation ratio, compressibility and crushability. The K-factor is estimated from:

$$K = 0.91e^{-0.09Q_t^{0.47}}\left(\frac{1}{1+F_r(0.17+0.061(Q_t-21.6)^{1/3})} - e^{-2F_r}\right) \qquad \text{(Peuchen et al., 2010)}$$

q_n = q_t-σ_{vo} = net cone resistance. This includes corrections for hydrostatic and transient pore pressures, in situ stress, and cone construction. The symbol for q_n may also be q_{net}.

where:
σ_{vo} = total in situ vertical stress at the cone base, relative to ground surface or seafloor. This is a calculated value.

Q_t = q_n/σ'_{vo} = normalized cone resistance

where:
σ'_{vo} = effective in situ vertical stress at the cone base, relative to ground surface or seafloor. This is a calculated value.

Q_{tn} = normalized cone resistance with variable stress exponent n, where:

$$Q_{tn} = [(q_t - \sigma_{vo})/P_a]\ (P_a/\sigma'_{vo})^n$$

$$n = 0.381\ (I_c) + 0.05\ (\sigma'_{vo} / P_a) - 0.15 \text{ and } n \leq 1 \qquad \text{(Zhang et al., 2002)}$$

I_c = soil behaviour type index (Robertson and Wride,1998)

$$I_c = [(3.47 - \log Q_{tn})^2 + (\log F_r + 1.22)^2\ ]^{\ 0.5}$$

F_r = f_t/q_n = normalized friction ratio.

B_q = pore pressure ratio.

Ground surface / seafloor:	Downhole (historic):
B_q = $K(u_1$-$u_o)/q_n$ or	B_q = $K(u_1$+u_{oi}-$u_o)/q_n$ or
B_q = $(u_2$-$u_o)/q_n$	B_q = $(u_2$+u_{oi}-$u_o)/q_n$

Note that pore pressure measurements (u) are commonly assumed to represent pore water pressures. This assumption is reasonable for soils saturated under in situ stress conditions and remaining saturated during penetration of the cone penetrometer. Furthermore, pressure u_2 at the cylindrical extension is commonly assumed equal to u_{2g} in the gap. This assumption is reasonable for saturated low-permeability soils (clays) that are normally consolidated or lightly overconsolidated and where the gap can become saturated by adequate supply of water and/or water pressure. A similar comment applies to u_3.

Presented values for u_2, q_t, q_n and B_q may be denoted by u_2*, q_t*, q_n*, B_q*, Q_t* and F_r* if u_2 is derived rather than measured, for example if derived by applying a K-factor.

Some deployment systems allow monitoring of CPT parameters in reverse mode, i.e. upon retraction of the cone penetrometer. This optional feature presents additional information that can improve interpretation of ground behaviour, for example strength sensitivity of fine-grained soil.

ACCURACY OF MEASUREMENTS

Accuracy Classes and Application Classes

Cone penetration test standards can follow a “prescriptive” approach, whereby specific detailed measures provided a “deemed to comply” practice. ASTM (2012) is an example of this approach. ISSMGE (1999) and ISO (2012, 2014) specify “performance” criteria for cone penetration test measurements. The ISO standard on metrological confirmation (ISO, 2003) provides the general framework for assessment of performance compliance. Peuchen and Terwindt (2014, 2015) provide guidance on uncertainty estimation for cone penetration test results.

The following comments apply:

– Accuracy is the “closeness of a measurement to the true value of the quantity being measured”. It is the accuracy as a whole that is ultimately important not the individual parts. Precision is the “closeness of each set of measurements to each other”. The resolution of a measuring system is the “minimum

size of the change in the value of a quantity that it can detect". It will influence the accuracy and precision of a measurement.
- Accuracy Class 3 and Application Class 3 typically represents industry practice. They are approximately equivalent to the more implicit requirements of ASTM International. Class 3 applies, unless specifically agreed otherwise.

So-called "zero drift" of a measured parameter is an approximate performance indicator for the measuring system. Zero drift is the absolute difference of the zero readings, reference readings or zero reference reading of a measuring system between the start and completion of the cone penetration test. The reference readings can be taken at (1) atmospheric pressure at ground surface or above water level or (2) under hydrostatic water pressure close to seafloor. The zero drift of the measured parameters should be within the allowable minimum accuracy according to the selected accuracy class. Correction of measured parameters for zero drift can be adopted if appropriate. Peuchen and Terwindt (2014) provide comments on interpretation of zero drift values.

Accuracy considerations for strongly layered soils should allow for heat flux phenomena. Heat flux gives an apparent shift in cone resistance (Post and Nebbeling, 1995). For example, friction in dense sand causes a cone to heat by about 1°C/MPa cone resistance. Resulting heat flux decreases cone resistance by an apparent shift in the order of 100 kPa to 200 kPa for a penetrating probe going from dense sand into clay. This is a temporary decrease lasting about 5 minutes. Ambient temperature compensation systems cannot avoid heat flux effects. Penetration interruption can serve as mitigation measure.

Shallow Penetration

Use of reaction equipment will affect stress conditions for shallow penetration. Particularly, offshore conditions may include extremely soft ground at seafloor. Soil disturbance, pore pressure build-up and consolidation of near-surface soft soil may take place. This will affect the measurements.

Downhole borehole deployment implies a typical limiting CPT stroke of 1.5 m or 3 m. It is common to perform multiple semi-continuous tests. Graphics for such tests typically show a build-up of CPT values for the initial 0.1 m to 0.5 m penetration. This penetration zone is immediately below the required borehole and represents complex ground stress conditions and/or borehole-induced ground disturbance that cannot be avoided.

Penetration Interruption

A penetration interruption may be unavoidable, for example to add a push rod or to perform a pore pressure dissipation test. This will affect test results.

Consolidation of low-permeability soil around a cone tip is of particular interest. A stationary cone penetrometer can apply local stresses that approach failure conditions, i.e. about 9 times the undrained shear strength or about 2 times the in situ mean effective stress. Pore pressure re-distribution and dissipation occur, resulting in a local increase in undrained shear strength and hence cone (bearing) resistance. A doubling of cone resistance may not be unreasonable for 100% consolidation. Supplementary considerations include:
- Small downward movement of a penetrometer (order of millimetres) during a test can contribute to maintaining local stresses approaching failure conditions.
- Soil consolidation around a cone penetrometer may lead to soil/penetrometer adhesion that is sufficient to give an increase in "cone" diameter. Resumption of penetration will lead to loss of adhered soil, usually within an equivalent distance of a few times the cone diameter.
- A low B_q value may imply partially drained penetration conditions. It is likely that any steady-state penetration conditions will not apply instantaneously upon resumption of penetration.
- Measuring sensors in a probe generate heat, but this is probably not significant for any stationary measurement. Fugro's strain-gauge load sensors are compensated for ambient temperature fluctuations.

Depth Measurement for Offshore Conditions

Offshore definition of the seafloor (ground surface) is difficult for extremely soft ground at seafloor. Penetration of the reaction equipment into a near-fluid zone of the seabed may take place unnoticed. Such settlement affects the start of penetration depth z. Also, settlement may continue at the time of testing.

Downhole CPT systems rely on depth control applicable to borehole drilling. Depth control according to Z2 of Table 4 is feasible for drilling systems deployed from a fixed platform, for example a jack-up. This value excludes uncertainty associated with determination of seafloor level. Drilling control from floating equipment, for example a geotechnical survey vessel, may be subject to the additional influence of waves and tides. Z2 is typically feasible for favourable conditions. Z3 or Z4 may apply for adverse conditions.

TABLE 4 DEPTH ACCURACY CLASSES ACCORDING TO ISO (2014)

Depth Accuracy Class	Maximum Data Point Depth Uncertainty [m]
Z1	0.1
Z2	0.5
Z3	1.0
Z4	2.0
Z5	> 2.0

Zero-Correction for Offshore Conditions

Water pressures generate significant values of cone resistance and pore pressure. The standardised practice is to correct these reference readings to zero at seafloor. CPT systems for non-drilling mode and for seafloor drilling mode allow zero-correction to hydrostatic conditions prior to the start of a test, typically with a zero-correction uncertainty approaching the resolution of the CPT system. Downhole borehole CPT systems latch into the lower end of a drill pipe. The pressure conditions in the drill pipe may not be in full equilibrium with the surrounding ground water pressure and zero-correction will be subject to increased uncertainty, i.e. uncertainty for pore pressure in the order of 100 kPa for deepwater tests (Peuchen, 2000). This uncertainty depends on factors such as the free-flow and viscosity of drill fluid between the drill bit and the seafloor. The uncertainty typically decreases with decreasing depth of the drill bit below sea level and below seafloor. Uncertainty for the zero-correction of cone resistance is approximately equivalent, but by a factor representing the net area ratio effect.

Deepwater Tests

A deepwater environment presents some favourable conditions for cone penetration tests, notably temperature. Ambient temperature conditions are practically constant and the measuring system has ample time to adjust to these temperatures. In addition, transient heat flow phenomenain a cone penetrometer are usually not applicable due to the generally very soft soil consistency and the absence of crust layers formed by desiccation of clay or silt in geological history.

Deepwater (piezo-cone) pore pressure measurements are essentially similar to shallow-water measurements, with the exception of an increased measuring range for pore pressure leading to some reduction in sensor accuracy. Saturation of a pore pressure measuring system is excellent for a deepwater environment, as the high pressures will force any gas bubbles into solution.

Currently available evidence indicates that a high-quality subtraction-type cone penetrometer is adequate for very soft soil characterisation to a water depth of 3000 metres and probably beyond.

ADDITIONAL MEASUREMENTS

Friction-cone and piezo-cone penetrometers allow specific additional measurements, such as friction set-up tests, pore pressure dissipation tests and measurements of ground water pressure. These additional measurements require a penetration interruption or may be feasible at the end of a test. It is also common to add other in situ test devices to a cone penetrometer. Table 5 presents the more common types.

TABLE 5 PROBES FOR ADDITIONAL IN SITU TESTS

Type of Probe	Properties	Units
Electrical Conductivity Penetrometer (ECPT)	Electrical conductivity, K	S/m
Temperature Cone Penetrometer (TCPT)	Temperature, T	°C
Seismic Cone Penetrometer (SCPT)	Shear wave velocity, v_s	m/s
Cone Pressuremeter (CPMT)	Shear stress-strain-time response, σ, ε, t	MPa, -, s
Natural Gamma Penetrometer (GCPT)	Natural gamma ray, γ	CPS
Cone Magnetometer (CMMT)	Magnetic flux density B, magnetic field horizontal angle θ and vertical angle ϕ	µT, °, °
Hydraulic Profiling Tool (HPT)	Permeability, k	m/s

S = Siemens
m = metre
s = second
Pa = Pascal
CPS = counts per second
T = Tesla

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INTRODUCTION

This document presents a summary of interpretation methods for Cone Penetration Test (CPT) results. The project-specific selection of methods depends on the agreed project requirements. Some of the methods suit computer-based interpretation of CPT data records.

Interpretation of Cone Penetration Test results helps provide parameters for geotechnical models. Conventional models are typically based on plasticity theory for ultimate limit states, and on elasticity theory and consolidation theory for serviceability limit states. Features of these geotechnical models are:

- analysis of either drained (sand model) behaviour or undrained (clay model) behaviour for plasticity models
- analysis for the ultimate limit state differs from that for the serviceability limit state.

CPT interpretation methods are mostly based on empirical correlations with limited theoretical backing. Data integration with other, complementary investigation techniques (such as drilling, sampling and laboratory testing) improves confidence levels.

The interpretation techniques discussed below are subject to limitations such as:

- The majority of interpretation methods apply to "conventional" sands and clays. Conventional methods may not be appropriate for silts, sand/clay/gravel mixtures, varved or layered soils, gassy soils, underconsolidated soils, peats, carbonate soils, cemented soils and residual soils. These non-conventional soils warrant a more specific approach.
- Empirical correlations use reference parameters such as the undrained shear strength determined from a laboratory single-stage Isotropically Consolidated Undrained triaxial test (CIU) on an undisturbed specimen obtained by means of push sampling techniques (Van der Wal et al., 2010). The reference parameter may not be appropriate for the selected geotechnical model, and adjustment may be necessary. Also, adjustment for test conditions may be necessary, for example in situ temperature versus laboratory temperature.
- The cone penetration test offers limited direct information on serviceability limit states (deformation), as the penetration process imposes large strains in the surrounding soil. In comparison to ultimate limit states, better complementary data will usually be required.
- CPT interpretation techniques are often indirect. Usually, interpretation requires estimates of various other parameters. This is consistent with an integrated geotechnical investigation approach. Inevitably, this approach also includes some redundancy of data.
- Drained or undrained behaviour for the geotechnical analysis at hand may or may not coincide with respectively drained or undrained behaviour during fixed-rate penetration testing. This interpretation difficulty remains largely unresolved at this time.
- The interpretations apply to conditions as encountered at the time of the geotechnical investigation. Geological, environmental and construction/operational factors may alter as-found conditions.

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PENETRATION BEHAVIOUR

Soil behaviour during cone penetration testing shows large displacements in the immediate vicinity of the penetrometer, and small elastic displacements further away from the penetrometer. Density/structure, stiffness and in situ stress conditions significantly affect the measured parameters.

The measured cone resistance (q_c) includes hydrostatic water pressures as well as stress-induced pore pressures. The pore pressures are usually negligible for clean sand because the ratio of effective stress to pore pressure is high. This ratio is, however, low for penetration into clay. Knowledge of pore pressures around the penetrometer can thus be important. CPT parameters that take account of pore pressure effects include total cone resistance (q_t), net cone resistance (q_n) and pore pressure ratio (B_q). These parameters can be calculated if Piezo-cone Penetration Test (PCPT or CPTU) data are available. The influence of pore pressures on sleeve friction f_s is relatively small. It is common to ignore this influence. Calculation of friction ratio R_f (defined as f_s/q_c) includes no allowance for pore pressure effects.

The penetration rate with respect to soil permeability determines whether soil behaviour is primarily undrained, drained or partially drained. In general, soil behaviour during cone penetration testing is drained in clean sand (no measurable pore pressures as a consequence of soil displacements) and undrained in clay (significant pore pressure changes). Partially drained behaviour occurs in soils with intermediate permeability, such as sandy silt. The following sections mostly consider interpretation of drained soil behaviour (sand) and undrained soil behaviour (clay).

SOIL BEHAVIOUR IDENTIFICATION

Identification of soil stratigraphy in terms of general soil behaviour (and to a lesser degree soil type) is a more important feature of CPT than other investigation technique.

Figures 1 to 3 show soil behaviour identification according to procedures given by Robertson (2009) and Ramsey (2002). Robertson (2009) represents an update of Robertson (1990), by exchange of Q_t with Q_{tn}. The procedures consider a normalised soil behaviour classification that provides general guidance on likely soil type (silty sand for example) and a preliminary indication of parameters such as angle of internal friction φ', overconsolidation ratio (OCR) and clay sensitivity (S_t). The procedures require piezo-cone test data:

$$Q_{tn} = [(q_t - \sigma_{vo})/P_a]\,(P_a/\sigma'_{vo})^n \qquad Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad F_r \text{ or } nR_f = \frac{f_s}{q_t - \sigma_{vo}}100\% \qquad B_q = \frac{u - u_0}{q_t - \sigma_{vo}}$$

where:
Q_{tn} = normalised cone resistance with variable stress exponent
Q_t = normalised cone resistance
q_t = corrected cone resistance
σ_{vo} = total in situ vertical stress
σ'_{vo} = effective in situ vertical stress
P_a = atmospheric pressure
n = stress exponent
f_s = measured sleeve friction
u = measured pore pressure
u_0 = theoretical hydrostatic pore pressure.

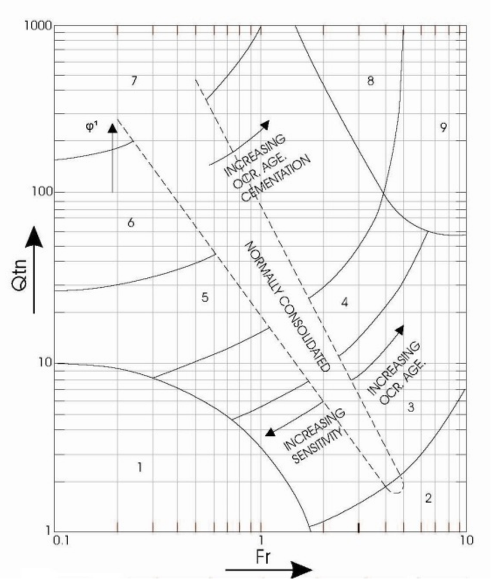
Zhang et al. (2002) defined stress exponent n as follows:

$$n = 0.381\,(I_c) + 0.05\,(\sigma'_{vo} / P_a) - 0.15 \text{ where } n \leq 1$$

Robertson and Wride (1998) defined soil behaviour type index I_c (Figure 3) as follows:

$$I_c = [(3.47 - \log Q_{tn})^2 + (\log F_r + 1.22)^2\,]^{\,0.5}$$

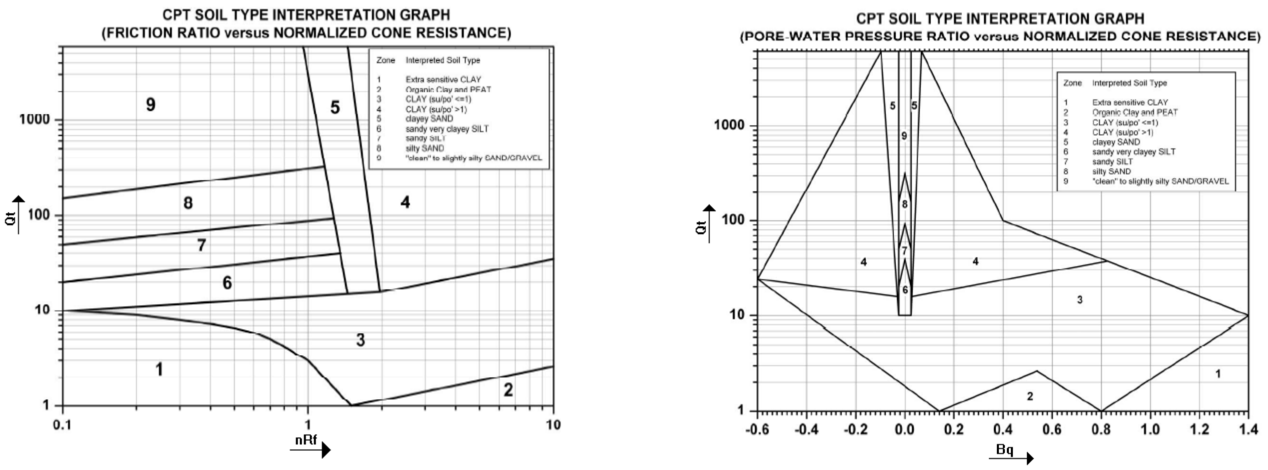
Soils with $I_c < 2.5$ are generally cohesionless, coarse grained, where cone penetration is generally drained and soils with $I_c > 2.7$ are generally cohesive, fine grained, where cone penetration is generally undrained (Robertson, 1990). Cone penetration in soils with $2.5 < I_c < 2.7$ is often partially drained.



1. Sensitive, fine grained
2. Organic soils - peats
3. Clays- clay to silty clay
4. Silt mixtures – clayey silt to silty clay
5. Sand mixtures – silty sand to sandy silt
6. Sands – clean sand to silty sand
7. Gravelly sand to sand
8. Very stiff sand to clayey sand*
9. Very stiff, fine grained*

(*) Heavily overconsolidated or cemented

Figure 1, Classification chart Robertson (2009)



1. Extra sensitive clay
2. Organic clay and peat
3. Clay ($s_u/\sigma'_{vo} <= 1$)
4. Clay ($s_u/\sigma'_{vo} > 1$)
5. Clayey sand
6. Sandy very clayey silt
7. Sandy silt
8. Silty sand
9. "Clean" sand/gravel

Figure 2, Classification charts Ramsey (2002)

Classification is only possible for certain combinations of Q_{tn}, Q_t , F_r, nR_f and B_q, as shown below.

Classification Limits	
Robertson	**Ramsey**
$1 \le Q_{tn} \le 1000$ $0.1 \le F_r \le 10$ $-0.2 \le B_q \le 1.4$	$1 \le Q_t \le 6000$ $0.1 \le nR_f \le 10$ $-0.6 \le B_q \le 1.4$

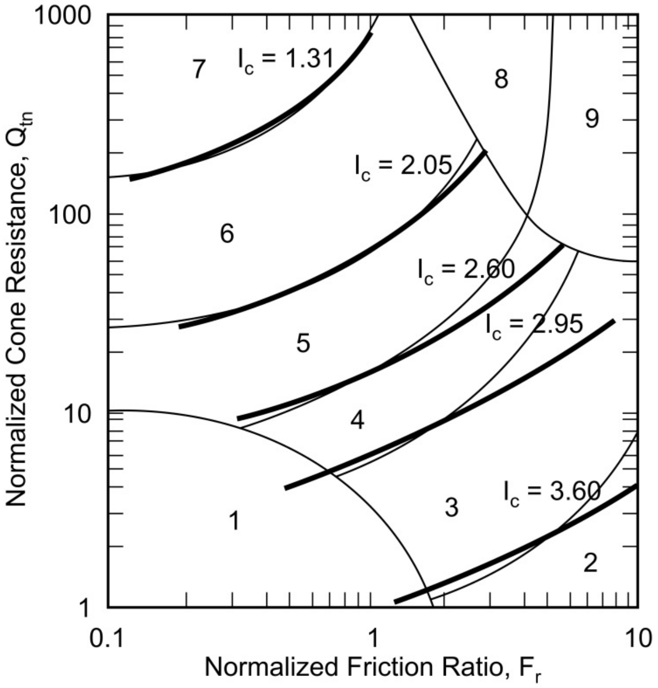


Figure 3, Soil behaviour type index I_c superimposed on Robertson (2009) classification chart

Figure 4 presents a classification chart for friction cone data according to Robertson (2010). This procedure requires no pore pressure input. A non-normalised soil behaviour type index, I_{SBT} applies:

$$I_{SBT} = [(3.47 - \log(q_c/P_a))^2 + (\log R_f + 1.22)^2]^{0.5}$$

I_{SBT} is similar to I_c. Values for I_{SBT} and I_c are typically comparable for effective in situ vertical stress between 50 kPa and 150 kPa.

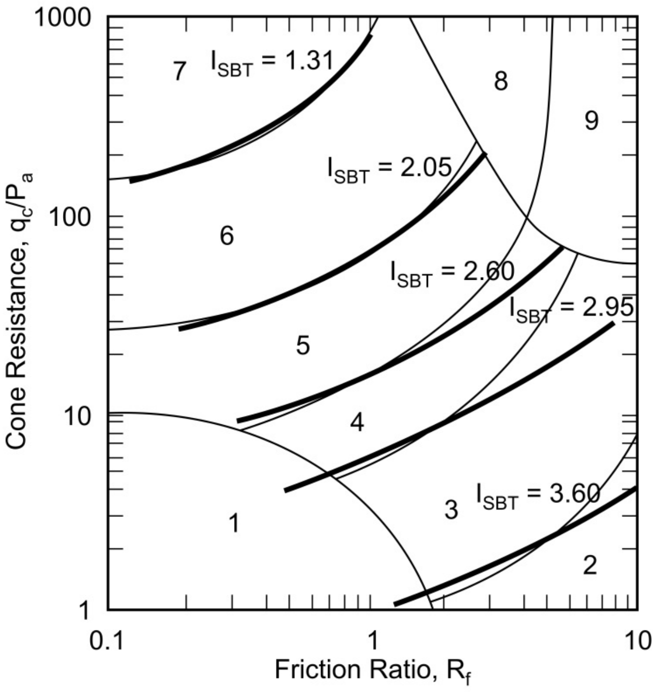


Figure 4, Robertson (2010) classification chart including I_{SBT}

SAND MODEL

Unit Weight – Sand

Unit weight of uncemented (silica) sand, silt and clay soils may be derived according to Mayne et al. (2010):

$$\gamma = 1.95\,\gamma_w \left(\frac{\sigma'_{vo}}{P_a}\right)^{0.06}\left(\frac{f_t}{P_a}\right)^{0.06}$$

where total unit weight γ and unit weight of water γ_w are in kN/m^3 and effective in situ vertical stress σ'_{vo} is in kPa. The symbol f_t refers to sleeve friction corrected for pore pressures acting on the end areas of the friction sleeve, with units in kPa. Atmospheric pressure P_a is in kPa.

In Situ Stress Conditions - Sand

A knowledge of in situ stress conditions is required for estimation of parameters such as relative density D_r and angle of internal friction of a sand deposit φ'. The effective in situ vertical stress σ'_{vo} may be calculated with a reasonable degree of accuracy but the effective in situ horizontal stress $\sigma'_{ho} = K_o\sigma'_{vo}$ is generally unknown. Usually, it is necessary to consider a range of conditions for K_o (coefficient of earth pressure at rest). The range considers overconsolidation as inferred from a geological assessment, pre-consolidation pressures of intermediate clay layers and/or theoretical limits of K_o.

Geological factors concerning overconsolidation include ice loading, soil loading and groundwater fluctuations. Possible subdivisions for these factors are mechanical, cyclic and ageing consolidation.

K_o may be directly correlated to Overconsolidation Ratio (OCR), as follows:

$$K_o = 0.4\,\sqrt{(OCR)}$$

Mayne and Kulhawy (1982) investigated mechanical overconsolidation of reconstituted laboratory specimens for over 170 different soils. A K_0 OCR correlation requiring effective angle of internal friction as input was found to provide a reasonable match. It can be shown that the $K_o = 0.4\,\sqrt{(OCR)}$ equation provides similar statistics to the Mayne and Kulhawy correlation.

No laboratory study can fully capture in situ behaviour. Particularly, K_o may be underestimated if effects such as ageing and cyclic loading are relevant.

In general, in situ K_o values are limited to the range $K_o = 0.5$ to $K_o = 1.5$. For many situations, K_o values are believed to be relatively low at greater depths (say $K_o < 1$ for depths exceeding 50 m). Jamiolkowski et al. (2003) recommend using a limiting value $K_o = 1$ in practice.

Relative Density - Sand

Procedures for estimation of in situ density condition (loose, dense, etc.) consist of:

(a) Estimation of in situ stress conditions σ'_{vo} and σ'_{ho}

(b) Empirical correlation of relative density D_r (or density condition) with q_c, σ'_{vo} and σ'_{ho}.

Estimation of stress conditions has been discussed above.

Common relationships between q_c and D_r are based on Cone Penetration Tests carried out in sand samples reconstituted in laboratory calibration chamber tests. Such tests are carried out as part of general geotechnical research projects and are subject to a number of limitations, such as:

- soil type dependence
- inaccuracies in determination of laboratory D_r
- limited range of stress levels and K_o values
- sample preparation and soil stress history simplifications.

Jamiolkowski et al. (2003) proposes the following relationship between q_c and D_r for normally and overconsolidated silica (dry) sands:

$$D_{r(dry)} = \frac{1}{2.96}\ln\left[\frac{\dfrac{q_c}{P_a}}{24.94\left(\dfrac{\sigma'_{vo}\left(\dfrac{1+2K_o}{3}\right)}{P_a}\right)^{0.46}}\right]$$

and for saturated sands:

$$D_{r(sat)} = \left(\frac{-1.87 + 2.32\ln\dfrac{q_c}{(P_a * \sigma'_{v0})^{0.5}}}{100} + 1\right)\frac{D_r\,(dry)}{100}$$

where relative density D_r is a fraction. The correlation for saturated sands results in relative densities that can be up to about 10% higher compared to the correlation for dry sands.

Determination of laboratory minimum and maximum index dry unit weights (γ_{dmin} and γ_{dmax}) forms the basis for the relative density concept (loose, dense sand, etc.). As yet, there is no internationally agreed procedure. Hence, laboratory test procedure dependence applies. Also, it is unlikely that any of the procedures consistently provide the "lowest" γ_{dmin} or the "highest" γ_{dmax}. In situ soil unit weights may therefore fall outside laboratory ranges. The relative density concept is necessary to provide a link between field investigations and laboratory testing on reconstituted specimens, as undisturbed sampling of sands is expensive.

Calibration chamber test results apply to a limited range of stress conditions only; typically:

$50\text{ kPa} < \sigma'_{vo} < 400\text{ kPa}$

$0.4 < K_o < 1.5$

Sample preparation for laboratory chamber tests is usually by means of dry pluviation. Soil stress history application is by mechanical overconsolidation.

Angle of Internal Friction - Sand

The effective shear strength parameter φ' is not a true constant. It depends on factors such as density, stress level, shearing mode and mineralogy. There is evidence that overconsolidation ratio, method of deposition and in situ stress anisotropy is less important.

Correlation of angle of internal friction φ' to cone resistance q_c may be done at various levels of sophistication. Simple procedures rely on a conservative assessment of soil behaviour classification. A more sophisticated empirical correlation consists of:
(a) Estimation of in situ stress conditions σ'_{vo} and σ'_{ho}
(b) Estimation of relative density D_r
(c) Empirical correlation of angle of internal friction φ' with D_r, σ'_{vo} and σ'_{ho}.

Estimation of stress conditions and relative density has been discussed above.

The empirical procedure proposed by Bolton (1986 and 1987) is used for estimation of φ'. This correlation applies to clean sands and considers peak secant angle of internal friction in Isotropically Consolidated Drained triaxial compression (CID) of reconstituted sand. This procedure requires estimation of the dilatancy index and the critical state angle of internal friction.

Kulhawy and Mayne (1990) determined an equation based upon 20 data sets obtained from calibration chamber tests. This equation is almost identical to the empirical formula determined earlier by Trofimenkov (1974) which was based on mechanical cone data. Mayne (2007) validated the use of total cone resistance q_t instead of cone resistance q_c used in the equation from Kulhawy and Mayne (1990).

$$\varphi' = 17.6 + 11.0 \log\left(\left(\frac{q_t}{P_a}\right) / \left(\frac{\sigma'_{vo}}{P_a}\right)^{0.5}\right) \qquad \text{(Mayne, 2007)}$$

Undrained Shear Strength - Sand

Undrained shear strength of cohesionless soil can be important for assessment of cyclic mobility and liquefaction potential. Geotechnical procedures other than the conventional limit state models are employed.

Compressibility - Sand

Correlations between CPT data and compressibility parameters are indicative only. Further developments in interpretation techniques may offer improvement in the future.

Elasticity theory is commonly employed for analysis of drained soil deformation behaviour. Secant moduli are adopted. A common guideline is an empirical correlation given by Baldi et al. (1989). The correlation is for silica-based sand and considers cone resistance q_c, in situ stress conditions and secant Young's modulus for drained stress change E'. The ratio of E'/q_c typically ranges from about 3 to 5 for recently deposited normally consolidated sands up to about $E'/q_c = 6$ to 25 for overconsolidated sands. The correlation has been inferred from laboratory conditions; including CPT tests in a calibration chamber and conventional triaxial compression tests on reconstituted sand samples. It takes account of the degree of deformation and overconsolidation. In this regard, it is noted that secant deformation moduli are strongly dependent on strain level: the elastic modulus increases with decreasing strain to an upper limit at about 10^{-4}% strain.

For estimation of initial (small strain) or dynamic shear moduli, ratios of G_{max}/q_c of between about 4 and 20 are considered, in accordance with Baldi et al. (1989).The basis for this correlation is similar to that of secant Young's modulus, except that laboratory resonant column tests serve as reference instead of triaxial compression tests. Results of limited in situ seismic cross-hole and downhole tests provide an approximate check of this correlation.

Constrained Modulus M - Sand

Kulhawy and Mayne (1990) derived two formulas for the determination of the constrained modulus for both normally consolidated and overconsolidated sands by indicating that the modulus is a function of relative density. The determination of relative density can be done with, for example, the methods indicated previously.

$$M = q_c * 10^{1.09-0.0075D_r} \qquad \text{(Normally consolidated sands, Kulhawy and Mayne, 1990)}$$

$$M = q_c * 10^{1.78-0.0122D_r} \qquad \text{(Overconsolidated sands, Kulhawy and Mayne, 1990)}$$

where D_r is in %, and q_c and M in kPa respectively.

Shear Wave Velocity v_s – Sand

If no in situ measurements of shear wave velocities (v_s) are available, then empirical correlation with CPT parameters may be considered. Hegazy and Mayne (2006) published a statistical correlation derived from 73 sites worldwide representing a range of soil types including sands, clays, soil mixtures and mine tailings (Figure 5). The correlation considers a normalized cone resistance (q_{c1N_hm}) and a soil behaviour type index (I_{c_hm}) as follows:

$$v_s = 0.0831 q_{c1N\_hm} (\sigma'_{vo} / P_a)^{0.25} \; e^{(1.786\, I_{c\_hm})} \qquad \text{(Hegazy and Mayne, 2006)}$$

where shear wave velocity v_s is in m/s and q_{c1N_hm} and I_{c_hm} are dimensionless. Calculations for q_{c1N_hm} and I_{c_hm} require iteration, and consider measured cone resistance q_c or corrected cone resistance q_t, measured sleeve friction f_s, total in situ vertical stress σ_{vo}, effective in situ vertical stress σ'_{vo} and atmospheric pressure P_a.

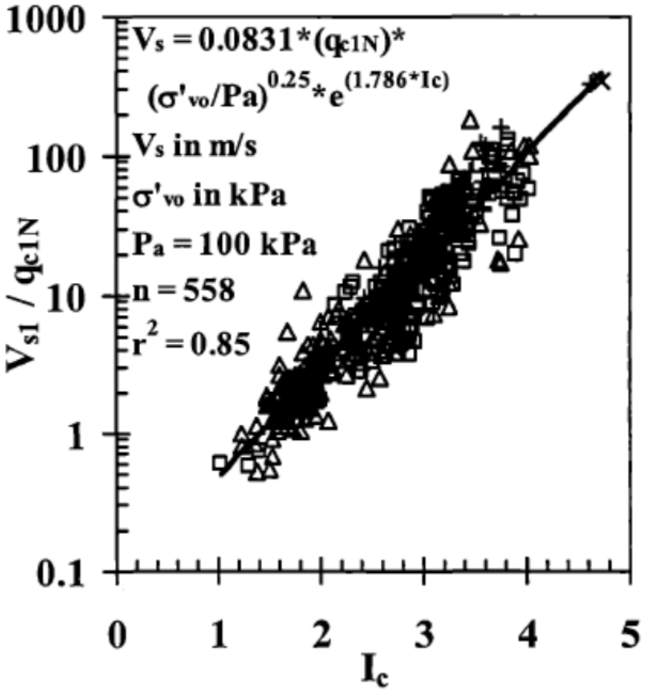


Figure 5, v_s – q_c correlation according to Hegazy and Mayne (2006)

Robertson and Cabal (2010) present a v_s correlation incorporating net cone resistance q_n (= $q_t - \sigma_{vo}$) and soil behaviour type index (I_c) as defined by Robertson and Wride (1998):

$$v_s = [\alpha_{vs}(q_t - \sigma_{v0}) / P_a]^{0.5} \text{ where } \alpha_{vs} = 10^{(0.55 I_c + 1.68)} \qquad \text{(Robertson and Cabal, 2010)}$$

where shear wave velocity v_s is in m/s and total cone resistance q_t, total in situ vertical stress σ_{vo} and atmospheric pressure P_a are in kPa. The method can be applied to a wide range of soil behaviour types, notably uncemented Holocene to Pleistocene age soils. Older deposits could have a higher shear wave velocity. Exceptions are Zones 1, 8 and 9 of Robertson (1990 and 2009).

Baldi et al. (1989) derived a correlation between shear wave velocity v_s and cone resistance q_c for uncemented silica sands. This correlation is based on data from CPT, cross-hole and Seismic Cone Penetration Tests (SCPT) performed in quaternary deposits of the predominantly silica Po river sand and Gioia Tauro sand with gravel.

$$v_s = 277 {q_c}^{0.13} {\sigma'_{vo}}^{0.27} \qquad \text{(Baldi et al., 1989)}$$

where shear wave velocity v_s is in m/s and cone resistance q_c and effective in situ vertical stress σ'_{vo} are in MPa.

Shear wave velocity may be normalised according to Robertson and Cabal (2010):

$$v_{s1} = v_s \cdot (P_a / \sigma'_{vo})^{0.25} \qquad \text{(Robertson and Cabal, 2010)}$$

Shear Modulus G_{max} - Sand

Interpretation of low-strain shear modulus can be considered by using the modified correlation proposed by Rix and Stokoe (1991) in which data from calibration test measurements is compared to the correlation obtained between G_{max} and q_c by Baldi et al. (1989).

$$G_{max} = 1634 (q_c)^{0.25} (\sigma'_{vo})^{0.375} \qquad \text{(Rix and Stokoe, 1991)}$$

where $G_{max,}$ q_c and σ'_{vo} are in kPa.

CLAY MODEL

Unit Weight – Clay

Empirical correlation between unit weight of clay and CPT parameters is as described in “Unit Weight – Sand” above.

In Situ Stress Conditions - Clay

Similar to sand, a knowledge of in situ stress conditions is generally necessary for estimation of other parameters such as consistency (soft, stiff, etc.) of a clay deposit and compressibility.

Calculation of the effective in situ vertical stress σ'_{vo} is reasonably accurate. A more approximate estimate applies to the effective in situ horizontal stress σ'_{ho}, or, more particular, K_o as $\sigma'_{ho} = K_o \sigma'_{vo}$.

Direct correlations for interpretation of the coefficient of earth pressure at rest K_o are uncommon.

For normally consolidated clays and silts, K_{onc} may be correlated with angle of internal friction, in accordance with Jaky (1944), or more simply in accordance with Mayne and Kulhawy (1982). The reference angle of internal friction is that obtained from a straight-line approximation of the Mohr-Coulomb failure envelope determined from Consolidated Undrained (CU) triaxial compression tests on undisturbed specimens.

For overconsolidated clays, K_{ooc} may be correlated with angle of internal friction and overconsolidation ratio, in accordance with Mayne and Kulhawy (1982). The plasticity index together with OCR may also be used for preliminary estimates of K_{ooc} as indicated by Brooker and Ireland (1965).

$$K_o = (1 - \sin\varphi') OCR^{\sin\varphi'} \qquad \text{(Mayne and Kulhawy, 1982)}$$

Overconsolidation Ratio - Clay

Overconsolidation ratio is defined as: OCR = σ'_p/σ'_{vo} where σ'_p is the pre-consolidation pressure considered to correspond with the maximum vertical effective stress to which the soil has been subjected, and σ'_{vo} is the current effective in situ vertical stress. The pre-consolidation pressure approximates a stress level where relatively small strains are separated from relatively large strains occurring on the virgin compression stress range. The reference OCR is usually based on laboratory oedometer tests carried out on undisturbed samples, and may thus be influenced by factors such as sample disturbance, strain rate effects and interpretation procedure.

Various analytical and semi-empirical models for interpretation of pre-consolidation pressure from piezo-cone test data are available. Sandven (1990) presents a summary. The procedures are mostly "experimental" and as yet uncommon in practice. Chen and Mayne (1996) presented a direct correlation between net cone resistance and overconsolidation ratio for 205 clay sites around the world, as follows:

$$OCR = 0.317\ Q_t \qquad \text{(Chen and Mayne, 1996)}$$

The overconsolidation ratio may also be inferred from a geological assessment and from undrained strength ratios.

Geological factors concerning overconsolidation have been discussed under "in situ stress conditions - sand". An empirical procedure for estimation of OCR based on undrained strength ratio s_u/σ'_{vo} is given by Wroth (1984). The procedure uses the strength rebound parameter Λ. Guidance for selection of Λ and normally consolidated undrained strength ratio is given by Mayne (1988). Historically, much use has also been made of the Skempton (1957) relationship between normally consolidated undrained strength ratio and plasticity index I_p. This equation is useful for preliminary estimates, considering that I_p probably relates to φ' in some complex manner.

Undrained Shear Strength - Clay

No single undrained shear strength exists. The in situ undrained shear strength s_u depends on factors such as mode of failure, stress history, anisotropy, strain rate and temperature.

Various theoretical and empirical procedures are available to correlate q_c with s_u. Theoretical approaches use bearing capacity, cavity expansion or steady penetration solutions, all of which require a number of simplifying assumptions. Empirical approaches are more common in engineering practice because of difficulties in realistic soil modelling. An empirical correlation for soft to stiff, intact and relatively homogeneous clays is given by Battaglio et al. (1986) as follows:

$$s_u = (q_c - \sigma_{vo})/N_c$$

where s_u, σ_{vo} and q_c are in kPa. N_c is an empirical factor that ranges between 10 and 25, with the higher N_c factors applying to clays with a relatively low plasticity index, and vice versa. The reference undrained shear strength is that determined from in situ vane test results. The term σ_{vo} (total in situ vertical stress) becomes insignificant for stiff clays at shallow depth so that the equation reduces to $s_u = q_c/N_c$.

For specific design situations, a different s_u reference strength should be used. For example, offshore axial pile capacity predictions in accordance with API (2011) recommend s_u to be based on undrained triaxial compression tests, which are likely to yield lower s_u values than in situ vane tests. A site-specific or regional approach should generally be preferred. For example, N_c factors of 15 to 20 have been commonly used for firm to hard North Sea clays. They give reasonable strength estimates for s_u values determined from pocket penetrometer, torvane and Unconsolidated Undrained triaxial tests (UU) on Shelby tube samples obtained by hammer sampling and push sampling techniques. Lower N_c factors are generally appropriate for soft clays and higher factors for heavily overconsolidated clays.

If piezo-cone test data are available, then improved correlations are feasible because of the pore pressure information. Empirical correlations of piezo-cone test results with laboratory undrained shear strengths are commonly expressed, as follows:

$$s_u = q_n/N_k$$

N_k ranges typically between 8 and 30 with the higher N_k factors applying to heavily overconsolidated clays.

Mayne et al. (2015) recommend a mean $N_k = 12$ with a standard deviation of 2.8 for correlation with laboratory anisotropically consolidated triaxial compressive strength. The recommendations are based on a study of 51 onshore and offshore clays and apply to normally consolidated to slightly overconsolidated clays with q_n values of typically less than 8 MPa. Slightly higher N_k values can be expected for average laboratory undrained shear strength, defined as the average of laboratory triaxial compression, simple shear and triaxial extension.

Clay Sensitivity

The sensitivity of a clay (S_t) is the ratio of undisturbed undrained shear strength to remoulded undrained shear strength. Sensitivity may be assessed from the CPT friction ratio R_f, in accordance with Schmertmann (1978):

$$S_t = N_s / R_f$$

where N_s is a correlation factor typically ranging between 5 and 10. The correlation is expected to be inaccurate for sensitive clays where uncertainty in very low values for sleeve friction may dominate results.

The reference S_t value is often taken to be that determined from undisturbed and remoulded laboratory unconsolidated undrained triaxial tests. This reference S_t value may differ from that determined from other tests, for example laboratory miniature vane tests. This is partly related to the definition of sensitivity. For vane tests, several measurements of undrained shear strength are possible:

- Intact (I) = undisturbed undrained shear strength as measured on an intact/undisturbed specimen.
- Intact-Residual (I-R) = measured post peak during initial shearing of the intact specimen.
- Intact-Vane Remoulded (I-VR) = measured after multiple-quick rotations of the vane after completion of the intact test.
- Hand Remoulded (HR) = steady state (post-peak if exists) resistance of hand remoulded test specimen.
- Hand Remoulded – Vane Remoulded (HR-VR) = steady state resistance of hand remoulded specimen measured after applying multiple-quick vane rotations.

Skempton and Northey (1952) present a correlation of sensitivity and laboratory liquidity index I_L. This correlation may allow a check on CPT-based interpretation of sensitivity.

Effective Shear Strength Parameters - Clay

Measurement of pore water pressures during penetration testing has led to development of interpretation procedures for estimation of effective stress parameters of cohesive soils. Background information may be found in Sandven (1990). Currently available procedures are evaluated to be "experimental" and are as yet not commonly adopted.

In general, CPT interpretation of effective shear strength parameters for clay and silt relies on soil behaviour-type classification.

It is noted that significant silt and sand fractions in a clay deposit will increase φ', while a significant clay fraction in silt will decrease φ'.

Masood and Mitchell (1993) provide an equation for the determination of φ' by combining sleeve friction with the Rankine earth-pressure theory. The equation is based on the following assumptions:

- Unit adhesion between soil and sleeve is negligible.
- Friction angle between soil and sleeve = $\varphi'/3$.
- Lateral earth pressure coefficient during penetration is equal to the Rankine coefficient of lateral earth pressure under passive conditions.

$$\frac{f_s}{\sigma'_{vo}} = \tan^2(45^\circ + \frac{\varphi'}{2})\tan(\frac{\varphi'}{3}) \qquad \text{(Masood and Mitchell, 1993)}$$

Mayne (2001) proposed an approximation of the Masood and Mitchell equation, as follows:

$$\varphi' = 30.8\left[\log(\frac{f_s}{\sigma'_{vo}}) + 1.26\right] \qquad \text{(Mayne, 2001)}$$

Mayne (2001) also proposed the following approximation of friction angle φ' based on pore pressure ratio B_q and the cone resistance number N_m (Senneset, Sandven and Janbu, 1989):

$$\varphi' = 29.5 B_q^{0.121}(0.256 + 0.336 B_q + \log N_m) \qquad \text{(Mayne, 2001)}$$

where

$$N_m = \frac{q_t - \sigma_{vo}}{\sigma'_{vo} + a}$$

where the cone resistance number N_m is dimensionless, total cone resistance q_t, total in situ vertical stress σ_{v0} and effective in situ vertical stress σ'_{v0} are in kPa.

Senneset et al. (1989) use the attraction value [a] as a function of soil type. In general the attraction value ranges from 5 to > 50 for both sands and clays and may be estimated directly from CPT results. The correlation is valid if the angle of plastification β is zero. In general a plastification angle of zero applies to medium sands and silts, sensitive clays and highly compressible clays.

Compressibility – Clay

Correlations between CPT data and compressibility parameters are viewed as indicative only, as discussed for sand compressibility.

The use of elasticity theory is common for analysis of undrained soil deformation behaviour. The adopted procedure is as follows:

(a) Estimation of undrained shear strength s_u from CPT data, as outlined above.

(b) Estimation of secant Young's moduli for undrained stress change E_u in general accordance with correlations based on s_u, as presented by Ladd et al. (1977).

Laboratory undrained triaxial tests carried out on undisturbed clay specimen form the basis for the E_u versus s_u correlations. Typical E_u/s_u ratios at a shear stress ratio of 0.3 range between about 300 and 900 for normally consolidated clays and E_u/s_u = 100 to 300 for heavily overconsolidated clay. Higher E_u/s_u ratios would apply to lower shear stress ratios, and vice versa.

Mitchell and Gardner (1976) present an approximate correlation of cone resistance with constrained modulus M (or coefficient of volume compressibility m_v, where $M = 1/m_v$). Typical ratios of M/q_c range between 1 and 8 for silts and clays. Refinements include q_c ranges and soil type (silt, clay, low plasticity, high plasticity, etc.). The correlation relies on the results of conventional laboratory oedometer tests carried out on undisturbed clay and silt samples. The constrained modulus can also be related (approximately) to secant Young's modulus E' and shear modulus G'.

It is noted that laboratory soil stiffness may differ from in situ stiffness because of inevitable sampling disturbance (in particular soil structure disturbance). In general, this implies that laboratory stiffness will usually be less than in situ stiffness.

Constrained Modulus M

Kulhawy and Mayne (1990) correlated constrained modulus M in clays with net cone resistance data. This relationship is based on data from 12 different test sites, with constrained moduli up to 60 MPa. The published standard deviation is 6.7 MPa.

$$M = 8.25\,q_n \qquad \text{(Kulhawy and Mayne, 1990)}$$

Shear Wave Velocity v_s – Clay

Hegazy and Mayne (2006) and Roberson and Cabal (2010) present empirical correlations between shear wave velocity and CPT parameters for a wide range of soils including clays, as described in “Shear Wave Velocity v_s – Sand” above. The Hegazy and Mayne correlation is sensitive to use of q_c or q_t. It should be used with caution for soils showing undrained or partially drained CPT response.

Mayne and Rix (1995) derived a correlation between shear wave velocity v_s and cone resistance q_c for intact and fissured clays. A database from Mayne and Rix (1993) was used including 31 different clay sites.

$$v_s = 1.75 q_c^{0.627} \qquad \text{(Mayne and Rix, 1995)}$$

where shear wave velocity v_s is in m/s and cone resistance q_c is in kPa.

Shear Modulus G_{max}

Mayne and Rix (1993) determined a relationship between G_{max} and q_c by studying 481 data sets from 31 sites all over the world. G_{max} ranged between about 0.7 MPa and 800 MPa.

$$G_{max} = 2.78\, q_c^{1.335} \qquad \text{(Mayne and Rix, 1993)}$$

where G_{max} and q_c are in kPa.

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INTRODUCTION

The downhole method of seismic wave testing relies on measuring the travel time interval of body waves travelling between a wave source on the ground surface and an array of geophones at a selected depth below ground surface. The body waves comprise shear waves (S-wave) and compression or primary pressure waves (P-wave). Wave velocities can give an indication of ground characteristics, such as low-strain modulus. This document discusses shear wave measurements only.

The common methods for geophone placement are:

1. Push technology, such as the Seismic Cone Penetration Test (SCPT) consisting of a Cone Penetration Test (CPT) and seismic downhole tests performed during penetration interruptions;
2. Borehole method, with geophones clamped inside a casing pipe.

The principal deployment modes for push technology are from “ground surface or seabed” and “downhole”. A downhole system latches into the lower end of a drill pipe.

Apparatus and procedures adopted by Fugro are in general accordance with ISO 19901-8 (2014), ASTM D7400 (2014) and BS 5930 (2015).

APPARATUS

Test apparatus includes the following:

- push apparatus, as appropriate for push technology,
- borehole drilling, casing pipe installation and grouting equipment, as appropriate for the borehole method,
- seismic wave source, for generating the seismic waves,
- trigger, for the start of recording of the seismograph upon activation of the seismic wave source,
- geophones for receiving the seismic waves,
- seismograph, for recording the signals from the geophones.

A seismic cone penetrometer can incorporate a single or dual array of geophones. The dual array version incorporates two sets of geophones at a fixed spacing.

PROCEDURE

The SCPT procedure includes a repeated sequence of the following steps:

- interrupting the CPT at the seismic downhole test level,
- activating the seismic wave source and recording of the geophone signals, if necessary with re-activating cycles to permit stacking,
- resuming CPT, repeating the test sequence as required.

The borehole test procedure includes the following steps:

- drilling of a borehole to below the maximum test depth,
- grouting of a casing pipe in the borehole to prevent borehole collapse, if required,
- installation and clamping of the geophones within the borehole at the designated test depth,
- activating the seismic wave source and recording of the geophone signals, if necessary with re-activating cycles to permit stacking,
- installation and clamping of the geophones at the next designated test depth, repeating the test sequence as required.

Seismic downhole testing is subject to limitations, as follows:

- Wave interference effects can prevent the interpretation of results applicable to tests close to the ground surface. Common interferences for S-waves are P-waves and surface waves. For some ground conditions, interference can also result from S-wave refraction and reflection. For example, refraction can occur along an interface between a low-velocity top layer and a high-velocity lower layer. Typically, reliable test interpretation applies below about 5 m depth. However, test interpretation is often feasible for a geophone depth of about 1 m.
- The use of a downhole push system requires consideration of wave interference through the drill pipe. The penetration of the geophones below the bottom of a borehole should not be less than about 0.5 m, but preferably at least 1 m.

- The selected seismic wave source affects the maximum depth of detection. Eventually, spherical divergence of the shear waves leads to an unacceptable signal-to-noise ratio, typically a ratio of less than about 2. The detection depth is typically in the order of 100 m for common seismic sources and favourable ground conditions. Unfavourable conditions include ground with strong absorption characteristics such as peat. Adverse wave reflection effects between high velocity and low velocity layers can also lead to a reduction in detection depth. For example, soft clay overlying dense sands or calcarenite rock interbedded with calcareous soil can prevent acceptable measurements at greater depths.

Common test termination criteria for a single test depth are:
- acceptable data quality with a maximum stack count of 20,
- unacceptable interference effects,
- inadequate signal-to-noise ratio.

Termination is at the discretion of the operator.

The criteria for termination of a test sequence are commonly:
- target depth,
- the termination criteria for conventional cone penetration testing (push technology) or for conventional borehole and casing pipe installation (borehole method),
- inadequate signal-to-noise ratio, with no expected improvement with depth.

TEST RESULTS

Primary test results consist of seismic wave traces for, usually multiple, test depths. The use of data filtering techniques is common for removing unwanted signals. Further data processing includes calculation of seismic wave velocities between individual test depths. This leads to a profile of average (apparent) seismic wave velocities for specific, usually contiguous, depth intervals.

Data processing considers a radially propagating wave train and is based on the assumption of laterally homogeneous ground, where wave train trajectories are according to Snell's law of refraction.

A single test with a dual-array system provides three velocities, one average velocity from source to upper seismic receiver, one average velocity from source to lower seismic receiver and an average velocity for the zone between the two receivers. The accuracy for the average velocity is largely unaffected by depth uncertainty and travel path. Other shear wave velocities will have lower accuracies, which can be calculated from an estimate of the uncertainties in travel path distance, either from source to receiver or from the relative distance between two test depths in a single profile. A single test with a single-array system provides one velocity only. Two tests with a single-array system in a single profile provide the opportunity for determination of three velocities, one from source to upper test depth, one from source to lower test depth and a differential velocity for the zone between the two test depths. Three or more tests provide additional opportunities for separating zones of interest.

The measurement of test depth spacing is particularly important for seismic systems using a single array of geophones. An example of unfavourable depth measurement conditions is downhole deployment of an SCPT system operated from a heaving vessel. A possible mitigation measure for spacing inaccuracy consists of decreasing the test spacing and averaging of results.

If required, test results can include low-strain (dynamic) elastic parameters, using measured or estimated densities. The following basic equations apply to the wave velocities of the S- and P-waves:

$$v_s = \sqrt{\frac{1}{2(1+\nu)} * \frac{E}{\rho}} \qquad = \sqrt{\frac{G}{\rho}}$$

$$v_p = \sqrt{\frac{1-\nu}{(1+\nu)(1-2\nu)} * \frac{E}{\rho}} = \sqrt{(K + \frac{4}{3}G) / \rho}$$

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where:
v_p = P-wave velocity [m/s]
v_s = S-wave velocity [m/s]
ρ = density of ground [t/m^3]
ν = low-strain Poisson's ratio [-]
E = low-strain Young's modulus [kPa]
G = low-strain shear modulus [kPa]
K = low-strain bulk modulus [kPa]

The following explicit relations are used to estimate the low-strain ground parameters:

$$G = \rho * v_s^2$$

$$K = \rho(v_p^2 - \frac{4}{3} v_s^2)$$

$$\nu = \frac{0.5 * (v_p / v_s)^2 - 1}{(v_p / v_s)^2 - 1}$$

$$E = \rho * v_s^2 * [2(1+\nu)]$$

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INTRODUCTION

This document describes survey of horizontal and elevation/depth reference points for geotechnical and/or environmental data acquisition.

National and international standards for geotechnical and/or environmental data acquisition (as ASTM, BSI, CEN and ISO) require such surveys, but do not describe procedural details. This document summarises common practice.

PROCEDURE

The procedure for positioning survey and depth measurement is typically as follows:

- definition of the type of survey and the target location
- set-up and initial checks of the survey system
- surface positioning survey of the reference point, i.e. the determination of grid coordinates
- subsurface positioning survey, i.e. adjustment of the surface positioning results for underwater offset
- measurement of the water depth
- calculation of elevation relative to a vertical datum, e.g. water level correction.

The activities depend on the project programme. For example, water level correction and subsurface positioning may not be part of the activities agreed upon.

SURVEY CLASSIFICATIONS

Positioning surveys require specific systems and procedures, such as those presented below for offshore applications. The International Hydrographic Organization (IHO, 2008) defines four orders of hydrographic survey to accommodate different uncertainty requirements (Table 1).

TABLE 1 – SUMMARY OF IHO CLASSIFICATION

IHO Order	Special	1a	1b	2
Description of Areas	Areas where under-keel clearance is critical	Areas shallower than 100 m where under-keel clearance is less critical but features of concern to surface shipping may exist	Areas shallower than 100 m where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area	Areas generally deeper than 100 m where a general description of the seafloor is considered adequate
Maximum Allowable Total Horizontal Uncertainty 95% Confidence Level	2 m	5 m + 5% of depth	5 m + 5% of depth	20 m + 10% of depth
Maximum Allowable Total Vertical Uncertainty 95% Confidence Level	a = 0.25 m b = 0.0075	a = 0.5 m b = 0.013	a = 0.5 m b = 0.013	a = 1.0 m b = 0.023
Full Seafloor Search	Required	Required	Not required	Not required
Feature Detection	Cubic features > 1 m	Cubic features > 2 m in depths up to 40 m; 10% of depth beyond 40 m	Not applicable	Not applicable
Recommended Maximum Line Spacing	Not defined as full seafloor search is required	Not defined as full seafloor search is required	3 x average depth or 25 m, whichever is greater	4 x average depth

Note: The use of coefficients a and b is as follows:

$$\pm\sqrt{[a^2 + (b * d)^2]}$$

where:

a	represents that portion of the uncertainty that does not vary with depth
b	is a coefficient which represents that portion of the uncertainty that varies with depth
d	is the depth
b*d	represents that portion of the uncertainty that varies with depth.

Figure 1 illustrates the effect of coefficients a and b.

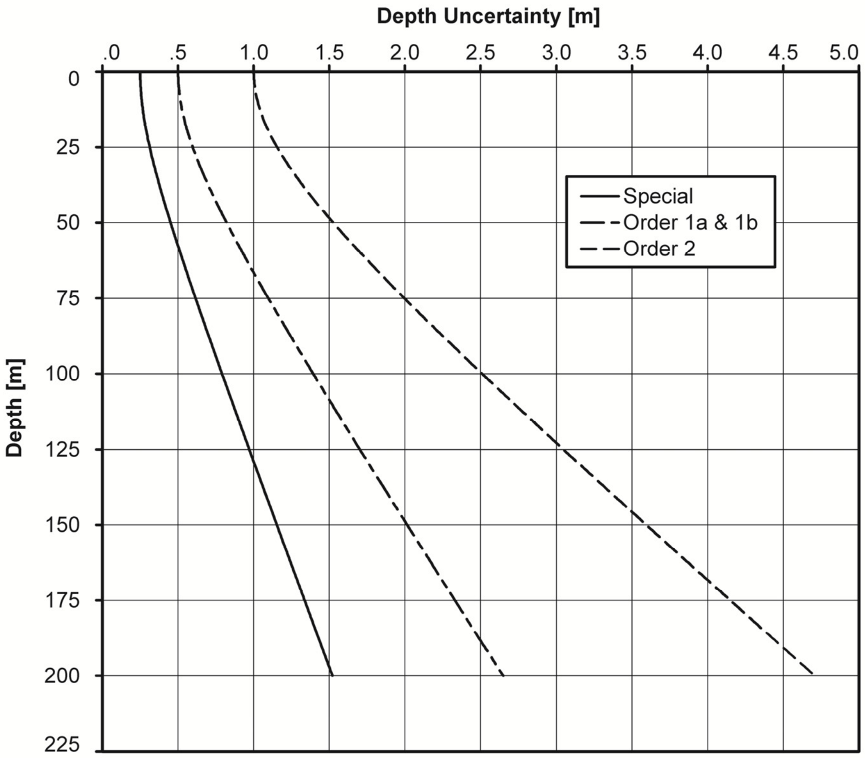

Figure 1 IHO depth uncertainty

IHO Survey Classification - Offshore Practice Examples

The IHO Special Order Survey is exceptional in geotechnical and/or environmental data acquisition. A Special Order system set-up may be comprised of: RTK DGPS; a multibeam echo sounder; a motion compensator, and a Conductivity Temperature Depth (CTD) probe. Subsurface positioning is uncommon in limited water depths.

An IHO Order 1a and 1b survey system set-up may include: high-accuracy DGPS; Long Base Line (LBL) subsurface positioning; a CTD probe with Digiquartz pressure sensor; a barometer; and a tide gauge.

IHO Order 2 surveys are common in geotechnical and/or environmental data acquisition. Such system set-ups could include: DGPS; Ultra Short Base Line (USBL) subsurface positioning (IMCA, 2011); CTD probe; single beam echo sounder or direct sounding by drill pipe; a motion compensator; and predicted tide correction.

These are examples of the simplest set-ups. Independent measurements are often made using a redundant system (OGP, 2011). For example, surface position may be determined by two independent DGPS systems or direct sounding by drill pipe and echo sounding.

Comments on Uncertainty Budget

IHO Order and offshore system set-ups involve relatively complex uncertainty budgets (uncertainty estimates). IHO considers total propagated uncertainties for the reference point on the seafloor. For example, horizontal positioning must not only consider the uncertainty of a DGPS antenna position, but also uncertainty in offset between antenna and actual position of a tool on the seafloor.

Horizontal positioning

- DGPS - antenna position uncertainty typically in the order of 1 to 2 metres.
- High accuracy DGPS - antenna position uncertainty typically in the order of 0.2 m.
- RTK DGPS – antenna position uncertainty typically in the order of centimetres.
- Gyro compass – uncertainty typically in the order of 0.5° to 1°.

DGPS uncertainty contributions include the geodetic network, vessel dynamics and antenna offset. Continuous logging on location allows some quantification of position uncertainty.

Subsurface positioning

- LBL system: receiver position uncertainty typically in the order of 1 metre.
- USBL system: uncertainty of typically 0.5 m plus 1% of distance between transducer and transceiver.

Uncertainty contributions include timing, ray bending, sound absorption, noise and offset.

Water depth measurement

- Direct sounding by drill pipe: uncertainty of typically about 1 m plus 0.5% of measured mean water depth.
- Echo sounder: uncertainty of typically about 0.3 m plus 1% of measured mean water depth.
- Digiquartz probe: probe position uncertainty of typically about 0.2 m plus 0.1% of measured mean water depth.
- Motion compensator: heave measurements have a typical uncertainty of 0.05 m, and roll and pitch an uncertainty of about 0.1°, relative to the mounting of the unit itself.

The pressure sensor estimates are corrected for atmospheric pressure. The echo sounder estimate typically incorporates CTD sound velocity checks, motion compensation, and transducer draught, including vessel squat correction. Vessel squat is a vertical displacement of the hull as a vessel moves, and is determined by water depth and the vessel shape and size. The direct sounding estimate includes uncertainties related to tape measurement, heave, drill pipe length variation due to self-weight and temperature change, drill pipe bending and offset from vertical axis.

Tide correction

- Predicted tides: correction uncertainty typically in the order of 0.2 m to 1 m, depending on tidal range and meteorological circumstances.
- High accuracy DGPS: antenna position uncertainty typically in the order of 0.3 m.
- Tide gauge: correction uncertainty typically in the order of 0.1 m.
- RTK DGPS: antenna position uncertainty typically in the order of 0.1 m.

Uncertainty budgets can be project-specific. Soft soils, for example, can introduce uncertainty in underwater vertical position of measurement. A water pressure measurement tool mounted on an underwater frame may sink into the soil, thus affecting the measurement. Insufficient acoustic contrast between water and soft soil may affect echo sounder water depth measurements.

An irregular or sloping seafloor may affect echo sounder measurements. An echo sounder determines the earliest arrival of acoustic waves within the beam area. The highest points within the beam are assumed to correlate with the seafloor position, and thus yield the "water depth".

Sample and Test Depths

The comments on IHO uncertainty budget apply to a reference point at seafloor. There may be additional uncertainty in the location of a test or sample. The reasons for this include:

- additional measurements. For example, measurement of the length of the drill pipe in case of a downhole sample
- offset of the test or sample location from the reference point, for example due to a towed device or inclined drill pipe.

Peuchen et al. (2005) present the following expression for offshore depth uncertainty assessment:

$$\Delta z = \pm\sqrt{[a^2 + (b * d)^2 + (c * z)^2]}$$

where:

a	constant depth uncertainty, i.e. the sum of all uncertainties that do not vary with depth in metres
b	uncertainty dependent on water depth, i.e. the sum of all water-depth dependent uncertainties
c	uncertainty dependent on test depth, i.e. the sum of all test depth dependent uncertainties
d	water depth in metres
z	test depth in metres relative to seafloor
Δz	test depth uncertainty in metres (95% confidence level)

Tables 2 through 4 present coefficients and accompanying premises.

TABLE 2 - COEFFICIENTS FOR DEPTH UNCERTAINTY ASSESSMENT

Geotechnical System	**Test Depth Uncertainty Δz**		
	a	**b**	**c**
Downhole – favourable	0.4 m	0.003	0.003
Downhole – adverse	1.0 m	0.005	0.004
Seabed – favourable	0.2 m	0	0.01
Seabed – adverse	0.8 m	0	0.02
Note: resolution estimated at 50% of uncertainty			

TABLE 3 - PREMISE TO ESTIMATED TEST DEPTH UNCERTAINTY – DOWNHOLE SYSTEM

Characteristics	**Offshore setting – downhole system**	
	Favourable	**Adverse**
Vessel - horizontal position	Variation within 5 m of target	Variation within 5 m of target
Vessel heave	1 m at “hook” point	3 m at “hook” point
Tidal variation	1.5 m, with correction for tidal variation by pressure sensor mounted on seabed frame	3 m, with correction for tidal variation by pressure sensor mounted on seabed frame
Seafloor	Firm and level	Very soft seabed soils or very rugged seafloor
Drill pipe checkpoint	Touchdown on seabed frame at borehole start	Touchdown on seabed frame at borehole start
Drill pipe bending	None	Minor
Borehole orientation	Vertical	Inclined at average 2^o from vertical from sea level to test depth z

TABLE 4 - PREMISE TO ESTIMATED TEST DEPTH UNCERTAINTY – SEABED SYSTEM

Characteristics	**Offshore setting – seabed system**	
	Favourable	**Adverse**
Vessel - horizontal position	Variation within 5 m of target	Variation within 5 m of target
Vessel heave	1 m at “hook” point	3 m at “hook” point
Tidal variation	1.5 m	3 m
Seafloor	Firm and level	Very soft seabed soils or very rugged seafloor
Orientation of Penetration	Vertical at start, with correction for measured inclination	Inclined at average 5^o from vertical from seafloor to test depth z

Offshore definition of the seafloor (ground surface) is difficult for extremely soft ground. Reaction equipment may penetrate unnoticed into a near-fluid zone of the seabed. Settlement may also continue during testing (Bouwmeester et al., 2009). Seabed frame settlement is likely to be governed by the following factors:

(1) Descent velocity and penetration into seabed, including possible erosion (scouring) caused by seabed frame descent and resulting water overpressures.
(2) Non-centric loading during touchdown and testing.
(3) Variable on-bottom weight of reaction equipment, because of drilling, sampling and testing activities and because of tensioning and hysteresis forces in a heave compensation system.
(4) Consolidation of seabed sediments.

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SYMBOLS AND UNITS

Symbol	Unit	Quantity
I - GENERAL		
L	m	Length
B	m	Width
D	m	Diameter
d	m	Depth
h	m	Height or thickness
z	m	Penetration or depth below reference level (usually ground surface)
A	m^2	Area
V	m^3	Volume
W	kN	Weight
t	s	Time
v	m/s	Velocity
a	m/s^2	Acceleration
g	m/s^2	Acceleration due to gravity ($g = 9.81\ m/s^2$)
m	kg	Mass
ρ	kg/m^3	Density
π	-	Mathematical constant (= 3.14159)
e	-	Base of natural logarithm (= 2.71828)
ln	-	Natural logarithm
log	-	Logarithm base 10
II - STRESS AND STRAIN		
P_a	kPa	Atmospheric pressure
u	MPa	Pore water pressure
u_o	MPa	Hydrostatic pore pressure relative to seafloor or phreatic surface
σ	kPa	Total stress
σ'	kPa	Effective stress
τ	kPa	Shear stress
t	kPa	Shear stress in s'-t space [= $(\sigma'_1 - \sigma'_3)/2$] or [= $(\sigma_1 - \sigma_3)/2$]
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
σ'_{ho}	kPa	Effective in situ horizontal stress
σ_{vo}	kPa	Total in situ vertical stress relative to ground surface or phreatic surface
σ'_{vo}	kPa	Effective in situ vertical stress (or p'_o)
σ'_h	kPa	Effective horizontal stress
σ'_v	kPa	Effective vertical stress
r_u	-	Pore pressure ratio [= u/σ_{vo}]
p'	kPa	Mean effective stress [= $(\sigma'_1 + \sigma'_2 + \sigma'_3)/3$]
q	kPa	Principal deviator stress [= $\sigma'_1 - \sigma'_3$] or [= $\sigma_1 - \sigma_3$]
s'	kPa	Mean effective stress in s'-t space [= $(\sigma'_1 + \sigma'_3)/2$]
ε	-	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	-	Principal strains
ε_v	-	Volumetric strain
γ	-	Shear strain
ν	-	Poisson's ratio
ν_u	-	Poisson's ratio for undrained stress change
ν_d	-	Poisson's ratio for drained stress change
E	MPa	Modulus of linear deformation (Young's modulus)
E_u	MPa	Modulus of linear deformation (Young's modulus for undrained stress change)
E_d	MPa	Modulus of linear deformation (Young's modulus for drained stress change)
G	MPa	Modulus of shear deformation (shear modulus)
G_{max}	MPa	Shear modulus at small strain
I_r	-	Rigidity index [= G/τ_{max} or G/s_u]
K	MPa	Modulus of compressibility (bulk modulus)
M	MPa	Constrained modulus [= $1/m_v$]
μ	-	Coefficient of friction
η	kPa.s	Coefficient of viscosity

Symbol	Unit	Quantity

III - PHYSICAL CHARACTERISTICS OF GROUND

(a) Density and Unit weights

γ	kN/m^3	Unit weight of ground (or bulk unit weight or total unit weight)
γ_d	kN/m^3	Unit weight of dry ground
γ_s	kN/m^3	Unit weight of solid particles
γ_w	kN/m^3	Unit weight of water
γ_{pf}	kN/m^3	Unit weight of pore fluid
γ_{dmin}	kN/m^3	Minimum index (dry) unit weight
γ_{dmax}	kN/m^3	Maximum index (dry) unit weight
γ' or γ_{sub}	kN/m^3	Unit weight of submerged ground
ρ	Mg/m^3 [= t/m^3]	Density of ground
ρ_d	Mg/m^3 [= t/m^3]	Density of dry ground
ρ_s	Mg/m^3 [= t/m^3]	Density of solid particles
ρ_w	Mg/m^3 [= t/m^3]	Density of water
D_r	-, %	Relative density [= $I_D = \gamma_{dmax} (\gamma_d - \gamma_{dmin})/\gamma_d(\gamma_{dmax} - \gamma_{dmin}) = (e_{max} - e)/(e_{max} - e_{min})$]
v	-	Specific volume [= 1+e]
e	-	Void ratio
e_o	-	Initial void ratio
e_{max}	-	Maximum index void ratio
e_{min}	-	Minimum index void ratio
I_D	-, %	Density index [= D_r]
R_D	-, %	Dry density ratio [= γ_d/γ_{dmax}]
n	-, %	Porosity
w	%	Water content
S_r	%	Degree of saturation
r	-, g/kg	Salinity of pore fluid [= ratio of mass of salt to mass of pore fluid]
R	g/l	Salinity of fluid [= ratio of mass of salt to volume of distilled water]
s	g/l	Salinity of fluid [= ratio of mass of salt to volume of fluid]
S	g/kg	Salinity of seawater [= ratio of mass of salt to mass of seawater]

(b) Consistency

w_L	%	Liquid limit
w_P	%	Plastic limit
I_P	%	Plasticity index [= $w_L - w_P$]
I_L	%	Liquidity index [= $(w - w_P)/(w_L - w_P)$]
I_C	%	Consistency index [= $(w_L - w)/(w_L - w_P)$]
A	-, %	Activity [= ratio of plasticity index to percentage by weight of clay-size particles]

(c) Particle size

D	mm	Particle diameter
D_n	mm	n percent diameter [n% < D]
C_u	-	Uniformity coefficient [= D_{60}/D_{10}]
C_c	-	Curvature coefficient [= $(D_{30})^2/D_{10}D_{60}$]

(d) Acoustic and Dynamic Properties

v_p	m/s	P-wave velocity (compression wave velocity)
v_s	m/s	S-wave velocity (shear wave velocity)
v_{s1}	m/s	S-wave velocity normalised to 100 kPa in situ vertical stress
D	-, %	Damping ratio of ground

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(e) Hydraulic properties

Symbol	Unit	Quantity
k	m/s	Coefficient of permeability
k_v	m/s	Coefficient of vertical permeability
k_h	m/s	Coefficient of horizontal permeability
i	-	Hydraulic gradient

(f) Thermal and Electrical properties

T	K, °C	Temperature
k	W/(m·K)	Thermal conductivity
a_L	1/°C	Thermal expansion coefficient (linear)
α	m^2/s	Thermal diffusion coefficient
ρ	Ω.m	Electrical resistivity
K	S/m	Electrical conductivity

(g) Magnetic properties

B	T	Magnetic flux density (or magnetic induction)

(h) Radioactive properties

γ	CPS	Natural gamma ray

IV - MECHANICAL CHARACTERISTICS OF GROUND

(a) Cone Penetration Test (CPT)

q_c	MPa	Cone resistance
q_{c1}	MPa	Cone resistance normalised to 100 kPa effective in situ vertical stress
f_s	MPa	Sleeve friction
f_t	MPa	Sleeve friction corrected for pore pressures acting on the end areas of the friction sleeve
R_f	%	Ratio of sleeve friction to cone resistance
R_{ft}	%	Ratio of sleeve friction to corrected cone resistance (f_s/q_t or f_t/q_t)
u_1	MPa	Pore pressure at the face of the cone
u_2	MPa	Pore pressure at the cylindrical extension above the base of the cone or in the gap between the friction sleeve and the cone
u_2*	MPa	Pore pressure u_2, but derived rather than measured
u_3	MPa	Pore pressure immediately above the friction sleeve or in the gap above the friction sleeve
K	-	Adjustment factor for ratio of pore pressure at u_1 to u_2 location
q_n	MPa	Net cone resistance
q_t	MPa	Corrected cone resistance (or total cone resistance)
B_q	-	Pore pressure ratio
Q_t	-	Normalized cone resistance [= q_n/σ'_{vo}]
Q_{tn}	-	Normalized cone resistance with variable stress exponent
F_r	%	Normalized friction ratio [= f_t/q_n]
N_c	-	Cone factor between q_c and s_u
N_k	-	Cone factor between q_n and s_u
I_c	-	Soil behaviour type index (for Q_{tn} and F_r)
I_{SBT}	-	Soil behaviour type index (for q_c and R_f)

(b) Standard Penetration Test (SPT)

N	Blows/0.3 m	SPT blow count
N_{60}	Blows/0.3 m	SPT blow count normalised to 60 % energy
$N_{1,60}$	Blows/0.3 m	SPT blow count normalised to 60 % energy and to 100 kPa effective in situ vertical stress

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Symbol	Unit	Quantity
(c) Strength of soil		
s_u	kPa	Undrained shear strength (or c_u)
s_u/σ'_{vo}	-	Undrained strength ratio
κ	kPa/m	Rate of increase of undrained shear strength with depth (linear)
c'	kPa	Effective cohesion intercept
φ'	°(deg)	Effective angle of internal friction
φ'_{cv}	°(deg)	Effective angle of internal friction at large strain
ε_{50}	%	Strain at 50 % of peak deviator stress (or ε_c)
E_{50}	MPa	Young's modulus at 50% of peak deviator stress
$s_{u;r}$	kPa	Undrained shear strength of remoulded soil
$s_{u;ar}$	kPa	Undrained shear strength of aged remoulded soil
s_R	kPa	Undrained residual shear strength
S_t	-	Sensitivity [= $s_u/s_{u;r}$ or s_u/s_R]
T_x	-	Thixotropy strength ratio [$T_x(t) = s_{u;ar}(t)/s_{u;r}$]
σ'_c	kPa	Effective consolidation pressure
M	-	Gradient of critical state line when projected onto a constant volume plane
A	-	Pore pressure coefficient for anisotropic pressure increment
B	-	Pore pressure coefficient for isotropic pressure increment
(d) Strength of rock		
$I_{s(50)}$	MPa	Point load strength index
σ_c	MPa	Uni-axial compressive strength
(e) Consolidation (one dimensional)		
σ'_p	kPa	Effective preconsolidation pressure (or effective vertical yield stress in situ)
σ^*_{ve}	kPa	Effective vertical stress on ICL at e_0
σ'_{vy}	kPa	Effective vertical yield stress in situ (or effective preconsolidation pressure)
C_c	-	Compression index
C^*_c	-	Intrinsic compression index [= $e^*_{100} - e^*_{1000}$]
C_s	-	Swelling index (or re-compression)
CR	-	Primary compression ratio [= $C_c/(1+e_0)$]
RR	-	Recompression ratio [= $C_s/(1+e_0)$]
e_0	-	Void ratio at σ'_{vo}
e_L	-	Void ratio at liquid limit w_L
e^*_{100}	-	Void ratio at σ'_v = 100 kPa during one-dimensional intrinsic compression
e^*_{1000}	-	Void ratio at σ'_v = 1000 kPa during one-dimensional intrinsic compression
C_α	-	Coefficient of secondary compression (primary compression)
$C_{\alpha s}$	-	Coefficient of secondary compression (swelling/re-compression)
c_v	m^2/s	Coefficient of consolidation
H	m	Drainage path length
ICL	-	Intrinsic compression line (Burland 1990)
I_v	-	Void index [= $(e_0 - e^*_{100})/C^*_c$]
m_v	m^2/MN	Coefficient of volume compressibility
M	MPa	Constrained modulus [= $1/m_v$]
p	kPa	Vertical pressure
OCR	-	Overconsolidation ratio [= σ'_p/σ'_{vo}]
SCC	-	Sedimentation compression curve
SCL	-	Sedimentation compression line (Burland 1990)
S_σ	-	Stress sensitivity [= $\sigma'_{vy}/\sigma^*_{ve}$]
YSR	-	Yield stress ratio [= $\sigma'_{vy}/\sigma'_{vo}$]

V - GEOTECHNICAL DESIGN

(a) Partial factors

γ_d	-	Factor related to model uncertainty or other circumstances
γ_f	-	Partial action factor (load factor)
γ_m	-	Partial material factor (partial safety factor)
γ_R	-	Partial resistance factor (partial safety factor)

(b) Seismicity

a_g	m/s^2	Effective peak ground acceleration (design ground acceleration)
d_g	m	Peak ground displacement
α	-	Acceleration ratio [= a_g/g]
τ_c	kPa	Seismic shear stress

(c) Compaction

ρ_{dmax}	Mg/m^3 [= t/m^3]	Maximum dry density
ρ_{max}	Mg/m^3 [= t/m^3]	Maximum density
w_{opt}	%	Optimum moisture content

(d) Earth pressure

δ	°(deg)	Angle of interface friction (between ground and foundation)
K	-	Coefficient of lateral earth pressure
K_a	-	Coefficient of active earth pressure
K_{ac}	-	Coefficient of active earth pressure for total stress analysis
K_p	-	Coefficient of passive earth pressure
K_{pc}	-	Coefficient of passive earth pressure for total stress analysis
K_o	-	Coefficient of earth pressure at rest
K_{onc}	-	K_o for normally consolidated soil
K_{ooc}	-	K_o for overconsolidated soil

(e) Foundations

A	m^2	Total foundation area
A’	m^2	Effective foundation area
B’	m	Effective width of foundation
E_s	MN/m^3	Modulus of subgrade reaction
k	MPa/m	Rate of change of modulus of subgrade reaction E_s with depth z
L’	m	Effective length of foundation
H	MN	Horizontal external force or action
V	MN	Vertical external force or action
M	MN.m	External moment
T	MN.m	External torsion moment
Q	MN	Total vertical resistance of a foundation/pile
Q_p	MN	End bearing of pile
Q_s	MN	Shaft resistance of pile
q_p	MPa	Unit end bearing
q_{lim}	MPa	Limit unit end bearing
f	kPa	Unit skin friction (or q_s)
f_{lim}	kPa	Limit unit skin friction
p	MN/m	Lateral resistance per unit length of pile
p_{lim}	MN/m	Limit lateral resistance per unit length of pile
s	m	Settlement
t	MN/m	Skin friction per unit length of pile
y	mm	Lateral pile deflection
z	mm	Axial pile displacement
α	-	Adhesion factor between ground and foundation (= f/s_u)
β	-	Adhesion factor between ground and foundation (= f/σ'_v or f/σ'_{vo})

Symbol	Unit	Quantity
δ	°(deg)	Angle of interface friction (between ground and foundation)
δ_{cv}	°(deg)	Constant volume or critical-state angle of interface friction (between ground and foundation)
N_c, N_q, N_γ	-	Bearing capacity factors
K_c, K_q, K_γ	-	Bearing capacity correction factors for inclined forces or actions, foundation shape and depth of embedment
i_c, i_q, i_γ	-	Bearing capacity correction factors for external force inclined from vertical shape
s_c, s_q, s_γ	-	Bearing capacity correction factors for foundation shape
d_c, d_q, d_γ	-	Bearing capacity correction factors for foundation embedment

Signs:
- A "prime" applies to effective stress.
- A "bar" above a symbol relates to average properties.
- A "dot" above a symbol denotes derivative with respect to time.
- The prefix "Δ" denotes an increment or a change.
- A “star” after a symbol denotes value corrected for pore fluid salinity.

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APPENDIX 2: POSITIONING REPORT

CONTENTS

FUGRO SURVEY B.V.

POSITIONING DATA
FOR MV BUCENTAUR

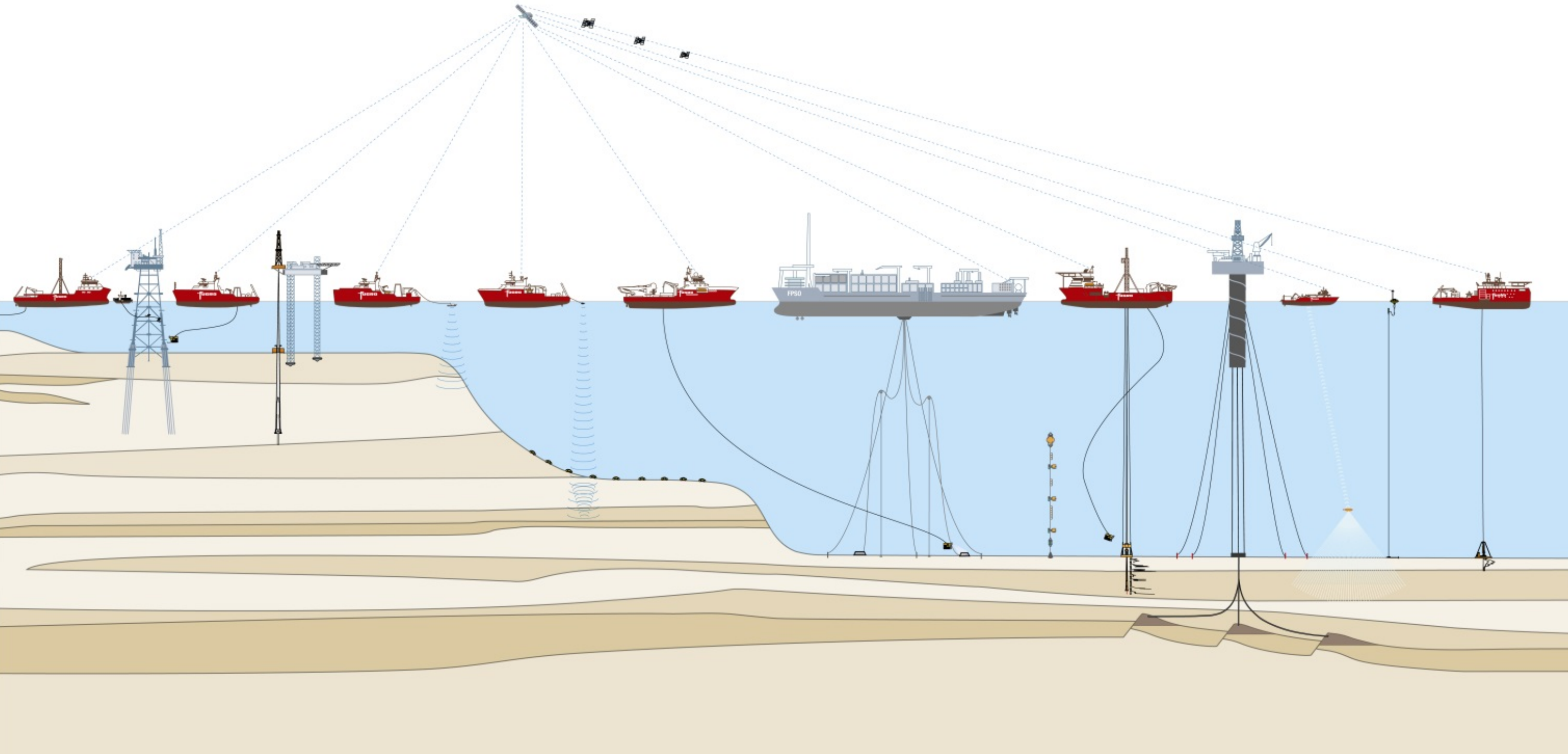
GEOTECHNICAL INVESTIGATION BOREHOLE LOCATIONS
Wind Farm Sites I and II
Hollandse Kust (Zuid) Wind Farm Zone
Dutch Sector, North Sea

30 June to 17 July 2016
Fugro Document No.: PH403-GEOT-03

Rijksdienst voor Ondernemend Nederland (RVO)

Final Issue

Rev 0



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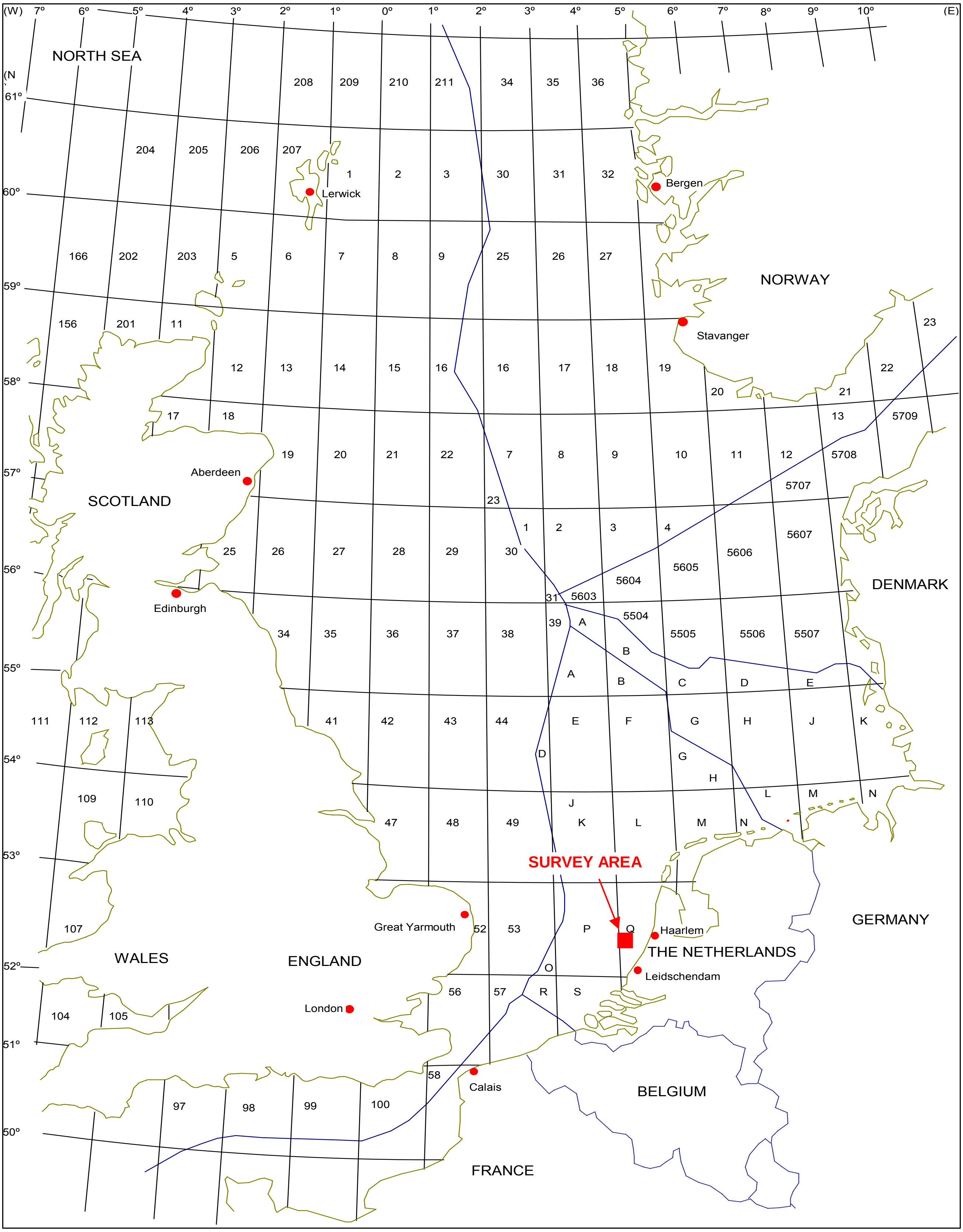
REPORT AMENDMENT SHEET

Rev No.	Report Section	Page No.	Table No.	Figure No.	Description
1	Entire				Offshore Preliminary Issue
2	Entire				Office QC
3	Entire				Divided into three parts as per locations
0	Entire				Final Issue



Location of Hollandse Kust (Zuid) Wind Farm Zone, Dutch Sector

CONTENTS

TABLES IN THE MAIN TEXT

FIGURES IN THE MAIN TEXT

ABBREVIATIONS

Accuracy	The accuracy of a measurement is its degree of closeness to its actual (true) value. Accuracy is the combination of the precision and reliability of an observation.
Augmentation Data	Additional information e.g. from a reference or tracking station, applied at a user receiver to improve the positioning solution. See also differential GNSS.
Azimuth	A horizontal angle measured from the spheroidal meridian clockwise from north through 360°. See also bearing and heading.
Bearing	Refers to a direction from one point to another on a chart right rotated from grid north (bearing = azimuth + convergence + arc to chord correction). See also azimuth and heading.
C-O Correction	Calculated minus observed correction. The difference found in a calibration procedure between a fixed value and an observation. The C-O correction must always be added to the observation.
Chart Datum	Vertical Datum used in charting. Chart data e.g. Mean Sea Level (MSL), Lowest Astronomical Tide (LAT), Lowest Low Water Springs (LLWS), Normaal Amsterdams Peil (Amsterdam Ordnance Datum) (NAP), Normal Null (NN). See also Vertical Datum.
CM	Central meridian, the meridian that defines the central line of longitude of the chart projection. It is a zone constant used in chart projections.
COG	Centre of Gravity
Convergence	Clockwise angle in a point between true north and grid north.
CRP	Common Reference Point is the origin of all vessel coordinates. It is also referred to as the vessel datum. It often corresponds to the drill string on drilling vessels.
Datum (Geodetic)	A mathematical model designed to best-fit part or all of the geoid. It is defined by an ellipsoid and the relationship between the ellipsoid and a point on the topographic surface established as the origin of datum. This relationship can be defined by six quantities, generally (but not necessarily) the geodetic latitude, longitude and the height of the origin, the two components of the deflection of the vertical at the origin, and the geodetic azimuth of a line, from the origin to some other point.
Datum Rotation (Geodetic)	Defined as the anti-clockwise rotation around the X-axis, Y-axis and Z-axis (Rx, Ry, and Rz) in the origin of two spheroids in terms of the Cartesian or geocentric coordinates. See also datum shift and scale.
Datum Shift (Geodetic)	Defined as the difference (ΔX, ΔY, ΔZ) in the origin of two spheroids in terms of the Cartesian or geocentric coordinates. See also datum rotation and scale.
Datum (Vessel)	The vessel datum is the origin of all vessel coordinates. It is referred to as the common reference point or CRP.

DGNSS	Augmentation technique requiring a GNSS receiver(s) to be placed at one or multiple known points from which GNSS observable (pseudo-range) corrections can be deduced. These corrections can then be applied to the offshore mobile receiver.
DP	Dynamic positioning, mainly referring to a system keeping the vessel in one position compensating for current, wind and other natural influences, using a variety of positioning systems as reference.
Differential Positioning	Determination of relative coordinates between two or more satellite receivers that are simultaneously tracking the same satellite signal.
Ellipsoid / Spheroid	In geodesy, unless otherwise specified, a mathematical figure formed by revolving an ellipse about its minor axis. It is often used interchangeably with spheroid. Two quantities define an ellipsoid: these are usually given as the length of the semi-major axis, a, and the inverse flattening, 1/f = a / (a-b), where b is the length of the semi-minor axis. Prolate and triaxial ellipsoids are invariably described as such.
False Easting / False Northing	Defined projection coordinate offsets to the origin point of the projection.
Geoid	The particular equipotential surface with coincides with mean sea level, and which may be imagined to extend through the continents. This surface is perpendicular to the force of gravity everywhere.
GLONASS	Russian global navigation satellite system.
GPS	Global positioning system.
GNSS	Global navigation satellite system. A combination solution of GPS and GLONASS with provision for the future European Galileo space system.
HDOP	Horizontal dilution of precision. A measure of the magnitude of DOP errors in latitude and longitude.
Heading	Course of a vessel measured with a heading system, i.e. a gyrocompass, or a GPS vector heading system. If the heading is magnetic this will be stated. See also azimuth and bearing.
HPR	Hydro acoustic positioning reference. See USBL definition.
Line Scale Factor	The ratio of a distance from point A to point B on the grid to the corresponding distance on the spheroid. K = plane distance/spheroidal distance 1/k=1/6(1/kA + 4/kM +1/kB). (kA, kB, kM being point scale factors at A, B, M. See also point scale factor)
Multifix	Multi reference differential global positioning system based on simultaneous calculated single DGPS positions for each reference station which solutions are then applied to a least squares calculation by which a new solution is created by weighting the single solutions on distance of the used reference station used in the single computations.

Offset	A station offset from the main survey station. Must be defined by an azimuth and distance or ∆X, ∆Y, ∆Z, or starboard/port, forward/aft, above/below.
OWF	Offshore Wind Farm
PDOP	Position dilution of precision. A unit-less figure of merit expressing the relationship between the error in user position and the error in satellite position.
PPP	Precise Point Positioning. A global GNSS augmentation technique that corrects for GNSS satellite clock and orbit errors, and employs additional modelling techniques to further correct and improve the point positioning accuracy.
Precision	A measure of the random errors in observations and estimated parameters.
Reference Station	A GNSS receiver located at a precisely known location and used to determine the differential corrections employed for DGNSS augmentation techniques.
Satellite Configuration	State of the satellite configuration at a specific time, relative to a specific user or set of users.
Satellite Constellation	The arrangement in space of the complete set of satellites of a system such as GPS.
Scale	Reduction/expansion used in datum-datum transformations. Unit: ppm (parts per million). See also datum shift and datum rotation.
Scale Factor (Point)	Ratio of an infinitesimal distance at a point on the grid to the corresponding distance on the spheroid. K = Δ (plane distance) / Δ (spheroidal distance).
S/CTD (probe)	Salinity or conductivity, temperature and depth probe. Used to determine speed of sound through the water column. Pressure to depth conversions may be applied to provide true depth values.
SD	Standard deviation. Measure of the dispersion of random errors about the mean value. If a large number of measurements or observations of the same quantity are made, the standard deviation is the square root of the sum of the squares of deviations from the mean value divided by the number of observations less one.
Sonardyne Ranger 2	Ranger 2 is a high performance acoustic position reference system designed for tracking underwater targets and positioning dynamically positioned (DP) vessels.
Starfix.G2	A decimetre accuracy integrated GNSS service which utilises Fugro’s own global network of reference stations to measure carrier phase observations. This data is then processed, producing a corrections solution for each navigation satellite. These corrections are applied to the satellite time reference clock and ephemeris (“orbit”) information, hence “clock and orbit corrections”. This service utilises both GPS and GLONASS L1 and L2 frequencies, thereby providing an accurate measurement of variations in Ionospheric thickness. This enables signal delay to be calculated more precisely, resulting in a more accurate satellite to antenna range, and hence a more accurate position solution. Starfix.G2 provides a high availability, high integrity, global solution to an accuracy of 10 cm (95 % confidence level) both horizontally and vertically.

Starfix.HP	This service utilises the Fugro international network of approximately 100 land-based reference stations. Unlike standard L1, which uses code based measurements, Starfix.HP is based upon carrier phase measurements which provide a much higher resolution. This service utilises the GPS L1 and L2 frequencies, thereby providing an accurate measurement of Ionospheric thickness. This results in a more accurate satellite to antenna range, and hence a more accurate position solution. At a distance of 1000 km from the nearest reference station Starfix.HP accuracies are typically 10 cm and 15 cm (95 % confidence level) in the horizontal and vertical planes respectively.
Starfix.XP	This service utilises a third party global network of reference stations to measure carrier phase observations. This data is then processed, producing a corrections solution for each navigation satellite. These corrections are applied to the satellite time reference clock and ephemeris (“orbit”) information, hence “clock and orbit corrections”. This service utilises the GPS L1 and L2 frequencies, thereby providing an accurate measurement of variations in Ionospheric thickness. This enables signal delay to be calculated more precisely, resulting in a more accurate satellite to antenna range, and hence a more accurate position solution. Starfix.XP provides a high performance global solution to an accuracy of 10 cm and 20 cm (95 % confidence level) in the horizontal and vertical planes respectively.
Starfix.L1	This service is a GPS positioning correction system using single frequency code correction data from the Fugro network of reference stations, delivered via both Inmarsat and SpotBeam satellites. These corrections, combined with a single frequency GPS receiver, can provide a positional accuracy of better than 1.5 m (95 %) horizontally at a distance of 500 km from the closest reference station.
Starfix.NG	Fugro’s in-house advanced vessel and ROV positioning software system.
StarPack	A StarPack unit consists of a survey grade GNSS receiver and powerful processor, running Linux multi-tasking operating system. The receiver is capable of tracking all current (GPS, GLONASS) and future (Galileo) systems. A StarPack can be extended with a second receiver (in the same unit), to provide accurate, GNSS derived heading.
Transceiver	A device that can transmit and receive signals.
Transducer	A device that converts electrical energy to acoustic energy and vice-versa.
Transponder	A device that can detect a signal on a particular frequency and in response transmits signal on another frequency.
UTM	Universal Transverse Mercator. A special case of the transverse Mercator projection whereby the projection parameters are specified by worldwide agreement, abbreviated as the UTM grid. It consists of 60 north south zones, each 6 degrees of longitude wide with a unique central meridian.

USBL	Ultra-Short BaseLine acoustic positioning method involving the measurement of range and bearing from a vessel-based transceiver to subsea transponders. It generally operates through phase discrimination of an acoustic signal as it passes over three transducers placed at right angles to each other within the Transducer head. Using this method, a three dimensional position of the beacon(s) can be determined.
Vertical Datum	An arbitrarily assumed value for a particular benchmark or a measured value at sea level at a tide station, or a fixed adjustment of many such measurements in a common adjustment. See also chart datum.
WGS 84	World Geodetic System 1984. A rotational ellipsoid having the following dimensions: semi-major axis 6378137.000 m, semi-minor axis (derived) 6356752.314 m, flattening (derived) 1/298.257224. This ellipsoid reference model / datum is the surface from which GPS coordinates are computed.

1. INTRODUCTION

Fugro was requested by Rijksdienst voor Ondernemend Nederland (RVO) to supply navigation and positioning services for the geotechnical drilling vessel MV Bucentaur at 140 geotechnical borehole drilling and/or in situ testing locations at the wind farm sites I to IV of the Hollandse Kust (zuid) Wind Farm Zone.

This report presents the results of positioning and water depth measurements in support of the geotechnical investigation on the 26 geotechnical borehole locations at the wind farm sites I and II.

The positions and depths reported here were checked and quality controlled by the FSBV office staff onshore and supersede the values in the preliminary field report.

The geotechnical borehole drilling was carried out between 30 June and 17 July 2016. The positioning results are given in Table 2.1, Table 2.2 and Table 2.3.

System positioning performance parameters are outlined in Section 5.3.

2. RESULTS

2.1 Field Locations

Table 2.1: Actual Coordinates and Water Depths

Datum: ETRS89, UTM Zone 31N, EPSG codes: 4258 and 25831					Water Depth (LAT) *		
Location	Easting [m]	Northing [m]	Latitude [North]	Longitude [East]	Pressure Sensor [m]	Echo Sounder [m]	Drill String [m]
HKZ1-BH01-SA	575785.69	5807003.39	52° 24' 28.8261"	004° 06' 50.7931"	21.8	22.0	22.5
HKZ1-BH01-SC	575782.19	5807008.56	52° 24' 28.9951"	004° 06' 50.6121"	21.7	22.0	21.9
HKZ1-BH02-SA	570257.40	5803814.18	52° 22' 48.2793"	004° 01' 55.8653"	22.8	23.0	23.4
HKZ1-BH03-SA	571804.25	5801442.18	52° 21' 30.7994"	004° 03' 15.8339"	21.7	22.0	22.1
HKZ1-BH03-SC	571799.82	5801439.50	52° 21' 30.7148"	004° 03' 15.5977"	21.7	22.0	22.0
HKZ1-BH04-SA	564964.99	5803848.82	52° 22' 51.7524"	003° 57' 16.0214"	23.2	23.5	24.0
HKZ1-BH05-SA	576102.16	5803509.55	52° 22' 35.6104"	004° 07' 04.6802"	21.8	22.0	22.2
HKZ1-BH06A-SC	564274.32	5801683.33	52° 21' 41.9683"	003° 56' 38.0028"	22.5	22.7	23.1
HKZ1-BH06-SA	564274.32	5801687.90	52° 21' 42.1162"	003° 56' 38.0059"	22.6	22.7	23.1
HKZ1-BH06-SC	564279.47	5801684.32	52° 21' 41.9982"	003° 56' 38.2757"	22.6	22.7	23.0
HKZ1-BH07-SA	564164.05	5800040.97	52° 20' 48.8662"	003° 56' 31.0438"	24.4	24.6	25.0
HKZ1-BH08-SA	568495.97	5802171.57	52° 21' 55.9271"	004° 00' 21.5122"	23.7	23.9	24.2
HKZ2-BH01-SA	568406.63	5796369.10	52° 18' 48.1958"	004° 00' 12.5361"	23.0	23.2	21.2
HKZ2-BH03A-SC	570489.32	5794485.63	52° 17' 46.2974"	004° 02' 01.0836"	20.3	20.6	20.2
HKZ2-BH03-SA	570485.26	5794479.47	52° 17' 46.0999"	004° 02' 00.8646"	20.2	20.6	20.8
HKZ2-BH03-SC	570491.88	5794480.74	52° 17' 46.1379"	004° 02' 01.2150"	20.2	20.6	20.9
HKZ2-BH04-SA	565259.53	5795388.58	52° 18' 17.8442"	003° 57' 25.6799"	22.3	22.3	22.9
HKZ2-BH06-SA	569240.95	5791848.79	52° 16' 21.5387"	004° 00' 53.2441"	21.7	21.8	21.4
HKZ2-BH07A-SA	565233.90	5790442.10	52° 15' 37.7803"	003° 57' 20.8806"	23.0	23.0	22.8
HKZ2-BH07-SA	565232.05	5790442.32	52° 15' 37.7882"	003° 57' 20.7832"	22.9	23.0	23.1
HKZ2-BH07-SC	565227.55	5790443.36	52° 15' 37.8238"	003° 57' 20.5466"	23.0	23.0	23.4
HKZ2-BH08-SA	566377.10	5792834.87	52° 16' 54.7210"	003° 58' 22.8666"	22.7	23.0	23.3
HKZ2-BH12-SA	566569.95	5793920.04	52° 17' 29.7544"	003° 58' 33.8138"	22.1	22.3	22.3
HKZ2-BH12-SC	566566.36	5793922.24	52° 17' 29.8272"	003° 58' 33.6259"	22.1	22.3	22.5
HKZ2-BH21-SA	565358.02	5796984.10	52° 19' 09.4350"	003° 57' 31.9950"	24.2	24.6	22.2
HKZ2-BH21-SC	565364.53	5796986.91	52° 19' 09.5231"	003° 57' 32.3408"	24.2	24.6	23.2
Notes: * = Refer to Section 5, Methodology for details on the different water depth measurements							

Table 2.2: Actual Coordinates in WGS 84

Datum: WGS 84, EPSG code: 4326		
Location	Latitude [North]	Longitude [East]
HKZ1-BH01-SA	52° 24' 28.8426"	004° 06' 50.8165"
HKZ1-BH01-SC	52° 24' 29.0116"	004° 06' 50.6356"
HKZ1-BH02-SA	52° 22' 48.2958"	004° 01' 55.8887"
HKZ1-BH03-SA	52° 21' 30.8159"	004° 03' 15.8574"
HKZ1-BH03-SC	52° 21' 30.7312"	004° 03' 15.6211"
HKZ1-BH04-SA	52° 22' 51.7689"	003° 57' 16.0448"
HKZ1-BH05-SA	52° 22' 35.6269"	004° 07' 04.7036"

Datum: WGS 84, EPSG code: 4326		
Location	**Latitude [North]**	**Longitude [East]**
HKZ1-BH06A-SC	52° 21' 41.9848"	003° 56' 38.0262"
HKZ1-BH06-SA	52° 21' 42.1327"	003° 56' 38.0293"
HKZ1-BH06-SC	52° 21' 42.0147"	003° 56' 38.2991"
HKZ1-BH07-SA	52° 20' 48.8827"	003° 56' 31.0672"
HKZ1-BH08-SA	52° 21' 55.9436"	004° 00' 21.5356"
HKZ2-BH01-SA	52° 18' 48.2123"	004° 00' 12.5595"
HKZ2-BH03A-SC	52° 17' 46.3138"	004° 02' 01.1070"
HKZ2-BH03-SA	52° 17' 46.1164"	004° 02' 00.8880"
HKZ2-BH03-SC	52° 17' 46.1544"	004° 02' 01.2384"
HKZ2-BH04-SA	52° 18' 17.8607"	003° 57' 25.7033"
HKZ2-BH06-SA	52° 16' 21.5552"	004° 00' 53.2675"
HKZ2-BH07A-SA	52° 15' 37.7968"	003° 57' 20.9040"
HKZ2-BH07-SA	52° 15' 37.8047"	003° 57' 20.8066"
HKZ2-BH07-SC	52° 15' 37.8403"	003° 57' 20.5700"
HKZ2-BH08-SA	52° 16' 54.7375"	003° 58' 22.8900"
HKZ2-BH12-SA	52° 17' 29.7709"	003° 58' 33.8372"
HKZ2-BH12-SC	52° 17' 29.8437"	003° 58' 33.6493"
HKZ2-BH21-SA	52° 19' 09.4515"	003° 57' 32.0184"
HKZ2-BH21-SC	52° 19' 09.5396"	003° 57' 32.3641"

Table 2.3: Actual Location Details

Datum: ETRS89, UTM Zone 31N, EPSG codes: 4258 and 25831				Standard Deviation		Intended to actual	
Location	**Easting [m]**	**Northing [m]**	**No. of Fixes**	**X [m]**	**Y [m]**	**Distance [m]**	**Bearing [°]**
HKZ1-BH01-SA	575785.69	5807003.39	100	0.08	0.07	3.22	154.47
HKZ1-BH01-SC	575782.19	5807008.56	100	0.15	0.12	3.09	316.97
HKZ1-BH02-SA	570257.40	5803814.18	100	0.12	0.13	1.32	333.05
HKZ1-BH03-SA	571804.25	5801442.18	100	0.19	0.14	3.05	90.38
HKZ1-BH03-SC	571799.82	5801439.50	100	0.07	0.07	3.03	207.07
HKZ1-BH04-SA	564964.99	5803848.82	100	0.12	0.13	1.67	13.54
HKZ1-BH05-SA	576102.16	5803509.55	100	0.16	0.13	3.11	302.01
HKZ1-BH06A-SC	564274.32	5801683.33	100	0.18	0.14	3.07	237.09
HKZ1-BH06-SA	564274.32	5801687.90	100	0.14	0.17	3.88	318.34
HKZ1-BH06-SC	564279.47	5801684.32	100	0.15	0.13	2.66	104.82
HKZ1-BH07-SA	564164.05	5800040.97	100	0.10	0.07	1.36	315.60
HKZ1-BH08-SA	568495.97	5802171.57	100	0.21	0.09	1.85	171.61
HKZ2-BH01-SA	568406.63	5796369.10	100	0.12	0.09	2.72	140.52
HKZ2-BH03A-SC	570489.32	5794485.63	100	0.09	0.10	3.64	5.04
HKZ2-BH03-SA	570485.26	5794479.47	100	0.14	0.17	4.52	235.92
HKZ2-BH03-SC	570491.88	5794480.74	100	0.17	0.16	3.14	113.63
HKZ2-BH04-SA	565259.53	5795388.58	100	0.29	0.21	2.86	147.70
HKZ2-BH06-SA	569240.95	5791848.79	100	0.20	0.13	2.57	31.65
HKZ2-BH07A-SA	565233.90	5790442.10	100	0.07	0.06	2.36	216.38
HKZ2-BH07-SA	565232.05	5790442.32	100	0.19	0.11	3.66	242.66

Datum: ETRS89, UTM Zone 31N, EPSG codes: 4258 and 25831				Standard Deviation		Intended to actual	
Location	**Easting [m]**	**Northing [m]**	**No. of Fixes**	**X [m]**	**Y [m]**	**Distance [m]**	**Bearing [°]**
HKZ2-BH07-SC	565227.55	5790443.36	100	0.18	0.16	7.78	265.28
HKZ2-BH08-SA	566377.10	5792834.87	100	0.10	0.07	2.64	133.92
HKZ2-BH12-SA	566569.95	5793920.04	100	0.12	0.14	2.67	97.74
HKZ2-BH12-SC	566566.36	5793922.24	100	0.47	0.37	2.07	332.94
HKZ2-BH21-SA	565358.02	5796984.10	100	0.13	0.12	3.7	239.14
HKZ2-BH21-SC	565364.53	5796986.91	100	0.28	0.18	3.45	74.72

3. OPERATIONS

3.1 Scope of Work

FSBV was contracted to provide positioning support for navigation between the borehole drilling and/or in situ testing locations and determination of the drill string position at each location. Geotechnical borehole drilling was carried out at 26 locations at the wind farm sites I and II.

Table 3.1: Intended Locations Provided by the Client

Datum: ETRS89, UTM Zone 31N, EPSG codes: 4258 and 25831				
Location	**Easting [m]**	**Northing [m]**	**Latitude [North]**	**Longitude [East]**
HKZ1-BH01-SA	575784.30	5807006.30	52° 24' 28.9210"	004° 06' 50.7219"
HKZ1-BH01-SC	575784.30	5807006.30	52° 24' 28.9210"	004° 06' 50.7219"
HKZ1-BH02-SA	570258.00	5803813.00	52° 22' 48.2409"	004° 01' 55.8961"
HKZ1-BH03-SA	571801.20	5801442.20	52° 21' 30.8015"	004° 03' 15.6727"
HKZ1-BH03-SC	571801.20	5801442.20	52° 21' 30.8015"	004° 03' 15.6727"
HKZ1-BH04-SA	564964.60	5803847.20	52° 22' 51.7001"	003° 57' 15.9996"
HKZ1-BH05-SA	576104.80	5803507.90	52° 22' 35.5557"	004° 07' 04.8184"
HKZ1-BH06A-SC	564276.90	5801685.00	52° 21' 42.0213"	003° 56' 38.1403"
HKZ1-BH06-SA	564276.90	5801685.00	52° 21' 42.0213"	003° 56' 38.1403"
HKZ1-BH06-SC	564276.90	5801685.00	52° 21' 42.0213"	003° 56' 38.1403"
HKZ1-BH07-SA	564165.00	5800040.00	52° 20' 48.8344"	003° 56' 31.0933"
HKZ1-BH08-SA	568495.70	5802173.40	52° 21' 55.9864"	004° 00' 21.4993"
HKZ2-BH01-SA	568404.90	5796371.20	52° 18' 48.2646"	004° 00' 12.4463"
HKZ2-BH03A-SC	570489.00	5794482.00	52° 17' 46.1800"	004° 02' 01.0639"
HKZ2-BH03-SA	570489.00	5794482.00	52° 17' 46.1800"	004° 02' 01.0639"
HKZ2-BH03-SC	570489.00	5794482.00	52° 17' 46.1800"	004° 02' 01.0639"
HKZ2-BH04-SA	565258.00	5795391.00	52° 18' 17.9232"	003° 57' 25.6008"
HKZ2-BH06-SA	569239.60	5791846.60	52° 16' 21.4684"	004° 00' 53.1713"
HKZ2-BH07A-SA	565235.30	5790444.00	52° 15' 37.8412"	003° 57' 20.9558"
HKZ2-BH07-SA	565235.30	5790444.00	52° 15' 37.8412"	003° 57' 20.9558"
HKZ2-BH07-SC	565235.30	5790444.00	52° 15' 37.8412"	003° 57' 20.9558"
HKZ2-BH08-SA	566375.20	5792836.70	52° 16' 54.7811"	003° 58' 22.7676"
HKZ2-BH12-SA	566567.30	5793920.40	52° 17' 29.7672"	003° 58' 33.6742"
HKZ2-BH12-SC	566567.30	5793920.40	52° 17' 29.7672"	003° 58' 33.6742"
HKZ2-BH21-SA	565361.20	5796986.00	52° 19' 09.4951"	003° 57' 32.1643"
HKZ2-BH21-SC	565361.20	5796986.00	52° 19' 09.4951"	003° 57' 32.1643"

Table 3.2: Intended Coordinates in WGS 84

Datum: WGS 84, EPSG code: 4326		
Location	**Latitude [North]**	**Longitude [East]**
HKZ1-BH01-SA	52° 24' 28.9374"	004° 06' 50.7454"
HKZ1-BH01-SC	52° 24' 28.9374"	004° 06' 50.7454"
HKZ1-BH02-SA	52° 22' 48.2574"	004° 01' 55.9195"
HKZ1-BH03-SA	52° 21' 30.8180"	004° 03' 15.6962"
HKZ1-BH03-SC	52° 21' 30.8180"	004° 03' 15.6962"

Datum: WGS 84, EPSG code: 4326		
Location	**Latitude [North]**	**Longitude [East]**
HKZ1-BH04-SA	52° 22' 51.7166"	003° 57' 16.0230"
HKZ1-BH05-SA	52° 22' 35.5722"	004° 07' 04.8418"
HKZ1-BH06A-SC	52° 21' 42.0378"	003° 56' 38.1637"
HKZ1-BH06-SA	52° 21' 42.0378"	003° 56' 38.1637"
HKZ1-BH06-SC	52° 21' 42.0378"	003° 56' 38.1637"
HKZ1-BH07-SA	52° 20' 48.8509"	003° 56' 31.1167"
HKZ1-BH08-SA	52° 21' 56.0029"	004° 00' 21.5227"
HKZ2-BH01-SA	52° 18' 48.2810"	004° 00' 12.4697"
HKZ2-BH03A-SC	52° 17' 46.1965"	004° 02' 01.0873"
HKZ2-BH03-SA	52° 17' 46.1965"	004° 02' 01.0873"
HKZ2-BH03-SC	52° 17' 46.1965"	004° 02' 01.0873"
HKZ2-BH04-SA	52° 18' 17.9397"	003° 57' 25.6242"
HKZ2-BH06-SA	52° 16' 21.4849"	004° 00' 53.1947"
HKZ2-BH07A-SA	52° 15' 37.8577"	003° 57' 20.9792"
HKZ2-BH07-SA	52° 15' 37.8577"	003° 57' 20.9792"
HKZ2-BH07-SC	52° 15' 37.8577"	003° 57' 20.9792"
HKZ2-BH08-SA	52° 16' 54.7976"	003° 58' 22.7910"
HKZ2-BH12-SA	52° 17' 29.7837"	003° 58' 33.6976"
HKZ2-BH12-SC	52° 17' 29.7837"	003° 58' 33.6976"
HKZ2-BH21-SA	52° 19' 09.5116"	003° 57' 32.1877"
HKZ2-BH21-SC	52° 19' 09.5116"	003° 57' 32.1877"

3.2 Resources

Personnel	**Name**	**From**	**To**
Party Chief	R. Lazenby	29 June 2016	17 July 2016
Surveyor	G. Kovacs	29 June 2016	17 July 2016

Only equipment used is listed below; refer to Section 5 (Methodology) for procedural explanations.

Positioning Equipment		
Navigation software		Starfix.NG online navigation suite
Primary positioning		GNSS with Starfix.G2 corrections (delivered via ESAT)
Secondary positioning		GNSS with Starfix.G2 corrections (delivered via AOR-E)
Tertiary positioning		GNSS with Starfix.HP corrections (delivered via AOR-E)
Quaternary positioning		GNSS with Starfix.HP corrections (delivered via ESAT)
Quinary positioning	(DP1)	GNSS with Starfix.Best corrections (delivered via ESAT)
Senary positioning	(DP2)	GNSS with Starfix.Best corrections (delivered via AOR-E)
Septenary positioning		VBS (delivered by ESAT)
Acoustic positioning		Simrad - Kongsberg HiPAP 500 controlled via APOS software
Primary heading system		TSS Meridian Surveyor heading system
Secondary heading system		Seatex Seapath 200 vector heading system
Tertiary heading system		StarPack Protrack vector heading system
Reference stations		Leidschendam, Rogaland, Aberdeen, Jacou, Torshavn, Galway

Bathymetry Equipment	
Primary System	Simrad Hydrographic echo sounder EA400
Secondary System	Sensordata SD204 pressure sensor
Tertiary System	Drill string
Vertical Motion Compensator	Seatex Seapath 200
Data Recording	Starfix.NG online navigation suite

3.3 Offsets

3.3.1 MV Bucentaur Vessel Offsets

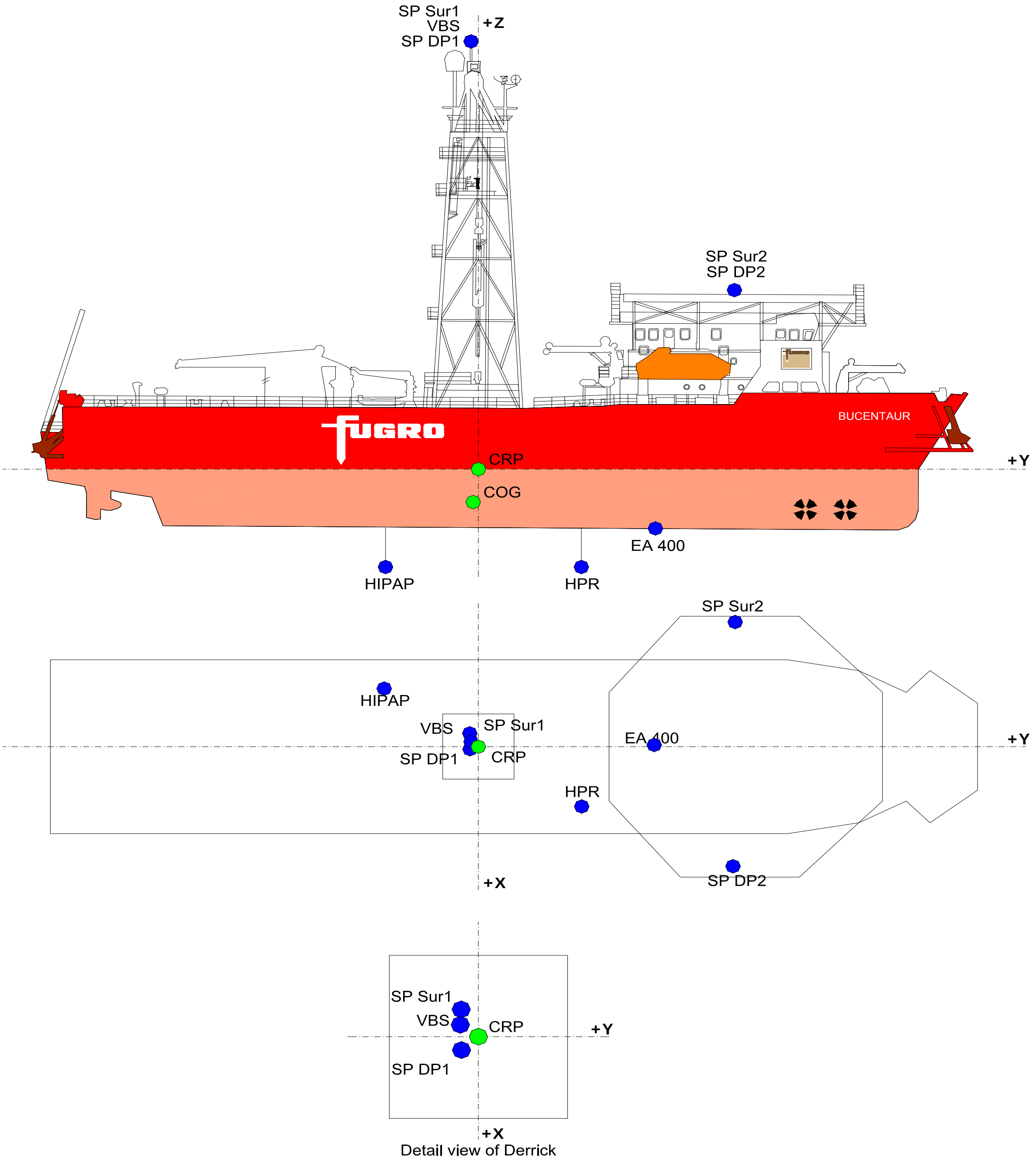


Figure 3.1: MV Bucentaur offsets diagram

Table 3.3: MV Bucentaur Vessel Offsets

ID	Offsets	Athwart (X) [m]	Along (Y) [m]	Height (Z) [m]
1	CRP	0.00	0.00	0.00
2	SP DP1	0.34	-0.46	35.58
3	SP SUR1	-1.15	-0.47	35.59
4	SP DP2	11.39	21.43	12.99

ID	Offsets	Athwart (X) [m]	Along (Y) [m]	Height (Z) [m]
5	SP SUR2	-11.33	21.61	13.11
6	VBS	-0.60	-0.51	35.57
7	HIPAP	-5.38	-7.76	-11.28
9	EA400 38 kHz	-0.08	14.89	-8.48
10	EA400 200 kHz	0.50	14.86	-8.49
11	Stern Centre	0.00	-39.60	0.00
12	COG	0.00	-0.41	-3.00
13	Seapath Physical Offset	-2.75	2.49	-0.76
14	HPR	5.33	8.48	-11.01

3.3.2 Seabed Frame Offsets

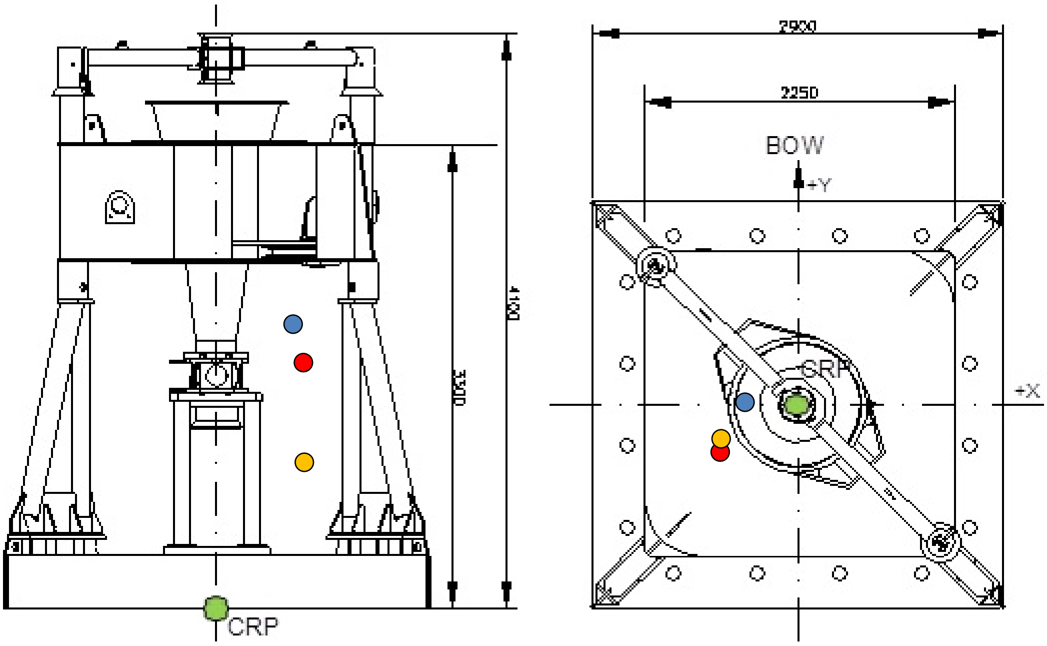


Figure 3.2: Seabed Frame offsets diagram

Table 3.4: Seabed Frame Offsets

Offsets			Athwart (X) [m]	Along (Y) [m]	Height (Z) [m]
CRP (Drill string centre)		●	0.00	0.00	0.00
HiPAP Beacon	(B25)	●	-0.90	-0.00	4.10
CTD Probe		●	-1.03	-0.23	4.06
CTD Probe 2		●	-1.03	-0.23	3.12

3.4 Calibration Results

This section details the results of the system calibrations that were carried out prior to positioning operations. Refer to Section 5 (Methodology), for a detailed description of the calibration procedures. Detailed results of the calibrations are available on request.

3.4.1 Positioning Systems

A positioning system verification was carried out on 28 June 2016 in IJmuiden, The Netherlands, by means of total station measurements from known points on the quay. The results of the verifications are presented in Table 3.5.

Table 3.5: Positioning System Verification

Date	Location	Method	ΔE [m]	S.D. [m]	ΔN [m]	S.D. [m]
28 June 2016	IJmuiden	Total Station	0.01	0.01	0.07	0.08

To check the integrity of the positioning systems a positioning system comparison was performed on 28 June 2016 in IJmuiden, The Netherlands. The differences between the positioning systems were within the expected system accuracy. The results of the comparisons are presented in Table 3.6.

Table 3.6: Positioning System Comparison

Date	Location	Positioning system	ΔE [m]	S.D. [m]	ΔN [m]	S.D. [m]
28 June 2016	IJmuiden	G2 Survey 1 – G2 Survey 2	-0.18	0.02	0.05	0.03
28 June 2016	IJmuiden	G2 Survey 1 – HP Survey 1	0.03	0.03	0.01	0.02
28 June 2016	IJmuiden	G2 Survey 1 – HP Survey 2	-0.15	0.02	0.05	0.05
28 June 2016	IJmuiden	G2 Survey 2 - HP Survey 1	0.21	0.04	-0.03	0.03
28 June 2016	IJmuiden	G2 Survey 2 - HP Survey 2	0.03	0.03	0.00	0.03
28 June 2016	IJmuiden	HP Survey 1 - HP Survey 2	-0.18	0.02	0.03	0.04

3.4.2 Heading Systems Alignment

The heading systems alignments were checked using Sun azimuth observations in IJmuiden, The Netherlands, on 29 June 2016. After completion of the checks the corrections were entered into the online navigation software. The results of the alignment checks are presented in Table 3.7.

Table 3.7: Heading Systems Alignment Check

Date	Location	Heading system	Method	Computed [°T]	Observed [°T]	C-O [°]
29 June 2016	IJmuiden	TSS Meridian	Sun azimuth obs.	154.54	154.37	0.17
29 June 2016	IJmuiden	Seapath	Sun azimuth obs.	154.54	154.86	-0.32
29 June 2016	IJmuiden	Protrack	Sun azimuth obs	154.54	154.52	0.02

3.4.3 Speed of Sound and Water Density Measurements

Before the start of project data acquisition and at regular intervals during the project; conductivity, temperature and pressure measurements were taken to establish the local speed of sound profile and average water density. The speed of sound profile was entered into the vessel’s Simrad EA400 echo sounder and HiPAP Ultra Short Baseline (USBL) system. The average water density was used for depth determination in conjunction with the pressure sensor. The results of these measurements are presented in Table 3.8.

Table 3.8: Speed of Sound and Water Density Measurements

Date	Location	Mean [m/s]	Transducer [m/s]	Seafloor [m/s]	Density [kg/m³]
27 June 2016	HKZ4-CPT09	1506.84	1506.98	1506.88	1024.25
3 July 2016	HKZ2-BH12-SA	1508.80	1509.37	1508.69	1025.31
9 July 2016	HKZ1-BH07-SA	1510.43	1510.32	1510.61	1024.94
14 July 2016	HKZ1-BH02-SA	1511.73	1511.58	1511.93	1024.72

3.4.4 Simrad HiPAP USBL

The Simrad HiPAP USBL system, installed on board the MV Bucentaur, was interfaced to the Starfix.NG as the sub-sea positioning system. A USBL Calibration was performed on 14 March 2016. The calibration was undertaken in the Stavanger DP Test Centre, Norway in a water depth of 394 m. The results of the calibration and the settings in both the systems are presented in Table 3.9:

Table 3.9: USBL Settings

Measurement	Date	X Offset [m]	Y Offset [m]	Z Offset [m]	Orientation [°]	Scale	Pitch [°]	Roll [°]
APOS	12 October 2014	-5.38	-7.759	-11.282	87.97	N/A	-0.08	-0.53
Starfix.NG	14 March 2016	0.00	0.00	0.00	0.46	1.00	-0.12	0.27

4. DATUM AND TOLERANCES

4.1 Geodetic and Projection Parameters

Table 4.1: Project Geodetic and Projection Parameters

<table>
<tr><th colspan="9">Global Positioning System Geodetic Parameters *</th></tr>
<tr><td colspan="3">Datum:</td><td colspan="6">World Geodetic System 1984 (WGS 84)</td></tr>
<tr><td colspan="3">Spheroid:</td><td colspan="6">World Geodetic System 1984</td></tr>
<tr><td colspan="3">Semi major axis:</td><td colspan="6">a = 6 378 137 m</td></tr>
<tr><td colspan="3">Inverse Flattening:</td><td colspan="6">1/f = 298.257 223 563</td></tr>
<tr><td colspan="3">EPSG Code:</td><td colspan="6">4326</td></tr>
<tr><th colspan="9">Local Datum Geodetic Parameters †</th></tr>
<tr><td colspan="3">Datum:</td><td colspan="6">European Terrestrial Reference System 1989 (ETRS89)</td></tr>
<tr><td colspan="3">Spheroid:</td><td colspan="6">GRS80</td></tr>
<tr><td colspan="3">Semi major axis:</td><td colspan="6">a = 6 378 137.000 m</td></tr>
<tr><td colspan="3">Inverse Flattening:</td><td colspan="6">1/f = 298.257222101</td></tr>
<tr><td colspan="3">EPSG Code:</td><td colspan="6">4258</td></tr>
<tr><th colspan="9">Datum Transformation Parameters ‡ from WGS 84 to Local Datum</th></tr>
<tr><td>Shift dX:</td><td>+0.05375</td><td>m</td><td>Rotation rX:</td><td>-0.002231</td><td>arcsec</td><td>Scale Factor:</td><td>0.002663</td><td>ppm</td></tr>
<tr><td>Shift dY:</td><td>+0.05095</td><td>m</td><td>Rotation rY:</td><td>-0.013494</td><td>arcsec</td><td>EPSG Code:</td><td>1149</td><td></td></tr>
<tr><td>Shift dZ:</td><td>-0.08827</td><td>m</td><td>Rotation rZ:</td><td>0.02181</td><td>arcsec</td><td></td><td></td><td></td></tr>
<tr><th colspan="9">Project Projection Parameters</th></tr>
<tr><td colspan="3">Grid Projection:</td><td colspan="6">Universal Transverse Mercator</td></tr>
<tr><td colspan="3">Projection Name</td><td colspan="6">UTM Zone 31 North (UTM 31N)</td></tr>
<tr><td colspan="3">Central Meridian:</td><td colspan="6">003° 00’ 00” East</td></tr>
<tr><td colspan="3">Latitude of Origin:</td><td colspan="6">00° 00’ 00” North</td></tr>
<tr><td colspan="3">False Easting:</td><td colspan="6">500 000 m</td></tr>
<tr><td colspan="3">False Northing:</td><td colspan="6">0 m</td></tr>
<tr><td colspan="3">Scale factor on Central Meridian:</td><td colspan="6">0.9996</td></tr>
<tr><td colspan="3">Units:</td><td colspan="6">Metre</td></tr>
<tr><td colspan="3">EPSG Code:</td><td colspan="6">25831</td></tr>
<tr><td colspan="9">Notes:
* = Fugro Starfix.NG navigation software always uses WGS 84 geodetic parameters as a primary datum for any geodetic calculations.
† = Source: Client
‡ = This is the right-handed coordinate frame rotation convention used by the Fugro Starfix navigation software.</td></tr>
</table>

4.2 Vertical Control

Chart Datum	LAT
Tidal Data	Real Time GNSS elevation measurements utilising Starfix.Best Height and reduced LAT using the DTU13 model
Time shift	Not applicable
Range factor	Not applicable
Barometric pressure variation	Factored in GNSS elevation measurements
Effect of wind	Factored in GNSS elevation measurements
Shallow water corrections	Not applicable
Seasonal changes in mean level	Considered
Seasonal changes in harmonic constants	Considered

4.3 System Performance Parameters

Surface positioning	± 0.5 m
USBL positioning	1 % slant range
Bathymetry (absolute)	± 0.5 m absolute using predicted tides
Bathymetry (relative)	Quartz pressure sensor CTD ± 0.01 % of range Echo sounder ± 1.0 % of depth Drill string - variable
GNSS 3D mode	5 satellites minimum, PDOP<6, Elevation > 10°
GNSS 2D mode	4 satellites minimum, HDOP<4, Elevation > 10°
Heading system	1°

5. METHODOLOGY

5.1 Introduction

Sections 5.2 to 5.4 inclusive describe the procedures for determining the coordinates and water depths of geotechnical sample and/or in situ testing locations. Section 5.5 describes the calibration procedures carried out for the heading system, surface and sub-surface positioning systems, and the echo sounder. The use of sub-surface positioning systems, primarily USBL and sector scan sonar, depends on the type of geotechnical sampling and/or in situ testing methods used, hence some descriptions in the sections below may not be applicable to this report.

5.2 Position Determination

The actual location may be determined by surface positioning alone or with additional use of USBL. The USBL determines the position of the centre of the seabed frame on the seafloor. Particularly in deeper water, use of USBL provides a more accurate position of the sample and/or in situ testing location since the seabed frame may be offset from the surface position of the drill string due to currents.

The position is determined as soon as the seabed frame makes contact with the seafloor. A minimum of 100 position fixes are logged at five-second intervals. Data outliers are then discarded in accordance with standard statistical procedures. To determine the final seafloor position of a sample and/or in situ testing location the following general sequence applies:

- From the global navigation satellite system (GNSS) receiver, the antenna’s latitude and longitude in WGS84 are transmitted to the navigation computer and converted to Easting and Northing on the local projection by the navigation software;
- The grid heading and X and Y offsets from the antenna to the common reference point (CRP) are applied to the antenna Easting and Northing in order to compute the position of the CRP on the local projection. If the USBL system is not used then this corresponds to the sample and/or in situ testing location since the CRP has been defined as the centre of the drill string;
- The grid heading and X and Y offsets from the CRP to the USBL transducer, mounted on the vessel’s hull, are applied to the CRP Easting and Northing to determine the transducer position on the local projection;
- The USBL system measures the slant range and relative bearing (measured clockwise from the vessel centreline) from the USBL transducer to the beacon, mounted on the seabed frame, and also the depth of the beacon relative to the transducer. These values are converted to ΔX, ΔY in the horizontal plane and ΔZ in the vertical plane by the USBL processor;
- The ΔX, ΔY, and ΔZ values are transmitted to the navigation computer where the Z offset of the USBL transducer is applied;
- The position of the beacon is computed in the local projection Easting and Northing and the beacon depth is computed relative to the water surface. The centre of the seabed frame, which corresponds to the seabed sample and/or in situ testing position, is derived from the USBL beacon position by applying the USBL beacons horizontal offsets. The heading of the frame is assumed to be the same as the vessel heading. When heading changes are implemented to the vessel after the location of the frame on the seafloor, the frame will be locked in its original heading by the use of a manual heading, derived from the position fix, in which heading information was logged.

5.3 System Configuration

5.3.1 DP Position System

The MV Bucentaur is configured according to the classification “Well Intervention Vessel II”. The vessel’s DP system is fed with two independent GNSS positions. Although the same equipment is used, the position solutions are generated using different correction sources and calculation methods.

Position and correction data from the DP system are sent to the survey system by means of galvanic isolators. This enables survey personnel to monitor and compare the positional data from the DP system. All equipment is installed in 19″ rack mount housings.

Additional correction redundancy is provided by cross-linking the two DP StarPack receivers to provide both AORE and ESAT corrections to each receiver. This prevents correction loss due to antenna masking.

Within the area of operations, accuracy and repeatability of the Starfix.Best Position solution are designed to be within 0.2 m in the horizontal plane and 0.5 m in the vertical plane (95 % confidence level). The position solution operates with a minimum of five GNSS satellites.

For safety reasons, changes to the DP positioning solution were restricted to changing the selection of the corrections satellite (i.e. Atlantic Ocean Region East (AORE), Éireann Satellite (ESAT)) and shore reference stations when entering a new work area. The system was under the full control and responsibility of the DP Operator. Position details from the DP system were sent to the survey software. Quality control (QC) checks cannot be performed for this system and its performance was fully outside FSBV’s responsibility.

5.3.1.1 DP1 Position

The DP1 position is a Starfix.Best Position solution, calculated in a stand-alone StarPack system. The Starfix.Best Position is a hybrid position consisting of a weighted combination of Fugro’s Starfix.G2, Starfix.XP and Starfix.Plus positioning solutions. Corrections are derived from the ESAT satellite transmissions and are received by the combined GNSS/L1/L2/Diff antenna.

5.3.1.2 DP2 Position

The DP2 position is also a Starfix.Best Position solution, calculated in a stand-alone StarPack system. Corrections are derived from the AOR-E satellite transmissions and are received by the combined GNSS/L1/L2/Diff antenna.

5.3.2 Survey Position and Navigation Systems

The survey team used two StarPack GNSS Precise Point Positioning (PPP) receivers for the surface positioning during the project. The three single modus calculation position solutions (Starfix.G2, Starfix.HP, and Starfix.Best) from the two StarPack receivers were interfaced to the survey computer by means of a galvanic isolated network connection and were made available for comparison and QC. Differential correction signal redundancy was achieved by cross-linking the two StarPack receivers to provide corrections from different satellite transmissions, if required. Both Starfix.G2 solutions were fed into Starfix.NG by means of a serial connection. All six position solutions, three per receiver, were fed into StarPack QC suite for QC purposes.

All positions and peripheral (heading system, USBL, etc.) data were sent to the navigation computer where all data transformations, offset and survey calculations, and data integration and logging were performed. All data can be graphically and numerically presented on the navigation computer or any other computer connected to the survey network. An off-line computer is available for the survey crew to post-process and report survey data.

The geodetic and the datum transformation parameters used are presented in Section 4.1.

5.3.2.1 Primary Positioning System

The primary survey positioning service used by the survey team was Starfix.G2 solution generated from StarPack Receiver 1. Positions were calculated by using clock and orbit corrections from the Fugro G2 network for both GPS and the Russian Global Navigation Satellite System (GLONASS) space vehicles. These corrections were received by the StarPack via ESAT transmissions and positions were output to the Starfix.NG software package.

5.3.2.2 Secondary Positioning System

The secondary positioning service used by the survey team was Starfix.G2 solution generated from StarPack Receiver 2. Positions were calculated using carrier phase corrections from the Fugro Starfix network. The corrections are received by the StarPack via AOR-E satellite transmissions and positions are output to the Starfix.NG software package.

5.3.2.3 Tertiary Positioning System

The tertiary positioning service used by the survey team was Starfix.HP solution generated from StarPack Receiver 2. Positions were calculated using clock and orbit corrections from the Fugro G2 network for both GPS and GLONASS space vehicles. The corrections are received by the StarPack via AOR-E satellite transmissions and positions are output to the Starfix.NG software package.

5.3.2.4 Quaternary Positioning System

The quaternary positioning service used by the survey team was Starfix.HP solution generated from StarPack Receiver 1. Positions were calculated by using carrier phase corrections from the Fugro Starfix network. The corrections were received by the StarPack via ESAT satellite transmissions and positions were output to the Starfix.NG software package.

5.3.2.5 Quinary and Senary Positioning Systems

The quinary and senary positioning service used by survey were the DP1 and DP2 Starfix.Best Position solutions. These position solutions are sent to the Starfix.NG software for QC.

5.3.2.6 Septenary Position System

The septenary positioning service used by the survey team was Starfix.VBS. This positioning system is a GPS L1 receiver with corrections based on a virtual reference station. The corrections from this virtual reference station are calculated by the corrections provider. The corrections are received by the

StarPack by ESAT satellite transmissions and positions are output to the Starfix.NG software package.

5.3.3 Quality Control

The DGNSS and GNSS PPP data was quality controlled using StarPackQC quality control monitoring application. Real-time QC information was displayed as Time Series graphs, tabulated data and graphical displays such as Sky Plots, Error Ellipses and Lock Time graphs depicting satellite lock status. The quality of DGNSS and GNSS PPP derived position fixing data was monitored whilst logging position data for individual locations and also throughout the entire project period.

An assessment of quality was made based on Position Time Series View with the following time series graphs available to display:

- Standard Deviations (Latitude, Longitude and Height);
- HDOP and VDOP;
- Number of SV's;
- Number of Station's;
- Deltas (Easting, Northing and Height);
- Correction Age;
- F-Test.

An assessment of quality was also made by:

- Data Table Views;
- Satellite Lock Time View,
- Error Ellipses View;
- Satellite Constellation Views.

Within the area of operations the accuracy and repeatability of the Starfix.G2 system was designed to be 0.1 m in the horizontal plane and 0.1 m in the vertical plane with 95 % confidence level.

5.4 Depth Determination

The depth at each location was measured using a combination of the following techniques:

- Echo sounder;
- Conductivity, Temperature, and Depth (CTD) probe;
- Drill string reading;
- USBL reading.

5.4.1 Echo Sounder

An echo sounder determines water depth by measuring the two-way travel time of a sound wave travelling from the transducer to the seafloor and back again. This value is divided by two and the resultant multiplied by the speed of sound through the water column.

The speed of sound values, entered into the echo sounder were determined by the use of CTD probe using the Chen and Millero (1977) formula, which is a function of temperature, pressure and salinity.

Depth values obtained by the echo sounder are corrected for the transducer’s draft. The transducer’s draft is directly entered into the echo sounder. Depth values derived from the echo sounder are obtained while the vessel’s echo sounder transducer is positioned over the sample and/or in situ testing location. A minimum of 100 measurements are used in the analysis, with any outliers being discarded, in accordance with standard statistical procedures.

5.4.2 Depth Measurement

A CTD probe or pressure sensor is secured to the seabed frame to measure water pressure using a Digiquartz sensor. The output from this unit is absolute pressure, i.e. atmospheric pressure plus water pressure. The atmospheric pressure is recorded on deployment and not updated until the probe returns to the surface. Adjustments are therefore necessary to take into account the actual atmospheric pressure changes that occur during the measurement cycle. Barometric pressure is recorded manually at four hourly intervals using the vessel’s barometer. An UNESCO-recognised formula is then used to convert the raw pressure values to depth values.

5.4.3 Drill String Reading

This is a physical measurement made by the drilling personnel and is the total length of pipe used to reach the seafloor. The measurement is corrected for the distance between the drill floor and the water surface (air gap), and corrected for local tidal variations. When operating in deep water, errors due to the effects of current may be induced in the drill string depth measurement.

5.4.4 USBL Reading

This is a measurement made by taking the HiPAP system USBL beacon Z-values (depth) and applying the vertical offset of the frame-mounted beacon above the seabed frame base.

5.5 System Calibration Procedures

Calibrations of all position and depth measuring equipment are carried out prior to sampling and/or in situ testing. This checks that all equipment is operating within acceptable limits and that the accuracy of the logged data is not compromised. Most equipment is permanently installed on the geotechnical drilling vessel and therefore not all calibrations are performed before the start of every sampling and/or in situ testing programme. The most recent calibrations of the equipment are assessed and new calibrations are carried out if deemed necessary.

5.5.1 Offset Measurements

At the start of the mobilisation, offsets from the vessel’s datum (normally the centre of the drill string) to the various DGNSS antennas and other relevant offset points are measured. These measurements are compared with measurements taken from a scaled vessel plan or a previous vessel offset diagram. Seabed frame offsets from the frame’s CRP to its transponder and the Z offset for the CTD probe are also measured. Offsets are entered into the navigation software. The USBL transducer offset is already corrected to the vessel’s CRP by the vessel’s Sonardyne Ranger 2 system programme.

5.5.2 Heading System Alignment Check

Three methods are possible when performing a heading system alignment check alongside. The resulting differences between computed and observed headings are entered into the navigation software as the heading system’s computed minus observed C-O correction.

5.5.2.1 Total Station

These methods of performing a heading system alignment check uses land survey techniques. Reflectors are placed at or near the bow and stern of the vessel on the centreline and their positions fixed at regular intervals. Simultaneous heading system readings and heading observations are taken. The true bearing between the reflectors is calculated and compared to the observed heading system reading.

5.5.2.2 Sun Azimuth

Sun azimuth observations are performed with a total station and a Sun filter, when the Sun is at a maximum elevation of approximately 30º. The vessel’s heading is determined by measuring the angle between the vessel’s centreline and the Sun azimuth and applying this angle to the computed Sun azimuth. The logged heading subtracted from the heading derived from the azimuth of the Sun will give the heading system’s C-O correction.

5.5.2.3 Taped Offsets

This method requires the known heading of the quay and two measurements are taken simultaneously from the quay to the vessel’s centreline. The distance between the two measurements provides a baseline for calculating the angle of the vessel’s centreline relative to the quay, which is then applied to the quay heading to derive the computed grid vessel heading. The convergence is applied to the computed grid heading to obtain the true heading which is compared with the observed heading system's reading in order to obtain the C-O correction.

5.5.3 Positioning System

In order to determine the integrity and reliability of the surface positioning systems, two main procedures are followed:

5.5.3.1 Positioning Verification

The position of the primary DGNSS antenna, in local projection coordinates, and computed from the navigation system, is compared to the position derived by land survey techniques. The total station measures directly to the DGNSS antenna from a known point on the quay. The DGPS antenna position and the position derived from land survey methods are logged simultaneously and should agree to better than 1 m. This process also verifies the geodetic parameters entered into the online survey software.

5.5.3.2 System Comparison

Once the position verification results are acceptable, a position comparison against all position computations is conducted. The antenna positions for all systems are logged and using the heading system and the measured antenna offsets are reduced to the vessel's CRP. The difference in the positions should agree to within 1 m and they are represented as Delta Easting (ΔE) and Delta Northing (ΔN).

5.5.4 Ultra Short Baseline System

A USBL allows the measurement of range and bearing from a vessel-based transceiver to one or more subsea transponders. It generally operates through the phase discrimination of an acoustic signal recorded by three orthogonal transducers combined in one head. A USBL calibration is executed whenever work is carried out on the transducer and at least once a year. Calibrations are carried out in water depths slightly deeper than those in which the operations will occur.

5.5.4.1 Preparation

During the USBL calibration sequence, the vessel must be free to manoeuvre around a stationary transponder. Before starting the actual USBL calibration, it is assumed that:

- The vessel's positioning system has been verified;
- The vessel's heading system alignment has been checked;
- All relevant offsets, including the height of the transponder's transducer above the seafloor, have been measured.

The actual water depth, measured by the echo sounder, and not corrected for tide, should also be known at the calibration site.

A speed of sound profile, determined at the calibration site, is entered into the USBL system before calibration data is collected.

For the USBL calibration a transponder, equipped with a remote controlled release mechanism or a surface buoy, is deployed, clear of all structures and pipelines, in an area with an approximate water depth slightly deeper than the proposed survey area. The surface positioning system is used to navigate the vessel during the calibration.

5.5.4.2 Offset (Spin) Test

The first part of the calibration is carried out to verify the offsets between the USBL system and the navigation system. This is normally done by manoeuvring the vessel directly over a beacon deployed on the seafloor and then rotating the vessel through 360° while logging the surface and USBL position. Any offset errors are displayed as a ‘snail trail’ showing the beacon position describing a circle around the intended beacon position. Alternatively, the vessel is positioned directly over the beacon, and an equal number of fixes are logged while the vessel is heading in each of the four cardinal directions.

The Z-offset is checked by comparing the Z component of the USBL observation and the value from the echo sounder, allowing for beacon height above the seafloor. As the vessel is directly over the seafloor beacon, this minimise any errors due to Range Scale and USBL transducer misalignment.

5.5.4.3 Range Scale, Orientation, Pitch and Roll

This phase of the calibration is carried out with the vessel positioned on the circumference of a circle of radius 1.5 to 2 times the water depth, centred on the beacon. The following describes a calibration with the vessel lying to the north, east, south, and west of the beacon with the vessel maintaining the same north heading. In the case of bad weather, this pattern may be rotated so that the vessel is heading into the current. The surface position of the vessel and the USBL position of the beacon are logged at each cardinal point. Generally a minimum of 100 fixes, at 5 second intervals, are logged at each cardinal point.

When the vessel is due north or south of the beacon and heading due north, roll errors are minimised and pitch errors are observed. Transducer alignment errors will plot the beacon offset to the east or west of its actual position. Range scaling errors will plot the beacon to the north or south of the actual position.

When the vessel moves to a position due east or west of the beacon, while still maintaining a heading of due north, roll errors are observed and pitch errors are minimised. Transducer alignment error will plot the beacon offset from its actual position. Range scaling errors will plot the beacon to the east or west of the actual position.

Any resultant errors will show the beacon plotted in four quadrants. If there are no errors, the beacon position will be shown as a circular scatter plot around the actual position.

The range error consists of a fixed error and the scalar multiplier. Overall it accounts for errors in ray path and speed of sound. The USBL module in Starfix.NG derives a range error value that contains and accounts for the range fixed error.

Starfix.NG computes the errors and displays the results as four parameters:

- Pitch error;
- Roll error;
- Transceiver misalignment;
- Range error.

5.5.4.4 Verification of Results

The calibration results are checked using one of two methods:

i. Two lines are run at right angles and in opposite directions over the top of the beacon.
ii. By conducting a spin test, where the vessel rotates through 360° at a distance of approximately two times the water depth.

In both cases the beacon’s position is continuously logged and should not deviate, within operational parameters, from its calibrated position. A reasonably tight, circular scatter plot a few metres across, depending on the navigation system performance, the USBL system performance, and the depth of water, is an indication of a good calibration result.

APPENDIX 3: RECOVERY LISTS

CONTENTS Plate

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH01-SA
Date: 16/Jul/2016

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	25	3" thin wall with CC and plastic bag. Sample tube bent.
W	02	1.00	100	55	3" thin wall with CC and plastic bag
W	03	2.00	100	60	3" thin wall with CC
W	04	3.00	100	50	3" thin wall with CC
W	05	4.00	100	45	2" thin wall with CC
W	06	4.50	100	50	2" thin wall with CC
W	07	5.50	100	60	2" thin wall with CC
W	08	6.50	100	45	2" thin wall with CC
W	09	7.00	100	55	2" thin wall with CC
W	10	8.00	100	65	2" thin wall with CC
W	11	9.00	100	50	2" thin wall with CC
W	12	10.00	100	60	2" thin wall with CC
W	13	11.00	100	50	2" thin wall with CC
W	14	12.00	100	60	2" thin wall with CC
W	15	13.00	100	40	2" thin wall with CC
W	16	13.50	100	90	3" thin wall with CC
W	17	14.50	100	80	3" thin wall with CC
W	18	15.50	100	75	3" thin wall with CC
LS	19	16.50	100	85	3" thin wall with CC and liner. Sample preserved in liner.
W	20	17.50	100	90	3" thin wall with CC
W	21	18.50	100	80	3" thin wall
W	22	19.50	100	55	3" thin wall
W	23	20.50	100	55	3" thin wall
W	24	21.50	100	80	3" thin wall
W	25	22.50	100	40	3" thin wall
W	26	23.50	100	80	3" thin wall
W	27	24.50	100	90	2" thin wall with CC
W	28	25.50	100	80	2" thin wall with CC
W	29	26.50	100	90	2" thin wall with CC

Borehole Summary: Total meters drilled: 62.0 [m] Total Number of samples: 55 Total Sample Recovery: 3595 [cm]
Total Number of CPT: 4 Total CPT Recovery: 1162 [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No.	N6196
Client:	Rijksdienst voor Ondernemend Nederland (RVO)
Location:	HKZ1-BH01-SA

Date: 16/Jul/2016

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	30	27.50	100	70	2" thin wall with CC
W	31	28.50	100	75	2" thin wall with CC
W	32	29.50	100	80	2" thin wall with CC
W	33	30.50	100	85	2" thin wall with CC
W	34	31.50	100	80	3" thick wall
W	35	32.50	100	55	3" thick wall
W	36	33.50	100	50	3" thick wall
W	37	34.50	100	35	2" thin wall with CC
W	38	35.00	100	55	2" thin wall with CC
W	39	36.00	100	75	2" thin wall with CC
W	40	37.00	100	70	3" thick wall
W	41	38.00	100	60	3" thick wall
W	42	39.00	100	70	3" thick wall
W	43	40.00	100	85	3" thick wall
W	44	41.00	100	65	3" thick wall
W	45	42.00	100	80	3" thick wall
W	46	43.00	100	60	3" thick wall
W	47	44.00	100	70	3" thick wall
W	48	45.00	100	60	3" thick wall
W	49	46.00	100	70	3" thick wall
W	50	47.00	100	70	3" thick wall
W	51	48.00	100	70	3" thick wall
W	52	49.00	100	60	3" thick wall
CPT	01	50.00	300	289	CP10 1706-1924
W	53	53.00	100	85	3" thick wall
CPT	02	54.00	300	294	CP10 1706-1924
W	54	57.00	100	55	3" thick wall
CPT	03	58.00	300	295	CP10 1706-1924
W	55	61.00	100	65	2" thin wall with CC
CPT	04	62.00	300	284	CP10 1706-1924. End of Borehole at 64.84 m BSF.

Borehole Summary:	Total meters drilled: 62.0 [m]	Total Number of samples: 55 Total Sample Recovery: 3595 [cm]
Total Number of CPT: 4	Total CPT Recovery: 1162 [cm]	Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea	
Project No.	N6196	
Client:	Rijksdienst voor Ondernemend Nederland (RVO)	
Location:	HKZ1-BH01-SC	Date: 16/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
SCPT	01	0.00	300	274	CP10 1706-1888
SCPT	02	3.00	300	290	CP10 1706-1888
SCPT	03	6.00	300	290	CP10 1706-1888
SCPT	04	9.00	300	284	CP10 1706-1888
SCPT	05	12.00	300	295	CP10 1706-1888
SCPT	06	15.00	300	299	CP10 1706-1888
SCPT	07	18.00	300	299	CP10 1706-1888
W	01	19.00	100	75	3" thin wall with CC
SCPT	08	21.00	300	300	CP10 1706-1888
SCPT	09	24.00	184	184	CP10 1706-1888
SCPT	10	27.00	300	293	CP10 1706-1888
SCPT	11	30.00	300	291	CP10 1706-1888
SCPT	12	33.00	222	219	CP10 1706-1888
SCPT	13	36.00	300	298	CP10 1706-1888
SCPT	14	39.00	300	300	CP10 1706-1888
W	02	39.00	100	50	3" thin wall
W	03	41.00	100	90	3" thin wall
SCPT	15	42.00	300	295	CP10 1706-1888
W	04	45.00	100	90	3" thin wall. End of borehole HKZ1-BH01-SC at 45.90 m BSF.

Borehole Summary: Total meters drilled: 45.0 [m] Total Number of samples: 4 Total Sample Recovery: 305 [cm]

Total Number of CPT: 15 Total CPT Recovery: 4211 [cm] Total Number of Seismic Velocity Tests: 15

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

GeODin/N6196 - Recovery list - Downhole.GLO FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH02-SA
Date: 14/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	45	3" thin wall with CC and plastic bag
W	02	0.50	95	55	3" thin wall with CC and plastic bag
W	03	1.50	100	50	3" thin wall with CC
W	04	2.50	100	55	3" thin wall with CC
W	05	3.50	100	60	3" thin wall with CC
W	06	4.50	100	65	3" thin wall with CC
W	07	5.50	95	65	3" thin wall with CC
W	08	6.50	90	65	3" thin wall with CC
W	09	7.50	100	55	3" thin wall
W	10	8.50	80	45	2" thin wall with CC
W	11	9.00	90	45	2" thin wall with CC
W	12	9.50	100	50	2" thin wall with CC
W	13	10.50	100	75	3" thin wall
W	14	11.50	100	90	3" thin wall
W	15	12.50	100	75	3" thin wall
W	16	13.50	100	80	3" thin wall
W	17	14.50	95	65	3" thin wall
W	18	15.50	70	55	3" thick wall
W	19	16.50	100	65	2" thin wall with CC
W	20	17.50	100	60	2" thin wall with CC
W	21	18.50	100	90	2" thin wall with CC
W	22	19.50	100	90	2" thin wall with CC
W	23	20.50	100	90	3" thick wall
W	24	21.50	100	90	3" thick wall
W	25	22.50	80	70	2" thin wall with CC
W	26	23.50	100	85	2" thin wall with CC
W	27	24.50	80	80	3" thick wall
W	28	25.50	50	45	3" thick wall
W	29	26.00	100	90	2" thin wall with CC
W	30	27.00	100	80	2" thin wall with CC
W	31	28.00	100	80	2" thin wall with CC

Borehole Summary: Total meters drilled: 49.5 [m] Total Number of samples: 53 Total Sample Recovery: 3700 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH02-SA

Date: 14/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	32	29.00	100	90	2" thin wall with CC
W	33	30.00	100	80	2" thin wall with CC
W	34	31.00	100	85	2" thin wall with CC
W	35	32.00	100	75	2" thin wall with CC
W	36	33.00	100	80	2" thin wall with CC
W	37	34.00	100	75	2" thin wall with CC
LS	38	35.00	100	70	3" thin wall with CC and liner. Sample preserved in liner.
W	39	36.00	95	90	3" thin wall with CC
W	40	37.00	70	50	3" thin wall with CC
W	41	38.00	95	55	2" thin wall with CC
W	42	39.00	100	80	2" thin wall with CC
W	43	40.00	100	65	2" thin wall with CC
W	44	41.00	95	50	2" thin wall with CC
W	45	42.00	60	45	2" thin wall with CC
W	46	42.50	90	55	2" thin wall with CC
W	47	43.50	100	75	2" thin wall with CC
W	48	44.50	100	75	3" thick wall
W	49	45.50	90	70	3" thick wall
W	50	46.50	100	90	3" thick wall
W	51	47.50	100	75	3" thick wall
W	52	48.50	100	75	3" thick wall
W	53	49.50	95	85	3" thick wall, End of Borehole at 50.35 m BSF.

Borehole Summary: Total meters drilled: 49.5 [m] Total Number of samples: 53 Total Sample Recovery: 3700 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

GeODin/N6196 - Recovery list - Downhole.GLO FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH03-SA
Date: 13/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	30	3" thin wall with CC and plastic bag
W	02	0.50	100	40	3" thin wall with CC and plastic bag
W	03	1.00	100	35	3" thin wall with CC
W	04	1.50	100	45	3" thin wall with CC
W	05	2.00	100	35	3" thin wall with CC
W	06	2.50	100	40	3" thin wall with CC
W	07	3.00	100	45	3" thin wall with CC
W	08	4.00	100	50	3" thin wall with CC
W	09	5.00	100	40	3" thin wall with CC
W	10	5.50	100	25	2" thin wall with CC
W	11	6.00	100	30	2" thin wall with CC
W	12	6.50	100	30	2" thin wall with CC
W	13	7.00	100	30	2" thin wall with CC
W	14	7.50	100	45	2" thin wall with CC
W	15	8.00	100	45	2" thin wall with CC
W	16	9.00	100	30	2" thin wall with CC
W	17	9.50	100	20	2" thin wall with CC
W	18	10.00	100	30	2" thin wall with CC
W	19	10.50	100	50	2" thin wall with CC
W	20	11.50	100	40	2" thin wall with CC
W	21	12.00	100	0	3" thin wall
W	21A	12.00	100	60	3" thin wall with CC
W	22	13.00	100	65	3" thin wall
W	23	14.00	100	80	3" thin wall
W	24	15.00	100	70	3" thin wall
W	25	16.00	100	75	3" thin wall
W	26	17.00	100	70	3" thin wall
W	27	18.00	100	70	3" thin wall
W	28	19.00	100	65	3" thin wall
W	29	20.00	100	75	2" thin wall with CC
W	30	21.00	100	80	2" thin wall with CC

Borehole Summary: Total meters drilled: 63.5 [m] Total Number of samples: 62 Total Sample Recovery: 3860 [cm]
Total Number of CPT: 5 Total CPT Recovery: 1312 [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH03-SA
Date: 13/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	31	22.00	100	80	2" thin wall with CC
W	32	23.00	100	75	2" thin wall with CC
W	33	24.00	100	85	2" thin wall with CC
W	34	25.00	100	80	2" thin wall with CC
W	35	26.00	100	80	2" thin wall with CC
W	36	27.00	100	75	2" thin wall with CC
W	37	28.00	100	85	2" thin wall with CC
W	38	29.00	100	75	2" thin wall with CC
W	39	30.00	100	80	2" thin wall with CC
W	40	31.00	100	70	2" thin wall with CC
W	41	32.00	100	80	2" thin wall with CC
W	42	33.00	100	75	2" thin wall with CC
W	43	34.00	100	80	2" thin wall with CC
W	44	35.00	100	70	2" thin wall with CC
W	45	36.00	100	75	2" thin wall with CC
W	46	37.00	100	75	2" thin wall with CC
W	47	38.00	100	75	2" thin wall with CC
W	48	39.00	100	75	3" thin wall
W	49	40.00	100	60	3" thin wall
W	50	41.00	100	80	3" thin wall
W	51	42.00	100	70	3" thin wall
W	52	43.00	100	85	3" thick wall
W	53	44.00	100	65	3" thick wall
W	54	45.00	100	70	3" thick wall
W	55	46.00	100	85	3" thick wall
W	56	47.00	100	85	3" thick wall
W	57	48.00	100	90	3" thick wall
W	58	49.00	100	90	3" thick wall
CPT	1	50.00	128	123	CP10 1706-1924
CPT	2	51.50	300	299	CP10 1706-1924
W	59	54.50	100	80	3" thin wall with CC

Borehole Summary: Total meters drilled: 63.5 [m] Total Number of samples: 62 Total Sample Recovery: 3860 [cm]
Total Number of CPT: 5 Total CPT Recovery: 1312 [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No.	N6196
Client:	Rijksdienst voor Ondernemend Nederland (RVO)
Location:	HKZ1-BH03-SA

Date: 13/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
CPT	3	55.50	300	294	CP10 1706-1924
W	60	58.50	100	90	3" thick wall
CPT	4	59.50	300	298	CP10 1706-1924
W	61	62.50	100	75	3" thick wall
CPT	5	63.50	300	298	CP10 1706-1924. End of Borehole HKZ1-BH03-SA at 66.50 m

Borehole Summary:

Total Number of CPT: 5

Total meters drilled: 63.5 [m]

Total CPT Recovery: 1312 [cm]

Total Number of samples: 62

Total Sample Recovery: 3860 [cm]

Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH03-SC

Date: 14/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
SCPT	01	0.00	300	276	CP10 1706-1888
SCPT	02	3.00	300	289	CP10 1706-1888
SCPT	03	6.00	300	290	CP10 1706-1888
SCPT	04	9.00	300	294	CP10 1706-1888
SCPT	05	12.00	300	287	CP10 1706-1888
W	01	14.00	100	80	3" thin wall with CC
SCPT	06	15.00	300	288	CP10 1706-1888
SCPT	07	18.00	300	296	CP10 1706-1888
SCPT	08	21.00	300	291	CP10 1706-1888
SCPT	09	24.00	300	291	CP10 1706-1888
SCPT	10	27.00	300	293	CP10 1706-1888
SCPT	11	30.00	300	293	CP10 1706-1888
SCPT	12	33.00	300	292	CP10 1706-1888
W	02	33.00	100	70	3" thin wall with CC
SCPT	13	36.00	300	292	CP10 1706-1888
SCPT	14	39.00	300	293	CP10 1706-1888
W	03	40.00	95	75	3" thin wall with CC
SCPT	15	42.00	300	294	CP10 1706-1888
SCPT	16	45.00	300	294	CP10 1706-1888
W	04	47.00	100	85	3" thin wall with CC. End of borehole at 47.94 m BSF.

Borehole Summary: Total meters drilled: 47.0 [m] Total Number of samples: 4 Total Sample Recovery: 310 [cm]
Total Number of CPT: 16 Total CPT Recovery: 4653 [cm] Total Number of Seismic Velocity Tests: 16

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH04-SA

Date: 12/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	55	3" thin wall with CC and plastic bag
W	02	1.00	95	55	3" thin wall with CC and plastic bag
W	03	2.00	95	60	3" thin wall with CC
W	04	3.00	90	40	3" thin wall with CC
W	05	3.50	95	45	3" thin wall with CC
W	06	4.00	100	40	3" thin wall with CC
W	07	4.50	100	40	3" thin wall with CC
W	08	5.00	100	50	3" thin wall with CC
W	09	6.00	100	60	3" thin wall with CC
W	10	7.00	90	60	3" thin wall with CC
W	11	8.00	80	55	3" thin wall with CC. Cutting shoe damaged.
W	12	9.00	100	55	2" thin wall with CC
W	13	10.00	100	60	2" thin wall with CC
W	14	11.00	100	60	2" thin wall with CC
W	15	12.00	100	70	2" thin wall with CC
W	16	13.00	100	85	2" thin wall with CC
W	17	14.00	100	25	2" thin wall with CC
W	18	14.50	100	45	2" thin wall with CC. Lower section of sample lost during sample retrieval. Drilled 1 m opposed to 0.5 m to improve sample recovery.
W	19	15.50	100	80	3" thin wall
W	20	16.50	100	75	3" thin wall
W	21	17.50	100	60	3" thin wall with CC
W	22	18.50	100	80	3" thin wall with CC
W	23	19.50	100	70	3" thin wall with CC
W	24	20.50	100	80	3" thin wall with CC
W	25	21.50	100	90	3" thin wall
W	26	22.50	100	85	3" thin wall with CC
W	27	23.50	100	90	3" thin wall with CC
W	28	24.50	100	90	3" thin wall with CC
W	29	25.50	100	75	3" thin wall with CC

Borehole Summary: Total meters drilled: 50.0 [m] Total Number of samples: 56 Total Sample Recovery: 3470 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH04-SA

Date: 12/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	30	26.50	100	85	3" thin wall with CC
W	31	27.50	100	80	3" thin wall with CC
W	32	28.50	100	90	3" thin wall with CC
W	33	29.50	100	65	3" thin wall with CC
W	34	30.50	95	60	3" thin wall with CC
W	35	31.50	100	75	3" thin wall with CC
W	36	32.50	100	65	3" thin wall with CC
W	37	33.50	80	50	3" thin wall with CC
W	38	34.50	55	40	3" thin wall with CC
W	39	35.00	100	55	2" thin wall with CC
W	40	36.00	100	50	2" thin wall with CC
W	41	37.00	100	70	2" thin wall with CC
W	42	38.00	100	50	2" thin wall with CC
W	43	39.00	100	55	2" thin wall with CC
W	44	40.00	75	45	2" thin wall with CC
W	45	40.50	100	60	2" thin wall with CC
W	46	41.50	100	50	2" thin wall with CC
W	47	42.50	90	55	2" thin wall with CC
W	48	43.50	80	50	2" thin wall with CC
W	49	44.50	65	40	2" thin wall with CC
W	50	45.00	60	45	2" thin wall with CC
W	51	45.50	55	45	2" thin wall with CC
W	52	46.00	100	85	2" thin wall with CC
W	53	47.00	100	75	2" thin wall with CC
W	54	48.00	90	60	2" thin wall with CC
W	55	49.00	90	55	2" thin wall with CC
W	56	50.00	100	80	2" thin wall with CC. End of borehole HKZ1-BH04-SA at 50.80 m BSF.

Borehole Summary:	Total meters drilled: 50.0 [m]	Total Number of samples: 56	Total Sample Recovery: 3470 [cm]
Total Number of CPT:	Total CPT Recovery: [cm]	Total Number of Seismic Velocity Tests:	

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

GeODin/N6196 - Recovery list - Downhole.GLO FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH05-SA
Date: 15/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	55	3" thin wall with CC and plastic bag
W	02	1.00	100	60	3" thin wall with CC and plastic bag
W	03	2.00	100	70	3" thin wall with CC
W	04	3.00	100	70	3" thin wall with CC
W	05	4.00	100	60	3" thin wall with CC
W	06	5.00	100	55	2" thin wall with CC
W	07	6.00	100	60	2" thin wall with CC
W	08	7.00	100	55	2" thin wall with CC
W	09	8.00	100	60	2" thin wall with CC
W	10	9.00	100	50	2" thin wall with CC
W	11	10.00	100	30	2" thin wall with CC
W	12	10.50	100	30	2" thin wall with CC
W	13	11.00	100	30	2" thin wall with CC
W	14	11.50	100	25	2" thin wall with CC
W	15	12.00	100	40	2" thin wall with CC
W	16	12.50	100	30	2" thin wall with CC
W	17	13.00	100	70	2" thin wall with CC
W	18	14.00	100	85	2" thin wall with CC
W	19	15.00	100	85	2" thin wall with CC
W	20	16.00	100	55	2" thin wall with CC
W	21	17.00	100	75	3" thick wall
W	22	18.00	100	50	3" thin wall
W	23	19.00	100	90	3" thin wall
W	24	20.00	100	75	3" thick wall
W	25	21.00	100	15	2" thin wall with CC. By mistake, 1 m drill-out instead of 0.5 m.
W	26	22.00	100	80	3" thin wall with CC. By mistake, 0.5 m drill-out instead of 1 m.
W	27	23.00	50	40	3" thin wall with CC. Start depth adjusted from 22.5 to 23.0 m. Penetration reduced.
W	28	23.50	100	70	3" thin wall with CC
W	29	24.50	100	80	3" thin wall with CC

Borehole Summary: Total meters drilled: 49.5 [m] Total Number of samples: 54 Total Sample Recovery: 3545 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH05-SA
Date: 15/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	30	25.50	100	80	3" thin wall with CC
W	31	26.50	100	90	3" thin wall with CC
W	32	27.50	100	80	2" thin wall with CC
W	33	28.50	100	60	2" thin wall with CC
W	34	29.50	100	70	2" thin wall with CC
W	35	30.50	100	80	2" thin wall with CC
W	36	31.50	100	60	2" thin wall with CC
W	37	32.50	100	55	2" thin wall with CC
W	38	33.50	100	55	2" thin wall with CC
W	39	34.50	100	60	2" thin wall with CC
W	40	35.50	100	85	2" thin wall with CC
W	41	36.50	100	85	2" thin wall with CC
W	42	37.50	100	75	2" thin wall with CC
W	43	38.50	100	75	2" thin wall with CC
W	44	39.50	100	80	2" thin wall with CC
W	45	40.50	100	75	2" thin wall with CC
W	46	41.50	100	75	2" thin wall with CC
W	47	42.50	100	90	2" thin wall with CC
W	48	43.50	100	85	2" thin wall with CC
W	49	44.50	100	75	2" thin wall with CC
W	50	45.50	100	75	2" thin wall with CC
W	51	46.50	100	80	2" thin wall with CC
W	52	47.50	100	75	2" thin wall with CC
W	53	48.50	100	90	2" thin wall with CC
W	54	49.50	100	85	2" thin wall with CC. End of borehole at 50.35 m BSF.

Borehole Summary:	Total meters drilled: 49.5 [m]	Total Number of samples: 54	Total Sample Recovery: 3545 [cm]
Total Number of CPT:	Total CPT Recovery: [cm]	Total Number of Seismic Velocity Tests:	

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

GeODin/N6196 - Recovery list - Downhole GLO   FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH06-SA
Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	65	3" thin wall with CC and plastic bag
W	02	1.00	100	60	3" thin wall with CC and plastic bag
W	03	2.00	100	65	3" thin wall with CC and plastic bag
W	04	3.00	100	60	3" thin wall with CC
W	05	4.00	100	55	3" thin wall with CC
W	06	5.00	95	50	3" thin wall with CC
W	07	6.00	95	45	2" thin wall with CC
W	08	6.50	100	50	2" thin wall with CC
W	09	7.50	100	40	2" thin wall with CC
W	10	8.00	100	40	2" thin wall with CC
W	11	8.50	100	35	2" thin wall with CC
W	12	9.00	100	50	2" thin wall with CC
W	13	10.00	95	35	2" thin wall with CC
W	14	10.50	100	40	2" thin wall with CC
W	15	11.00	100	45	2" thin wall with CC
W	16	11.50	100	50	2" thin wall with CC
W	17	12.50	100	50	2" thin wall with CC
W	18	13.50	100	60	2" thin wall with CC
W	19	14.50	100	70	2" thin wall with CC
W	20	15.50	100	85	3" thin wall
W	21	16.50	80	60	3" thin wall
W	22	17.50	100	65	3" thin wall
W	23	18.50	100	25	3" thin wall
W	24	19.00	100	50	3" thin wall with CC
W	25	20.00	100	70	3" thin wall with CC
W	26	21.00	100	80	3" thin wall with CC
W	27	22.00	100	70	3" thin wall with CC
W	28	23.00	100	85	3" thin wall with CC
W	29	24.00	100	55	3" thin wall
W	30	25.00	100	95	3" thin wall
W	31	26.00	100	80	3" thin wall

Borehole Summary:	Total meters drilled: 64.5 [m]	Total Number of samples: 60 Total Sample Recovery: 3765 [cm]
Total Number of CPT: 6	Total CPT Recovery: 998 [cm]	Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No.	N6196
Client:	Rijksdienst voor Ondernemend Nederland (RVO)
Location:	HKZ1-BH06-SA

Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	32	27.00	100	90	3" thin wall
W	33	28.00	95	70	3" thin wall
W	34	29.00	100	75	3" thick wall
W	35	30.00	95	75	3" thick wall
W	36	31.00	95	80	3" thick wall
W	37	32.00	70	55	3" thick wall
W	38	33.00	100	65	2" thin wall with CC
W	39	34.00	95	60	2" thin wall with CC
W	40	35.00	100	35	2" thin wall with CC
W	41	35.50	60	45	3" thick wall
W	42	36.00	80	30	3" thick wall
W	43	36.50	90	60	3" thick wall
W	44	37.50	80	65	3" thick wall
W	45	38.50	95	85	3" thick wall
W	46	39.50	100	80	3" thick wall
W	47	40.50	100	60	3" thick wall
W	48	41.50	100	80	3" thick wall
W	49	42.50	95	80	3" thick wall
W	50	43.50	100	80	3" thick wall
W	51	44.50	100	85	3" thick wall
W	52	45.50	100	75	3" thick wall
W	53	46.50	95	80	3" thick wall
W	54	47.50	100	80	3" thick wall
W	55	48.50	100	70	3" thick wall
W	56	49.50	90	85	3" thick wall
CPT	1	50.50	300	297	CP10 1706-2149
W	57	53.50	100	90	3" thick wall
W	58	54.50	85	55	3" thick wall
CPT	2	55.50	65	61	CP10 1706-2149
CPT	3	56.50	230	223	CP10 1706-2149
W	59	59.00	55	35	2" thin wall with CC

Borehole Summary: Total meters drilled: 64.5 [m] Total Number of samples: 60 Total Sample Recovery: 3765 [cm]

Total Number of CPT: 6 Total CPT Recovery: 998 [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH06-SA
Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
CPT	4	59.50	80	73	CP10 1706-2149
CPT	5	60.50	60	54	CP10 1706-2149
CPT	6	61.50	300	290	CP10 1706-2149
W	60	64.50	70	55	2" thin wall with CC. End of borehole at 65.05 m BSF.

Borehole Summary: Total meters drilled: 64.5 [m] Total Number of samples: 60 Total Sample Recovery: 3765 [cm]
Total Number of CPT: 6 Total CPT Recovery: 998 [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No.	N6196
Client:	Rijksdienst voor Ondernemend Nederland (RVO)
Location:	HKZ1-BH06-SC

Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
SCPT	01	0.00	300	292	CP10 1706-2366
SCPT	02	3.00	300	292	CP10 1706-2366. End of borehole at 5.92 m BSF.

Borehole Summary:
Total meters drilled: 3.0 [m]
Total Number of samples:
Total Sample Recovery: [cm]

Total Number of CPT: 2
Total CPT Recovery: 584 [cm]
Total Number of Seismic Velocity Tests: 2

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	Hollandse Kust (zuid) WFZ, WFS I - Dutch Sector, North Sea
Project No.	N6196
Client:	Rijksdienst voor Ondernemend Nederland (RVO)
Location:	HKZ1-BH06A-SC

Date: 17/Jul/2016

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
SCPT	01	6.00	300	292	CP10 1706-1888
SCPT	02	9.00	300	294	CP10 1706-1888
SCPT	03	12.00	300	287	CP10 1706-1888
SCPT	04	15.00	300	294	CP10 1706-1888
W	01	17.00	100	75	3" thin wall
SCPT	05	18.00	300	299	CP10 1706-1888
SCPT	06	21.00	300	294	CP10 1706-1888
SCPT	07	24.00	300	294	CP10 1706-1888
W	02	25.00	100	70	3" thin wall
SCPT	08	27.00	300	294	CP10 1706-1888
SCPT	09	30.00	300	295	CP10 1706-1888
SCPT	10	33.00	300	290	CP10 1706-1888
SCPT	11	36.00	300	293	CP10 1706-1888
SCPT	12	39.00	300	293	CP10 1706-1888
W	03	39.00	100	90	3" thin wall
SCPT	13	42.00	300	295	CP10 1706-1888
W	04	43.00	100	90	3" thin wall
SCPT	14	45.00	300	298	CP10 1706-1888. End of borehole HKZ1-BH06A-SC at 47.98 m BSF.

Borehole Summary:	Total meters drilled: 45.0 [m]	Total Number of samples: 4	Total Sample Recovery: 325 [cm]
Total Number of CPT: 14	Total CPT Recovery: 4112 [cm]	Total Number of Seismic Velocity Tests: 14	

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

GeODin/N6196 - Recovery list - Downhole.GLO FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH07-SA

Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	50	3" thin wall with CC
W	02	1.00	100	50	3" thin wall with CC and plastic bag
W	03	2.00	90	50	3" thin wall with CC and plastic bag
W	04	3.00	90	60	3" thin wall with CC and plastic bag
W	05	4.00	95	50	3" thin wall with CC and plastic bag
W	06	5.00	100	45	2" thin wall with CC and plastic bag
W	07	5.50	100	40	2" thin wall with CC and plastic bag
W	08	6.00	95	45	2" thin wall with CC and plastic bag
W	09	6.50	90	50	2" thin wall with CC and plastic bag
W	10	7.50	75	40	2" thin wall with CC
W	11	8.00	75	40	2" thin wall with CC
W	12	8.50	65	30	2" thin wall with CC
W	13	9.00	70	40	2" thin wall with CC
W	14	9.50	100	45	2" thin wall with CC
W	15	10.00	100	45	2" thin wall with CC
W	16	10.50	100	55	2" thin wall with CC
W	17	11.50	90	35	2" thin wall with CC
W	18	12.00	100	35	2" thin wall with CC
W	19	12.50	100	40	3" thin wall. Tube damaged.
W	20	13.00	100	85	3" thick wall
W	21	14.00	100	70	3" thin wall with CC
W	22	15.00	100	70	3" thin wall with CC
W	23	16.00	100	30	3" thin wall with CC. CC damaged.
W	24	17.00	100	75	3" thin wall with CC
W	25	18.00	100	70	3" thin wall with CC
W	26	19.00	100	70	3" thin wall with CC
W	27	20.00	100	70	3" thin wall with CC
W	28	21.00	90	70	3" thin wall
W	29	22.00	95	80	3" thin wall
W	30	23.00	95	75	3" thin wall
W	31	24.00	95	85	3" thin wall

Borehole Summary: Total meters drilled: 50.0 [m] Total Number of samples: 60 Total Sample Recovery: 3425 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title:	HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA	
Project No.	N6196	
Client:	Rijksdienst voor Ondernemend Nederland (RVO)	
Location:	HKZ1-BH07-SA	Date: 10/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	32	25.00	95	85	3" thick wall
W	33	26.00	85	60	3" thin wall
W	34	27.00	100	85	2" thin wall with CC
W	35	28.00	100	70	2" thin wall with CC
W	36	29.00	90	55	2" thin wall with CC
W	37	30.00	100	80	2" thin wall with CC
W	38	31.00	100	75	2" thin wall with CC
W	39	32.00	95	70	2" thin wall with CC
W	40	33.00	100	50	2" thin wall with CC
W	41	34.00	100	50	2" thin wall with CC
W	42	35.00	100	40	2" thin wall with CC
W	43	35.50	100	40	2" thin wall with CC
W	44	36.00	100	50	2" thin wall with CC
W	45	37.00	100	55	2" thin wall with CC
W	46	38.00	100	20	2" thin wall with CC
W	47	38.50	100	20	2" thin wall with CC
W	48	39.00	100	25	2" thin wall with CC
W	49	39.50	100	50	2" thin wall with CC
W	50	40.50	100	45	2" thin wall with CC
W	51	41.00	100	65	2" thin wall with CC
W	52	42.00	100	90	2" thin wall with CC
W	53	43.00	100	85	2" thin wall with CC
W	54	44.00	100	65	2" thin wall with CC
W	55	45.00	100	70	2" thin wall with CC
W	56	46.00	100	70	2" thin wall with CC
W	57	47.00	100	60	2" thin wall with CC
W	58	48.00	100	60	2" thin wall with CC
W	59	49.00	100	70	2" thin wall with CC
W	60	50.00	100	70	2" thin wall with CC. End of borehole at 50.70 m BSF.

Borehole Summary:	Total meters drilled: 50.0 [m]	Total Number of samples: 60 Total Sample Recovery: 3425 [cm]
Total Number of CPT:	Total CPT Recovery: [cm]	Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:	Fugro Representative:
Name: P. Watson / J. van Houten	Name: M. Klein

RECOVERY LIST (DOWNHOLE MODE)

Project Title: HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH08-SA
Date: 09/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	01	0.00	100	50	3" thin wall with CC and plastic bag
W	02	1.00	100	65	3" thin wall with CC and plastic bag
W	03	2.00	100	45	3" thin wall with CC and plastic bag
W	04	2.50	100	50	3" thin wall with CC and plastic bag
W	05	3.50	100	55	3" thin wall with CC and plastic bag
W	06	4.50	100	60	3" thin wall with CC and plastic bag
W	07	5.50	95	60	3" thin wall with CC
W	08	6.50	95	40	3" thin wall with CC
W	09	7.00	95	50	3" thin wall with CC
W	10	8.00	100	50	2" thin wall with CC
W	11	9.00	100	50	2" thin wall with CC
W	12	10.00	80	50	2" thin wall with CC
W	13	11.00	100	70	3" thin wall. Cutting shoe damaged.
W	14	12.00	100	70	3" thin wall
W	15	13.00	100	85	3" thin wall
W	16	14.00	100	45	3" thin wall
W	17	14.50	100	60	3" thin wall
W	18	15.50	100	70	3" thin wall with CC
W	19	16.50	100	70	3" thin wall with CC
W	20	17.50	100	60	3" thin wall with CC
W	21	18.50	100	60	3" thin wall with CC
W	22	19.50	100	60	3" thin wall with CC
W	23	20.50	100	70	3" thin wall with CC
W	24	21.50	100	65	3" thin wall with CC
W	25	22.50	100	60	3" thin wall with CC
W	26	23.50	100	60	3" thin wall with CC
W	27	24.50	100	60	3" thin wall with CC
W	28	25.50	100	65	3" thin wall with CC
W	29	26.50	100	70	3" thin wall with CC
W	30	27.50	100	70	3" thin wall with CC
W	31	28.50	100	70	3" thin wall with CC

Borehole Summary: Total meters drilled: 50.0 [m] Total Number of samples: 56 Total Sample Recovery: 3370 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:

Name: P. Watson / J. van Houten

Fugro Representative:

Name: M. Klein

GeODin/N6196 - Recovery list - Downhole.GLO FEBV/GEN/FOR/011 ISSUE GeODin01

RECOVERY LIST (DOWNHOLE MODE)

Project Title: HOLLANDSE KUST (ZUID) WFZ, WFS I - DUTCH SECTOR, NORTH SEA
Project No. N6196
Client: Rijksdienst voor Ondernemend Nederland (RVO)
Location: HKZ1-BH08-SA
Date: 09/Jul/16

Type	Number	Depth [m]	Penetration [cm]	Recovery [cm]	Remarks
W	32	29.50	100	65	3" thin wall with CC
W	33	30.50	100	65	3" thin wall with CC
W	34	31.50	100	70	3" thin wall with CC
W	35	32.50	100	40	3" thin wall with CC
W	36	33.00	100	65	3" thin wall with CC
W	37	34.00	100	65	3" thin wall with CC
W	38	35.00	100	35	3" thin wall with CC
W	39	35.50	100	25	3" thin wall with CC
W	40	36.00	100	35	3" thin wall with CC
W	41	36.50	100	25	3" thin wall with CC
W	42	37.00	100	65	2" thin wall with CC
W	43	38.00	100	60	2" thin wall with CC
W	44	39.00	100	80	2" thin wall with CC
W	45	40.00	100	80	2" thin wall with CC
W	46	41.00	100	40	2" thin wall with CC
W	47	41.50	100	80	2" thin wall with CC
W	48	42.50	100	80	2" thin wall with CC
W	49	43.50	100	80	2" thin wall with CC
W	50	44.50	100	10	2" thin wall with CC
W	51	45.00	100	80	2" thin wall with CC
W	52	46.00	100	80	2" thin wall with CC
W	53	47.00	100	70	2" thin wall with CC
W	54	48.00	100	70	2" thin wall with CC
W	55	49.00	100	70	2" thin wall with CC
W	56	50.00	100	70	2" thin wall with CC. End of borehole at 50.70 m BSF.

Borehole Summary: Total meters drilled: 50.0 [m] Total Number of samples: 56 Total Sample Recovery: 3370 [cm]
Total Number of CPT: Total CPT Recovery: [cm] Total Number of Seismic Velocity Tests:

Remarks:

Client Representative:
Name: P. Watson / J. van Houten

Fugro Representative:
Name: M. Klein

APPENDIX 4: CONE CALIBRATION CERTIFICATES

CONTENTS Plate

CALIBRATION CERTIFICATE

Applicant	**Fugro Engineers B.V.**
	Prismastraat 4
	2631 RT, Nootdorp
	The Netherlands

Certificate Number
FCN16006765

Instrument	**Cone Penetrometer**
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888

Page 1 of 9

Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration date 03-May-2016

Calibrate before 03-May-2017

Calibrated Sensor	**Manufacturer / Type**	**Calibrated Range**	**Maximum Rating**	**Procedure**
Cone [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Cone+Fric. [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Pore 2 [Pressure]	Keller PA-8/200bar (8467.8)	0 to 20 MPa	0 to 30 MPa	FEBV.CAL.PRO.004
Slope [Inclination]	ADXL	0 to 15 Deg	0 to 20 Deg	FEBV.CAL.PRO.005

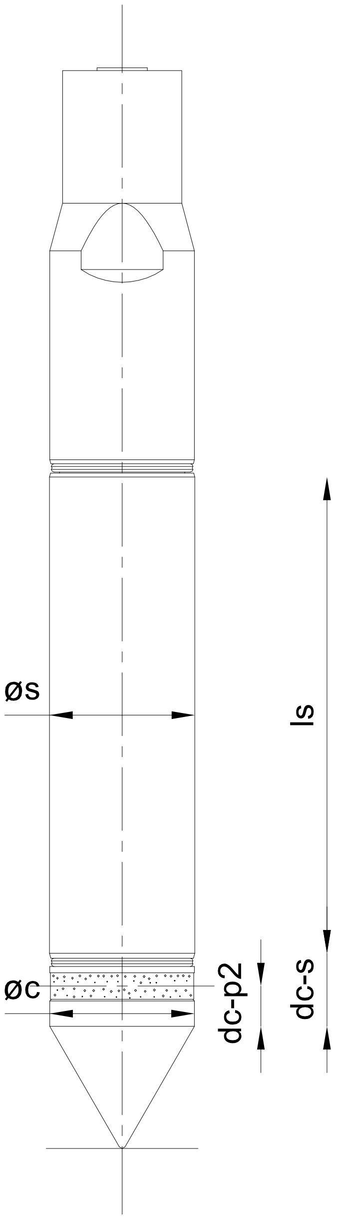
Nootdorp, 03-May-2016

Gerry Sinjorgo
Manager Transducer Workshop

TYPICAL DIMENSIONS

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888

Certificate Number
FCN16006765



Typical Dimensions

Ac	Cross-sectional projected area of the cone	0.001 m²
As	Surface area of the friction sleeve	0.015 m²
af	Cone net area ratio	0.75
scf	Friction sleeve net area ratio	0
øc	Diameter of the cylindrical part of the cone	35.8 mm
øs	Diameter of the friction sleeve	36.1 mm
ls	Length of the friction sleeve	132.7 mm
dc-s	Cone - friction sleeve distance	13.5 mm
dc-p2	Cone - pore 2 distance	5 mm

Diagram is not to scale

This certificate shall not be reproduced, except in full, without written permission of Fugro

CONE CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.003•Fw+0.015 [kN]

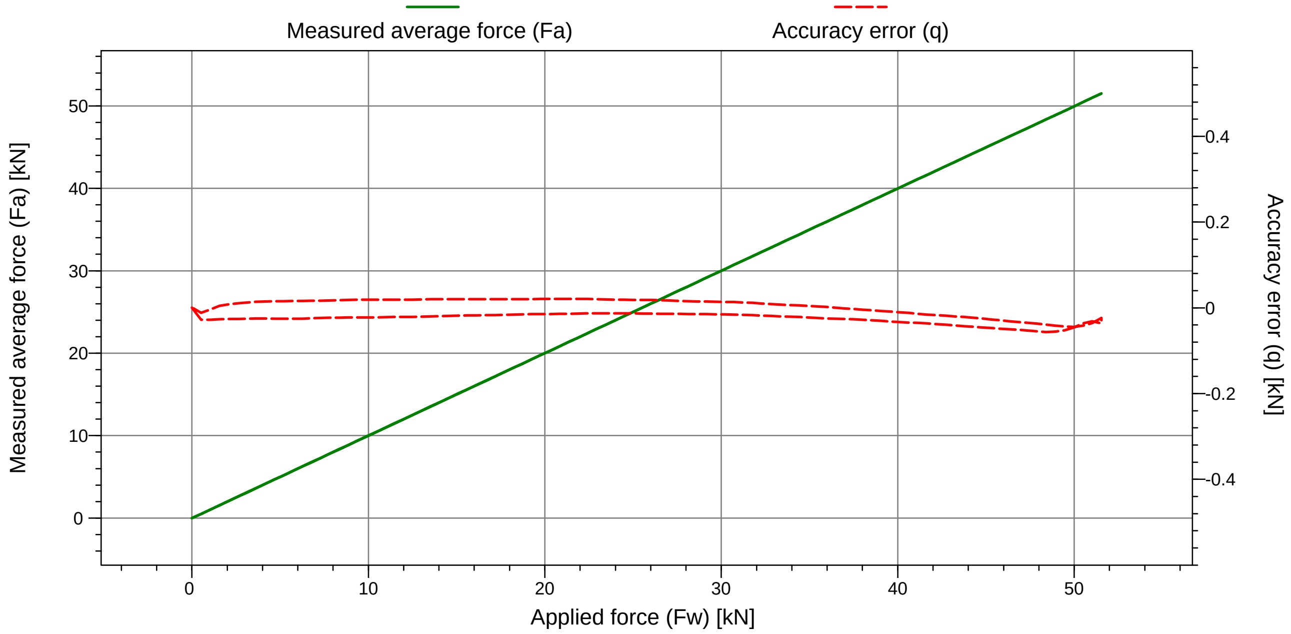
Calibration Details	
Calibration Date	03 May 2016 10:43:11
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Page 3 of 9

Sensor	
Channel	Cone [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.045
Max repeatability error (b)	[kN]	0.009
Max reversibility error (v)	[kN]	0.041
Zero load error (Fc0)	[kN]	0.001
Zero load offset (F0)	[kN]	0.004
Resolution	[kN]	3.71E-05
Noise RMS	[kN]	0.001



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	-0.002	0.001	0.001	0.000	0.000	0.002	
10.000	9.977	9.978	9.978	9.978	-0.022	0.001	0.041
20.000	19.983	19.986	19.987	19.985	-0.015	0.004	0.035
30.000	29.983	29.985	29.987	29.985	-0.015	0.003	0.029
40.000	39.965	39.967	39.970	39.967	-0.033	0.005	0.023
50.000	49.959	49.950	49.955	49.955	-0.045	0.009	
40.000	39.989	39.990	39.991	39.990	-0.010	0.002	
30.000	30.013	30.014	30.015	30.014	0.014	0.002	
20.000	20.021	20.021	20.020	20.021	0.021	0.000	
10.000	10.019	10.019	10.019	10.019	0.019	0.001	
0.000	0.002	0.003	-0.003	0.001	0.001	0.005	

CONE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

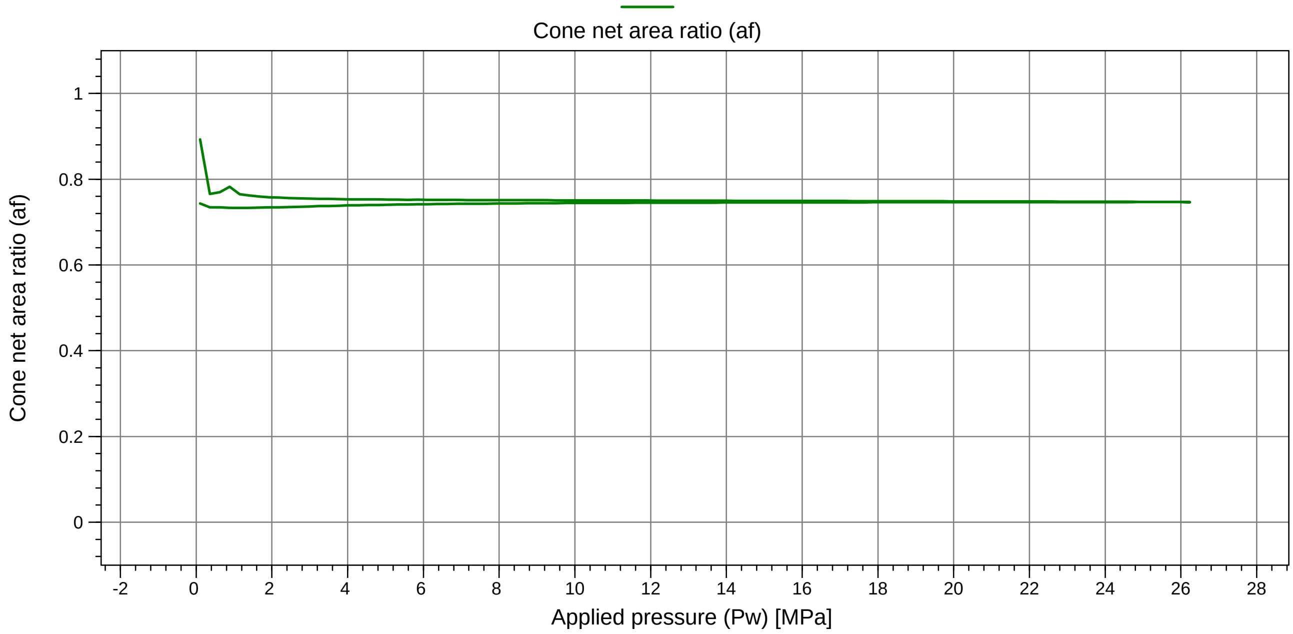
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 14:39:36
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Characteristics	**Unit**	**Value**
Cone net area ratio (af)	[-]	0.75

The cone net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) [MPa]	**Measured cone net area ratio 1 (af,1)**	**Measured cone net area ratio 2 (af,2)**	**Measured cone net area ratio 3 (af,3)**	**Measured average cone net area ratio (af)**
4.000	0.738	0.739	0.739	0.739
8.000	0.743	0.743	0.744	0.743
12.000	0.745	0.745	0.745	0.745
16.000	0.746	0.746	0.746	0.746
20.000	0.746	0.746	0.746	0.746
16.000	0.749	0.749	0.749	0.749
12.000	0.750	0.750	0.750	0.750
8.000	0.751	0.751	0.751	0.751
4.000	0.753	0.753	0.753	0.753

CONE+FRIC. CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

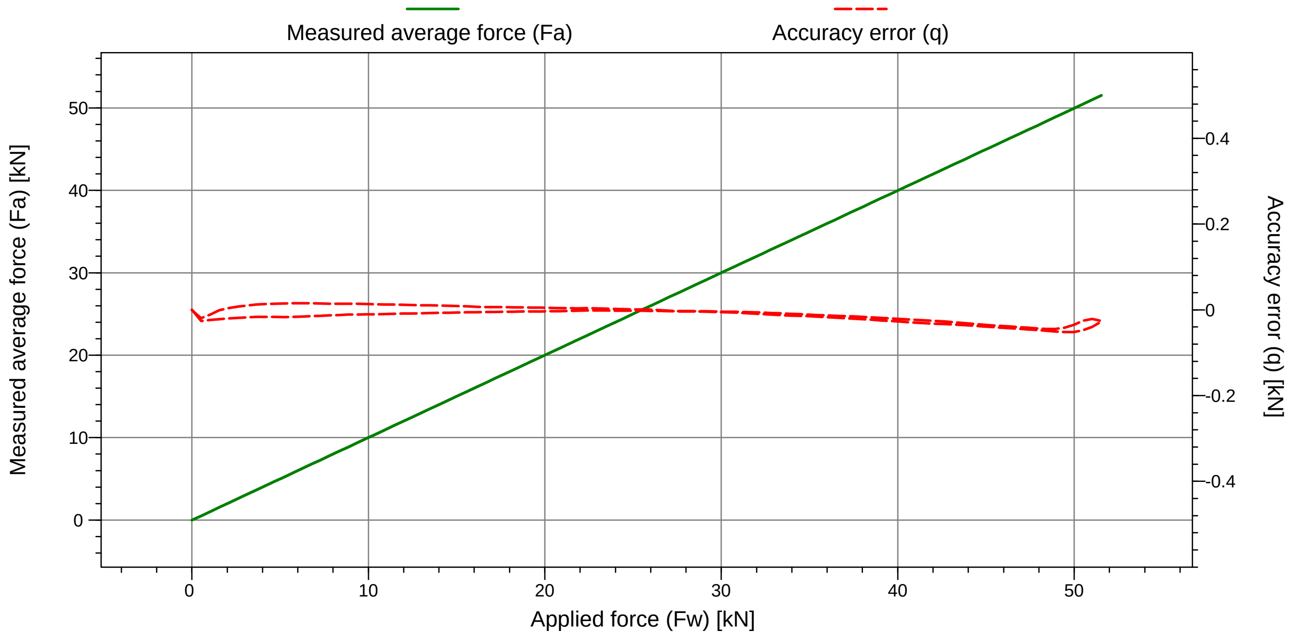
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.003•Fw+0.015 [kN]

Calibration Details	
Calibration Date	03 May 2016 10:43:11
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Sensor	
Channel	Cone+Fric. [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.034
Max repeatability error (b)	[kN]	0.010
Max reversibility error (v)	[kN]	0.024
Zero load error (Fc0)	[kN]	0.001
Zero load offset (F0)	[kN]	0.006
Resolution	[kN]	3.73E-05
Noise RMS	[kN]	0.001
Tip-Sleeve Interaction	[kPa]	1.4
Tip-Sleeve Interaction %	[%]	0.27



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	-0.001	0.001	0.000	0.000	0.000	0.001	
10.000	9.990	9.990	9.988	9.989	-0.011	0.001	0.024
20.000	19.996	19.997	19.997	19.996	-0.004	0.001	0.008
30.000	29.996	29.996	29.995	29.996	-0.004	0.001	-0.001
40.000	39.979	39.978	39.980	39.979	-0.021	0.002	-0.006
50.000	49.972	49.962	49.964	49.966	-0.034	0.010	
40.000	39.973	39.973	39.973	39.973	-0.027	0.000	
30.000	29.994	29.995	29.995	29.995	-0.005	0.001	
20.000	20.006	20.005	20.004	20.005	0.005	0.002	
10.000	10.014	10.014	10.012	10.013	0.013	0.002	
0.000	0.001	0.002	-0.006	-0.001	-0.001	0.008	

FRICTION SLEEVE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

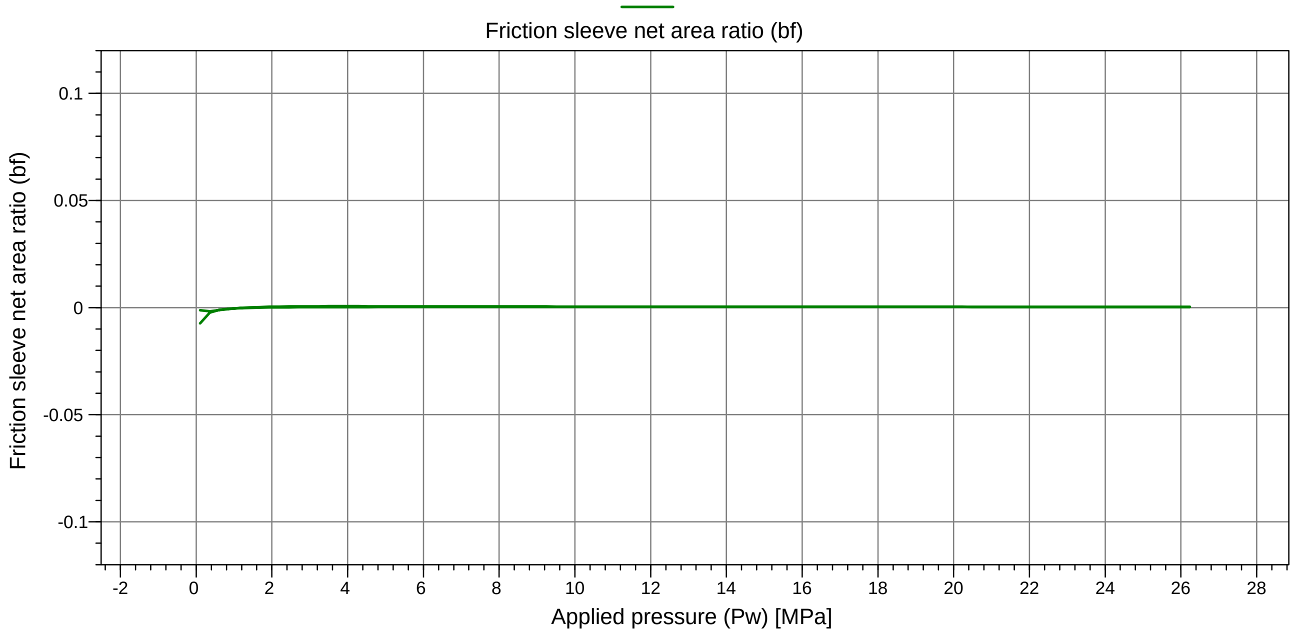
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 14:39:37
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Characteristics	**Unit**	**Value**
Friction sleeve net area ratio (bf)	[-]	0.00032

The friction sleeve net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) **[MPa]**	**Measured friction sleeve net area ratio (bf) 1 (bf,1)**	**Measured friction sleeve net area ratio (bf) 2 (bf,2)**	**Measured friction sleeve net area ratio (bf) 3 (bf,3)**	**Measured average Friction sleeve net area ratio (bf)**
4.000	0.001	0.001	0.001	0.001
8.000	0.001	0.001	0.000	0.001
12.000	0.000	0.000	0.000	0.000
16.000	0.000	0.000	0.000	0.000
20.000	0.000	0.000	0.000	0.000
16.000	0.000	0.000	0.000	0.000
12.000	0.000	0.000	0.000	0.000
8.000	0.000	0.000	0.000	0.000
4.000	0.000	0.000	0.000	0.000

PORE 2 CALIBRATION RESULT [PRESSURE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

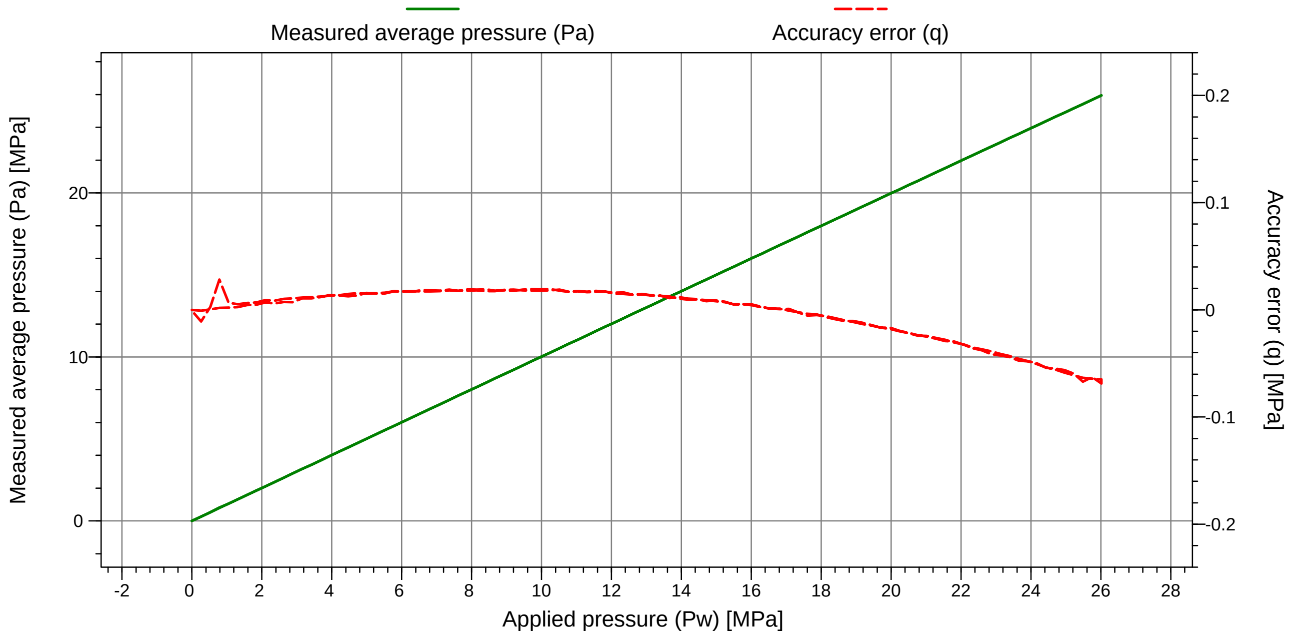
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 14:39:36
Procedure	FEBV.CAL.PRO.004
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Sensor	
Channel	Pore 2 [Pressure]
Manufacturer / Type	Keller PA-8/200bar (8467.8)
Calibrated Range	0 to 20 MPa
Maximum Rating	0 to 30 MPa

Characteristics	Unit	Value
Max accuracy error (q)	[MPa]	0.019
Max repeatability error (b)	[MPa]	0.004
Max reversibility error (v)	[MPa]	0.001
Zero load error (Pc0)	[MPa]	0.001
Zero load offset (P0)	[MPa]	-0.029
Resolution	[MPa]	1.41E-05
Noise RMS	[MPa]	0.000



Applied pressure (Pw) [MPa]	Measured pressure 1 (Pa,1) [MPa]	Measured pressure 2 (Pa,2) [MPa]	Measured pressure 3 (Pa,3) [MPa]	Measured average pressure (Pa) [MPa]	Accuracy error (q) [MPa]	Repeatability error (b) [MPa]	Reversibility error (v) [MPa]
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
4.000	4.012	4.014	4.015	4.014	0.014	0.003	0.000
8.000	8.019	8.018	8.020	8.019	0.019	0.002	0.000
12.000	12.016	12.016	12.017	12.017	0.017	0.001	-0.001
16.000	16.005	16.005	16.006	16.005	0.005	0.001	-0.001
20.000	19.982	19.982	19.986	19.983	-0.017	0.004	
16.000	16.005	16.004	16.005	16.004	0.004	0.001	
12.000	12.016	12.014	12.015	12.015	0.015	0.002	
8.000	8.019	8.018	8.019	8.019	0.019	0.002	
4.000	4.012	4.014	4.014	4.013	0.013	0.002	
0.000	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	

SLOPE CALIBRATION RESULT [INCLINATION]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB20SN2-P1E1M1-V1
Serial Number	1706-1888
Electronics	5382
Node Type	7001
Hardware Version	4.00
Software Version	7.08

Reference	
Manufacturer	Hoek-O-Mat
Serial Number	2109-0002
Uncertainty	0.6 [Deg]

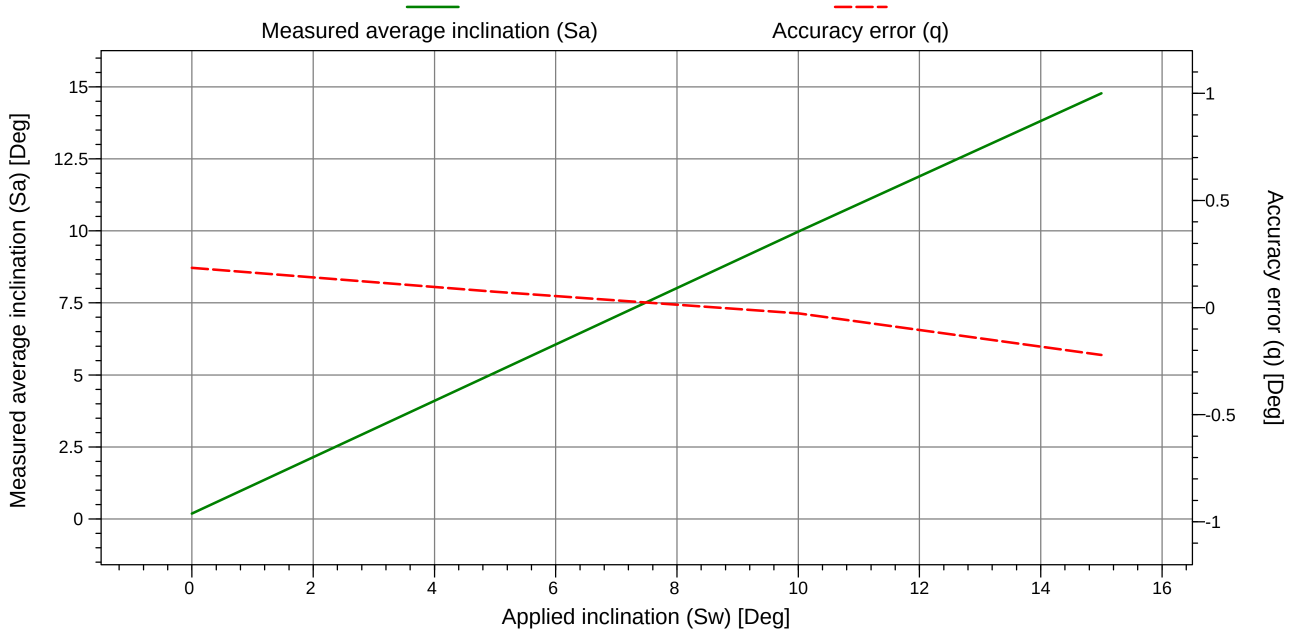
Calibration Details	
Calibration Date	03 May 2016 10:52:51
Procedure	FEBV.CAL.PRO.005
Software Version	1.22.0.17638

Certificate Number
FCN16006765

Sensor	
Channel	Slope [Inclination]
Manufacturer / Type	ADXL
Calibrated Range	0 to 15 Deg
Maximum Rating	0 to 20 Deg

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[Deg]	0.2
Max repeatability error (b)	[Deg]	0.2
Zero load error (Sc0)	[Deg]	0.1
Zero load offset (S0)	[Deg]	0.2
Resolution	[Deg]	1.27E-05
Noise RMS	[Deg]	0.0

Inclination is defined as the angular deviation of the cone penetrometer from the vertical.



Applied inclination (Sw) [Deg]	**Measured inclination 1 (Sa,1) [Deg]**	**Measured inclination 2 (Sa,2) [Deg]**	**Measured inclination 3 (Sa,3) [Deg]**	**Measured average inclination (Sa) [Deg]**	**Accuracy error (q) [Deg]**	**Repeatability error (b) [Deg]**
0.0	0.1	0.2	0.3	0.2	0.2	0.2
5.0	5.0	5.1	5.1	5.1	0.1	0.1
10.0	10.0	9.9	10.0	10.0	0.0	0.1
15.0	14.9	14.7	14.7	14.8	-0.2	0.2

SYMBOLS, DEFINITIONS AND REFERENCES

Certificate Number
FCN16006765

Symbols and Definitions (general)

af	Cone net area ratio, defined as the factor between the applied pressure to the instrument and the indicated cone resistance.
af,x	Measured cone net area ratio at measurement x.
b	Repeatability error, defined as the maximum difference between the measurements of the instrument at the applied value.
bf	Friction sleeve net area ratio, defined as the factor between the applied pressure to the instrument and the indicated sleeve friction.
bf,x	The measured friction sleeve net area ratio at measurement x.
Noise RMS	Signal noise, defined as the quadratic mean when the sensor is not subjected to load.
q	Accuracy error, defined as the difference between the average indicated value by the instrument and the applied value.
Resolution	Smallest change in a quantity being measured that causes a perceptible change in the corresponding indication.
Tip-Sleeve Interaction	Effect of cone tip measurements on derived friction measurements, due to coupling of the cone tip and friction sleeve element. Expressed in terms of friction and as a percentage of the full scale output of the cone tip.
v	Reversibility error, defined as the difference between the average indicated value by the instrument at a certain applied value when it was increased and when it was decreased.

Symbols and Definitions (quantity specific: Q may be substituted for F, P or S, as appropriate)

Q0	Zero load offset, instrument output where the specified measured quantity value is zero.
Qa	Average indicated quantity value by the instrument.
Qa,x	Quantity value indicated by the instrument at measurement x.
Qc0	Zero load error, defined as the difference between the average indicated value by the instrument before and after the load cycle has been applied.
Qw	Applied reference quantity value.

Quantities

F	Force
P	Pressure
S	Inclination

References

European Co-operation For Accreditation (2013), "Evaluation of the uncertainty of measurement in calibration", European Co-operation For Accreditation, 75 p. (Publication ; EA-4/02 M:2013)

ISO International Organization for Standardization (1999), "General requirements for the competence of testing and calibration laboratories", International Standard ISO 17025:2005

ISO International Organization for Standardization (2003), "Measurement management systems - requirements for measurement processes and measuring equipment", International Standard ISO 10012:2003

International Organization for Standardization (ISO) (2000), "Quality management systems - Requirements", International Standard ISO 9001

CALIBRATION CERTIFICATE

Applicant	**Fugro Engineers B.V.** Prismastraat 4 2631 RT, Nootdorp The Netherlands	**Certificate Number** **FCN16005925**

Instrument	**Cone Penetrometer**	Page 1 of 8
Manufacturer	Fugro	
Type	CP10-CF50PB10-P1E1M1-V1	
Serial Number	1706-1924	

Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration date 20-Jan-2016

Calibrate before 20-Jan-2017

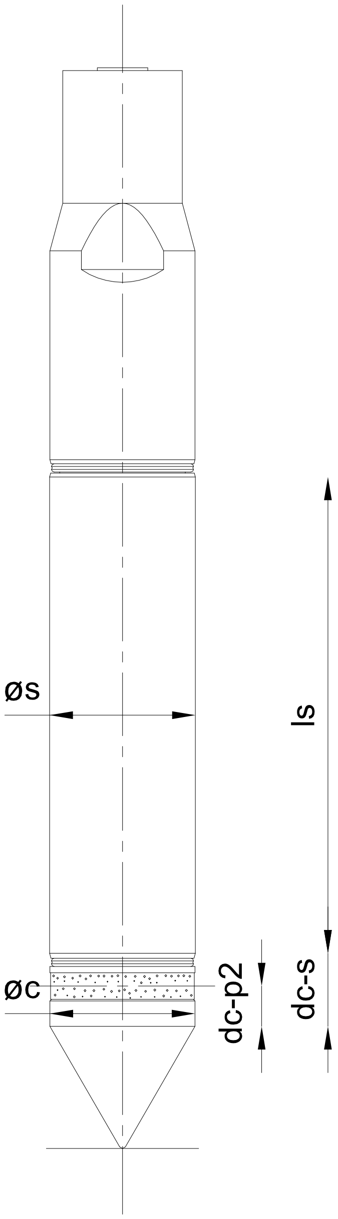
Calibrated Sensor	Manufacturer / Type	Calibrated Range	Maximum Rating	Procedure
Cone [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Cone+Fric. [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Pore 2 [Pressure]	Keller PA-8/100bar (8467.8)	0 to 10 MPa	0 to 15 MPa	FEBV.CAL.PRO.004

Nootdorp, 20-Jan-2016

Gerry Sinjorgo
Manager Transducer Workshop

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924

Certificate Number
FCN16005925



Typical Dimensions

Ac	Cross-sectional projected area of the cone	0.001 m²
As	Surface area of the friction sleeve	0.015 m²
af	Cone net area ratio	0.75
scf	Friction sleeve net area ratio	0
øc	Diameter of the cylindrical part of the cone	35.8 mm
øs	Diameter of the friction sleeve	36.1 mm
ls	Length of the friction sleeve	132.7 mm
dc-s	Cone - friction sleeve distance	13.5 mm
dc-p2	Cone - pore 2 distance	5 mm

Diagram is not to scale

CONE CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924
Electronics	5363
Node Type	7001
Hardware Version	4.00
Software Version	7.08

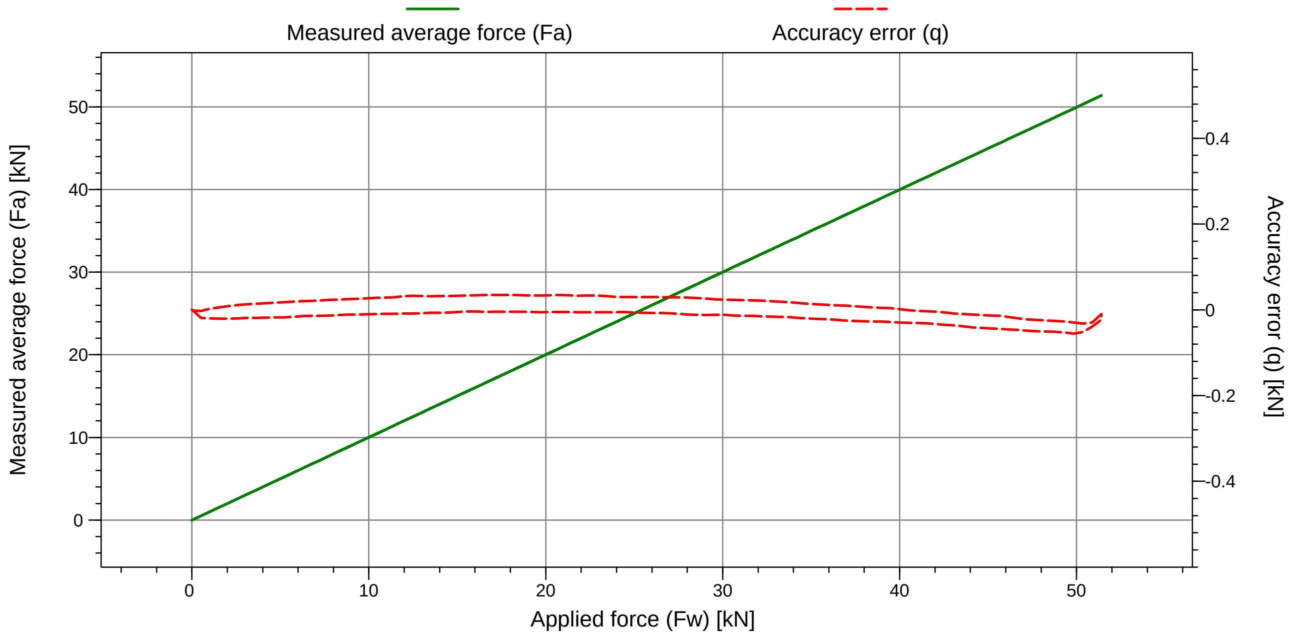
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0002
Uncertainty	0.003•Fw+0.015 [kN]

Certificate Number
FCN16005925

Calibration Details	
Calibration Date	20 Jan 2016 08:32:17
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Sensor	
Channel	Cone [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	Unit	Value
Max accuracy error (q)	[kN]	0.055
Max repeatability error (b)	[kN]	0.007
Max reversibility error (v)	[kN]	0.039
Zero load error (Fc0)	[kN]	0.002
Zero load offset (F0)	[kN]	-0.009
Resolution	[kN]	3.71E-05
Noise RMS	[kN]	0.000



Applied force (Fw) [kN]	Measured force 1 (Fa,1) [kN]	Measured force 2 (Fa,2) [kN]	Measured force 3 (Fa,3) [kN]	Measured average force (Fa) [kN]	Accuracy error (q) [kN]	Repeatability error (b) [kN]	Reversibility error (v) [kN]
0.000	-0.002	0.000	0.001	0.000	0.000	0.003	
10.000	9.989	9.988	9.991	9.990	-0.010	0.004	0.038
20.000	19.994	19.995	19.994	19.994	-0.006	0.001	0.039
30.000	29.988	29.987	29.989	29.988	-0.012	0.002	0.035
40.000	39.968	39.970	39.972	39.970	-0.030	0.004	0.031
50.000	49.943	49.947	49.945	49.945	-0.055	0.003	
40.000	40.001	40.001	40.002	40.001	0.001	0.001	
30.000	30.022	30.023	30.025	30.024	0.024	0.003	
20.000	20.032	20.033	20.037	20.034	0.034	0.005	
10.000	10.025	10.025	10.032	10.027	0.027	0.007	
0.000	-0.002	-0.002	-0.001	-0.002	-0.002	0.001	

CONE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924
Electronics	5363
Node Type	7001
Hardware Version	4.00
Software Version	7.08

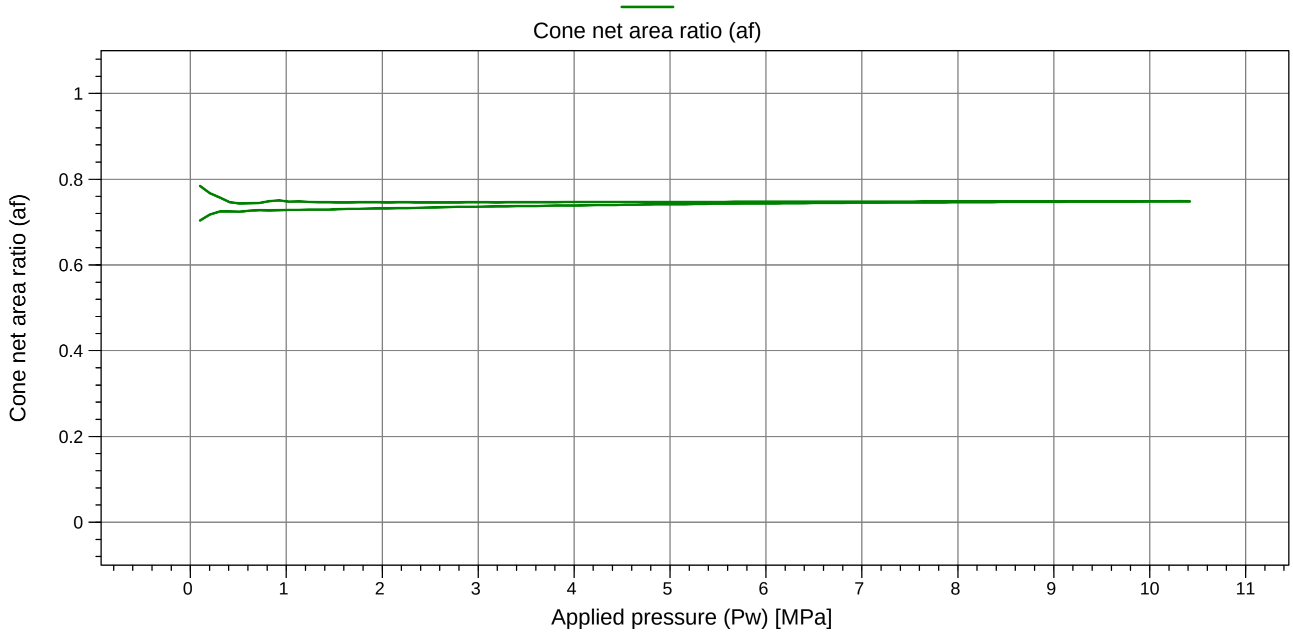
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	20 Jan 2016 08:59:56
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005925

Characteristics	Unit	Value
Cone net area ratio (af)	[-]	0.75

The cone net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) [MPa]	Measured cone net area ratio 1 (af,1)	Measured cone net area ratio 2 (af,2)	Measured cone net area ratio 3 (af,3)	Measured average cone net area ratio (af)
2.000	0.729	0.732	0.734	0.732
4.000	0.737	0.739	0.740	0.739
6.000	0.743	0.744	0.744	0.743
8.000	0.746	0.746	0.746	0.746
10.000	0.748	0.748	0.748	0.748
8.000	0.748	0.748	0.748	0.748
6.000	0.747	0.747	0.748	0.747
4.000	0.746	0.747	0.747	0.747
2.000	0.745	0.747	0.747	0.746

CONE+FRIC. CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924
Electronics	5363
Node Type	7001
Hardware Version	4.00
Software Version	7.08

Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0002
Uncertainty	0.003•Fw+0.015 [kN]

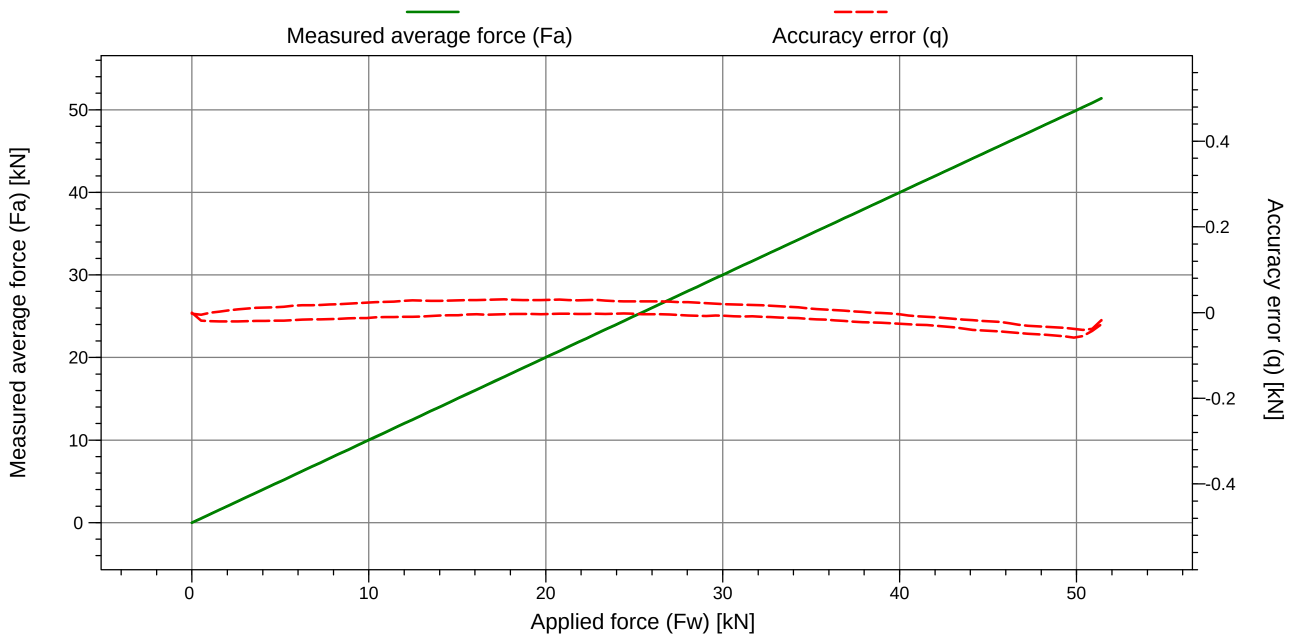
Calibration Details	
Calibration Date	20 Jan 2016 08:32:18
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005925

Page 5 of 8

Sensor	
Channel	Cone+Fric. [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.058
Max repeatability error (b)	[kN]	0.006
Max reversibility error (v)	[kN]	0.036
Zero load error (Fc0)	[kN]	0.003
Zero load offset (F0)	[kN]	-0.009
Resolution	[kN]	3.69E-05
Noise RMS	[kN]	0.001
Tip-Sleeve Interaction	[kPa]	0.6
Tip-Sleeve Interaction %	[%]	0.12



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	-0.002	0.001	0.001	0.000	0.000	0.003	
10.000	9.988	9.985	9.989	9.988	-0.012	0.004	0.036
20.000	19.997	19.997	19.994	19.996	-0.004	0.003	0.033
30.000	29.994	29.992	29.993	29.993	-0.007	0.001	0.027
40.000	39.973	39.974	39.975	39.974	-0.026	0.001	0.022
50.000	49.942	49.943	49.941	49.942	-0.058	0.001	
40.000	39.997	39.996	39.995	39.996	-0.004	0.002	
30.000	30.020	30.020	30.021	30.020	0.020	0.001	
20.000	20.029	20.028	20.031	20.029	0.029	0.003	
10.000	10.022	10.021	10.027	10.024	0.024	0.006	
0.000	-0.003	-0.003	-0.002	-0.003	-0.003	0.001	

FRICTION SLEEVE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924
Electronics	5363
Node Type	7001
Hardware Version	4.00
Software Version	7.08

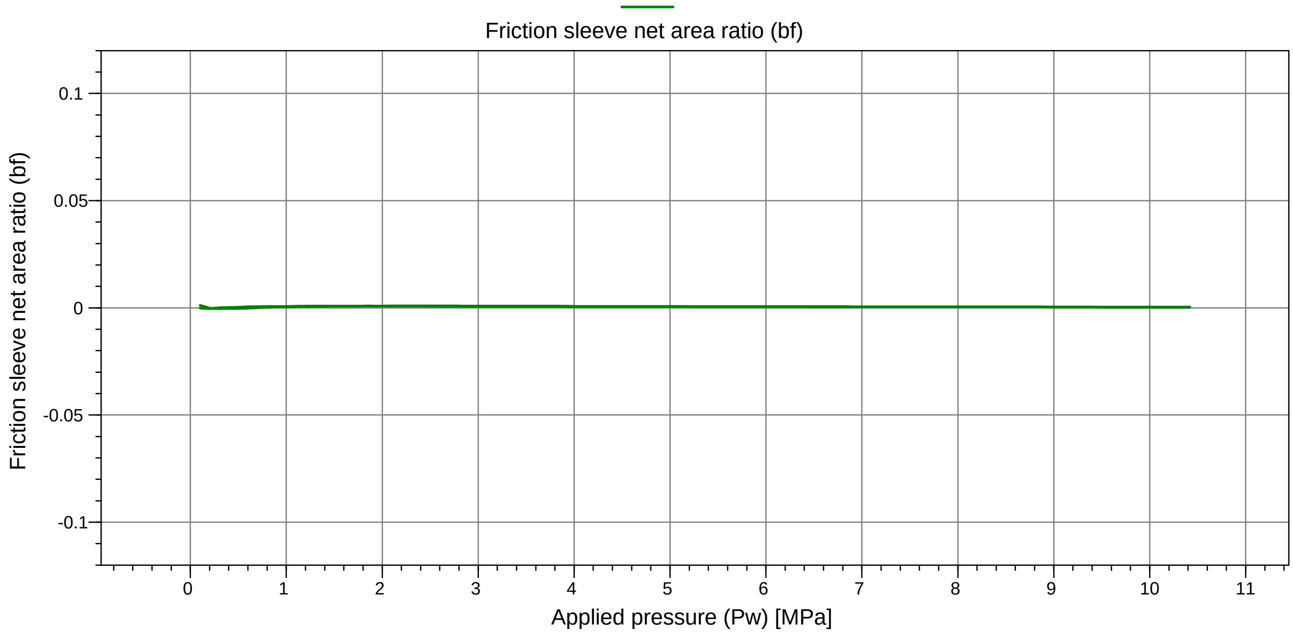
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	20 Jan 2016 08:59:56
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005925

Characteristics	Unit	Value
Friction sleeve net area ratio (bf)	[-]	0.00034

The friction sleeve net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) [MPa]	Measured friction sleeve net area ratio 1 (bf,1)	Measured friction sleeve net area ratio 2 (bf,2)	Measured friction sleeve net area ratio 3 (bf,3)	Measured average friction sleeve net area ratio (bf)
2.000	0.001	0.001	0.001	0.001
4.000	0.001	0.001	0.001	0.001
6.000	0.001	0.001	0.001	0.001
8.000	0.000	0.000	0.000	0.000
10.000	0.000	0.000	0.000	0.000
8.000	0.000	0.000	0.000	0.000
6.000	0.001	0.001	0.000	0.001
4.000	0.001	0.001	0.001	0.001
2.000	0.001	0.001	0.001	0.001

PORE 2 CALIBRATION RESULT [PRESSURE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-1924
Electronics	5363
Node Type	7001
Hardware Version	4.00
Software Version	7.08

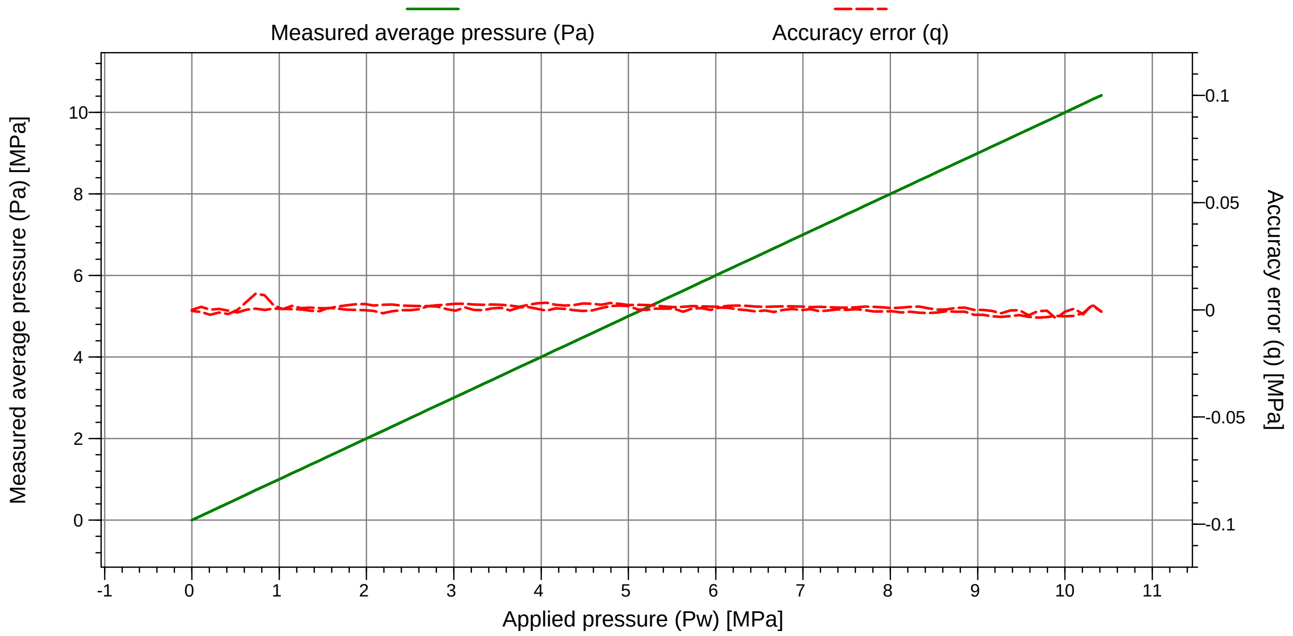
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	20 Jan 2016 08:59:55
Procedure	FEBV.CAL.PRO.004
Software Version	1.19.0.16298

Certificate Number
FCN16005925

Sensor	
Channel	Pore 2 [Pressure]
Manufacturer / Type	Keller PA-8/100bar (8467.8)
Calibrated Range	0 to 10 MPa
Maximum Rating	0 to 15 MPa

Characteristics	Unit	Value
Max accuracy error (q)	[MPa]	0.003
Max repeatability error (b)	[MPa]	0.003
Max reversibility error (v)	[MPa]	0.003
Zero load error (Pc0)	[MPa]	0.001
Zero load offset (P0)	[MPa]	-0.005
Resolution	[MPa]	2.11E-06
Noise RMS	[MPa]	0.000



Applied pressure (Pw) [MPa]	Measured pressure 1 (Pa,1) [MPa]	Measured pressure 2 (Pa,2) [MPa]	Measured pressure 3 (Pa,3) [MPa]	Measured average pressure (Pa) [MPa]	Accuracy error (q) [MPa]	Repeatability error (b) [MPa]	Reversibility error (v) [MPa]
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2.000	2.001	1.998	2.001	2.000	0.000	0.003	0.003
4.000	3.999	4.000	4.001	4.000	0.000	0.002	0.003
6.000	6.000	6.002	6.000	6.000	0.000	0.002	0.001
8.000	8.001	8.001	7.997	7.999	-0.001	0.003	0.001
10.000	9.997	9.997	9.996	9.997	-0.003	0.001	
8.000	8.001	8.001	8.001	8.001	0.001	0.000	
6.000	6.001	6.002	6.002	6.001	0.001	0.001	
4.000	4.003	4.003	4.003	4.003	0.003	0.001	
2.000	2.003	2.003	2.002	2.003	0.003	0.000	
0.000	-0.001	0.000	-0.001	-0.001	-0.001	0.000	

Symbols and Definitions (general)

af	Cone net area ratio, defined as the factor between the applied pressure to the instrument and the indicated cone resistance.
af,x	Measured cone net area ratio at measurement x.
b	Repeatability error, defined as the maximum difference between the measurements of the instrument at the applied value.
bf	Friction sleeve net area ratio, defined as the factor between the applied pressure to the instrument and the indicated sleeve friction.
bf,x	The measured friction sleeve net area ratio at measurement x.
Noise RMS	Signal noise, defined as the quadratic mean when the sensor is not subjected to load.
q	Accuracy error, defined as the difference between the average indicated value by the instrument and the applied value.
Resolution	Smallest change in a quantity being measured that causes a perceptible change in the corresponding indication.
Tip-Sleeve Interaction	Effect of cone tip measurements on derived friction measurements, due to coupling of the cone tip and friction sleeve element. Expressed in terms of friction and as a percentage of the full scale output of the cone tip.
v	Reversibility error, defined as the difference between the average indicated value by the instrument at a certain applied value when it was increased and when it was decreased.

Symbols and Definitions (quantity specific: Q may be substituted for F or P, as appropriate)

Q0	Zero load offset, instrument output where the specified measured quantity value is zero.
Qa	Average indicated quantity value by the instrument.
Qa,x	Quantity value indicated by the instrument at measurement x.
Qc0	Zero load error, defined as the difference between the average indicated value by the instrument before and after the load cycle has been applied.
Qw	Applied reference quantity value.

Quantities

F	Force
P	Pressure

References

European Co-operation For Accreditation (2013), "Evaluation of the uncertainty of measurement in calibration", European Co-operation For Accreditation, 75 p. (Publication ; EA-4/02 M:2013)

ISO International Organization for Standardization (1999), "General requirements for the competence of testing and calibration laboratories", International Standard ISO 17025:2005

ISO International Organization for Standardization (2003), "Measurement management systems - requirements for measurement processes and measuring equipment", International Standard ISO 10012:2003

International Organization for Standardization (ISO) (2000), "Quality management systems - Requirements", International Standard ISO 9001

CALIBRATION CERTIFICATE

Certificate Number
FCN16005877

Page 1 of 8

Applicant	**Fugro Engineers B.V.**
	Prismastraat 4 2631 RT, Nootdorp The Netherlands

Instrument	**Cone Penetrometer**
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149

Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration period 15-Jan-2016 through 18-Jan-2016

Calibrate before 15-Jan-2017

Calibrated Sensor	Manufacturer / Type	Calibrated Range	Maximum Rating	Procedure
Cone [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Cone+Fric. [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Pore 2 [Pressure]	Keller PA-8/100bar (8467.8)	0 to 10 MPa	0 to 15 MPa	FEBV.CAL.PRO.004

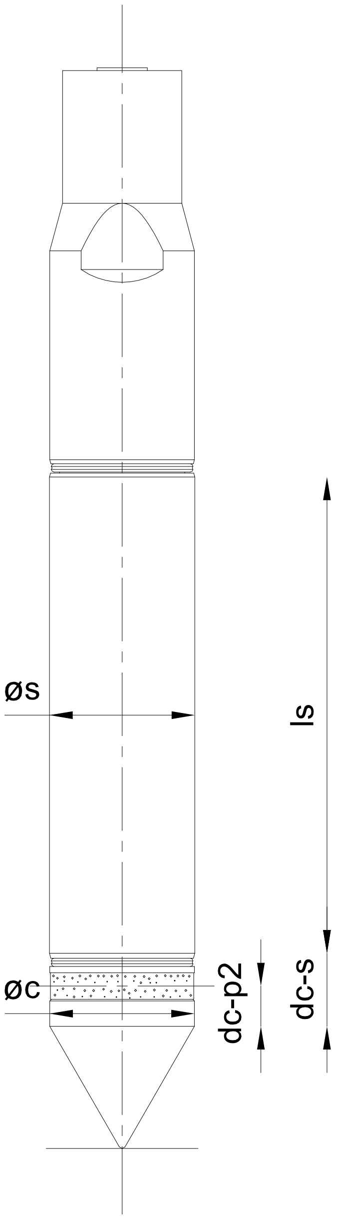
Nootdorp, 18-Jan-2016

Gerry Sinjorgo
Manager Transducer Workshop

TYPICAL DIMENSIONS

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149

Certificate Number
FCN16005877



Typical Dimensions

Ac	Cross-sectional projected area of the cone	0.001 m²
As	Surface area of the friction sleeve	0.015 m²
af	Cone net area ratio	0.75
scf	Friction sleeve net area ratio	0
øc	Diameter of the cylindrical part of the cone	35.8 mm
øs	Diameter of the friction sleeve	36.1 mm
ls	Length of the friction sleeve	132.7 mm
dc-s	Cone - friction sleeve distance	13.5 mm
dc-p2	Cone - pore 2 distance	5 mm

Diagram is not to scale

CONE CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149
Electronics	2672
Node Type	7001
Hardware Version	3.00
Software Version	4.01

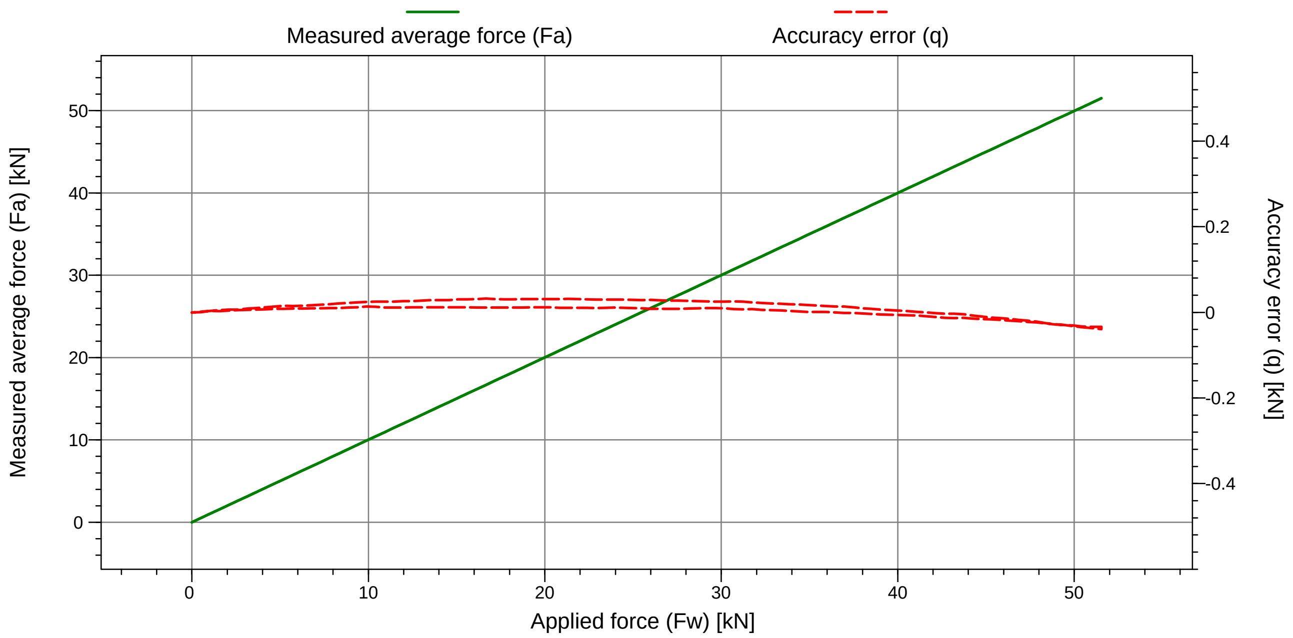
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.0026•Fw+0.0086 [kN]

Calibration Details	
Calibration Date	15 Jan 2016 10:20:19
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005877

Sensor	
Channel	Cone [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.031
Max repeatability error (b)	[kN]	0.006
Max reversibility error (v)	[kN]	0.019
Zero load error (Fc0)	[kN]	0.001
Zero load offset (F0)	[kN]	-0.003
Resolution	[kN]	1.9E-05
Noise RMS	[kN]	0.001



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	0.000	0.000	0.001	0.000	0.000	0.001	
10.000	10.014	10.012	10.014	10.014	0.014	0.002	0.011
20.000	20.016	20.011	20.010	20.012	0.012	0.006	0.019
30.000	30.008	30.011	30.010	30.010	0.010	0.003	0.015
40.000	39.992	39.996	39.993	39.994	-0.006	0.004	0.010
50.000	49.970	49.967	49.970	49.969	-0.031	0.003	
40.000	40.007	40.003	40.003	40.004	0.004	0.004	
30.000	30.027	30.025	30.023	30.025	0.025	0.005	
20.000	20.032	20.030	20.031	20.031	0.031	0.002	
10.000	10.025	10.023	10.024	10.024	0.024	0.002	
0.000	0.000	0.000	-0.003	-0.001	-0.001	0.003	

CONE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149
Electronics	2672
Node Type	7001
Hardware Version	3.00
Software Version	4.01

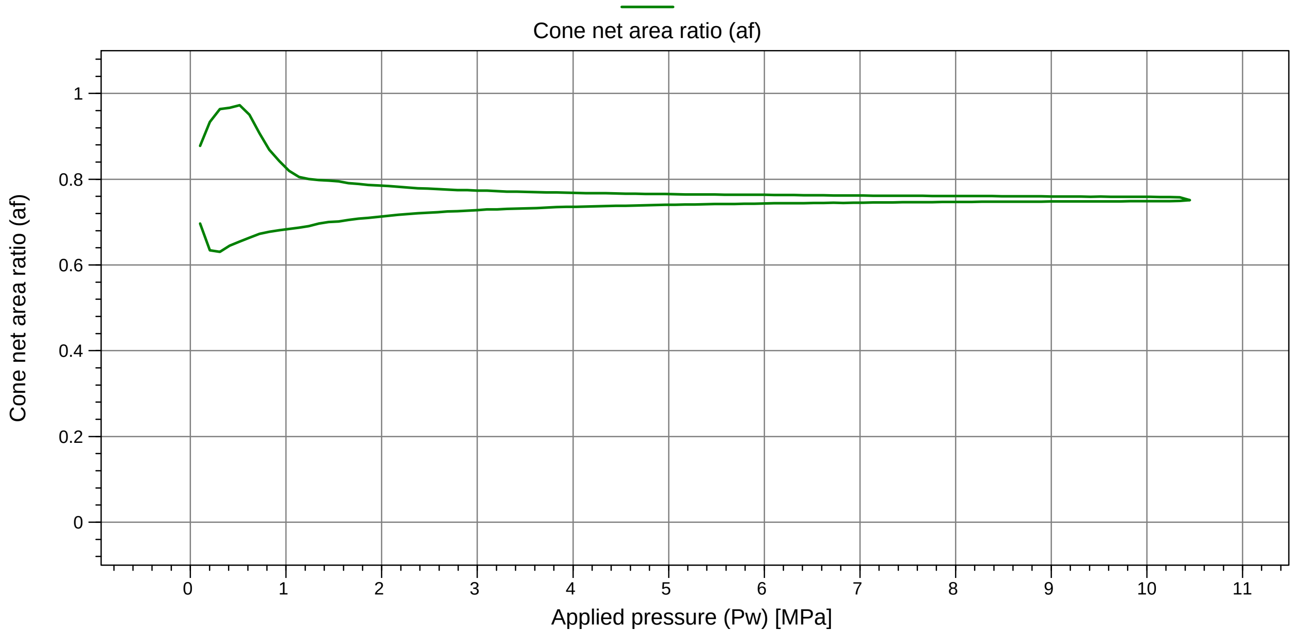
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.00056•Pw+0.0024 [MPa]

Calibration Details	
Calibration Date	18 Jan 2016 09:12:18
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005877

Characteristics	**Unit**	**Value**
Cone net area ratio (af)	[-]	0.75

The cone net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) **[MPa]**	**Measured cone net area ratio 1 (af,1)**	**Measured cone net area ratio 2 (af,2)**	**Measured cone net area ratio 3 (af,3)**	**Measured average cone net area ratio (af)**
2.000	0.712	0.713	0.713	0.713
4.000	0.736	0.735	0.735	0.735
6.000	0.743	0.743	0.743	0.743
8.000	0.747	0.747	0.747	0.747
10.000	0.749	0.749	0.749	0.749
8.000	0.761	0.761	0.761	0.761
6.000	0.763	0.763	0.764	0.763
4.000	0.768	0.768	0.769	0.768
2.000	0.785	0.785	0.784	0.785

CONE+FRIC. CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149
Electronics	2672
Node Type	7001
Hardware Version	3.00
Software Version	4.01

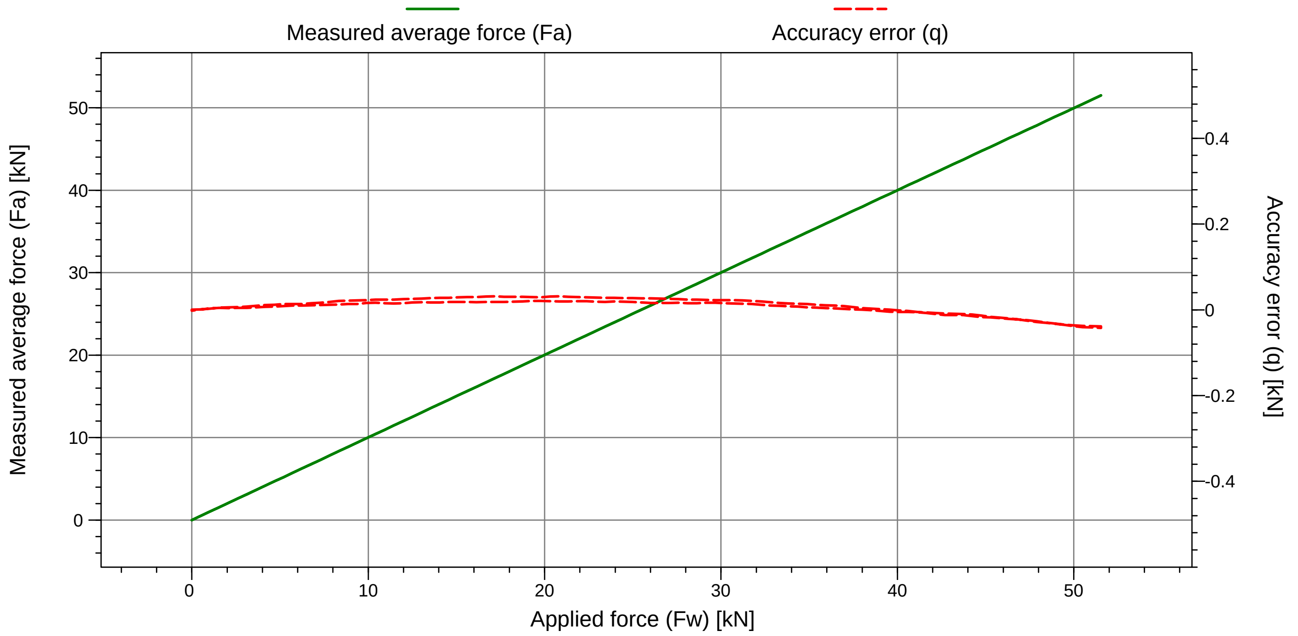
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.0026•Fw+0.0086 [kN]

Calibration Details	
Calibration Date	15 Jan 2016 10:20:19
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005877

Sensor	
Channel	Cone+Fric. [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.036
Max repeatability error (b)	[kN]	0.010
Max reversibility error (v)	[kN]	0.009
Zero load error (Fc0)	[kN]	0.002
Zero load offset (F0)	[kN]	-0.003
Resolution	[kN]	1.92E-05
Noise RMS	[kN]	0.001
Tip-Sleeve Interaction	[kPa]	0.9
Tip-Sleeve Interaction %	[%]	0.19



Applied force (Fw) **[kN]**	**Measured force 1 (Fa,1)** **[kN]**	**Measured force 2 (Fa,2)** **[kN]**	**Measured force 3 (Fa,3)** **[kN]**	**Measured average force (Fa)** **[kN]**	**Accuracy error (q)** **[kN]**	**Repeatability error (b)** **[kN]**	**Reversibility error (v)** **[kN]**
0.000	0.001	-0.001	0.000	0.000	0.000	0.002	
10.000	10.016	10.014	10.020	10.017	0.017	0.006	0.006
20.000	20.021	20.019	20.021	20.020	0.020	0.003	0.009
30.000	30.010	30.019	30.018	30.016	0.016	0.009	0.007
40.000	39.989	39.998	39.998	39.995	-0.005	0.009	0.004
50.000	49.958	49.964	49.968	49.964	-0.036	0.010	
40.000	39.997	39.999	40.001	39.999	-0.001	0.004	
30.000	30.020	30.024	30.023	30.022	0.022	0.005	
20.000	20.026	20.028	20.035	20.030	0.030	0.008	
10.000	10.022	10.022	10.025	10.023	0.023	0.003	
0.000	-0.001	-0.001	-0.004	-0.002	-0.002	0.003	

FRICTION SLEEVE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149
Electronics	2672
Node Type	7001
Hardware Version	3.00
Software Version	4.01

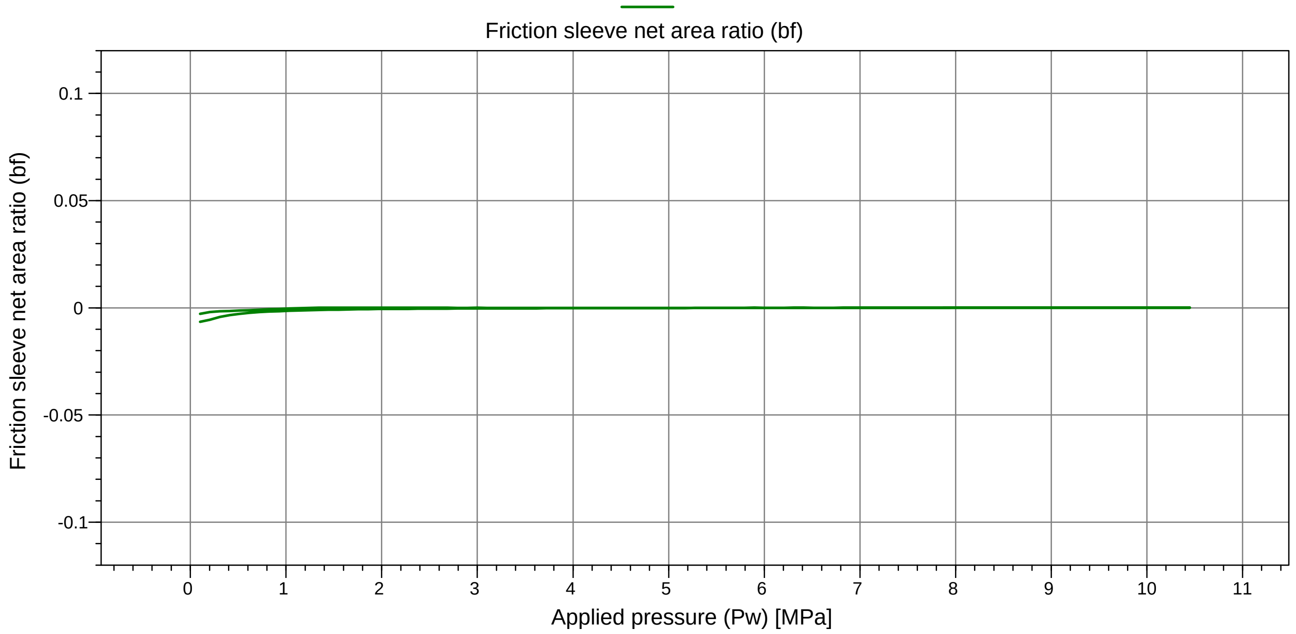
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.00056•Pw+0.0024 [MPa]

Calibration Details	
Calibration Date	18 Jan 2016 09:12:18
Procedure	FEBV.CAL.PRO.003
Software Version	1.19.0.16298

Certificate Number
FCN16005877

Characteristics	**Unit**	**Value**
Friction sleeve net area ratio (bf)	[-]	0.00006

The friction sleeve net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) **[MPa]**	**Measured friction sleeve net area ratio 1 (bf,1)**	**Measured friction sleeve net area ratio 2 (bf,2)**	**Measured friction sleeve net area ratio 3 (bf,3)**	**Measured average friction sleeve net area ratio (bf)**
2.000	0.000	0.000	0.000	0.000
4.000	0.000	0.000	0.000	0.000
6.000	0.000	0.000	0.000	0.000
8.000	0.000	0.000	0.000	0.000
10.000	0.000	0.000	0.000	0.000
8.000	0.000	0.000	0.000	0.000
6.000	0.000	0.000	0.000	0.000
4.000	0.000	0.000	0.000	0.000
2.000	-0.001	-0.001	-0.001	-0.001

PORE 2 CALIBRATION RESULT [PRESSURE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10-P1E1M1-V1
Serial Number	1706-2149
Electronics	2672
Node Type	7001
Hardware Version	3.00
Software Version	4.01

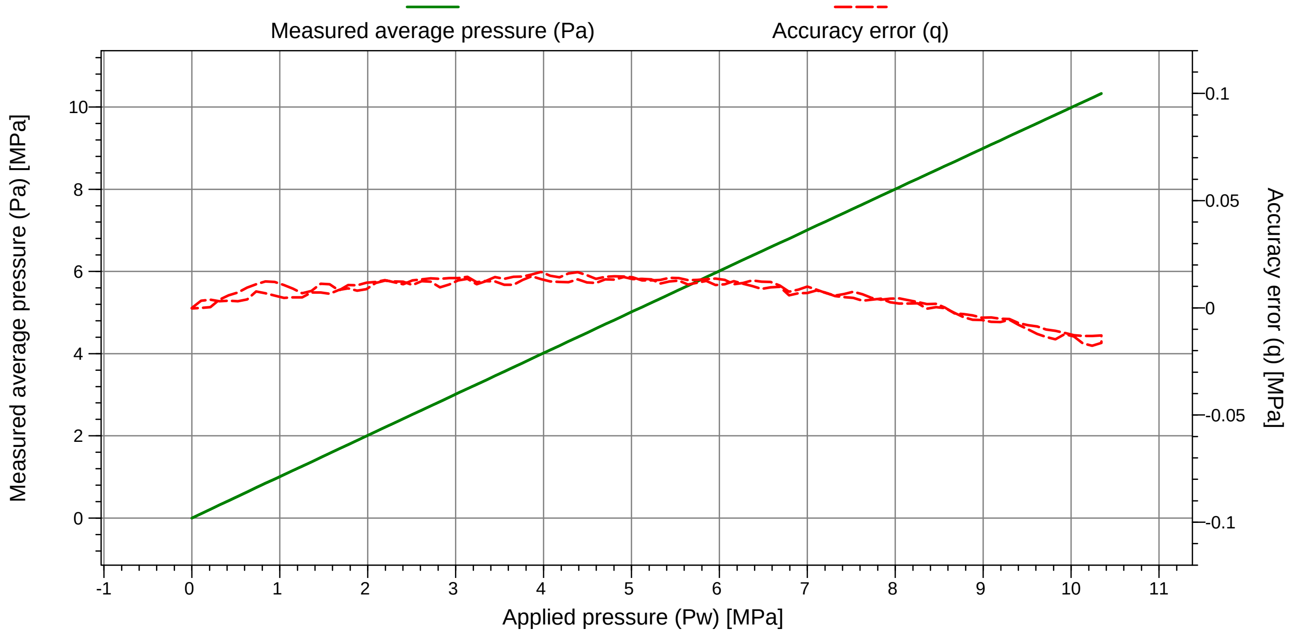
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.00056•Pw+0.0024 [MPa]

Calibration Details	
Calibration Date	18 Jan 2016 09:12:18
Procedure	FEBV.CAL.PRO.004
Software Version	1.19.0.16298

Certificate Number
FCN16005877

Sensor	
Channel	Pore 2 [Pressure]
Manufacturer / Type	Keller PA-8/100bar (8467.8)
Calibrated Range	0 to 10 MPa
Maximum Rating	0 to 15 MPa

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[MPa]	0.016
Max repeatability error (b)	[MPa]	0.007
Max reversibility error (v)	[MPa]	0.003
Zero load error (Pc0)	[MPa]	0.000
Zero load offset (P0)	[MPa]	-0.005
Resolution	[MPa]	2.14E-06
Noise RMS	[MPa]	0.000



Applied pressure (Pw) [MPa]	**Measured pressure 1 (Pa,1) [MPa]**	**Measured pressure 2 (Pa,2) [MPa]**	**Measured pressure 3 (Pa,3) [MPa]**	**Measured average pressure (Pa) [MPa]**	**Accuracy error (q) [MPa]**	**Repeatability error (b) [MPa]**	**Reversibility error (v) [MPa]**
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2.000	2.008	2.010	2.010	2.009	0.009	0.002	0.003
4.000	4.015	4.012	4.012	4.013	0.013	0.002	0.003
6.000	6.010	6.014	6.007	6.010	0.010	0.007	0.003
8.000	8.005	8.000	8.001	8.002	0.002	0.006	0.003
10.000	9.990	9.986	9.987	9.988	-0.012	0.004	
8.000	8.004	8.006	8.003	8.004	0.004	0.003	
6.000	6.013	6.014	6.014	6.014	0.014	0.002	
4.000	4.015	4.017	4.017	4.016	0.016	0.002	
2.000	2.012	2.013	2.011	2.012	0.012	0.002	
0.000	-0.001	0.000	0.000	0.000	0.000	0.001	

Symbols and Definitions (general)

af	Cone net area ratio, defined as the factor between the applied pressure to the instrument and the indicated cone resistance.
af,x	Measured cone net area ratio at measurement x.
b	Repeatability error, defined as the maximum difference between the measurements of the instrument at the applied value.
bf	Friction sleeve net area ratio, defined as the factor between the applied pressure to the instrument and the indicated sleeve friction.
bf,x	The measured friction sleeve net area ratio at measurement x.
Noise RMS	Signal noise, defined as the quadratic mean when the sensor is not subjected to load.
q	Accuracy error, defined as the difference between the average indicated value by the instrument and the applied value.
Resolution	Smallest change in a quantity being measured that causes a perceptible change in the corresponding indication.
Tip-Sleeve Interaction	Effect of cone tip measurements on derived friction measurements, due to coupling of the cone tip and friction sleeve element. Expressed in terms of friction and as a percentage of the full scale output of the cone tip.
v	Reversibility error, defined as the difference between the average indicated value by the instrument at a certain applied value when it was increased and when it was decreased.

Symbols and Definitions (quantity specific: Q may be substituted for F or P, as appropriate)

Q0	Zero load offset, instrument output where the specified measured quantity value is zero.
Qa	Average indicated quantity value by the instrument.
Qa,x	Quantity value indicated by the instrument at measurement x.
Qc0	Zero load error, defined as the difference between the average indicated value by the instrument before and after the load cycle has been applied.
Qw	Applied reference quantity value.

Quantities

F	Force
P	Pressure

References

European Co-operation For Accreditation (2013), "Evaluation of the uncertainty of measurement in calibration", European Co-operation For Accreditation, 75 p. (Publication ; EA-4/02 M:2013)

ISO International Organization for Standardization (1999), "General requirements for the competence of testing and calibration laboratories", International Standard ISO 17025:2005

ISO International Organization for Standardization (2003), "Measurement management systems - requirements for measurement processes and measuring equipment", International Standard ISO 10012:2003

International Organization for Standardization (ISO) (2000), "Quality management systems - Requirements", International Standard ISO 9001

CALIBRATION CERTIFICATE

Applicant	**Fugro Engineers B.V.**
	Prismastraat 4 2631 RT, Nootdorp The Netherlands

Certificate Number
FCN16006762

Instrument	**Cone Penetrometer**
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366

Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration date 03-May-2016

Calibrate before 03-May-2017

Calibrated Sensor	Manufacturer / Type	Calibrated Range	Maximum Rating	Procedure
Cone [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Cone+Fric. [Force]	Fugro Loadcell	0 to 50 kN	0 to 100 kN	FEBV.CAL.PRO.003
Pore 2 [Pressure]	Keller PA-8/100bar (8467.8)	0 to 10 MPa	0 to 15 MPa	FEBV.CAL.PRO.004
Slope [Inclination]	ADXL	0 to 15 Deg	0 to 20 Deg	FEBV.CAL.PRO.005

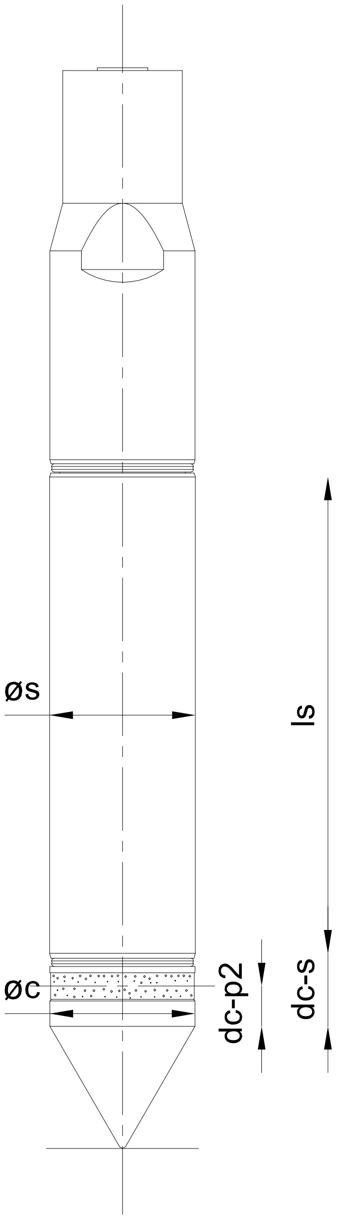
Nootdorp, 03-May-2016

Gerry Sinjorgo
Manager Transducer Workshop

TYPICAL DIMENSIONS

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366

Certificate Number
FCN16006762



Typical Dimensions		
Ac	Cross-sectional projected area of the cone	0.001 m²
As	Surface area of the friction sleeve	0.015 m²
af	Cone net area ratio	0.75
scf	Friction sleeve net area ratio	0
øc	Diameter of the cylindrical part of the cone	35.8 mm
øs	Diameter of the friction sleeve	36.1 mm
ls	Length of the friction sleeve	132.7 mm
dc-s	Cone - friction sleeve distance	13.5 mm
dc-p2	Cone - pore 2 distance	5 mm

Diagram is not to scale

CONE CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

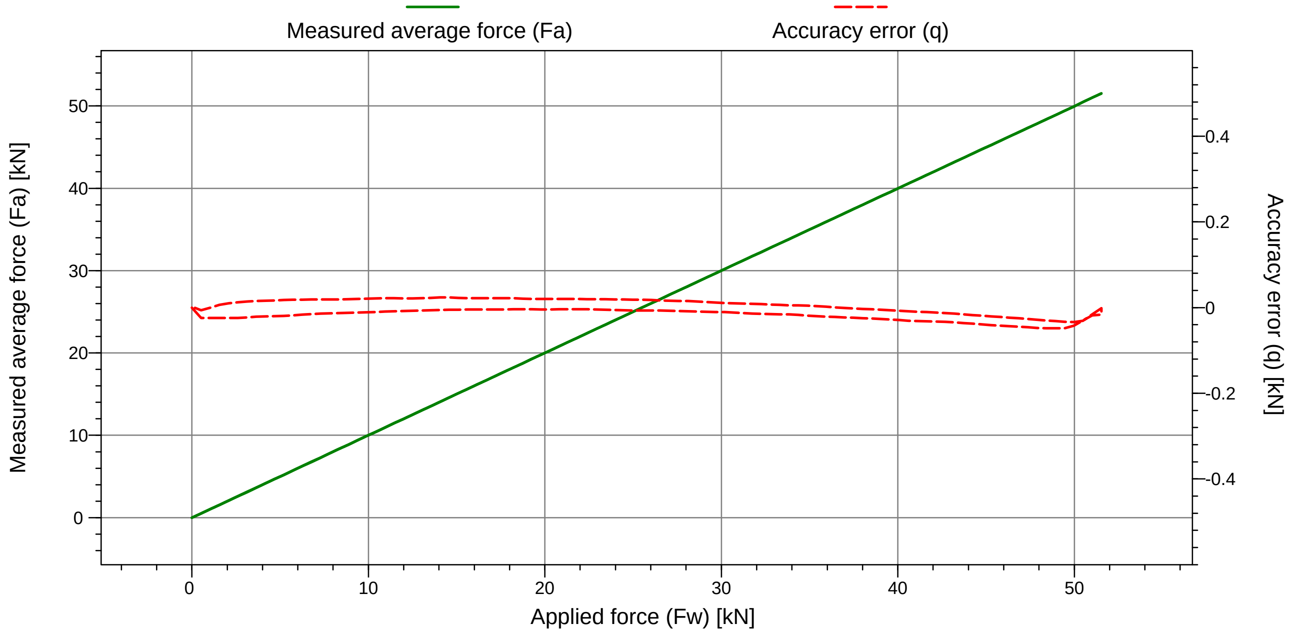
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.003•Fw+0.015 [kN]

Calibration Details	
Calibration Date	03 May 2016 09:00:08
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Sensor	
Channel	Cone [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.042
Max repeatability error (b)	[kN]	0.009
Max reversibility error (v)	[kN]	0.032
Zero load error (Fc0)	[kN]	0.002
Zero load offset (F0)	[kN]	0.006
Resolution	[kN]	3.68E-05
Noise RMS	[kN]	0.000



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	0.001	-0.001	0.000	0.000	0.000	0.001	
10.000	9.987	9.988	9.991	9.989	-0.011	0.004	0.032
20.000	19.995	19.995	19.997	19.996	-0.004	0.002	0.024
30.000	29.988	29.990	29.991	29.990	-0.010	0.003	0.021
40.000	39.969	39.971	39.972	39.971	-0.029	0.003	0.022
50.000	49.956	49.954	49.964	49.958	-0.042	0.009	
40.000	39.993	39.994	39.992	39.993	-0.007	0.002	
30.000	30.010	30.013	30.010	30.011	0.011	0.003	
20.000	20.020	20.021	20.020	20.020	0.020	0.002	
10.000	10.021	10.022	10.020	10.021	0.021	0.002	
0.000	0.002	0.002	0.003	0.002	0.002	0.001	

CONE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

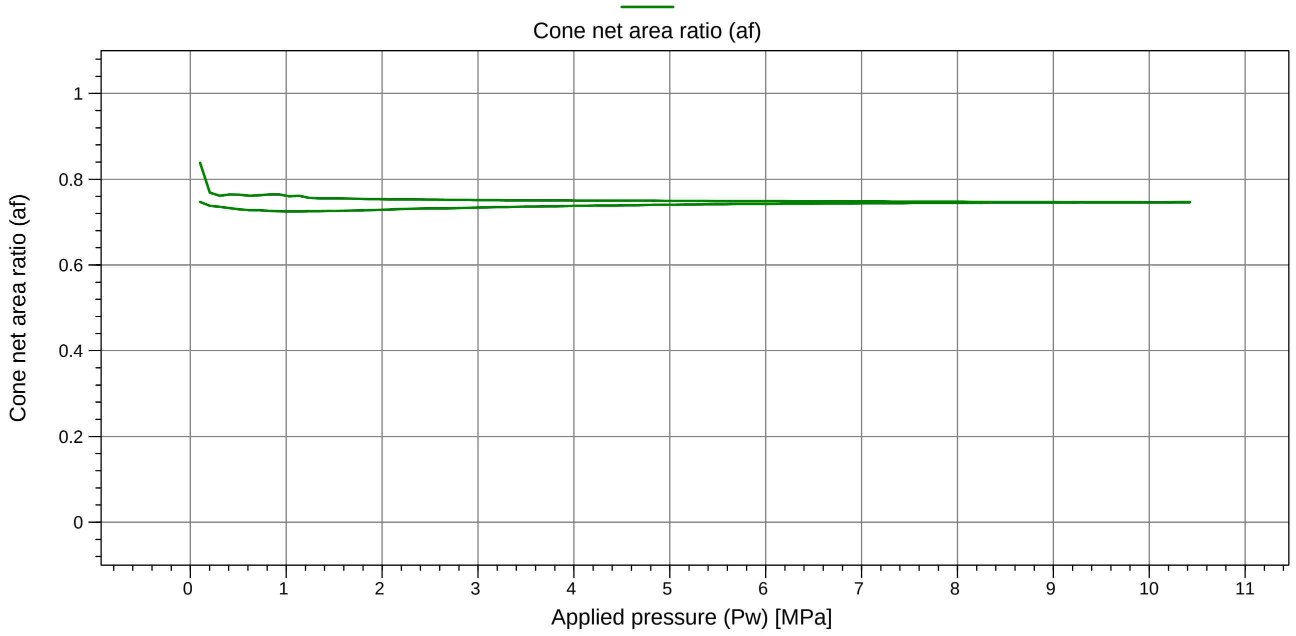
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 10:06:01
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Characteristics	**Unit**	**Value**
Cone net area ratio (af)	[-]	0.75

The cone net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) **[MPa]**	**Measured cone net area ratio 1 (af,1)**	**Measured cone net area ratio 2 (af,2)**	**Measured cone net area ratio 3 (af,3)**	**Measured average cone net area ratio (af)**
2.000	0.728	0.729	0.729	0.729
4.000	0.738	0.738	0.738	0.738
6.000	0.742	0.742	0.742	0.742
8.000	0.744	0.745	0.745	0.745
10.000	0.746	0.746	0.746	0.746
8.000	0.747	0.747	0.747	0.747
6.000	0.748	0.748	0.749	0.748
4.000	0.750	0.750	0.750	0.750
2.000	0.753	0.753	0.754	0.753

CONE+FRIC. CALIBRATION RESULT [FORCE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

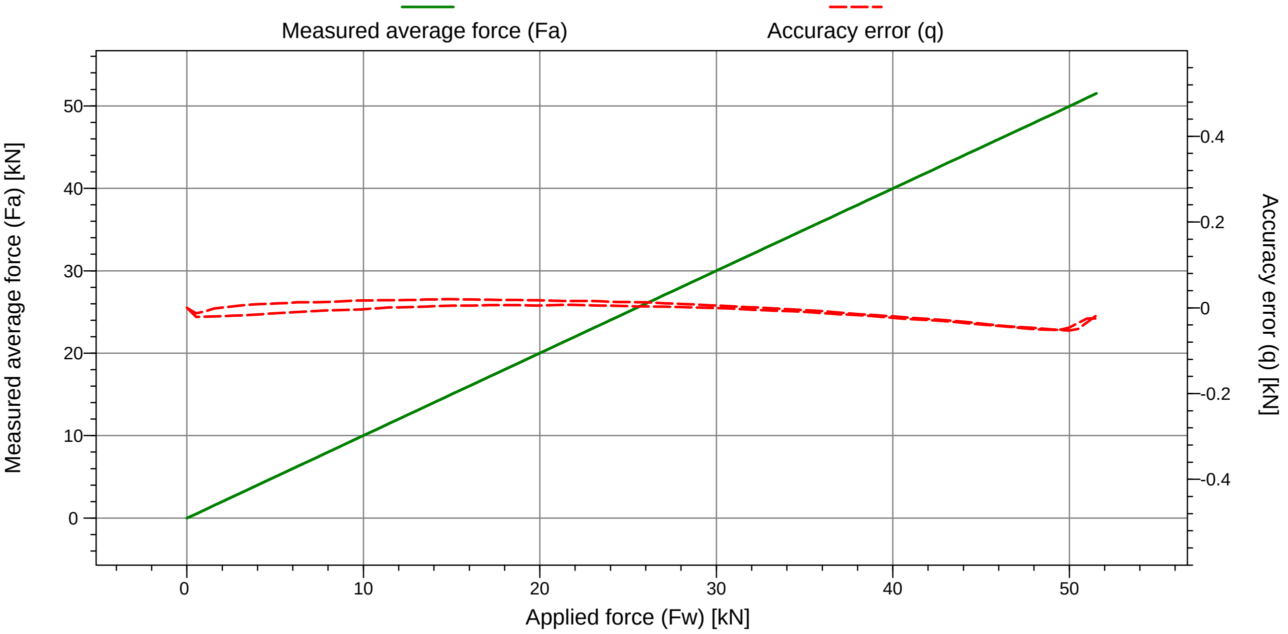
Reference	
Manufacturer	Zwick/Roell
Serial Number	6034-0003
Uncertainty	0.003•Fw+0.015 [kN]

Calibration Details	
Calibration Date	03 May 2016 09:00:09
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Sensor	
Channel	Cone+Fric. [Force]
Manufacturer / Type	Fugro Loadcell
Calibrated Range	0 to 50 kN
Maximum Rating	0 to 100 kN

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[kN]	0.046
Max repeatability error (b)	[kN]	0.010
Max reversibility error (v)	[kN]	0.020
Zero load error (Fc0)	[kN]	0.000
Zero load offset (F0)	[kN]	0.010
Resolution	[kN]	3.67E-05
Noise RMS	[kN]	0.000
Tip-Sleeve Interaction	[kPa]	1.3
Tip-Sleeve Interaction %	[%]	0.26



Applied force (Fw) [kN]	**Measured force 1 (Fa,1) [kN]**	**Measured force 2 (Fa,2) [kN]**	**Measured force 3 (Fa,3) [kN]**	**Measured average force (Fa) [kN]**	**Accuracy error (q) [kN]**	**Repeatability error (b) [kN]**	**Reversibility error (v) [kN]**
0.000	0.001	-0.001	0.000	0.000	0.000	0.002	
10.000	9.996	9.996	9.998	9.997	-0.003	0.002	0.020
20.000	20.006	20.004	20.006	20.005	0.005	0.002	0.012
30.000	29.999	29.999	29.999	29.999	-0.001	0.000	0.006
40.000	39.976	39.976	39.978	39.977	-0.023	0.002	0.003
50.000	49.952	49.950	49.960	49.954	-0.046	0.010	
40.000	39.979	39.982	39.980	39.980	-0.020	0.002	
30.000	30.005	30.006	30.005	30.005	0.005	0.001	
20.000	20.018	20.017	20.017	20.017	0.017	0.001	
10.000	10.017	10.017	10.016	10.017	0.017	0.001	
0.000	-0.001	0.000	0.000	0.000	0.000	0.001	

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FRICTION SLEEVE NET AREA RATIO RESULT

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

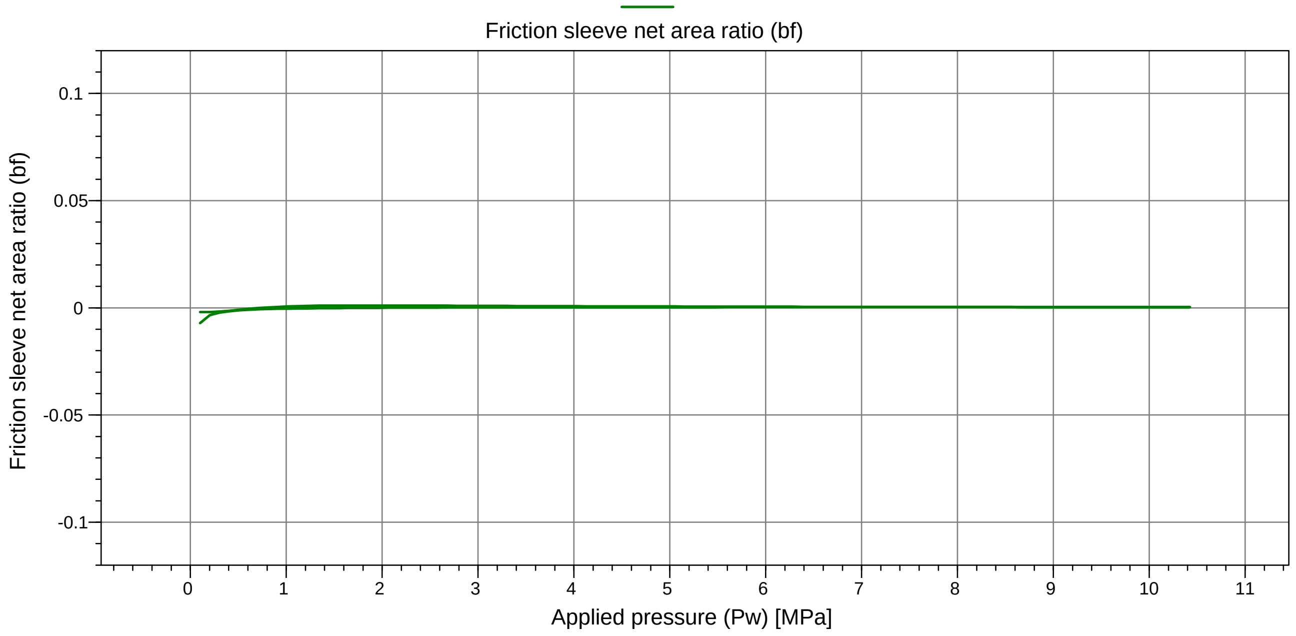
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 10:06:01
Procedure	FEBV.CAL.PRO.003
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Characteristics	**Unit**	**Value**
Friction sleeve net area ratio (bf)	[-]	0.00030

The friction sleeve net area ratio presented above is determined at the maximum applied pressure during the measurement.



Applied pressure (Pw) **[MPa]**	**Measured friction sleeve net area ratio (bf) 1 (bf,1)**	**Measured friction sleeve net area ratio (bf) 2 (bf,2)**	**Measured friction sleeve net area ratio (bf) 3 (bf,3)**	**Measured average Friction sleeve net area ratio (bf)**
2.000	0.001	0.001	0.001	0.001
4.000	0.001	0.001	0.001	0.001
6.000	0.001	0.001	0.001	0.001
8.000	0.000	0.000	0.000	0.000
10.000	0.000	0.000	0.000	0.000
8.000	0.000	0.000	0.000	0.000
6.000	0.000	0.000	0.000	0.000
4.000	0.000	0.000	0.000	0.000
2.000	0.000	0.000	0.000	0.000

PORE 2 CALIBRATION RESULT [PRESSURE]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

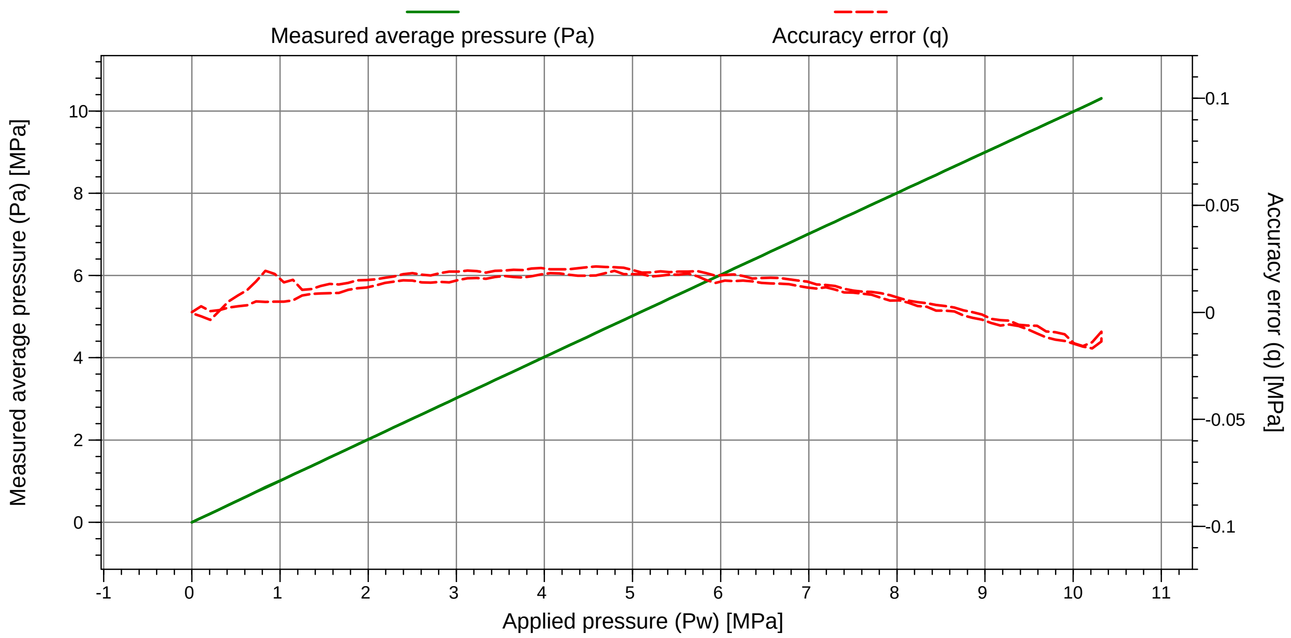
Reference	
Manufacturer	Keller PA-33X
Serial Number	3257-0002
Uncertainty	0.0005•Pw+0.002 [MPa]

Calibration Details	
Calibration Date	03 May 2016 10:06:00
Procedure	FEBV.CAL.PRO.004
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Sensor	
Channel	Pore 2 [Pressure]
Manufacturer / Type	Keller PA-8/100bar (8467.8)
Calibrated Range	0 to 10 MPa
Maximum Rating	0 to 15 MPa

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[MPa]	0.020
Max repeatability error (b)	[MPa]	0.003
Max reversibility error (v)	[MPa]	0.003
Zero load error (Pc0)	[MPa]	0.000
Zero load offset (P0)	[MPa]	-0.015
Resolution	[MPa]	2.18E-06
Noise RMS	[MPa]	0.000



Applied pressure (Pw) **[MPa]**	**Measured pressure 1 (Pa,1)** **[MPa]**	**Measured pressure 2 (Pa,2)** **[MPa]**	**Measured pressure 3 (Pa,3)** **[MPa]**	**Measured average pressure (Pa)** **[MPa]**	**Accuracy error (q)** **[MPa]**	**Repeatability error (b)** **[MPa]**	**Reversibility error (v)** **[MPa]**
0.000	0.000	0.000	0.000	0.000	0.000	0.000	
2.000	2.011	2.012	2.012	2.012	0.012	0.001	0.003
4.000	4.019	4.017	4.018	4.018	0.018	0.002	0.003
6.000	6.015	6.013	6.015	6.014	0.014	0.003	0.003
8.000	8.004	8.006	8.006	8.005	0.005	0.002	0.002
10.000	9.986	9.984	9.986	9.985	-0.015	0.002	
8.000	8.006	8.007	8.007	8.007	0.007	0.001	
6.000	6.018	6.016	6.018	6.017	0.017	0.002	
4.000	4.021	4.020	4.021	4.020	0.020	0.000	
2.000	2.015	2.015	2.016	2.015	0.015	0.001	
0.000	0.000	0.000	0.000	0.000	0.000	0.000	

SLOPE CALIBRATION RESULT [INCLINATION]

Instrument	
Manufacturer	Fugro
Type	CP10-CF50PB10SN2-P1E1M1-V1
Serial Number	1706-2366
Electronics	5252
Node Type	7001
Hardware Version	4.00
Software Version	7.08

Reference	
Manufacturer	Hoek-O-Mat
Serial Number	2109-0002
Uncertainty	0.6 [Deg]

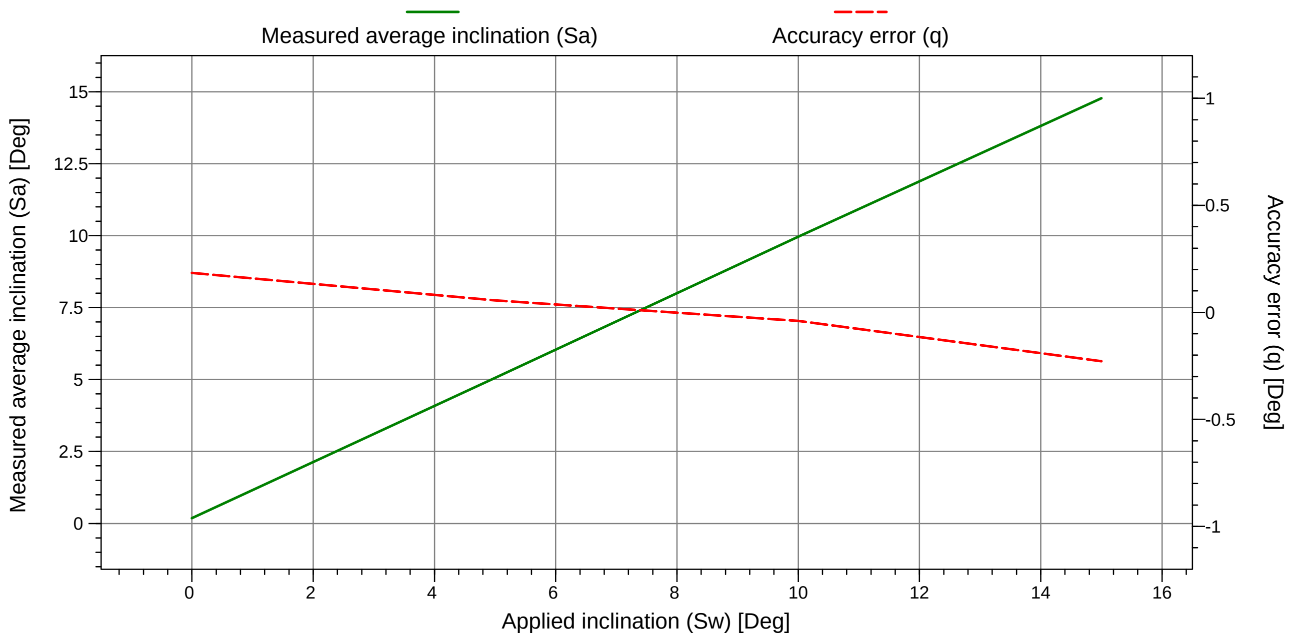
Calibration Details	
Calibration Date	03 May 2016 09:14:18
Procedure	FEBV.CAL.PRO.005
Software Version	1.22.0.17638

Certificate Number
FCN16006762

Sensor	
Channel	Slope [Inclination]
Manufacturer / Type	ADXL
Calibrated Range	0 to 15 Deg
Maximum Rating	0 to 20 Deg

Characteristics	**Unit**	**Value**
Max accuracy error (q)	[Deg]	0.2
Max repeatability error (b)	[Deg]	0.2
Zero load error (Sc0)	[Deg]	0.0
Zero load offset (S0)	[Deg]	0.2
Resolution	[Deg]	1.28E-05
Noise RMS	[Deg]	0.0

Inclination is defined as the angular deviation of the cone penetrometer from the vertical.



Applied inclination (Sw) [Deg]	**Measured inclination 1 (Sa,1) [Deg]**	**Measured inclination 2 (Sa,2) [Deg]**	**Measured inclination 3 (Sa,3) [Deg]**	**Measured average inclination (Sa) [Deg]**	**Accuracy error (q) [Deg]**	**Repeatability error (b) [Deg]**
0.0	0.2	0.1	0.3	0.2	0.2	0.1
5.0	5.0	5.0	5.1	5.1	0.1	0.1
10.0	10.0	9.9	10.0	10.0	0.0	0.1
15.0	14.9	14.7	14.8	14.8	-0.2	0.2

SYMBOLS, DEFINITIONS AND REFERENCES

Certificate Number
FCN16006762

Symbols and Definitions (general)

af	Cone net area ratio, defined as the factor between the applied pressure to the instrument and the indicated cone resistance.
af,x	Measured cone net area ratio at measurement x.
b	Repeatability error, defined as the maximum difference between the measurements of the instrument at the applied value.
bf	Friction sleeve net area ratio, defined as the factor between the applied pressure to the instrument and the indicated sleeve friction.
bf,x	The measured friction sleeve net area ratio at measurement x.
Noise RMS	Signal noise, defined as the quadratic mean when the sensor is not subjected to load.
q	Accuracy error, defined as the difference between the average indicated value by the instrument and the applied value.
Resolution	Smallest change in a quantity being measured that causes a perceptible change in the corresponding indication.
Tip-Sleeve Interaction	Effect of cone tip measurements on derived friction measurements, due to coupling of the cone tip and friction sleeve element. Expressed in terms of friction and as a percentage of the full scale output of the cone tip.
v	Reversibility error, defined as the difference between the average indicated value by the instrument at a certain applied value when it was increased and when it was decreased.

Symbols and Definitions (quantity specific: Q may be substituted for F, P or S, as appropriate)

Q0	Zero load offset, instrument output where the specified measured quantity value is zero.
Qa	Average indicated quantity value by the instrument.
Qa,x	Quantity value indicated by the instrument at measurement x.
Qc0	Zero load error, defined as the difference between the average indicated value by the instrument before and after the load cycle has been applied.
Qw	Applied reference quantity value.

Quantities

F	Force
P	Pressure
S	Inclination

References

European Co-operation For Accreditation (2013), "Evaluation of the uncertainty of measurement in calibration", European Co-operation For Accreditation, 75 p. (Publication ; EA-4/02 M:2013)

ISO International Organization for Standardization (1999), "General requirements for the competence of testing and calibration laboratories", International Standard ISO 17025:2005

ISO International Organization for Standardization (2003), "Measurement management systems - requirements for measurement processes and measuring equipment", International Standard ISO 10012:2003

International Organization for Standardization (ISO) (2000), "Quality management systems - Requirements", International Standard ISO 9001

CALIBRATION CERTIFICATE

Applicant	**Fugro Engineers B.V.**
	Prismastraat 4 2631 RT, Nootdorp The Netherlands

Certificate Number
FCN16006553

Instrument	**Seismic Penetrometer**
Manufacturer	Fugro
Type	SP10-G0-P1E1M6-V1
Serial Number	1733-0008

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Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration date 06-Apr-2016

Calibrate before 06-Apr-2017

Calibrated Sensor	**Manufacturer / Type**	**Calibrated Range**	**Maximum Rating**	**Procedure**

Nootdorp, 06-Apr-2016

Gerry Sinjorgo
Manager Transducer Workshop

CALIBRATION CERTIFICATE

Applicant	**Fugro Engineers B.V.**
	Prismastraat 4 2631 RT, Nootdorp The Netherlands

Certificate Number
FCN16006766

Page 1 of 1

Instrument	**Seismic Penetrometer**
Manufacturer	Fugro
Type	SP10-G0-P1E1M1-V1
Serial Number	1733-0012

Calibration method The instrument was calibrated according to Fugro procedures using a comparison technique against a reference standard.

Environmental Conditions	
Temperature during calibration	20.5 ± 3 °C
Atmospheric pressure during calibration	1000 ± 100 mbar

Result The result is shown on the next page(s).

Uncertainty The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides a confidence level of approximately 95%. The standard uncertainty has been determined in accordance with EA-4/02.

Traceability Fugro reference standards are periodically recertified and are traceable to the International System of Units (SI). Fugro’s calibration system meets or exceeds the requirements of ISO 9001:2008, ISO 10012:2003 and ISO/IEC 17025:2005.

Calibration date 03-May-2016

Calibrate before 03-May-2017

Calibrated Sensor	**Manufacturer / Type**	**Calibrated Range**	**Maximum Rating**	**Procedure**

Nootdorp, 03-May-2016

Gerry Sinjorgo
Manager Transducer Workshop

This investigation was carried out by Fugro Engineers B.V., commissioned by RVO.nl, an agency of the Ministry of Economic Affairs and Climate Policy.

The information in this document is valid at the time of publishing (see month/year). Updates will be published on the website https://offshorewind.rvo.nl/ at the relevant sitemap (Hollandse Kust (zuid)/Hollandse Kust (noord)/Hollandse Kust (west)), General Information, submap Revision Log and Q & A. In the Revision Log is indicated which versions are the latest and what the changes are in relation to previous versions. The documents can be found at the relevant sites, indicated in the Revision Log.

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Netherlands Enterprise Agency (RVO.nl) | December 2016