Geotechnical Report
Laboratory Test Data
Wind Farm Site I&II
Borssele Wind Farm Zone
Dutch Sector, North Sea

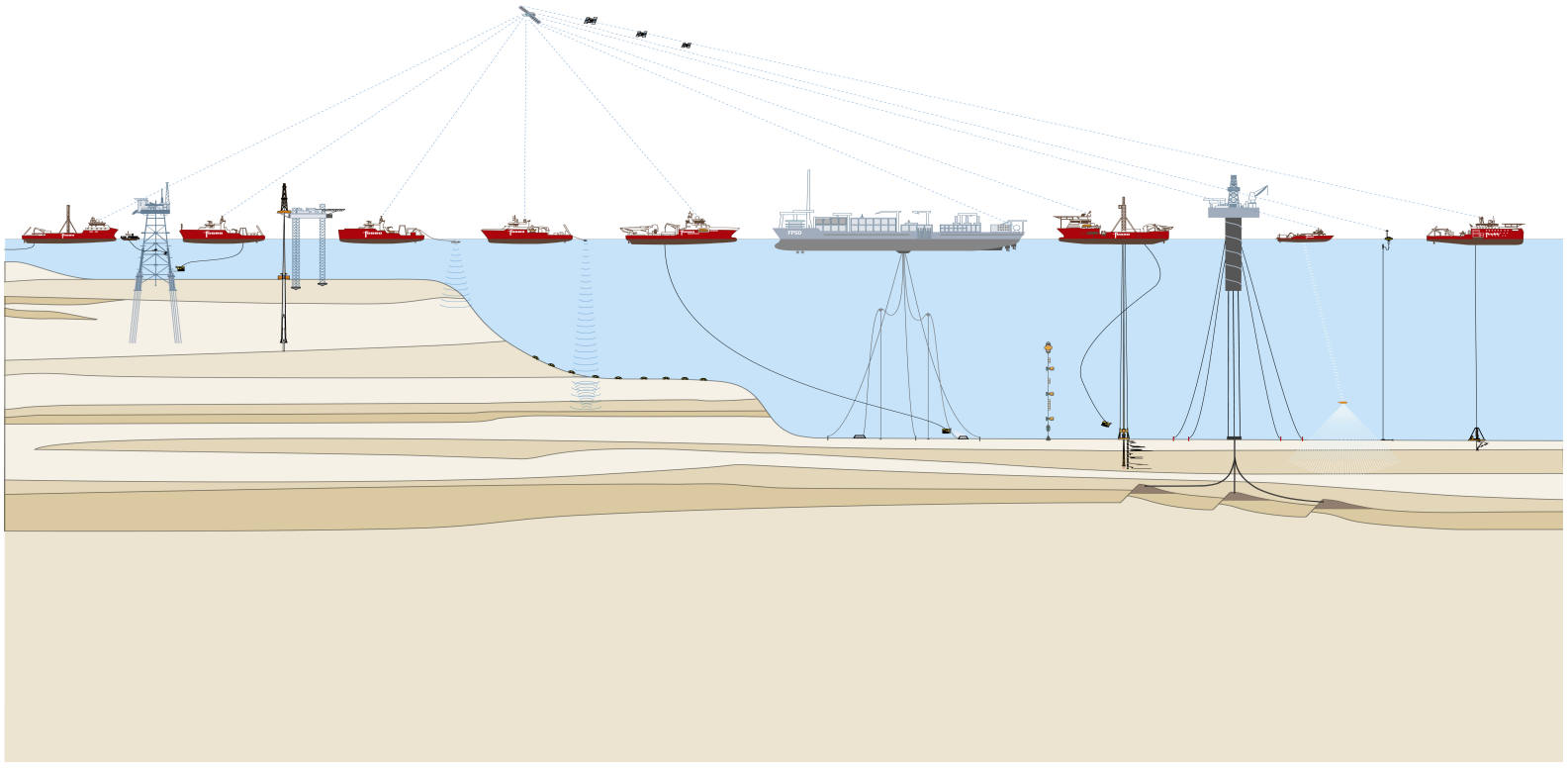
Client Reference No. TN48112

Fugro Report No. N6016/07

Issue 3

Rijksdienst voor Ondernemend Nederland

Rijksdienst voor Ondernemend Nederland (RVO)



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Client	Rijksdienst voor Ondernemend Nederland (RVO)
Client Address	Croeselaan 15 3521 BJ Utrecht The Netherlands
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Attention: Mr R. de Bruijne

Our ref: N6016/07(3)/MKL/EMG

Nootdorp, 4 September 2015

Geotechnical Report – Laboratory Test Data –
Wind Farm Site I&II – Borssele Wind Farm Zone – Dutch Sector, North Sea

This report presents geotechnical information. The report was prepared in accordance with Contract WOZ1500008 between Rijksdienst voor Ondernemend Nederland (RVO) and Fugro Engineers B.V., dated 17 March 2015.

The principal team members for report preparation were Mr P. Holley (Geotechnical Engineer) and undersigned. We acknowledge the valuable assistance of Mr R. de Bruijne, who acted as Client contact for this project.

Thank you for the opportunity to be of service. Please do not hesitate to contact us if you require any additional information.

Yours faithfully
FUGRO ENGINEERS B.V.

M. Klein
Principal Geotechnical Engineer

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REPORT ISSUE CONTROL

Section	Page No.	Plate No.	Issue No.	Revision

Notes:

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
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QUALITY MANAGEMENT RECORD

Project Lead: R. Atsma – Senior Project Engineer

Report Review and Approval: J. Peuchen – Principal Engineer

Report Section	Prepared By	Checked By
Main Text	MKL	LJP
Plates following Main Text	MKL	LJP
A Geotechnical Laboratory Test Results	PH	MKL
– Laboratory Testing Overview	PH	MKL
– Index Laboratory Tests	PH	MKL
– Microscopic Inspection	PH	MKL
– Static Triaxial Tests	PH	MKL
– Static Direct Simple Shear Tests	PH	MKL
– Cyclic Triaxial Tests	PH	MKL
– Cyclic Direct Simple Shear Tests	PH	MKL

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SUMMARY

The Dutch Ministry of Economic Affairs is responsible for the legislative framework for the development of offshore wind farms in the Netherlands. Within this framework (a) (concession) tender(s) for subsidy for construction and operation of (a) wind farm(s) will be organized under the SDE+ regulation. As part of the tender preparations, the Netherlands Enterprise Agency (RVO) has requested Fugro to perform a geotechnical investigation of Wind Farm Site WFS I & II of the Borssele Wind Farm Zone (WFZ). The Borssele Wind Farm Zone is located in the Dutch Sector of the North Sea, approximately 36 km from the coastline (refer to "Vicinity Map" on Plate 1-1 and "Detailed Location Plan" on Plates 1-2 to 1-3).

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

- improve the geological and geotechnical understanding;
- 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 included geotechnical borehole drilling with downhole sampling and in situ testing, seafloor in situ testing and geotechnical laboratory testing. An office programme of geotechnical laboratory testing and reporting of results followed the offshore phase.

This report is one of a set of Fugro reports. This particular report provides laboratory test results for WFS I&II:

- Results of geotechnical index tests;
- Results of static triaxial and direct simple shear tests, including measurement of small strain on selected specimens;
- Results of cyclic triaxial and cyclic simple shear tests;
- Cyclic test results plotted for S-N degradation curves and with background Drammen Clay Model.

This report is one in a series of reports prepared as part of this project (refer to "List of Project Reports" on Plate 1-4). Companion reports for WFS I&II contain results of geotechnical borehole locations, seafloor in situ test locations, and describe a geological ground model for site WFS I&II including geological setting, stratigraphy, lateral variability, geohazards and basic geotechnical parameter values respectively.

SAMENVATTING

Het Ministerie van Economische Zaken is verantwoordelijk voor het wettelijke kader van de ontwikkeling van windparken op zee in Nederland. Binnen dit kader vallen inschrijvingen voor de Stimulering Duurzame Energie (SDE+) subsidieregeling voor de bouw en uitvoering van (een) windpark(en) op zee. T.b.v. de voorbereiding van de inschrijvingen heeft de Rijksdienst Voor Ondernemend Nederland (RVO) Fugro gecontracteerd voor een geotechnisch onderzoek in de kavels WFS I & II van windgebied Borssele (WFZ). Het windgebied Borssele ligt in het Nederlandse deel van de Noordzee, ongeveer 36 km voor de kust (zie “Vicinity Map” op Page v en “Detailed Location Plan” op Page vi).

Het doel van het geotechnisch onderzoek en bijbehorend programma van laboratoriumproeven is om:

- inzicht te verkrijgen in de geologische en geotechnische omstandigheden;
- 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 op locatie bestond uit geotechnische boorgaten met monsternames en in situ testen, sonderingen vanaf de zeebodem en geotechnische laboratoriumproeven. Vervolgens zijn op kantoor een geotechnisch laboratorium testprogramma en rapportage van de resultaten uitgevoerd.

Dit rapport maakt deel uit van een serie van Fugro rapporten. Dit rapport bevat resultaten van geotechnisch onderzoek voor WFS I & II:

- Resultaten van geotechnische classificatie laboratoriumproeven;
- Resultaten van statische triaxial en statische directe schuif proeven, inclusief meting van “small strain” op geselecteerde monsters;
- Resultaten van cyclische triaxial en cyclische schuifproeven;
- Plotten van cyclische resultaten tegen S-N degradatie grafieken en met achtergrond “Drammen Clay” model.

Dit rapport maakt deel uit van een serie van rapporten t.b.v. dit project (zie “List of Project Reports” op Page 1-4). Zes andere rapporten die WFS I&II behandelen bevatten respectievelijk: de resultaten van de geotechnische boorgat locaties, in situ test locaties vanaf de zeebodem, en een geologisch grondmodel voor WFS I&II voorzien van informatie over het geologisch kader, stratigrafie, laterale variabiliteit geo-risico’s en algemene geotechnische parameters

1. INTRODUCTION

1.1 Purpose of Report

The Dutch Ministry of Economic Affairs is responsible for the legislative framework for the development of offshore wind farms in the Netherlands. Within this framework (a) (concession) tender(s) for subsidy for construction and operation of (a) wind farm(s) will be organized under the SDE+ regulation. As part of the tender preparations, the Netherlands Enterprise Agency (RVO), henceforth referred to as 'Client', has requested Fugro to perform a geotechnical investigation of Wind Farm Site WFS I & II of the Borssele Wind Farm Zone (WFZ). The Borssele Wind Farm Zone is located in the Dutch Sector of the North Sea, approximately 36 km from the coastline (refer to "Vicinity Map" on Plate1-1 and "Detailed Location Plan" on Plates 1-2 to 1-3).

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

- improve the geological and geotechnical understanding;
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- 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 included geotechnical borehole drilling with downhole sampling and in situ testing, seafloor in situ testing and geotechnical laboratory testing. An 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. This particular report provides geotechnical results for WFS I&II, including:

- Results of geotechnical index tests;
- Results of static triaxial and direct simple shear tests, including measurement of small strain on selected specimens;
- Results of cyclic triaxial and cyclic simple shear tests and post-cyclic static tests;
- Cyclic test results plotted for S-N degradation curves and with background Drammen Clay Model.

Results presented in this report are for an area demarcated as Investigation Areas I and II. WFS I&II are within these areas. The boundaries of WFS I&II are subject to change.

1.3 Project Responsibilities and Use of Report

This report presents information according to a project specification determined and monitored by the Client.

This report must be read in conjunction with “Guide for Use of Report”, Section B.

Fugro understands that this report will be used for the purpose described in this “Introduction” 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.

1.4 Report Format

This report is one in a series of reports. Refer to Plate 1-4 for a list of Fugro reports prepared as part of this project. Companion reports for WFS I&II contain results of geotechnical borehole locations, seafloor in situ tests and describe a geological ground model for site WFS I&II including geological setting, stratigraphy, lateral variability, geohazards and basic geotechnical parameter values respectively.

The principal sections of this report are the Summary, Main Text, Plates following Main Text, and Section A. 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;
- Section A provides the principal information as described in Section 1.2 “Scope of Report”. This section should be read in conjunction with the Plates following Main Text, where applicable;
- Section A starts with primary information, which may consist of links to Plates following Main Text. Plate numbering starts with a section number, e.g. Plate A1-1 belongs to Section A1.

2. STUDY OVERVIEW

2.1 Sources of Information

This report uses and summarises selected information.

Client-supplied information included Geotechnical Scope of Work (RVO, 2015).

Survey of documents held in the Fugro database provided additional information, including information about the regional geology and general geotechnical data.

2.2 Laboratory Test Programme

2.2.1 Test Results

Geotechnical laboratory testing comprised (where appropriate) geotechnical index, microscopic inspection and (cyclic) strength, i.e. Isotropically Consolidated Undrained (CIUc and CIUe) triaxial tests in compression and extension, Cyclic CIU Triaxial (CTXL) tests, Direct Simple Shear (DSS) and Cyclic DSS (CSS) tests. Laboratory test results are provided in Section A "Geotechnical Laboratory Test Results". Section A further presents details and includes commentary on individual test results where required.

The static and cyclic test programme covered specimens of five distinct formations present across WFS I&II: Southern Blight, Eem/Kreftenheye, Tongeren, Rupel and Dongern. The Southern Blight, Eem/Kreftenheye and Tongeren formations consist predominantly of coarse-grained soils and the Rupel and Dongern formations consist predominantly of fine-grained soils.

The test programme consisted of:

- For each coarse-grained soil unit (three soil units in total):
  a. one (1) static consolidated undrained triaxial compression test including bender element tests for determination of shear wave velocity
  b. one (1) static consolidated undrained triaxial test
  c. and four (4) or five (5) cyclic consolidated undrained triaxial tests
- For each fine-grained soil unit (two soil units in total):
  a. two (2) or three (3) direct simple shear tests
  b. five (5) or six (6) cyclic simple shear tests
  c. one (1) static consolidated undrained triaxial compression test including bender element tests
  d. one (1) static consolidated undrained triaxial compression test
  e. two (2) static consolidated undrained triaxial extension tests.

Cyclic test results are plotted as cyclic degradation S-N curves, refer to Plates 2-1 and 2-2. The S-N curves were generated using a best-fit power regression model.

Static test results are included on Plates 2-1 and 2-2. However, to derive the regression lines for coarse grained material (Plate 2-1), static test results have been omitted from the data set. S-N curves proposed by Andersen (2009) are included as a reference. Vertical effective consolidation stress was used in the normalization of cyclic stresses.

Regression lines for the fine grained materials (Plate 2-2) use only selected cyclic test results from those which did not show failure after 1500 cycles. The test at the highest cyclic stress ratio (for N>1500) was used for the regression in case of multiple tests with N>1500. Tests results with no clear failure after 1500 cycles at lower CSR were not considered for the regression lines, although the data points are still included on Plate 2-2. Normalization of cyclic shear stresses uses a static reference undrained shear strength ($s_{u;ref}$). This reference strength is selected using the DSS test result on proximal samples.

Presented S-N curves should be used with care. Specific design situations require verification of suitability of the laboratory approach and presented regression lines.

Cyclic shear tests data are further plotted with background Drammen Clay Model contours (Andersen, 1988), refer to Plate 2-3. Selected $s_{u;ref}$ is the same as used for the S-N normalization.

2.2.2 Premises and Assumptions

The laboratory test programme was in addition to earlier laboratory test programmes performed as part of this project, refer to Plate 1-4. Tests were conducted according to ISO (2014).

For the coarse-grained soil units, test specimens were reconstituted. Testing was performed on batch samples, i.e. for each soil unit a selection of samples were mixed to form a batch. For each batch, static and cyclic testing was performed on specimens with the same densities and consolidation stresses.

Undisturbed specimens were used for static and cyclic testing of fine-grained soil units. Test conditions, i.e. vertical and radial stresses for re-compression, were selected on the basis of in situ stress conditions.

Cyclic testing was performed at 0.1 Hz, i.e. a cycle of 10 seconds. Specimens were subjected to stress controlled cyclic loading under undrained conditions and sinusoidal loading waveform. Specimens were tested at selected cyclic stresses (q_{cy} / τ_{cy}) with average cyclic stresses (q_{ay} / τ_{av}) set to zero.

Specimen failure is considered to be achieved when one of the following conditions has been met:

- The average shear strain amplitude exceeds 3.75% in coarse-grained soils or 15% in fine-grained soils;
- The cyclic shear strain amplitude exceeds 3.75% in coarse-grained soils or 15% in fine-grained soils;
- Excess pore water pressure exceeds 95% of the effective stress in the specimen at the start of cycling;
- The applied cyclic shear stress drops to less than 90% of the specified value.

Cyclic testing will be terminated when failure of the specimen is evident or at 1500 cycles, whichever is earlier.

2.2.3 Test preparations and test conditions

Triaxial testing was performed at isotropic conditions following an assessment of expected in situ stress conditions. Consolidation history was estimated using available oedometer test data and using Cone Penetration Test (CPT) correlation. The assessment indicated an Overconsolidation Ratio (OCR) of approximately 2.5 to 3 for the Rupel formation and around 3 to 3.5 for the Dongern formation.

Coefficient of earth pressure at rest (K_0) was estimated using Brooker and Ireland (1965) their proposed relation between OCR, plasticity[1] and K_0 and Mayne and Kulhawy (1982). Both methods indicated a K_0 value of around 1 for both soil units.

The in situ stress conditions used the unit weight profiles as used in calculation of derived CPT parameters, presented in companion reports (Plate 1-4). For fine-grained specimens, consolidation stresses were selected similar to calculated in situ stresses. For coarse-grained specimens, selected consolidation and test stresses represent an approximate average of in situ stress levels within the target formation. For the Southern Bight formation, a higher than average level was selected considering the recommended lower limits of the test apparatus (which is around 10 kPa to 15 kPa). Consolidation stresses are the same for tests on coarse-grained specimens from the same formation.

For the coarse-grained material “batch-samples” were prepared. Available particle size distribution data from samples from various formations were used to select a number of samples with similar grading as the predominant grading of the target formation. On these samples, microscopic inspection was performed to confirm that angularity and sphericity of the individual samples were similar. The microscopic inspection confirmed that samples could be batched. Section A3 presents results of the microscopic inspection. After samples were batched, sieving analyses were done to confirm that sample grading was in line with the predominant grading of the target formation. Results of the sieving analyses on the batch samples are presented in Section A2. No soil was re-used after testing.

Selected dry densities for coarse-grained specimen preparation were based on (a) average measured unit weights and water contents and (b) minimum and maximum index dry unit weights. The selected densities represent relative densities of approximately 70% (Southern Bight), 100% (Eem/ Kreftenheye) and 60% (Tongeren). It may be noted that the method for determination of the maximum index unit weight is different from the method of triaxial test specimen preparation. The results of maximum index unit weight tests are typically higher and may not be fully achieved during test specimen preparation.

[1] Atterberg limits indicate a plasticity between 40% to 60% for the Rupel formation and 80% to 100% for the Dongern formation.

3. REFERENCES

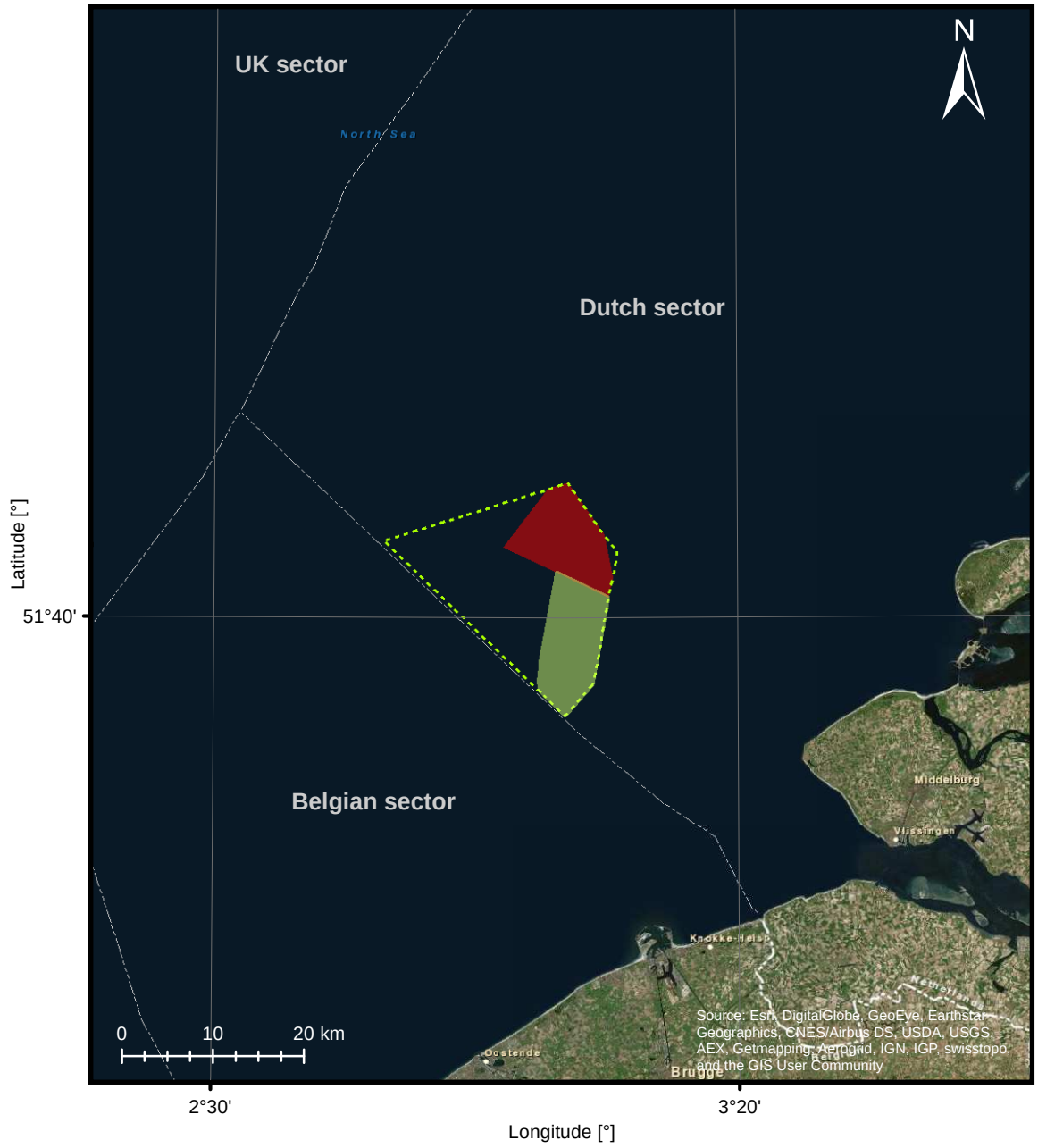
Andersen, K.H. and Lauritzsen, R., (1988), “Bearing Capacity for Foundations with Cyclic Loads”, Journal of Geotechnical Engineering, Vol. 114, No.5, pp. 540-555.

Andersen, K.H. (2009), "Bearing Capacity under Cyclic Loading - Offshore, along the Coast, and on Land. The 21st Bjerrum Lecture presented in Oslo, 23 November 2007", Canadian Geotechnical Journal, Vol. 46, No. 5, pp. 513-535.

BSI British Standards Institution (1999), "Code of Practice for Site Investigations", British Standard BS 5930:1999.

ISO International Organization for Standardization (2014), “Petroleum and Natural Gas Industries - Specific Requirements for Offshore Structures – Part 8: Marine Soil Investigations”, International Standard ISO 19901-8:2014.

Rijksdienst voor Ondernemend Nederland (2015), “Soil Investigations Wind Farm Zones - Section IV-d. Scope of Work Geotechnical Survey - Borssele Wind Farm Zone - Wind Farm Site I & II”, Rev F, 17 March 2015.



Investigation Area I
Investigation Area II
Outline of Borssele Wind Farm Zone
Maritime_Boundary

Ellipsoid: GRS 1980
Datum: ETRS 1989

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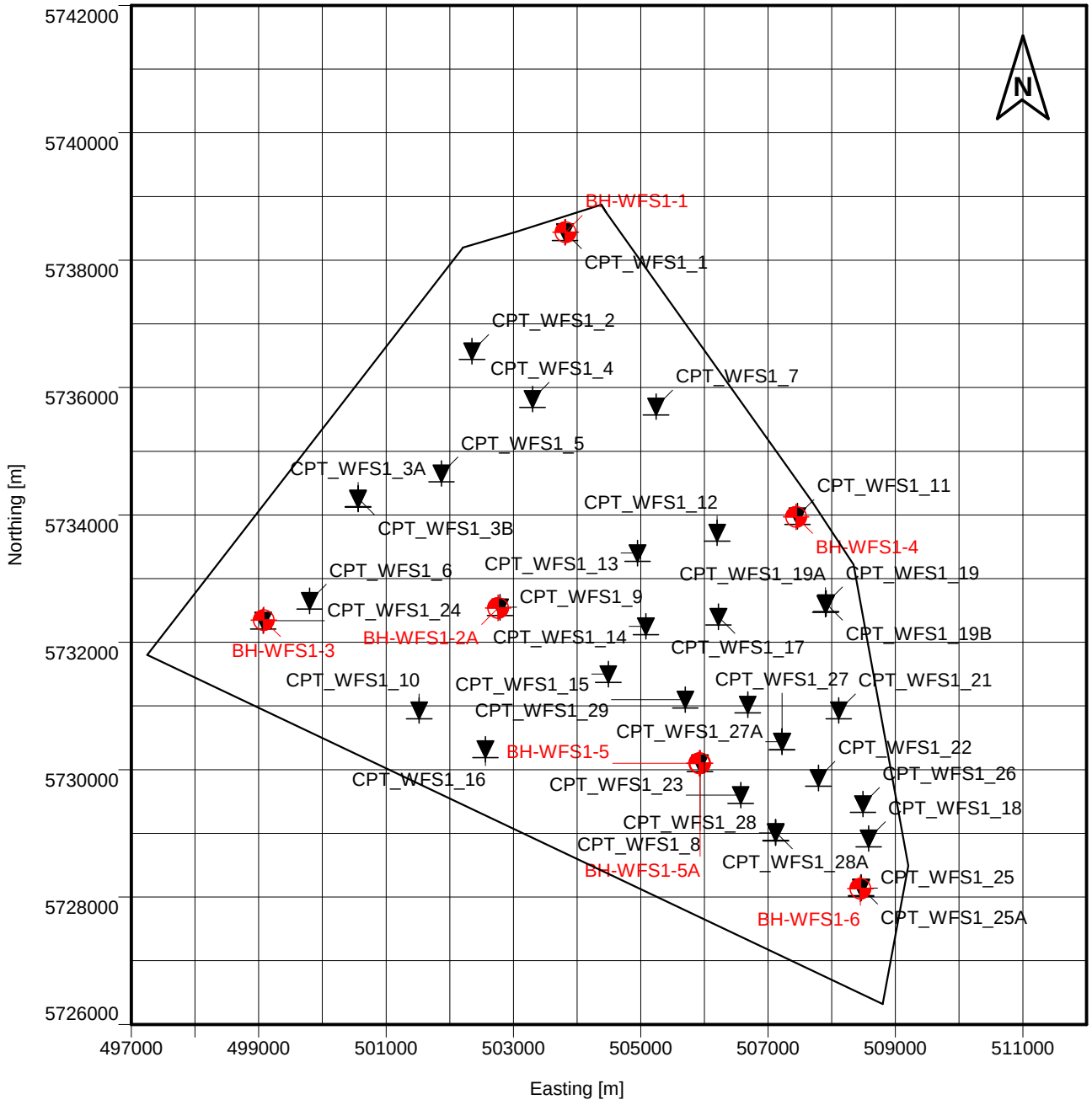
VICINITY MAP

BORSSELE WIND FARM ZONE, WFS I & II – DUTCH SECTOR, NORTH SEA



Rotary borehole drilling, sampling and testing

Cone penetration testing

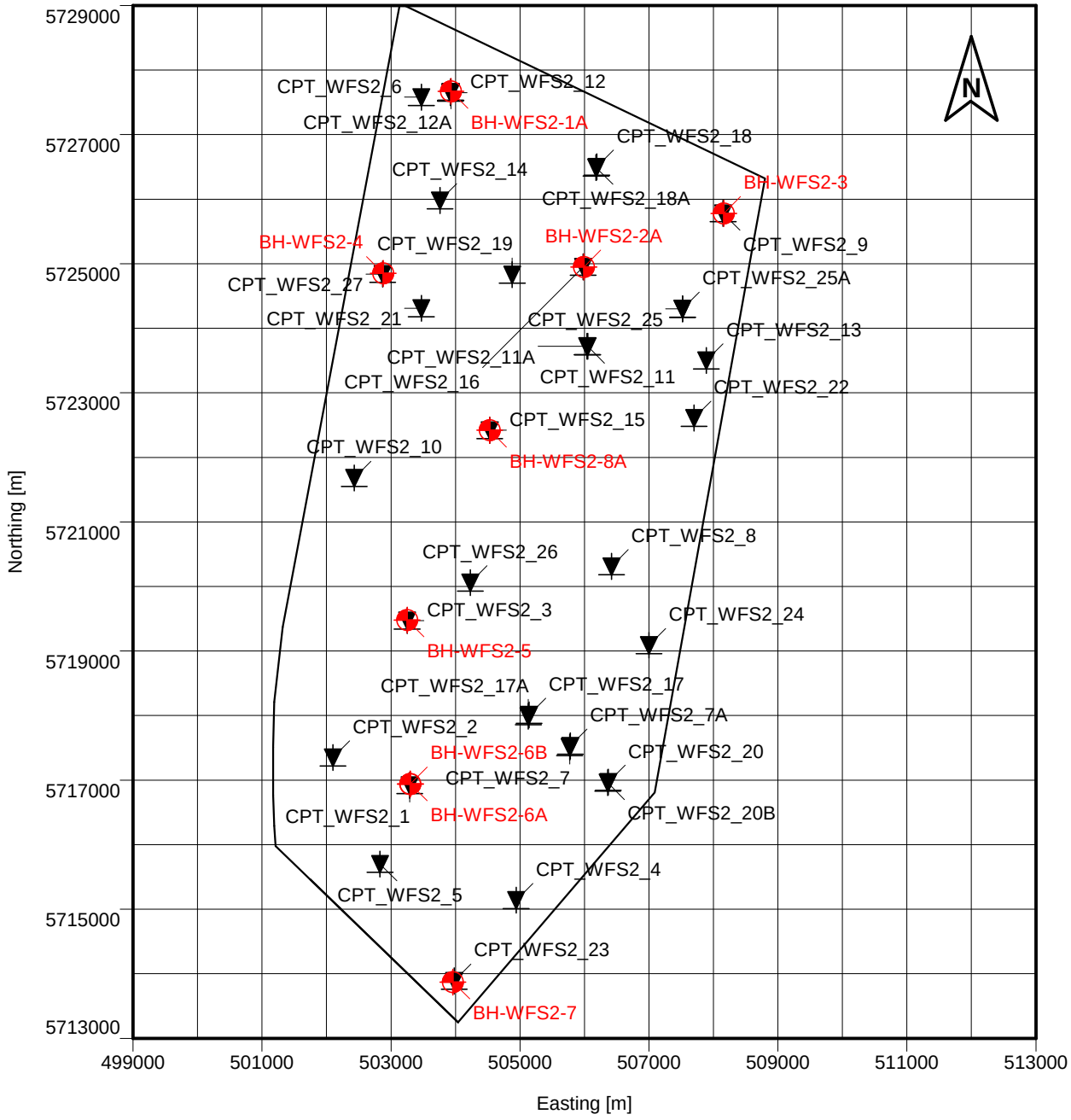
Investigation Area - I

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

GeODin-System 3.0 / N6016-07 Detailed location plan WFS I - (BH and CPT).GGF / 2015-08-31 / 16:20:00

DETAILED LOCATION PLAN

BORSSELE WIND FARM ZONE, WFS I & II – DUTCH SECTOR, NORTH SEA



GeODin-System 3.0 / N6016-07 Detailed location plan WFS II - (BH and CPT).GGF / 2015-08-31 / 16:20:27

DETAILED LOCATION PLAN

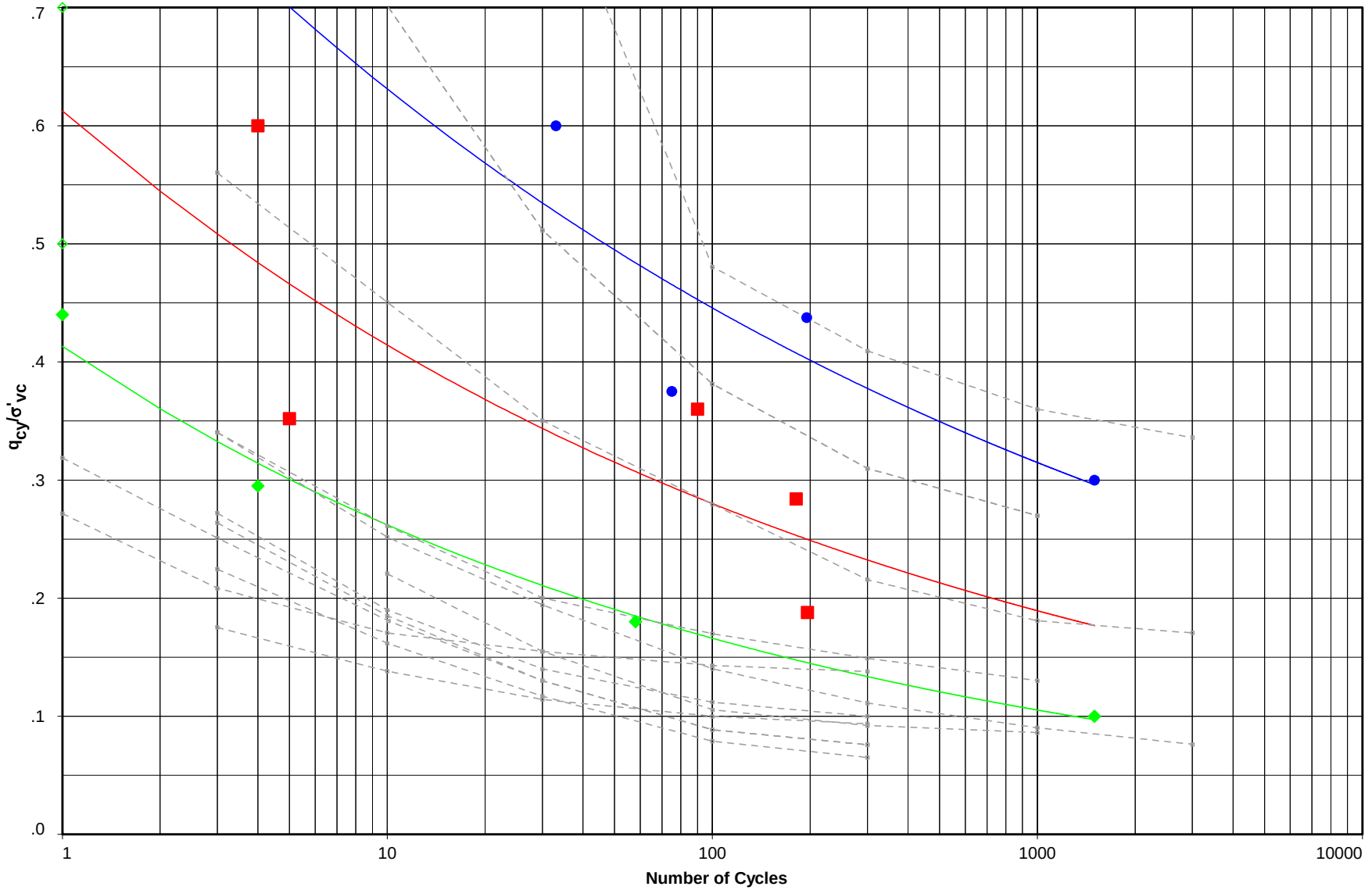
BORSSELE WIND FARM ZONE, WFS I & II – DUTCH SECTOR, NORTH SEA

Report Number	Title	Contents
N6016/01	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site I Borssele 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.
N6016/02	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site I Borssele Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including interpreted geotechnical logs and results from seafloor cone penetration tests.
N6016/03	Geotechnical Report - Investigation Data - Geotechnical Borehole Locations Wind Farm Site II Borssele 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.
N6016/04	Geotechnical Report - Investigation Data - Seafloor In Situ Test Locations Wind Farm Site II Borssele Wind Farm Zone - Dutch Sector, North Sea	Geotechnical data including interpreted geotechnical logs and results from seafloor cone penetration tests.
N6016/05	Geological Ground Model Wind Farm Site I Borssele Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including, stratigraphy, lateral soil variability, geohazards, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6016/06	Geological Ground Model Wind Farm Site II Borssele Wind Farm Zone - Dutch Sector, North Sea	Geological ground model including, stratigraphy, lateral soil variability, geohazards, basic geotechnical parameter values and assessment of geotechnical suitability of selected types of structures.
N6016/07	Geotechnical Report - Laboratory Test Data Wind Farm Sites I & II Borssele Wind Farm Zone - Dutch Sector, North Sea	Results of advanced static and cyclic laboratory tests.

LIST OF FUGRO REPORTS
BORSSELE WIND FARM ZONE, WFS I&II – DUTCH SECTOR, NORTH SEA

NORMALIZED CYCLIC DEVIATOR STRESS VERSUS NUMBER OF CYCLES TO FAILURE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA



Note 1: CIU triaxial test results from Southern Bight and Eem/Kreftenheye batch samples plot outside the graph

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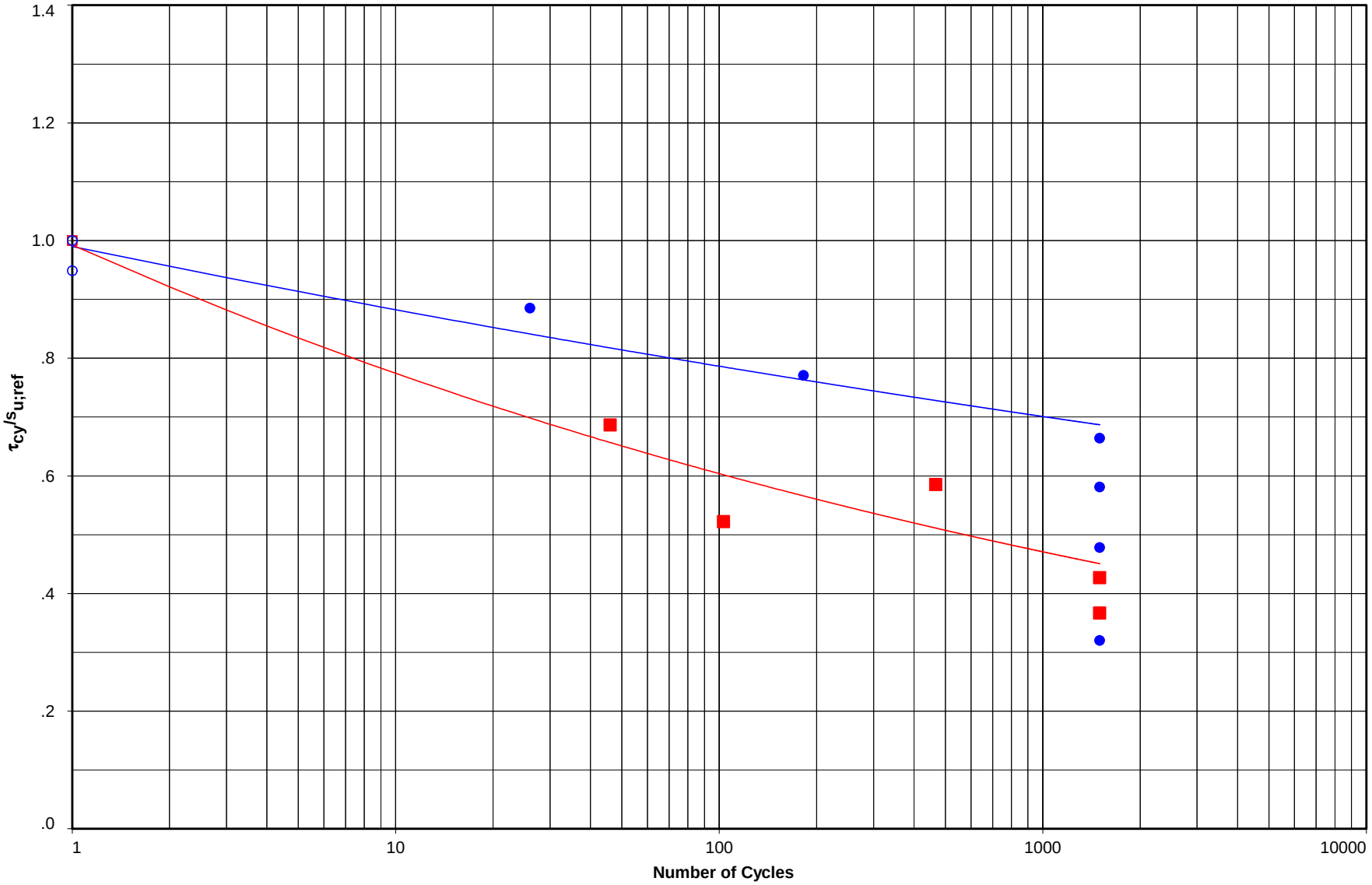
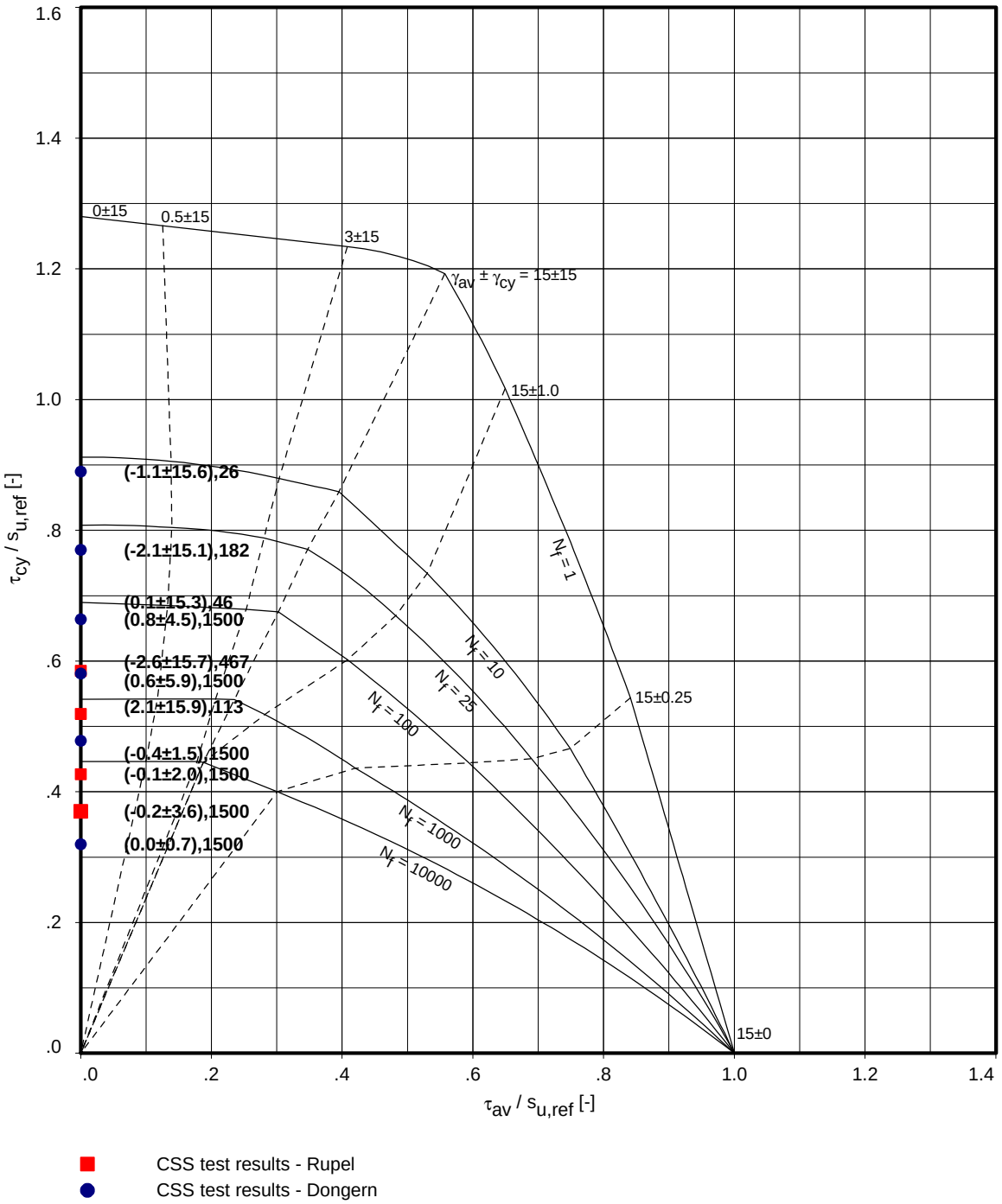
NORMALIZED CYCLIC SHEAR STRESS VERSUS NUMBER OF CYCLES TO FAILURE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Note(s):
- Comparison of cyclic direct simple shear test results with Drammen clay model at YSR = 1 (Andersen et al., 1988)
- (γ_{av}±γ_{cy}),N_f : Average shear strain and cyclic shear strain (%) at final number of cycles

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CYCLIC SIMPLE SHEAR TESTS - DRAMMEN CLAY COMPARISON (YSR=1)

BORSSELE WIND FARM ZONE, WFS I&II - DUTCH SECTOR, NORTH SEA

SECTION A: GEOTECHNICAL LABORATORY TEST RESULTS

SECTION A1: LABORATORY TESTING OVERVIEW

TEXT – SECTION A1: Page

LIST OF PLATES IN SECTION A1: Plate

A1. LABORATORY TESTING OVERVIEW

A1.1 SUMMARY OF LABORATORY TESTS

Main Text Section 2.2 titled “Laboratory Test Programme” presents an overview of the geotechnical laboratory tests performed including discussion of adopted strategy, premises and assumptions. Section A presents results from the laboratory tests performed. Table A1.1 presents the type and number of laboratory tests along with test references. Note that water content, unit weight and pocket penetrometer tests, which are part of test types are not presented in this table. Laboratory test data are presented per type per section.

Table A1.1: Overview of Laboratory Test Programme

Test Type	Total Number of Tests	Formation					Test Procedure (ISO, 2014)
		Southern Bight	Eem/Kreftenheye	Tongeren	Rupel	Dongern	
Geotechnical Index							
Particle Size Analysis (Sieving)	3	1	1	1	-	-	BS1377:Part 2:1990 / Fugro in-house procedure
Microscopic Inspection	27	10	11	6	-	-	In general accordance with BS 5930:1999
Strength							
Isotropically Consolidated Undrained Triaxial (CIU) compression with (Bender Elements)	5 / (5)	1 / (1)	1 / (1)	1 / (1)	1 / (1)	1 / (1)	BS1377:Part 8:1990 / Fugro in-house procedure
Isotropically Consolidated Undrained Triaxial (CIU) extension	4	-	-	-	2	2	Fugro in-house procedure
Direct Simple Shear (DSS)	5	-	-	-	2	3	Fugro in-house procedure based ASTM6528-07
Cyclic							
Cyclic Isotropically Consolidated Undrained Triaxial (CTXL)	13	5	4	4	-	-	Fugro in-house procedure
Cyclic Direct Simple Shear	11	-	-	-	5	6	Fugro in-house procedure based ASTM6528-07

Strength testing on coarse-grained material was performed on batch samples. Testing on the fine-grained formation selected undisturbed samples were used. Table C1.2 below presents a summary of the samples used for batch sample preparation and strength testing.

Table A1.2: Test Specimens per Formation

Formation[(1)]	Location	Site	Sample	Sample Type	Sample Depth [m bsf]	Test Type
Southern Bight	BH-WFS1-1	WFSI	2A/2B	Bag	3.00 / 3.30	- CIUc(+BE) - CTXL
	BH-WFS1-3	WFSI	2A/2B	Bag	1.00 / 1.30	
	BH-WFS1-4	WFSI	2A/2B	Bag	1.00 / 1.30	
	BH-WFS2-4	WFSII	3A	Bag	2.00	
	BH-WFS2-5	WFSII	2A/2B	Bag	1.00 / 1.20	
			4A/4B	Bag	3.00 / 3.30	
Eem/Kreftenheye	BH-WFS1-6A	WFSI	7A	Bag	6.00	- CIUc(+BE) - CTXL
			12A	Bag	13.00	
	BH-WFS2-3	WFSII	4A	Bag	5.00	
	BH-WFS2-4	WFSII	10A	Bag	9.00	
	BH-WFS2-6A	WFSII	4A	Bag	8.00	
Tongeren	BH-WFS1-2A	WFSI	22A	Bag	52.00	- CIUc(+BE) - CTXL
			25A	Bag	64.50	
	BH-WFS1-3	WFSI	14B	Bag	25.40	
			16A	Bag	34.00	
	BH-WFS1-5A	WFSI	17B	Bag	56.45	
	BH-WFS1-6	WFSI	25C	Bag	53.60	
Rupel	BH-WFS1-1	WFSI	17D	WAX	51.50	CIUe
			18C	WAX	52.25	CIUc+BE
	BH-WFS1-4	WFSI	17C / 17D	WAX	34.75 / 34.95	- DSS - CSS
			20B	WAX	40.55	CIUc
			21D	WAX	44.95	CIUe
	BH-WFS2-3	WFSII	9B	WAX	18.05	DSS
Dongern	BH-WFS2-6A	WFSII	15B	WAX	40.05	DSS
			18D	WAX	49.4	CIUc+BE
			20B	WAX	54.35	CIUe
	BH-WFS2-7		19C / 19D / 20C	WAX	33.30 / 33.50 / 34.10	- DSS - CSS
			21D	WAX	38.50	CIUe
			22D	WAX	39.50	CIUc

Notes:
(1) Samples for the Southern Bight, Eem/Kreftenheye and Tongeren were batched. Laboratory testing, apart from the microscopic inspection, was performed on batch samples.

Table A1.3 presents and overview of the selected dry density and consolidation conditions for the various batch samples. In general sample preparation achieved the specified conditions.

Table A1.3: Target Test Preparation Conditions for Batch Samples

Formation	Test Type	Target Dry Density [Mg/m^3]	Isotropic Consolidation Stress [kPa]
Southern Bight	- CIUc(+BE) - CTXL	1.63	25
Eem/Kreftenheye		1.70	80
Tongeren		1.61	400
Notes: - Actual dry densities may vary slightly compared to target			

Figures 1 to 3 below present summaries of the particle size distribution PSD curves used for batch sampling.

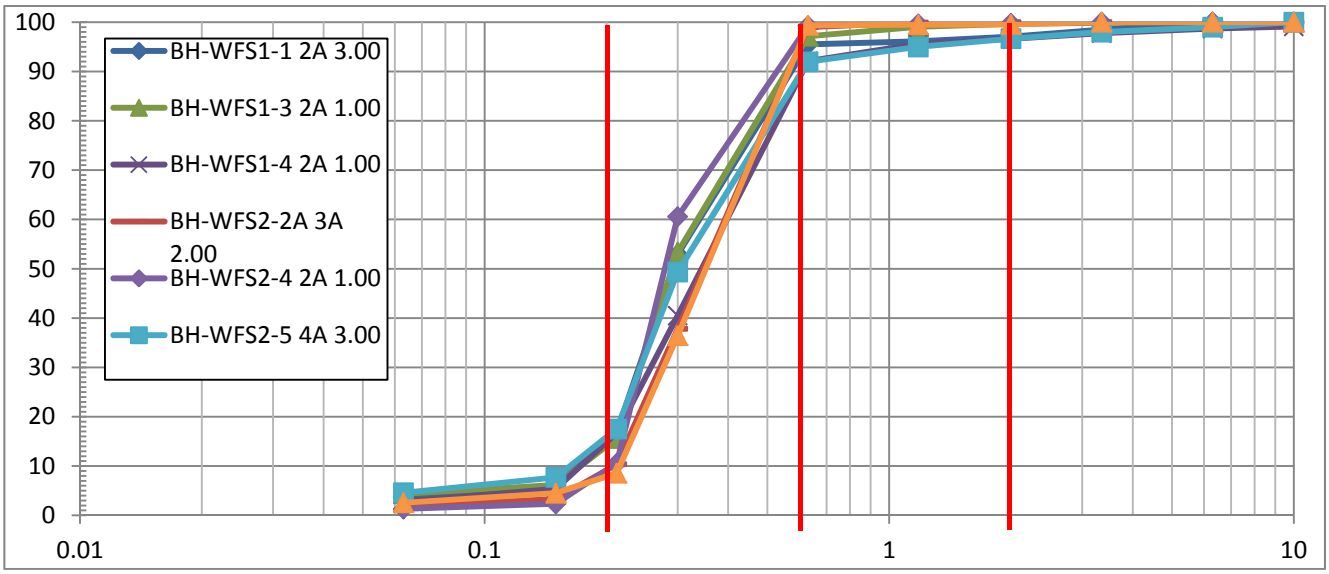


Figure 1. PSD curves of samples used for the Southern Bight batch sample

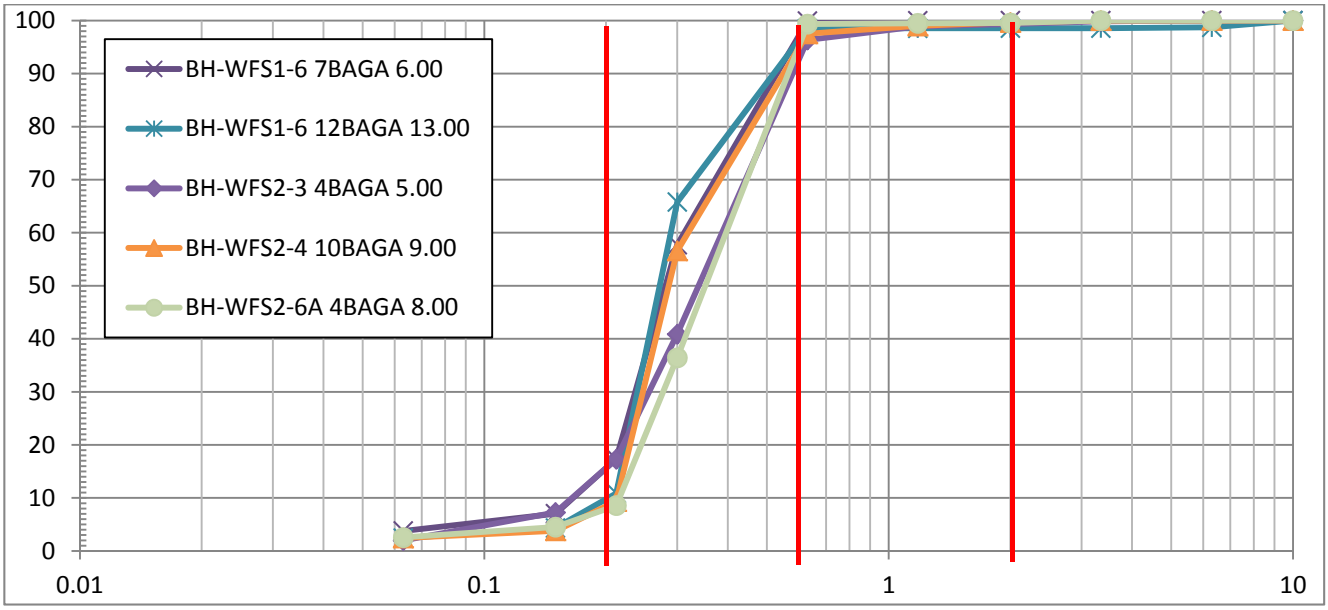


Figure 2. PSD curves of samples used for the Eem/Kreftenheye batch sample

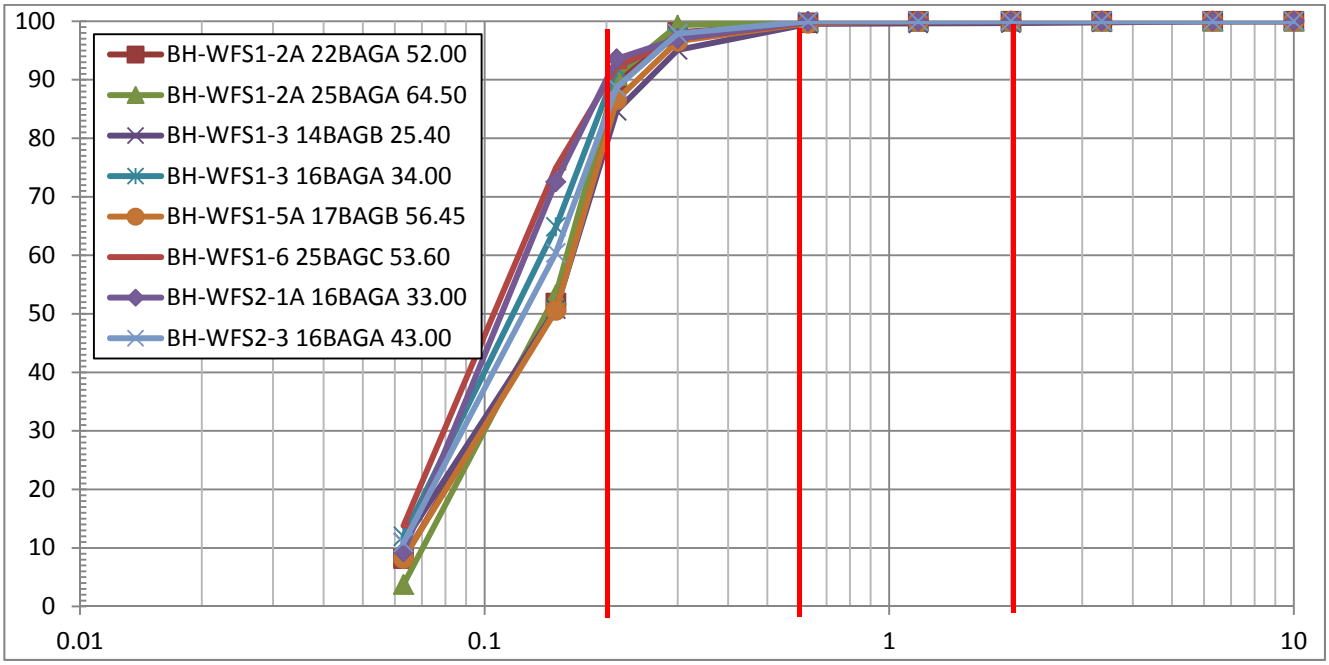


Figure 3. PSD curves of samples used for the Tongeren batch sample

A1.2 QUALITY OF RESULTS

In general, the laboratory test results are considered to be of good quality. Assessed quality of laboratory test data is according to expectations for used sampling practice and laboratory test methods. Laboratory tests were only performed on suitable soil samples.

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 strength tests results correlate reasonably well with the shear strength derived from the in situ tests, although some scatter is noted. This is likely attributed to heterogeneity of the test specimens in combination with differences between the various testing techniques used.

An indication of sample quality may be derived from the recompression stage of fine-grained specimens in an isotropically consolidated undrained (CIU) test, according to ISO (2014). The method applies to a limited range of soil conditions.

For eight CIU triaxial test specimens, the applicability criteria are valid. Undisturbed sample quality classifies as Class 1 to 4 (very good to excellent to very poor), with $\Delta e/e_0$-values ranging between 0.0 and 0.12.

A1.3 PRACTICE FOR SAMPLE HANDLING AND LABORATORY TESTING

Initial Sample Handling – refer to companion reports, refer to Plate 1-3

Site Geotechnical Laboratory – refer to companion reports, refer to Plate 1-3

Office Geotechnical Laboratory

Test Programme:	Soil description (of test specimens), sample photography, geotechnical index tests and static and cyclic strength/stiffness
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
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 – Geotechnical 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
Sample Waxed in Cardboard Tube:	– Removal of sample from tube by cutting – Geotechnical testing; – If applicable, selection and labelling of left-over sample sections for undisturbed preservation and/or disturbed preservation
Sample in Plastic Bags	– Geotechnical testing – If applicable, selection and labelling of left-over sample sections for disturbed preservation

Sample Storage and Disposition

Sample Storage:	– Storage temperature within the range +2 °C and +35 °C – Protection from direct sunlight
Transport:	Not applicable
Final Disposition:	In accordance with laboratory procedures

References

Computer Program GeODin®, Recording, Presentation and Analysis of Geo-data.

A1.4 INDEX LABORATORY TESTS

Three particle size distribution curves are included. These present results of the sieving analyses on the three batch samples.

Note that individual strength and shear test results include a sample description of the test specimen. For the coarse-grained specimens this is from the batch sample.

A1.5 MICROSCOPIC INSPECTION

The microscopic inspections were performed on samples planned for batching. No microscopic inspections were done on the individual batch samples.

Microscopic inspection indicated that selected samples from the individual formations were similar in composition.

A1.6 TRIAXIAL TESTS

Some of the triaxial tests on coarse-grained material required use of CO_2 flushing of the test specimen during the saturation phase. This was required for CIU02, CIU04 and CIU06. No CO_2 was used during saturation of other test specimens.

In general, the CIU triaxial test results on coarse-grained material were according expectations. Specimens from the Southern Bight and Eem/Kreftenheye showed typical behaviour for dense to very dense sands, i.e. a sharp increase in deviator stress due to a negative shear-induced pore pressures. The resulting stress path for these tests shows strain-hardening behaviour. For several tests, the strain-hardening continues up to approximately 6% to 8% strain, after which the process is reversed and strain-softening occurs, i.e. further strain results in decreasing deviator stresses. An exception to this is CIU02 of the Southern Bight batch sample which continues to show strain-hardening behaviour during the complete shearing stage.

The two CIU tests on the Tongeren batch sample show both strain-softening and limited-strain-hardening behaviour, CIU05 and CIU06, respectively. During CIU05, deviator stress and pore pressure increase rapidly after the start of shearing. After approximately 1% strain the maximum deviator stress is reached and after approximately 8% strain the sample deforms continuously at approximately 200 kPa deviator stress. In contrast to this CIU06, shows initially a similar behaviour as CIU05, with a rapid increase of deviator stress and pore pressure at 1% to 2% strain, however, thereafter the pore pressure decreases resulting in a further increase of the deviator stress. The different stress-strain behaviour may be related to minor differences in composition and density of tested specimens. The batch sample includes approximately 15% fines. It was prepared to resemble medium dense conditions. Observed stress-strain behaviour is not uncommon for medium dense sands and minor variations in density and fines content may result in different behaviour.

Bender element tests were performed during CIU01, CIU03 and CIU05 to measure shear modulus at small strain (G_{max}). Results are in line with expectations considering the differences in specimen's void ratio and effective consolidation stresses. The specimens with the lower effective stresses have lower G_{max} values and the ratio $Gmax/\sigma'_{vc}$ generally reduces with increasing σ'_{vc}. The G_{max} values are in general accordance with small strain measurements specifically conducted for some of the test specimen.

The measured shear wave velocities for the test specimens tend to be lower than those inferred for in situ conditions. Reasons include:

- Method of shear wave velocity determination differs - seismic downhole and/or CPT-based correlation versus bender elements;
- Approximation of specimen density versus in situ soil density has inherent uncertainty;
- Specimen preparation method differs from in situ soil deposition;
- In situ soil includes long-term stress history and time effects (aging).

Note that Bender Element test are done at a variety of frequencies, generally in range of 1,000 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, as is the case for the three bender element tests done on the coarse grained batch samples.

The results of the CIU triaxial compression and extension tests on fine-grained specimens were in line with expectations considering stress history of the formation. Compression tests results generally show the typical behaviour expected of (overconsolidated) clays: 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 water pressure decrease).

Extension tests show behaviour similar to the compression tests, but reversed, i.e. a sharp initial decrease in deviator stress q, a non-linear p'/q relationship and an initial decrease of pore water pressure followed by a decrease proportional to the overconsolidation ratio.

CIU triaxial extension test specimens have a height over diameter (H/D) ratio of approximately 1 to 1.8. This (H/D) is to ensure there is enough head-room in the triaxial cell to allow the specimen to extend during the shearing phase of the triaxial test.

A1.7 DIRECT SIMPLE SHEAR TESTS

The majority of the test results are in line with expectations. Shear behaviour shows a continuous increase in shear stress in combination with an initial increase of pore pressure followed by a decrease after approximately 6% to 12% shear (shallowest and deepest specimen). An exception is DSS03 for which pore pressure response continues to rise at increasing strain levels. The sample photograph indicates the presence of silt pockets. This may have contributed to the different behaviour.

Results of DSS01 and DSS04 were used as a reference strength for the planning and normalization of the CSS tests. An additional DSS, i.e. DSS05, was performed to verify test results of DSS04. Test results for DSS04 and DSS05 were similar, i.e. undrained shear strengths were 253 kPa and 240 kPa respectively.

A1.8 CYCLIC TRIAXIAL TESTS

Test specimens used for cyclic testing were not pre-sheared prior to start of the cyclic test phase.

Cyclic tests results generally show a consistent behaviour, i.e. number of cycles to failure (N) increase at lower cyclic stress ratios (CSR). Furthermore, resistance to cyclic loading increases at higher relative densities, with

the Tongeren batch specimens plotting at the lower end and the Eem/kreftenheye plotting at high CSR levels (at similar N-values). Note that the Tongeren batch sample includes approximately 15% fines. This contributes to the lower cyclic resistances compared to the tests from the other two batch samples.

The cyclic tests generally show a steady increase of pore pressure at low cyclic and average strain levels up to pore pressure ratio values between 0.6 and 0.8. Thereafter, pore pressure (ratios) and cyclic and average strain levels progressively increase at higher rates and failure is typically is within 5 to 20 cycles. The measured pore pressure response toward failure is consistent with expectations for medium dense to dense sand. As the effective stress within the soil approaches zero, the soil dilates in order to sustain an increasing deviatoric stress. The dilation ceases momentarily at the stress reversal point before unloading occurs. This is clearly seen in the temporary drop in pore pressure once the pore pressure ratios are above 0.8 to 0.9.

Some test results appear lower than expected trends. These include CTXL03 and CTXL04, both on the Southern Bight batch and CTXL08 on the Eem/Kreftenheye batch. Test preparation and execution were evaluated and found to be within expected tolerances. Differences in test results may be attributed to minor differences in specimen composition.

Post-cyclic static testing was performed on the majority of samples. Typical stress strain behaviour was similar to the static CIU tests, with the Southern Bight and Eem/kreftenheye samples showing strain-hardening behaviour and the Tongeren formations showing both strain softening and (limited-) strain-hardening behaviour.

A1.9 CYCLIC SIMPLE SHEAR TESTS

Test specimens used for cyclic testing were not pre-sheared prior to start of the cyclic test phase.

Cyclic shear test results show an initial rapid increase in pore pressure ratios of about 0.6 to 0.8. Thereafter pore pressures show limited increase and the maximum pore pressure ratio per cycle remains around these ratios. Average cyclic strain levels are low and cyclic stress levels show a steady increase with subsequent cycles. This is as expected for two-way loading.

The first four of the six tests, performed on specimens from the Dongern formation, reached 1500 cycles. CSR values were increased after each test. For the fifth and sixth tests, failure occurred before the 1500 cycles were reached. The relatively high CSR values may be related to assignment of reference strength. Reference strengths were based on DSS tests in close proximity of the CSS specimens. Two DSS tests were performed giving similar static strength values. The cyclic resistance is possibly higher than static resistance.

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

COHESIONLESS SPECIMENS

BORSSELE WIND FARM ZONE I&II – DUTCH SECTOR, NORTH SEA

Location	Sample No.	Test Type	Test ID	Initial Conditions			Final Consolidation Conditions						
				w_i [%]	γ_i [kN/m³]	e_0 [-]	w_f [-]	γ_f [kN/m³]	σ'_{vc} [kPa]	σ'_{rc} [kPa]	e_{pc} [-]	$\varepsilon_{vol;pc}$ [%]	$\varepsilon_{v;pc}$ [%]
Various (batch sample)	Southern Bight	CIUc+BE	01	10.7	17.6	0.637	23.9	19.7	26	26	0.634	0.24	0.04
		CIUc	02	10.8	17.6	0.639	24.0	19.7	25	25	0.636	0.19	-
	Eem / Kreftenheye	CIUc+BE	03	11.3	18.3	0.579	21.7	20.1	80	80	0.576	0.22	0.07
		CIUc	04	10.2	19.5	0.465	17.4	20.9	80	80	0.460	0.35	-
	Tongeren	CIUc+BE	05	10.0	17.4	0.647	22.9	19.9	400	400	0.606	2.45	0.39
		CIUc	06	10.0	17.4	0.646	22.8	19.9	400	400	0.603	2.59	-

Sample No.	Test Type	Test Id.	At Peak Deviator Stress					At Maximum Stress Ratio			Post-Saturation		Post-Consolidation	
			q [kPa]	u [-]	ε_a [%]	ε_{50} [%]	E_{50} [MPa]	q [kPa]	u [-]	ε_a [%]	v_s [m/s]	G_{max} [MPa]	v_s [m/s]	G_{max} [MPa]
Southern Bight	CIUc+BE	01	420	-119	5.9	1.61	13.0	115	-7	0.8	105	22	136	37
	CIUc	02	759	-348	20.0	3.41	11.1	167	-37	1.4	-	-	-	-
Eem / Kreftenheye	CIUc+BE	03	2430	-881	12.2	2.96	41.1	384	-32	1.1	156	50	204	85
	CIUc	04	2054	-523	7.3	2.49	41.3	627	-71	1.8	-	-	-	-
Tongeren	CIUc+BE	05	249	250	0.8	0.08	158.0	200	320	9.4	170	58	282	162
	CIUc	06	282	262	19.8	0.30	47.3	263	278	8.8	-	-	-	-

Notes:

- $\sigma'_{vc} = \sigma'_{vc(max)}$

Key:

$w_{i/f}$	=	initial / after consolidation water content
$\gamma_{i/f}$	=	initial / after consolidation unit weight
e_0	=	initial void ratio
e_{pc}	=	void ratio at end of consolidation
$\sigma'_{vc/rc}$	=	vertical / radial effective stress at end of consolidation
$\varepsilon_{vol;pc}$	=	volumetric strain at end of consolidation
$\varepsilon_{v;pc}$	=	vertical strain at end of consolidation
q	=	deviator stress
u	=	excess pore pressure
ε_a	=	axial strain at peak deviator stress or maximum stress ratio
ε_{50}	=	axial strain at 50% of peak deviator stress
E_{50}	=	Young's modulus at 50% of peak deviator stress in compression
v_s	=	shear wave velocity
G_{max}	=	shear modulus at small strain

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

COHESIVE SPECIMENS

BORSSELE WIND FARM ZONE I&II – DUTCH SECTOR, NORTH SEA

Location	Sample No.	Formation	Depth [m]	Test Type	Initial Conditions			Final Consolidation Conditions							$\Delta e/e_o$ [-]
					w_i [%]	γ_i [kN/m³]	e_0 [-]	w_f [-]	γ_f [kN/m³]	σ'_{vc} [kPa]	σ'_{rc} [kPa]	e_{pc} [-]	$\varepsilon_{vol;pc}$ [%]	$\varepsilon_{v;pc}$ [%]	
BH-WFS1-1	17D	Rupel	51.52	CIUe	27.1	19.4	0.731	27.1	19.4	490	490	0.731	0.02	-	0.00
BH-WFS1-1	18C		52.29	CIUc+BE	24.6	19.3	0.708	24.0	19.4	500	500	0.690	1.06	0.22	0.03
BH-WFS1-4	20B		40.56	CIUc	24.9	19.7	0.675	24.9	19.7	400	400	0.675	0.01	-	0.00
BH-WFS1-4	21D		44.97	CIUe	24.7	19.8	0.670	24.8	19.8	450	450	0.670	0.54	-	0.00
BH-WFS2-6A	18D	Dongern	49.44	CIUc+BE	44.3	17.4	1.199	38.9	18.0	480	480	1.052	6.64	1.20	0.12
BH-WFS2-6A	20B		54.37	CIUe	39.1	18.3	1.025	39.2	18.2	525	525	1.027	-0.11	-	0.00
BH-WFS2-7	21D		28.52	CIUe	39.4	18.1	1.050	39.0	18.1	350	350	1.040	0.51	-	0.01
BH-WFS2-7	22D		39.52	CIUc	45.6	17.3	1.228	45.6	17.4	355	355	1.227	0.04	-	0.00

Location	Sample No.	Depth [m]	Test Type	At Peak Deviator Stress					At Maximum Stress Ratio			Post-Saturation		Post-Consolidation	
				s_u [kPa]	s_u/σ'_{vc} [-]	ε_a [%]	ε_{50} [%]	E_{50} [MPa]	s_u [kPa]	s_u/σ'_{vc} [-]	ε_a [%]	v_s [m/s]	G_{max} [MPa]	v_s [m/s]	G_{max} [MPa]
BH-WFS1-1	17D	51.52	CIUe	-175	0.36	-5.50	-0.50	-	-175	0.36	-5.50	-	-	-	-
BH-WFS1-1	18C	52.29	CIUc+BE	282	0.56	3.23	0.62	45.5	276	0.55	2.88	253	126	265	139
BH-WFS1-4	20B	40.56	CIUc	336	0.84	5.18	1.66	20.2	297	0.74	3.68	-	-	-	-
BH-WFS1-4	21D	44.97	CIUe	-252	0.56	-9.48	-1.54	-	-249	0.55	-8.98	-	-	-	-
BH-WFS2-6A	18D	49.44	CIUc+BE	149	0.31	1.44	0.16	91.3	145	0.30	5.46	191	65	225	92
BH-WFS2-6A	20B	54.37	CIUe	-321	0.61	-2.37	-0.46	-	-321	0.61	-2.37	-	-	-	-
BH-WFS2-7	21D	28.52	CIUe	-114	0.32	-2.50	-0.17	-	-113	0.32	-2.63	-	-	-	-
BH-WFS2-7	22D	39.52	CIUc	140	0.39	1.44	0.25	56.5	140	0.39	1.32	-	-	-	-

Notes:

- $\sigma'_{vc} = \sigma'_{vc(max)}$

Key:

$w_{i/f}$ = initial / after consolidation water content
$\gamma_{i/f}$ = initial / after consolidation unit weight
e_0 = initial void ratio
e_{pc} = void ratio at end of consolidation
Δe = change of void ratio from initial conditions to estimated in-situ stress conditions
$\sigma'_{vc/rc}$ = vertical / radial effective stress at end of consolidation
$\varepsilon_{vol;pc}$ = volumetric strain at end of consolidation
$\varepsilon_{v;pc}$ = vertical strain at end of consolidation
s_u = undrained shear strength
ε_a = axial strain at peak deviator stress or maximum stress ratio
ε_{50} = axial strain at 50% of peak deviator stress
E_{50} = Young's modulus at 50% of peak deviator stress in compression
v_s = shear wave velocity
G_{max} = shear modulus at small strain

SUMMARY OF CYCLIC TRIAXIAL TEST RESULTS

COHESIONLESS SOIL SPECIMENS

BORSSELE WIND FARM ZONE I&II – DUTCH SECTOR, NORTH SEA

Location	Formation	Test ID	Initial Conditions			Final Consolidation Conditions					Cyclic Loading							Post-Cyclic Static (At Peak Deviator Stress)		
			w_i	γ_i	e_0	w_f	γ_f	σ'_{vc}	e_{pc}	$\varepsilon_{vol;pc}$	$\sigma'_{v;ref}$	$q_{av}/\sigma'_{v;ref}$	$q_{cv}/\sigma'_{v;ref}$	N	ε_{av}	ε_{cy}	u_a	q_f	ε_f	u_f
			[%]	[kN/m³]	[-]	[-]	[kN/m³]	[kPa]	[-]	[%]	[kPa]	[-]	[-]	[-]	[%]	[%]	[kPa]	[kPa]	[%]	[kPa]
Various (batch sample)	Southern Bight	CTXL01	10.5	17.6	0.635	23.9	19.7	25	0.632	0.16	25	0	0.60	4	-3.3	4.4	12	2	18.7	23
		CTXL02	10.0	17.6	0.627	23.6	19.8	25	0.624	0.18	25	0	0.28	181	-3.8	13.2	19	42	23.3	8
		CTXL03	10.3	17.6	0.633	23.8	19.7	25	0.631	0.14	25	0	0.19	196	-3.9	16.6	23	4	23.3	23
		CTXL04	10.0	17.6	0.629	18.4	20.7	25	0.489	8.59	25	0	0.35	5	-0.5	12.3	19	1	-2.0	23
		CTXL13	10.1	17.6	0.631	23.7	19.7	25	0.628	0.16	25	0	0.36	90	-2.1	15.1	21	37	23.4	12
	Eem / Kreften-heye	CTXL05	9.9	18.3	0.560	21.1	20.2	80	0.560	0.00	80	0	0.60	33	0.3	9.9	47	-	-	-
		CTXL06	10.0	18.3	0.560	21.0	20.2	80	0.557	0.17	80	0	0.30	1500	0.0	0.0	17	1652	19.1	-680
		CTXL07	9.6	18.3	0.554	20.8	20.2	80	0.551	0.23	80	0	0.44	195	-19.4	7.8	56	1585	24.1	-674
		CTXL08	10.0	18.3	0.557	21.0	20.2	80	0.556	0.08	80	0	0.38	75	-2.8	11.7	60	787	21.0	-210
	Tongeren	CTXL09	10.1	17.4	0.645	23.1	19.8	400	0.611	2.07	400	*0.14*	0.44	1	-7.9	8.3	122	-	-	-
		CTXL10	9.3	17.4	0.634	22.6	19.9	400	0.599	2.12	400	-	0.30	4	-8.6	12.4	296	108	25.8	339
		CTXL11	9.5	17.4	0.637	22.3	20.0	400	0.592	2.74	400	-	0.10	1500	-0.0	0.0	92	219	0.8	257
		CTXL12	9.7	17.4	0.642	21.0	20.2	400	0.556	5.22	400	-	0.18	58	-3.0	15.7	347	140	19.4	351

Notes:

- $\sigma'_{vc} = \sigma'_{vc(max)}$
- Numbers in italic are being verified and may change

Key:

$w_{i/f}$	=	initial / final water content
$\gamma_{i/f}$	=	initial / final unit weight
$\sigma'_{vc/rc}$	=	vertical effective stress at end of consolidation
$e_{0/pc}$	=	initial / at end of consolidation void ratio
$\varepsilon_{vol;pc}$	=	volumetric strain at end of consolidation
$\sigma'_{v;ref}$	=	reference vertical stress
N	=	number of cycles to failure
q_{ay}	=	average deviator stress at N
q_{cy}	=	cyclic deviator stress at N
ε_{ay}	=	average axial strain at N
ε_{cy}	=	cyclic axial strain at N
u_a	=	pore water pressure at N
q_f	=	deviator stress at failure
ε_f	=	axial strain at failure
u_f	=	pore water pressure at failure

SUMMARY OF (CYCLIC) DIRECT SIMPLE SHEAR – CONSOLIDATION STAGE

BORSSELE WIND FARM ZONE I&II - DUTCH SECTOR, NORTH SEA

Location	Sample No.	Depth [m]	Formation	Test ID	Initial Conditions			Final Consolidation Conditions					$\Delta e/e_o$ [-]
					w_i [%]	γ_i [kN/m³]	e_0 [-]	w_f [-]	γ_f [kN/m³]	σ'_{vc} [kPa]	e_{pc} [-]	$\varepsilon_{v;pc}$ [%]	
BH-WFS2-3	9B	18.06	Rupel	DSS02	28.1	19.4	0.749	27.6	19.5	185	0.735	1.10	0.02
BH-WFS1-4	17C	34.76		DSS01	22.6	20.1	0.612	22.0	20.2	350	0.597	1.39	0.03
BH-WFS1-4	17C	*35.00*		CSS01	20.5	20.1	0.584	18.8	20.5	350	0.538	2.89	0.08
BH-WFS1-4	17C	*35.04*		CSS02	21.1	19.9	0.610	20.4	20.0	350	0.589	1.27	0.02
BH-WFS1-4	17D	35.05		CSS03	22.5	20.0	0.625	21.4	20.2	350	0.594	1.86	0.05
BH-WFS1-4	17D	35.00		CSS04	22.5	20.2	0.604	21.4	20.4	351	0.574	1.85	0.05
BH-WFS1-4	17C	*35.07*		CSS05	21.6	19.9	0.614	20.4	20.1	350	0.582	1.98	0.05
BH-WFS2-6A	15B	40.06	Dongern	DSS03	23.8	18.7	0.751	21.0	19.1	400	0.676	6.22	0.10
BH-WFS2-7	19C	33.31		DSS04	40.4	17.7	1.105	39.5	17.8	310	1.082	1.56	0.02
BH-WFS2-7	20C	34.31		DSS05	40.8	17.5	1.134	39.7	17.6	316	1.105	1.39	0.03
BH-WFS2-7	19C	33.40		CSS06	38.9	18.0	1.046	38.1	18.1	310	1.022	1.15	0.02
BH-WFS2-7	19C	33.45		CSS07	39.2	17.7	1.087	38.4	17.8	310	1.065	1.01	0.02
BH-WFS2-7	19D	33.55		CSS08	40.6	17.6	1.116	39.1	17.8	310	1.076	1.91	0.04
BH-WFS2-7	19D	33.59		CSS09	40.6	17.7	1.113	39.4	17.8	310	1.079	1.58	0.03
BH-WFS2-7	19D	33.61		CSS10	36.7	17.8	1.044	35.5	17.9	310	1.014	1.49	0.03
BH-WFS2-7	20C	34.39		CSS11	42.1	17.5	1.156	41.2	17.6	316	1.134	1.04	0.02

Notes:
- $\sigma'_{vc} = \sigma'_{vc(max)}$
- Shear stage performed at constant volume
- Numbers in italic are being verified and may change

Key:

w_i	=	initial water content
γ_i	=	initial unit weight
e_0	=	initial void ratio
e_{pc}	=	void ratio at end of consolidation
σ'_{vc}	=	vertical effective stress at end of consolidation
$\varepsilon_{v;pc}$	=	vertical strain at end of consolidation
Δe	=	change of void ratio from initial conditions to estimated in-situ stress conditions

SUMMARY OF (CYCLIC) DIRECT SIMPLE SHEAR – TEST RESULTS

BORSSELE WIND FARM ZONE I&II – DUTCH SECTOR, NORTH SEA

Location	Sample No.	Formation	Depth [m]	Test ID.	σ'_{vc} [kPa]	At Peak Shear Stress (static)				Cyclic Loading							At Peak Shear Stress (post-cyclic static)		
						s_u [kPa]	s_u/σ'_{vc} [-]	γ_c [%]	Δu [kPa]	$S_{u;ref}$ [kPa]	$\tau_{av}/S_{u;ref}$ [-]	$\tau_{cy}/S_{u;ref}$ [-]	N [-]	γ_{av} [%]	γ_{cy} [%]	u_a [kPa]	τ_f [kPa]	γ_c [%]	Δu_f [kPa]
BH-WFS2-3	9B	Rupel	18.06	DSS02	185	180	0.97	9.8	-79	-	-	-	-	-	-	-	-	-	-
BH-WFS1-4	17C		34.76	DSS01	350	316	0.90	27.5	-76	-	-	-	-	-	-	-	-	-	-
BH-WFS1-4	17C		*35.00*	CSS01	350	-	-	-	-	316	0	0.37	1500	-0.2	3.6	263	211	20.8	89
BH-WFS1-4	17C		*35.04*	CSS02	350	-	-	-	-	316	0	0.52	103	1.84	14.4	164	159	27.3	98
BH-WFS1-4	17D		35.05	CSS03	350	-	-	-	-	316	0	0.43	1500	-0.1	2.0	204	325	29.9	-50
BH-WFS1-4	17D		35.00	CSS04	350	-	-	-	-	316	0	0.59	467	-2.6	15.7	201	233	30.0	8
BH-WFS1-4	17C		*35.07*	CSS05	350	-	-	-	-	316	0	0.69	46	0.1	15.3	187	285	29.9	-4
BH-WFS2-6A	15B	Dongern	40.06	DSS03	400	152	0.38	14.7	115	-	-	-	-	-	-	-	-	-	-
BH-WFS2-7	19C		33.31	DSS04	310	253	0.82	11.5	-109	-	-	-	-	-	-	-	-	-	-
BH-WFS2-7	20C		34.31	DSS05	316	240	0.76	10.1	-44	-	-	-	-	-	-	-	-	-	-
BH-WFS2-7	19C		33.40	CSS06	310	-	-	-	-	253	0	0.32	1500	0.0	0.7	26	211	7.2	-80
BH-WFS2-7	19C		33.45	CSS07	310	-	-	-	-	253	0	0.48	1500	-0.4	1.5	136	291	13.2	-119
BH-WFS2-7	19D		33.55	CSS08	310	-	-	-	-	253	0	0.58	1500	0.6	5.9	171	234	15.2	-47
BH-WFS2-7	19D		33.59	CSS09	310	-	-	-	-	253	0	0.66	1500	0.8	4.5	169	285	14.2	-60
BH-WFS2-7	19D		33.61	CSS10	310	-	-	-	-	253	0	0.77	182	-2.1	15.1	132	210	28.9	-88
BH-WFS2-7	20C		34.39	CSS11	316	-	-	-	-	253	0	0.89	26	-1.1	15.6	7	210	29.7	-161

Notes:

- $\sigma'_{vc} = \sigma'_{vc(max)}$
- Static, cyclic and post-cyclic shear stages performed at constant volume
- Numbers in italic are being verified and may change

Key:

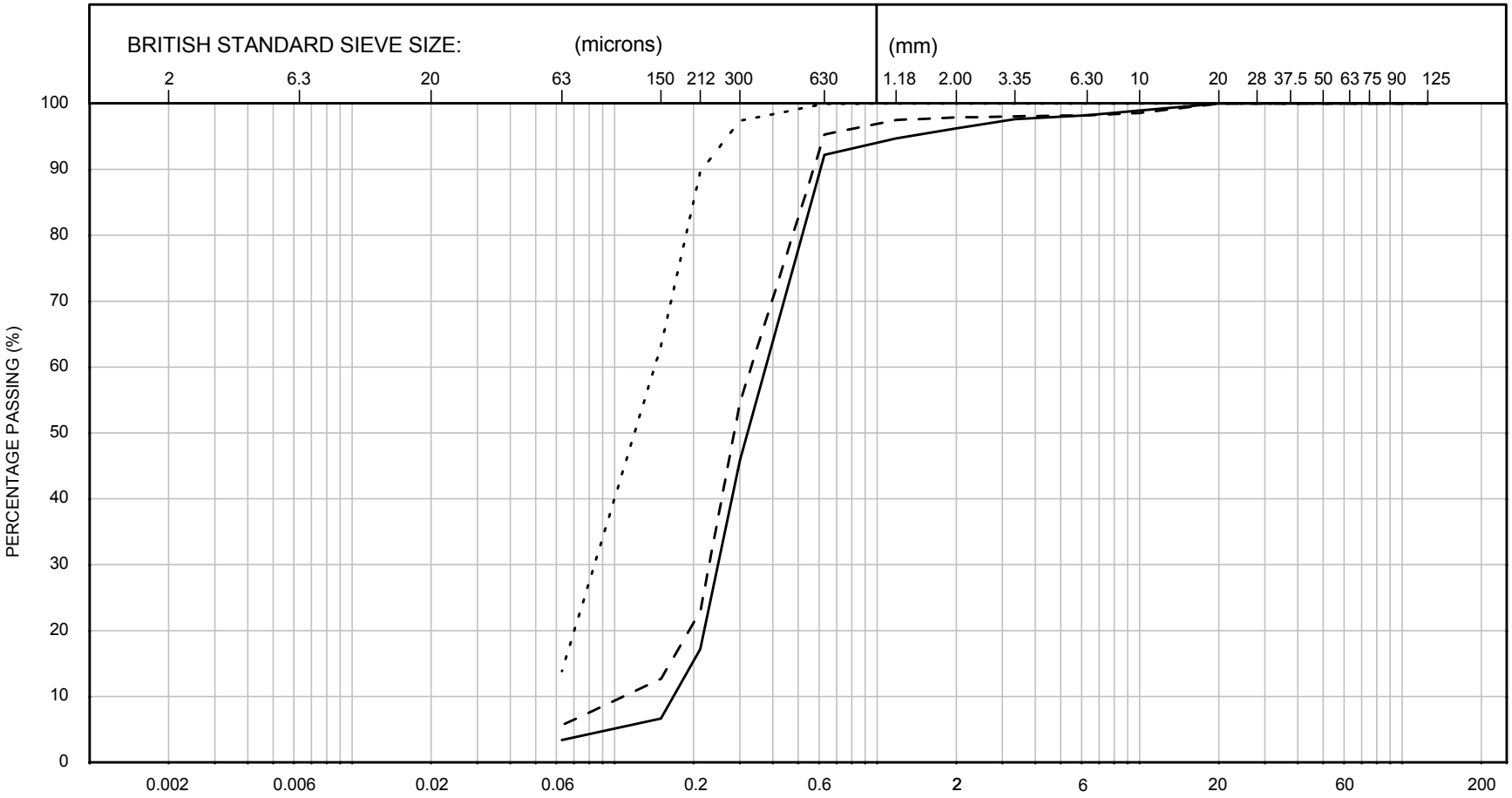
σ'_{vc}	=	vertical effective stress at end of consolidation
s_u	=	undrained shear strength
γ_c	=	shear strain at peak shear stress
Δu	=	change in inferred pore water pressure
$s_{u;ref}$	=	reference undrained shear strength
N	=	number of cycles to failure
τ_{ay}	=	average shear stress at N
τ_{cy}	=	cyclic shear stress at N
γ_{ay}	=	average shear strain at N
γ_{cy}	=	cyclic shear strain at N
u_a	=	inferred pore water pressure at N
τ_f	=	shear stress at failure
γ_f	=	shear strain at failure
u_f	=	inferred pore water pressure at failure

SECTION A2: INDEX LABORATORY TESTS

LIST OF PLATES IN SECTION A2: Plate

PARTICLE SIZE DISTRIBUTION TEST RESULTS

BORSSELE WIND FARM SITE I&II - 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
——	Southern Bight	Batch	-	9.2	N/A	-	3	94	3	-
– –	Eem/ Kreftenheye	Batch	-	9.2	N/A	-	5	93	2	-
- - -	Tongeren	Batch	-	9.2	N/A	-	13	87	-	-

* 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

SECTION A3: MICROSCOPIC INSPECTION

FUGRO GEOCONSULTING LIMITED

Technical Note: Microscope Descriptions

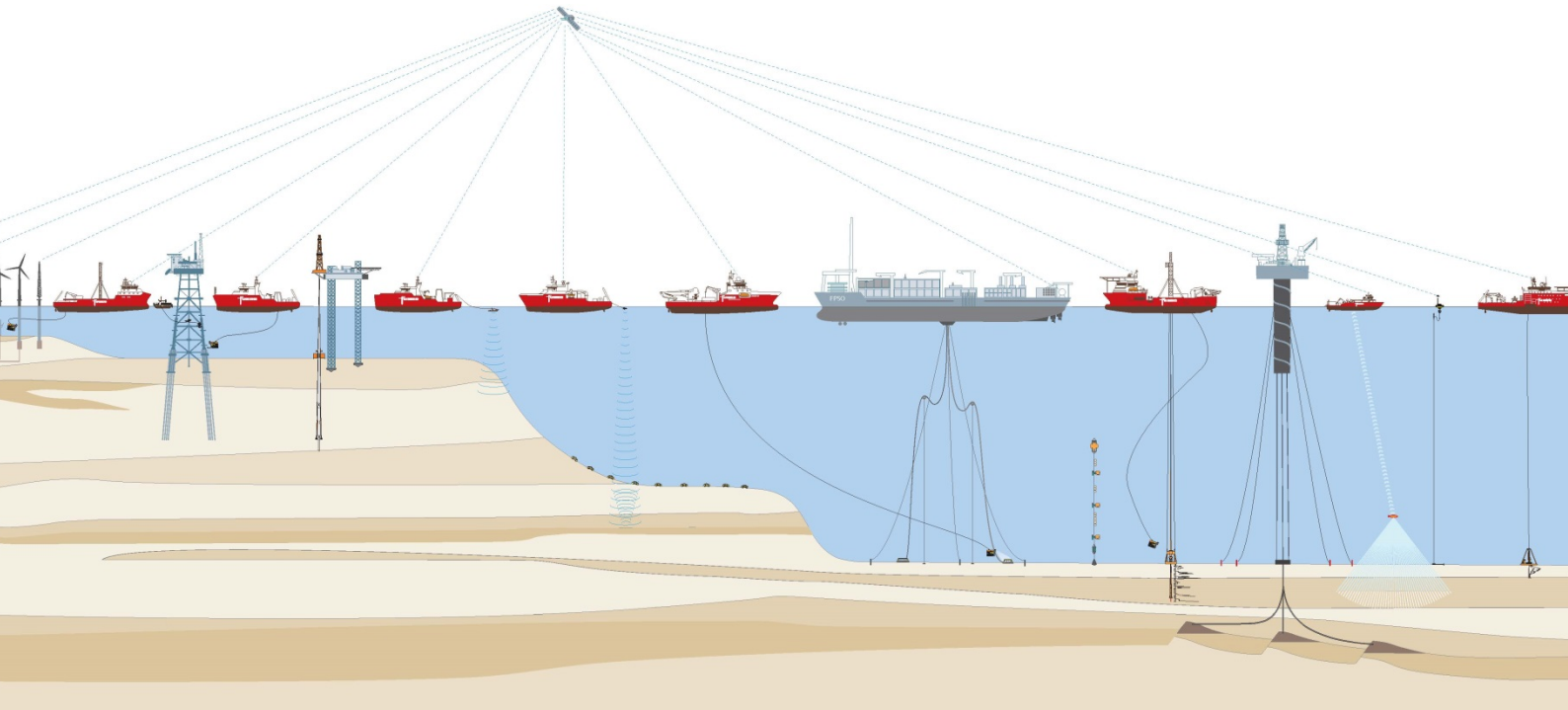
Borssele Offshore Wind Farm, The Netherlands
North Sea

Fugro Document No.: J11286-TN-001(02)

Rijksdienst voor Ondernemend Nederland (RVO.nl)

Rijksdienst voor Ondernemend Nederland

Final Technical Note



Project Name:	Borssele Microscope Photography		
Project Number:	J11286	**Document Number:**	J11286-TN-001(02)
Subject:	Microscope Descriptions		
Issued to:	Rijksdienst voor Ondernemend Nederland (RVO.nl) and Fugro Engineers B.V.		
Issue Date:	25 August 2015		
Prepared by:	Leah Arlott and Abigail Walters		
Checked by:	Chris E Smith	**Approved by:**	Lorraine O'Leary and Grant Lewis

1. PURPOSE OF STUDY

Reflected light microscopic analysis was carried out on 27 samples from the Borssele windfarm site on behalf of Fugro Engineers B.V. in order to determine the composition of three principal soil units. Microscope analysis provides an additional dataset that can be compared with other relevant geotechnical data (e.g. particle size distribution (PSD) and X-ray diffraction (XRD)) and allows further interpretation based on similar geological formations in the North Sea.

1.1 Project Overview

The 27 samples were taken from 12 geotechnical borehole locations, from depths ranging between 1.0 m and 56.5 m below seafloor (BSF). All samples are bag samples. Table 1.1 summarises the soil units and samples tested.

Table 1.1 Summary of Samples for Microscope Work

Soil Unit	Location	Bag Sample ID	Depth Below Seafloor [m]
Southern Bight (A)	BH-WFS1-1	2A/2B	3.00
	BH-WFS1-3	2A/2B	1.00
	BH-WFS1-4	2A/2B	1.00
	BH-WFS2-4	3A	2.00
	BH-WFS2-5	2A/2B	1.00
		4A	3.00
Eem/Kreftenheye (B)	BH-WFS1-6A	7A	6.00
		10A	8.00
		11A	9.00
		12A	13.00
	BH-WFS2-3	4A	5.00
		5A	7.00
	BH-WFS2-4	10A	9.00
		8A	7.00
		9A	8.00
	BH-WFS2-6A	4A	8.00
		5A	9.00
Tongeren (E2)	BH-WFS1-3	14B	25.40
		16A	34.00
	BH-WFS1-5A	17B	56.45
	BH-WFS1-6	25C	53.60
	BH-WFS2-1A	16A	33.00
	BH-WFS2-3	16A	43.00

1.2 Guidelines on Use of Technical Note

Appendix A (Guidelines on Use of Technical Note) outlines the limitations of this technical note, in terms of a range of considerations including, but not limited to, its purpose, its scope, the data on which it is based, its use by third parties, possible future changes in design procedures and possible changes in the conditions at the site with time. It represents a clear exposition of the constraints which apply to all technical notes issued by Fugro. It should be noted that the Guidelines do not in any way supersede the terms and conditions of the contract between Fugro and Rijksdienst voor Ondernemend Nederland (RVO.nl).

2. METHODOLOGY

2.1 Slide Preparation

Slides of washed and unwashed material were prepared for each sample by smearing a layer of sediment approximately one grain thick onto a glass slide. Care was taken to avoid removing or crushing coarser grains, where present. The washed slide was prepared by washing a small amount of sediment in a clean tray using deionised water. Washing was undertaken to remove any clay or silt coating on grains. In some cases, samples were washed several times until the washing water was visually considered clean.

2.2 Sediment Classification and Descriptions

All sediment classifications for this technical note have been undertaken in accordance with BS 5930:1999 (BSI, 2010).

A hand-sample analysis of the prepared slides and bagged samples was undertaken in order to obtain a generalised soil description. A Munsell colour chart was used to describe the colour of slide samples at least 2 hours following slide preparation, ensuring colours were consistently described from dry samples.

Percentages of each mineral constituent were estimated using a point count method aided by comparison charts such as those of Terry and Chilingar (1955) and Folk (1951). Angularity was estimated and Krumbein roundness number (*r*K) ranges were assigned based on Krumbein (1941). Sizes of shells and shell fragments were described according to BS 5930:1999 (BSI, 2010).

2.3 Photography

Representative photographs were taken at two frame widths: 4 mm and 10 mm. All photographs were taken at these two frame widths to ensure consistency and comparability between plates and samples. The microscope was carefully focussed on the sample prior to the taking of each photograph. Where grains occur at different levels on the slide it was not possible to get the entire frame in focus; in this case the microscope was focussed on the majority of the grains.

Digital photograph files issued with this technical note are named according to the sample name and location, followed by “UW” for unwashed samples and “W” for washed samples. The frame width is also included in the file name.

Features of note in samples, for example echinoid fragments or minerals, were photographed and named as outlined above. Many of these features were photographed during microscope analysis, at differing frame widths.

3. RESULTS

This section presents a broad overview of the findings for each soil unit. Please refer to the plates provided for a detailed description of each sample (Southern Bight Soil Unit - Plates 1.1 to 1.10, Eem/Kreftenheye Soil Unit - Plates 2.1 to 2.11 and Tongeren Soil Unit - Plates 3.1 to 3.6).

3.1 Southern Bight Soil Unit

The Southern Bight soil unit is a moderately to well sorted silty fine to medium sand which commonly contains angular shell fragments. Colours are generally light yellowish browns in the unwashed samples and light grey in washed samples.

The main constituents of the unit are:

- Quartz, which accounts for between 70% and 90% of the sample and is generally clear or colourless, with some grains showing hues of yellow, orange, red or pink;
- Lithic/mafic fragments, accounting for up to 15% of the sample and generally black, grey or dark brown in colour;
- Feldspar, which is approximately 5% of samples and generally white or pale yellowish brown in colour;
- Other minor constituents, which are less than 5% of the sample, including shell fragments and bioclastic debris, glauconite, and mica (muscovite and biotite).

In addition to these constituents, some unwashed samples exhibit a trace coating of silt and/or clay.

3.2 Eem/Kreftenheye Soil Unit

The Eem/Kreftenheye soil unit is a well sorted fine to medium sand. Colours are generally light brownish greys, greys or yellowish browns in unwashed samples and light grey in washed samples.

The main constituents of the unit are:

- Quartz, which accounts for between 85% and 95% of the sample and is generally clear or colourless, with some grains orange, red or pink;
- Lithic/mafic fragments, accounts for up to 5% of the sample and generally dark grey, brown or black in colour;
- Feldspar, which is up to approximately 5% of samples and generally white, pink or orange in colour;
- Other minor constituents, which are generally less than 5% of the sample, including shell fragments and bioclastic debris, calcite, epidote, glauconite, and mica (muscovite).

In addition to these constituents, some unwashed samples exhibit a coating of silt. Epidote in Eem/Kreftenheye samples is pale green in colour with translucent to transparent subangular to

subrounded grains and vitreous lustre. This differentiates it from glauconite pellets which are generally dark green and opaque with no lustre.

3.3 Tongeren Soil Unit

The Tongeren soil unit is a moderately to well sorted clayey or silty fine sand, and is generally olive grey in colour when unwashed and grey or light grey when washed.

The main constituents of the Tongeren unit are:

- Quartz, which accounts for between 85% and 88% of the sample and is generally clear or colourless, with some grains pale yellow, pale orange or pale pink;
- Glauconite pellets, account for between 7% and 10% of the sample and dark greyish green in colour;
- Lithic/mafic fragments, which is up to 5% of the sample and generally dark grey, brown or black in colour;
- Other minor constituents, which are generally less than 5% of the sample, including shell fragments and bioclastic debris, calcite, epidote, glauconite, and mica.

All samples are coated with either clay or silt. Epidote in Tongeren samples is pale green in colour with translucent to transparent subangular to subrounded grains and vitreous lustre. This differentiates it from glauconite pellets which are generally dark green and opaque with no lustre. Epidote was only identified in one sample of the Tongeren soil unit (Sample BH-WFS2-3 16 BAG A).

4. REFERENCES

BSI, 2010. *BS 5930:1999 Code of Practice for Site Investigations, Incorporating Amendment No. 2*. London: BSI.

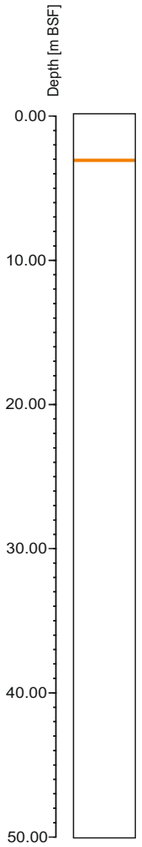
FOLK, R. L., 1951. *A Comparison Chart for Visual Percentage Estimation*, Journal of Sedimentary Petrology, **21** (1) pp 32–33.

KRUMBEIN, W. C., 1941. *Measurement and Geological Significance of Shape and Roundness of Sedimentary Particles,* Journal of Sedimentary Petrology **11** (2), pp 64–72.

TERRY, R. D and CHILINGAR, G. V., 1955. *Summary of "Concerning some additional aids in studying sedimentary formations'* In. SHESTOV, M.S., 1955. *Studying Sedimentary Formations,* Journal of Sedimentary Petrology, **25** (3), pp 229–234.

LIST OF PLATES

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately to well sorted fine to coarse SAND with few fine to coarse sand-sized angular shell fragments

Colour:
Unwashed: Light olive brown (2.5Y-5/3)
Washed: Light grey (2.5Y-7/2)

Microscope Description
Sample is moderately sorted – unwashed sample shows trace coating of clay

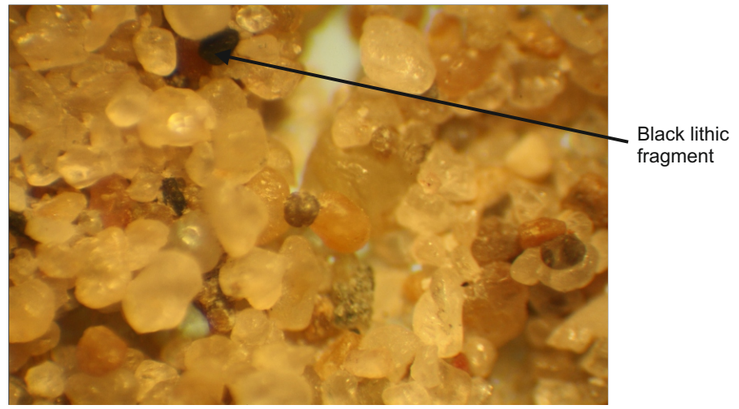
80% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity QUARTZ
- ~ 80% colourless to light yellow/beige
- ~ 15% beige to dark yellow
- ~ 5% light pink to reddish orange

13% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity black to dark brown MAFIC/LITHIC FRAGMENTS
5% – Fine to medium sand-sized subrounded (*r*K = 0.5 to 0.6) medium to high sphericity white FELDSPAR
2% – Medium to coarse sand-sized angular (*r*K = 0.1 to 0.2) low sphericity white to pale pink SHELL FRAGMENTS

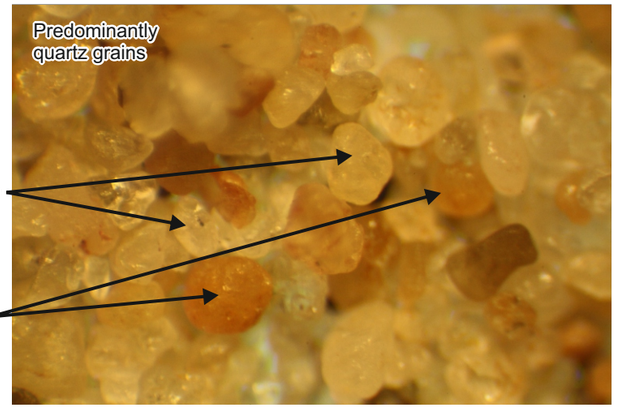
Trace: Muscovite, Glauconite pellets

Reflected Light Microphotographs

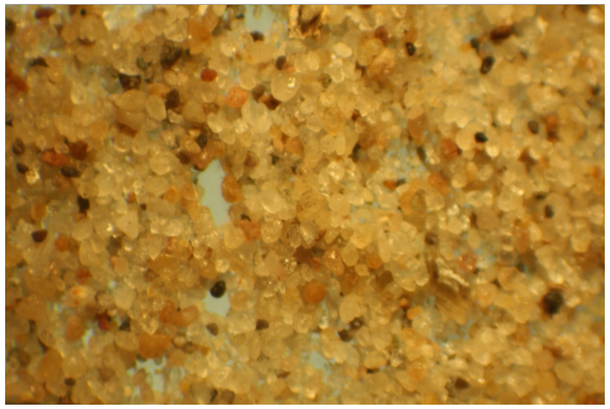
Unwashed Sample



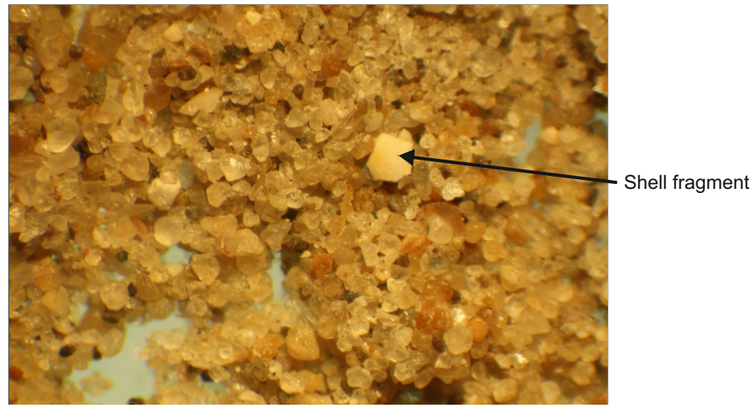
Washed Sample



Washed Sample

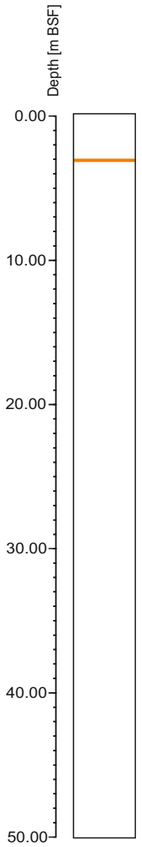


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-1** **Sample Name: 2 BAG A**	**Depth [m BSF]: 3.00** **Soil Unit: Southern Bight**	**Plate Number: 1.1**	Logged by: ASW Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted slightly clayey fine to medium SAND with few coarse sand-sized angular shell fragments

Colour:
Unwashed: Greyish brown (2.5Y-5/2)
Washed: Light brownish grey (2.5Y-6/2)

Microscope Description
Sample is moderately to poorly sorted – unwashed sample shows trace coating of silt

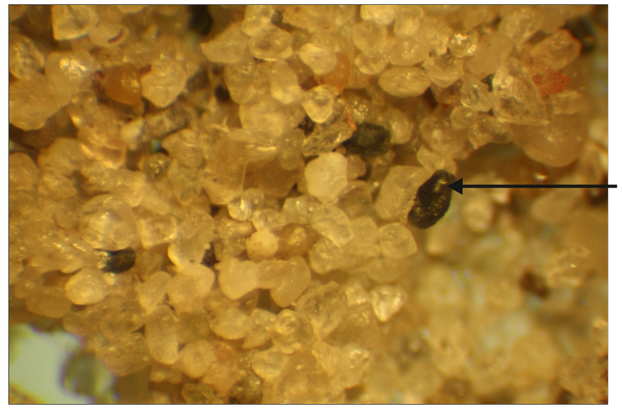
85% – Fine to medium sand-sized subangular to well-rounded (*r*K = 0.3 to 0.9) low to high sphericity QUARTZ
- ~ 60% clear/colourless
- ~ 25% light pink to reddish orange
- ~ 15% translucent/opaque colourless
- ~ 10% beige to yellow

8% – Fine to medium sand-sized angular to subangular (*r*K = 0.1 to 0.4) low sphericity black to dark brown MAFIC/LITHIC FRAGMENTS
3% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to medium sphericity MUSCOVITE
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) light pink to colourless FELDSPAR
2% – Fine to coarse sand-sized SHELL FRAGMENTS/BIOCLASTIC debris (1 no. small whole gastropod shell)

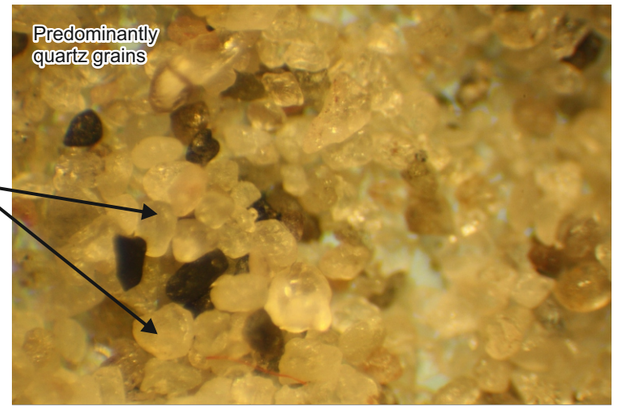
Trace: Glauconite pellets

Reflected Light Microphotographs

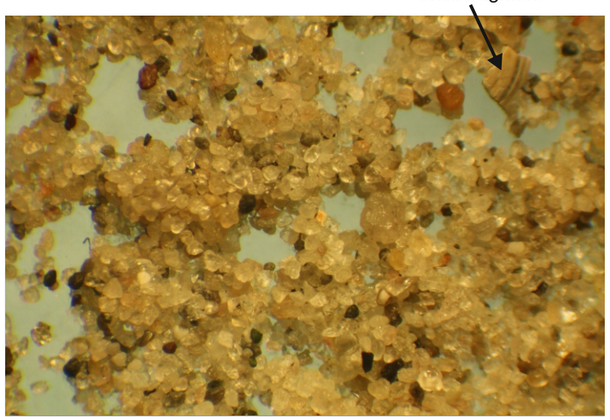
Unwashed Sample



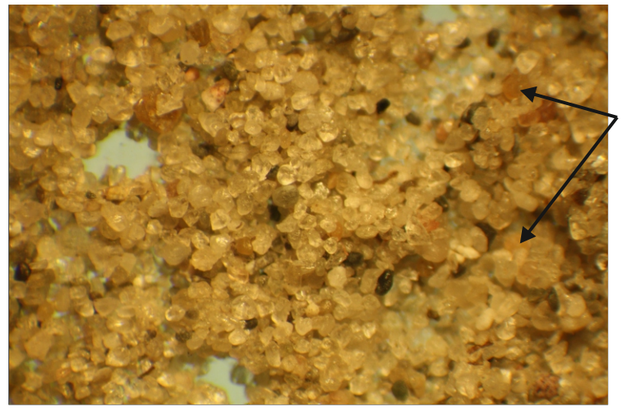
Washed Sample



Washed Sample

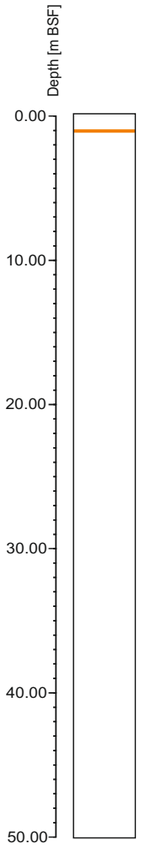


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-1** **Sample Name: 2 BAG B**	**Depth [m BSF]: 3.00** **Soil Unit: Southern Bight**	**Plate Number: 1.2**	Logged by: LM Date: 05/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted slightly silty fine to coarse SAND with trace fine to coarse sand-sized shell fragments

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Pale brown (2.5Y-7/3)

Microscope Description
Sample is moderately sorted

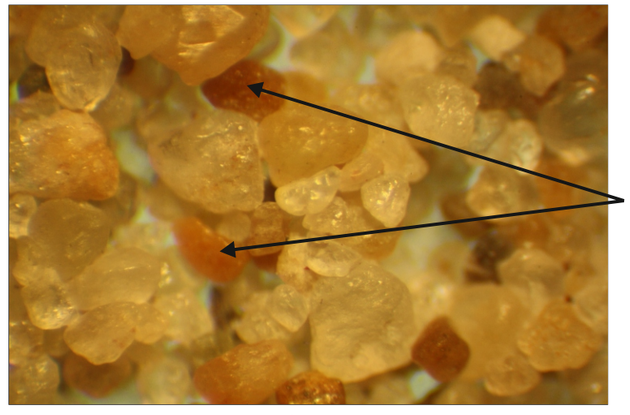
86% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
- ~ 80% clear/colourless to pale yellow
- ~ 15% dark yellow to beige
- ~ 5% pale pink to red

8% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity black and dark reddish brown MAFIC/LITHIC FRAGMENTS
5% – Fine to medium sand-sized subrounded (*r*K = 0.5 to 0.6) low to high sphericity pale beige to white (opaque) CHERT/FELDSPAR
1% – Coarse sand- to fine gravel-sized white to beige angular (*r*K = 0.1 to 0.2) low sphericity SHELL FRAGMENTS

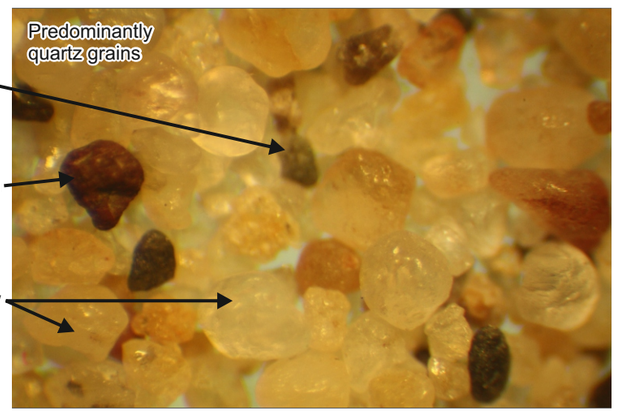
Trace: Glauconite pellets, Biotite

Reflected Light Microphotographs

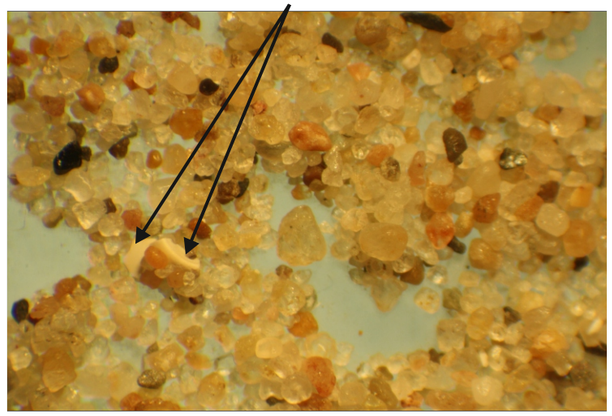
Unwashed Sample



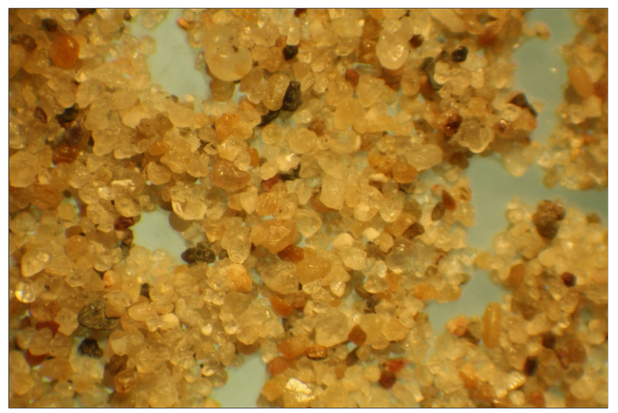
Washed Sample



Washed Sample

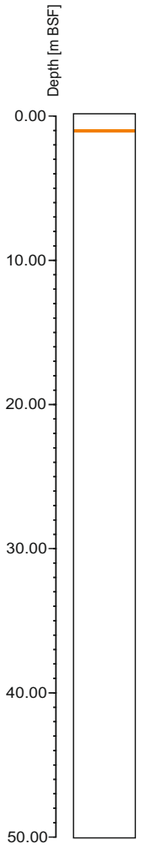


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-3** **Sample Name: 2 BAG A**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.3**	Logged by: ASW Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted slightly silty medium SAND with few angular shell fragments

Colour:
Unwashed: Pale brown (2.5Y-7/4)
Washed: Light yellowish brown (2.5Y-6/4)

Microscope Description
Sample is moderately to well sorted

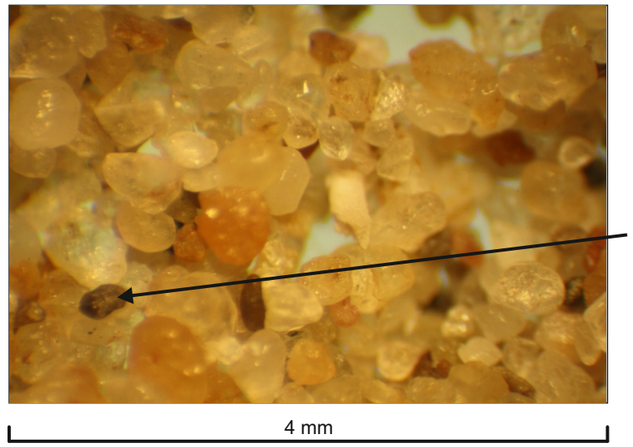
70% – Medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium sphericity QUARTZ
- ~ 50% clear, colourless
- ~ 20% light pink to orange
- ~ 20% beige to yellow
- ~ 10% frosted, colourless

15% – Fine to coarse sand-sized angular to subangular (*r*K = 0.1 to 0.4) low to high sphericity black to dark grey and dark brown MAFIC/LITHIC FRAGMENTS
10% – Fine to coarse sand-sized angular to subangular (*r*K = 0.1 to 0.4) low to high sphericity pink to beige LITHIC FRAGMENTS
2% – Medium to coarse sand-sized angular (*r*K = 0.1 to 0.2) low sphericity pink and beige SHELL FRAGMENTS
2% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity dark grey LITHIC FRAGMENTS
1% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity milky white CALCITE

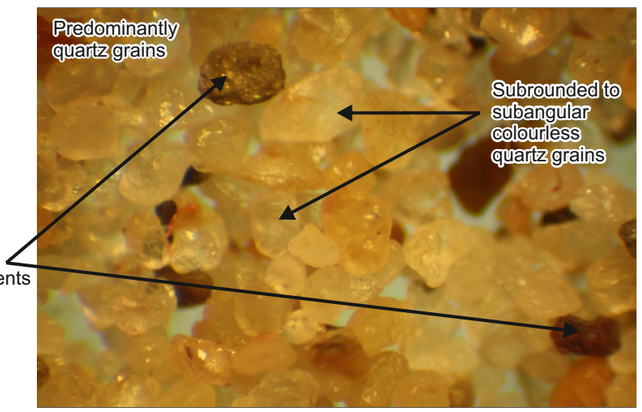
Trace: Feldspar, Glauconite pellets, Mica

Reflected Light Microphotographs

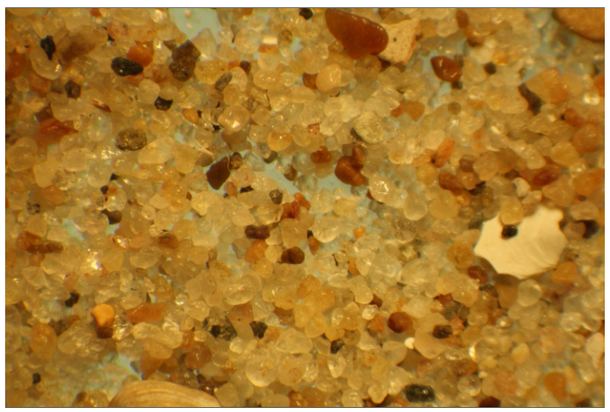
Unwashed Sample



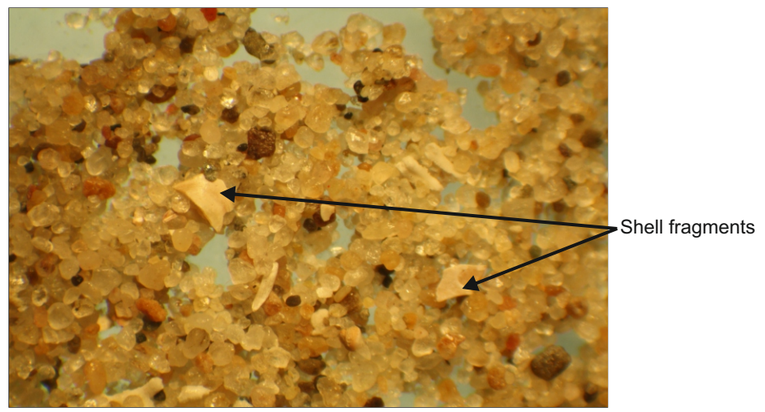
Washed Sample



Washed Sample

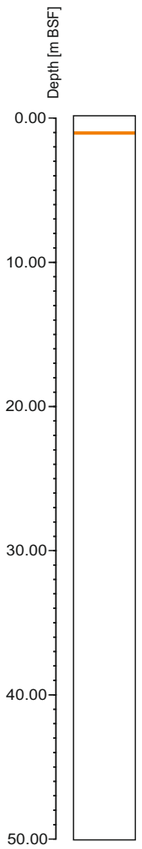


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-3** **Sample Name: 2 BAG B**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.4**	Logged by: LM Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted fine to medium SAND with few fine gravel-sized angular shell fragments

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Pale brown (2.5Y-7/3)

Microscope Description
Sample is moderately sorted

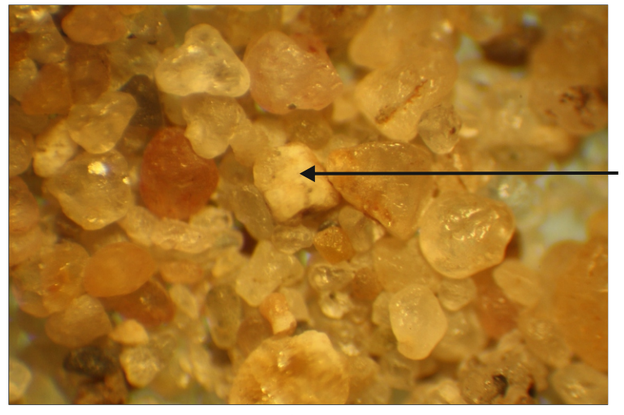
89% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity QUARTZ
- ~ 90% colourless to pale yellow/beige
- ~ 8% dark yellow/beige
- ~ 2% pink to reddish brown

5% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity dark grey to black and brown LITHIC FRAGMENTS
3% – Medium sand- to fine gravel-sized angular to subangular (*r*K = 0.1 to 0.4) low sphericity white to orange/beige SHELL and BIOCLASTIC FRAGMENTS
3% – Fine to medium sand-sized subrounded to rounded (*r*K = 0.5 to 0.8) low to medium sphericity pale orange to white FELDSPAR

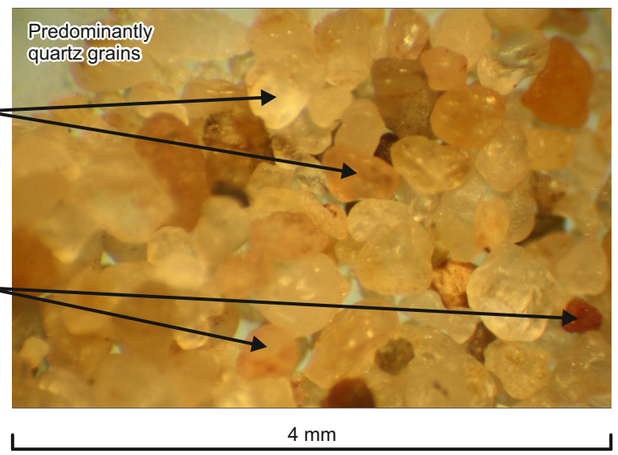
Trace: Mica

Reflected Light Microphotographs

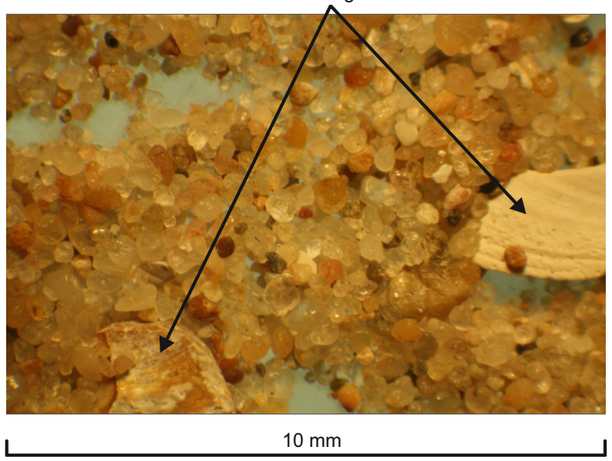
Unwashed Sample



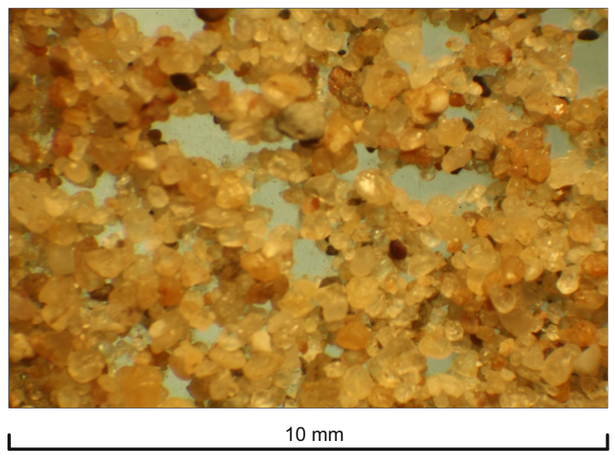
Washed Sample



Washed Sample

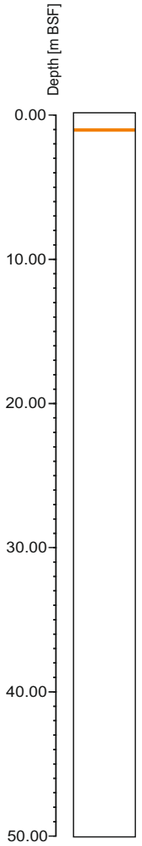


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-4** **Sample Name: 2 BAG A**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.5**	Logged by: ASW Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Poorly sorted slightly clayey fine to coarse SAND with few fine gravel-sized angular shell fragments

Colour:
Unwashed: Light olive brown (2.5Y-5/3)
Washed: Pale brown (2.5Y-7/3)

Microscope Description
Sample is poorly sorted – unwashed sample shows coating of silt

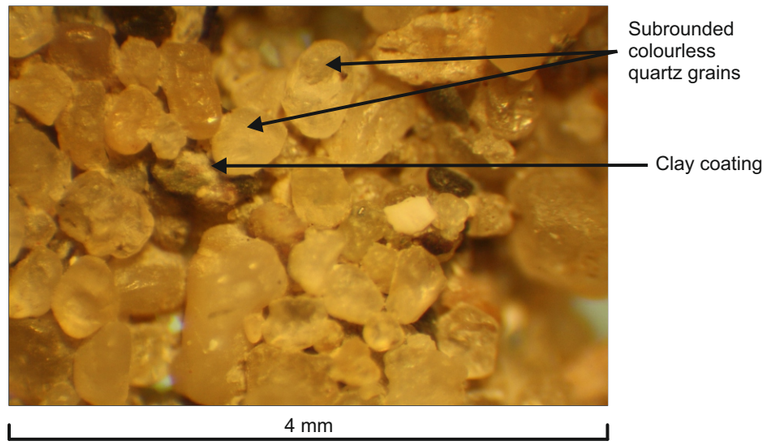
85% –Silt- to coarse sand-sized subrounded to rounded (*r*K = 0.5 to 0.8) medium to high sphericity QUARTZ
~ 60% clear, colourless
~ 20% frosted, colourless
~ 20% light pink to orange/yellow

5% – Medium sand- to fine gravel-sized angular (*r*K = 0.1 to 0.2) low sphericity black and dark reddish brown MAFIC/LITHIC FRAGMENTS
5% – Silt- to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to medium sphericity white opaque FELDSPAR
3% – Medium to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity white SHELL FRAGMENTS
2% – Medium to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity Muscovite

Trace: Glauconite pellets

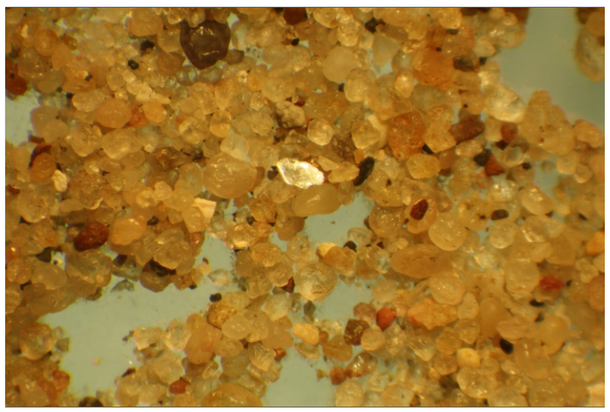
Reflected Light Microphotographs

Unwashed Sample

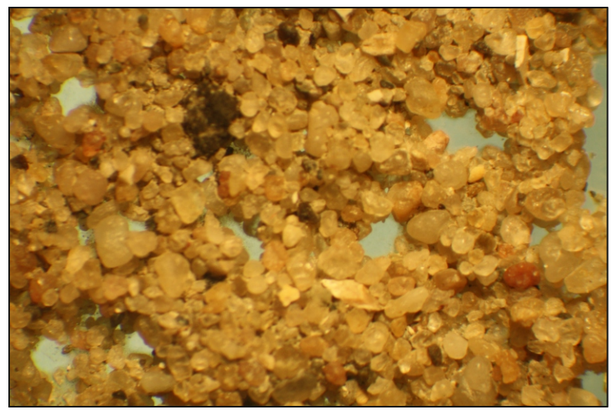


Washed Sample

Washed Sample

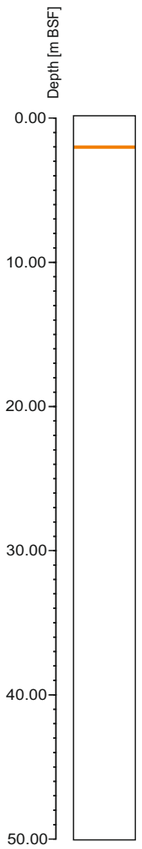


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-4** **Sample Name: 2 BAG B**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.6**	Logged by: LM Date:05/06/2015 Checked by:LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted medium SAND with few fine to coarse sand-sized angular shell fragments

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Pale brown (2.5Y-7/3)

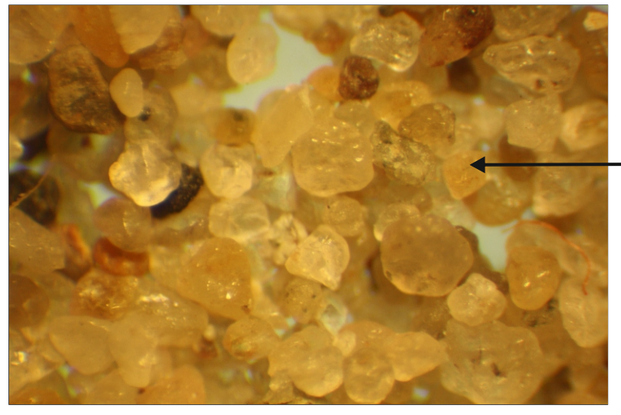
Microscope Description
Sample is well sorted

90% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
~90% colourless to pale yellow/beige
~7% dark yellow/beige
~3% pale pink to red
6% – Fine to coarse sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity black to dark brown LITHIC FRAGMENTS
4% – Fine to medium sand-sized subrounded to rounded (*r*K = 0.5 to 0.8) medium to high sphericity yellow to light brown FELDSPAR

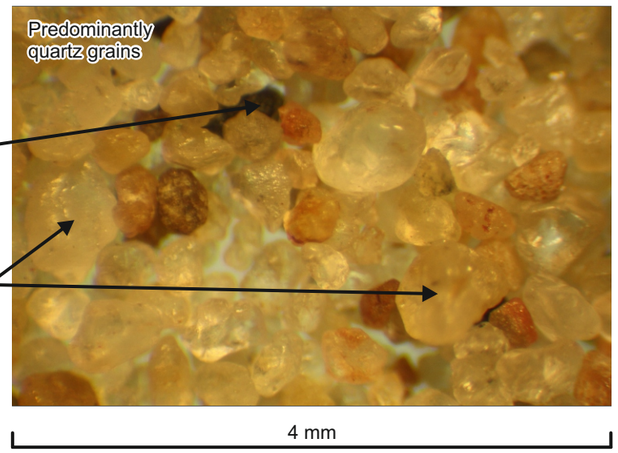
Trace: Silt- to fine sand-sized sub-rounded (*r*K = 0.5 to 0.6) low sphericity white to dark red SHELL FRAGMENTS

Reflected Light Microphotographs

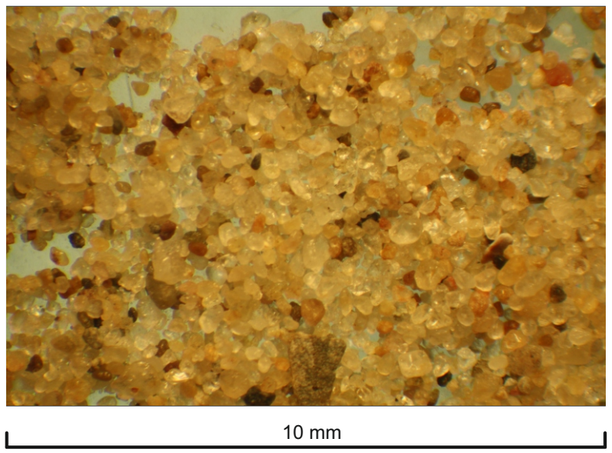
Unwashed Sample



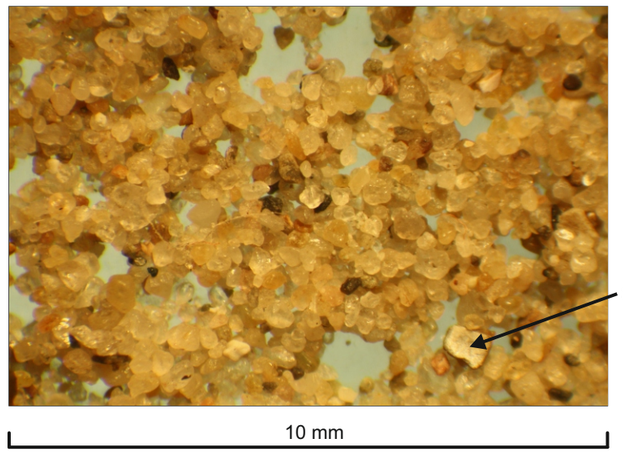
Washed Sample



Washed Sample

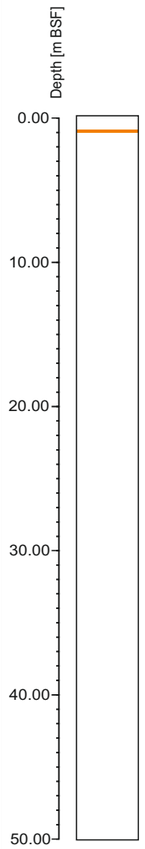


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-4** **Sample Name: 3 BAG A**	**Depth [m BSF]: 2.00** **Soil Unit: Southern Bight**	**Plate Number: 1.7**	Logged by: ASW Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately to poorly sorted slightly clayey fine to coarse SAND with fine gravel-sized angular shells and shell fragments (bivalve)

Colour:
Unwashed: Dark grey (2.5Y-4/1)
Washed: Grey (2.5Y-6/1)

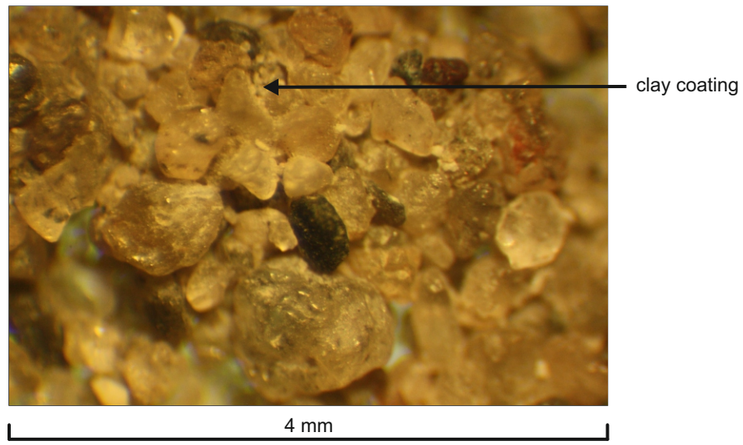
Microscope Description
Sample is moderately to poorly sorted – unwashed sample shows coating of clay and silt

90% – Fine to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity QUARTZ
~ 70% clear, colourless
~ 10% frosted/translucent
~ 10% clear to frosted light pink
~ 5% beige to yellow
~ 5% orange
5% – Fine to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) medium sphericity black and dark reddish brown MAFIC/LITHIC FRAGMENTS
3% – Fine to medium sand-sized subrounded (*r*K = 0.5 to 0.6) low to medium sphericity MUSCOVITE
2% – Fine sand- to fine gravel-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity BIOCLASTIC DEBRIS (bivalve, echinoderm)

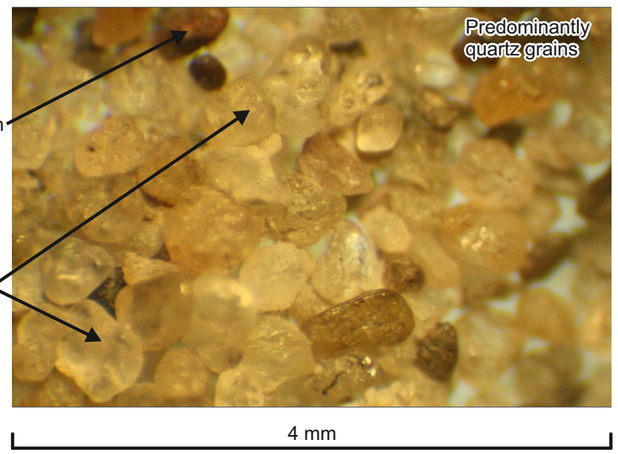
Trace: Glauconite pellets, Epidote

Reflected Light Microphotographs

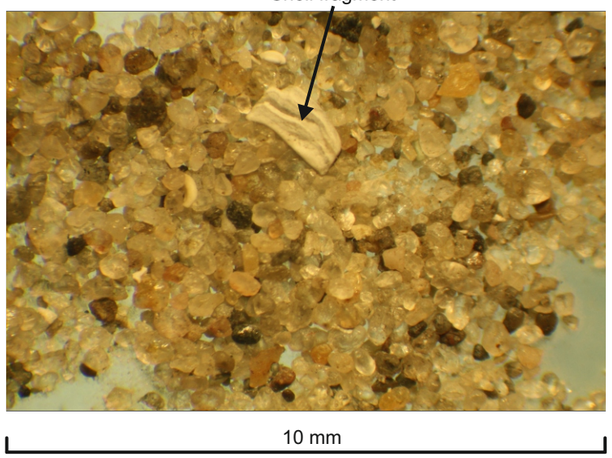
Unwashed Sample



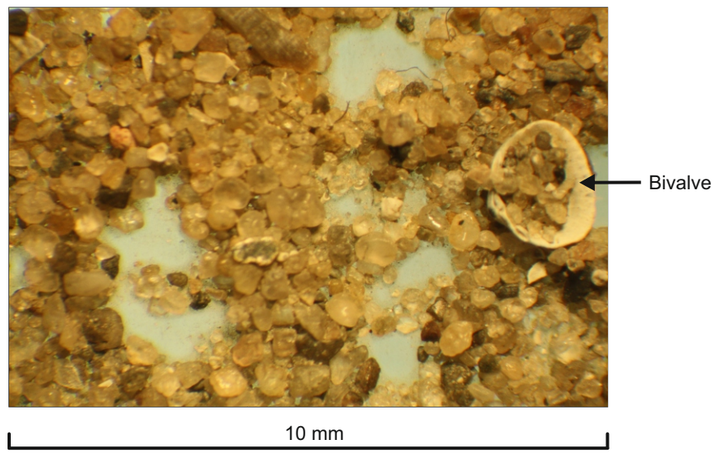
Washed Sample



Washed Sample

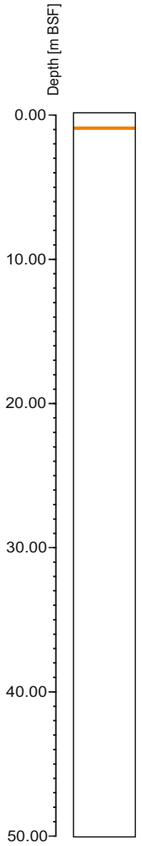


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-5** **Sample Name: 2 BAG A**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.8**	Logged by: LM Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted medium to coarse SAND with trace fine gravel-sized angular shell fragments

Colour:
Unwashed: Light olive brown (2.5Y-5/4)
Washed: Light yellowish brown (2.5Y-6/3)

Microscope Description
Sample is moderately sorted

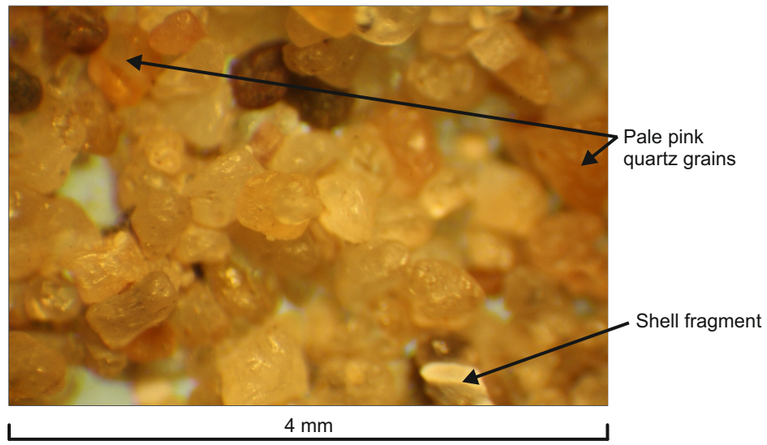
90% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity QUARTZ
- ~ 90% colourless to pale yellow
- ~ 10% light brown
- ~ Trace pink to red

4% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity black to dark grey/black and brown LITHIC FRAGMENTS
3% – Fine to medium sand-sized subrounded to rounded (*r*K = 0.5 to 0.8) medium to high sphericity white to pale orange FELDSPAR
3% – Medium sand- to medium gravel-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity SHELL FRAGMENTS

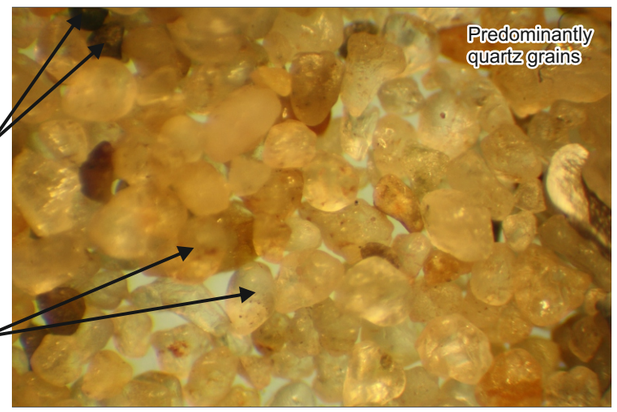
Trace: Bioclastic debris (echinoid), mica

Reflected Light Microphotographs

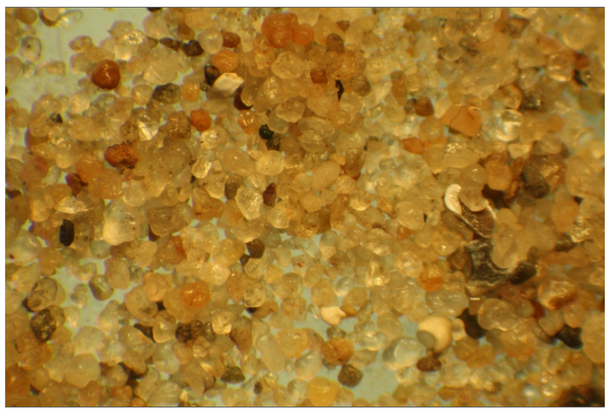
Unwashed Sample



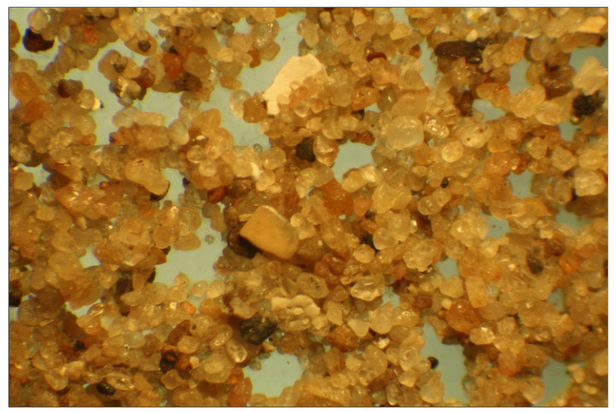
Washed Sample



Washed Sample

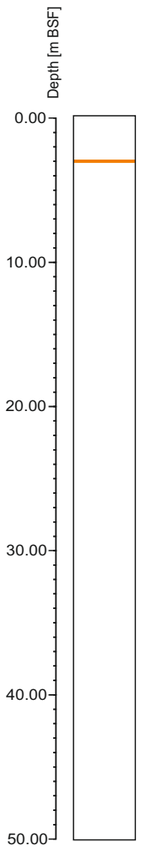


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-5** **Sample Name: 2 BAG B**	**Depth [m BSF]: 1.00** **Soil Unit: Southern Bight**	**Plate Number: 1.9**	Logged by: ASW Date:05/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted slightly clayey fine to coarse SAND with medium to coarse sand-sized to fine gravel-sized angular shell fragments

Colour:
Unwashed: Light olive brown (2.5Y-5/3)
Washed: Light yellowish brown (2.5Y-6/3)

Microscope Description
Sample is moderately to well sorted – unwashed sample shows coating of clay and silt

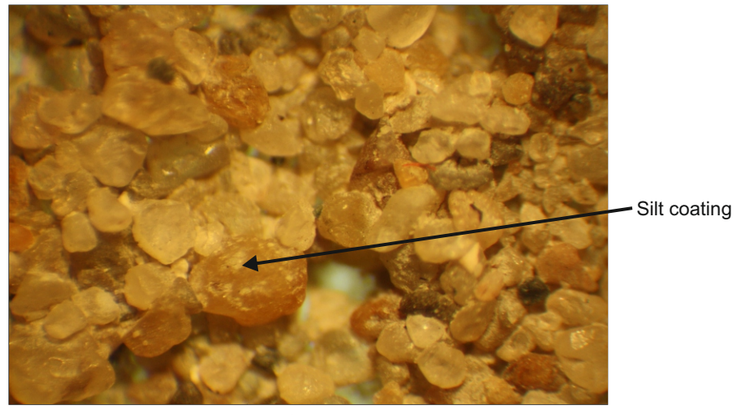
90% – Fine to medium sand-sized angular to rounded (*r*K = 0.1 to 0.8) low to high sphericity QUARTZ
- ~ 50% clear, colourless
- ~ 30% frosty/translucent
- ~ 10% light pink to orange
- ~ 10% yellow to beige

4% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to medium sphericity dark grey/black and dark brown LITHIC FRAGMENTS
3% – Fine to medium sand-sized subangular (*r*K = 0.3 to 0.4) low to medium sphericity pink/cloudy/yellow FELDSPAR
3% – Medium sand-sized to fine gravel-sized angular to subangular (*r*K = 0.1 to 0.4) low to medium sphericity white to pale pink SHELL FRAGMENTS (bivalve, echinoderm)

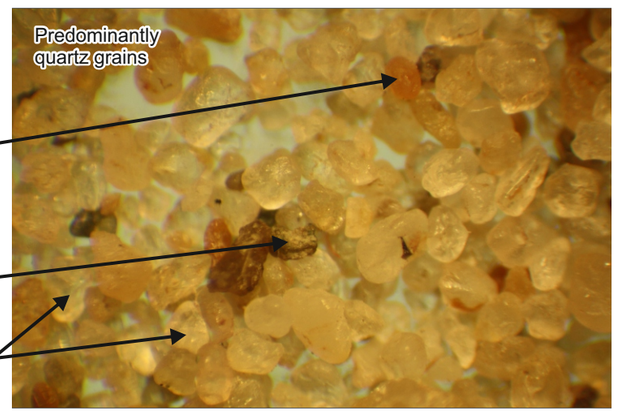
Trace: Chert, Glauconite pellets, Muscovite

Reflected Light Microphotographs

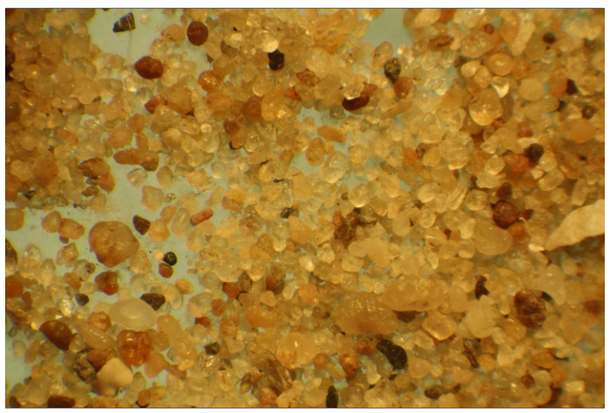
Unwashed Sample



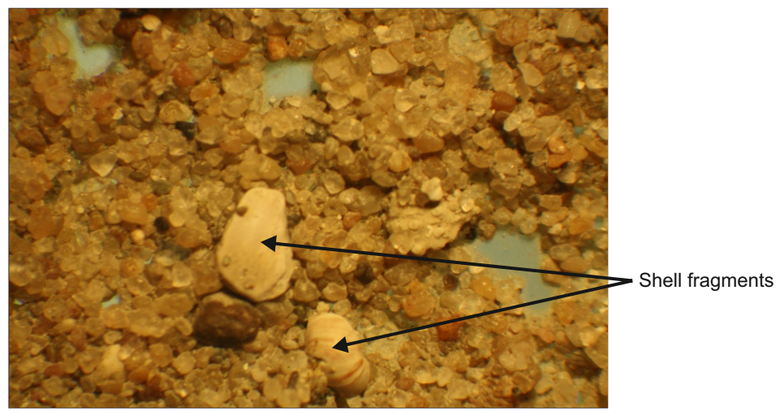
Washed Sample



Washed Sample

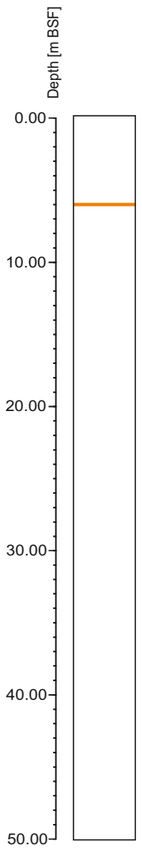


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-5** **Sample Name: 4 BAG A**	**Depth [m BSF]: 3.00** **Soil Unit: Southern Bight**	**Plate Number: 1.10**	Logged by: LM Date: 05/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted fine to medium SAND

Colour:
Unwashed: Light brownish grey (2.5Y-6/2)
Washed: Light grey (2.5Y-7/1)

Microscope Description
Sample is well sorted – unwashed sample shows coating of silt

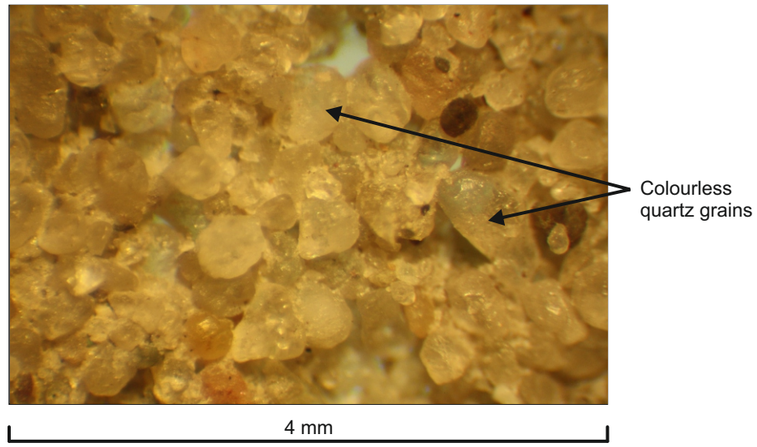
94% – Fine to medium sand-sized subangular to rounded (mostly subrounded) (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
- ~ 95% colourless, clear
- ~ 4% beige to light yellow
- ~ 1% light pink to reddish orange/red

4% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity dark brown to black LITHIC FRAGMENTS
2% – Fine to medium sand-sized subrounded (*r*K = 0.5 to 0.6) medium to high sphericity pale orange to brown FELDSPAR

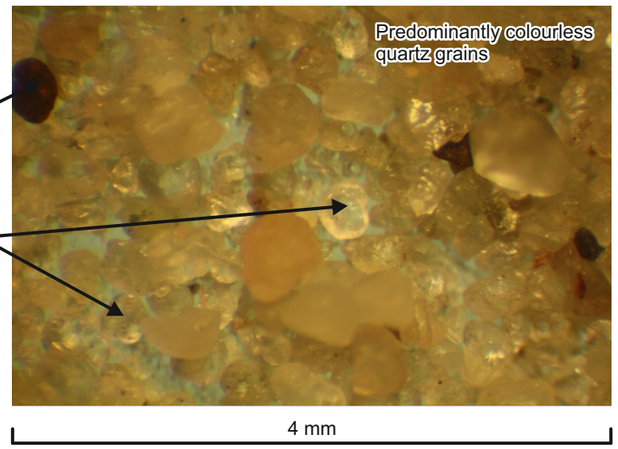
Trace: Epidote

Reflected Light Microphotographs

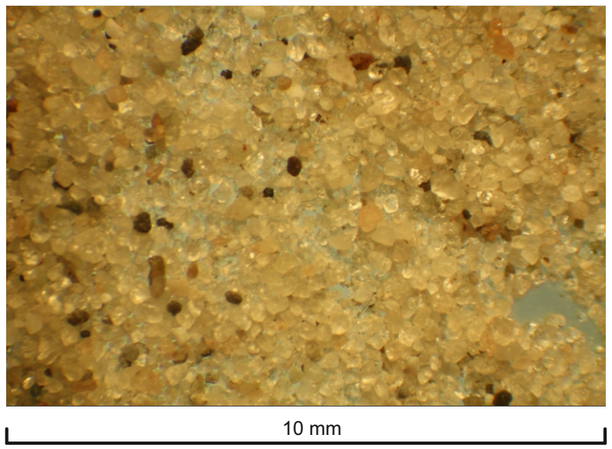
Unwashed Sample



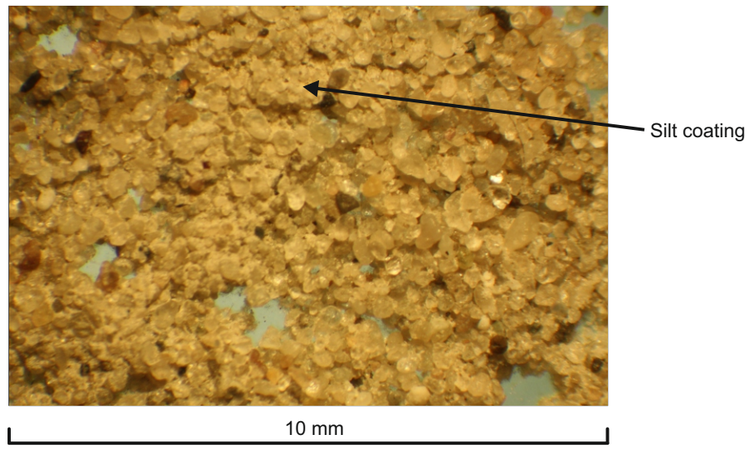
Washed Sample



Washed Sample

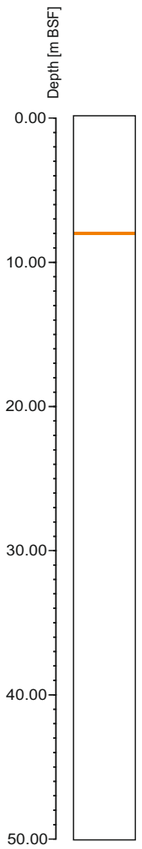


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-6a** **Sample Name: 7 BAG A**	**Depth [m BSF]: 6.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.1**	Logged by: ASW Date: 09/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted fine to medium SAND

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Light grey (2.5Y-7/2)

Microscope Description
Sample is well sorted – unwashed sample shows trace coating of silt

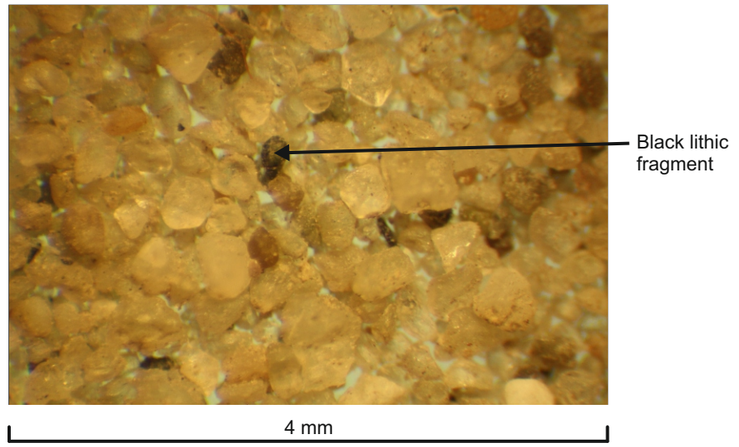
85% – Fine to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity QUARTZ
~ 80% clear, colourless
~ 10% beige to light yellowish
~ 10% frosted, translucent

5% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) dark grey to black MAFIC/LITHIC FRAGMENTS
5% – Fine to coarse sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium sphericity pink to cloudy translucent FELDSPAR
5% – Fine to medium sand-sized subrounded (*r*K = 0.5 to 0.6) low to high sphericity light green EPIDOTE

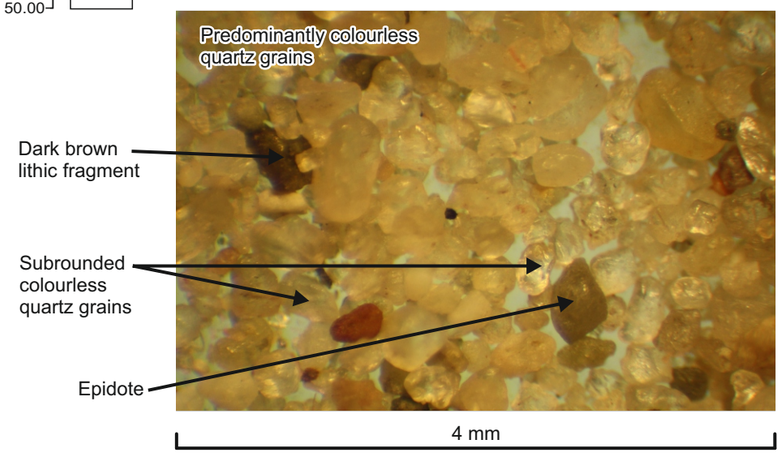
Trace: Muscovite

Reflected Light Microphotographs

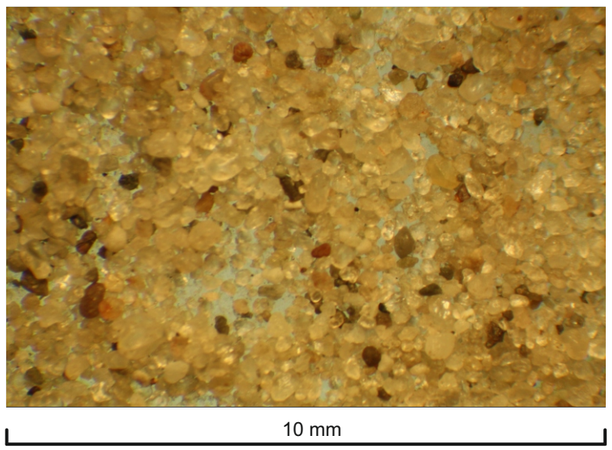
Unwashed Sample



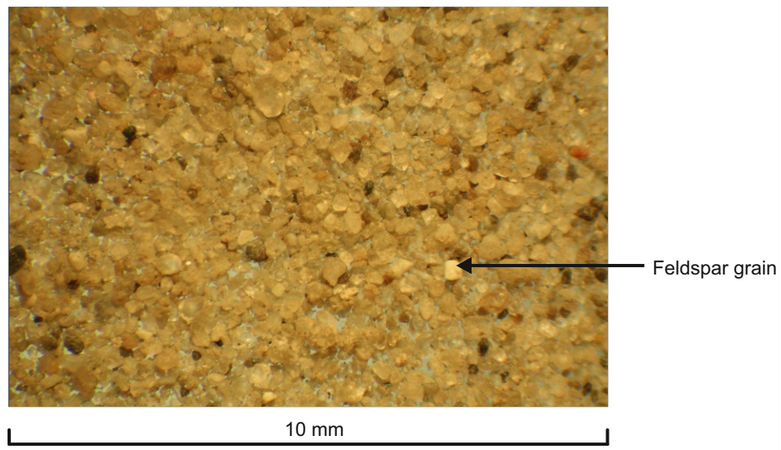
Washed Sample



Washed Sample

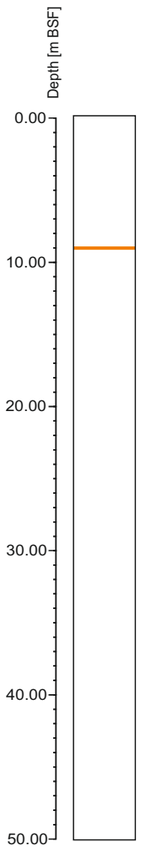


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-6a** **Sample Name: 10 BAG A**	**Depth [m BSF]: 8.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.2**	Logged by: LM Date:08/06/2015 Checked by:LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted medium SAND

Colour:
Unwashed: Grey (2.5Y-6/1)
Washed: Light grey (2.5Y-7/1)

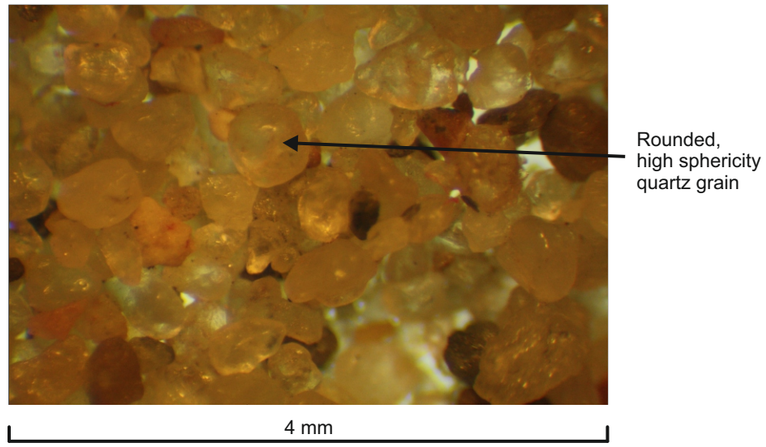
Microscope Description
Sample is moderately well sorted

88% – Fine to coarse sand-sized subrounded to well-rounded (*r*K = 0.5 to 0.9) medium to high sphericity QUARTZ
~ 75% clear, colourless
~ 20% frosted, translucent
~ 5% light pink to yellow/beige

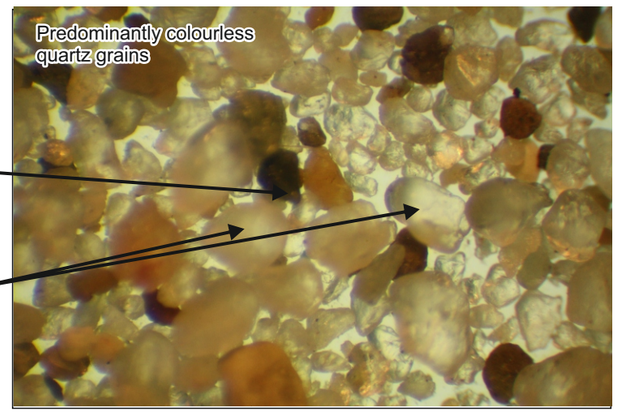
4% – Fine to medium sand-sized subrounded to well-rounded (*r*K = 0.5 to 0.9) medium to high sphericity light pink to cloudy and translucent FELDSPAR
4% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium sphericity dark grey to black LITHIC/MAFIC fragments
2% – Fine to medium sand-sized subangular (*r*K = 0.3 to 0.4) low sphericity light to dark green EPIDOTE
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium sphericity MUSCOVITE

Reflected Light Microphotographs

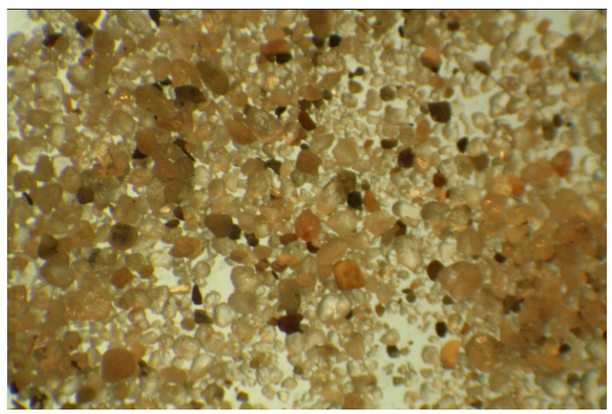
Unwashed Sample



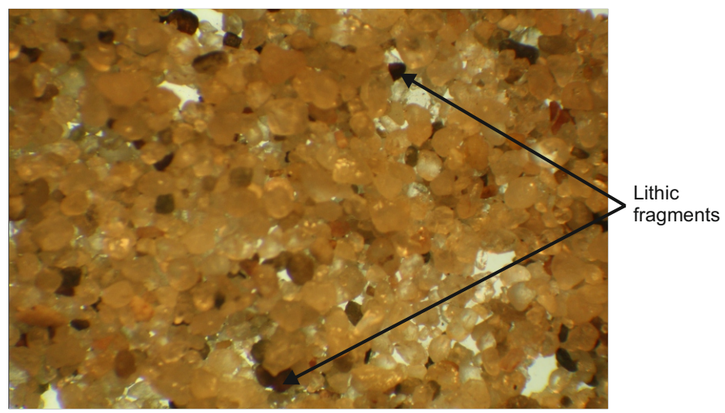
Washed Sample



Washed Sample

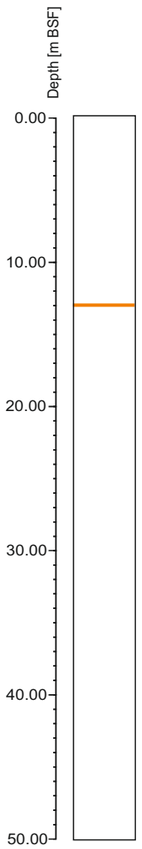


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-6a** **Sample Name: 11 BAG A**	**Depth [m BSF]: 9.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.3**	Logged by: LM Date: 08/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted fine to medium SAND

Colour:
Unwashed: Light brownish grey (2.5Y-6/2)
Washed: Light grey (2.5Y-7/1)

Microscope Description
Sample is well sorted

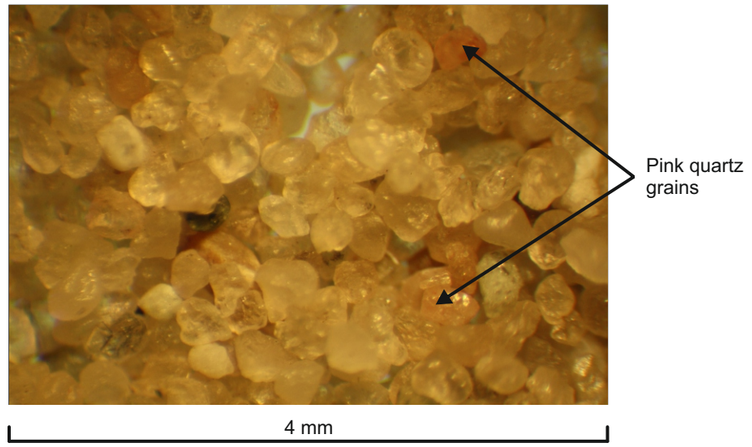
90% – Fine to coarse sand-sized subrounded to well-rounded (*r*K = 0.5 to 0.9) medium to high sphericity QUARTZ
~ 85% clear, colourless
~ 10% frosted, translucent
~ 5% pink to light yellow/beige

2% to 3% – Medium sand-sized angular to subangular (*r*K = 0.1 to 0.4) low to medium sphericity green GLAUCONITE pellets
2% – Fine to medium sand-sized angular to subangular (*r*K = 0.1 to 0.4) low sphericity dark grey to black and dark brown LITHIC/MAFIC FRAGMENTS (occasional high lustre visible)
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity MICA (predominantly Biotite)
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity opaque milky white, beige to light pink FELDSPAR
1% to 2% – Fine to medium subangular (*r*K = 0.3 to 0.4) low to medium sphericity green EPIDOTE

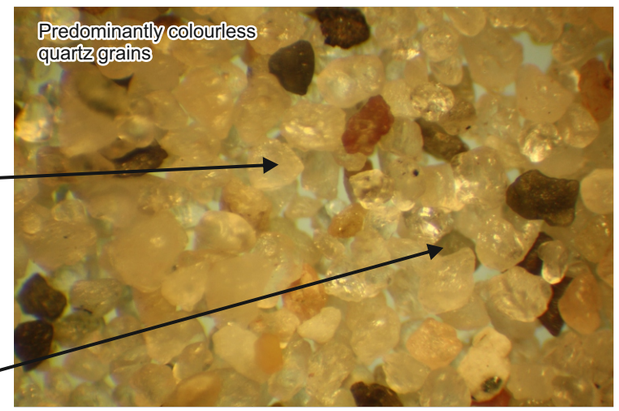
Trace: Calcite, Glauconite/Chlorite pellets

Reflected Light Microphotographs

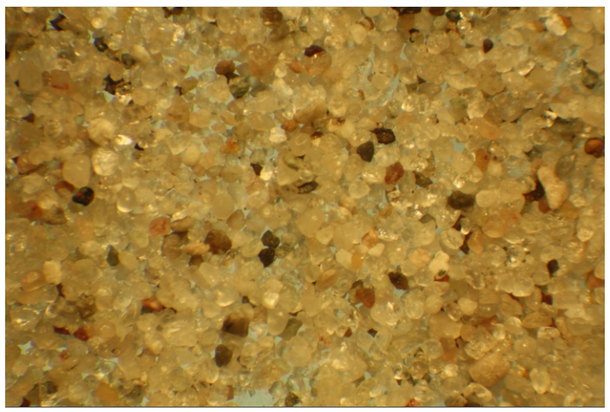
Unwashed Sample



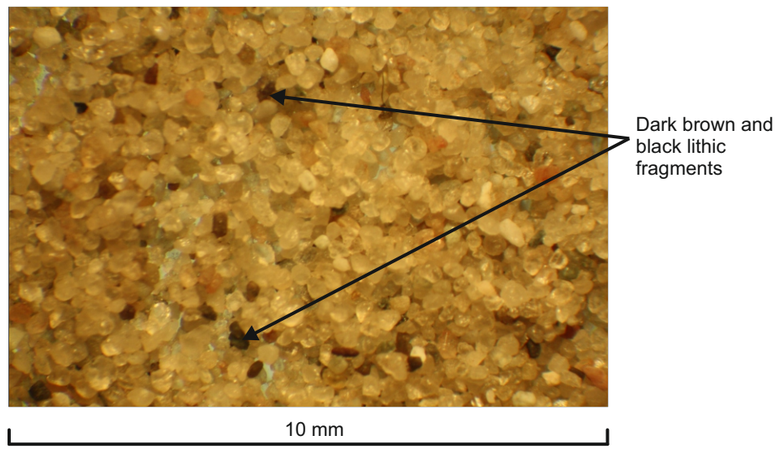
Washed Sample



Washed Sample

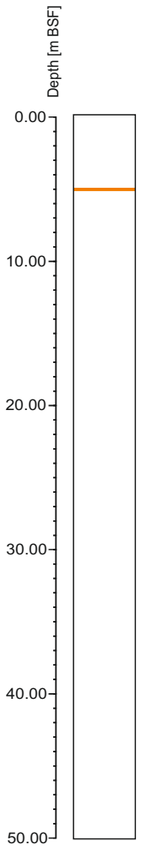


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-6a** **Sample Name: 12 BAG A**	**Depth [m BSF]: 13.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.4**	Logged by: LM Date:08/06/2015 Checked by:LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted medium to coarse SAND with trace fine sand- to coarse gravel-sized angular shell fragments

Colour:
Unwashed: Light grey (2.5Y-7/2)
Washed: Light grey (2.5Y-7.5/2)

Microscope Description
Sample is moderately to well sorted

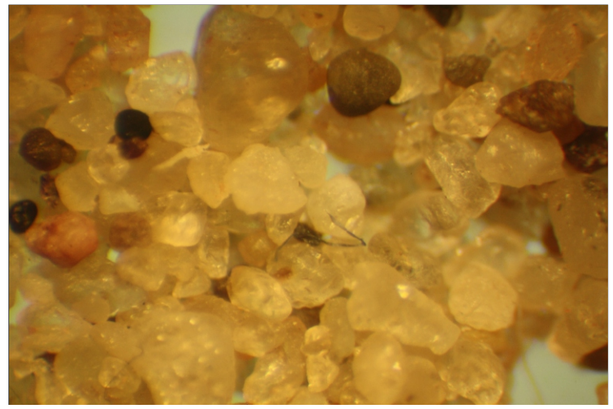
85% – Fine to coarse sand-sized subangular to well-rounded (*r*K = 0.3 to 0.9) low to high sphericity QUARTZ
~ 45% clear, colourless
~ 45% frosted, translucent
~ 10% pink to light yellow/beige and orange

10% – Fine to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low sphericity white to light pink FELDSPAR
2% – Medium to coarse sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low sphericity MAFIC/LITHIC FRAGMENTS
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity green EPIDOTE

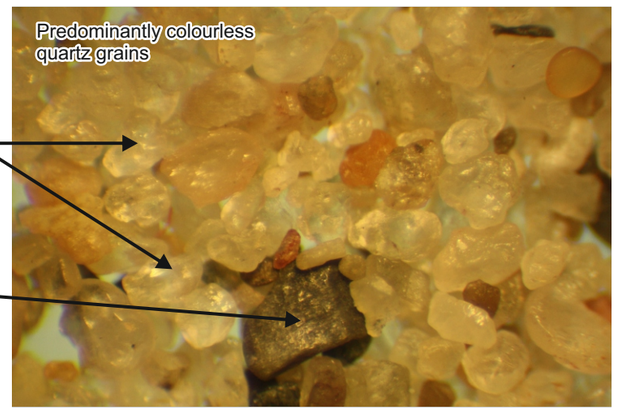
Trace: Muscovite, Calcite, Bioclastic debris

Reflected Light Microphotographs

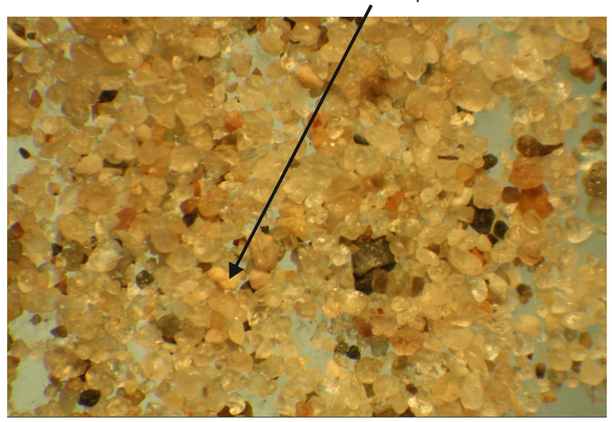
Unwashed Sample



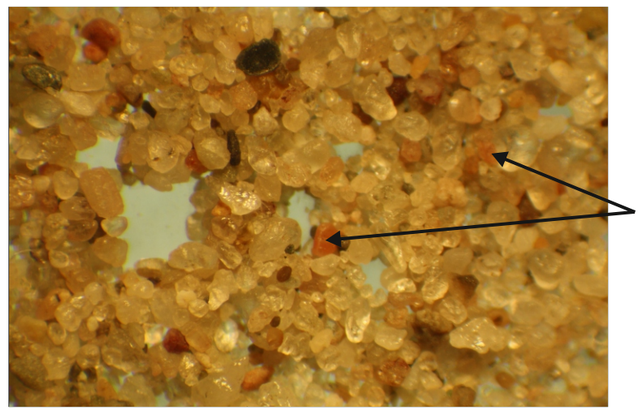
Washed Sample



Washed Sample

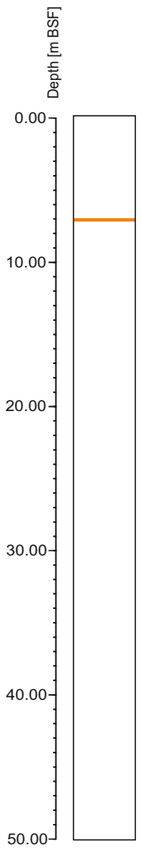


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-3** **Sample Name: 4 BAG A**	**Depth [m BSF]: 5.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.5**	Logged by: LM Date: 08/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately to poorly sorted clayey fine to coarse SAND with few medium sand-sized to fine gravel-sized angular shell fragments

Colour:
Unwashed: Light brownish grey (2.5Y-6/2)
Washed: Light grey (2.5Y-7.5/2)

Microscope Description
Sample is moderately to poorly sorted – unwashed sample is silt coated

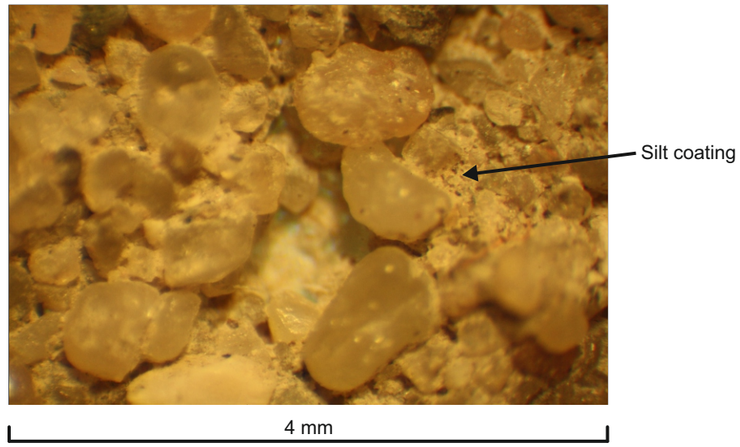
85% – Silt- to coarse sand-sized angular to rounded (*r*K = 0.1 to 0.8) medium sphericity QUARTZ
~ 20% clear, colourless
~ 60% frosted, translucent
~ 20% pink to orange, some yellowish

5% – Fine to coarse sand-sized angular to rounded (*r*K = 0.1 to 0.8) medium sphericity opaque milky white to frosted FELDSPAR
5% – Fine to medium sand-sized subangular (*r*K = 0.3 to 0.4) low to medium sphericity dark grey to black LITHIC/MAFIC FRAGMENTS
3% – Medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) medium to high sphericity MUSCOVITE
2% – Silt- to medium sand-sized angular to subangular (*r*K = 0.1 to 0.4) medium sphericity green GLAUCONITE/CHLORITE pellets

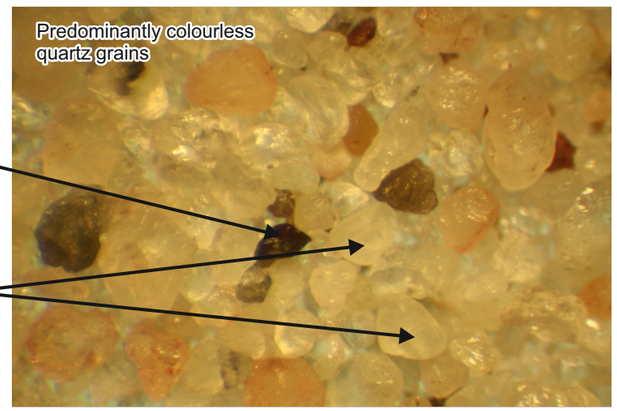
Trace: Bioclastic debris, Calcite

Reflected Light Microphotographs

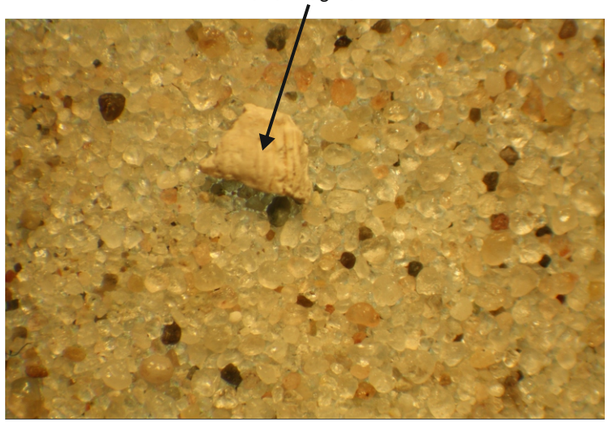
Unwashed Sample



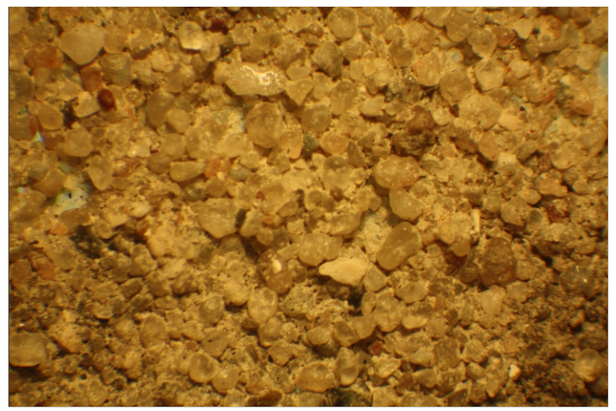
Washed Sample



Washed Sample

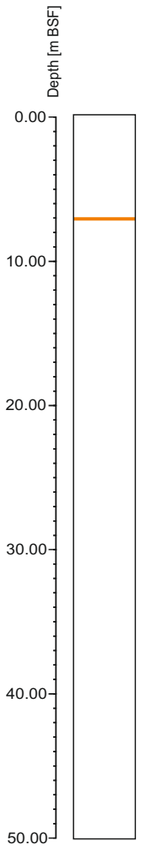


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-3** **Sample Name: 5 BAG A**	**Depth [m BSF]: 7.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.6**	Logged by: LM Date:08/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted fine to medium SAND

Colour:
Unwashed: Light brownish grey (2.5Y-6/2)
Washed: Grey (2.5Y-6/1)

Microscope Description
Sample is well sorted

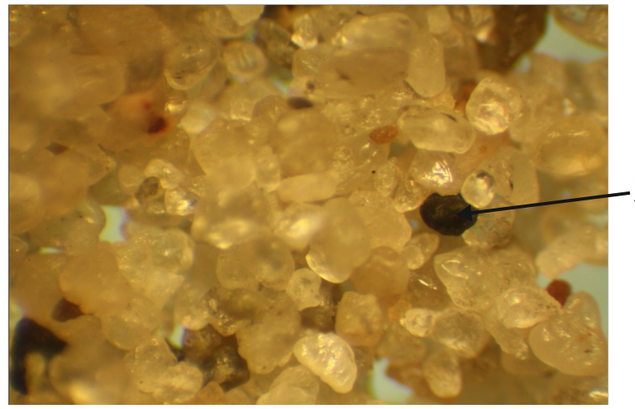
95% – Fine to medium subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
~ 95% clear, colourless to frosted and translucent
~ 3% pale orange to beige
~ 2% pale pink to red

5% – Fine to medium subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity dark brown to black LITHIC FRAGMENTS

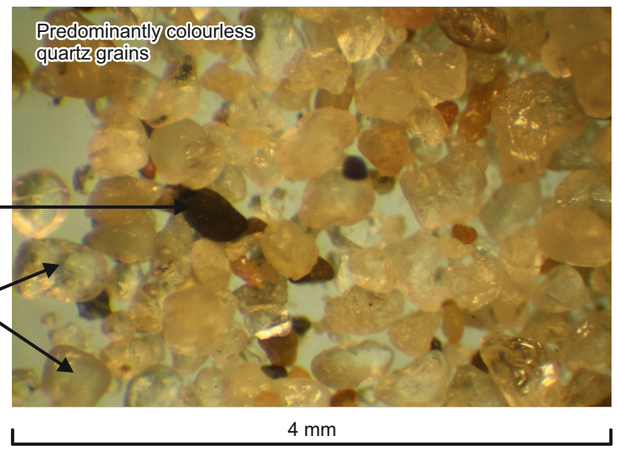
Trace: Glauconite pellets, Epidote and milky white Feldspar

Reflected Light Microphotographs

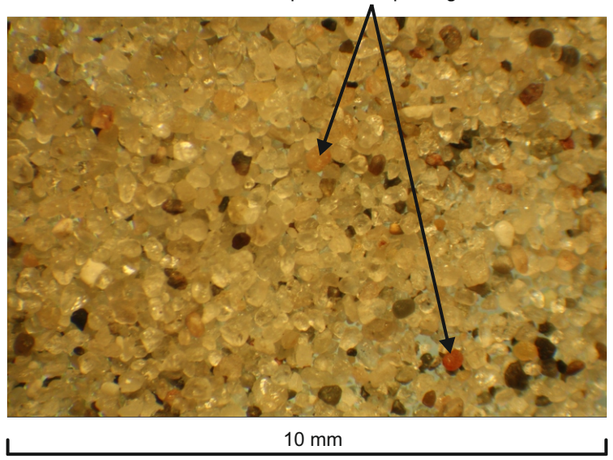
Unwashed Sample



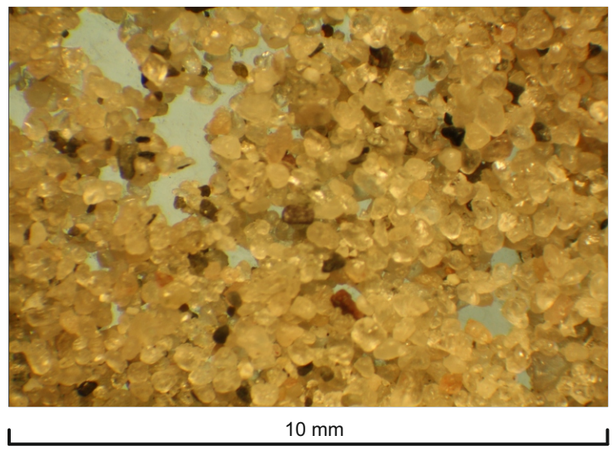
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

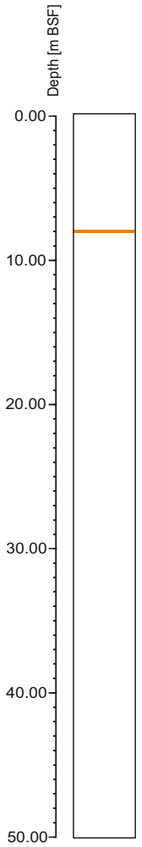
Sample Location: BH-WFS2-4
Sample Name: 8 BAG A

Depth [m BSF]: 7.0
Soil Unit: Eem/Kreftenheye

Plate Number: 2.7

Logged by: ASW	Date:09/06/2015	FUGRO
Checked by: LA/CES	Date:12/06/2015	
Approved by: GML	Date:25/08/2015	

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted medium SAND

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Pale brown (2.5Y-8/2)

Microscope Description
Sample is moderately to well sorted – unwashed sample is silt coated

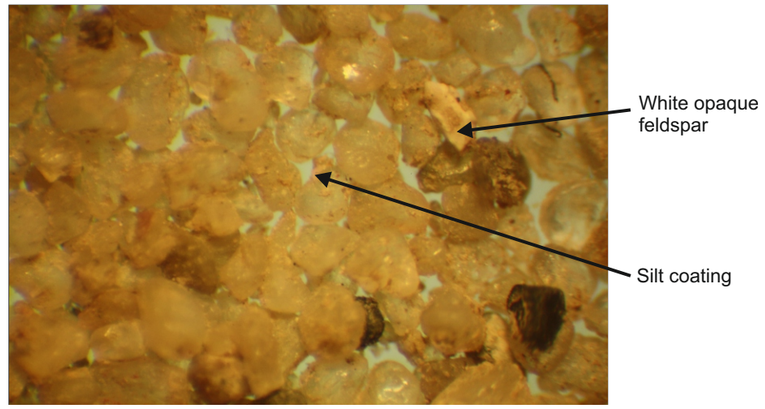
94% – Fine to medium subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity QUARTZ
~ 95% clear, colourless to frosted, translucent
~ 4% pale orange
~ 1% light pink to red

5% – Fine to medium subrounded (*r*K = 0.5 to 0.6) low to high sphericity dark grey to black LITHIC FRAGMENTS
1% – Fine to medium subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity opaque white to orange FELDSPAR/CHERT

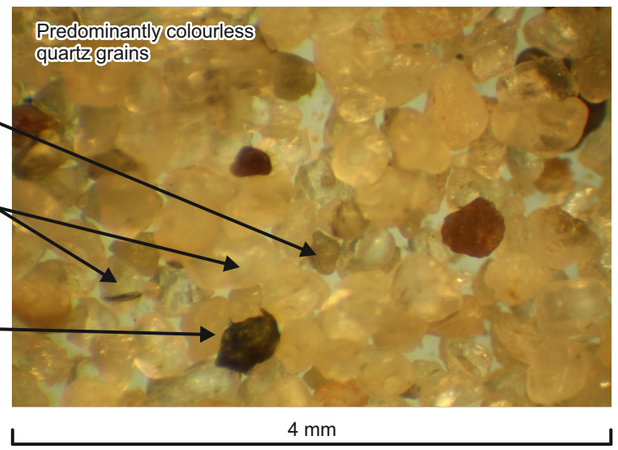
Trace: Muscovite, Glauconite pellets and Epidote

Reflected Light Microphotographs

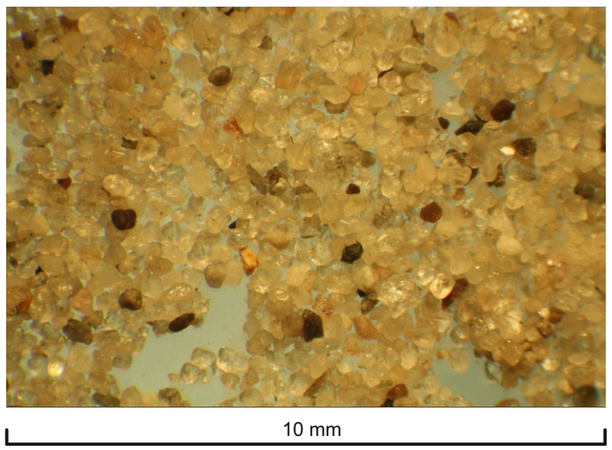
Unwashed Sample



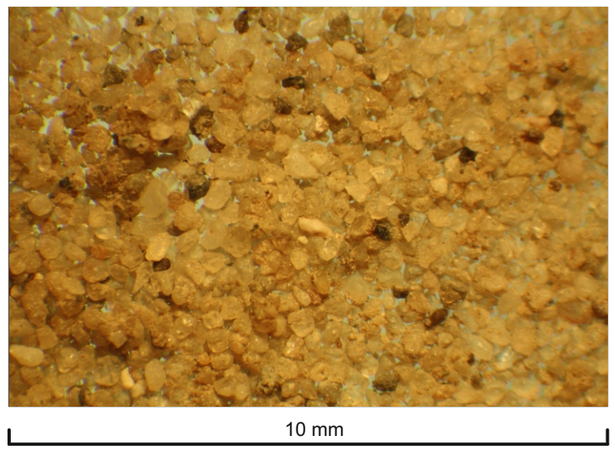
Washed Sample



Washed Sample

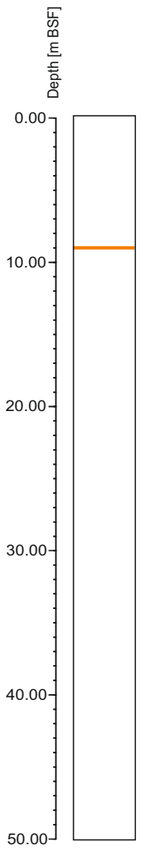


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-4** **Sample Name: 9 BAG A**	**Depth [m BSF]: 8.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.8**	Logged by: ASW Date:09/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted medium to coarse SAND with few fine gravel-sized angular shell fragments

Colour:
Unwashed: Light grey (2.5Y-7/2)
Washed: Light grey (2.5Y-7/1)

Microscope Description
Sample is well sorted

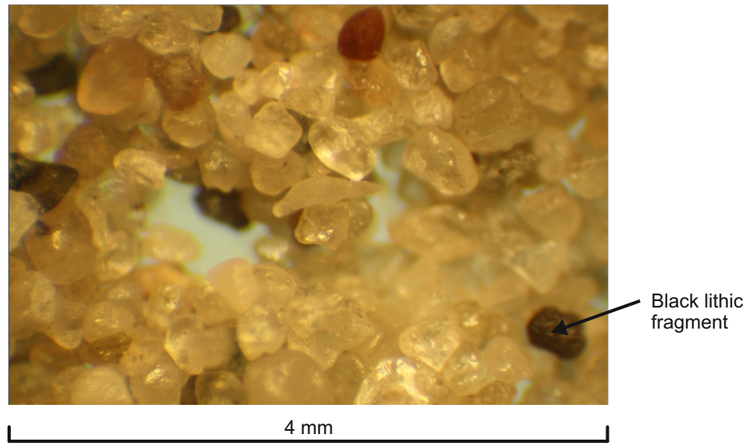
80% – Fine to coarse sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity QUARTZ
~ 45% clear, colourless
~ 35% frosted, translucent
~ 20% light pink to light yellow/orange

8% – Fine to medium sand-sized subangular (*r*K = 0.3 to 0.4) low to high sphericity MICA (predominantly biotite)
6% – Medium to coarse sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity BIOCLASTIC debris
4% – Fine to coarse sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium sphericity light pink/orange to frosted, translucent FELDSPAR
1% – Fine to coarse sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity dark grey to black and dark brown MAFIC/LITHIC FRAGMENTS
1% – Medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity green EPIDOTE

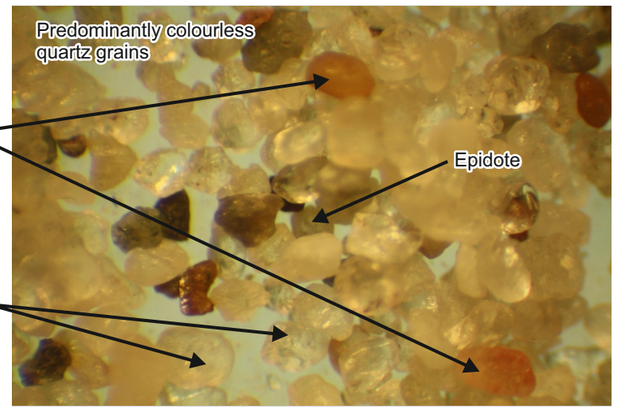
Trace: Calcite, Chert

Reflected Light Microphotographs

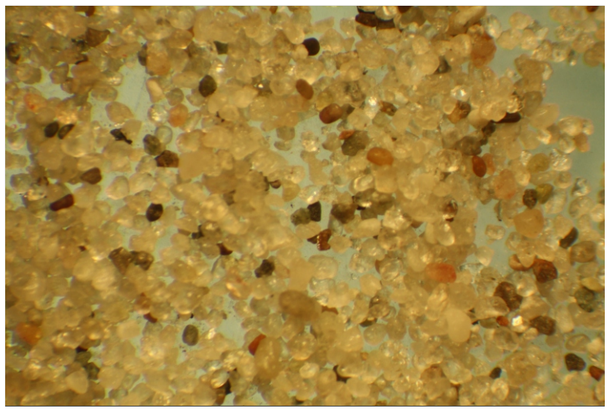
Unwashed Sample



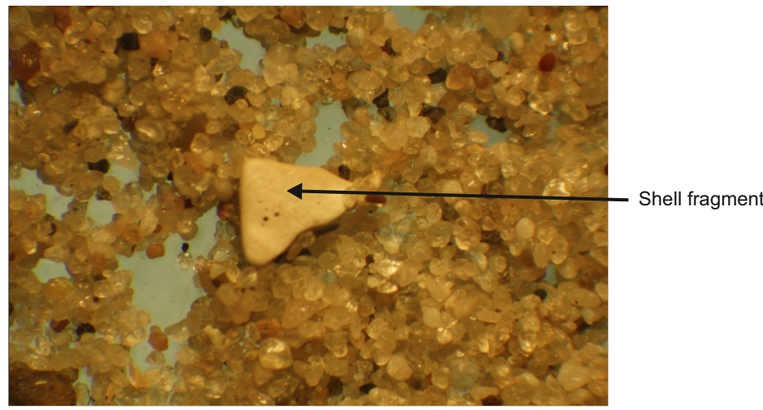
Washed Sample



Washed Sample

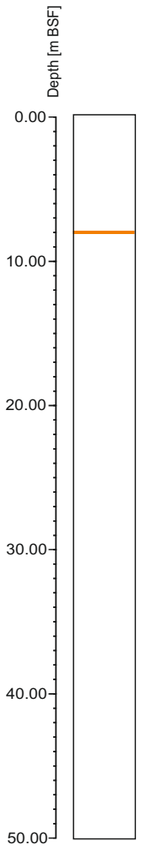


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-4** **Sample Name: 10 BAG A**	**Depth [m BSF]: 9.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.9**	Logged by: LM Date: 08/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted medium SAND

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Light grey (2.5Y-7/1)

Microscope Description
Well sorted – unwashed sample shows trace coating of silt

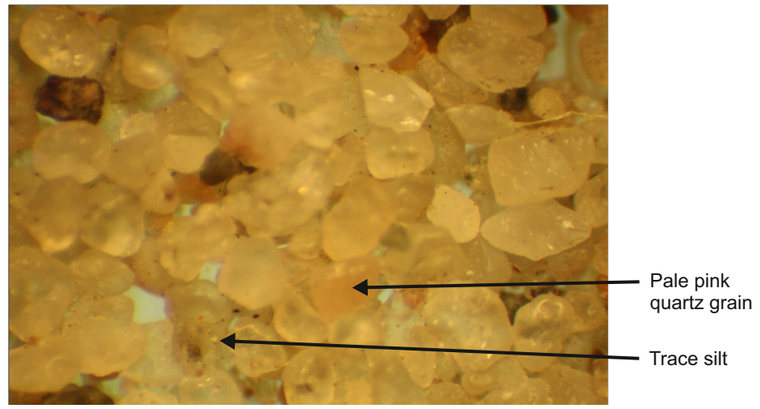
90% – Fine to medium subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity QUARTZ
~ 95% clear, colourless to frosted, translucent
~ 4% pale orange
~ 1% pale pink

6% – Fine to medium angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity dark grey to black and dark brown LITHIC FRAGMENTS
4% – Fine to medium subrounded (*r*K = 0.5 to 0.6) medium to high sphericity orange opaque FELDSPAR/CHERT

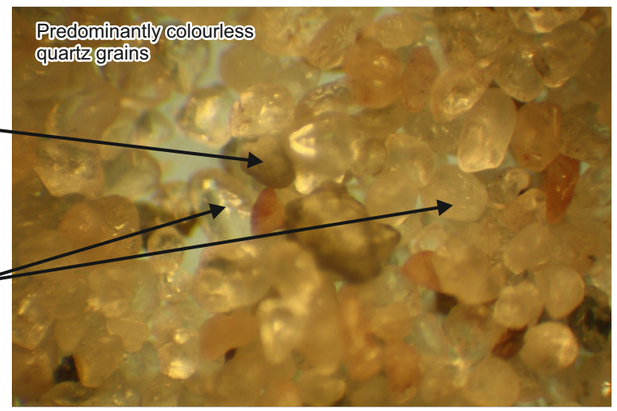
Trace: Glauconite pellets, Epidote and Muscovite

Reflected Light Microphotographs

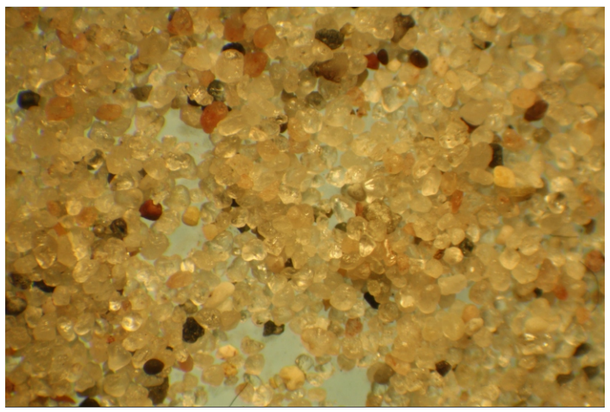
Unwashed Sample



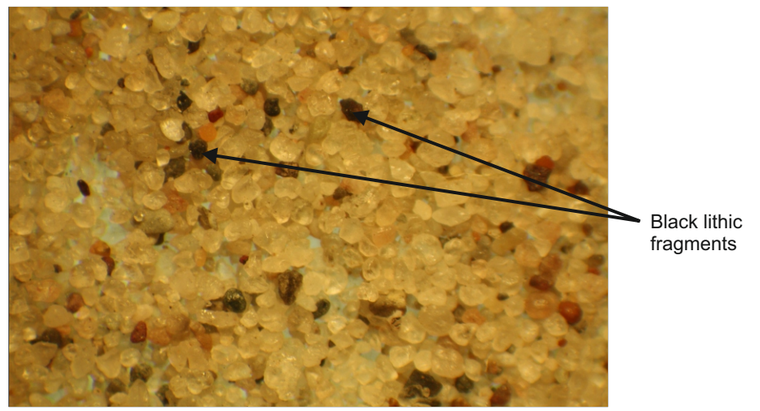
Washed Sample



Washed Sample

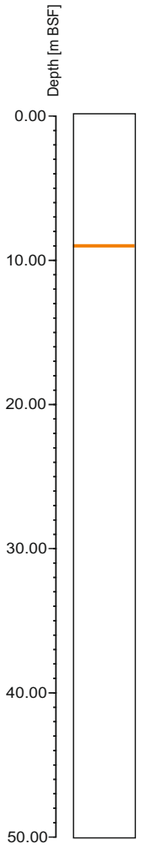


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS2-6a** **Sample Name: 4 BAG A**	**Depth [m BSF]: 8.0** **Soil Unit: Eem/Kreftenheye**	**Plate Number: 2.10**	Logged by: ASW Date: 09/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted very silty fine SAND

Colour:
Unwashed: Light yellowish brown (2.5Y-6/3)
Washed: Light brownish grey (2.5Y-6/2)

Microscope Description
Moderately sorted – unwashed sample is coated with silt

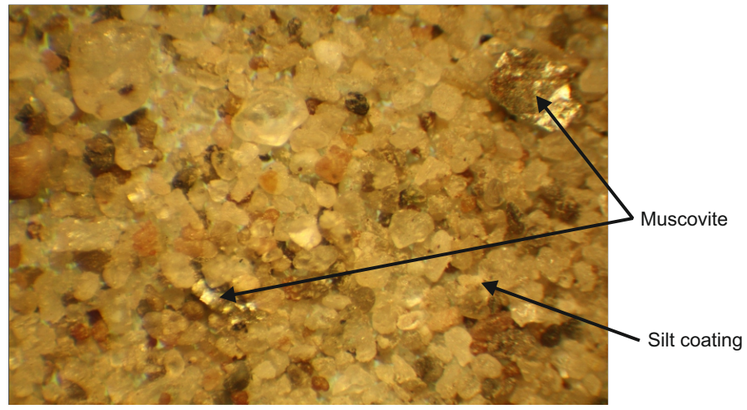
90% – Fine (trace medium) subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
~ 90% clear, colourless to frosted, translucent
~ 8% pale to medium orange
~ 2% light pink to red

6% – Fine angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity grey to black LITHIC FRAGMENTS
2% – Fine subrounded to rounded (*r*K = 0.5 to 0.8) medium to high sphericity white opaque FELDSPAR
2% – Fine to medium sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to medium sphericity MUSCOVITE

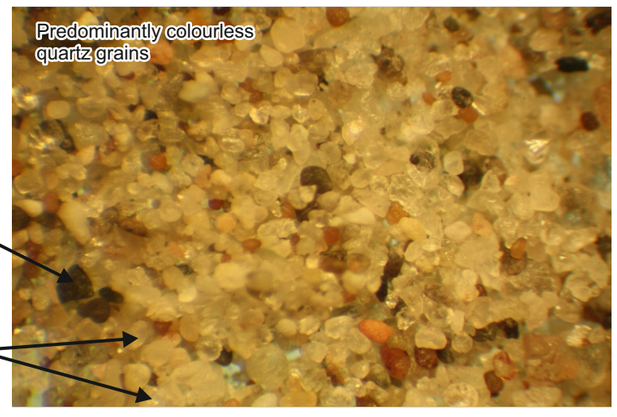
Trace: Glauconite pellets and Epidote

Reflected Light Microphotographs

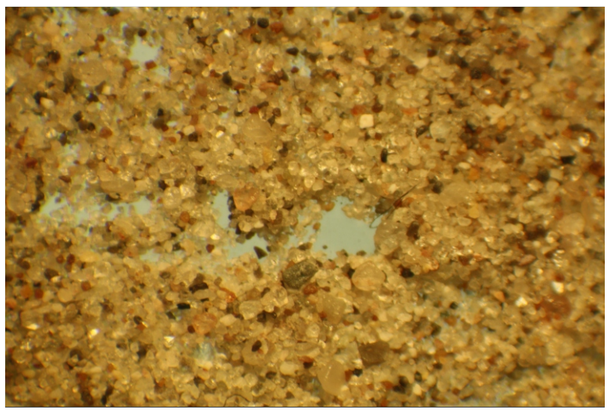
Unwashed Sample



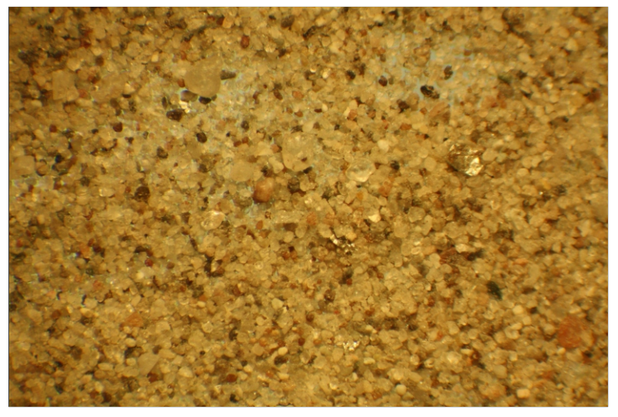
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

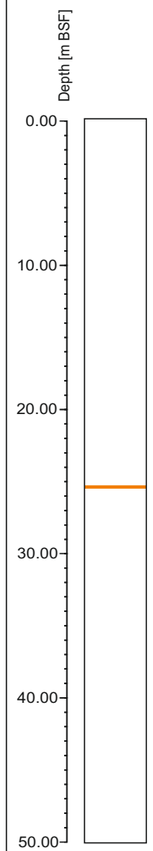
Sample Location: BH-WFS2-6a
Sample Name: 5 BAG A

Depth [m BSF]: 9.0
Soil Unit: Eem/Kreftenheye

Plate Number: 2.11

Logged by:	ASW	Date:09/06/2015
Checked by:	LA/CES	Date:12/06/2015
Approved by:	GML	Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted clayey fine to medium SAND

Colour:
Unwashed: Dark grey (5Y-4/1)
Washed: Grey (5Y-5/1)

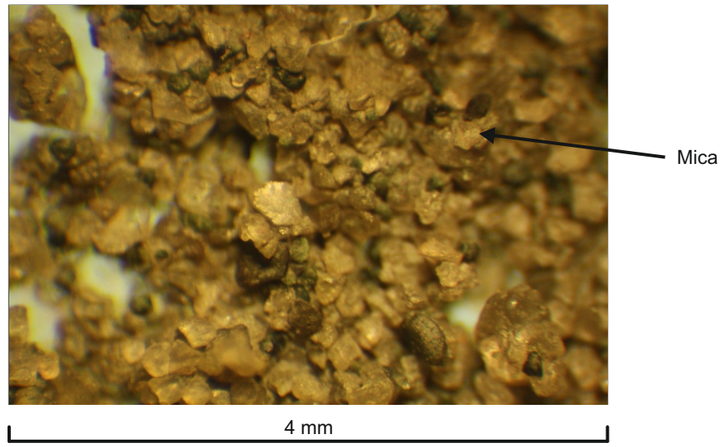
Microscope Description
Sample is moderately sorted – unwashed sample shows clay and silt coating

88% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity QUARTZ
~ 97% clear/colourless to frosted
~ 3% pale pink to orange to red
8% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity dark greyish green GLAUCONITE pellets (some show alteration and replacement by pyrite)
4% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity black to dark grey LITHIC FRAGMENTS

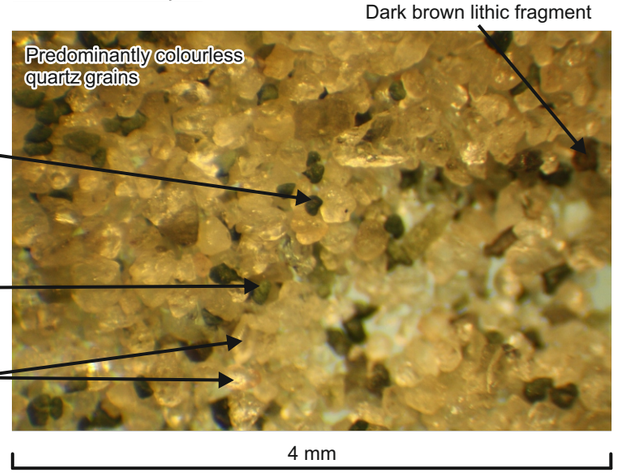
Trace: Fine sand-sized subangular (*r*K = 0.3 to 0.4) medium sphericity dark brown to reddish brown lithic fragments, trace Mica in unwashed sample

Reflected Light Microphotographs

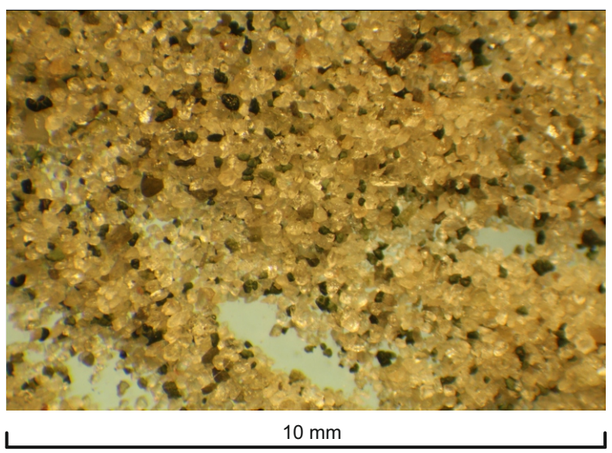
Unwashed Sample



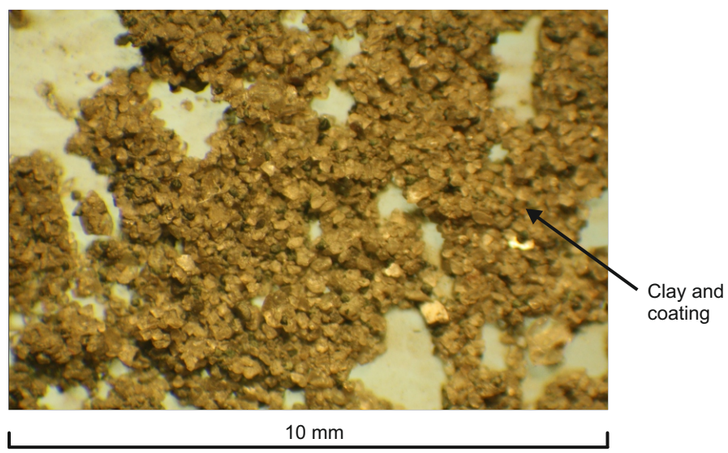
Washed Sample



Washed Sample

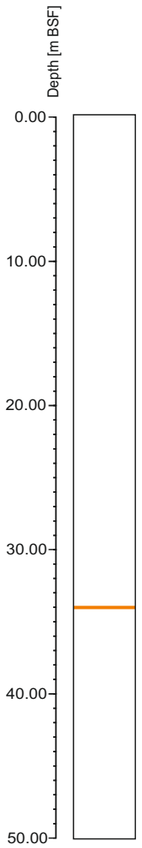


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-3** **Sample Name: 14 BAG B**	**Depth [m BSF]: 25.40** **Soil Unit: Tongeren**	**Plate Number: 3.1**	Logged by: ASW Date:09/06/2015 Checked by: LA/CES Date:12/06/2015 Approved by: GML Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted slightly silty clayey SAND

Colour:
Unwashed: Dark olive grey (5Y-3/2)
Washed: Grey (5Y-6/1)

Microscope Description
Sample is moderately sorted – unwashed sample shows clay and silt coating

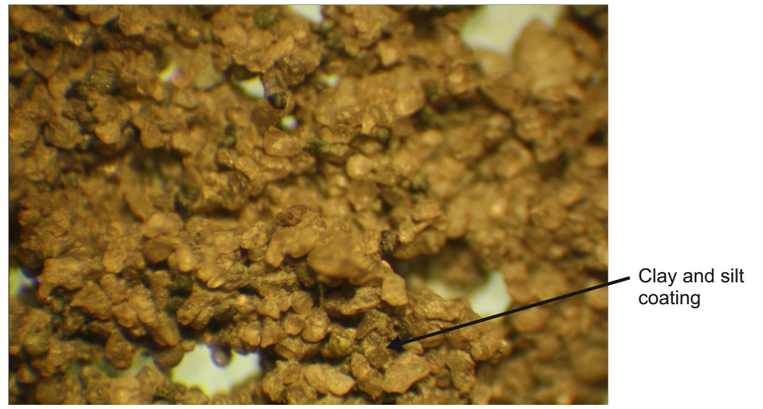
86% – Fine to medium sand-sized subangular to rounded (*r*K = 0.3 to 0.8) medium to high sphericity QUARTZ
- ~ 98% clear/colourless to frosted
- ~ 2% pale yellow to beige
- ~ trace pale pink

10% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity dark green to greyish green GLAUCONITE pellets (some show alteration and replacement by pyrite)
4% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity black to dark brown LITHIC FRAGMENTS

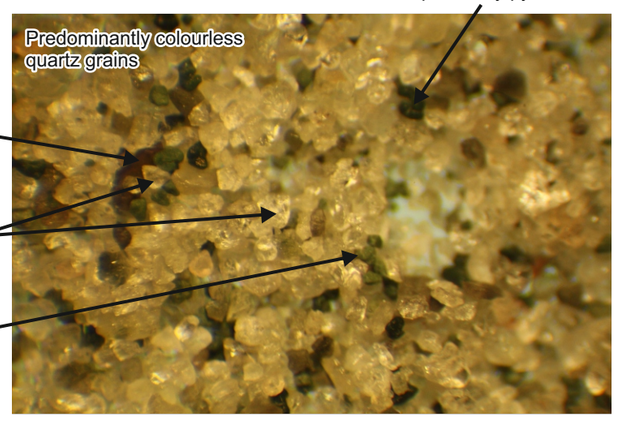
Trace: Opaque feldspar, Mica (unwashed sample)

Reflected Light Microphotographs

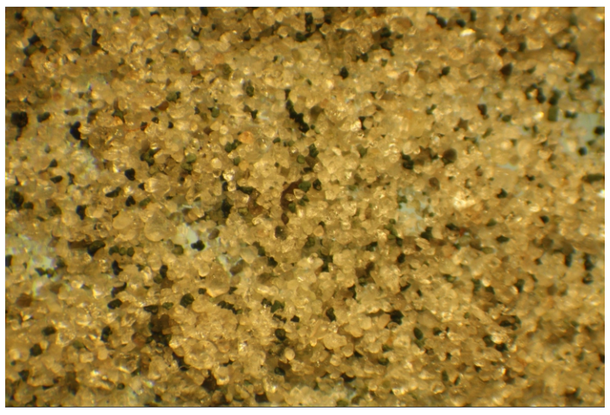
Unwashed Sample



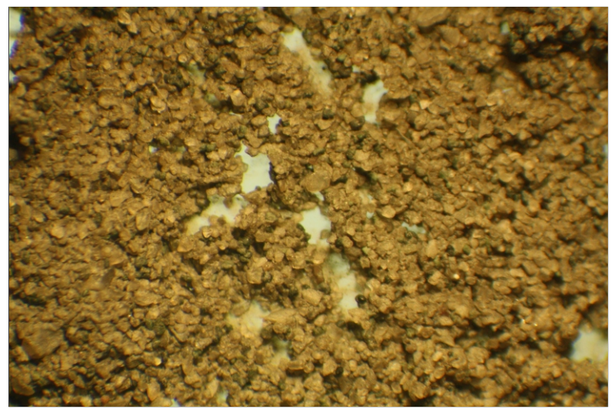
Washed Sample



Washed Sample

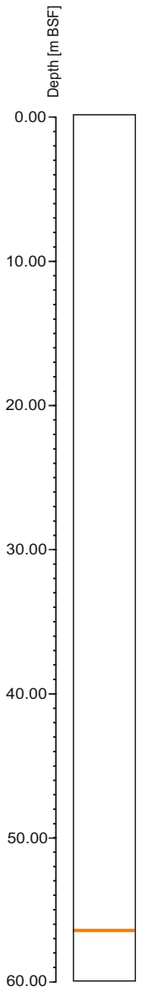


Unwashed Sample



J11286 - N6016 Borssele **Detailed Microscope Description**	**Sample Location: BH-WFS1-3** **Sample Name: 16 BAG A**	**Depth [m BSF]: 34.00** **Soil Unit: Tongeren**	**Plate Number: 3.2**	Logged by: ASW Date: 09/06/2015 Checked by: LA/CES Date: 12/06/2015 Approved by: GML Date: 25/08/2015	FUGRO

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted fine SAND

Colour:
Unwashed: Olive grey (5Y-4/2)
Washed: Olive grey (5Y-5/2)

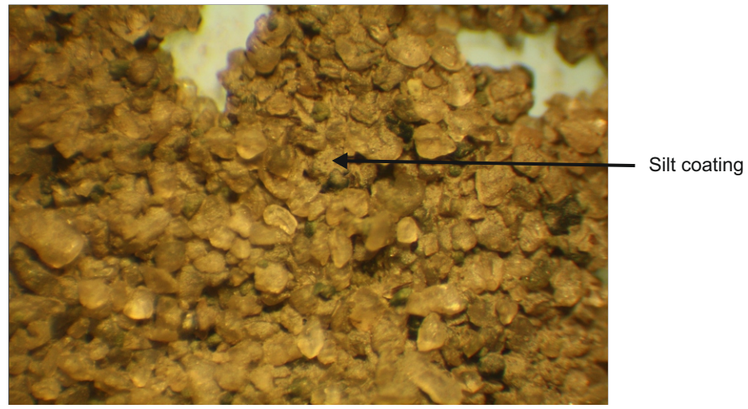
Microscope Description
Sample is moderately to well sorted – unwashed sample shows silt coating

88% – Fine (occasionally medium) sand-sized subangular to rounded (*r*K = 0.3 to 0.8) low to high sphericity QUARTZ
~ 98% clear/colourless to frosted
~ 2% pale pink to pale orange
8% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity dark greyish green GLAUCONITE pellets (some show alteration and replacement by pyrite)
3% – Fine sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity black and dark grey LITHIC FRAGMENTS
1% – Medium sand-sized subangular (*r*K = 0.3 to 0.4) medium sphericity dark brown to black LITHIC FRAGMENTS

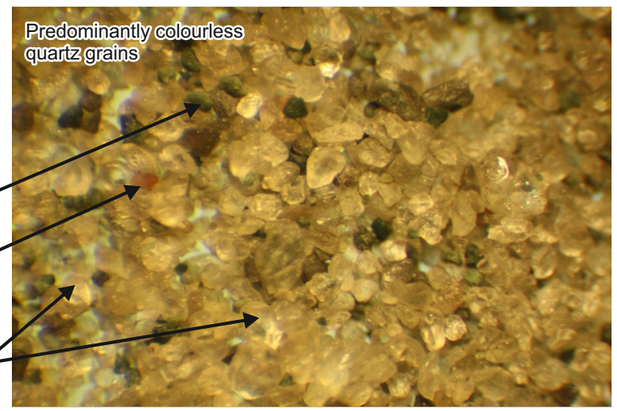
Trace: Mica

Reflected Light Microphotographs

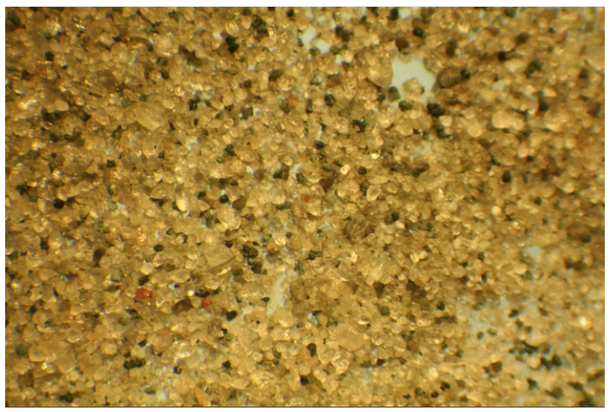
Unwashed Sample



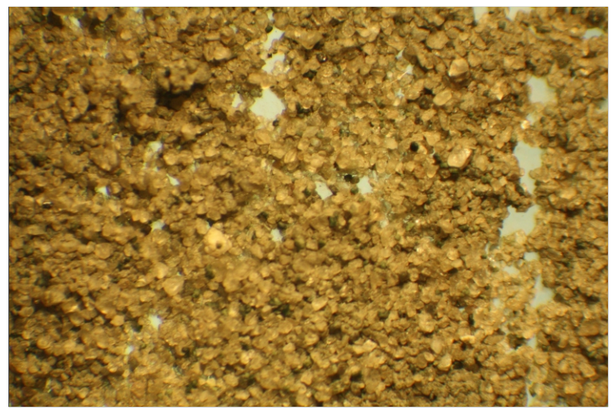
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

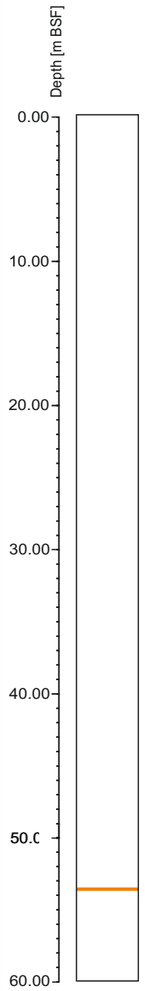
Sample Location: BH-WFS1-5a
Sample Name: 17 BAG B

Depth [m BSF]: 56.45
Soil Unit: Tongeren

Plate Number: 3.3

Logged by: ASW	Date:09/06/2015	FUGRO
Checked by: LA/CES	Date:12/06/2015	
Approved by: GML	Date:25/08/2015	

Sample Microscope Description



Sample Description

Hand-Specimen Description
Well sorted slightly clayey silty fine SAND

Colour:
Unwashed: Olive grey (5Y-4/2)
Washed: Grey (5Y-5/1)

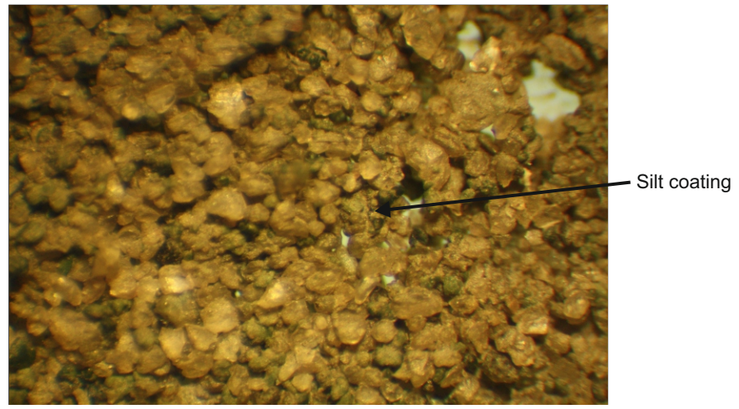
Microscope Description
Sample is well sorted – unwashed sample shows silt coating

85% – Fine sand-sized angular to subrounded (*r*K = 0.1 to 0.6) medium to high sphericity QUARTZ
~ 95% clear/colourless to frosted
~ 5% pale beige
~ trace pale pink
10% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity dark green to greyish green GLAUCONITE pellets (some show alteration and replacement by pyrite)
5% – Fine sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity black to dark grey LITHIC FRAGMENTS

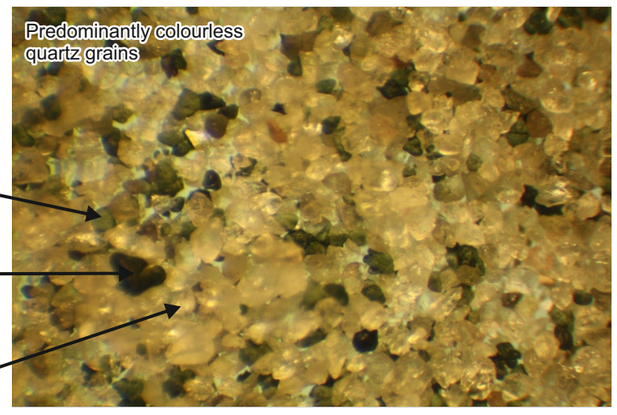
Trace: Mica (unwashed sample)

Reflected Light Microphotographs

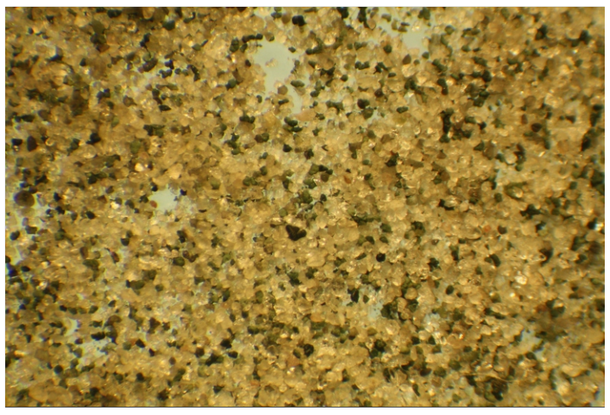
Unwashed Sample



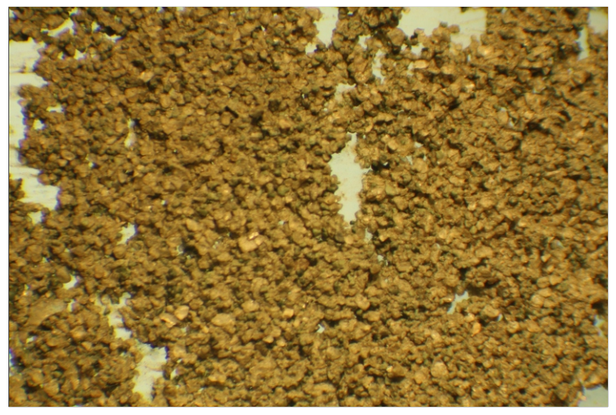
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

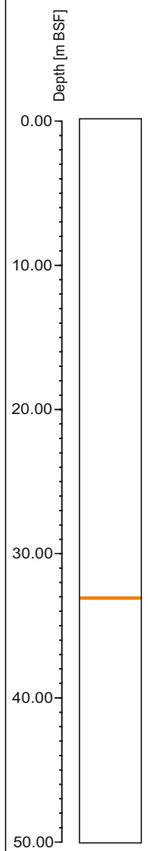
Sample Location: BH-WFS1-6
Sample Name: 25 BAG C

Depth [m BSF]: 53.60
Soil Unit: Tongeren

Plate Number: 3.4

Logged by:	ASW	Date:09/06/2015
Checked by:	LA/CES	Date:12/06/2015
Approved by:	GML	Date:25/08/2015

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately to well sorted silty fine SAND

Colour:
Unwashed: Olive grey (5Y-4/2)
Washed: Grey (5Y-5/1)

Microscope Description
Sample is moderately to well sorted – unwashed sample shows trace silt coating

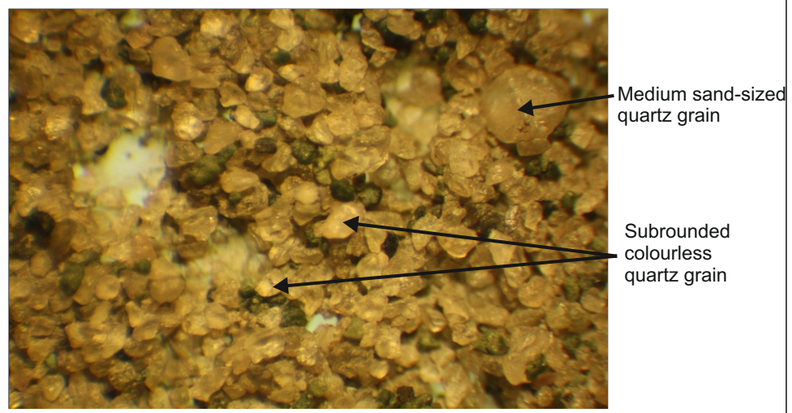
88% – Fine (trace medium) sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity QUARTZ
- ~ 97% clear/colourless to frosted
- ~ 2% pale beige to pale orange
- ~ 1% pale pink

7% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) medium to high sphericity dark green to greyish green GLAUCONITE pellets (some show alteration and replacement by pyrite)
5% – Fine sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity dark brown to black LITHIC FRAGMENTS

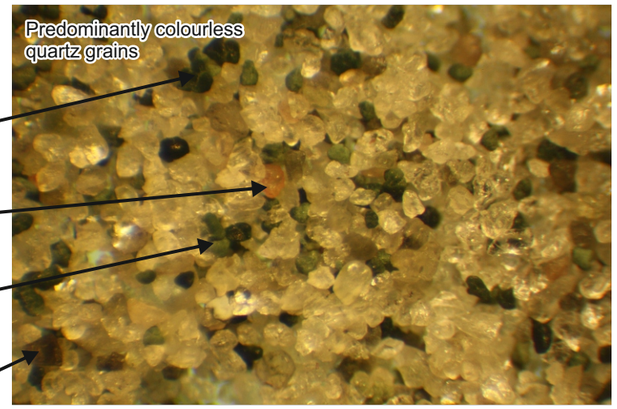
Trace: Mica

Reflected Light Microphotographs

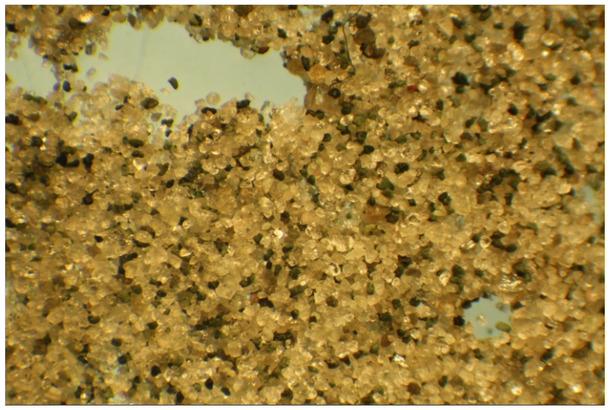
Unwashed Sample



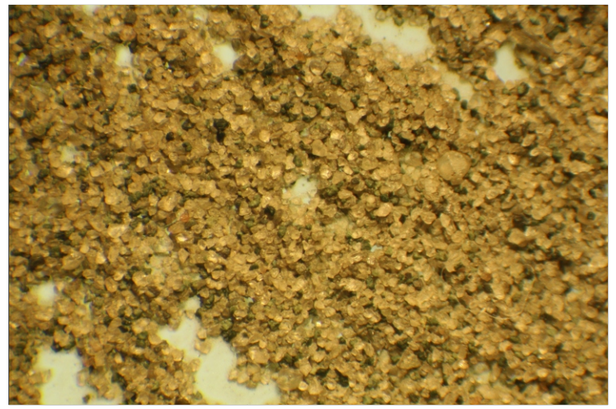
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

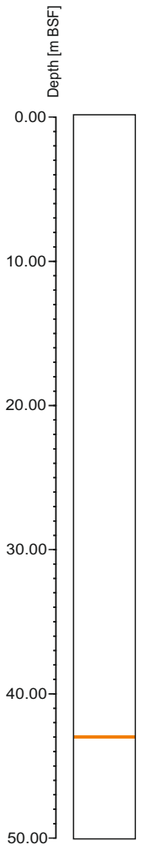
Sample Location: BH-WFS2-1a
Sample Name: 16 BAG A

Depth [m BSF]: 33.00
Soil Unit: Tongeren

Plate Number: 3.5

Logged by: ASW	Date:09/06/2015	FUGRO
Checked by: LA/CES	Date:12/06/2015	
Approved by: GML	Date:25/08/2015	

Sample Microscope Description



Sample Description

Hand-Specimen Description
Moderately sorted clayey fine to medium SAND

Colour:
Unwashed: Dark grey (5Y-4/1)
Washed: Grey (5Y-6/1)

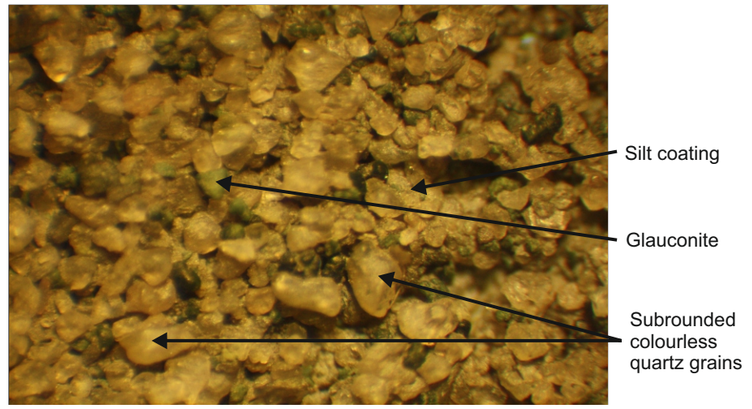
Microscope Description
Sample is moderately to well sorted – unwashed sample shows silt coating

85% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity QUARTZ
~ 95% clear/colourless to frosted
~ 5% pale yellow/beige
10% – Fine sand-sized subangular to subrounded (*r*K = 0.3 to 0.6) low to high sphericity dark green to greenish black GLAUCONITE pellets
5% – Fine to medium sand-sized angular to subrounded (*r*K = 0.1 to 0.6) low to high sphericity dark grey to black (trace dark brownish red) LITHIC fragments

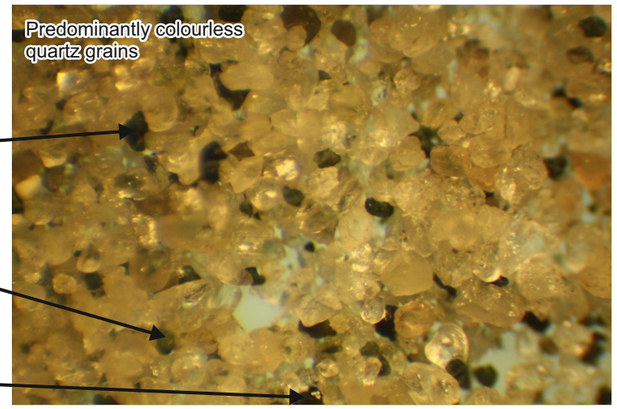
Trace: Pale green, translucent mineral (possible epidote), Mica (unwashed sample)

Reflected Light Microphotographs

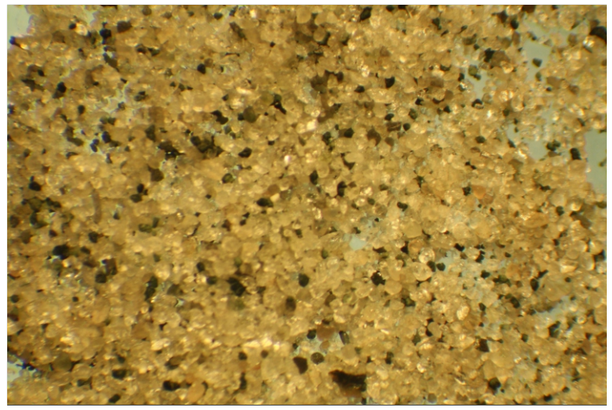
Unwashed Sample



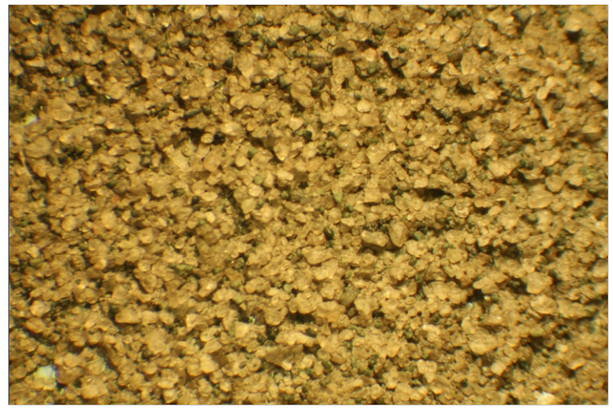
Washed Sample



Washed Sample



Unwashed Sample



J11286 - N6016 Borssele
Detailed Microscope Description

Sample Location: BH-WFS2-3
Sample Name: 16 BAG A

Depth [m BSF]: 43.00
Soil Unit: Tongeren

Plate Number: 3.6

Logged by: ASW	Date:09/06/2015	FUGRO
Checked by: LA/CES	Date:12/06/2015	
Approved by: GML	Date:25/08/2015	

SECTION A4: STATIC TRIAXIAL TESTS

LIST OF PLATES IN SECTION A4: Plate

VISUAL DESCRIPTION
Brown medium SAND with shell fragments and some fine gravel.

GENERAL	
Date test started	03/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.4
Length	[mm]	144.0
Moisture content	[%]	10.7
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.637
Degree of saturation	[%]	45
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	BS1377: 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 BS1377: Part 8: 1990 Clause 5.3
Consolidation - Isotropic	BS1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern Bight_CIUc
Processed by	PH
Date	05/08/2015
Checked by	LJ
Date	11/08/2015
Approved by	DT
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp to 800 kPa, 100 kPa thereafter
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1014
Mid height PWP	[kPa]	-
B value achieved	[-]	0.99

S_{VH} BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Peak to Peak		
Distance	[mm]	138.99
Time	[ms]	1.33
Velocity	[m/s]	104.90
Bulk density	[Mg/m^3]	2.01
Frequency	[Hz]	3571.00
G_{max}	[MPa]	22.09

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	999
Base PWP	[kPa]	999
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	26
Effective axial pressure	[kPa]	26
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.24
External axial strain	[%]	0.04
Local axial strain	[%]	-0.01
Local radial strain	[%]	-
Moisture content	[%]	23.9
Bulk density	[Mg/m^3]	2.01
Dry density	[Mg/m^3]	1.62
Void ratio	[-]	0.634
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

S_{VH} BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC		
Peak to Peak		
Distance	[mm]	138.94
Time	[ms]	1.02
Velocity	[m/s]	135.68
Bulk density	[Mg/m^3]	2.01
Frequency	[Hz]	3571.00
G_{max}	[MPa]	37.00

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	26
Initial effective axial pressure	[kPa]	26
Rate of strain	[%/hour]	0.50
At peak deviator stress		
Corrected deviator stress	[kPa]	420
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	5.90
Local axial strain	[%]	4.54
Local radial strain	[%]	-
Excess base PWP	[kPa]	-119
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	144
Effective axial pressure	[kPa]	564
Principal effective stress ratio	[-]	3.91
ε_{50}	[%]	1.61
Secant modulus (E_{50}) at ε_{50}	[kPa]	13037
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	115
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.82
Local axial strain	[%]	0.53
Local radial strain	[%]	-
Excess base PWP	[kPa]	-7
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	32
Effective axial pressure	[kPa]	148
Principal effective stress ratio	[-]	4.55
At 10% axial strain		
Corrected deviator stress	[kPa]	374
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	7.69
Local radial strain	[%]	-
Excess base PWP	[kPa]	-114
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	139
Effective axial pressure	[kPa]	514
Principal effective stress ratio	[-]	3.69

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

At 0.01% axial strain		
Corrected deviator stress	[kPa]	15
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.04
Local axial strain	[%]	0.01
Local radial strain	[%]	-
Excess base PWP	[kPa]	4
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	22
Effective axial pressure	[kPa]	36
Principal effective stress ratio	[-]	1.67
At 0.1% axial strain		
Corrected deviator stress	[kPa]	42
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.20
Local axial strain	[%]	0.10
Local radial strain	[%]	-
Excess base PWP	[kPa]	8
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	18
Effective axial pressure	[kPa]	60
Principal effective stress ratio	[-]	3.38

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

Photograph unavailable

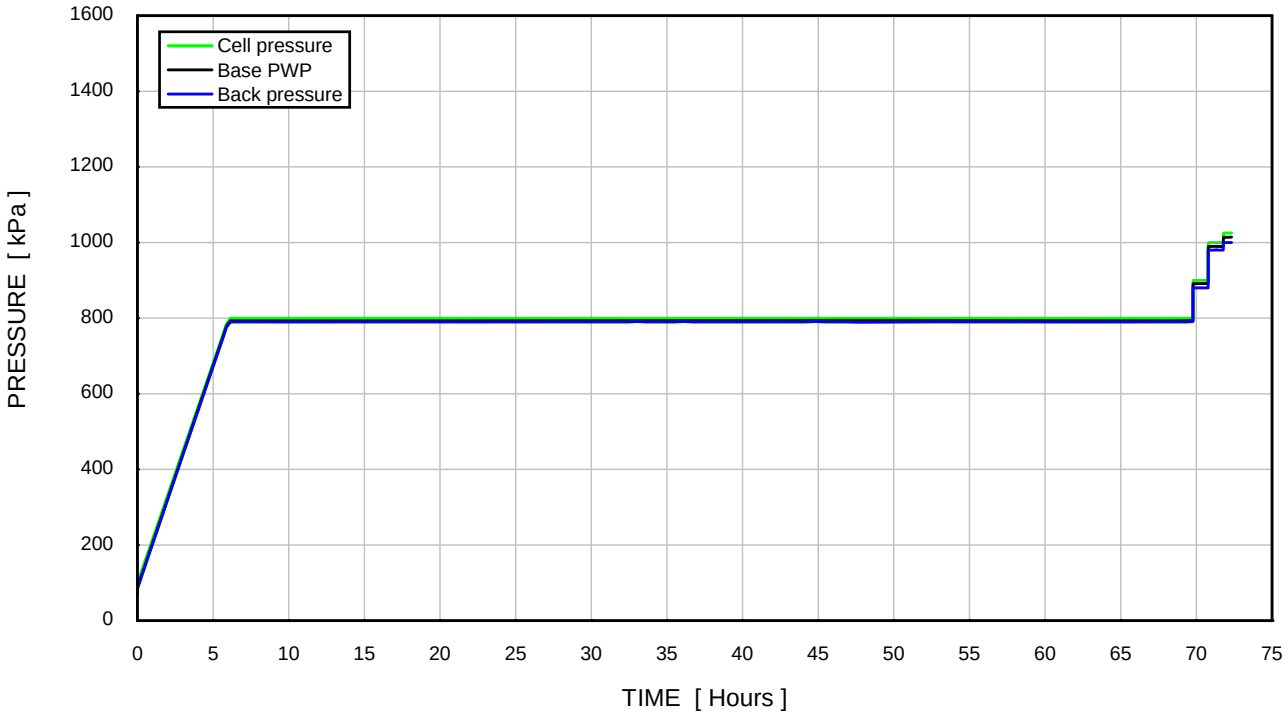
Photograph unavailable

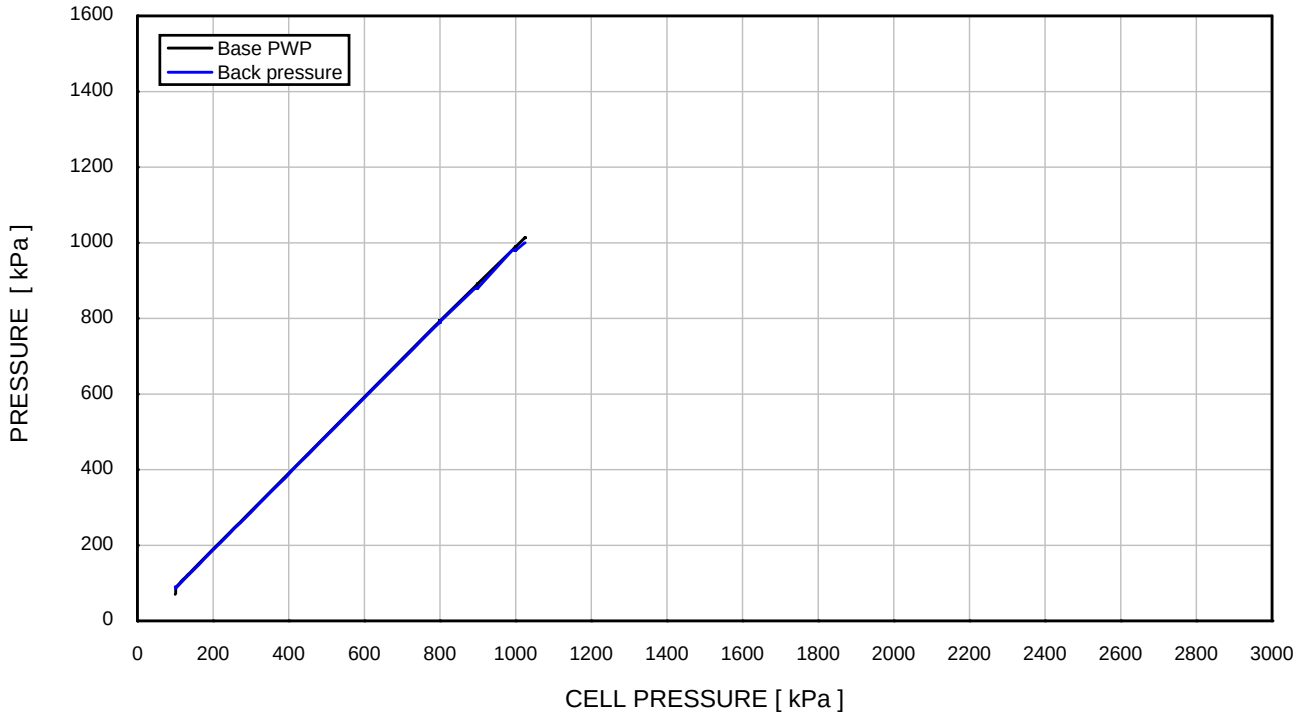
FINAL CONDITIONS		
Moisture content	[%]	23.9
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CIU01

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

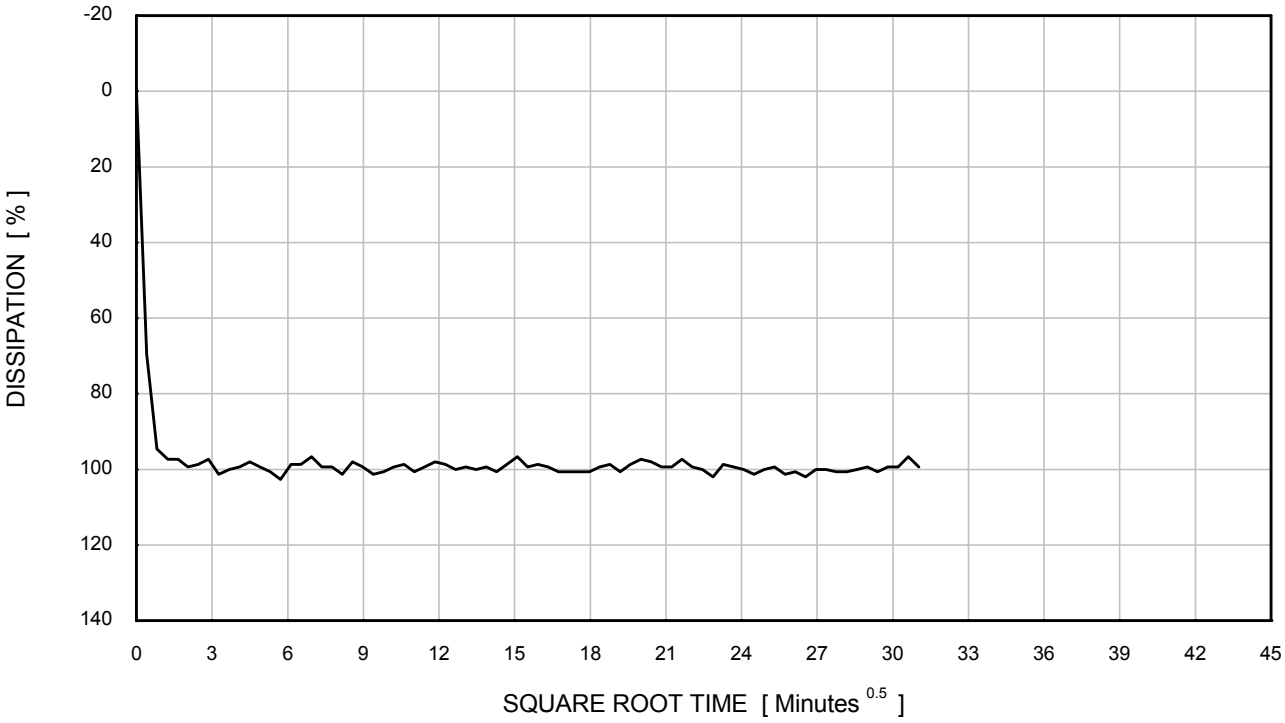


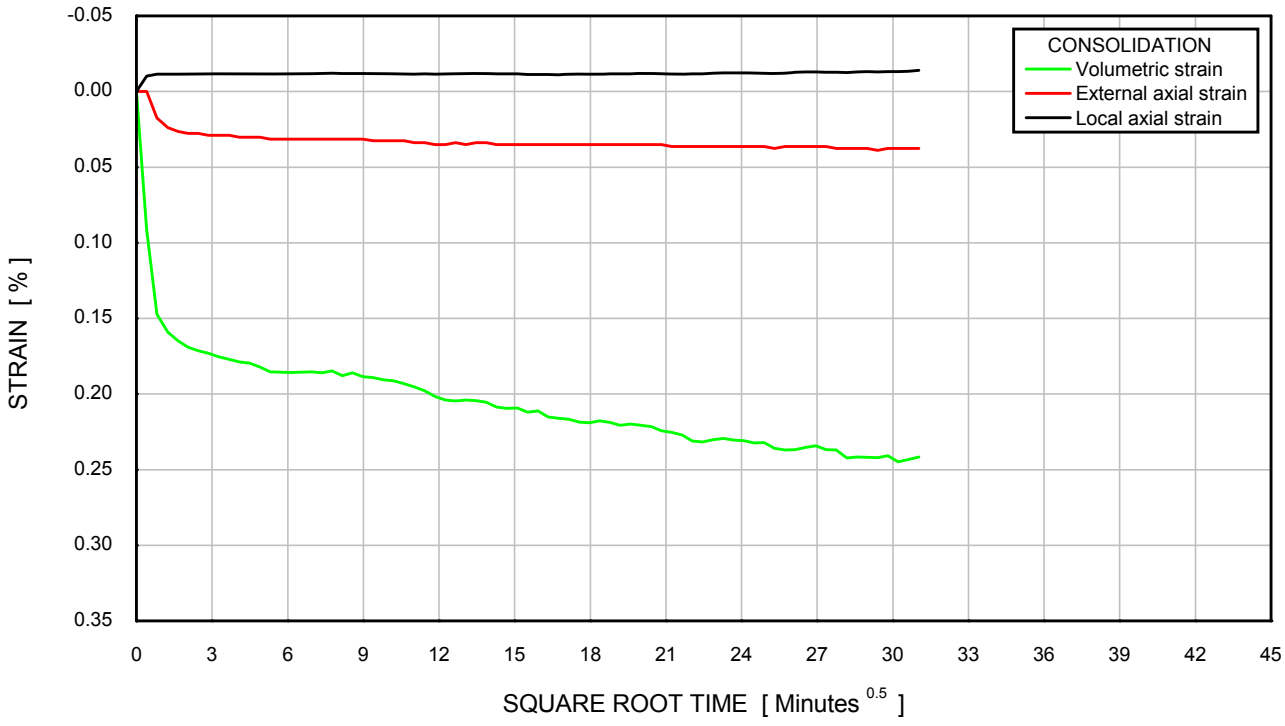


B value	:	0.99			
Initial σ'_r	:	30	kPa	Borehole	: Batch
Initial σ'_a	:	30	kPa	Sample	: Southern Bight
Final σ'_r	:	11	kPa	Depth [m]	: -
Final σ'_a	:	11	kPa	Test No.	: 235

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

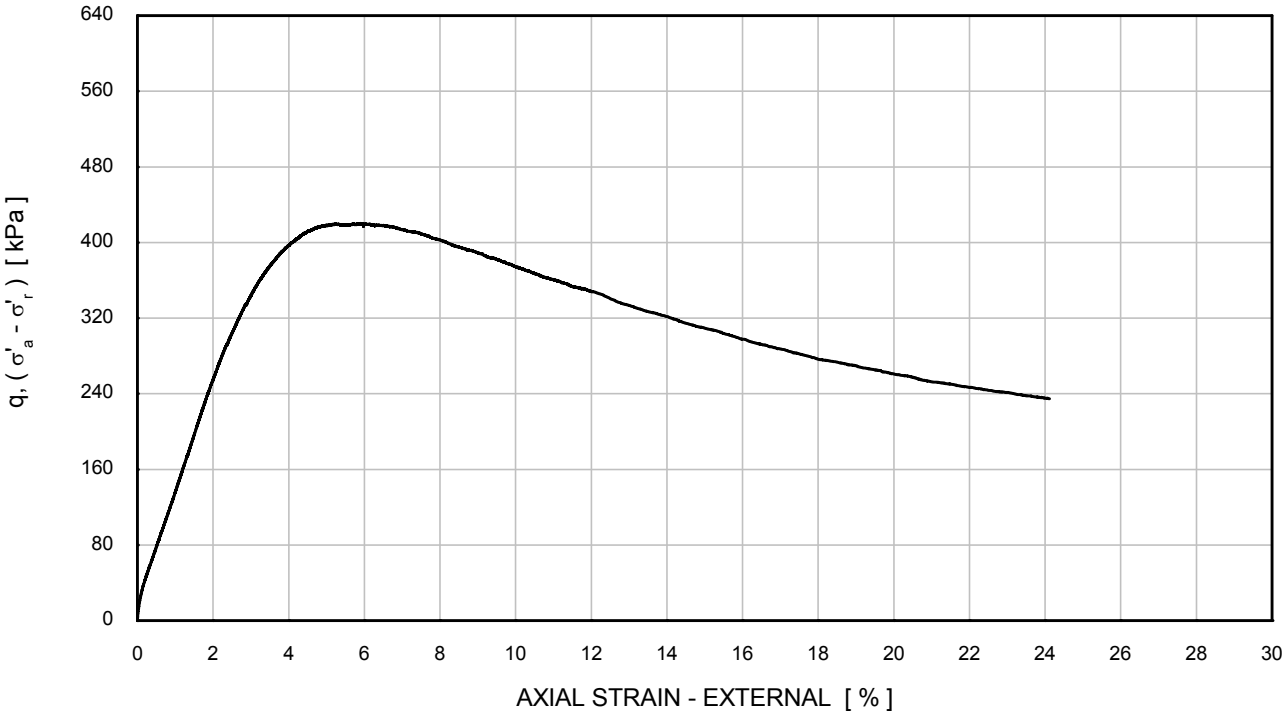


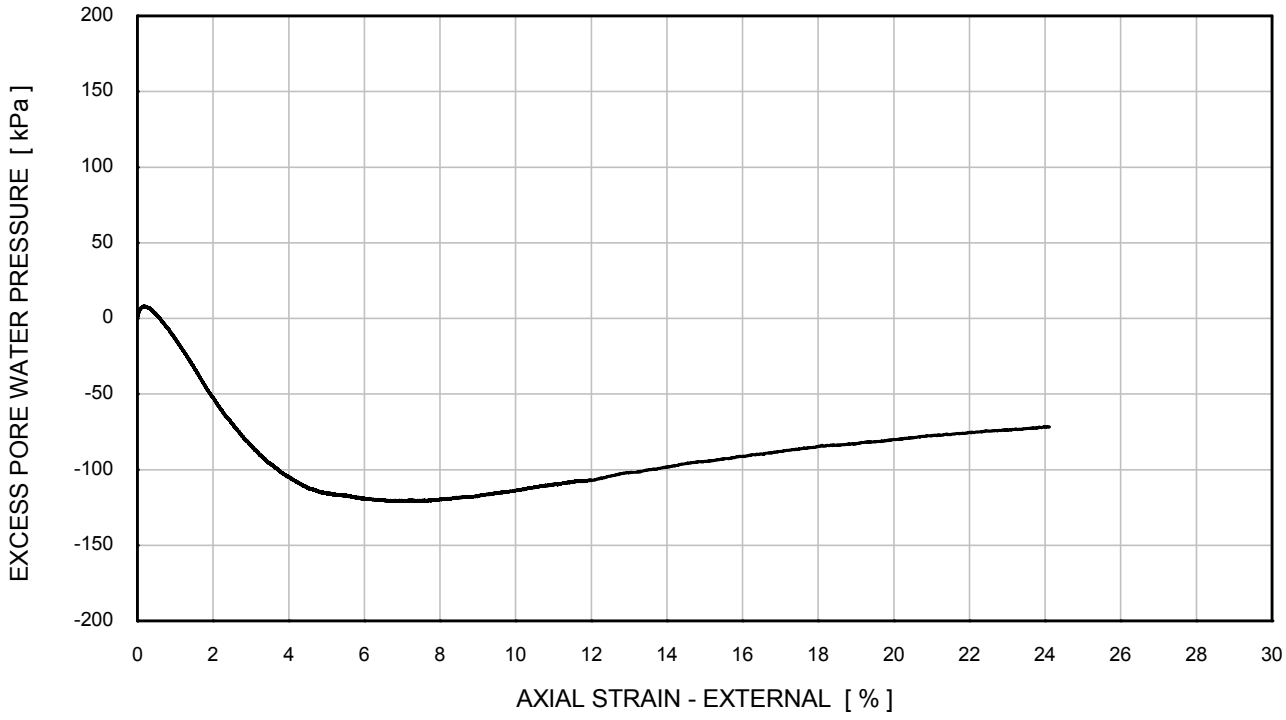


σ'_{rc}	:	26 kPa	Borehole	:	Batch
σ'_{ac}	:	26 kPa	Sample	:	Southern Bight
			Depth [m]	:	-
			Test No.	:	235

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

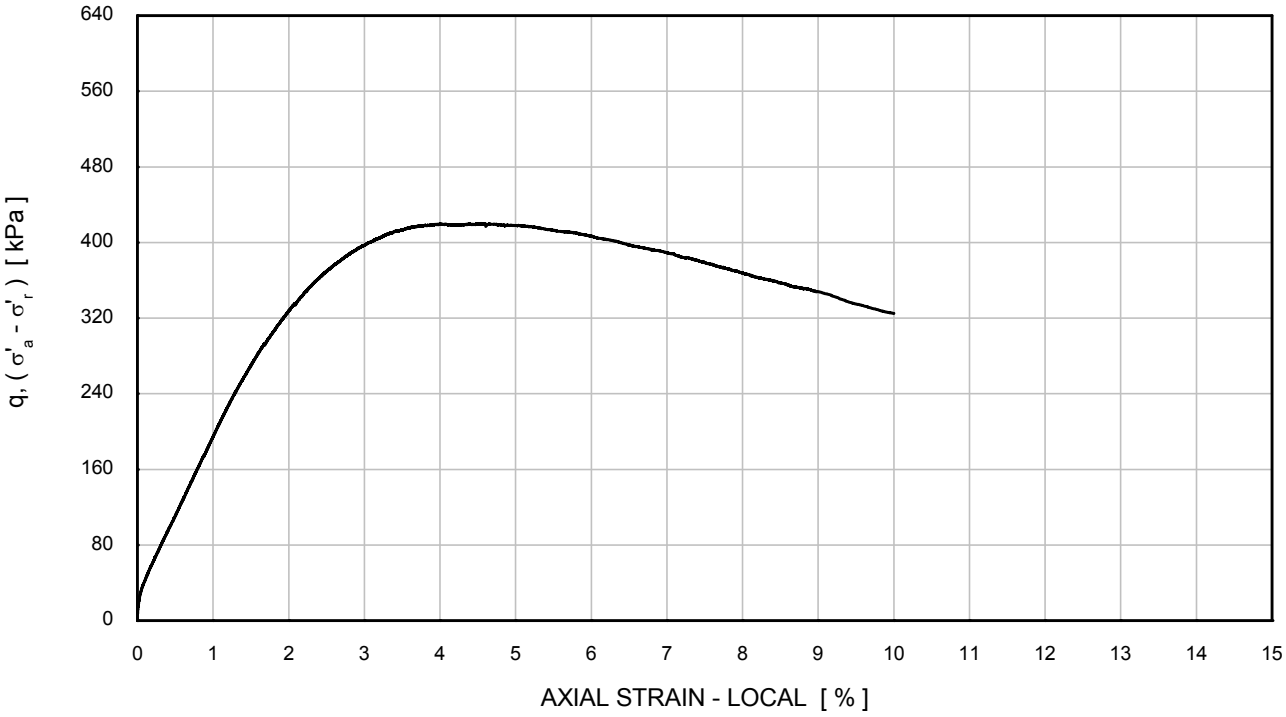


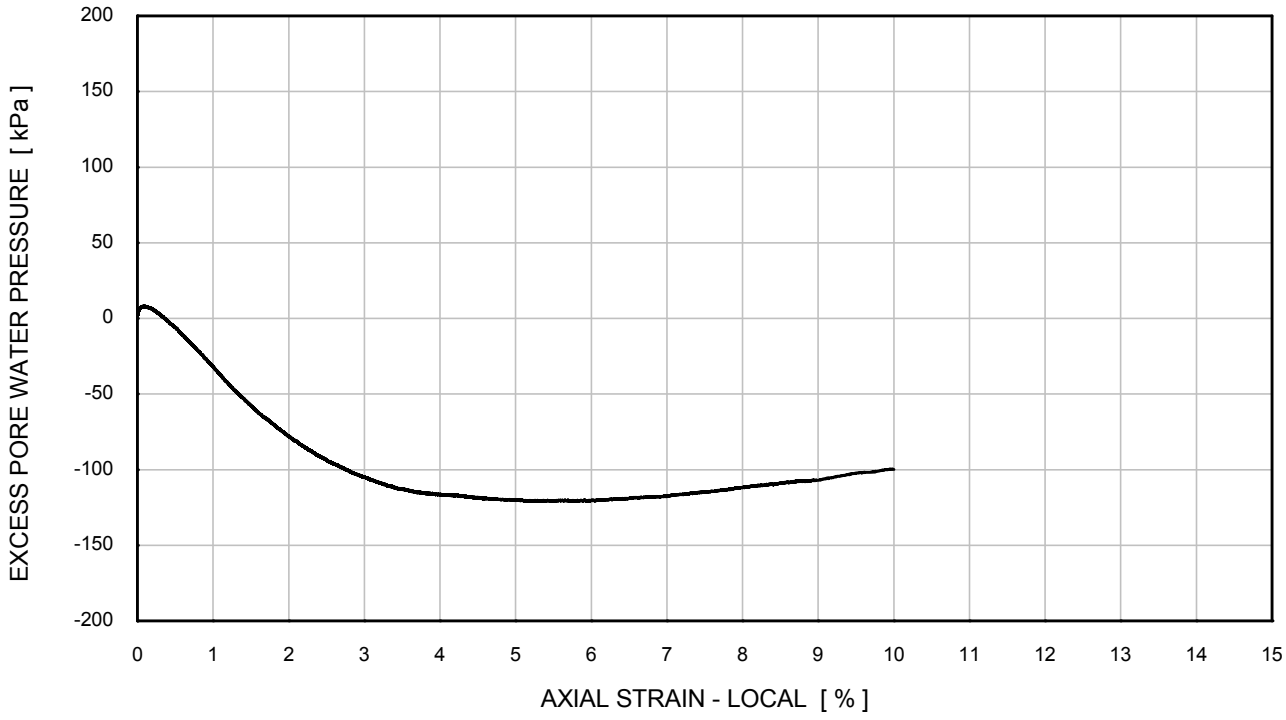


Initial σ'_r	:	26	kPa	Borehole	: Batch
Initial σ'_a	:	26	kPa	Sample	: Southern Bight
q_{peak}	:	420	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	5.90	%	Test No.	: 235
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

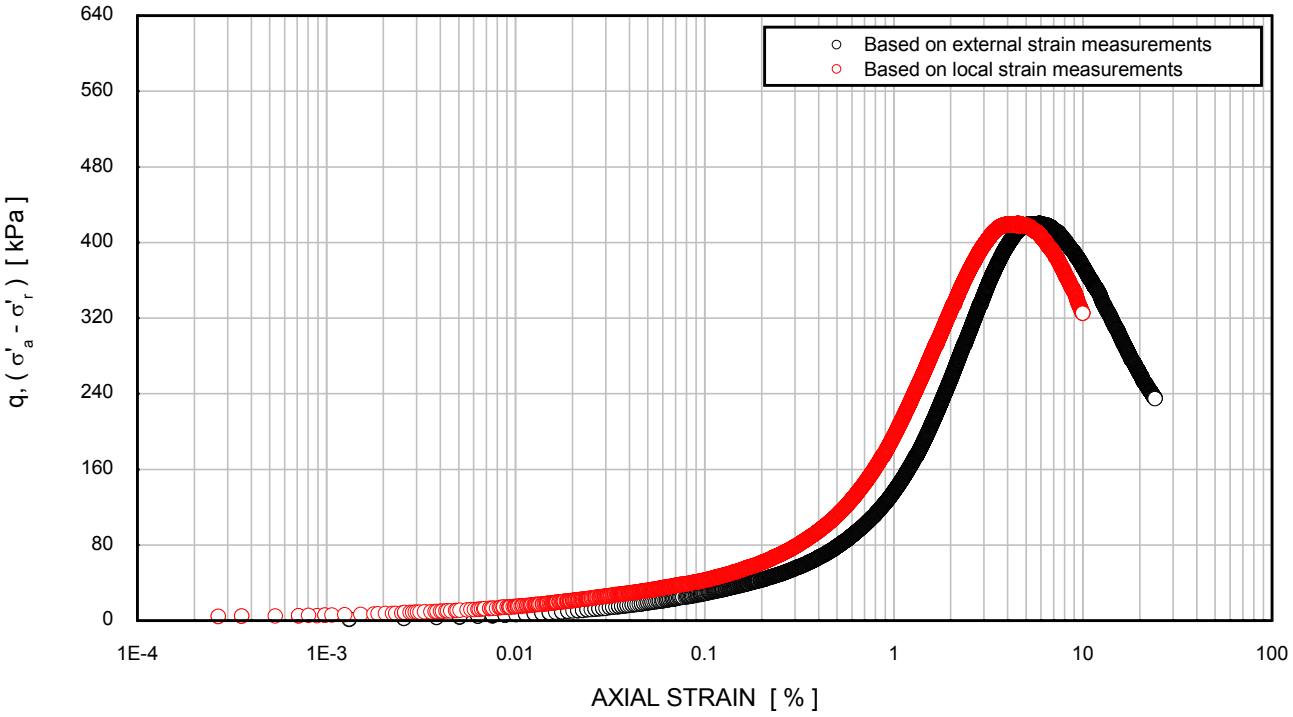


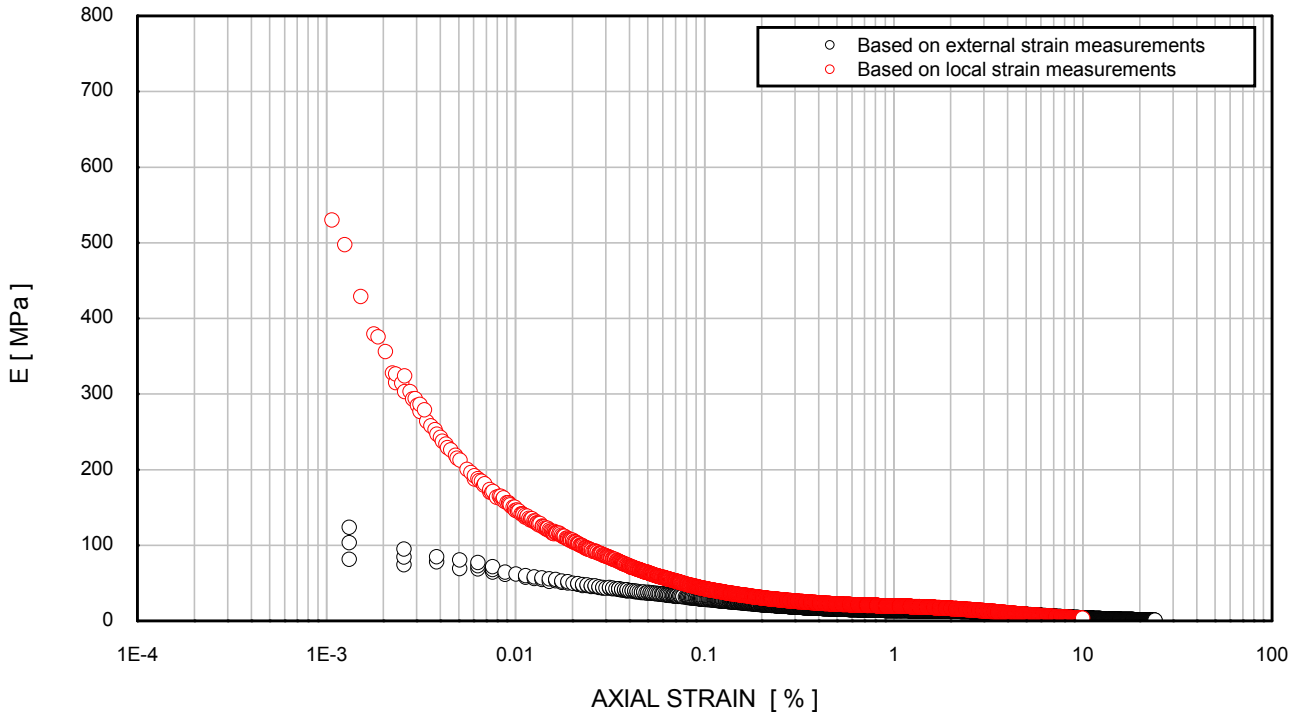


Initial σ'_r	:	26	kPa	Borehole	: Batch
Initial σ'_a	:	26	kPa	Sample	: Southern Bight
q_{peak}	:	420	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	5.90	%	Test No.	: 235
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

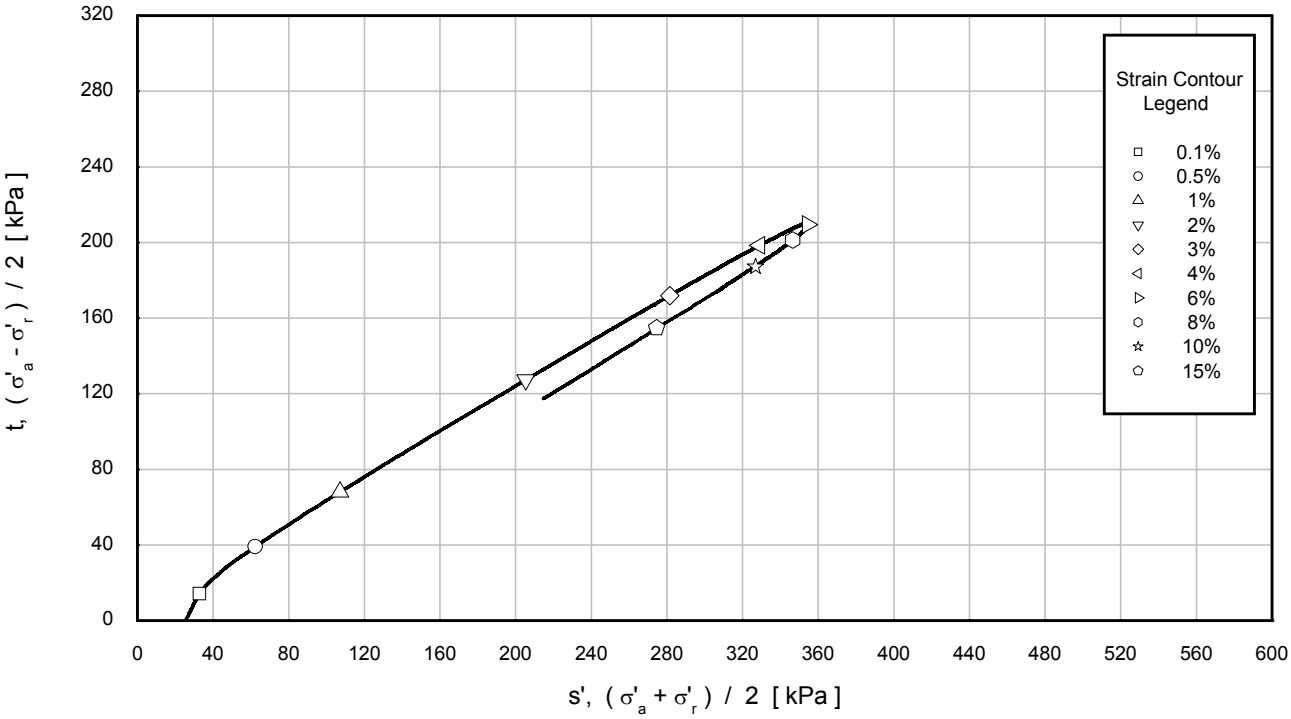


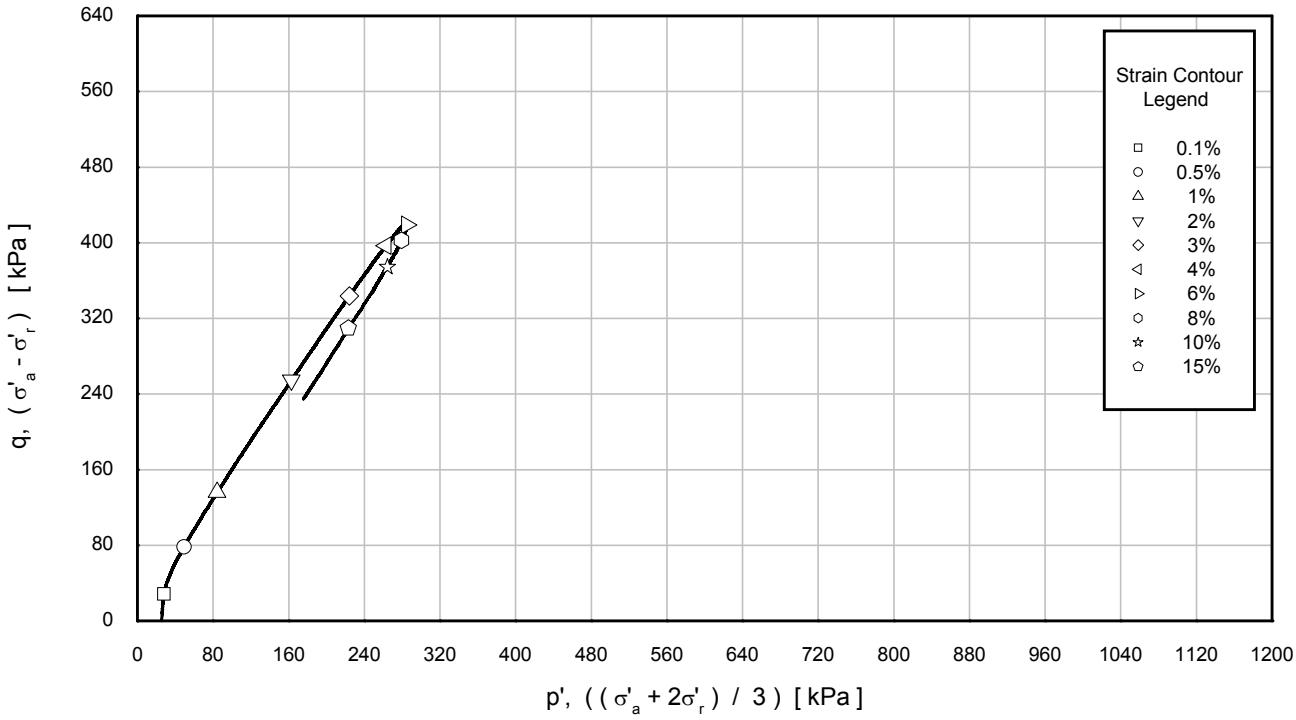


Initial σ'_r	:	26	kPa	Borehole	: Batch
Initial σ'_a	:	26	kPa	Sample	: Southern Bight
q_{peak}	:	420	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	5.90	%	Test No.	: 235
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

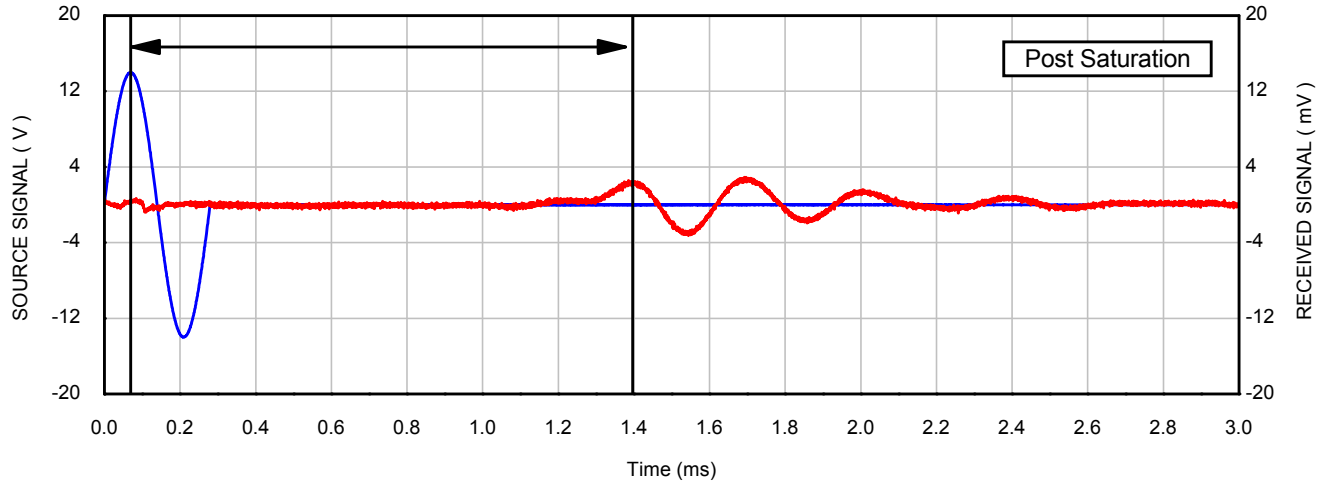


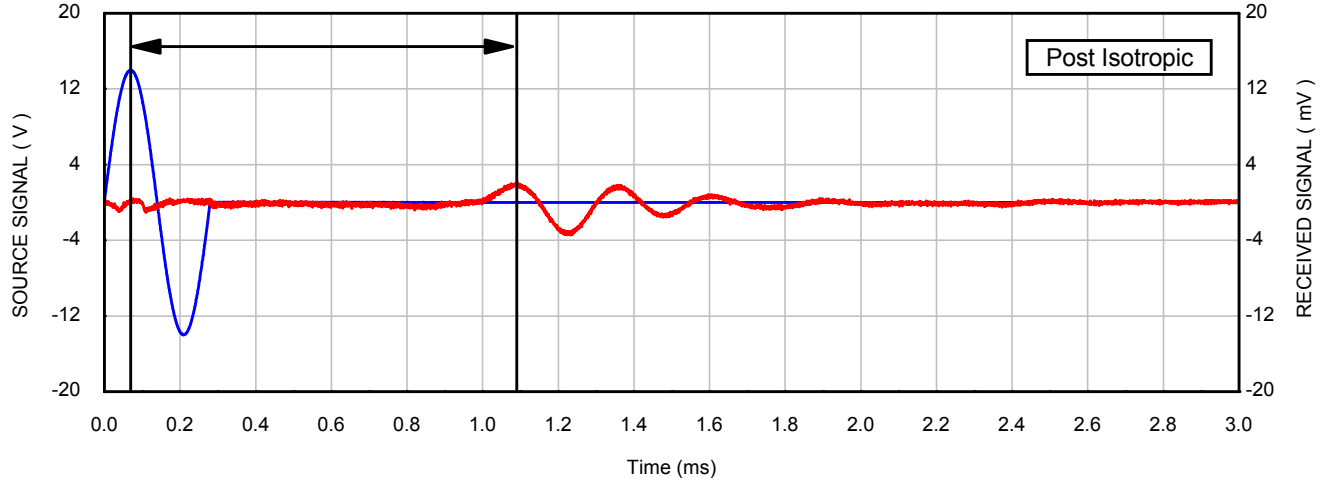


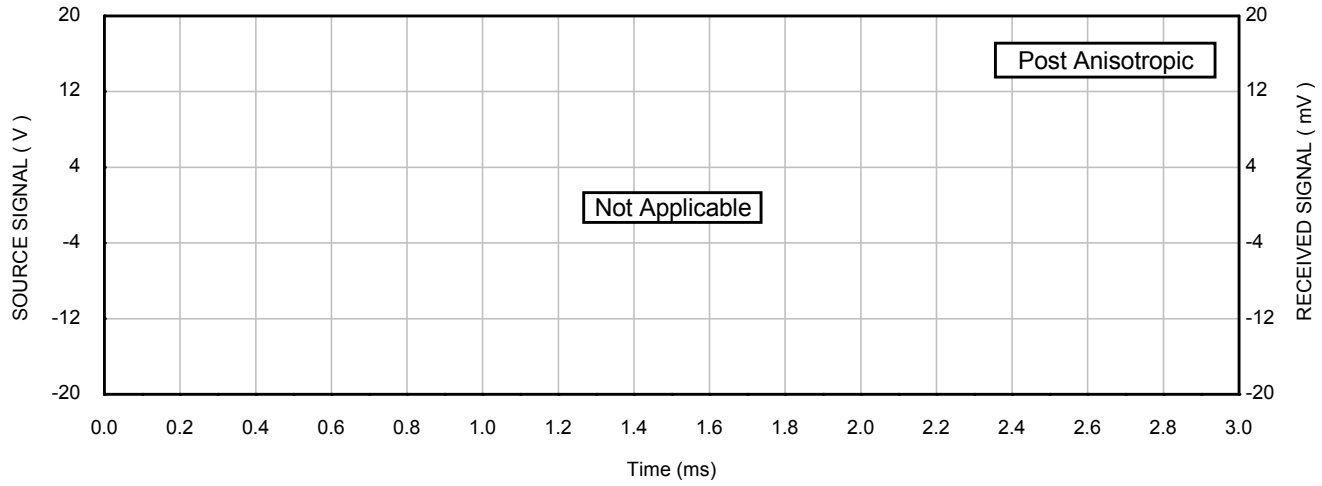
Initial σ'_r	:	26	kPa	Borehole	: Batch
Initial σ'_a	:	26	kPa	Sample	: Southern Bight
q_{peak}	:	420	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	5.90	%	Test No.	: 235
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA







Source Signal
Received Signal

Borehole	:	Batch
Sample	:	Southern Bight
Depth [m]	:	--
Test No.	:	235

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SVH BENDER ELEMENT DETERMINATIONS (PEAK TO PEAK)

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / Southern Bight_Batch_CU.XLS
Template Issue: 2
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

VISUAL DESCRIPTION
Yellowish brown fine to medium SAND with fine to medium gravel and shell fragments.

GENERAL	
Date test started	06/08/2015
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	(mm)	72.1
Length	(mm)	135.0
Moisture content	(%)	10.8
Bulk density	(Mg/m³)	1.79
Dry density	(Mg/m³)	1.62
Void ratio		0.639
Degree of saturation	(%)	45

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	10
Pore pressure on completion	(kPa)	464
Cell pressure on completion	(kPa)	475
B value achieved		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 7
Note: Fugro testing procedures are available on request	

Borehole	Southern Bight
Sample	Batch
Depth (m)	CIU02

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / Southern Bight_Batch_CU.XLS
Checked by: PH Date: 07/08/2015
Approved by: PH Date: 07/08/2015

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	475
Back pressure	(kPa)	450
Effective cell pressure	(kPa)	25
Pore pressure on completion	(kPa)	450
Pore pressure dissipation	(%)	100
Moisture content	(%)	24.0
Bulk density	(Mg/m³)	2.01
Dry density	(Mg/m³)	1.62
Void ratio		0.636
Degree of saturation	(%)	100
Volumetric strain	(%)	0.19

Mode of failure: Compound failure

Borehole	Southern Bight
Sample	Batch
Depth (m)	CIU02

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / Southern Bight_Batch_CU.XLS
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	450
Initial effective cell pressure	(kPa)	25
Rate of strain	(%/hour)	0.91
At peak deviator stress		
Corrected deviator stress	(kPa)	759
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	20.00
Excess pore pressure	(kPa)	-348
Major principal effective stress	(kPa)	1132
Minor principal effective stress	(kPa)	373
Principal effective stress ratio		3.03
Epsilon 50 (ε 50)	(%)	3.41
Secant modulus (E50) at ε 50	(kPa)	11125
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	167
Membrane correction applied	(kPa)	0.1
Drain correction applied	(kPa)	0
Axial strain	(%)	1.37
Excess pore pressure	(kPa)	-37
Major principal effective stress	(kPa)	229
Minor principal effective stress	(kPa)	62
Principal effective stress ratio		3.68
At 10% axial strain		
Corrected deviator stress	(kPa)	682
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	10.00
Excess pore pressure	(kPa)	-283
Major principal effective stress	(kPa)	990
Minor principal effective stress	(kPa)	308
Principal effective stress ratio		3.21

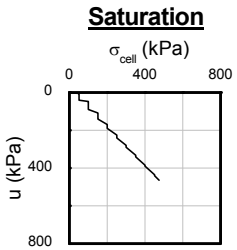
FINAL CONDITIONS		
Moisture content	(%)	24.0
Bulk density	(Mg/m³)	2.01
Dry density	(Mg/m³)	1.62

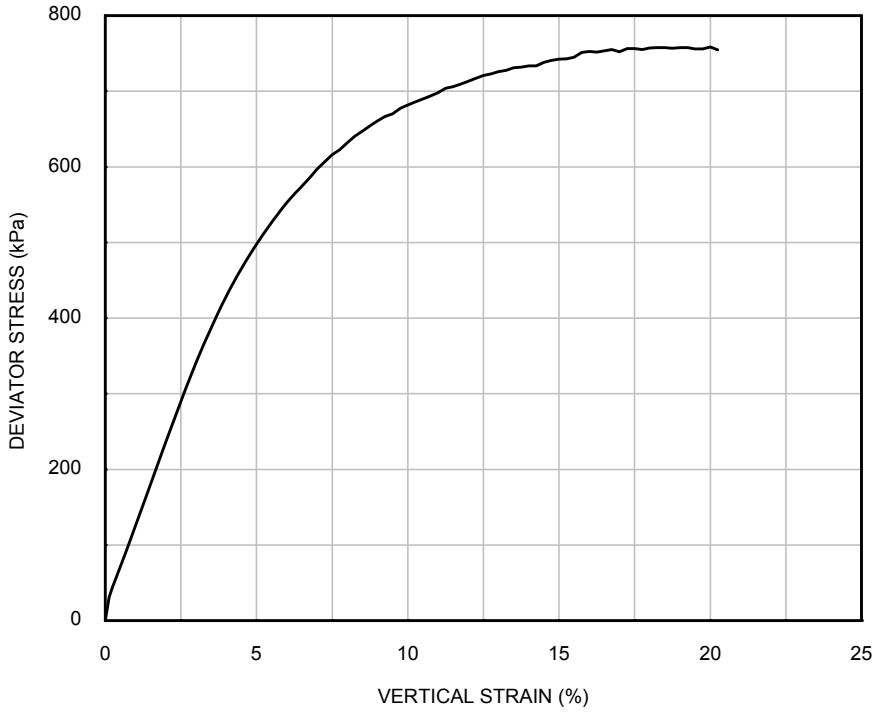
Borehole	Southern Bight
Sample	Batch
Depth (m)	CIU02

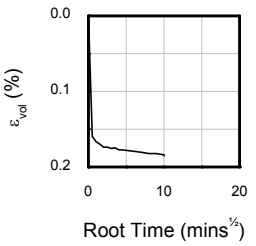
SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

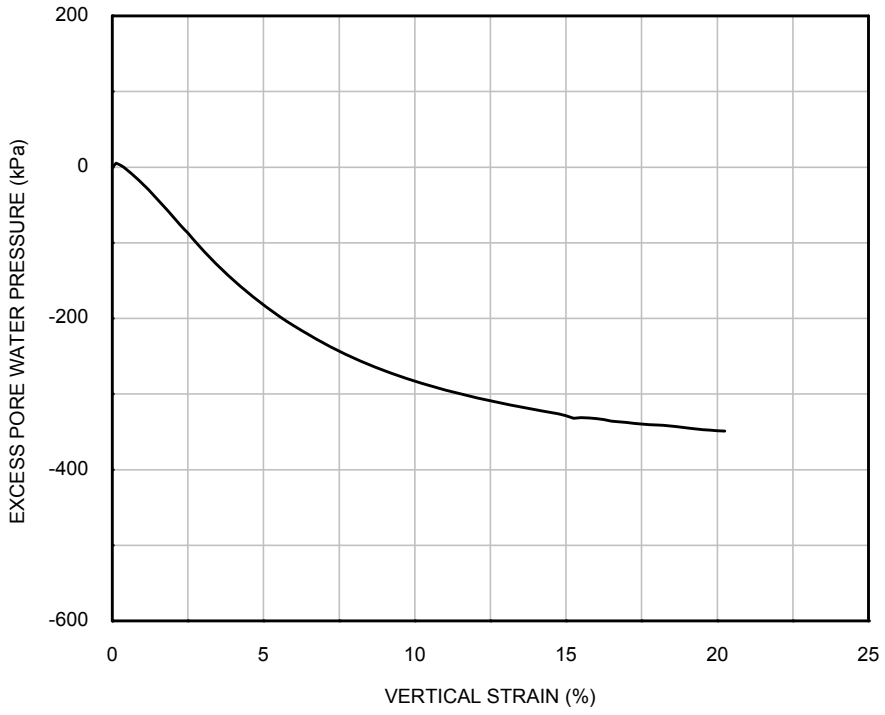
Drawn by: ER Date: 07/08/2015
Template Issue: 4.1
Filename: J11286 \ EFFECTIV \ Southern Bight_Batch_CU.OPJ
Date : 07/08/2015
Checked by: PH
Date : 07/08/2015
Approved by: PH







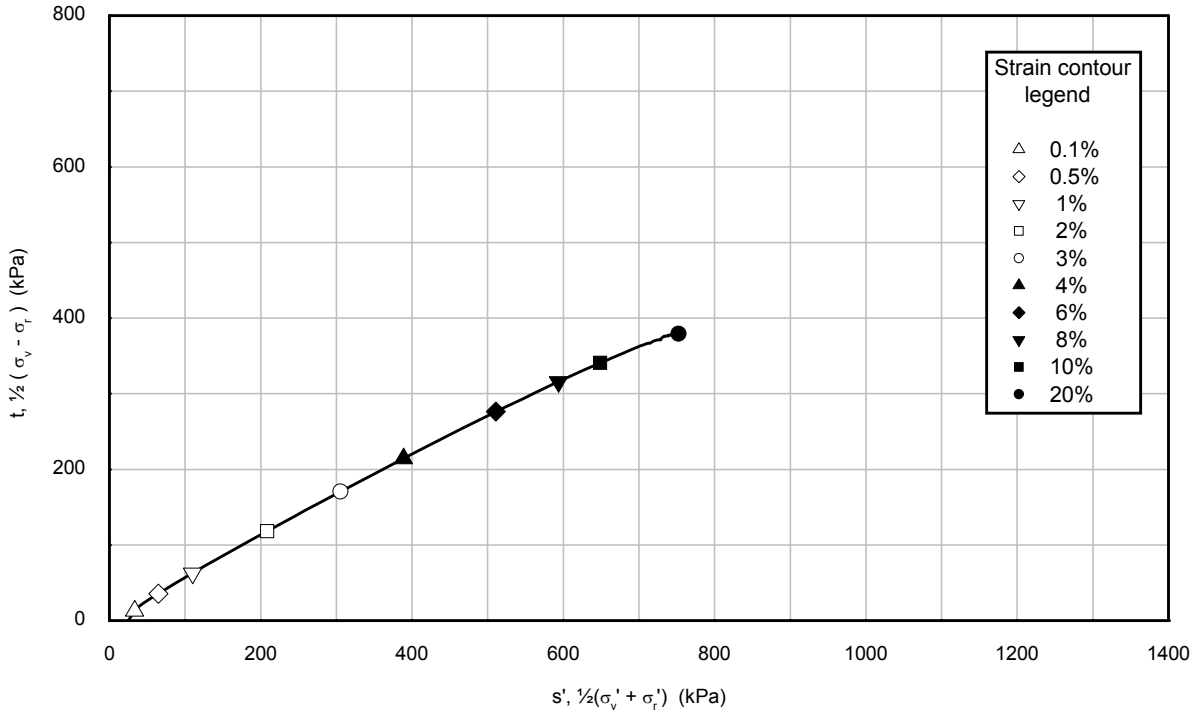
Consolidation

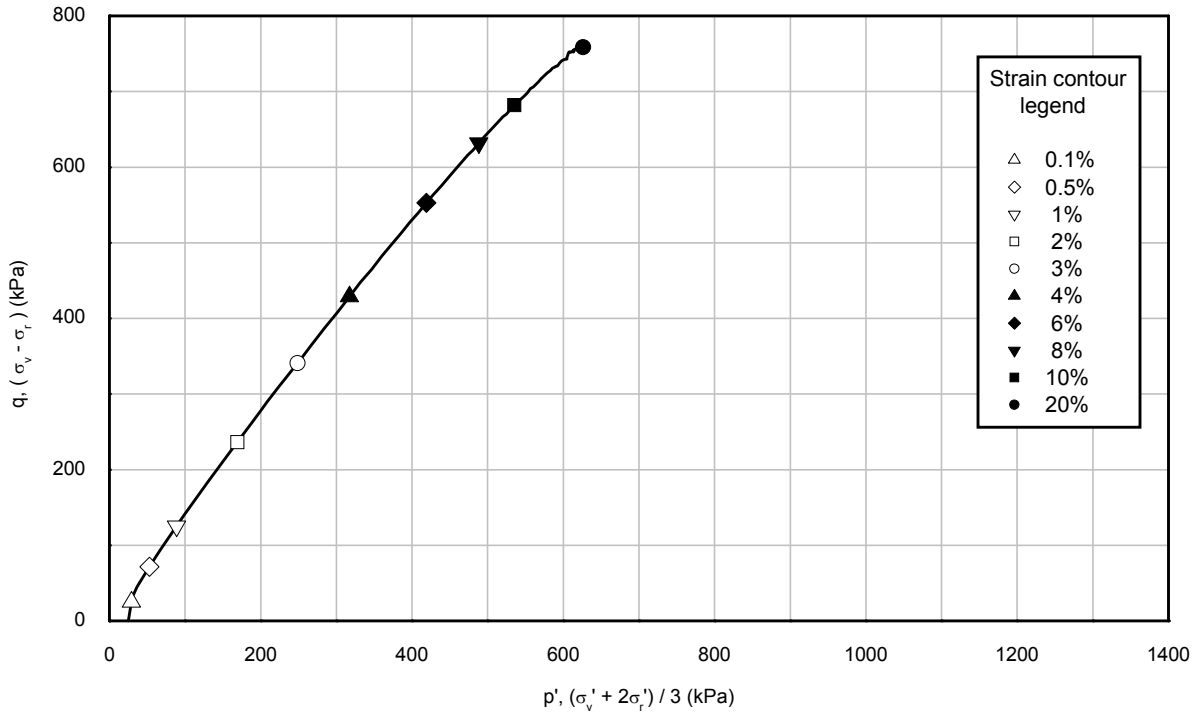


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	25	25	Southern Bight	Batch	CIU02-

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	25	25	Southern Bight	Batch	CIU02

Drawn by: ER Date: 07/08/2015

Filename: J11286 \ EFFECTIV \ Southern Bight_Batch_CU.OPJ Date : 07/08/2015

Template Issue: 4.1 Date : 07/08/2015

Checked by: PH Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Brown medium SAND with numerous shells and shell fragments, and some fine to medium gravel.

GENERAL	
Date test started	07/03/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.4
Length	[mm]	144.0
Moisture content	[%]	11.3
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.68
Void ratio	[-]	0.579
Degree of saturation	[%]	52
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	BS1377: 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 BS1377: Part 8: 1990 Clause 5.3
Consolidation - Isotropic	BS1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ 0. BATCH_Eem Kreftenheye_CIUc_BELA
Processed by	PH
Date	04/08/2015
Checked by	LJ
Date	12/08/2015
Approved by	DT
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp to 800 kPa, then 100 kPa thereafter
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1080
Base PWP	[kPa]	1045
Mid height PWP	[kPa]	-
B value achieved	[-]	0.96

S_{VH} BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Peak to Peak		
Distance	[mm]	139.74
Time	[ms]	0.89
Velocity	[m/s]	156.22
Bulk density	[Mg/m^3]	2.04
Frequency	[Hz]	5000.00
G_{max}	[MPa]	49.90

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1080
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.22
External axial strain	[%]	0.07
Local axial strain	[%]	0.03
Local radial strain	[%]	-
Moisture content	[%]	21.7
Bulk density	[Mg/m^3]	2.05
Dry density	[Mg/m^3]	1.68
Void ratio	[-]	0.576
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

S_{VH} BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC		
Peak to Peak		
Distance	[mm]	139.64
Time	[ms]	0.68
Velocity	[m/s]	204.15
Bulk density	[Mg/m^3]	2.05
Frequency	[Hz]	5000.00
G_{max}	[MPa]	85.32

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	80
Initial effective axial pressure	[kPa]	80
Rate of strain	[%/hour]	0.49
At peak deviator stress		
Corrected deviator stress	[kPa]	2430
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	12.20
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-881
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	961
Effective axial pressure	[kPa]	3391
Principal effective stress ratio	[-]	3.53
ε_{50}	[%]	2.96
Secant modulus (E_{50}) at ε_{50}	[kPa]	41098
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	384
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	1.07
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-32
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	112
Effective axial pressure	[kPa]	496
Principal effective stress ratio	[-]	4.42
At 10% axial strain		
Corrected deviator stress	[kPa]	2413
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-850
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	930
Effective axial pressure	[kPa]	3343
Principal effective stress ratio	[-]	3.60

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

At 0.01% axial strain		
Corrected deviator stress	[kPa]	25
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.02
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	5
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	75
Effective axial pressure	[kPa]	99
Principal effective stress ratio	[-]	1.33
At 0.1% axial strain		
Corrected deviator stress	[kPa]	124
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.20
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	22
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	59
Effective axial pressure	[kPa]	183
Principal effective stress ratio	[-]	3.12

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

Photograph unavailable

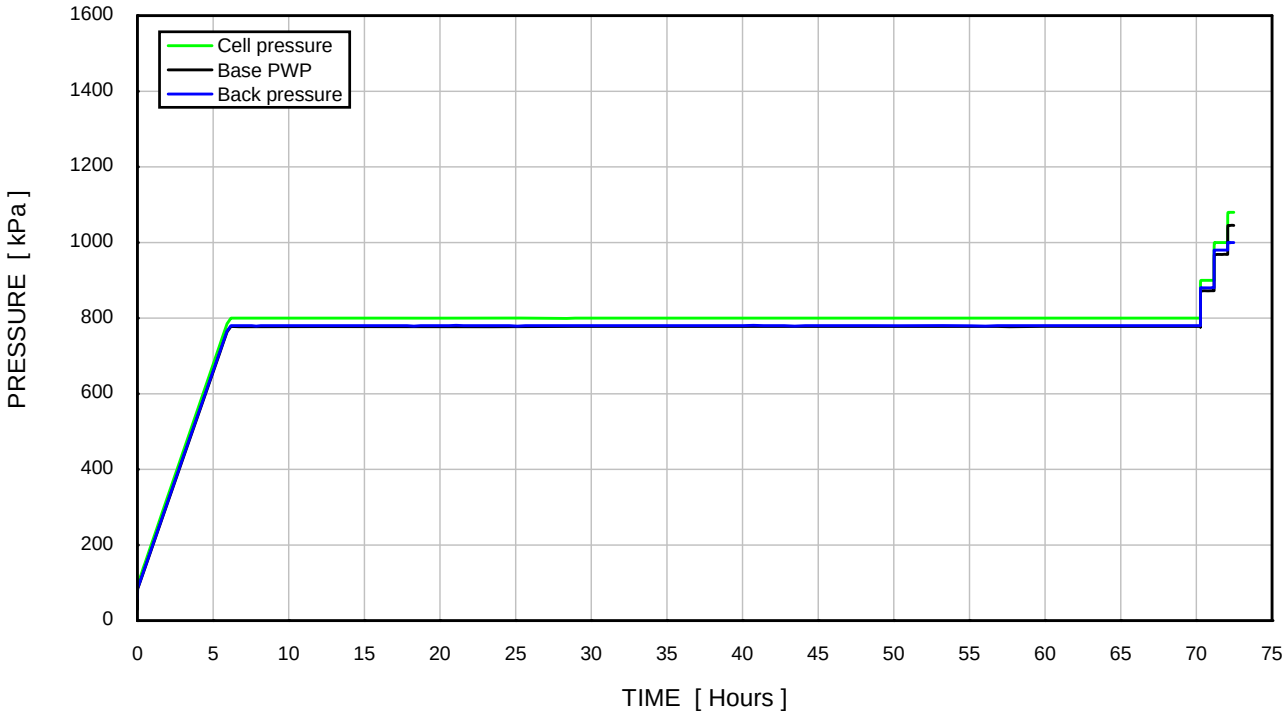
Photograph unavailable

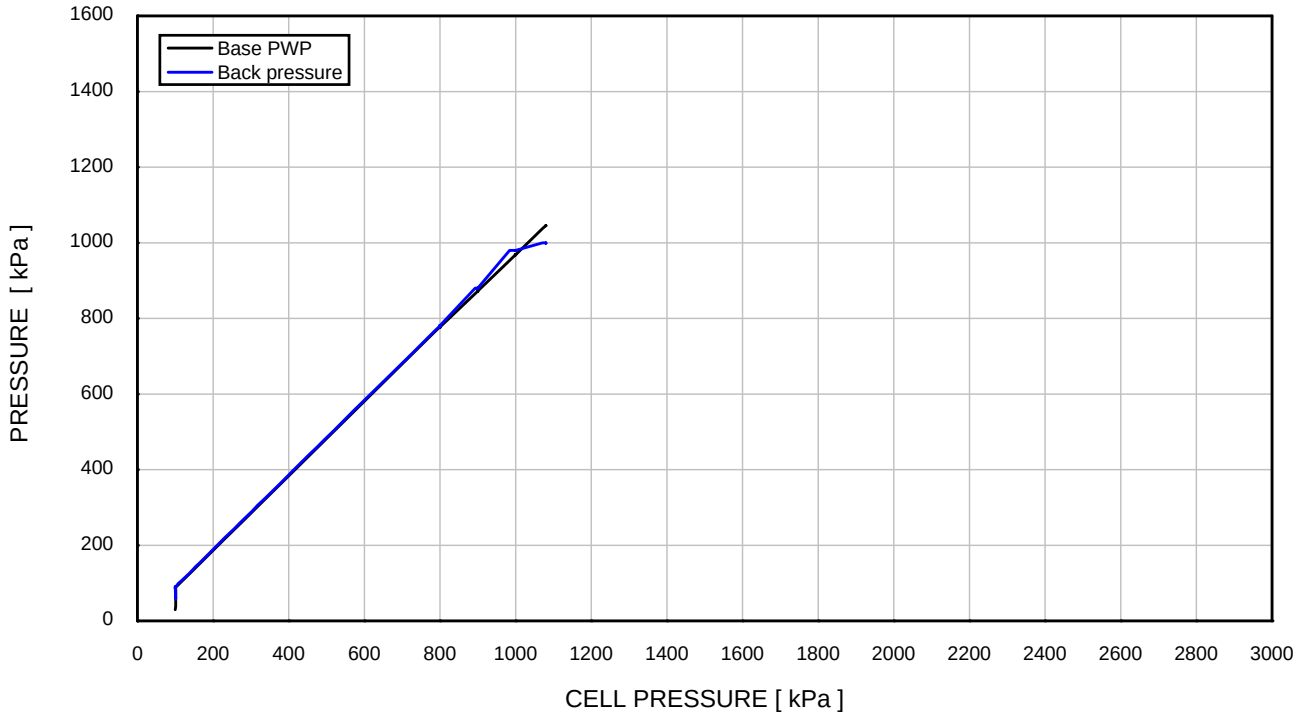
FINAL CONDITIONS		
Moisture content	[%]	21.7
Bulk density	[Mg/m³]	2.05
Dry density	[Mg/m³]	1.68

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CIU03

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

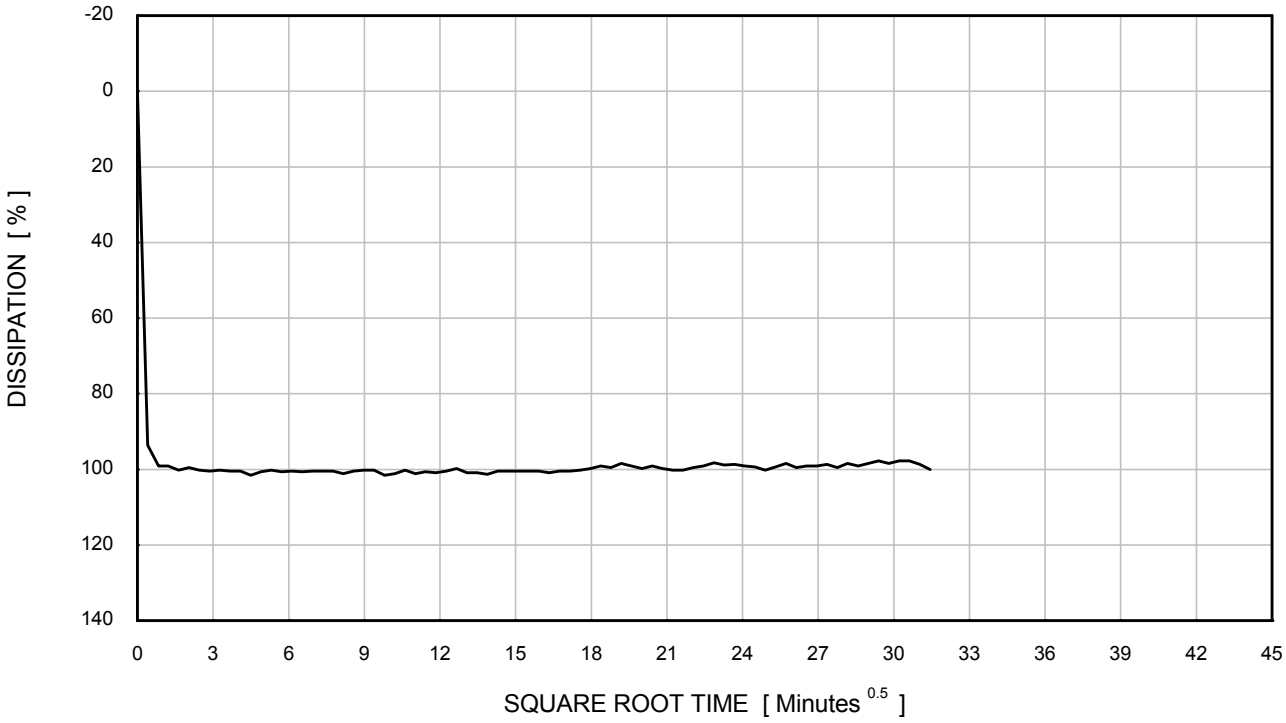


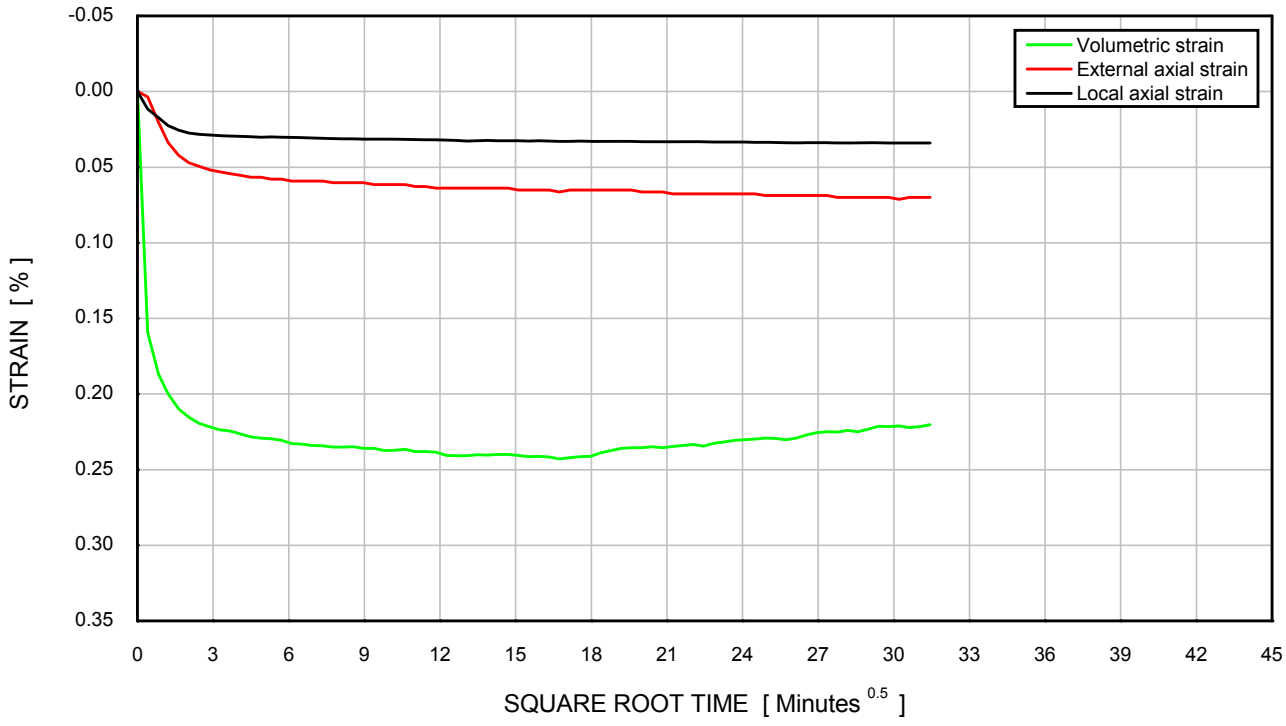


B value	:	0.96			
Initial σ'_r	:	70	kPa	Borehole	: Batch
Initial σ'_a	:	79	kPa	Sample	: Eem / Kreftenheye
Final σ'_r	:	35	kPa	Depth [m]	: -
Final σ'_a	:	35	kPa	Test No.	: CIU03

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

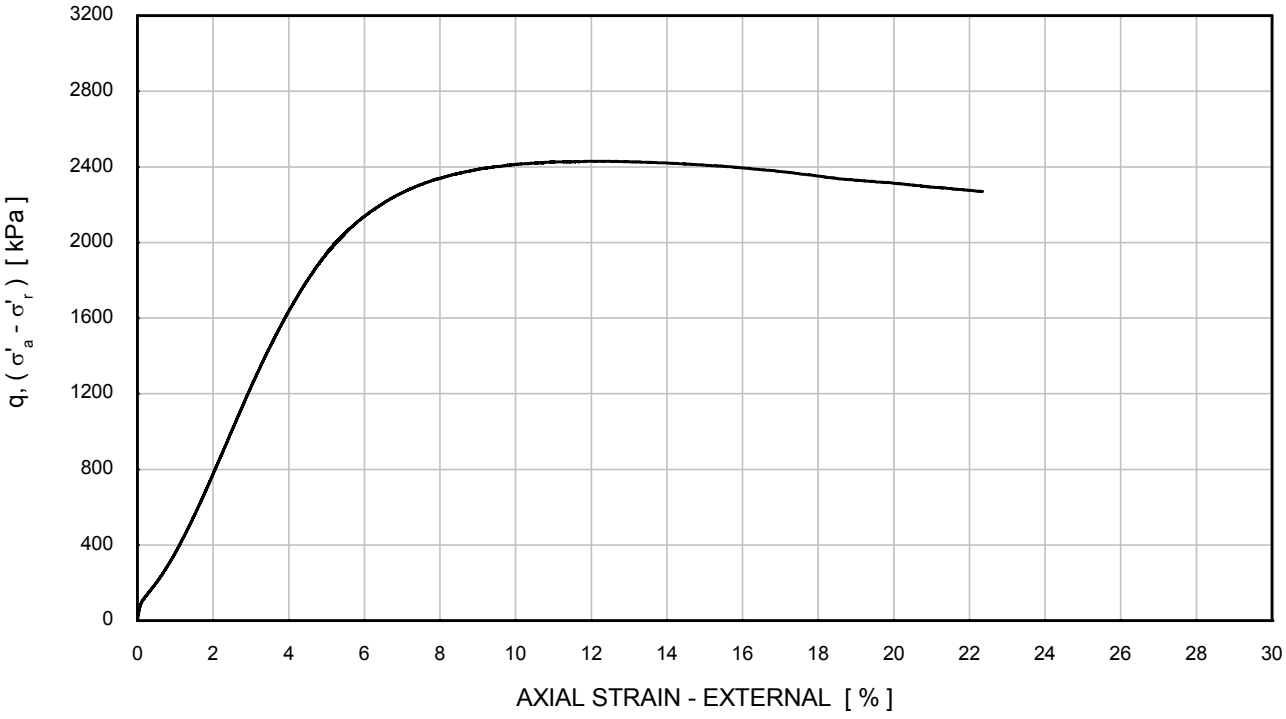


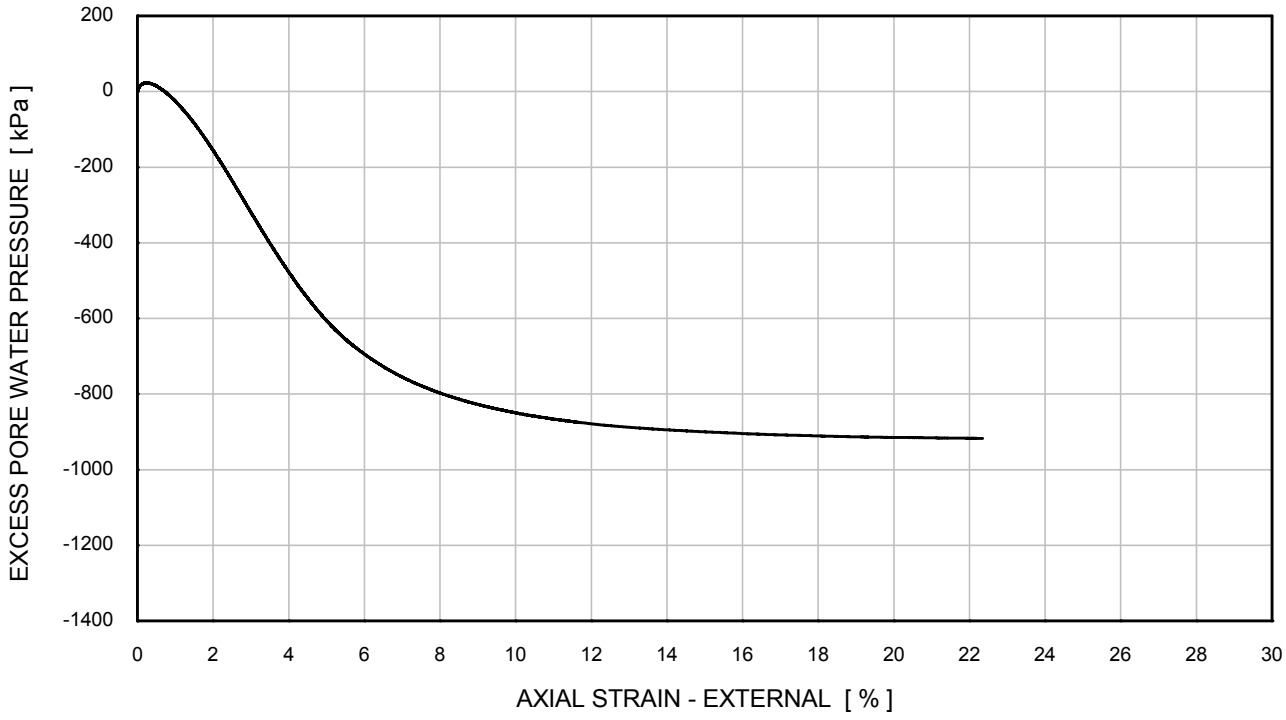


σ'_{rc}	:	80 kPa	Borehole	:	Batch
σ'_{ac}	:	80 kPa	Sample	:	Eem / Kreftenheye
			Depth [m]	:	-
			Test No.	:	CIU03

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

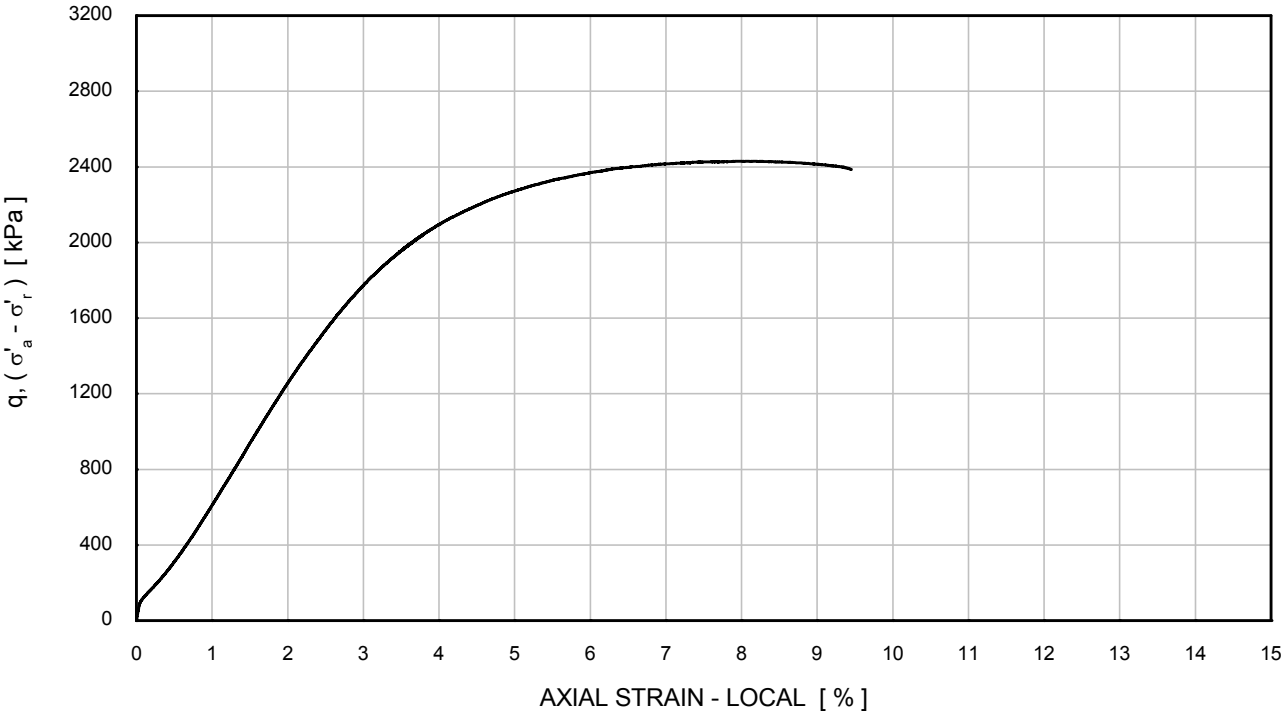


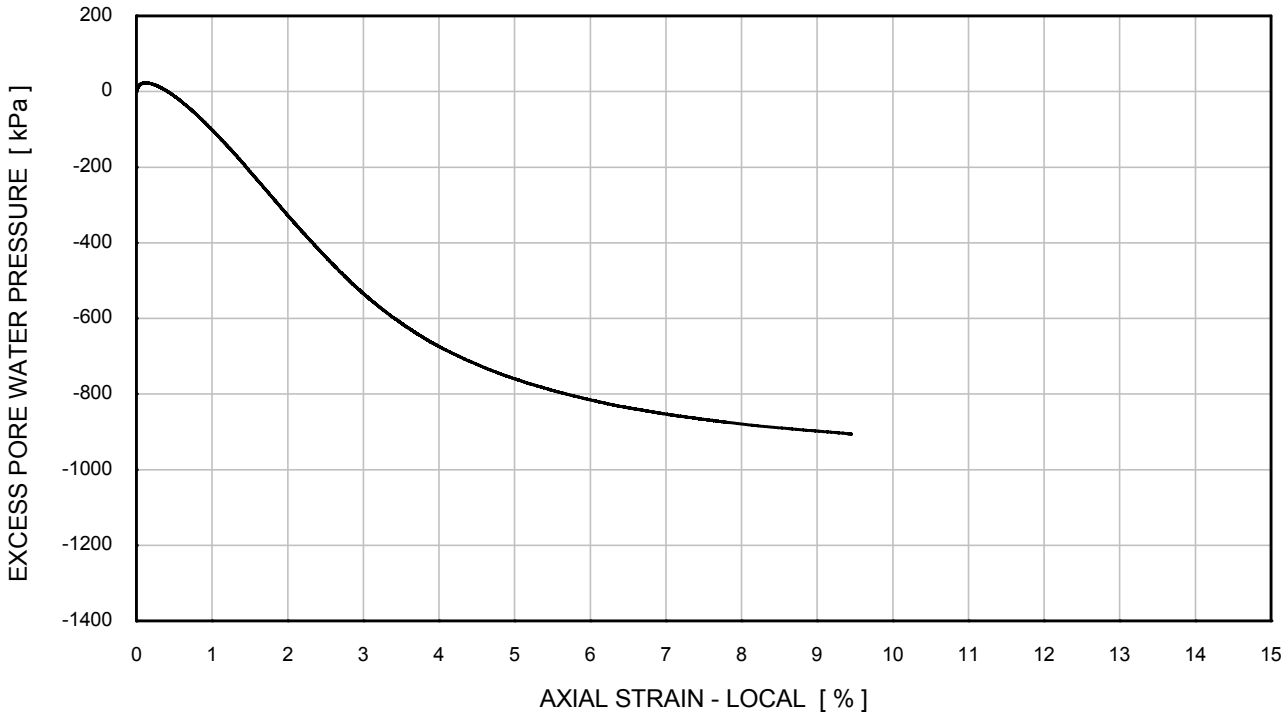


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem / Kreftenheye
q_{peak}	:	2430 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	12.20 %	Test No.	:	CIU03
Rate of strain	:	0.49 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

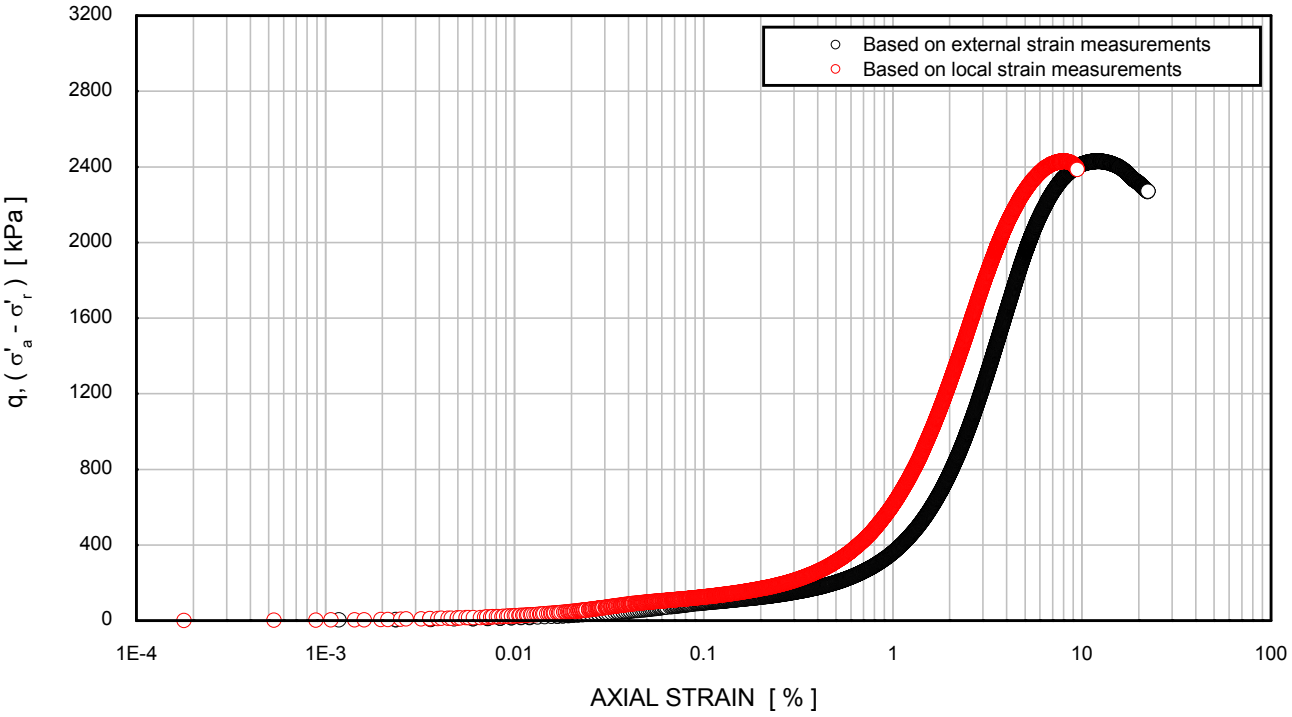


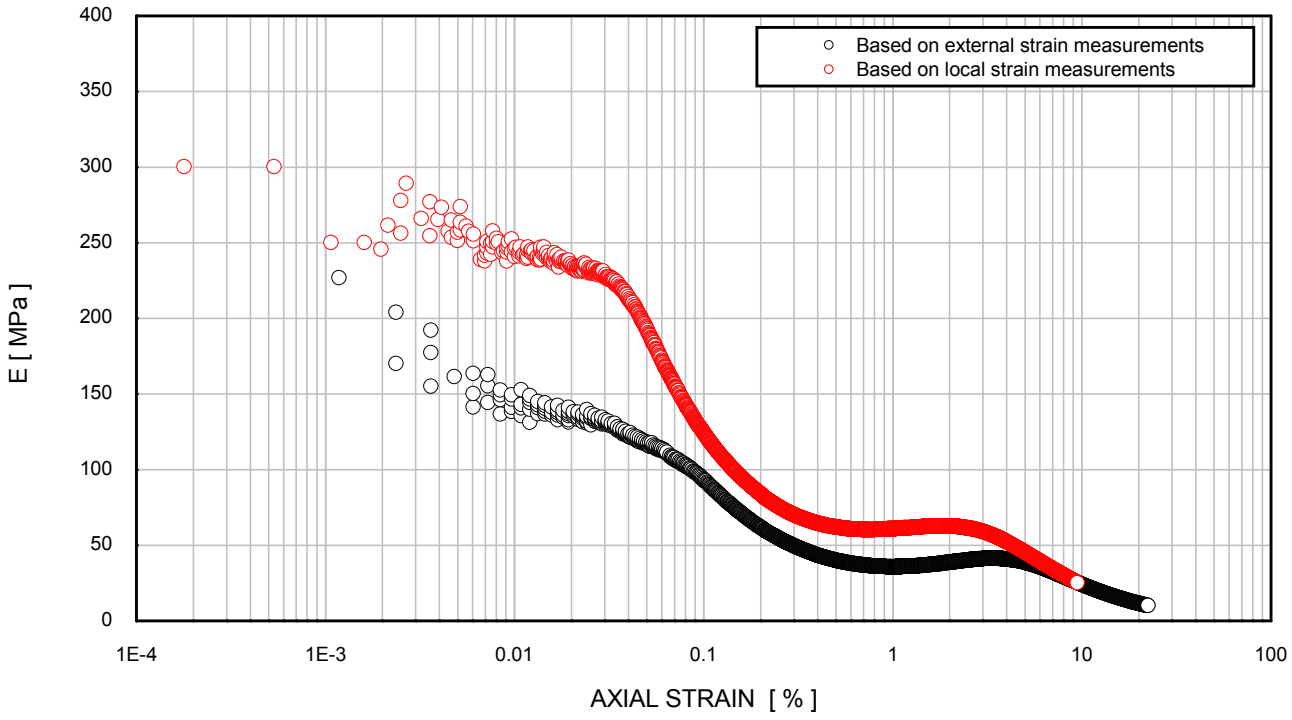


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem / Kreftenheye
q_{peak}	:	2430 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	12.20 %	Test No.	:	CIU03
Rate of strain	:	0.49 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

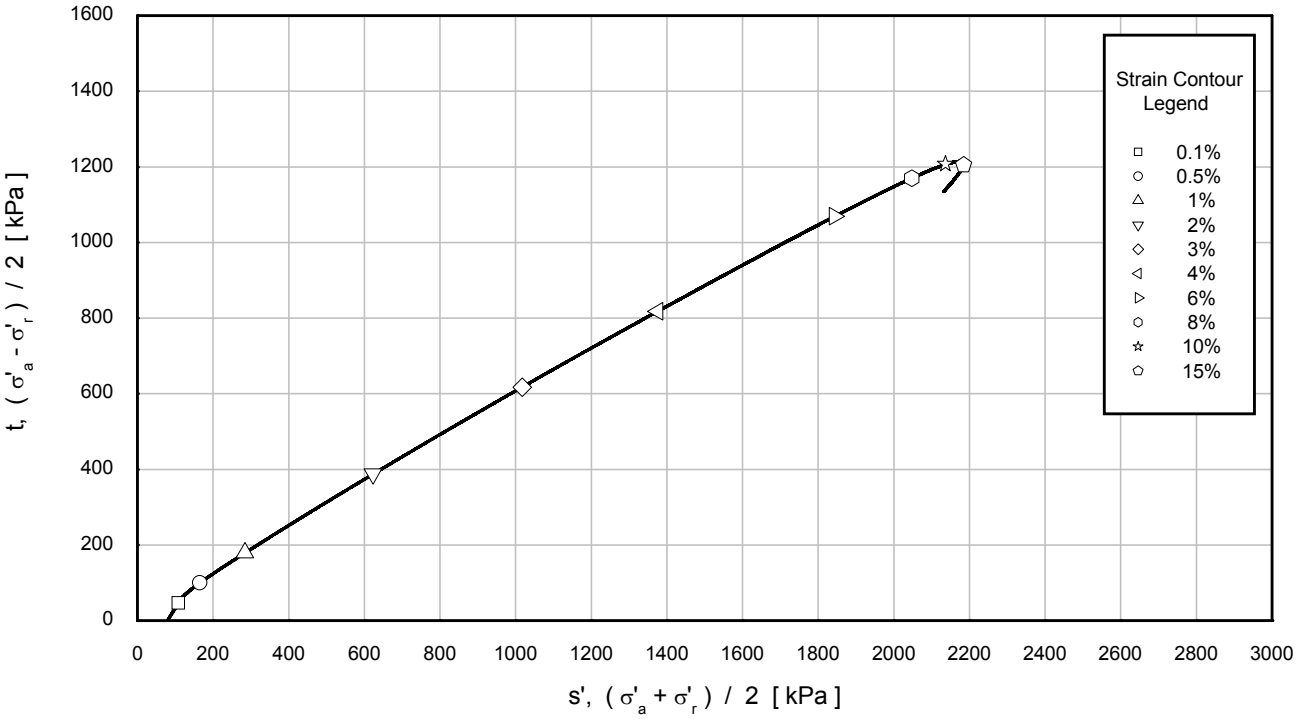


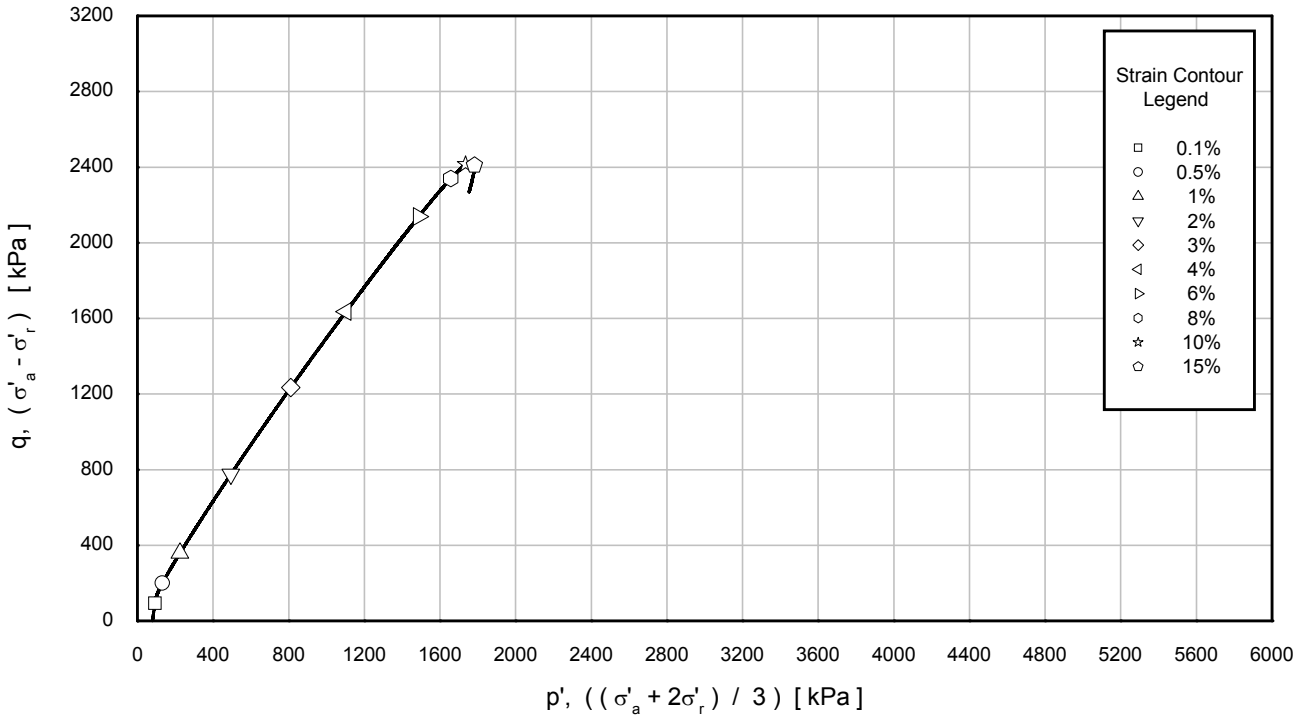


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{peak}	:	2430	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	12.20	%	Test No.	: CIU03
Rate of strain	:	0.49	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

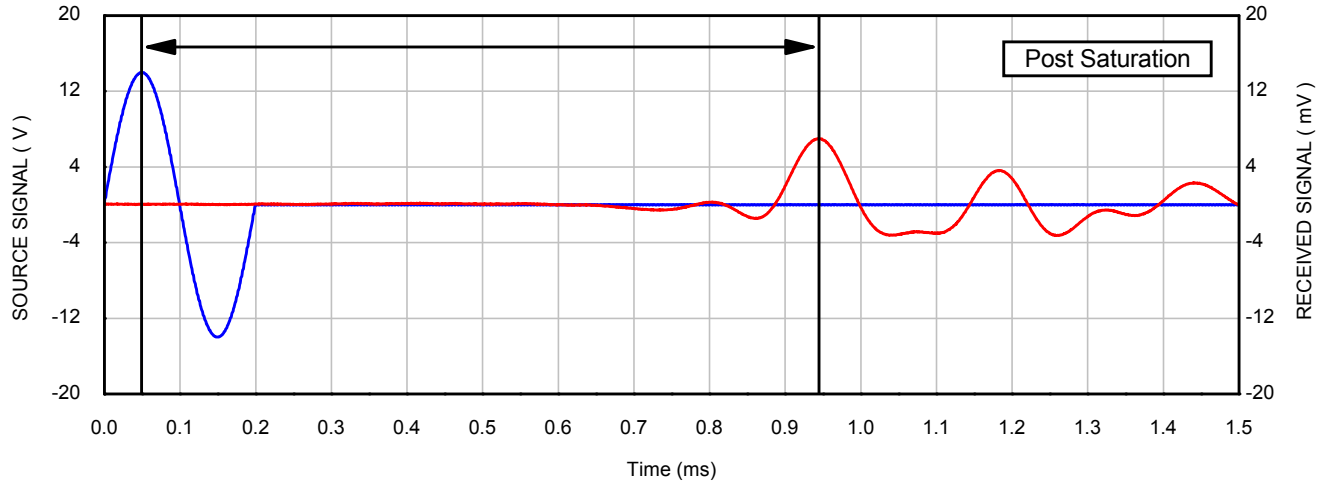


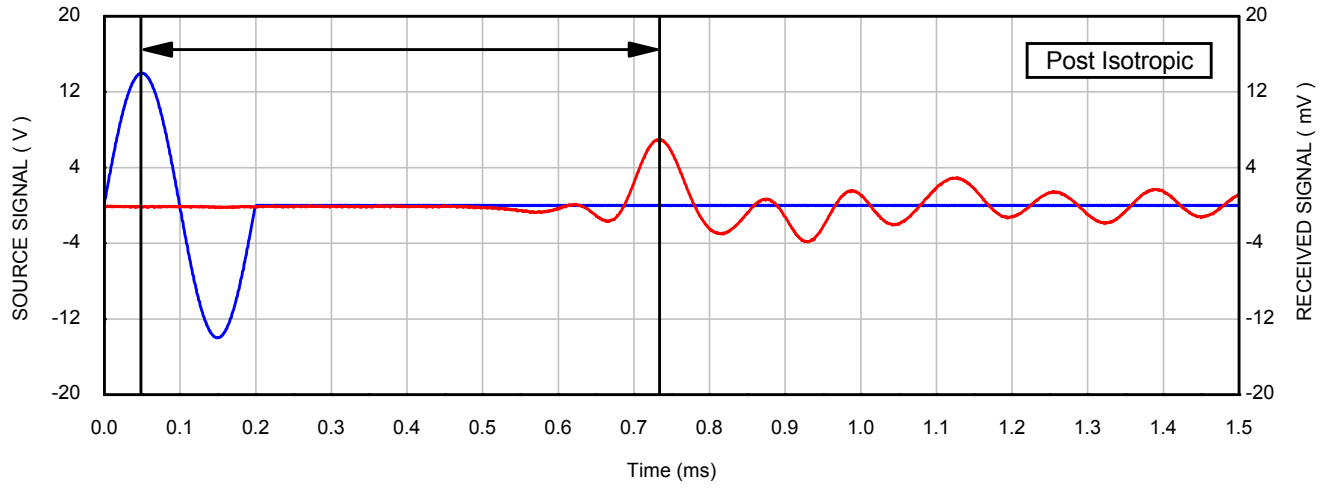


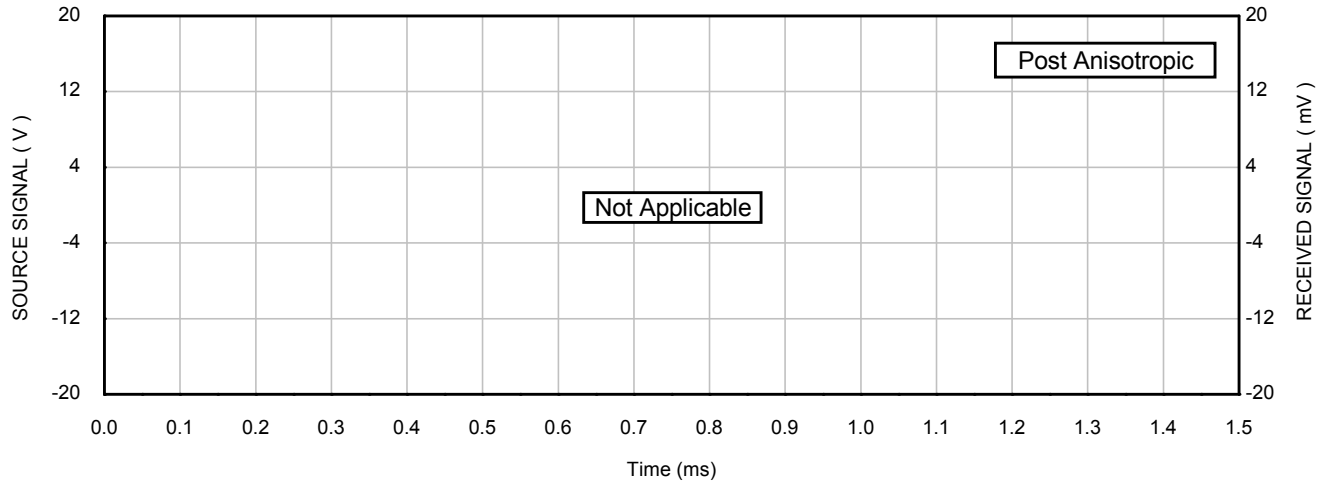
Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{peak}	:	2430	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	12.20	%	Test No.	: CIU03
Rate of strain	:	0.49	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA







Source Signal
Received Signal

Borehole	:	Batch
Sample	:	Eem / Kreftenheye
Depth [m]	:	--
Test No.	:	CIU03

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SVH BENDER ELEMENT DETERMINATIONS (PEAK TO PEAK)

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / Eem/ Kreftenheye_Batch_CU.XLS
Template Issue: 2
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

VISUAL DESCRIPTION
Yellowish brown fine to medium SAND with fine to medium gravel and shell fragments.

GENERAL	
Date test started	06/08/2015
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	(mm)	72.1
Length	(mm)	135.0
Moisture content	(%)	10.2
Bulk density	(Mg/m³)	1.99
Dry density	(Mg/m³)	1.81
Void ratio		0.465
Degree of saturation	(%)	58

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	667
Cell pressure on completion	(kPa)	680
B value achieved		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 7
Note: Fugro testing procedures are available on request	

Borehole	Eem/ Kreftenheye
Sample	Batch
Depth (m)	CIU04

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	680
Back pressure	(kPa)	600
Effective cell pressure	(kPa)	80
Pore pressure on completion	(kPa)	600
Pore pressure dissipation	(%)	100
Moisture content	(%)	17.4
Bulk density	(Mg/m³)	2.13
Dry density	(Mg/m³)	1.82
Void ratio		0.460
Degree of saturation	(%)	100
Volumetric strain	(%)	0.35

Mode of failure: Compound failure

Borehole	Eem/ Kreftenheye
Sample	Batch
Depth (m)	CIU04

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ER Date: 07/08/2015
Template Issue: 2
Filename: J11286 / EFFECTIV / Eem/ Kreftenheye_Batch_CU.XLS
Checked by: PH Date: 07/08/2015
Approved by: PH Date: 07/08/2015

Date: 07/08/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / Eem/ Kreftenheye_Batch_CU.XLS
Template Issue: 2
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	600
Initial effective cell pressure	(kPa)	80
Rate of strain	(%/hour)	0.91
At peak deviator stress		
Corrected deviator stress	(kPa)	2054
Membrane correction applied	(kPa)	0.6
Drain correction applied	(kPa)	0
Axial strain	(%)	7.25
Excess pore pressure	(kPa)	-523
Major principal effective stress	(kPa)	2657
Minor principal effective stress	(kPa)	603
Principal effective stress ratio		4.41
Epsilon 50 (ε 50)	(%)	2.49
Secant modulus (E50) at ε 50	(kPa)	41328
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	627
Membrane correction applied	(kPa)	0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	1.75
Excess pore pressure	(kPa)	-71
Major principal effective stress	(kPa)	778
Minor principal effective stress	(kPa)	151
Principal effective stress ratio		5.15
At 10% axial strain		
Corrected deviator stress	(kPa)	1918
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	10.00
Excess pore pressure	(kPa)	-564
Major principal effective stress	(kPa)	2563
Minor principal effective stress	(kPa)	644
Principal effective stress ratio		3.98

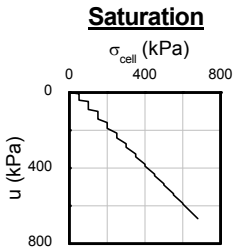
FINAL CONDITIONS		
Moisture content	(%)	17.4
Bulk density	(Mg/m³)	2.13
Dry density	(Mg/m³)	1.82

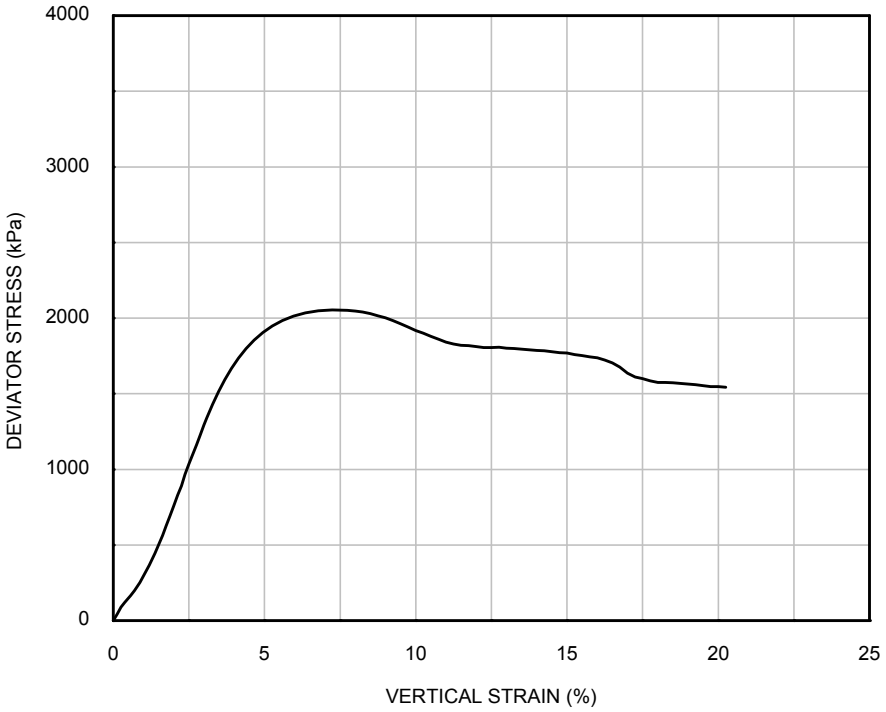
Borehole	Eem/ Kreftenheye
Sample	Batch
Depth (m)	CIU04

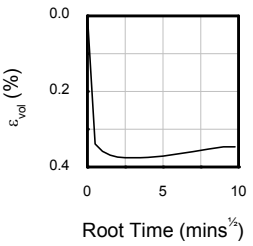
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

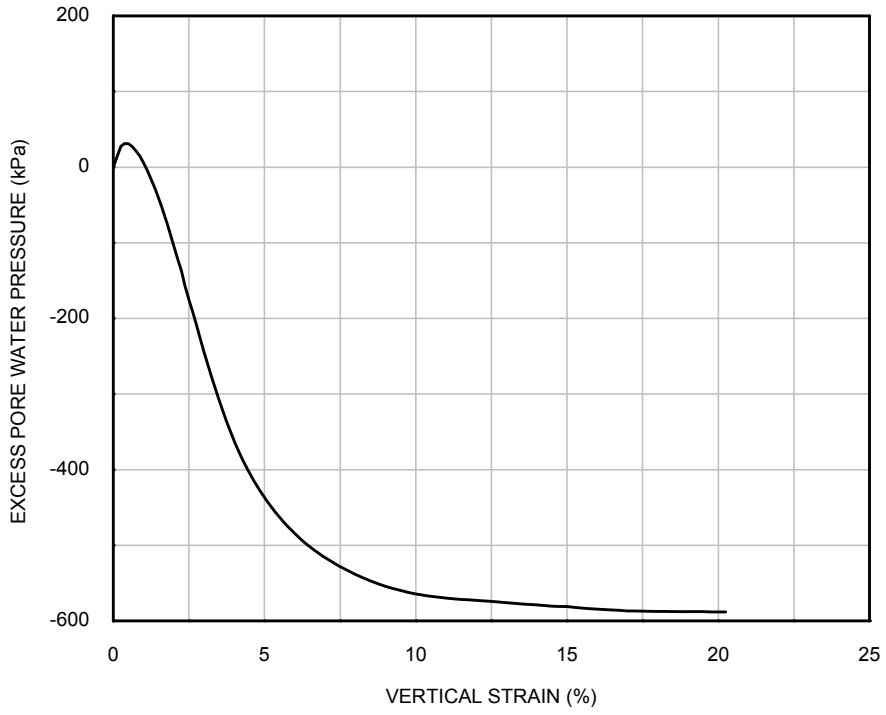
Drawn by: ER Date: 07/08/2015
Template Issue: 4.1 Date : 07/08/2015
Filename: J11286 \ EFFECTIV \ Eem/ Krefthenheye_Batch_CU.OPJ Date : 07/08/2015
Checked by: PH
Approved by: PH







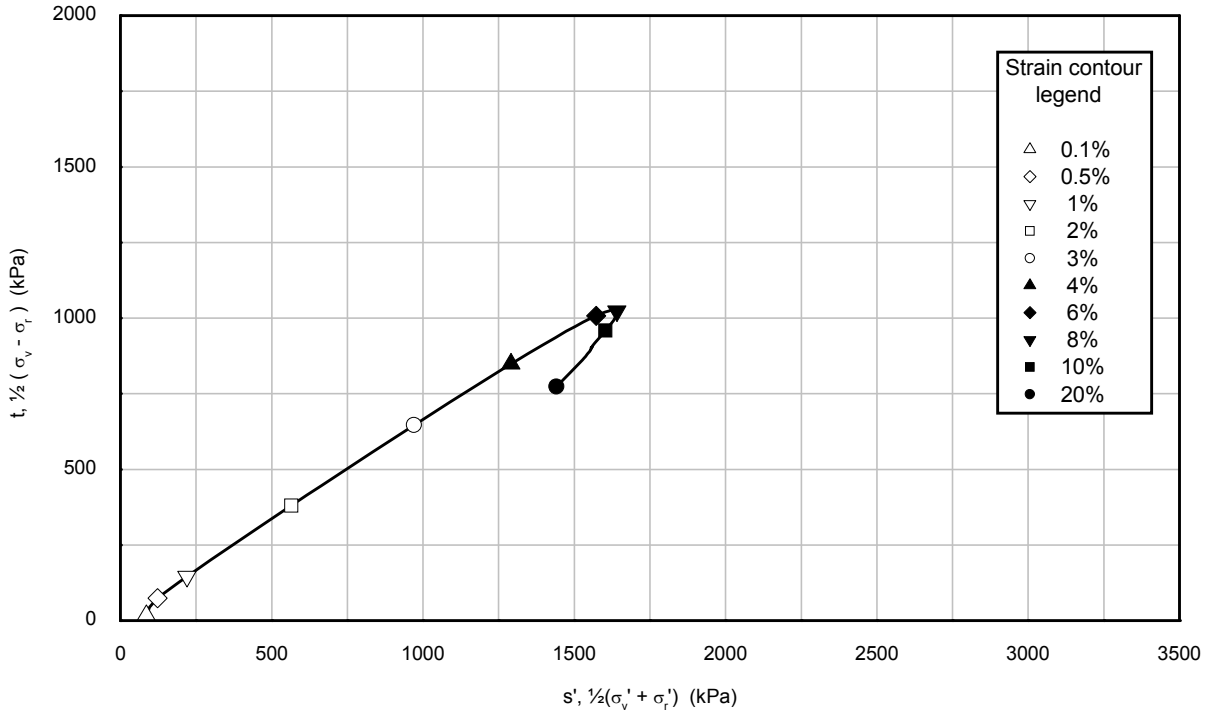
Consolidation

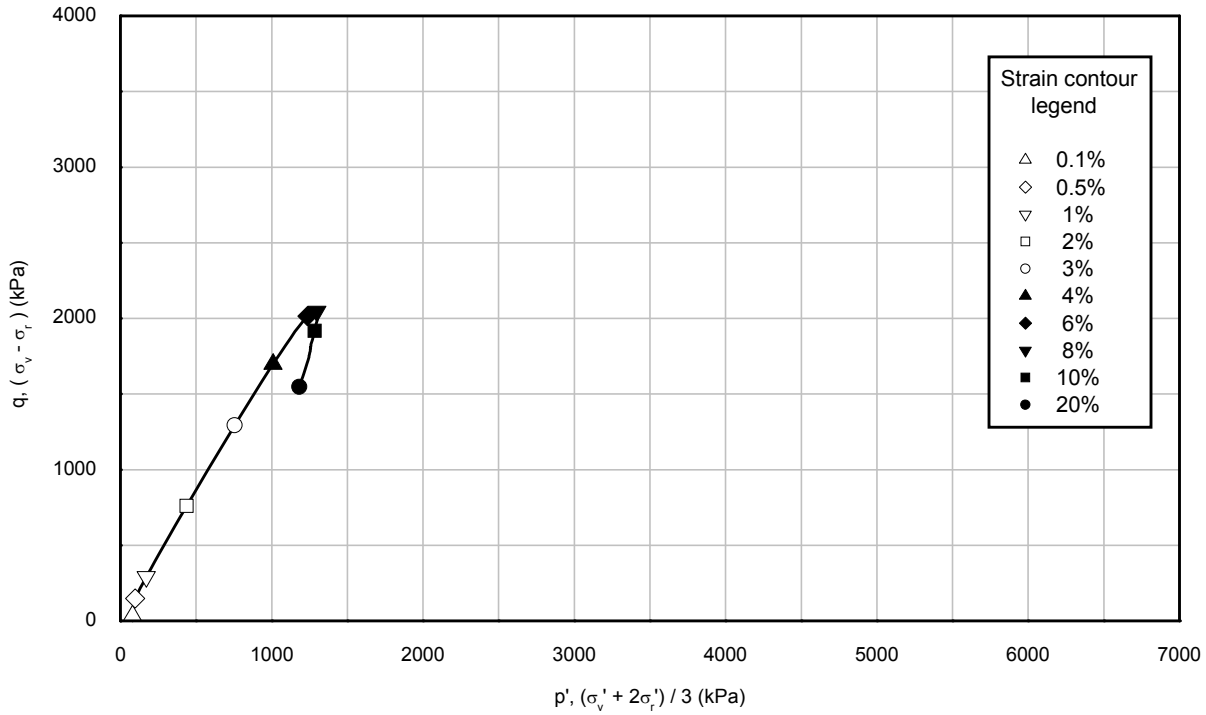


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	80	80	Eem / Krefthenheye	Batch	-

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	80	80	Eem / Krefthenheye	Batch	-

Drawn by: ER Date: 07/08/2015

Filename: J11286 \ EFFECTIV \ Eem/ Krefthenheye_Batch_CU.OPJ

Template Issue: 4.1

Date : 07/08/2015

Checked by: PH

Date : 07/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Olive grey silty fine SAND

GENERAL	
Date test started	03/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.4
Length	[mm]	144.0
Moisture content	[%]	10.0
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.61
Void ratio	[-]	0.647
Degree of saturation	[%]	41
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	BS1377: 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 BS1377: Part 8: 1990 Clause 5.3
Consolidation - Isotropic	BS1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Tongeren_CIUc
Processed by	PH
Date	05/08/2015
Checked by	LJ
Date	12/08/2015
Approved by	DT
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp to 800 kPa, 100 kPa thereafter
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1400
Base PWP	[kPa]	1362
Mid height PWP	[kPa]	-
B value achieved	[-]	0.95

S_{VH} BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Peak to Peak		
Distance	[mm]	139.05
Time	[ms]	0.82
Velocity	[m/s]	170.40
Bulk density	[Mg/m^3]	2.00
Frequency	[Hz]	6250.00
G_{max}	[MPa]	58.13

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1400
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	400
Effective axial pressure	[kPa]	400
Deviator stress	[kPa]	0
Volumetric strain	[%]	2.45
External axial strain	[%]	0.39
Local axial strain	[%]	0.04
Local radial strain	[%]	-
Moisture content	[%]	22.9
Bulk density	[Mg/m^3]	2.03
Dry density	[Mg/m^3]	1.65
Void ratio	[-]	0.606
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

S_{VH} BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC		
Peak to Peak		
Distance	[mm]	138.48
Time	[ms]	0.49
Velocity	[m/s]	282.27
Bulk density	[Mg/m^3]	2.03
Frequency	[Hz]	6250.00
G_{max}	[MPa]	161.51

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	400
Initial effective axial pressure	[kPa]	401
Rate of strain	[%/hour]	0.50
At peak deviator stress		
Corrected deviator stress	[kPa]	249
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.78
Local axial strain	[%]	0.61
Local radial strain	[%]	-
Excess base PWP	[kPa]	250
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	150
Effective axial pressure	[kPa]	399
Principal effective stress ratio	[-]	2.66
ε_{50}	[%]	0.08
Secant modulus (E_{50}) at ε_{50}	[kPa]	157960
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	200
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.26
Local axial strain	[%]	9.35
Local radial strain	[%]	-
Excess base PWP	[kPa]	320
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	280
Principal effective stress ratio	[-]	3.49
At 10% axial strain		
Corrected deviator stress	[kPa]	200
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	9.14
Local radial strain	[%]	-
Excess base PWP	[kPa]	319
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	81
Effective axial pressure	[kPa]	281
Principal effective stress ratio	[-]	3.45

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

At 0.01% axial strain		
Corrected deviator stress	[kPa]	39
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.01
Local axial strain	[%]	0.01
Local radial strain	[%]	-
Excess base PWP	[kPa]	16
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	384
Effective axial pressure	[kPa]	423
Principal effective stress ratio	[-]	1.10
At 0.1% axial strain		
Corrected deviator stress	[kPa]	170
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.14
Local axial strain	[%]	0.10
Local radial strain	[%]	-
Excess base PWP	[kPa]	112
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	288
Effective axial pressure	[kPa]	458
Principal effective stress ratio	[-]	1.59

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

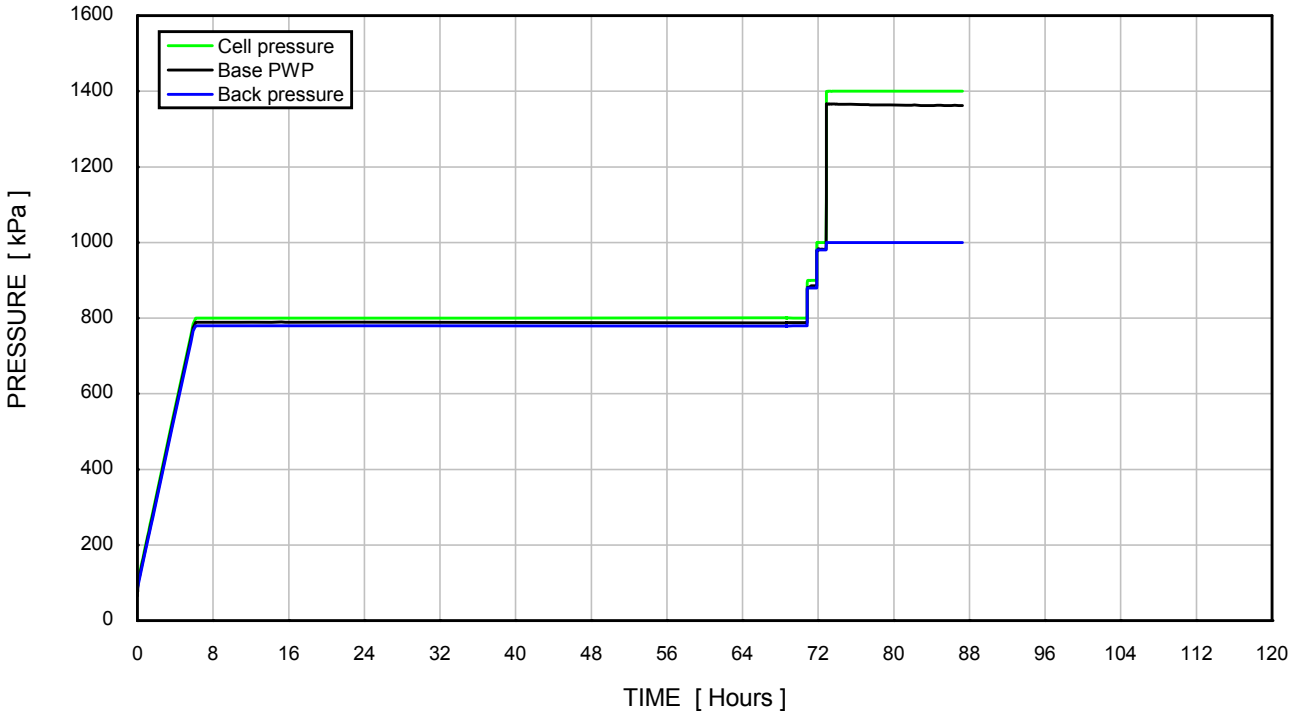
Moisture content	[%]	22.9
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.65

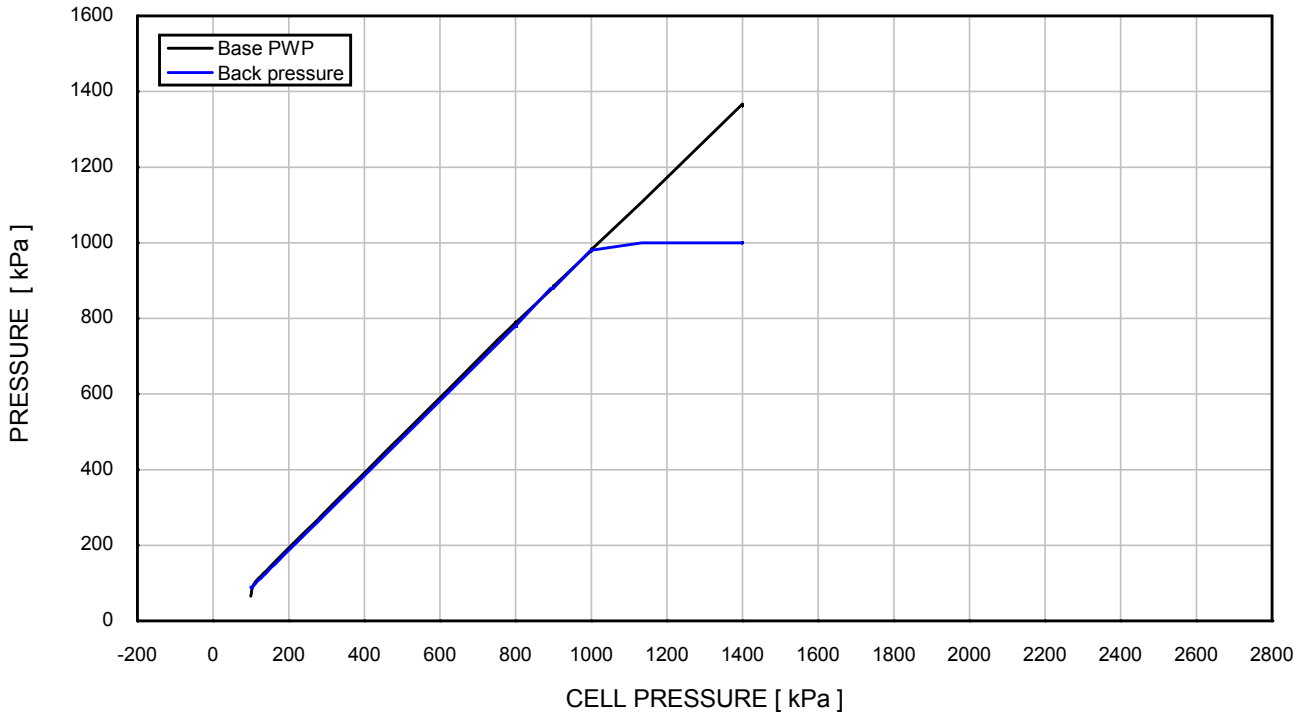
TEST IDENTIFICATION

Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CIU05

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

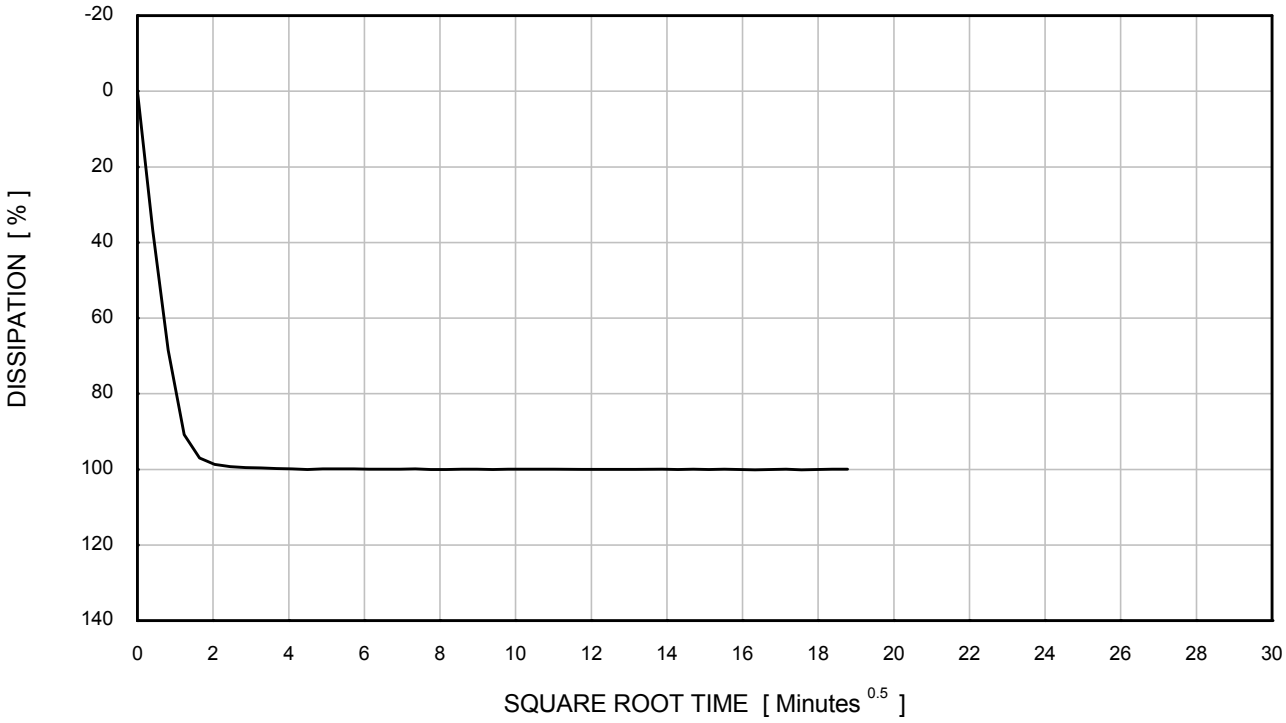


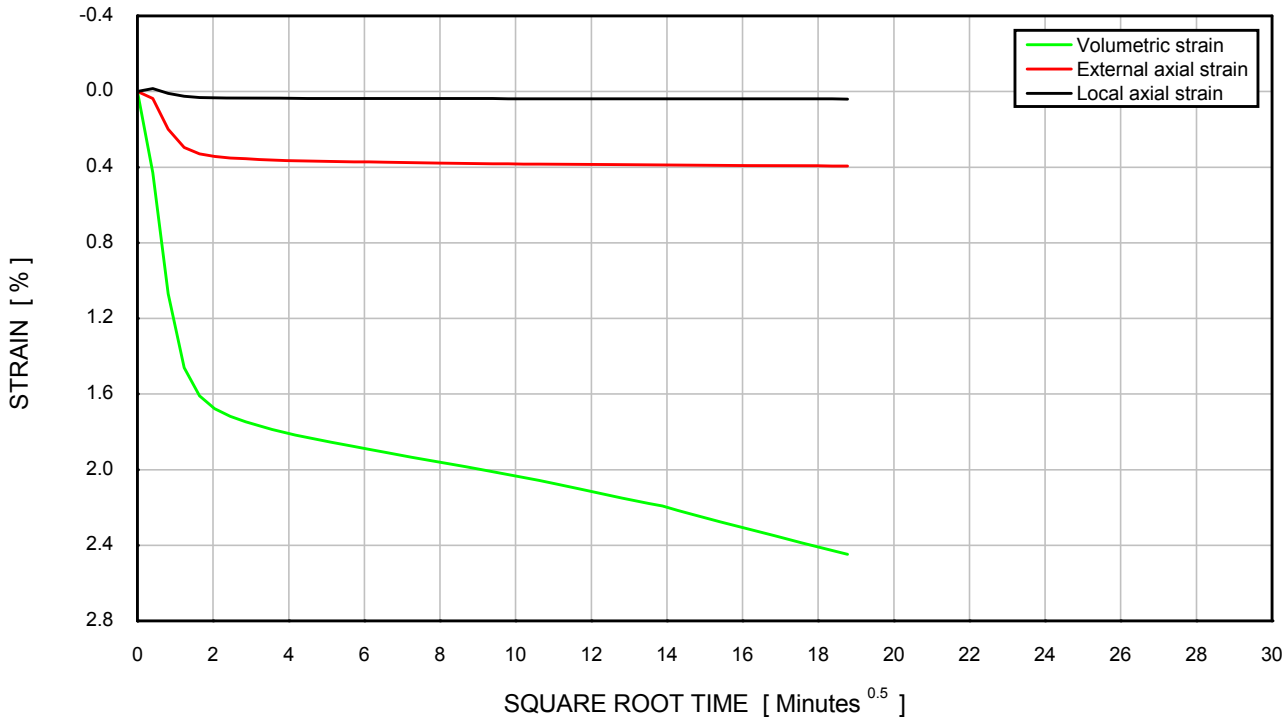


B value	:	0.95			
Initial σ'_r	:	34	kPa	Borehole	: Batch
Initial σ'_a	:	34	kPa	Sample	: Tongeren
Final σ'_r	:	38	kPa	Depth [m]	: -
Final σ'_a	:	38	kPa	Test No.	: CIU05

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

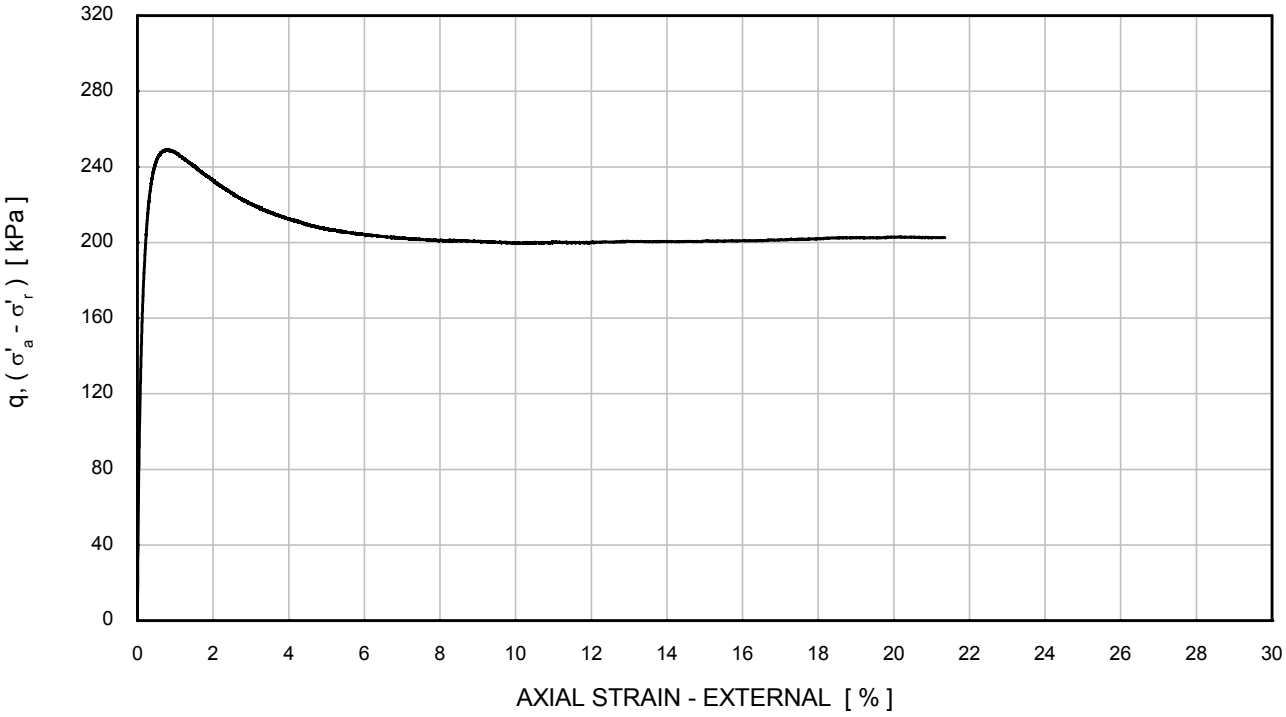


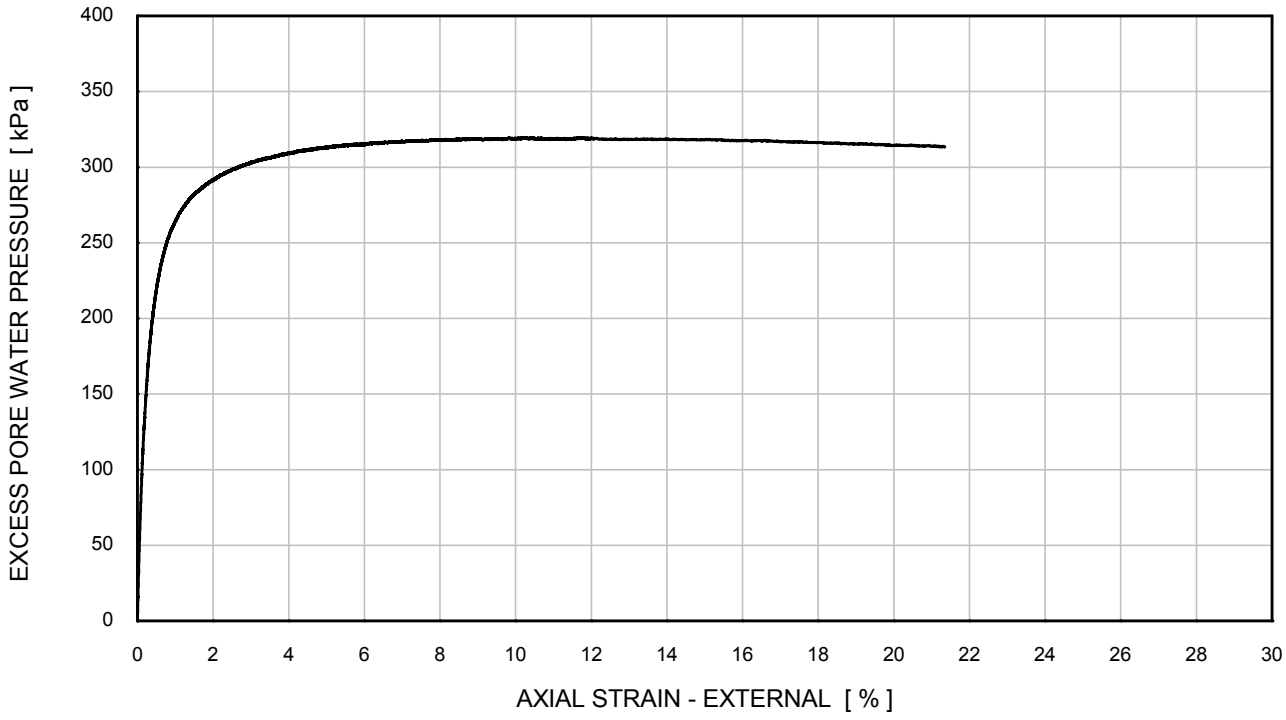


σ'_{rc}	: 400 kPa	Borehole	: Batch
σ'_{ac}	: 400 kPa	Sample	: Tongeren
		Depth [m]	: -
		Test No.	: CIU05

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

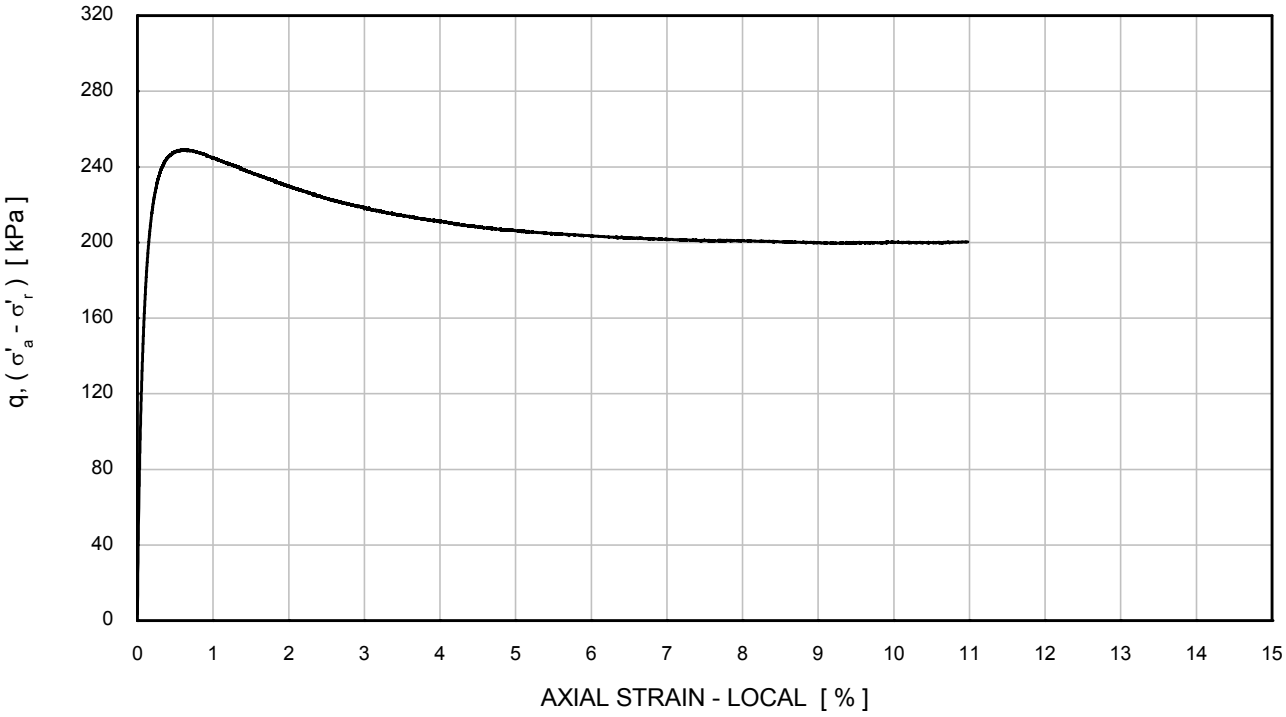


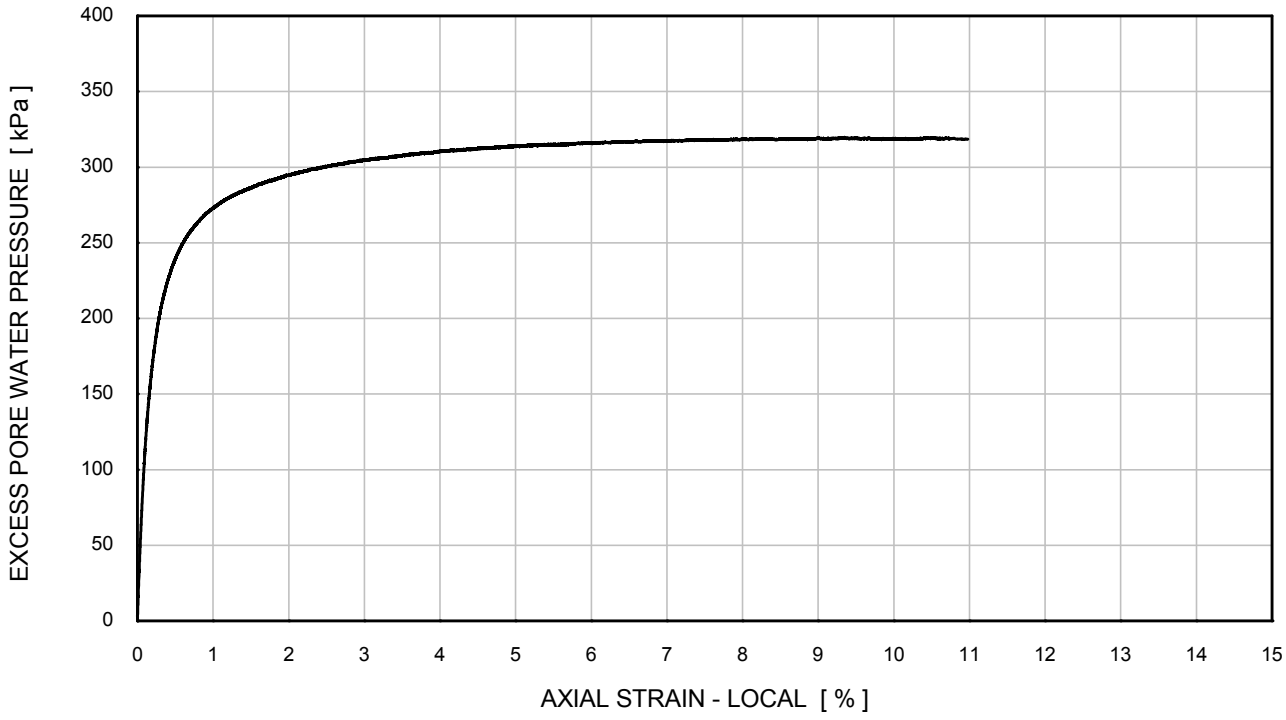


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{peak}	:	249 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	0.78 %	Test No.	:	CIU05
Rate of strain	:	0.50 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

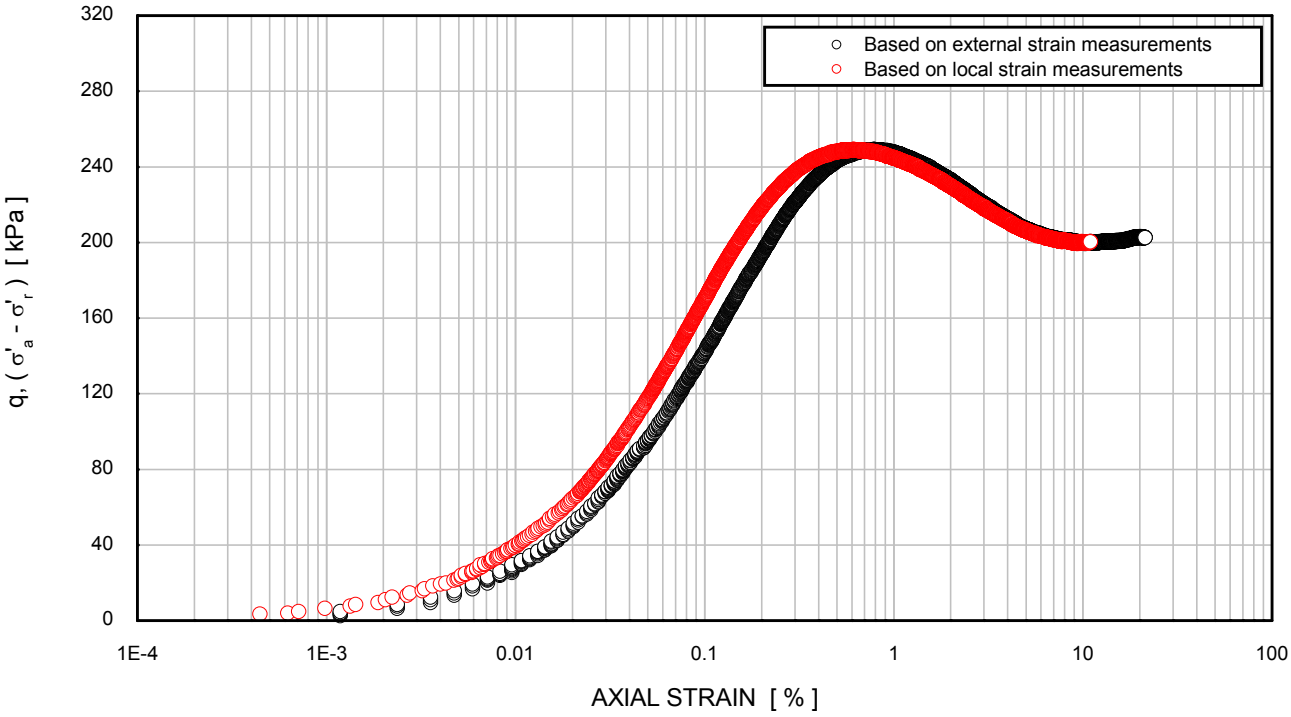


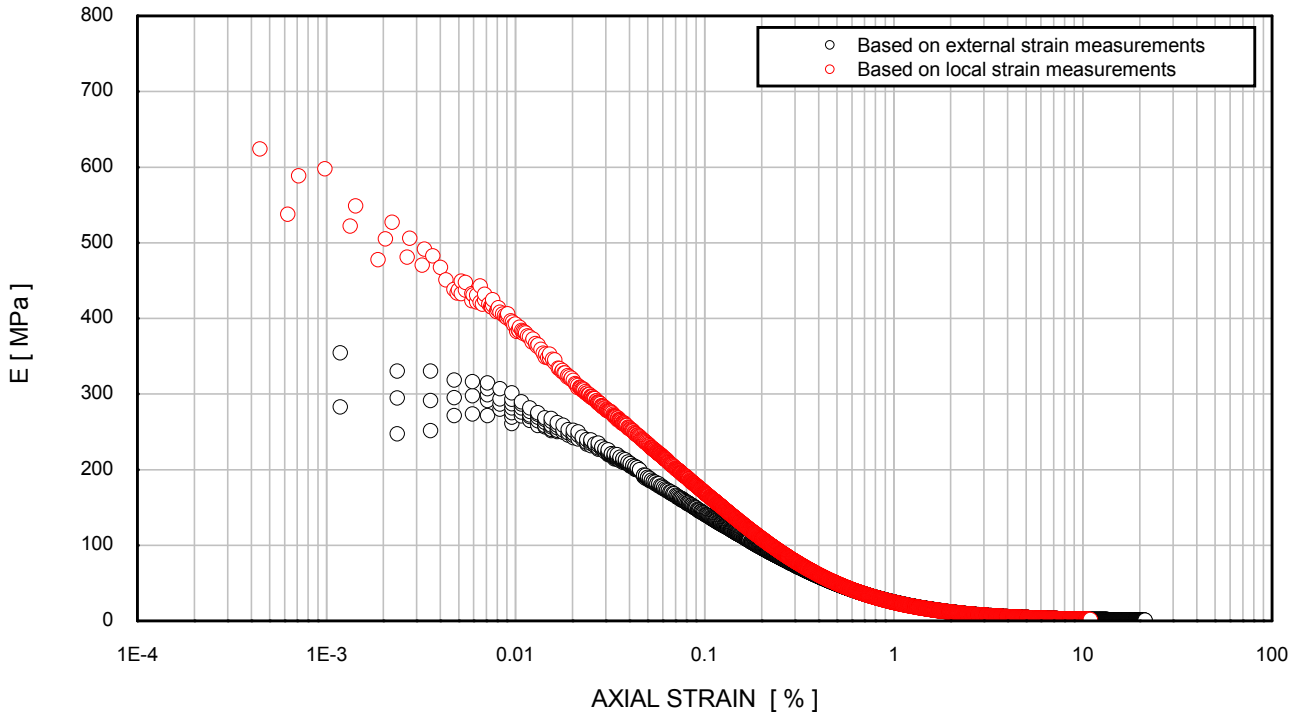


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{peak}	:	249 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	0.78 %	Test No.	:	CIU05
Rate of strain	:	0.50 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

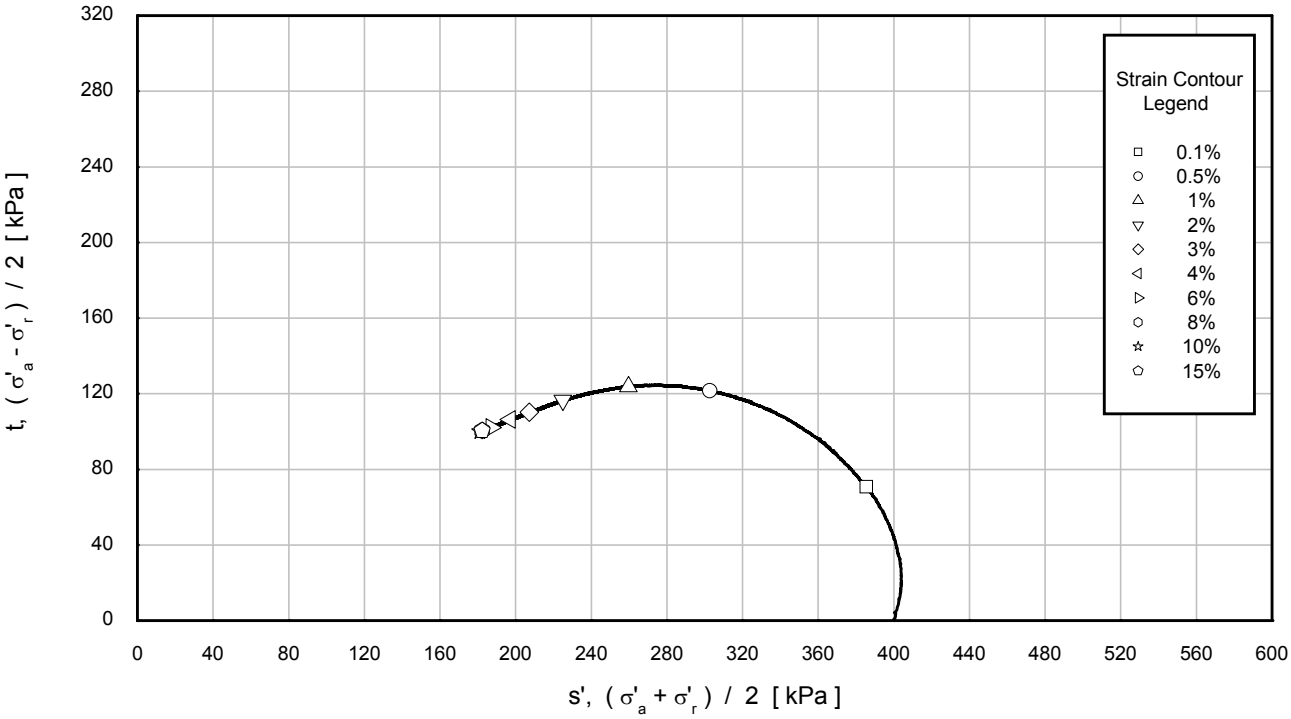


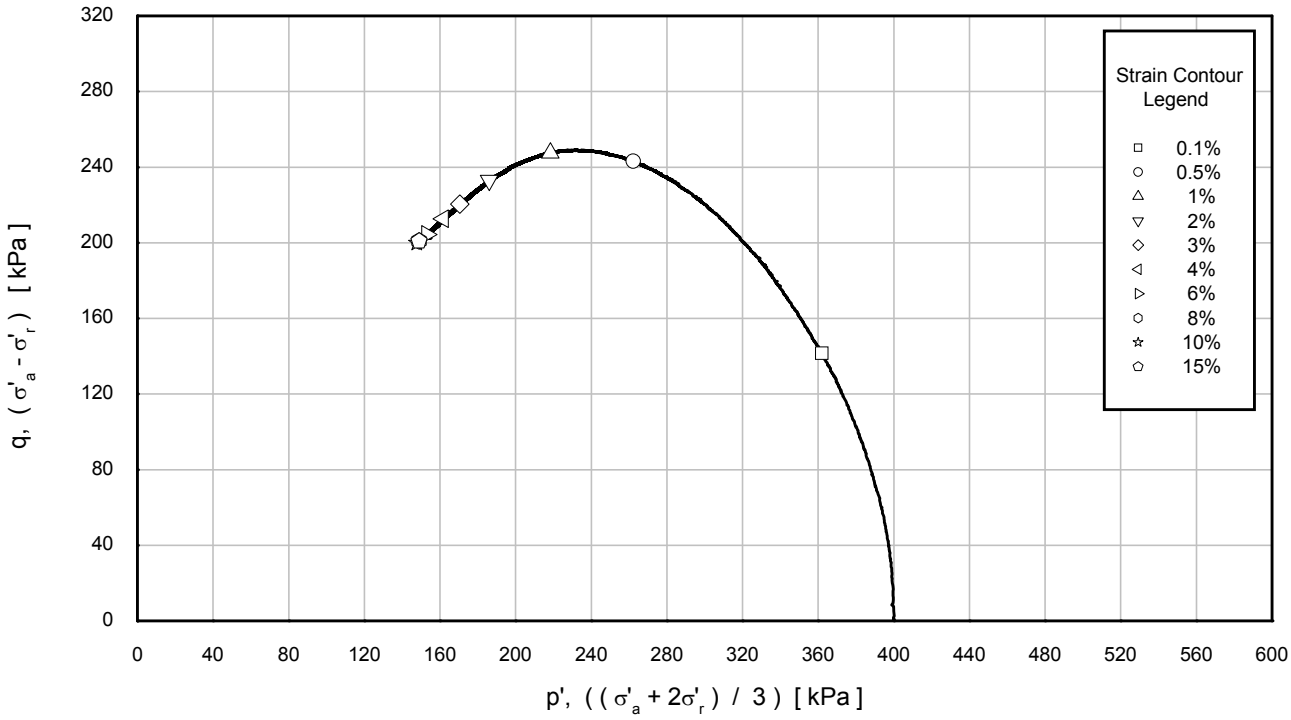


Initial σ'_r	:	400	kPa	Borehole	: Batch
Initial σ'_a	:	400	kPa	Sample	: Tongeren
q_{peak}	:	249	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	0.78	%	Test No.	: CIU05
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

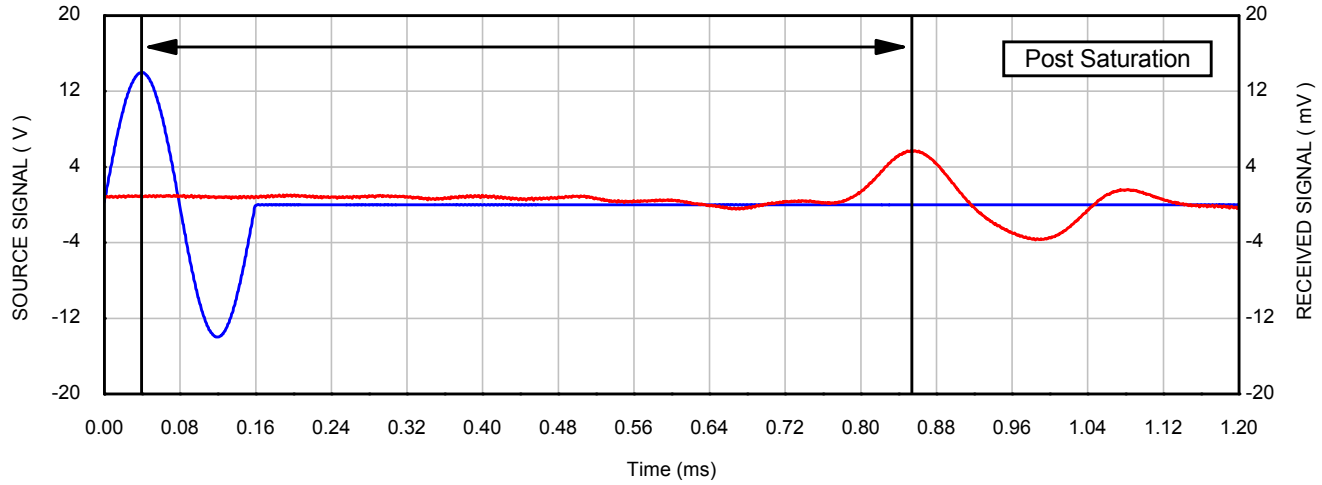


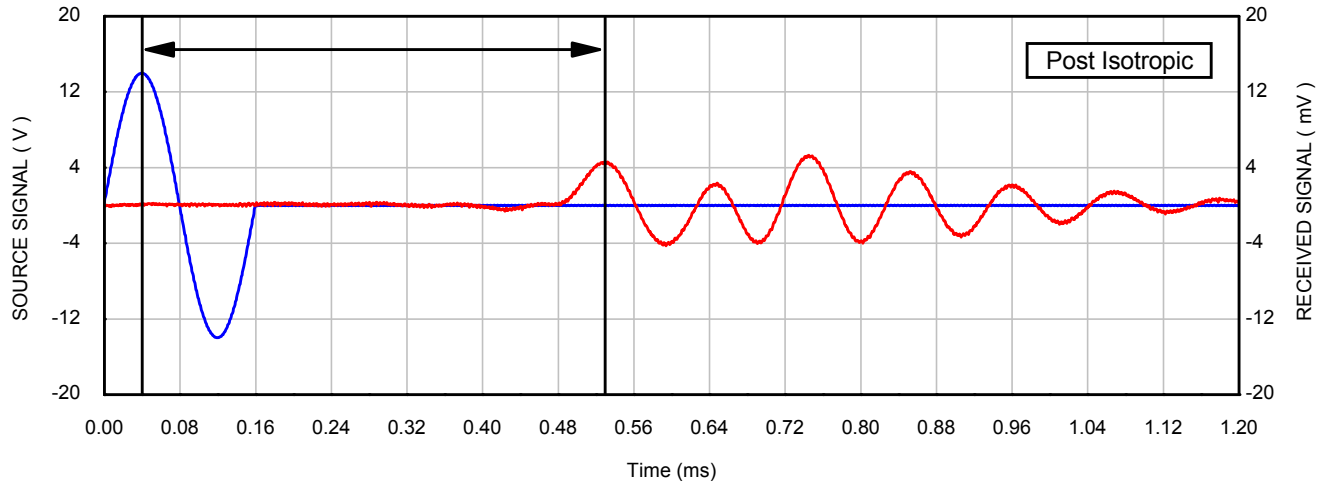


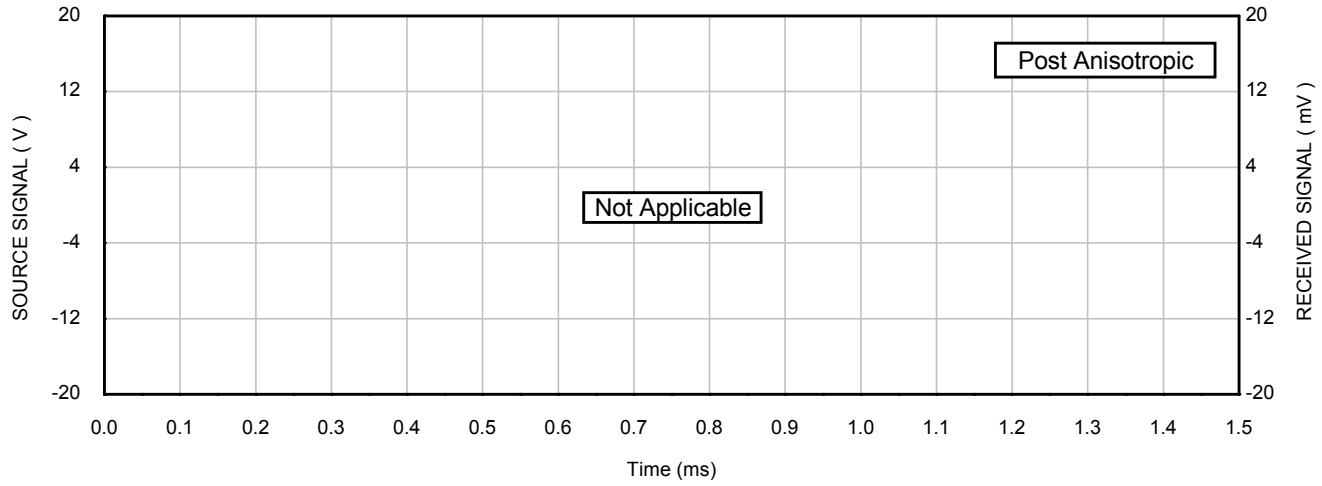
Initial σ'_r	:	400	kPa	Borehole	: Batch
Initial σ'_a	:	400	kPa	Sample	: Tongeren
q_{peak}	:	249	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	0.78	%	Test No.	: CIU05
Rate of strain	:	0.50	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA







Source Signal
Received Signal

Borehole	:	Batch
Sample	:	Tongeren
Depth [m]	:	--
Test No.	:	CIU05

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SVH BENDER ELEMENT DETERMINATIONS (PEAK TO PEAK)

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / Tongeren_Batch_CU.XLS
Template Issue: 2
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

VISUAL DESCRIPTION
Dark grey fine SAND.

GENERAL	
Date test started	06/08/2015
Type of sample	Recompacted
Specimen orientation	Vertical
Type of drains fitted	One end

INITIAL		
Diameter	(mm)	72.1
Length	(mm)	135.0
Moisture content	(%)	10.0
Bulk density	(Mg/m³)	1.77
Dry density	(Mg/m³)	1.61
Void ratio		0.646
Degree of saturation	(%)	41

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	10
Pore pressure on completion	(kPa)	768
Cell pressure on completion	(kPa)	800
B value achieved		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	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	Tongeren
Sample	Batch
Depth (m)	CIU06

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ER Date: 07/08/2015

Template Issue: 2 Filename: J11286 / EFFECTIV / Tongeren_Batch_CU.XLS

Checked by: PH Date: 07/08/2015

Approved by: PH Date: 07/08/2015

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	800
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	400
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Moisture content	(%)	22.8
Bulk density	(Mg/m³)	2.03
Dry density	(Mg/m³)	1.65
Void ratio		0.603
Degree of saturation	(%)	100
Volumetric strain	(%)	2.59

Mode of failure: Compound failure

Borehole	Tongeren
Sample	Batch
Depth (m)	CIU06

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 07/08/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / Tongeren_Batch_CU.XLS
Date: 07/08/2015
Checked by: PH
Date: 07/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	400
Rate of strain	(%/hour)	0.91
At peak deviator stress		
Corrected deviator stress	(kPa)	282
Membrane correction applied	(kPa)	1.3
Drain correction applied	(kPa)	0
Axial strain	(%)	19.83
Excess pore pressure	(kPa)	262
Major principal effective stress	(kPa)	420
Minor principal effective stress	(kPa)	138
Principal effective stress ratio		3.04
Epsilon 50 (ε 50)	(%)	0.30
Secant modulus (E50) at ε 50	(kPa)	47302
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	263
Membrane correction applied	(kPa)	0.7
Drain correction applied	(kPa)	0
Axial strain	(%)	8.83
Excess pore pressure	(kPa)	278
Major principal effective stress	(kPa)	386
Minor principal effective stress	(kPa)	122
Principal effective stress ratio		3.16
At 10% axial strain		
Corrected deviator stress	(kPa)	268
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	10.00
Excess pore pressure	(kPa)	275
Major principal effective stress	(kPa)	393
Minor principal effective stress	(kPa)	125
Principal effective stress ratio		3.15

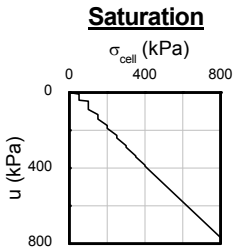
FINAL CONDITIONS		
Moisture content	(%)	22.8
Bulk density	(Mg/m³)	2.03
Dry density	(Mg/m³)	1.65

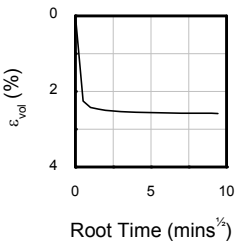
Borehole	Tongeren
Sample	Batch
Depth (m)	CIU06

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

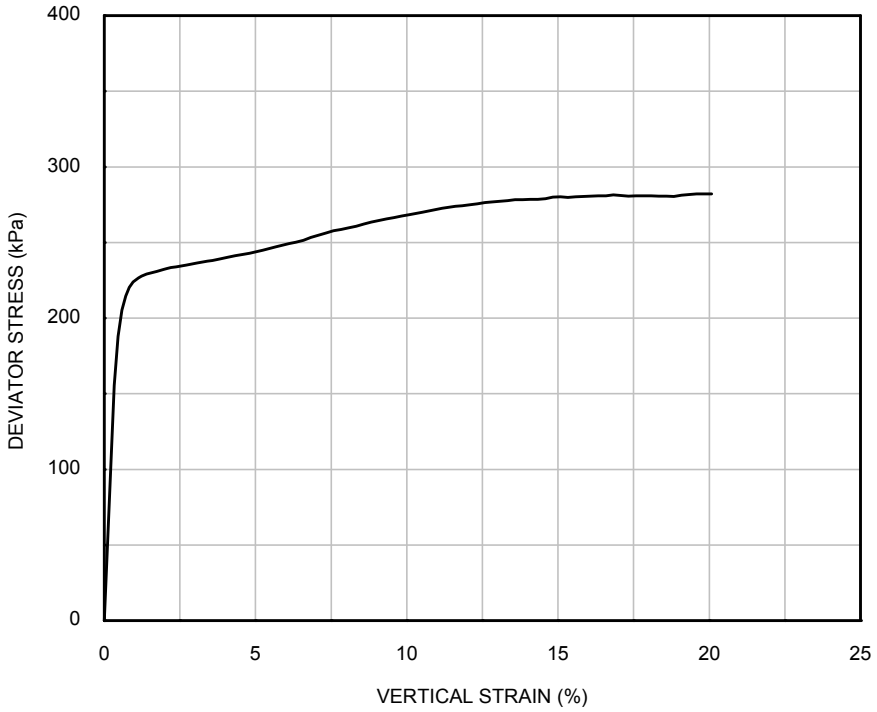
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

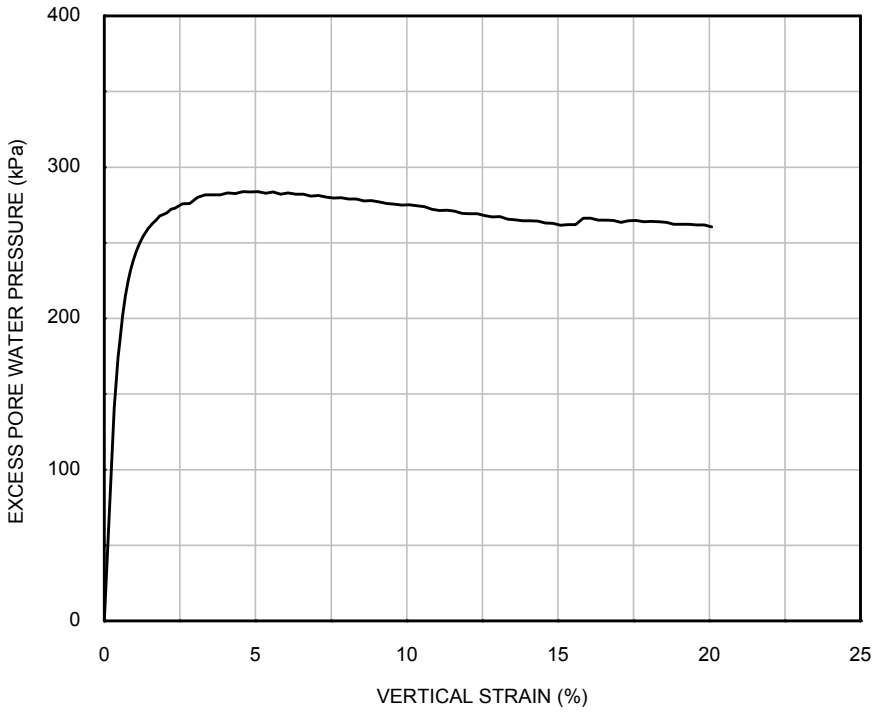
Drawn by: ER Date: 07/08/2015
Filename: J11286 \ EFFECTIV \ Tongeren_Batch_CU.OPJ
Template Issue: 4.1
Date : 07/08/2015
Checked by: PH
Date : 07/08/2015
Approved by: PH





Consolidation

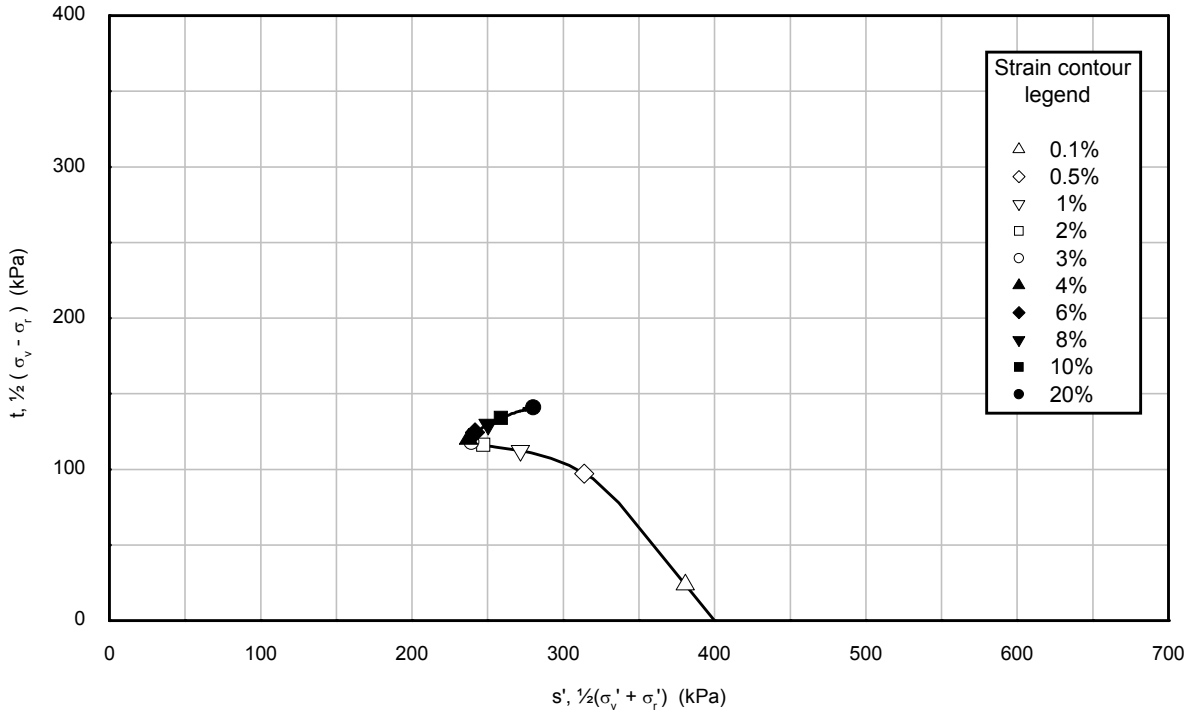


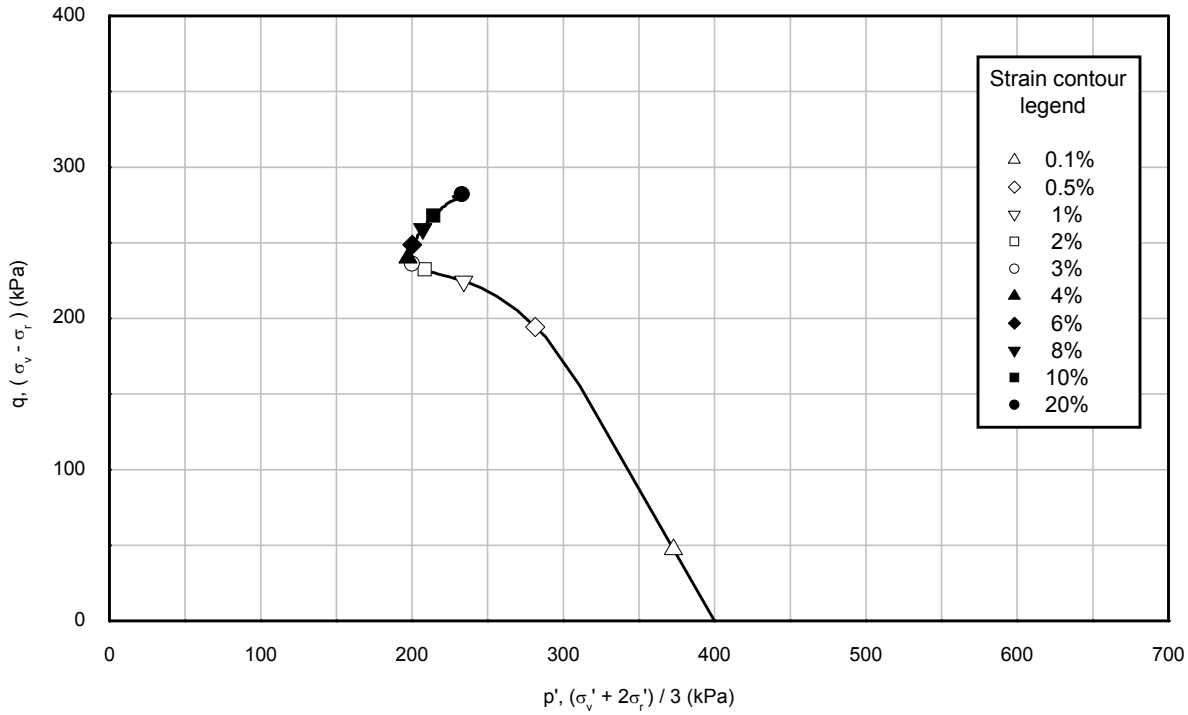


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	400	400	Tongeren	Batch	CIU06

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	400	400	Tongeren	Batch	CIU06

Drawn by: ER Date: 07/08/2015

Filename: J11286 \ EFFECTIV \ Tongeren_Batch_CU.OPJ

Template Issue: 4.1

Date : 07/08/2015

Checked by: PH

Date : 07/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength dark grey CLAY with pockets of silt.

GENERAL	
Date test started	30/06/2015
Type of sample	Undisturbed
Type of drains fitted	Radial (spiral) & one end

INITIAL		
Diameter	[mm]	71.6
Length	[mm]	145.9
Moisture content	[%]	24.6
Bulk density	[Mg/m³]	1.97
Dry density	[Mg/m³]	1.58
Void ratio	[-]	0.708
Degree of saturation	[%]	94
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	500

TESTING PROCEDURES USED	
Specimen Set-up	BS1377: 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 BS1377: Part 8: 1990 Clause 5.3
Consolidation - Isotropic	BS1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ BH-WFS1-1_18C_CIUc
Processed by Date	PH 04/08/2015
Checked by Date	LJ 10/08/2015
Approved by Date	DT 12/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Undrained ramp to 800 kPa, 100 kPa thereafter
Differential pressure used	[kPa]	N/A
Cell pressure	[kPa]	1500
Base PWP	[kPa]	1082
Mid height PWP	[kPa]	-
B value achieved	[-]	0.97

S_{VH} BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Peak to Peak		
Distance	[mm]	141.67
Time	[ms]	0.56
Velocity	[m/s]	252.98
Bulk density	[Mg/m^3]	1.97
Frequency	[Hz]	5000.00
G_{max}	[MPa]	126.11

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1500
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	500
Effective axial pressure	[kPa]	500
Deviator stress	[kPa]	0
Volumetric strain	[%]	1.06
External axial strain	[%]	0.22
Local axial strain	[%]	0.08
Local radial strain	[%]	-
Moisture content	[%]	24.0
Bulk density	[Mg/m^3]	1.98
Dry density	[Mg/m^3]	1.60
Void ratio	[-]	0.690
Degree of saturation	[%]	94

TEST IDENTIFICATION	
Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

S_{VH} BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC		
Peak to Peak		
Distance	[mm]	141.35
Time	[ms]	0.53
Velocity	[m/s]	265.20
Bulk density	[Mg/m^3]	1.98
Frequency	[Hz]	5000.00
G_{max}	[MPa]	139.32

TEST IDENTIFICATION	
Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	501
Initial effective axial pressure	[kPa]	501
Rate of strain	[%/hour]	0.10
At peak deviator stress		
Corrected deviator stress	[kPa]	564
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	3.23
Local axial strain	[%]	1.87
Local radial strain	[%]	-
Excess base PWP	[kPa]	192
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	308
Effective axial pressure	[kPa]	873
Principal effective stress ratio	[-]	2.83
ε_{50}	[%]	0.62
Secant modulus (E_{50}) at ε_{50}	[kPa]	45539
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	552
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	2.88
Local axial strain	[%]	1.66
Local radial strain	[%]	-
Excess base PWP	[kPa]	205
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	296
Effective axial pressure	[kPa]	848
Principal effective stress ratio	[-]	2.87
At 10% axial strain		
Corrected deviator stress	[kPa]	341
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	0.00
Local radial strain	[%]	-
Excess base PWP	[kPa]	117
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	384
Effective axial pressure	[kPa]	725
Principal effective stress ratio	[-]	1.89

TEST IDENTIFICATION	
Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

At 0.01% axial strain		
Corrected deviator stress	[kPa]	72
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.05
Local axial strain	[%]	0.01
Local radial strain	[%]	-
Excess base PWP	[kPa]	43
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	458
Effective axial pressure	[kPa]	530
Principal effective stress ratio	[-]	1.16
At 0.1% axial strain		
Corrected deviator stress	[kPa]	185
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.23
Local axial strain	[%]	0.10
Local radial strain	[%]	-
Excess base PWP	[kPa]	119
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	381
Effective axial pressure	[kPa]	566
Principal effective stress ratio	[-]	1.48

TEST IDENTIFICATION	
Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

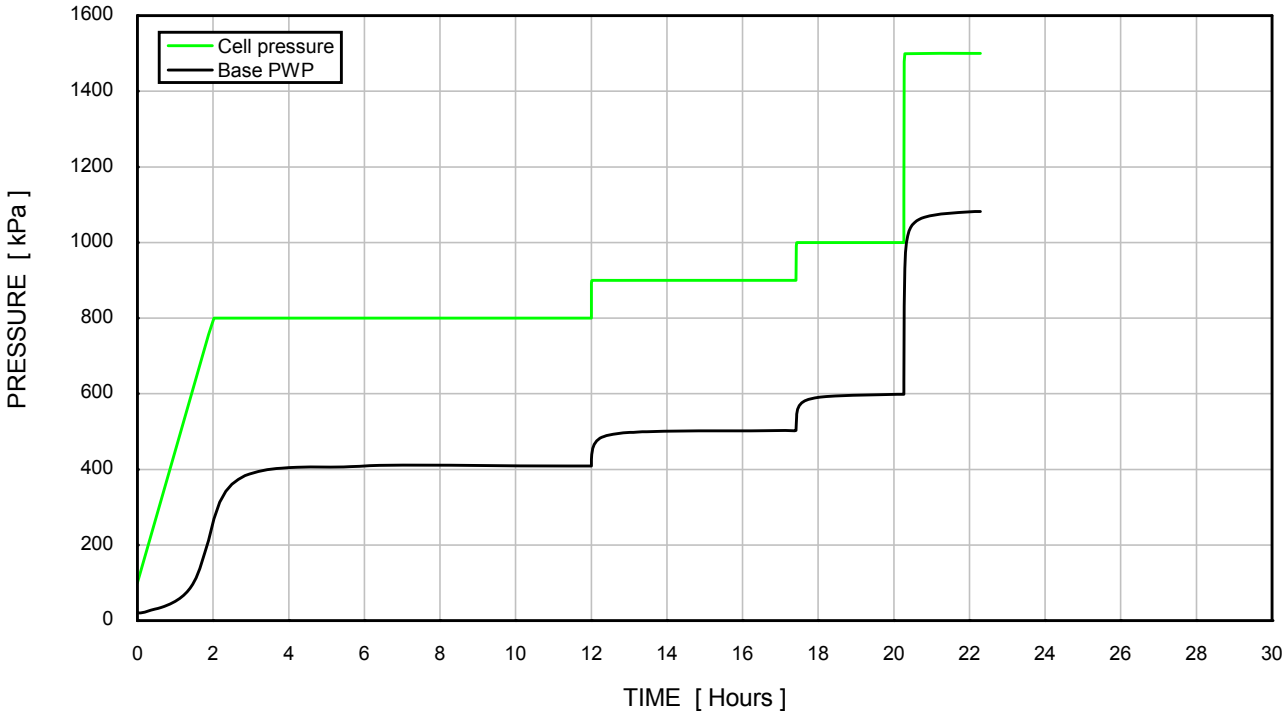
Moisture content	[%]	24.0
Bulk density	[Mg/m³]	1.98
Dry density	[Mg/m³]	1.60

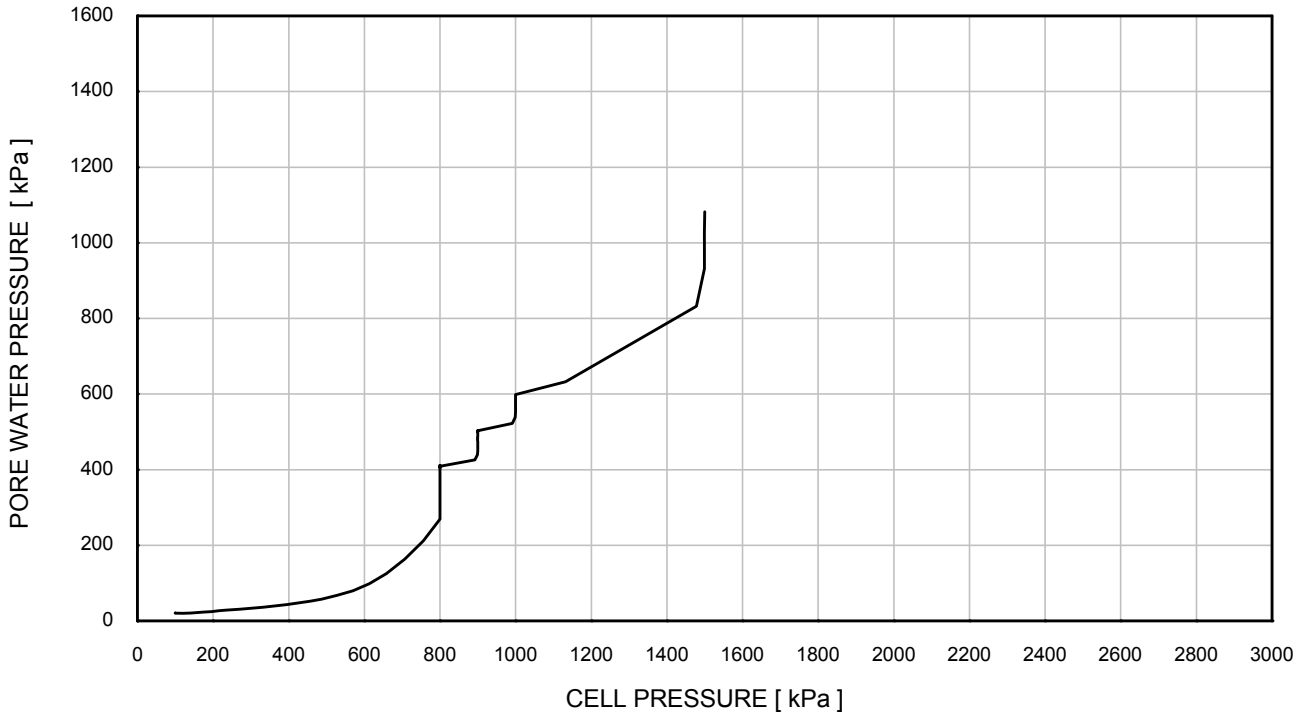
TEST IDENTIFICATION

Borehole	BH-WFS1-1
Sample	18WAXC
Depth [m]	52.29
Test number	234

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

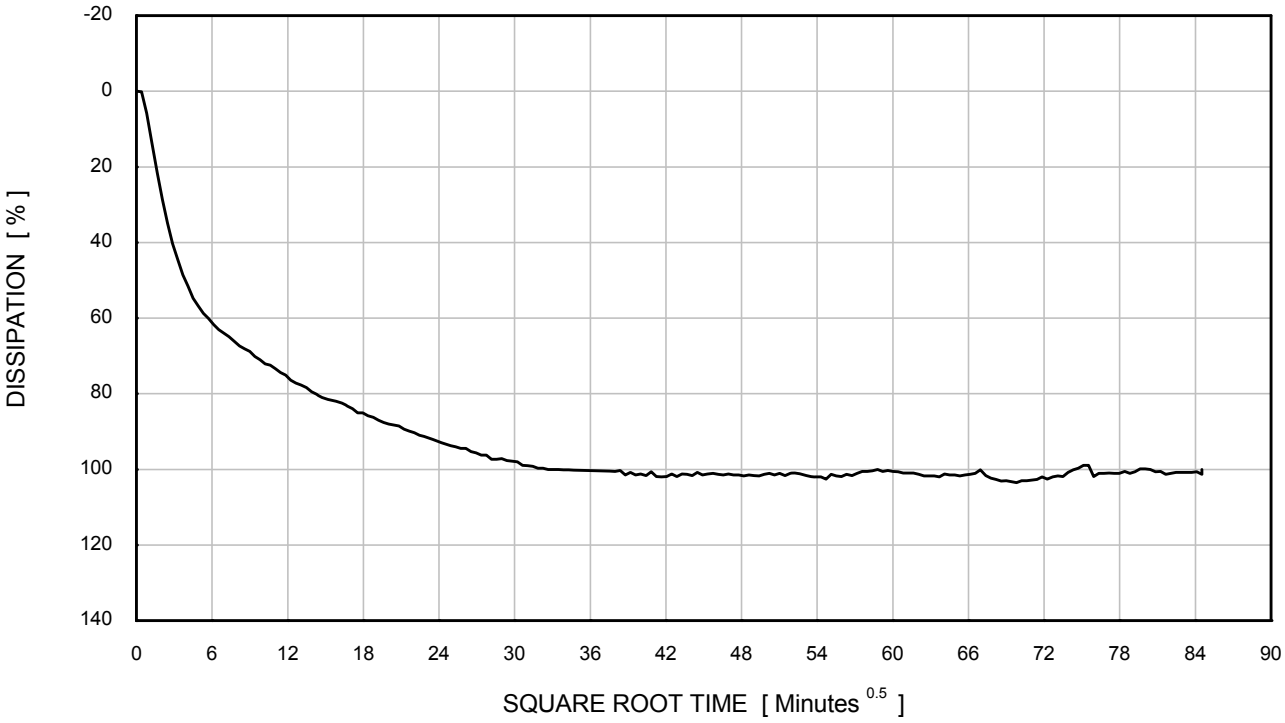


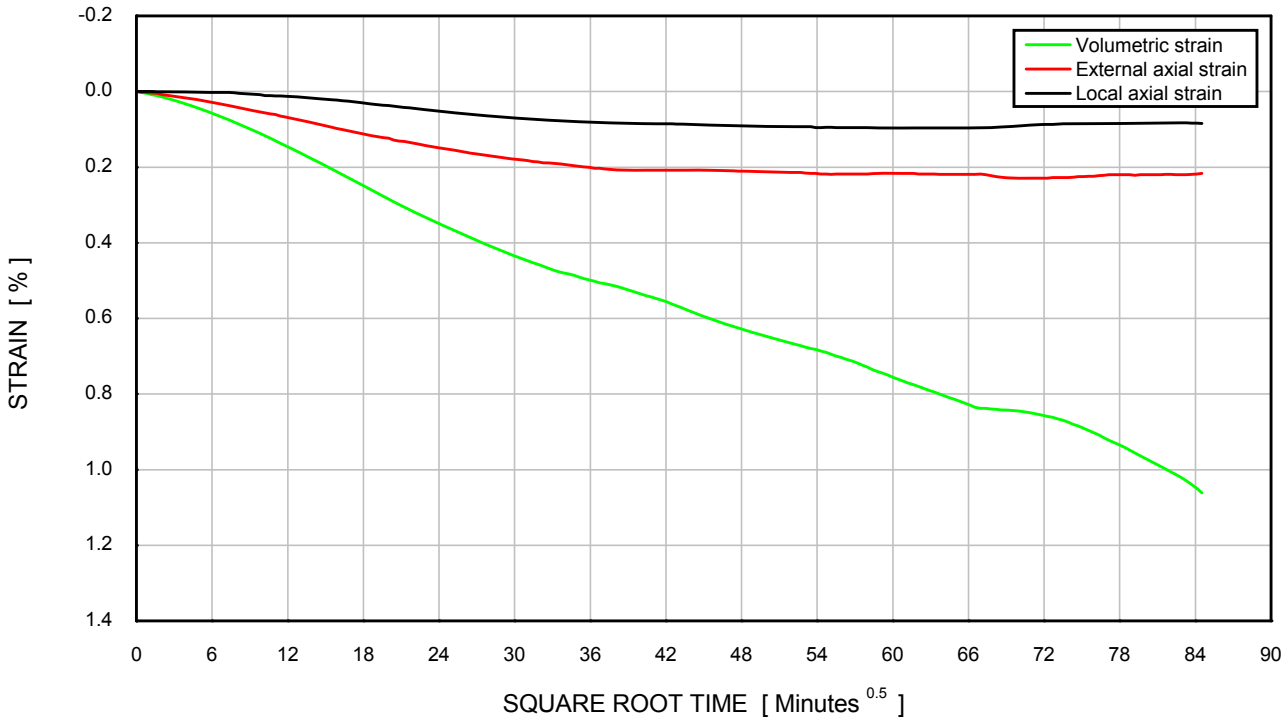


B value	: 0.97	Borehole	: BH-WFS1-1
Initial σ'_r	: 79 kPa	Sample	: 18WAXC
Initial σ'_a	: 80 kPa	Depth [m]	: 52.29
Final σ'_r	: 418 kPa	Test No.	: 234
Final σ'_a	: 418 kPa		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
SATURATION STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

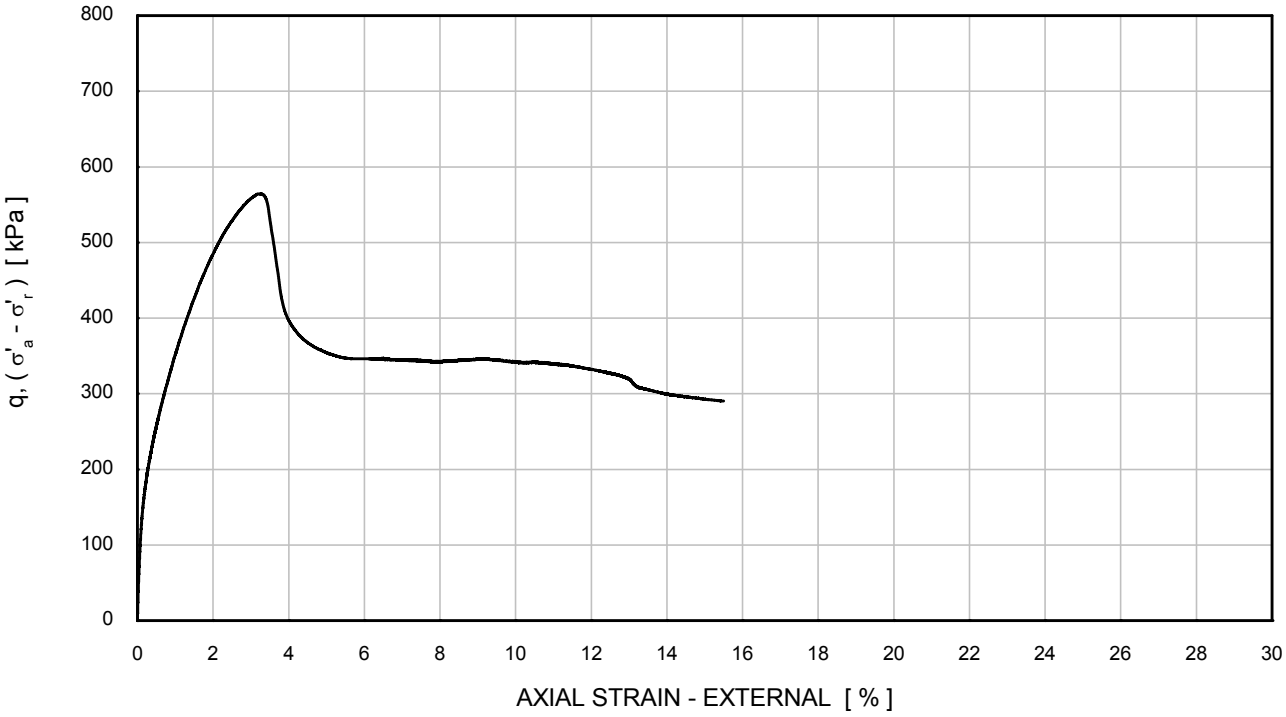


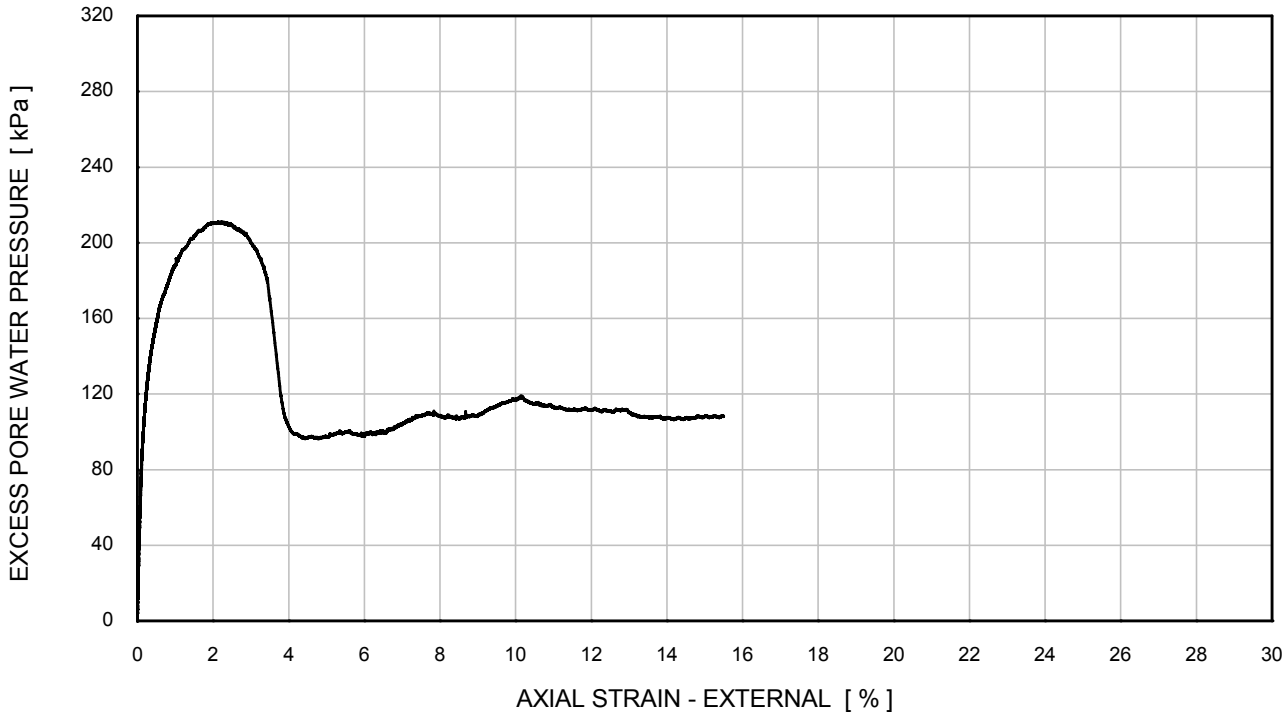


σ'_{rc}	: 500 kPa	Borehole	: BH-WFS1-1
σ'_{ac}	: 500 kPa	Sample	: 18WAXC
		Depth [m]	: 52.29
		Test No.	: 234

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

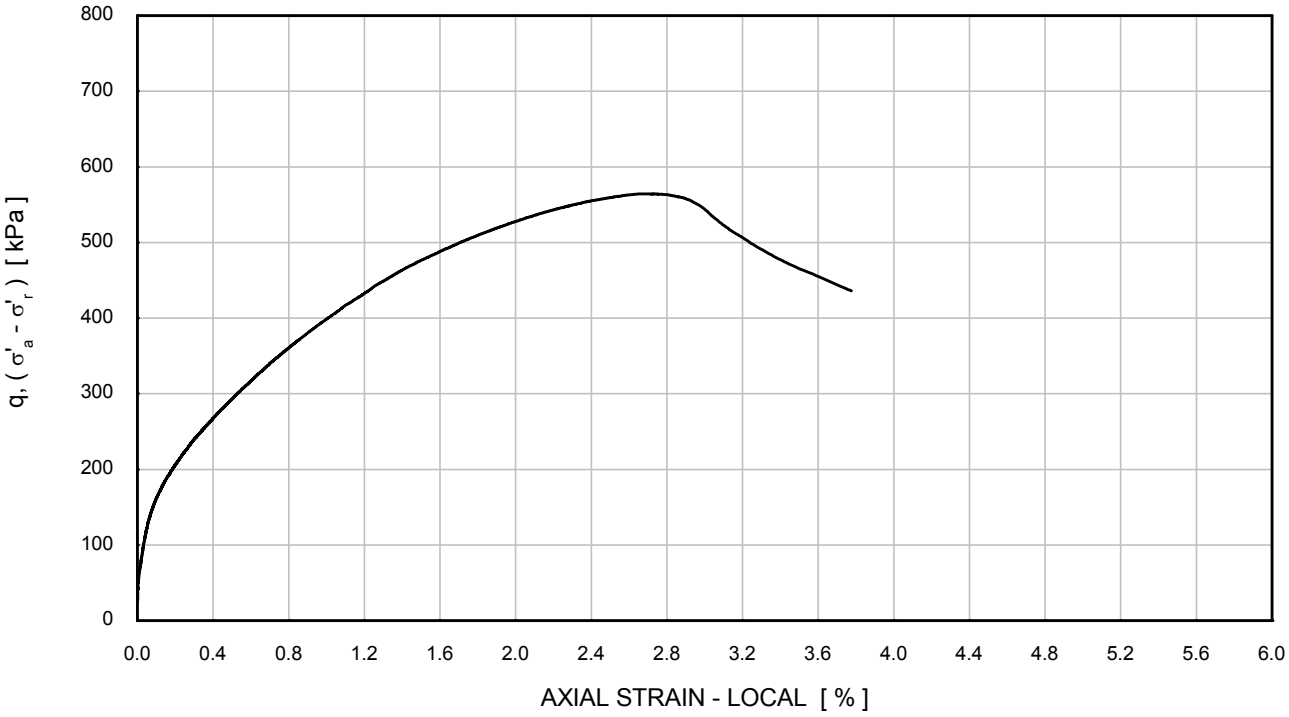


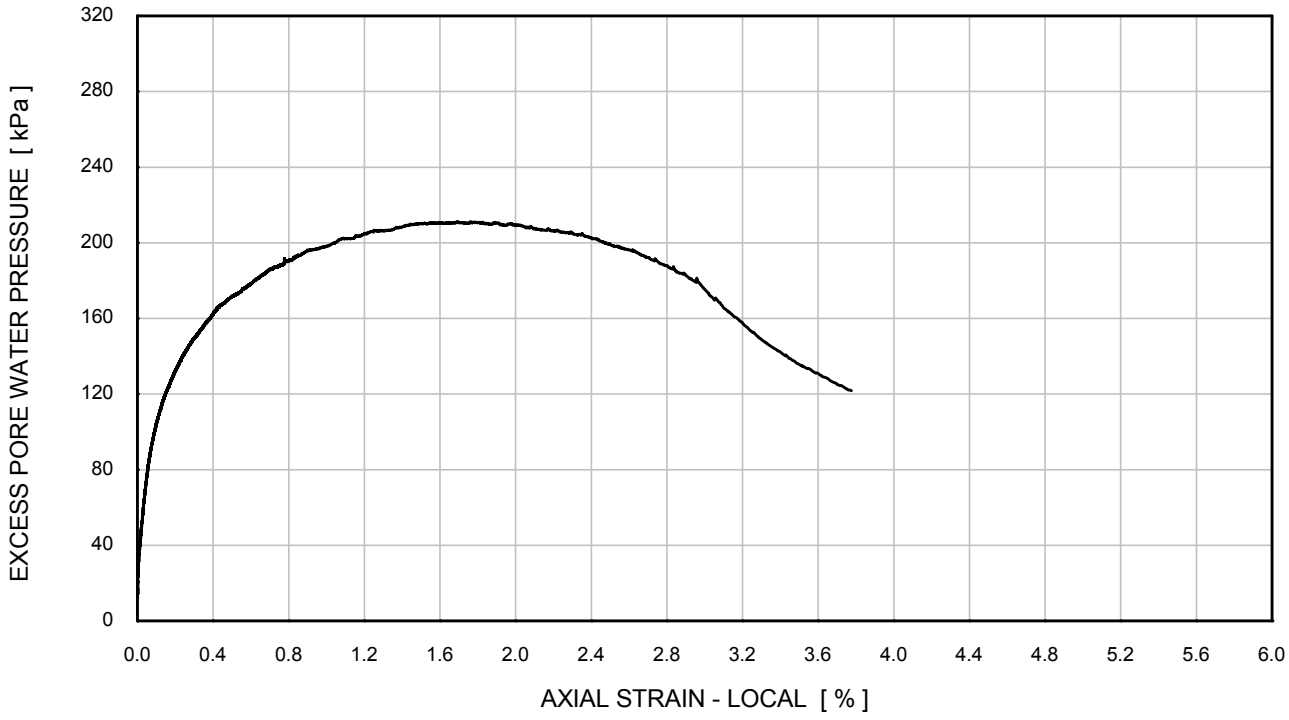


Initial σ'_r	: 501 kPa	Borehole	: BH-WFS1-1
Initial σ'_a	: 501 kPa	Sample	: 18WAXC
q_{peak}	: 564 kPa	Depth [m]	: 52.29
Ext. ε at q_{peak}	: 3.23 %	Test No.	: 234
Rate of strain	: 0.10 %/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

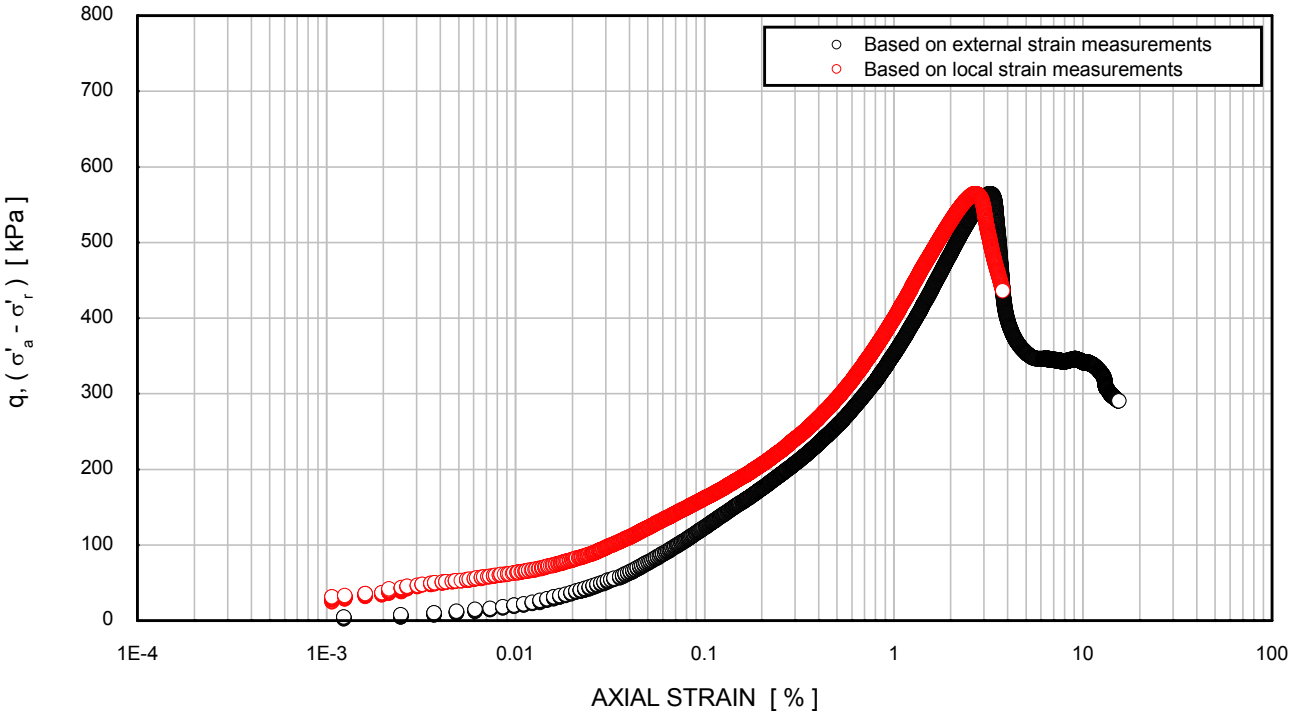


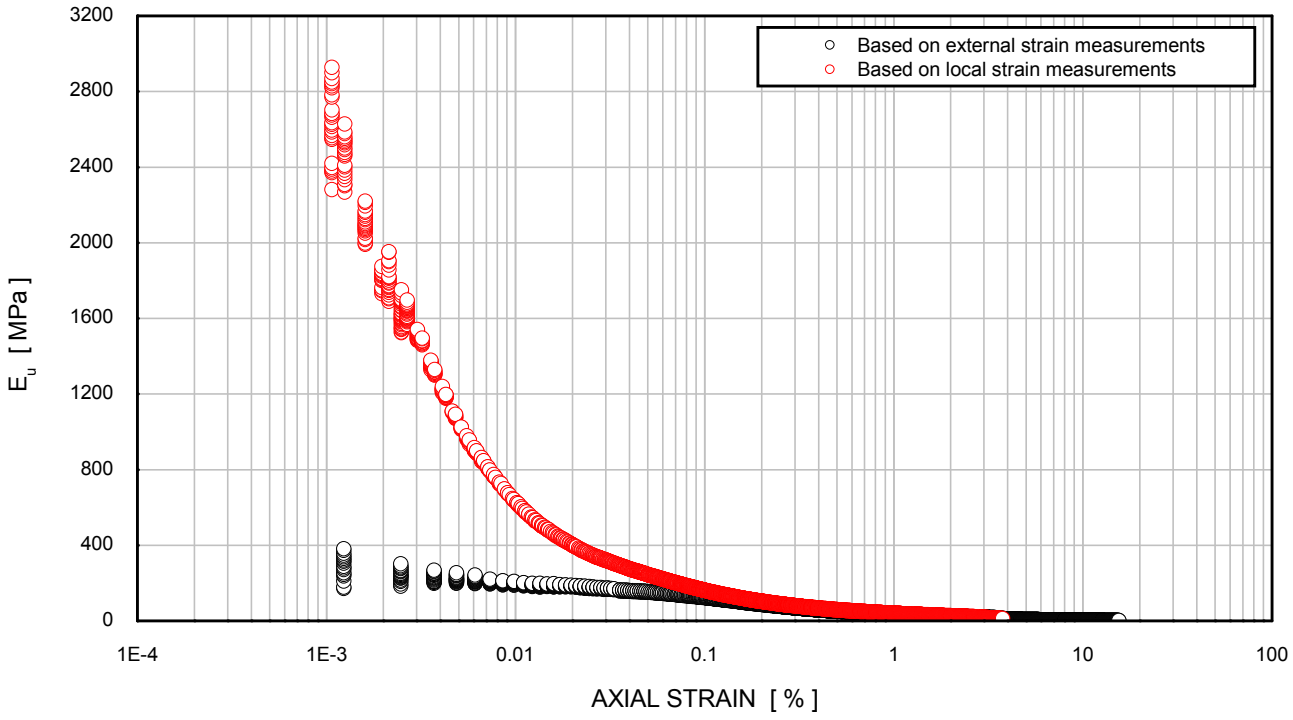


Initial σ'_r	:	501 kPa	Borehole	:	BH-WFS1-1
Initial σ'_a	:	501 kPa	Sample	:	18WAXC
q_{peak}	:	564 kPa	Depth [m]	:	52.29
Ext. ε at q_{peak}	:	3.23 %	Test No.	:	234
Rate of strain	:	0.10 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

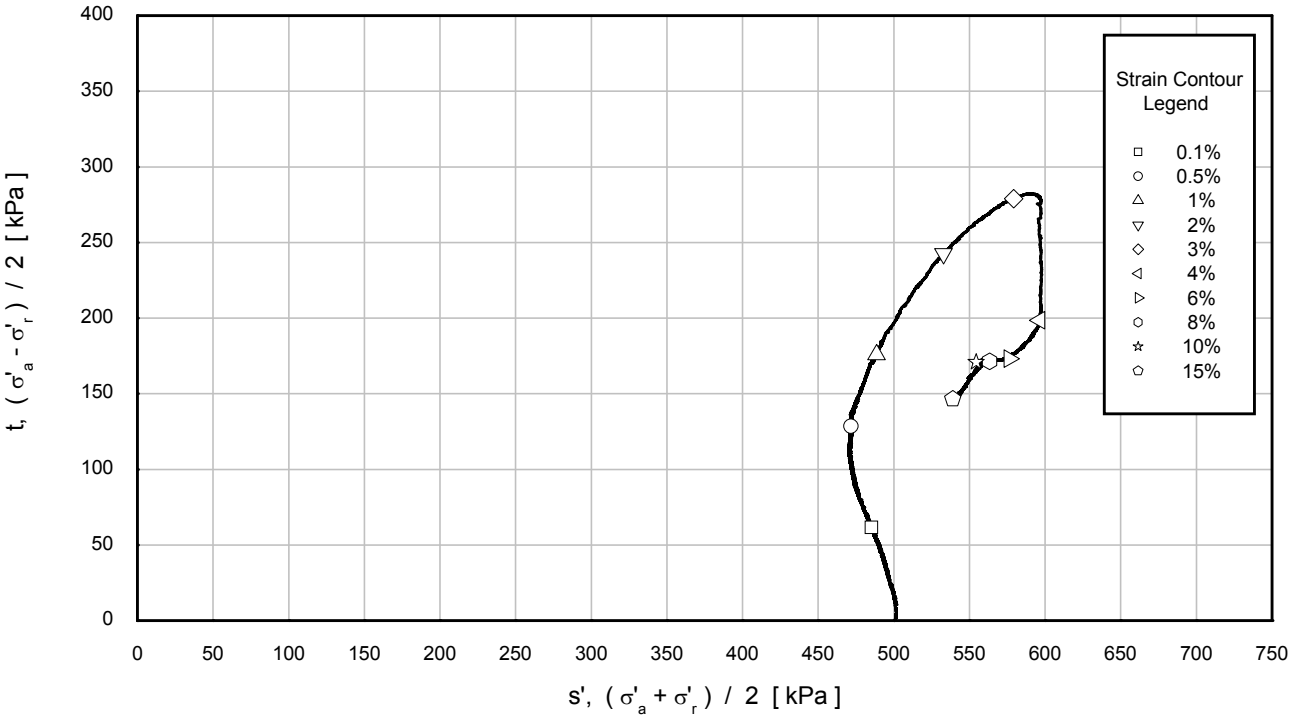


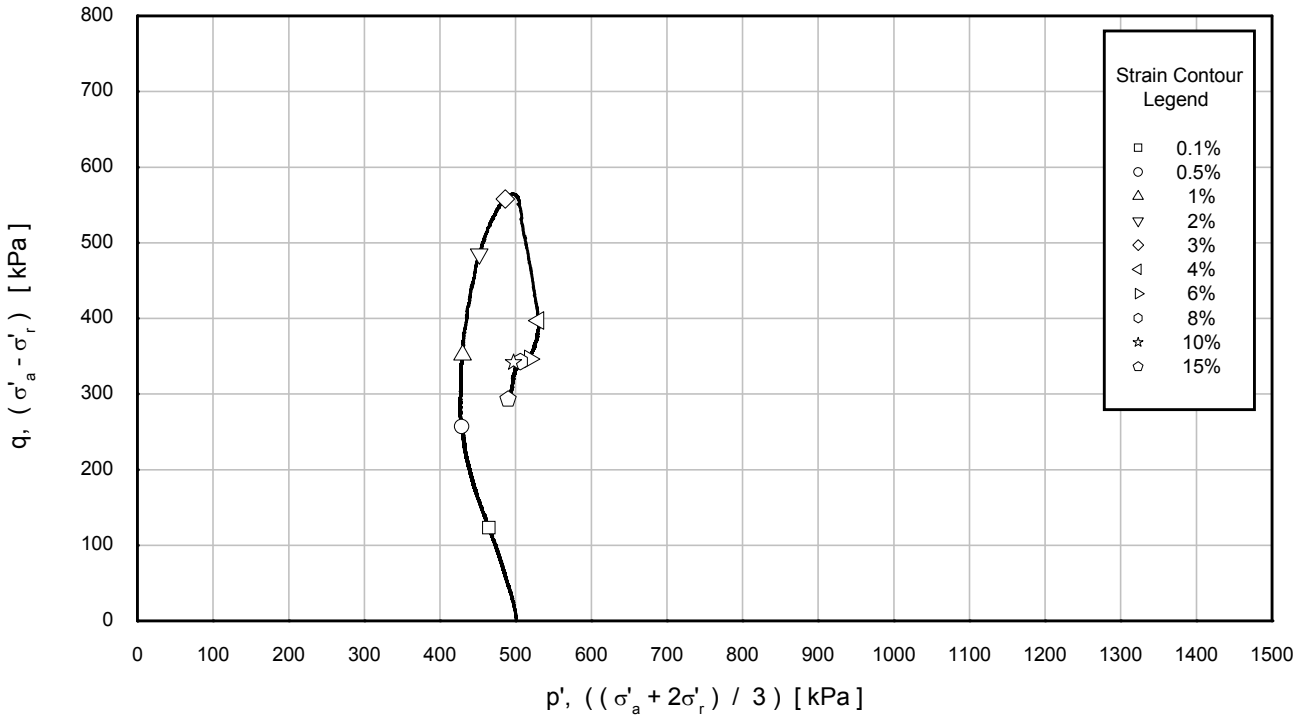


Initial σ'_r	:	501 kPa	Borehole	:	BH-WFS1-1
Initial σ'_a	:	501 kPa	Sample	:	18WAXC
q_{peak}	:	564 kPa	Depth [m]	:	52.29
Ext. ε at q_{peak}	:	3.23 %	Test No.	:	234
Rate of strain	:	0.10 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

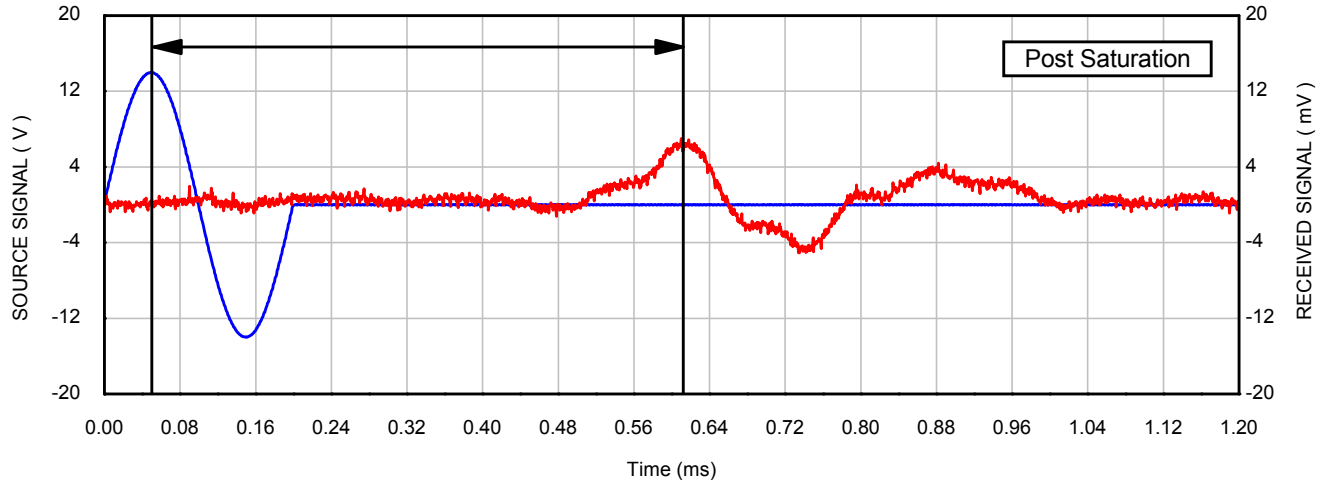


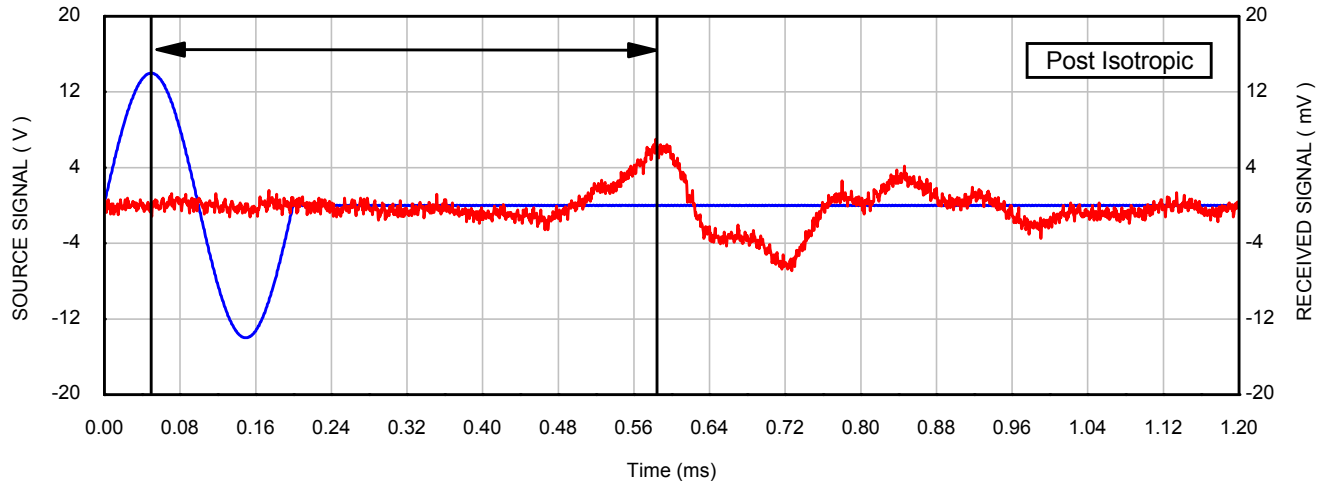


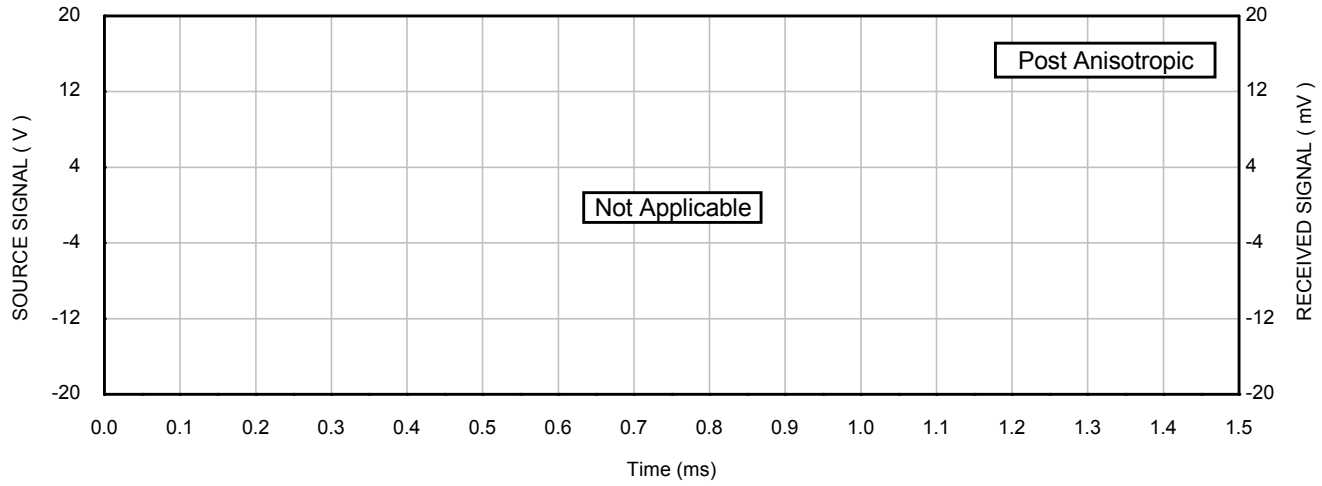
Initial σ'_r	:	501	kPa	Borehole	: BH-WFS1-1
Initial σ'_a	:	501	kPa	Sample	: 18WAXC
q_{peak}	:	564	kPa	Depth [m]	: 52.29
Ext. ε at q_{peak}	:	3.23	%	Test No.	: 234
Rate of strain	:	0.10	%/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA







Source Signal
Received Signal

Borehole	: BH-WFS1-1
Sample	: 18WAXC
Depth [m]	: 52.29
Test No.	: 234

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SVH BENDER ELEMENT DETERMINATIONS (PEAK TO PEAK)

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 19/06/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS1-4_20WAXB_CU.XLS
Template Issue: 2
Date: 23/06/2015
Checked by: PH
Date: 23/06/2015
Approved by: PH

VISUAL DESCRIPTION
Extremely high strength dark grey CLAY with pockets of light grey fine sand.

GENERAL	
Date test started	12/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	72.0
Length	(mm)	139.9
Moisture content	(%)	24.9
Bulk density	(Mg/m³)	2.01
Dry density	(Mg/m³)	1.61
Void ratio		0.675
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	50
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	602
Cell pressure on completion	(kPa)	1000
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	BH-WFS1-4
Sample	20WAXB
Depth (m)	40.56

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 19/06/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS1-4_20WAXB_CU.XLS
Date: 23/06/2015
Checked by: PH
Approved by: PH
Date: 23/06/2015

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	1000
Back pressure	(kPa)	600
Effective cell pressure	(kPa)	400
Pore pressure on completion	(kPa)	600
Pore pressure dissipation	(%)	100
Moisture content	(%)	24.9
Bulk density	(Mg/m³)	2.01
Dry density	(Mg/m³)	1.61
Void ratio		0.675
Degree of saturation	(%)	100
Volumetric strain	(%)	0.01

Mode of failure: Compound Failure

Borehole	BH-WFS1-4
Sample	20WAXB
Depth (m)	40.56

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 19/06/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS1-4_20WAXB_CU.XLS
Template Issue: 2
Date: 23/06/2015
Checked by: PH
Approved by: PH
Date: 23/06/2015

SHEARING		
Initial pore pressure	(kPa)	600
Initial effective cell pressure	(kPa)	400
Rate of strain	(%/hour)	0.42
At peak deviator stress		
Corrected deviator stress	(kPa)	671
Membrane correction applied	(kPa)	0.5
Drain correction applied	(kPa)	0
Axial strain	(%)	5.18
Excess pore pressure	(kPa)	111
Major principal effective stress	(kPa)	960
Minor principal effective stress	(kPa)	289
Principal effective stress ratio		3.32
Epsilon 50 (ε 50)	(%)	1.66
Secant modulus (E50) at ε 50	(kPa)	20197
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	593
Membrane correction applied	(kPa)	0.3
Drain correction applied	(kPa)	0
Axial strain	(%)	3.68
Excess pore pressure	(kPa)	175
Major principal effective stress	(kPa)	818
Minor principal effective stress	(kPa)	225
Principal effective stress ratio		3.64
At 10% axial strain		
Corrected deviator stress	(kPa)	450
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	10.00
Excess pore pressure	(kPa)	-21
Major principal effective stress	(kPa)	871
Minor principal effective stress	(kPa)	421
Principal effective stress ratio		2.07

FINAL CONDITIONS		
Moisture content	(%)	24.9
Bulk density	(Mg/m³)	2.01
Dry density	(Mg/m³)	1.61

Borehole	BH-WFS1-4
Sample	20WAXB
Depth (m)	40.56

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ER Date: 19/06/2015

Template Issue: 2

Filename: J11286 / EFFECTIV / BH-WFS1-4_20WAXB_CU.XLS

Checked by: PH Date: 23/06/2015

Approved by: PH Date: 23/06/2015

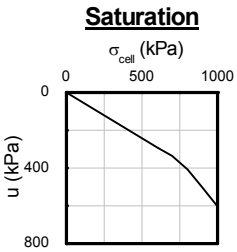
SPECIMEN PHOTOGRAPHS

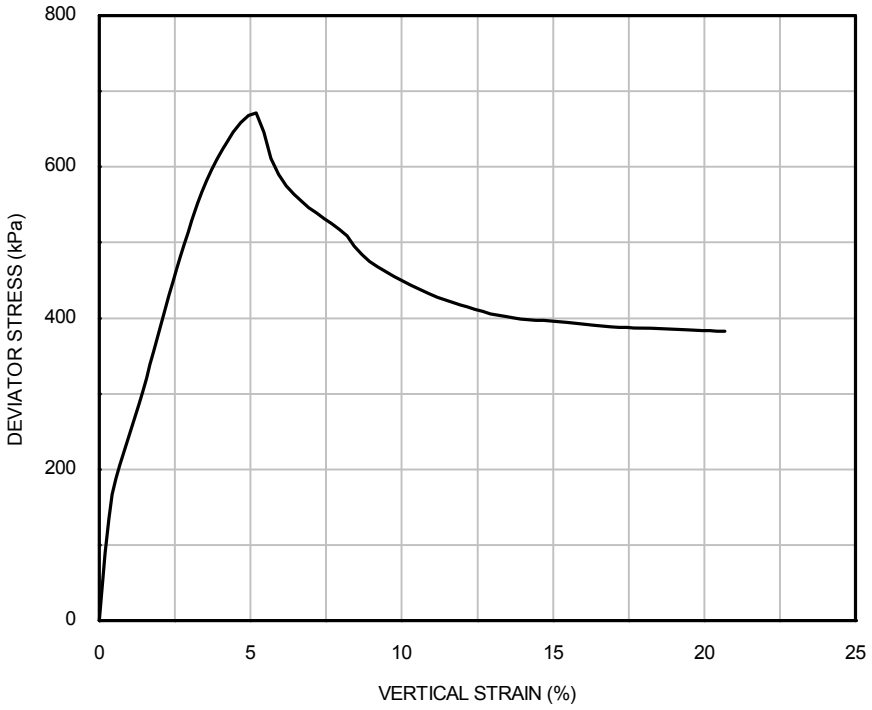
Borehole	BH-WFS1-4
Sample	20WAXB
Depth (m)	40.56

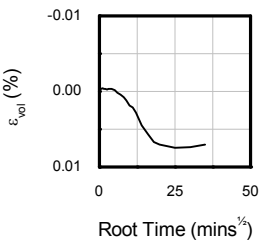
SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

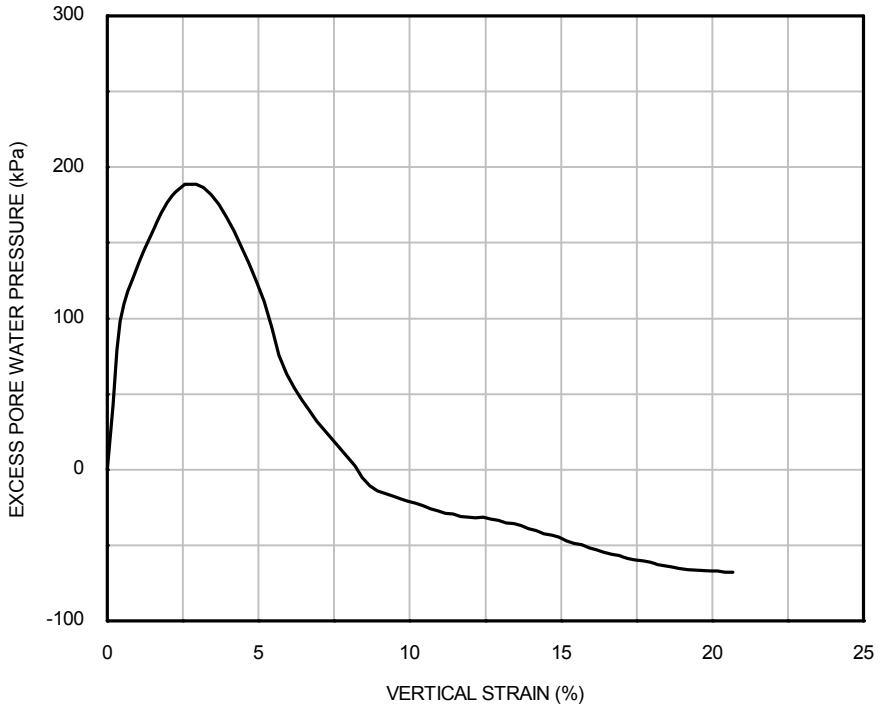
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 19/06/2015
Drawn by: ER
Template Issue: 4.1
Filename: J11286 \ EFFECTIV \ BH-WFS1-4_20WAXB_CU.OPJ
Date : 23/06/2015
Checked by: PH
Date : 23/06/2015
Approved by: PH







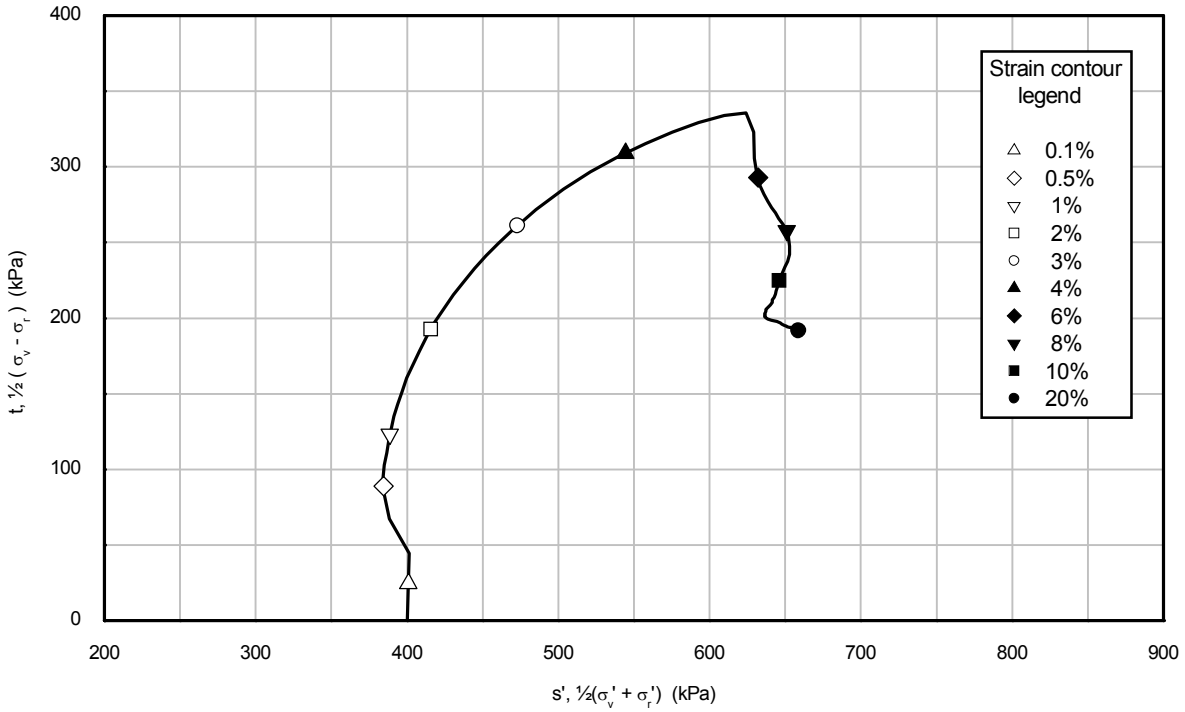


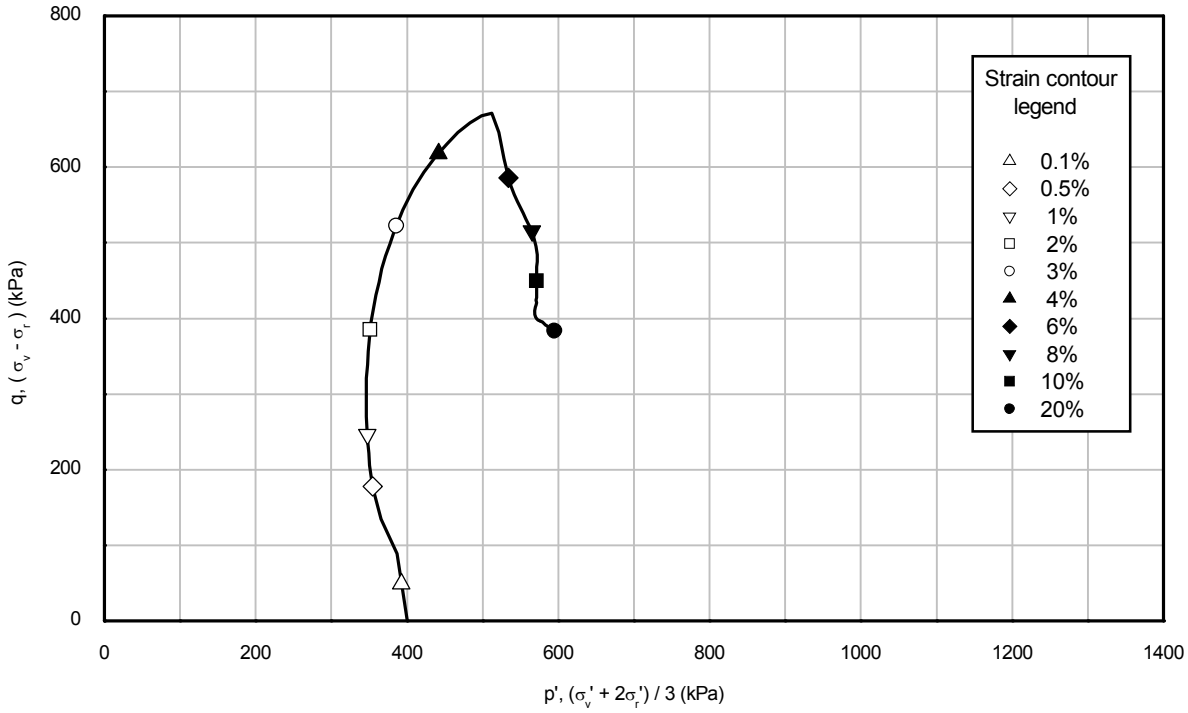
Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	400	400	BH-WFS1-4	20WAXB	40.56

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ER Date: 19/06/2015
Template Issue: 4.1
Filename: J11286 \ EFFECTIV \ BH-WFS1-4_20WAXB_CU.OPJ
Date : 23/06/2015
Checked by: PH
Date : 23/06/2015
Approved by: PH





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	400	400	BH-WFS1-4	20WAXB	40.56

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
High strength olive grey fissured CLAY.

GENERAL	
Date test started	30/06/2015
Type of sample	Undisturbed
Type of drains fitted	Radial (spiral) & one end

INITIAL		
Diameter	[mm]	71.6
Length	[mm]	145.9
Moisture content	[%]	44.3
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.23
Void ratio	[-]	1.199
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	215

TESTING PROCEDURES USED	
Specimen Set-up	BS1377: 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 BS1377: Part 8: 1990 Clause 5.3
Consolidation - Isotropic	BS1377: Part 8: 1990 Clause 6
Consolidation - Anisotropic	Not applicable
Shearing	BS1377: Part 8: 1990 Clause 7
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ BH-WFS2-6_18D_CIUc
Processed by Date	PH 04/08/2015
Checked by Date	LJ 10/08/2015
Approved by Date	DT 12/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Undrained ramp to 800 kPa, 100 kPa thereafter
Differential pressure used	[kPa]	N/A
Cell pressure	[kPa]	1480
Base PWP	[kPa]	1313
Mid height PWP	[kPa]	-
B value achieved	[-]	1.00

S_{VH} BENDER ELEMENT DETERMINATIONS - POST SATURATION		
Peak to Peak		
Distance	[mm]	141.66
Time	[ms]	0.74
Velocity	[m/s]	191.17
Bulk density	[Mg/m^3]	1.77
Frequency	[Hz]	5000.00
G_{max}	[MPa]	64.76

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1480
Back pressure	[kPa]	1002
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	480
Effective axial pressure	[kPa]	480
Deviator stress	[kPa]	0
Volumetric strain	[%]	6.64
External axial strain	[%]	1.20
Local axial strain	[%]	0.91
Local radial strain	[%]	-
Moisture content	[%]	38.9
Bulk density	[Mg/m^3]	1.83
Dry density	[Mg/m^3]	1.32
Void ratio	[-]	1.052
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

S_{VH} BENDER ELEMENT DETERMINATIONS - POST ISOTROPIC		
Peak to Peak		
Distance	[mm]	139.91
Time	[ms]	0.62
Velocity	[m/s]	224.57
Bulk density	[Mg/m^3]	1.83
Frequency	[Hz]	5000.00
G_{max}	[MPa]	92.14

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	480
Initial effective axial pressure	[kPa]	480
Rate of strain	[%/hour]	0.10
At peak deviator stress		
Corrected deviator stress	[kPa]	298
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	1.44
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	176
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	304
Effective axial pressure	[kPa]	602
Principal effective stress ratio	[-]	1.98
ε_{50}	[%]	0.16
Secant modulus (E_{50}) at ε_{50}	[kPa]	91284
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	289
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	5.46
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	189
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	291
Effective axial pressure	[kPa]	580
Principal effective stress ratio	[-]	1.99
At 10% axial strain		
Corrected deviator stress	[kPa]	261
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	191
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	289
Effective axial pressure	[kPa]	551
Principal effective stress ratio	[-]	1.90

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

At 0.01% axial strain		
Corrected deviator stress	[kPa]	33
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.02
Local axial strain	[%]	0.01
Local radial strain	[%]	-
Excess base PWP	[kPa]	17
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	463
Effective axial pressure	[kPa]	497
Principal effective stress ratio	[-]	1.07
At 0.1% axial strain		
Corrected deviator stress	[kPa]	128
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.12
Local axial strain	[%]	0.10
Local radial strain	[%]	-
Excess base PWP	[kPa]	75
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	405
Effective axial pressure	[kPa]	533
Principal effective stress ratio	[-]	1.32

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

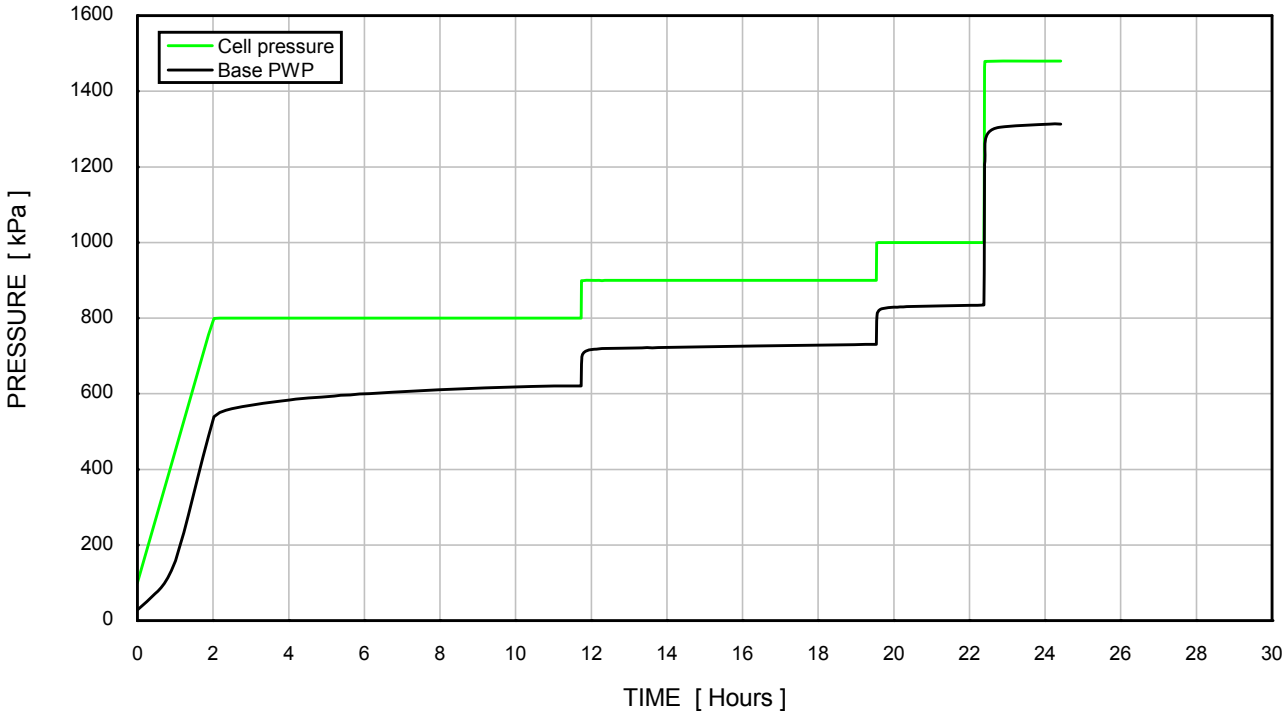
Moisture content	[%]	38.9
Bulk density	[Mg/m³]	1.83
Dry density	[Mg/m³]	1.32

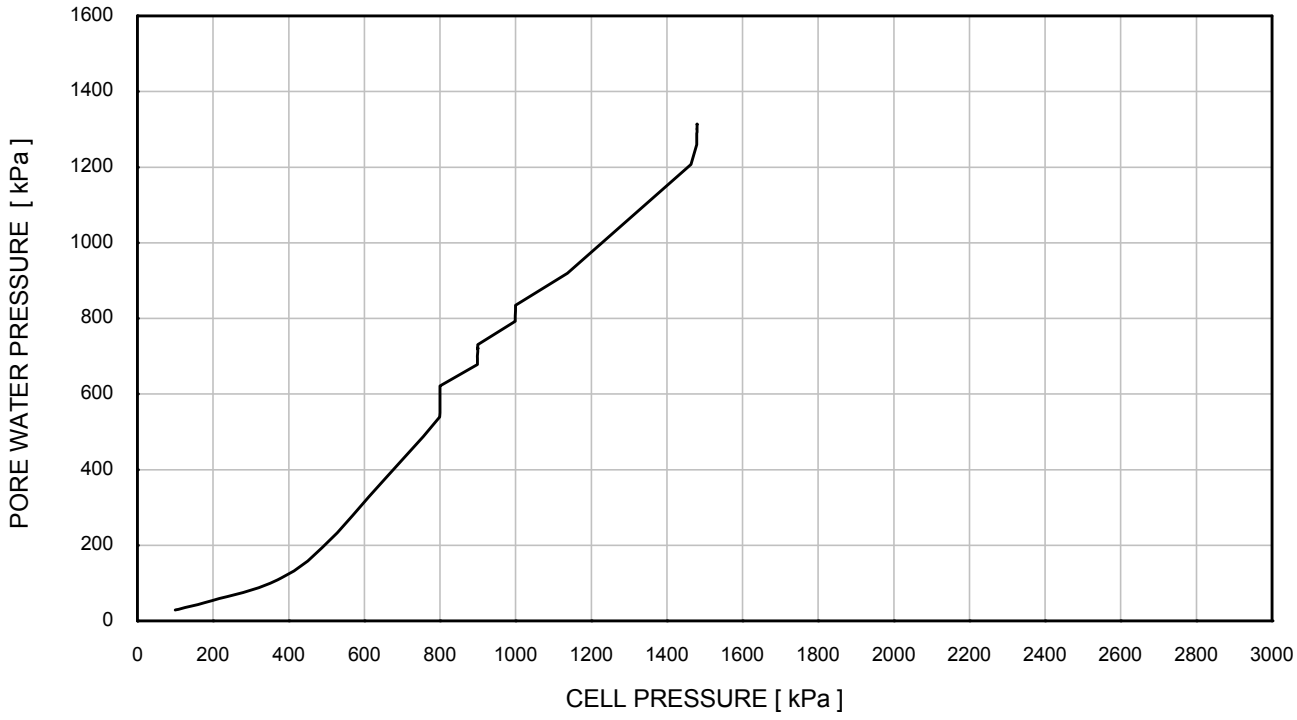
TEST IDENTIFICATION

Borehole	BH-WFS2-6A
Sample	18WAXD
Depth [m]	49.44
Test number	-

SUMMARY OF ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST WITH LOCAL STRAIN MEASUREMENT

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

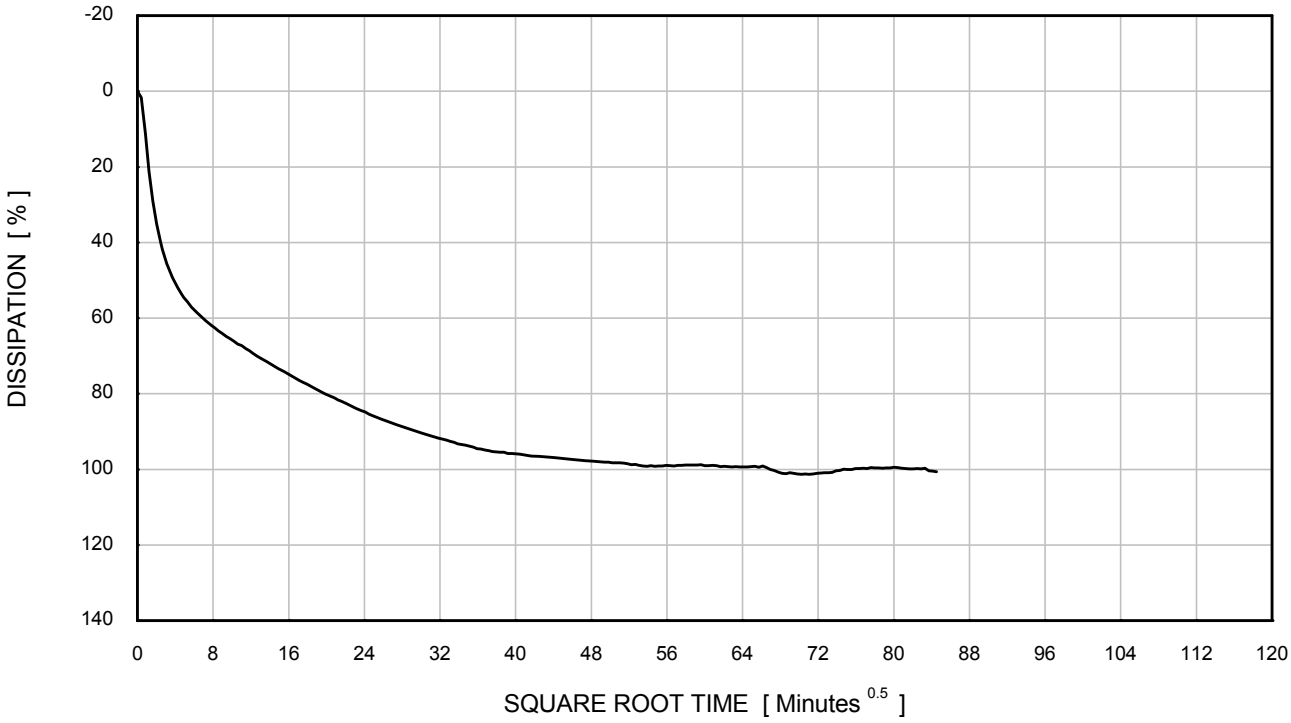


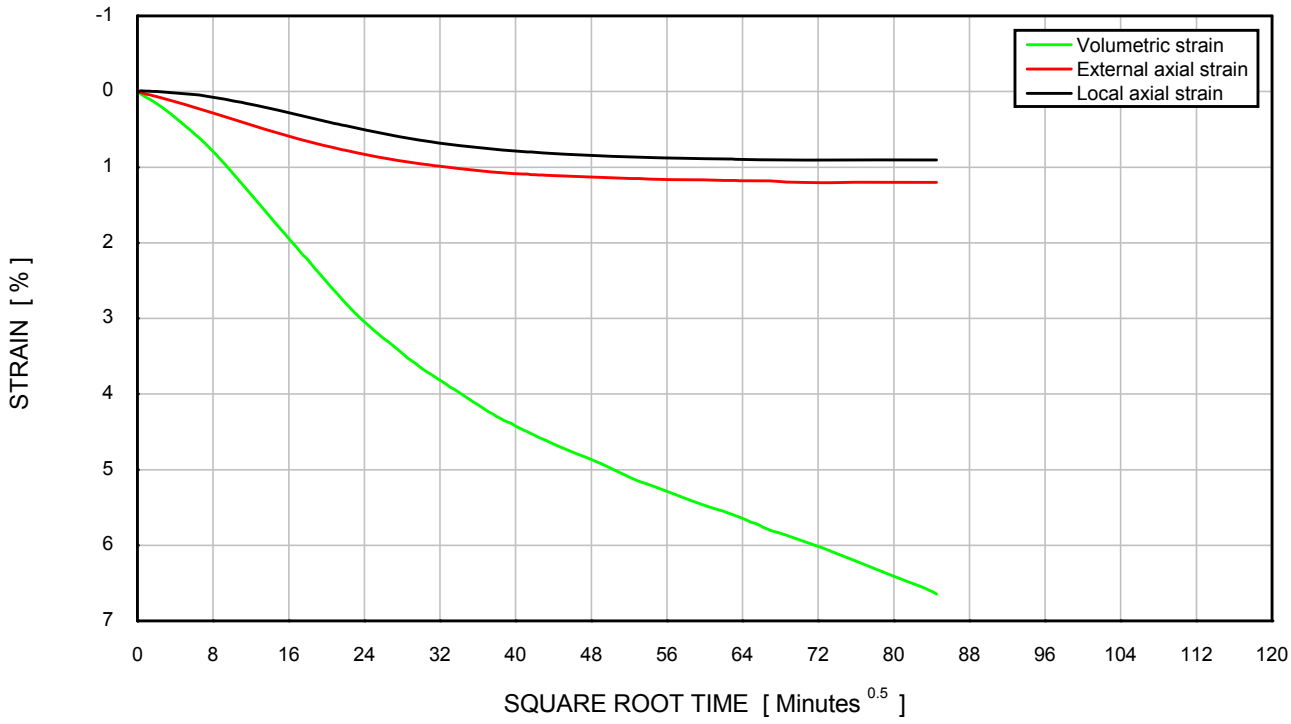


B value	:	1.00			
Initial σ'_r	:	72	kPa	Borehole	: BH-WFS2-6A
Initial σ'_a	:	72	kPa	Sample	: 18WAXD
Final σ'_r	:	167	kPa	Depth [m]	: 49.44
Final σ'_a	:	167	kPa	Test No.	: 233

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
SATURATION STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

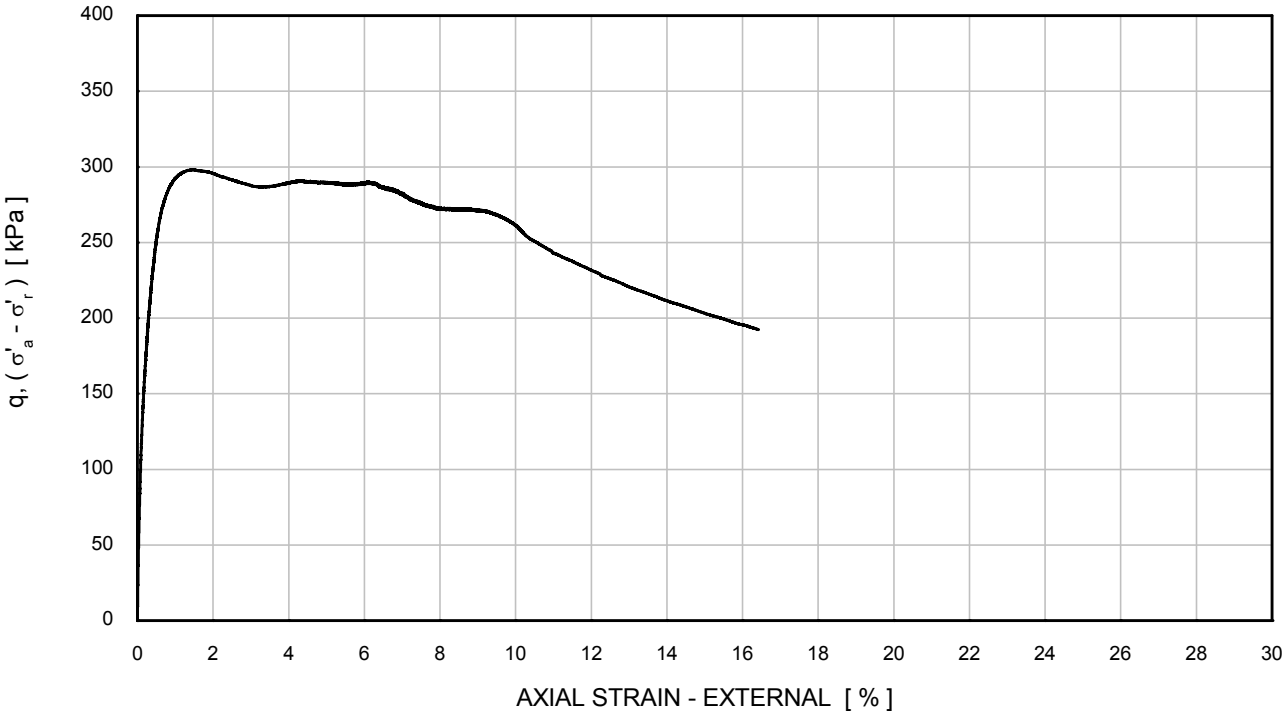


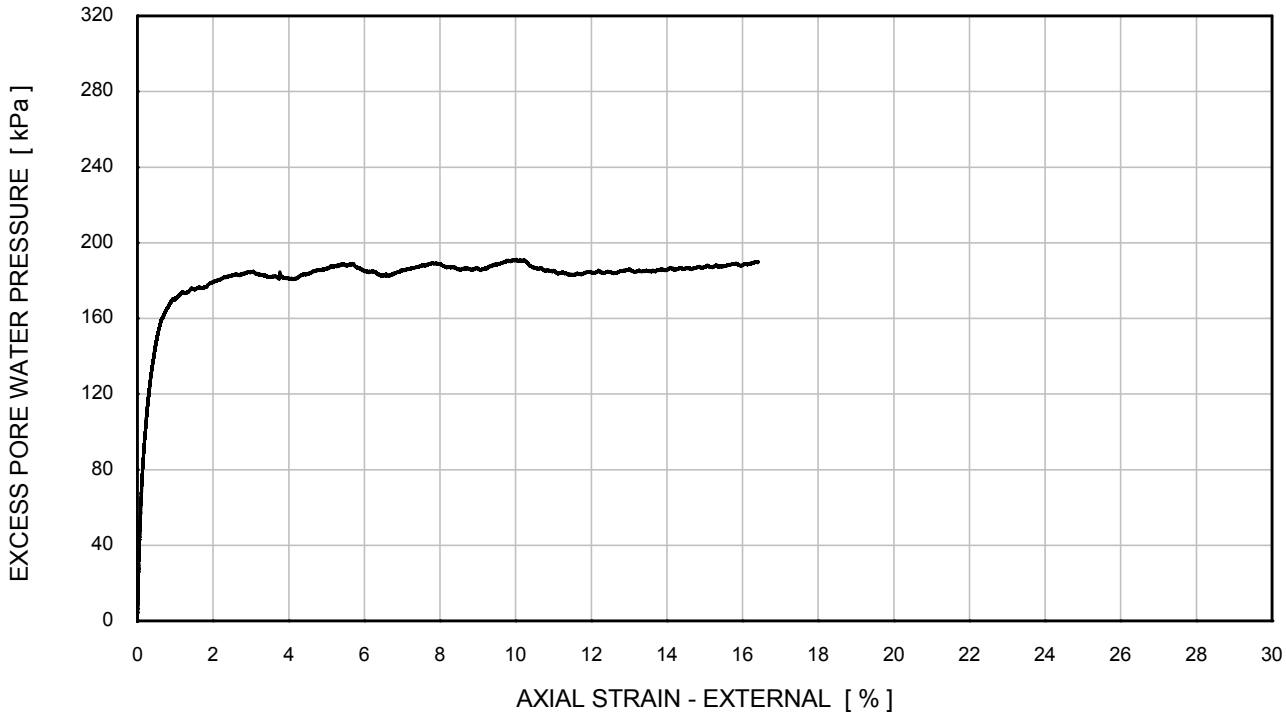


σ'_{rc}	: 480 kPa	Borehole	: BH-WFS2-6A
σ'_{ac}	: 480 kPa	Sample	: 18WAXD
		Depth [m]	: 49.44
		Test No.	: 233

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

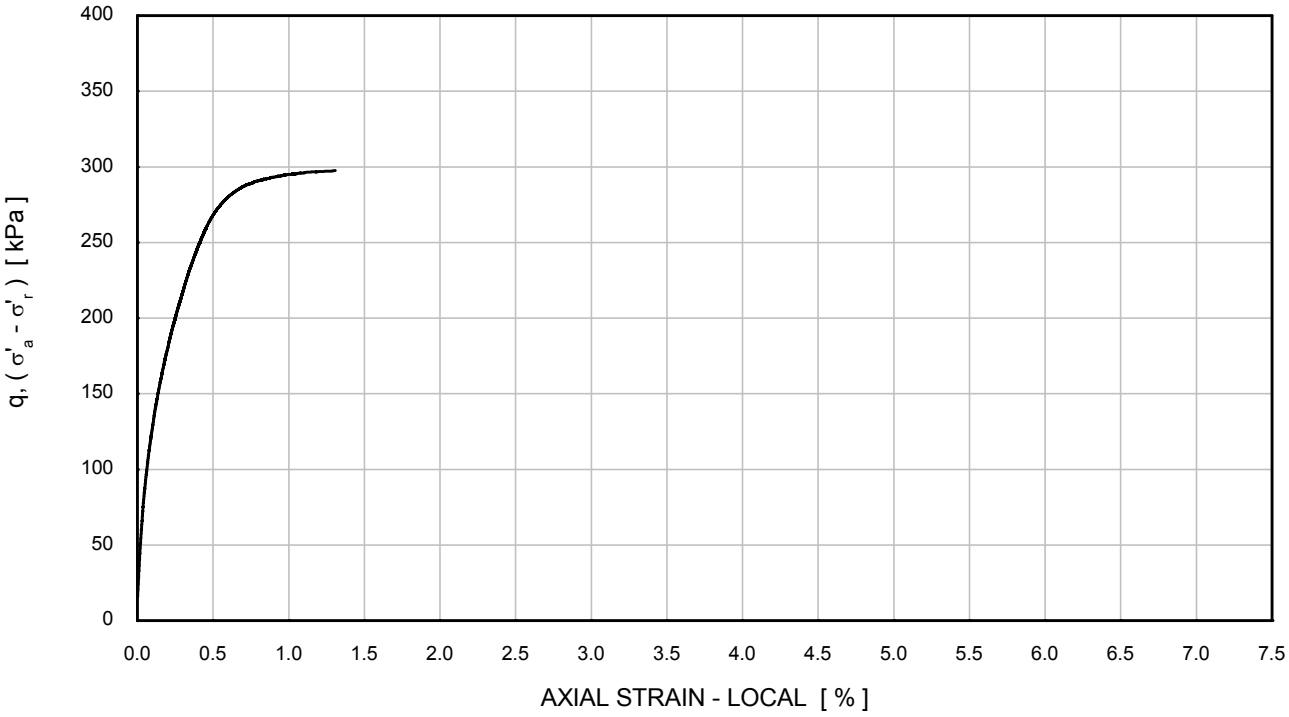


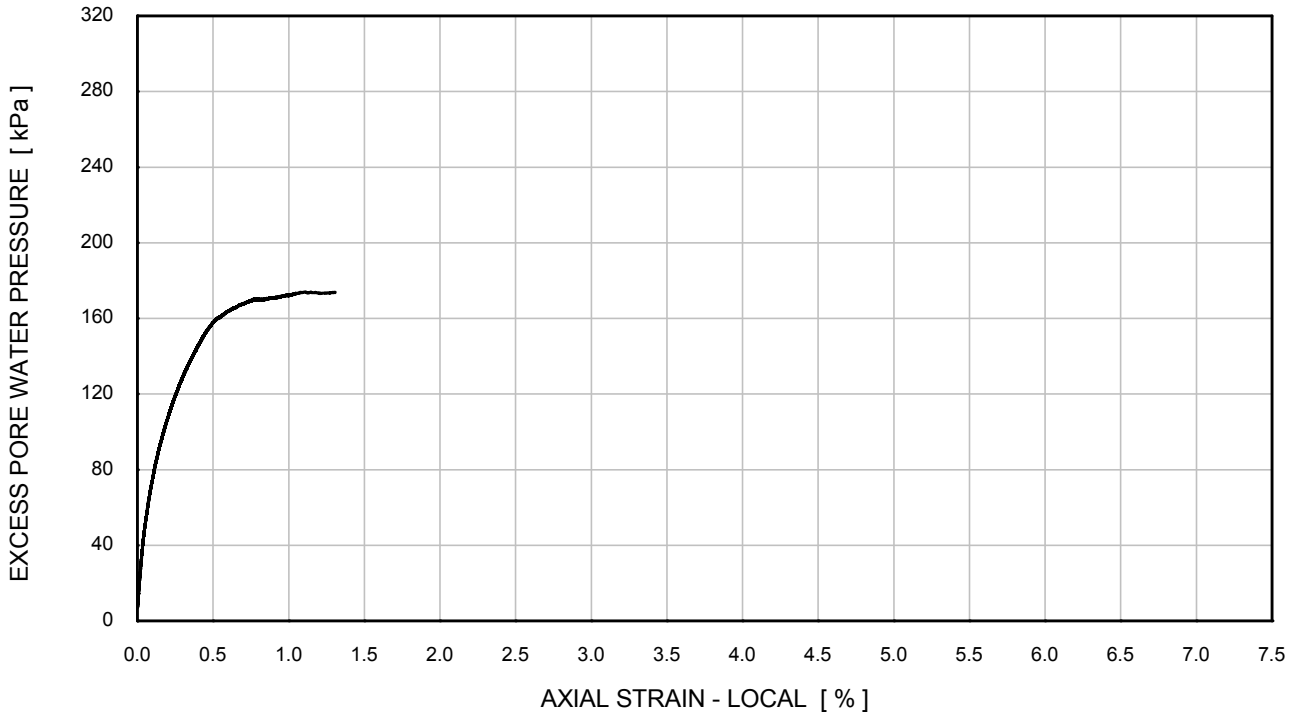


Initial σ'_r	:	480 kPa	Borehole	:	BH-WFS2-6A
Initial σ'_a	:	480 kPa	Sample	:	18WAXD
q_{peak}	:	298 kPa	Depth [m]	:	49.44
Ext. ε at q_{peak}	:	1.44 %	Test No.	:	233
Rate of strain	:	0.10 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

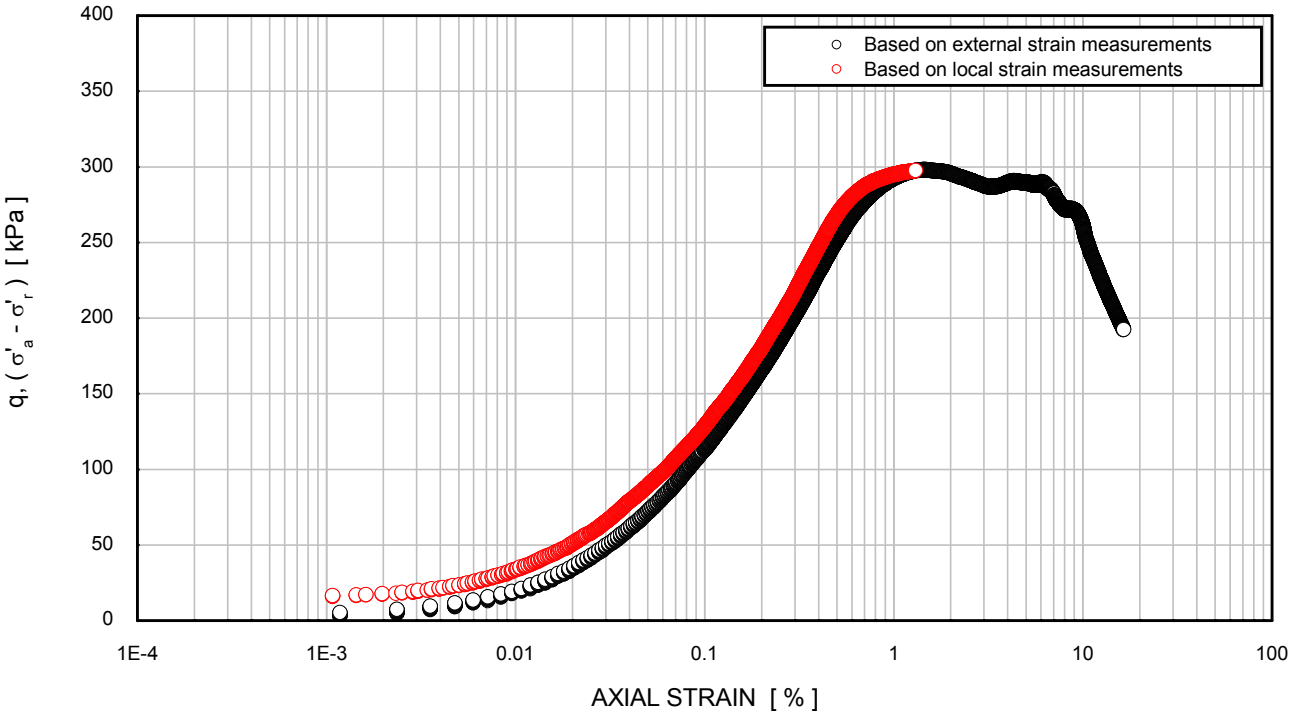


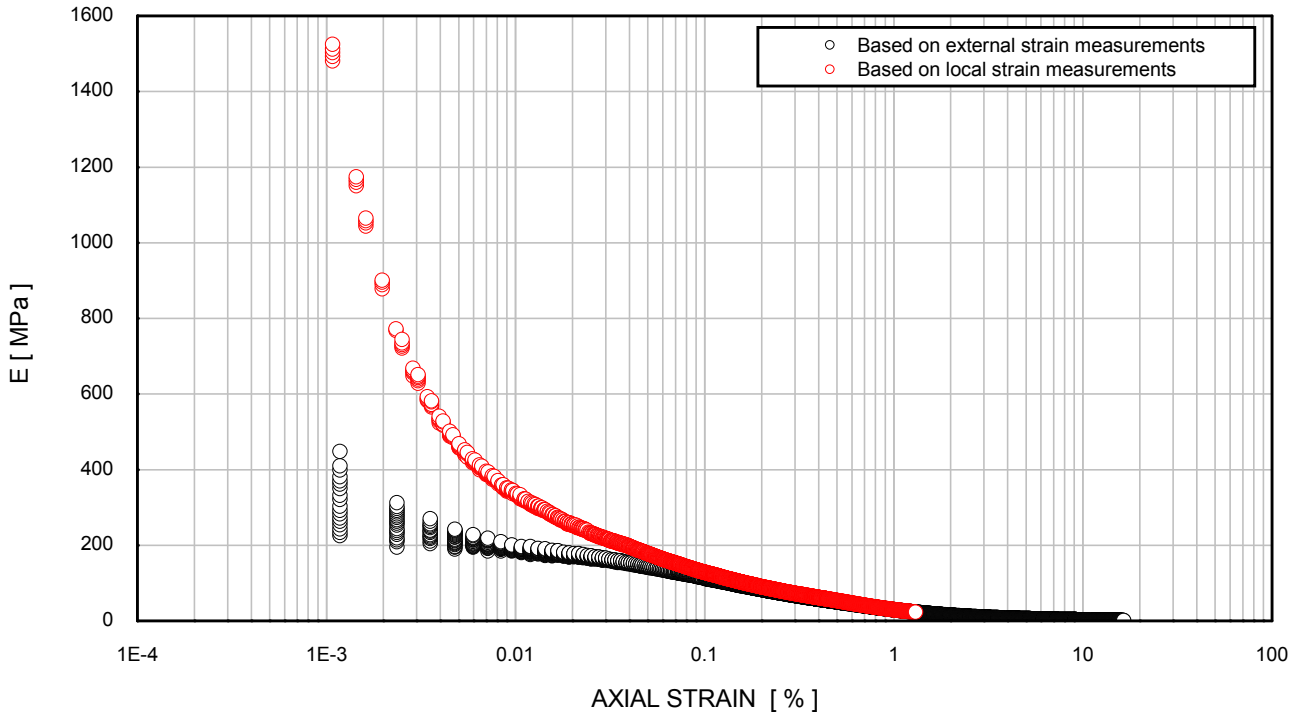


Initial σ'_r	: 480 kPa	Borehole	: BH-WFS2-6A
Initial σ'_a	: 480 kPa	Sample	: 18WAXD
q_{peak}	: 298 kPa	Depth [m]	: 49.44
Ext. ε at q_{peak}	: 1.44 %	Test No.	: 233
Rate of strain	: 0.10 %/hour		

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

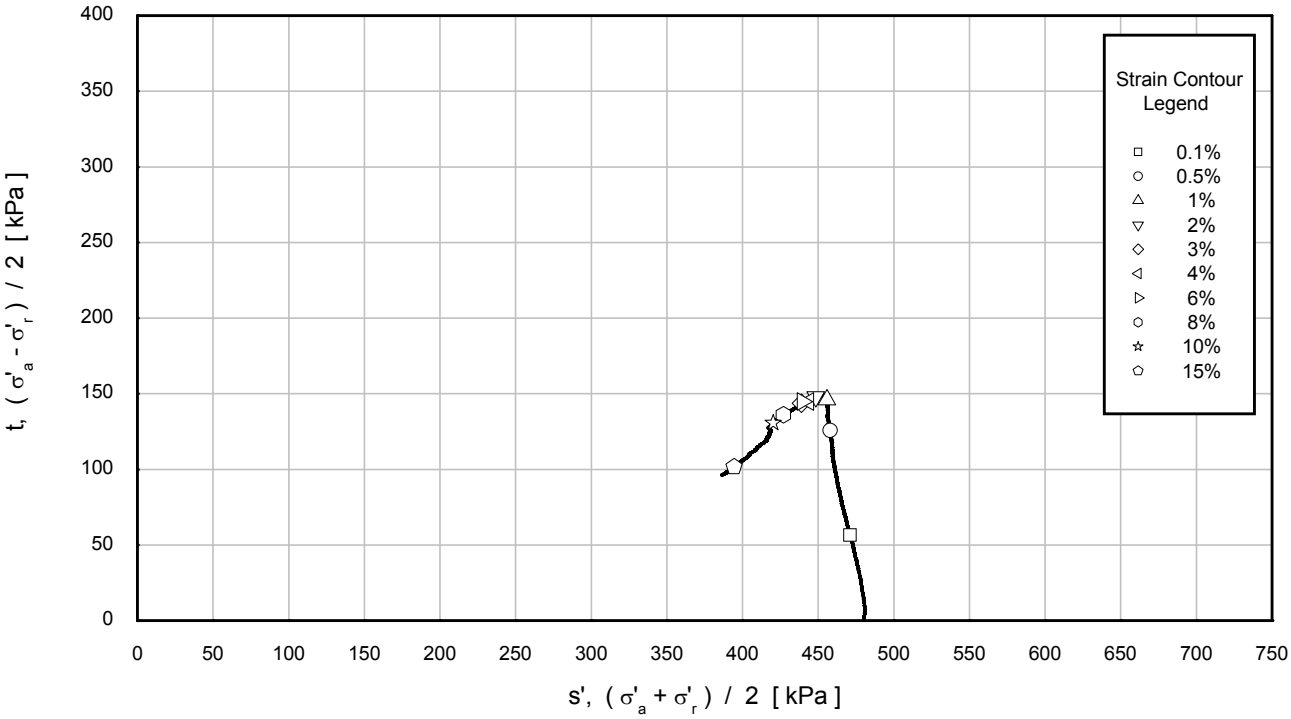


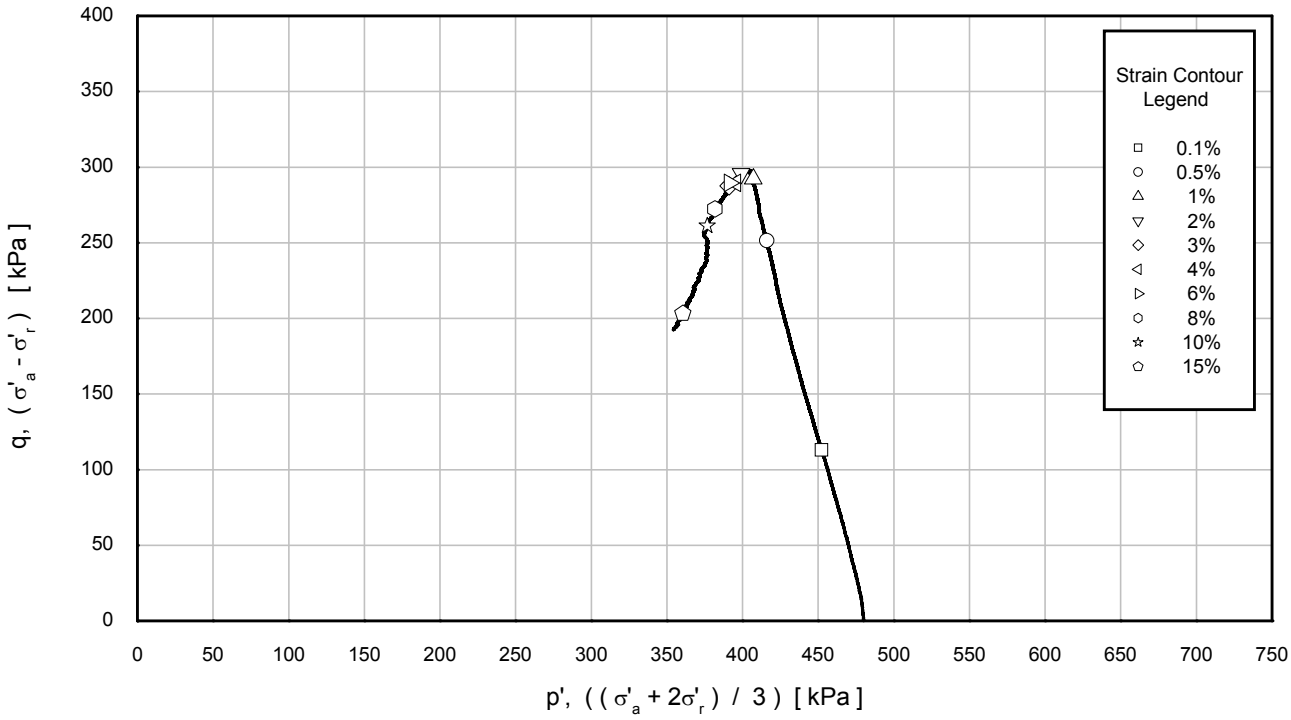


Initial σ'_r:	480	kPa	Borehole	:	BH-WFS2-6A
Initial σ'_a	: 480	kPa	Sample	:	18WAXD
q_{peak}	: 298	kPa	Depth [m]	:	49.44
Ext. ε at q_{peak}	: 1.44	%	Test No.	:	233
Rate of strain	: 0.10	%/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

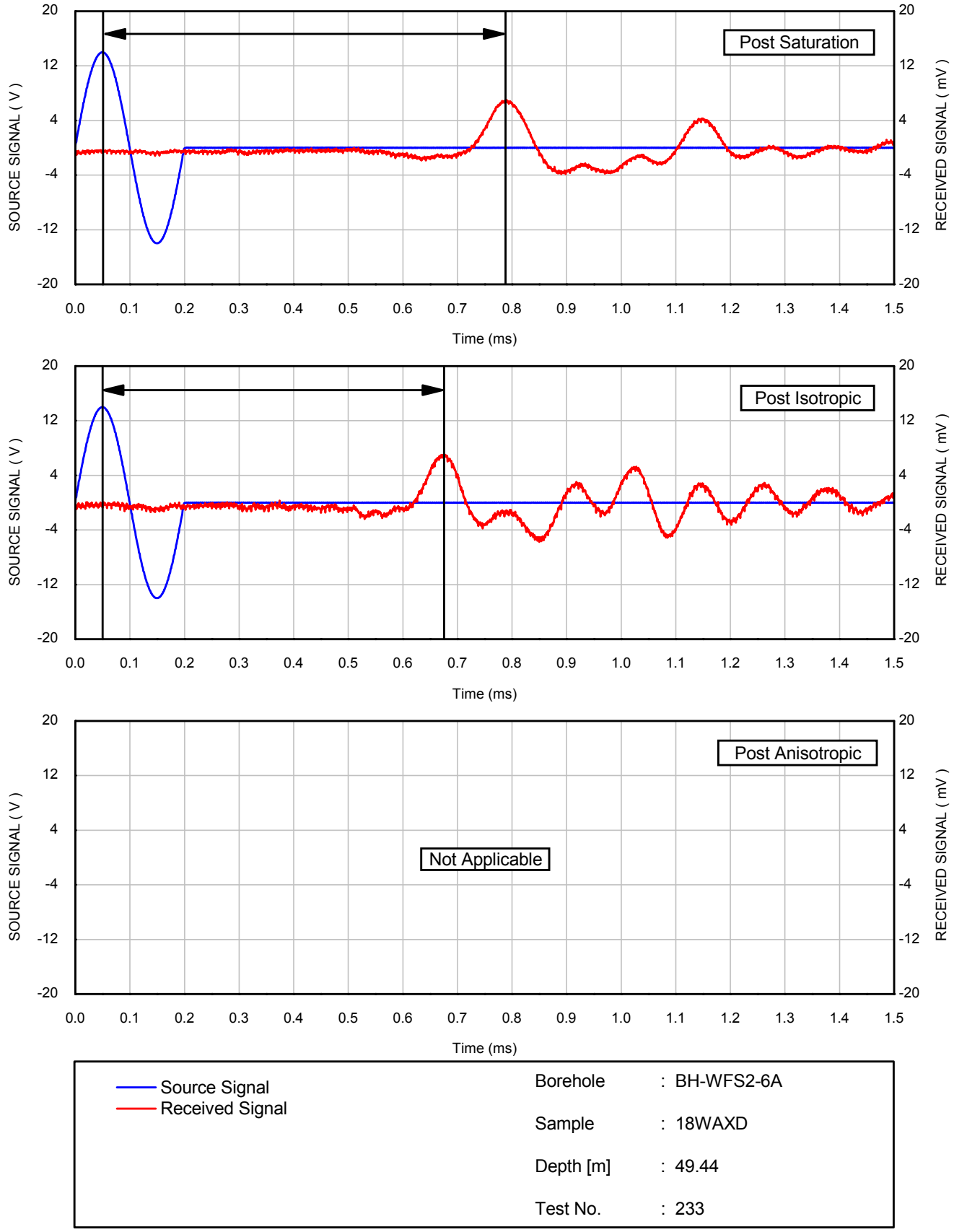




Initial σ'_r	:	480 kPa	Borehole	:	BH-WFS2-6A
Initial σ'_a	:	480 kPa	Sample	:	18WAXD
q_{peak}	:	298 kPa	Depth [m]	:	49.44
Ext. ε at q_{peak}	:	1.44 %	Test No.	:	233
Rate of strain	:	0.10 %/hour			

ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA



ISOTROPICALLY CONSOLIDATED TRIAXIAL TEST
WITH LOCAL STRAIN MEASUREMENT
SVH BENDER ELEMENT DETERMINATIONS (PEAK TO PEAK)

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 23/06/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS2-7_22WAXD_CU.XLS
Template Issue: 2
Date: 24/06/2015
Checked by: PH
Date: 24/06/2015
Approved by: PH

VISUAL DESCRIPTION
High strength greenish grey CLAY.

GENERAL	
Date test started	12/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.9
Length	(mm)	139.8
Moisture content	(%)	45.6
Bulk density	(Mg/m³)	1.76
Dry density	(Mg/m³)	1.21
Void ratio		1.228
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	621
Cell pressure on completion	(kPa)	955
B value achieved		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 5.4
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	BH-WFS2-7
Sample	22WAXD
Depth (m)	39.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 23/06/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS2-7_22WAXD_CU.XLS
Date: 24/06/2015
Checked by: PH
Approved by: PH
Date: 24/06/2015

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	955
Back pressure	(kPa)	600
Effective cell pressure	(kPa)	355
Pore pressure on completion	(kPa)	600
Pore pressure dissipation	(%)	100
Moisture content	(%)	45.6
Bulk density	(Mg/m³)	1.77
Dry density	(Mg/m³)	1.21
Void ratio		1.227
Degree of saturation	(%)	100
Volumetric strain	(%)	0.04

Mode of failure: Shear failure

Borehole	BH-WFS2-7
Sample	22WAXD
Depth (m)	39.52

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 23/06/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS2-7_22WAXD_CU.XLS
Date: 24/06/2015
Checked by: PH
Approved by: PH
Date: 24/06/2015

SHEARING		
Initial pore pressure	(kPa)	600
Initial effective cell pressure	(kPa)	355
Rate of strain	(%/hour)	0.22
At peak deviator stress		
Corrected deviator stress	(kPa)	279
Membrane correction applied	(kPa)	0.1
Drain correction applied	(kPa)	0
Axial strain	(%)	1.44
Excess pore pressure	(kPa)	148
Major principal effective stress	(kPa)	486
Minor principal effective stress	(kPa)	207
Principal effective stress ratio		2.34
Epsilon 50 (ε 50)	(%)	0.25
Secant modulus (E50) at ε 50	(kPa)	56533
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	279
Membrane correction applied	(kPa)	0.1
Drain correction applied	(kPa)	0
Axial strain	(%)	1.32
Excess pore pressure	(kPa)	149
Major principal effective stress	(kPa)	485
Minor principal effective stress	(kPa)	206
Principal effective stress ratio		2.35
At 10% axial strain		
Corrected deviator stress	(kPa)	219
Membrane correction applied	(kPa)	0.8
Drain correction applied	(kPa)	0
Axial strain	(%)	10.00
Excess pore pressure	(kPa)	90
Major principal effective stress	(kPa)	484
Minor principal effective stress	(kPa)	265
Principal effective stress ratio		1.82

FINAL CONDITIONS		
Moisture content	(%)	45.6
Bulk density	(Mg/m³)	1.77
Dry density	(Mg/m³)	1.21

Borehole	BH-WFS2-7
Sample	22WAXD
Depth (m)	39.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Checked by: PH Date: 24/06/2015 Approved by: PH Date: 24/06/2015 Template Issue: 2 Filename: J11286 / EFFECTIV / BH-WFS2-7_22WAXD_CU.XLS Drawn by: ER Date: 23/06/2015

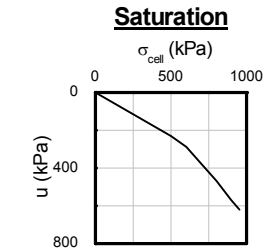
SPECIMEN PHOTOGRAPHS

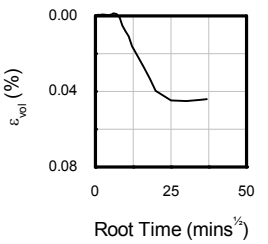
Borehole	BH-WFS2-7
Sample	22WAXD
Depth (m)	39.52

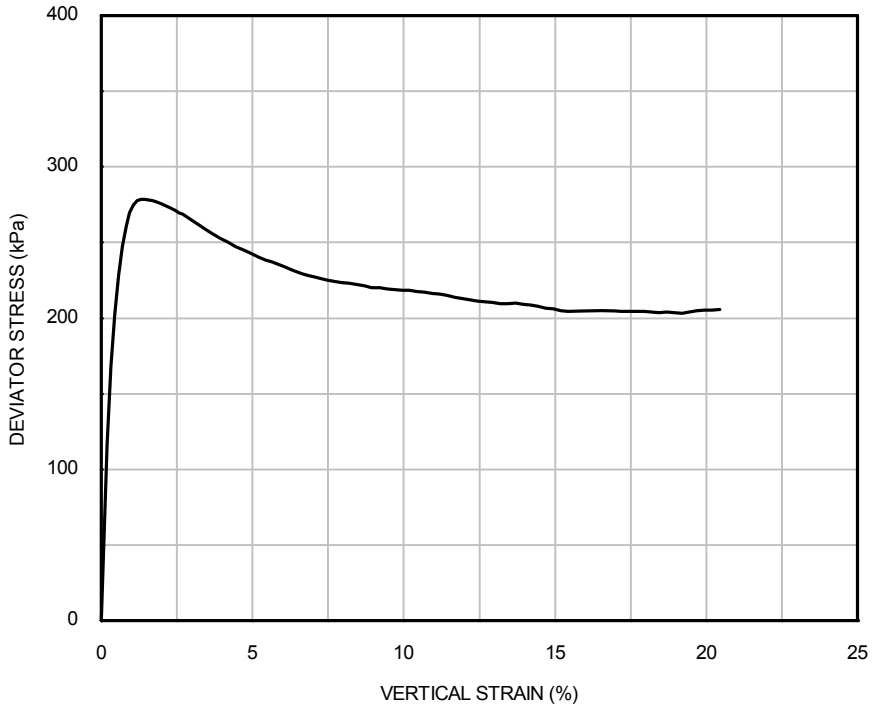
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST : SINGLE SPECIMEN

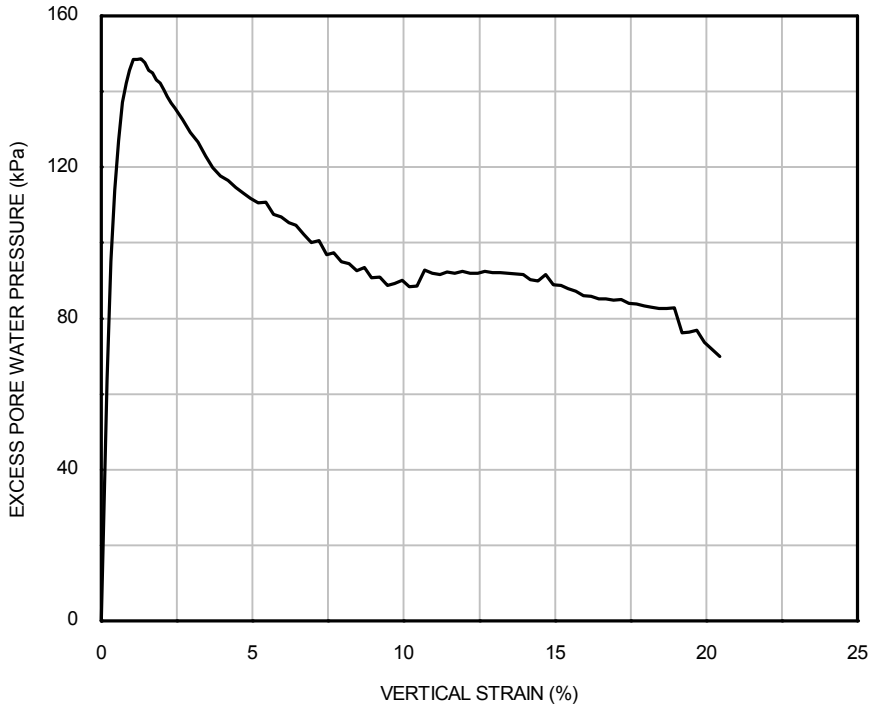
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ER Date: 23/06/2015
Template Issue: 4.1 Filename: J11286 \ EFFECTIV \ BH-WFS2-7_22WAXD_CU.OPJ
Date : 24/06/2015 Date : 24/06/2015
Checked by: PH Approved by: PH





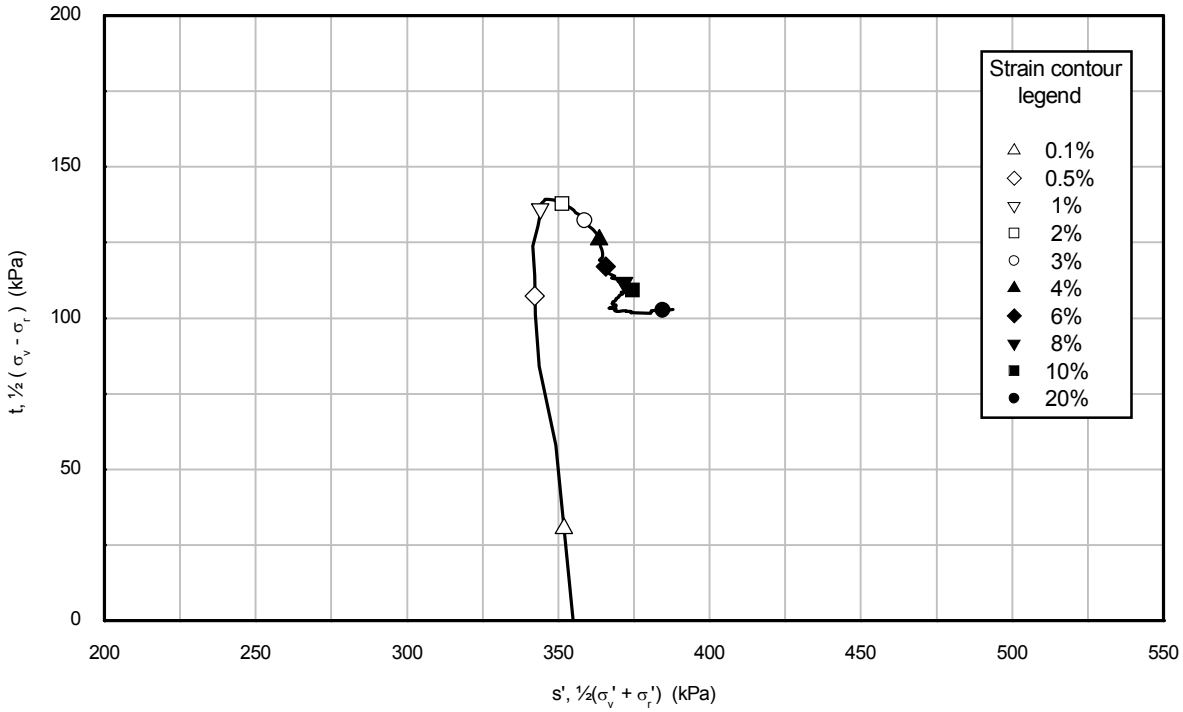


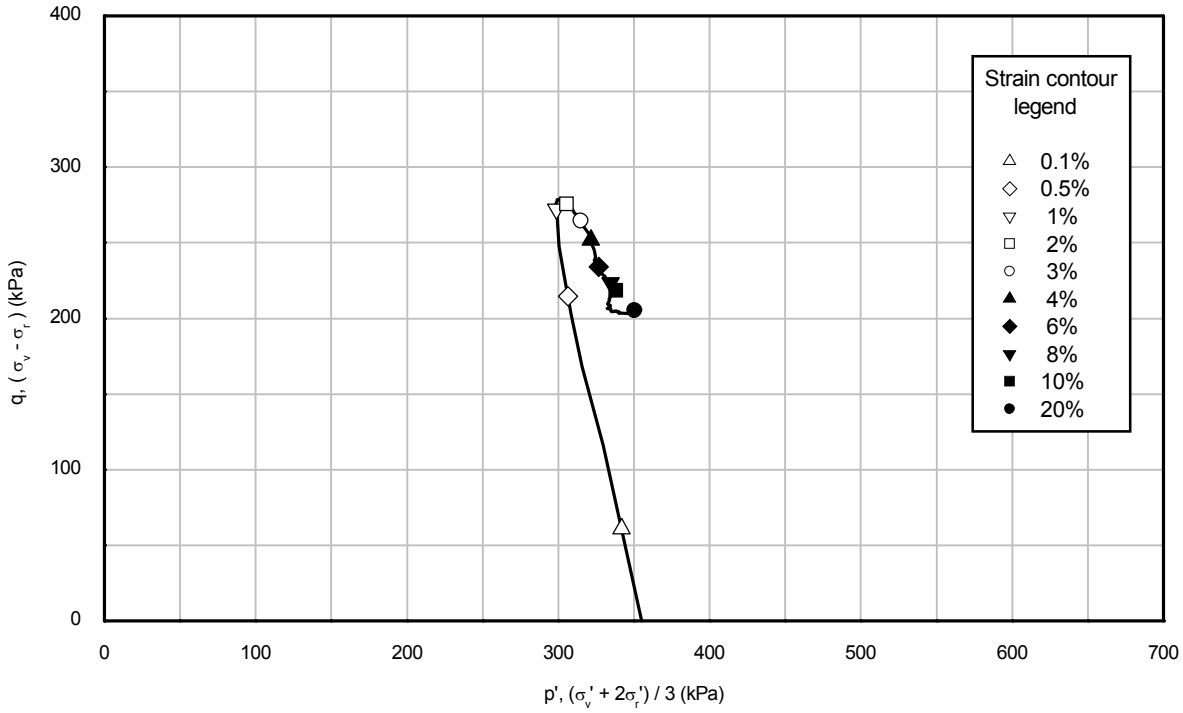


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	355	355	BH-WFS2-7	22WAXD	39.52

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	355	355	BH-WFS2-7	22WAXD	39.52

Drawn by: ER Date: 23/06/2015

Filename: J11286 \ EFFECTIV \ BH-WFS2-7_22WAXD_CU.OPJ

Template Issue: 4.1

Date : 24/06/2015

Checked by: PH

Date : 24/06/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 14/07/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS1-1_17WAXD_IE.XLS
Template Issue: 2
Date: 16/07/2015
Checked by: AB
Date: 04/08/2015
Approved by: PH

VISUAL DESCRIPTION
Very high strength dark olive grey CLAY.

GENERAL	
Date test started	02/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.4
Length	(mm)	124.9
Moisture content	(%)	27.1
Bulk density	(Mg/m³)	1.98
Dry density	(Mg/m³)	1.56
Void ratio		0.731
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	417
Cell pressure on completion	(kPa)	890
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 5.3
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	

*Air conditioning failure mid test resulted in laboratory temperature being out of specification (±2˚C)

Borehole	BH-WFS1-1
Sample	17WAXD
Depth (m)	51.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 14/07/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS1-1_17WAXD_IE.XLS
Template Issue: 2
Date: 16/07/2015
Checked by: AB
Date: 04/08/2015
Approved by: PH

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	890
Back pressure	(kPa)	400
Effective cell pressure	(kPa)	490
Pore pressure on completion	(kPa)	400
Pore pressure dissipation	(%)	100
Moisture content	(%)	27.1
Bulk density	(Mg/m³)	1.98
Dry density	(Mg/m³)	1.56
Void ratio		0.731
Degree of saturation	(%)	100
Volumetric strain	(%)	0.02

Mode of failure: Necking Failure

Borehole	BH-WFS1-1
Sample	17WAXD
Depth (m)	51.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 14/07/2015
Drawn by: ER
Filename: J11286 / EFFECTIV / BH-WFS1-1_17WAXD_IE.XLS
Template Issue: 2
Date: 16/07/2015
Checked by: AB
Date: 04/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	400
Initial effective cell pressure	(kPa)	490
Rate of strain	(%/hour)	0.21
At peak deviator stress		
Corrected deviator stress	(kPa)	-349
Membrane correction applied	(kPa)	-0.6
Drain correction applied	(kPa)	0
Axial strain	(%)	-5.50
Excess pore pressure	(kPa)	-234
Major principal effective stress	(kPa)	375
Minor principal effective stress	(kPa)	724
Principal effective stress ratio		0.52
Epsilon 50 (ε 50)	(%)	-0.50
Secant modulus (E50) at ε 50	(kPa)	35274
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	-349
Membrane correction applied	(kPa)	-0.6
Drain correction applied	(kPa)	0
Axial strain	(%)	-5.50
Excess pore pressure	(kPa)	-234
Major principal effective stress	(kPa)	375
Minor principal effective stress	(kPa)	724
Principal effective stress ratio		0.52
At -10% axial strain		
Corrected deviator stress	(kPa)	-283
Membrane correction applied	(kPa)	-1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	-10.00
Excess pore pressure	(kPa)	-222
Major principal effective stress	(kPa)	429
Minor principal effective stress	(kPa)	712
Principal effective stress ratio		0.60

FINAL CONDITIONS		
Moisture content	(%)	27.1
Bulk density	(Mg/m³)	1.98
Dry density	(Mg/m³)	1.56

Borehole	BH-WFS1-1
Sample	17WAXD
Depth (m)	51.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 14/07/2015
Drawn by: ER
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS1-1_17WAXD_IE.XLS
Checked by: AB
Date: 16/07/2015
Approved by: PH
Date: 04/08/2015

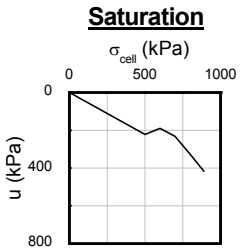
SPECIMEN PHOTOGRAPHS

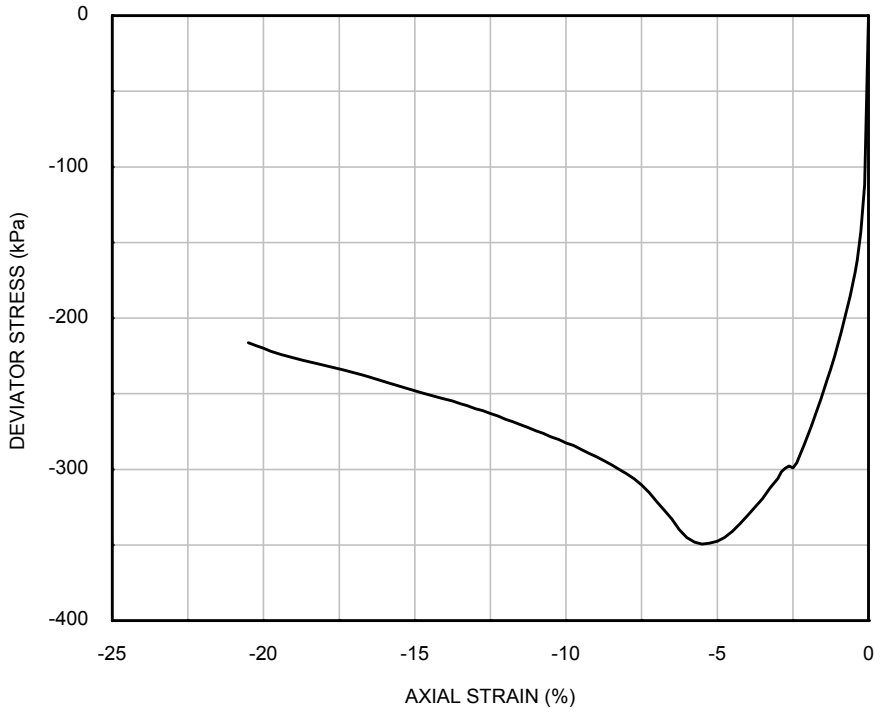
Borehole	BH-WFS1-1
Sample	17WAXD
Depth (m)	51.52

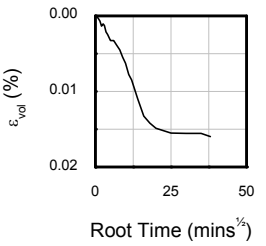
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

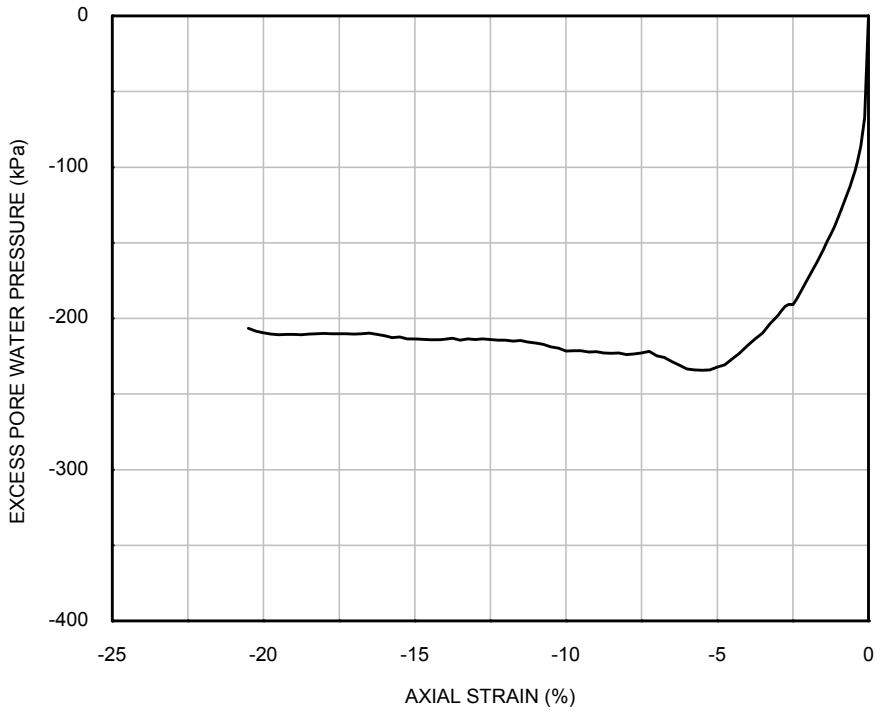
Drawn by: ER Date: 14/07/2015
Template Issue: 4.1 Filename: J11286 \ EFFECTIV \ BH-WFS1-1_17WAXD_IE.OPJ
Date : 16/07/2015 Date : 04/08/2015
Checked by: ALB Approved by: PH







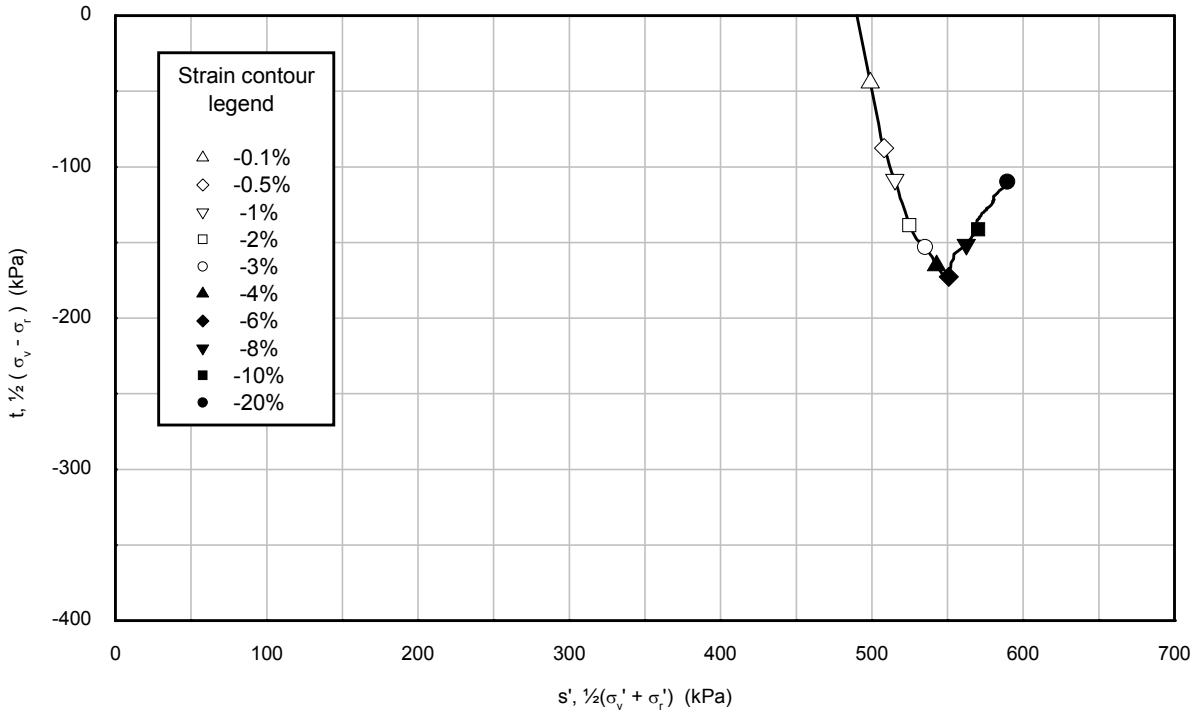
Consolidation

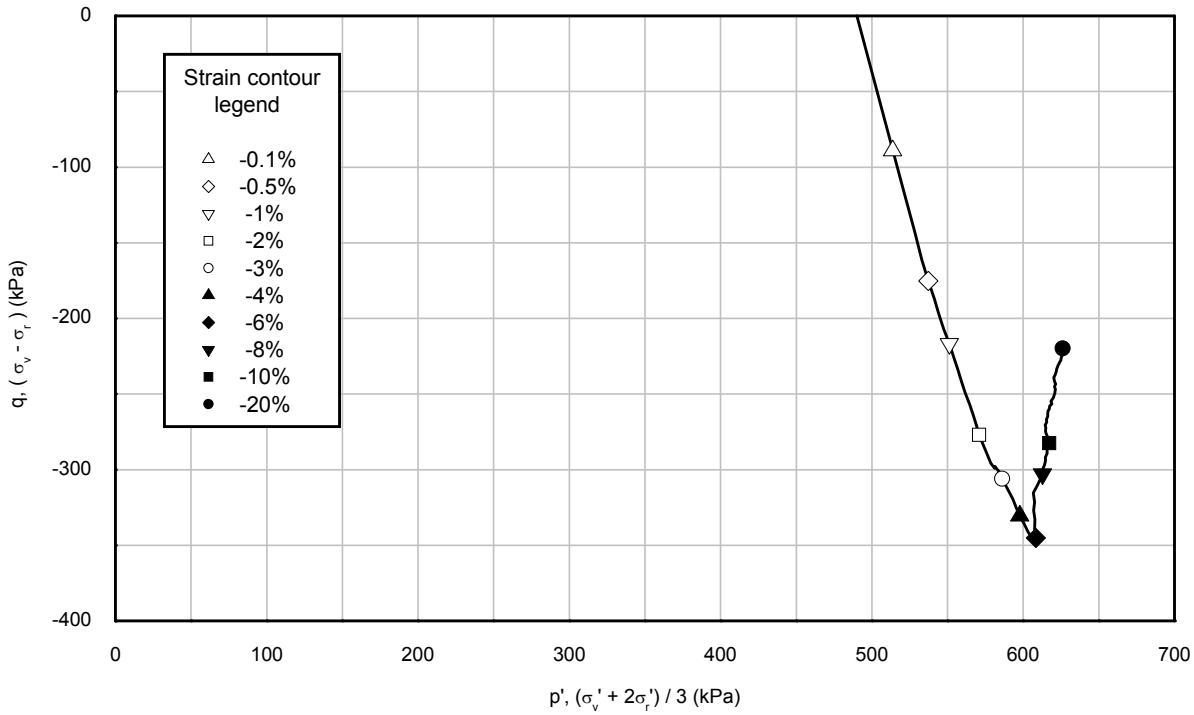


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	490	490	BH-WFS1-1	17WAXD	51.52

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	490	490	BH-WFS1-1	17WAXD	51.52

Drawn by: ER Date: 14/07/2015

Filename: J11286 \ EFFECTIV \ BH-WFS1-1_17WAXD_IE.OPJ

Template Issue: 4.1

Date : 16/07/2015

Checked by: ALB

Date : 04/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 03/07/2015
Drawn by: ALB
Filename: J11286 / EFFECTIV / BH-WFS1-4_21WAXD_IE.XLS
Template Issue: 2
Date: 04/08/2015
Checked by: PH
Date: 04/08/2015
Approved by: PH

VISUAL DESCRIPTION
Hard very dark grey CLAY.

GENERAL	
Date test started	18/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.7
Length	(mm)	124.8
Moisture content	(%)	24.7
Bulk density	(Mg/m³)	2.02
Dry density	(Mg/m³)	1.62
Void ratio		0.670
Degree of saturation	(%)	99

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	400
Pore pressure on completion	(kPa)	751
Cell pressure on completion	(kPa)	1150
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	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	

*Air conditioning failure mid test resulted in laboratory temperature being out of specification (±2˚C)

Borehole	BH-WFS1-4
Sample	21WAXD
Depth (m)	44.97

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	1150
Back pressure	(kPa)	700
Effective cell pressure	(kPa)	450
Pore pressure on completion	(kPa)	700
Pore pressure dissipation	(%)	100
Moisture content	(%)	24.8
Bulk density	(Mg/m³)	2.02
Dry density	(Mg/m³)	1.62
Void ratio		0.670
Degree of saturation	(%)	100
Volumetric strain	(%)	0.54

Mode of failure: Necking Failure

Borehole	BH-WFS1-4
Sample	21WAXD
Depth (m)	44.97

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 03/07/2015
Template Issue: 2 Filename: J11286 / EFFECTIV / BH-WFS1-4_21WAXD_IE.XLS
Checked by: PH Date: 04/08/2015
Approved by: PH Date: 04/08/2015

Date: 03/07/2015
Drawn by: ALB
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS1-4_21WAXD_IE.XLS
Date: 04/08/2015
Checked by: PH
Date: 04/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	700
Initial effective cell pressure	(kPa)	450
Rate of strain	(%/hour)	0.28
At peak deviator stress		
Corrected deviator stress	(kPa)	-503
Membrane correction applied	(kPa)	-1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	-9.48
Excess pore pressure	(kPa)	-356
Major principal effective stress	(kPa)	304
Minor principal effective stress	(kPa)	806
Principal effective stress ratio		0.38
Epsilon 50 (ε 50)	(%)	-1.54
Secant modulus (E50) at ε 50	(kPa)	16368
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	-498
Membrane correction applied	(kPa)	-1.0
Drain correction applied	(kPa)	0
Axial strain	(%)	-8.98
Excess pore pressure	(kPa)	-347
Major principal effective stress	(kPa)	299
Minor principal effective stress	(kPa)	797
Principal effective stress ratio		0.38
At -10% axial strain		
Corrected deviator stress	(kPa)	-490
Membrane correction applied	(kPa)	-1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	-10.00
Excess pore pressure	(kPa)	-359
Major principal effective stress	(kPa)	319
Minor principal effective stress	(kPa)	809
Principal effective stress ratio		0.39

FINAL CONDITIONS		
Moisture content	(%)	24.8
Bulk density	(Mg/m³)	2.02
Dry density	(Mg/m³)	1.62

Borehole	BH-WFS1-4
Sample	21WAXD
Depth (m)	44.97

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 03/07/2015

Template Issue: 2

Filename: J11286 / EFFECTIV / BH-WFS1-4_21WAXD_IE.XLS

Checked by: PH Date: 04/08/2015

Approved by: PH Date: 04/08/2015

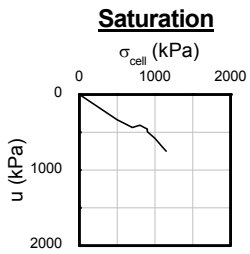
SPECIMEN PHOTOGRAPHS

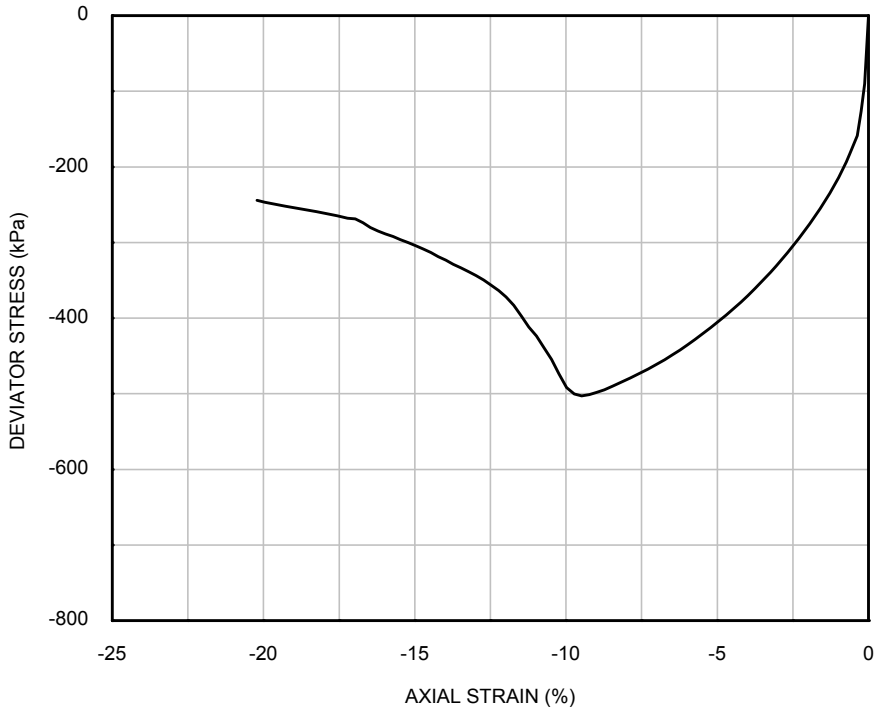
Borehole	BH-WFS1-4
Sample	21WAXD
Depth (m)	44.97

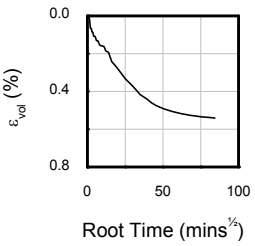
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

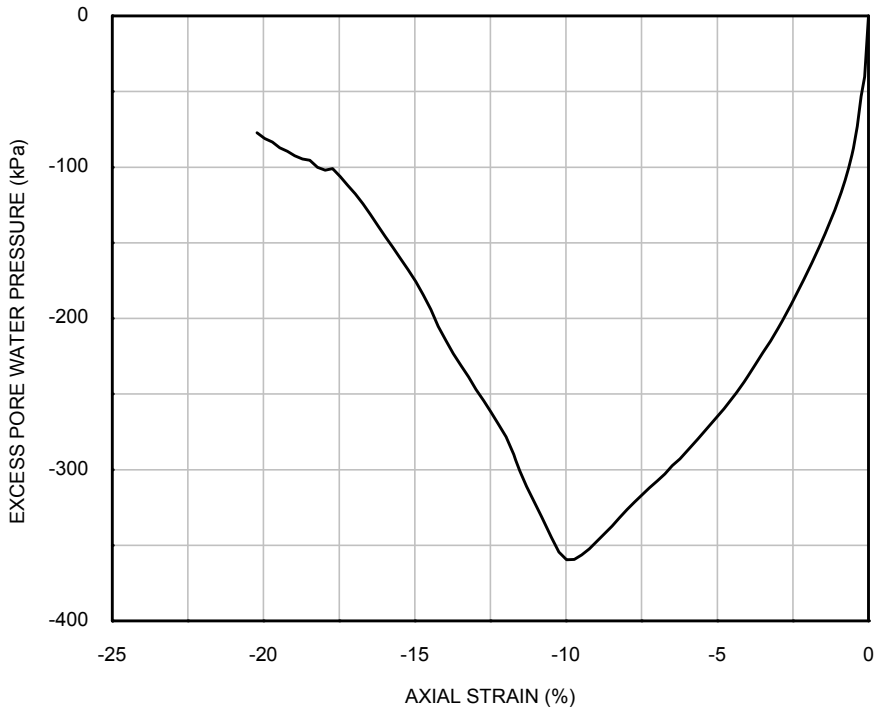
Drawn by: ALB Date: 03/07/2015
Template Issue: 4.1 Filename: J11286 \ EFFECTIV \ BH-WFS1-4_21WAXD_IE.OPJ
Date : 04/08/2015 Date : 04/08/2015
Checked by: PH Approved by: PH







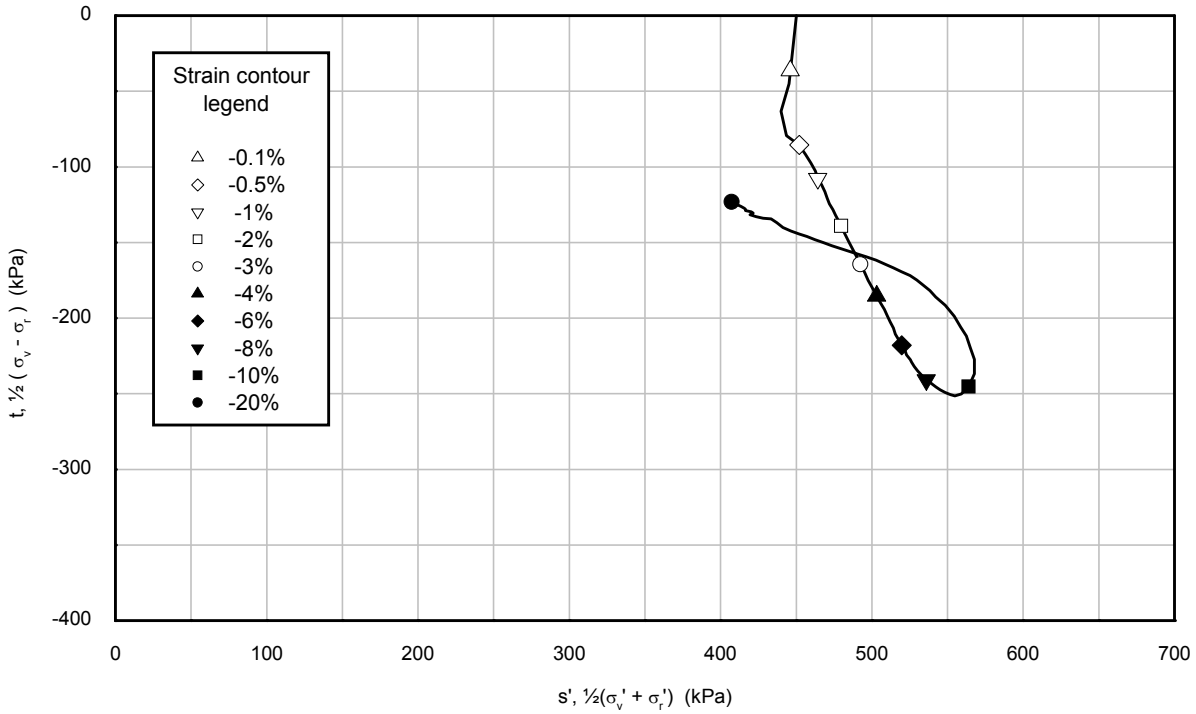
Consolidation

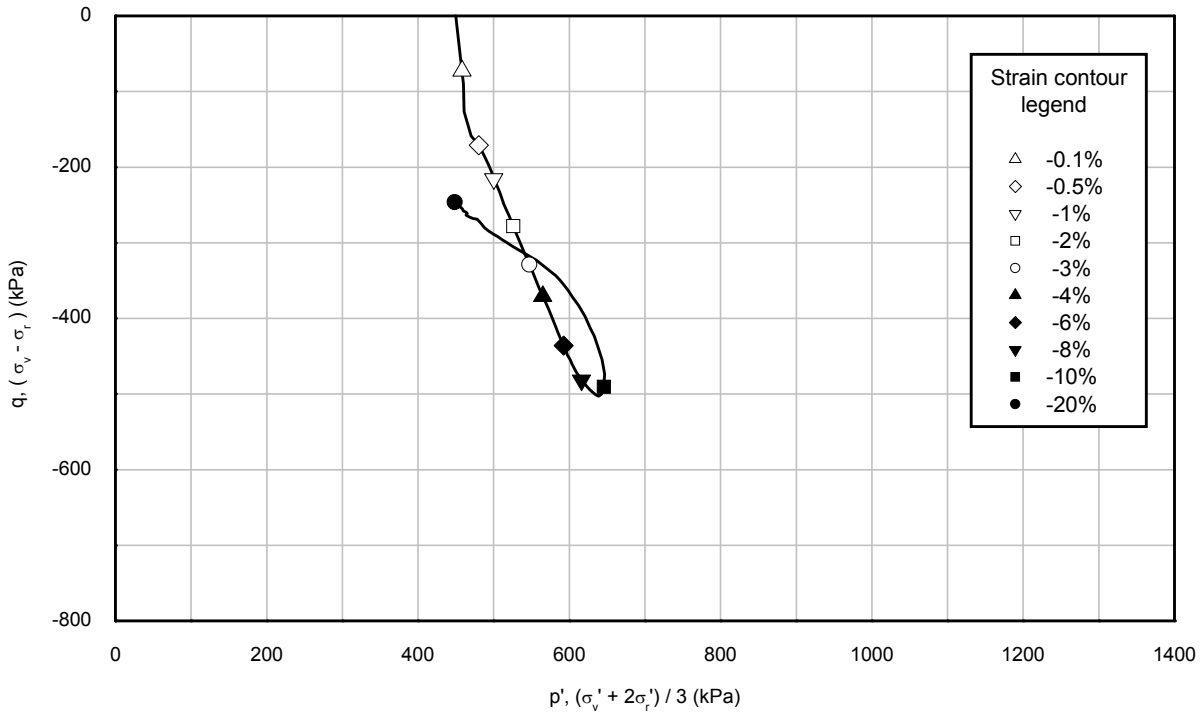


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	450	450	BH-WFS1-4	21WAXD	44.97

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	450	450	BH-WFS1-4	21WAXD	44.97

Drawn by: ALB Date: 03/07/2015

Filename: J11286 \ EFFECTIV \ BH-WFS1-4_21WAXD_IE.OPJ

Template Issue: 4.1

Date : 04/08/2015

Checked by: PH

Date : 04/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 03/07/2015
Drawn by: ALB
Filename: J11286 / EFFECTIV / BH-WFS2-6A_20WAXB_IE.XLS
Template Issue: 2
Date: 04/08/2015
Checked by: PH
Date: 04/08/2015
Approved by: PH

VISUAL DESCRIPTION
Hard dark greenish grey.

GENERAL	
Date test started	22/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.7
Length	(mm)	124.8
Moisture content	(%)	39.1
Bulk density	(Mg/m³)	1.86
Dry density	(Mg/m³)	1.33
Void ratio		1.025
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	831
Cell pressure on completion	(kPa)	1125
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	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	

*Air conditioning failure mid test resulted in laboratory temperature being out of specification (±2˚C)

Borehole	BH-WFS2-6A
Sample	20WAXB
Depth (m)	54.37

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	1125
Back pressure	(kPa)	600
Effective cell pressure	(kPa)	525
Pore pressure on completion	(kPa)	600
Pore pressure dissipation	(%)	100
Moisture content	(%)	39.2
Bulk density	(Mg/m³)	1.85
Dry density	(Mg/m³)	1.33
Void ratio		1.027
Degree of saturation	(%)	100
Volumetric strain	(%)	-0.11

Mode of failure: Necking Failure

Borehole	BH-WFS2-6A
Sample	20WAXB
Depth (m)	54.37

SUMMARY OF
ISOTROPICALLY CONSOLIDATED UNDRAINED
TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 03/07/2015
Template Issue: 2 Filename: J11286 / EFFECTIV / BH-WFS2-6A_20WAXB_IE.XLS
Checked by: PH Date: 04/08/2015
Approved by: PH Date: 04/08/2015

Date: 03/07/2015
Drawn by: ALB
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS2-6A_20WAXB_IE.XLS
Date: 04/08/2015
Checked by: PH
Date: 04/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	600
Initial effective cell pressure	(kPa)	525
Rate of strain	(%/hour)	0.28
At peak deviator stress		
Corrected deviator stress	(kPa)	-642
Membrane correction applied	(kPa)	-0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	-2.37
Excess pore pressure	(kPa)	-268
Major principal effective stress	(kPa)	151
Minor principal effective stress	(kPa)	793
Principal effective stress ratio		0.19
Epsilon 50 (ε 50)	(%)	-0.46
Secant modulus (E50) at ε 50	(kPa)	69305
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	-642
Membrane correction applied	(kPa)	-0.2
Drain correction applied	(kPa)	0
Axial strain	(%)	-2.37
Excess pore pressure	(kPa)	-268
Major principal effective stress	(kPa)	151
Minor principal effective stress	(kPa)	793
Principal effective stress ratio		0.19
At -10% axial strain		
Corrected deviator stress	(kPa)	-305
Membrane correction applied	(kPa)	-1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	-10.00
Excess pore pressure	(kPa)	-153
Major principal effective stress	(kPa)	372
Minor principal effective stress	(kPa)	678
Principal effective stress ratio		0.55

FINAL CONDITIONS		
Moisture content	(%)	39.2
Bulk density	(Mg/m³)	1.85
Dry density	(Mg/m³)	1.33

Borehole	BH-WFS2-6A
Sample	20WAXB
Depth (m)	54.37

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 03/07/2015

Template Issue: 2

Filename: J11286 / EFFECTIV / BH-WFS2-6A_20WAXB_IE.XLS

Checked by: PH Date: 04/08/2015

Approved by: PH Date: 04/08/2015

SPECIMEN PHOTOGRAPHS

Borehole	BH-WFS2-6A
Sample	20WAXB
Depth (m)	54.37

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

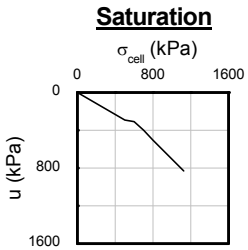
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

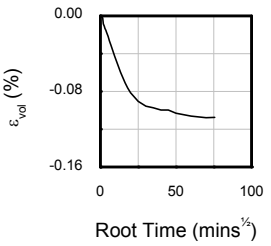
Drawn by: ALB Date: 03/07/2015

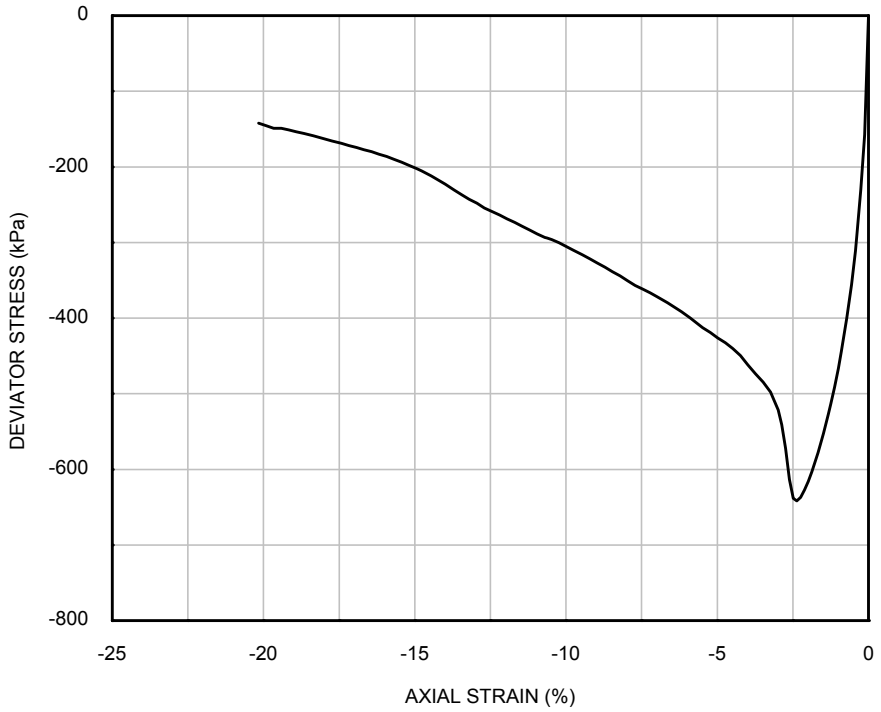
Template Issue: 4.1 Filename: J11286 \ EFFECTIV \ BH-WFS2-6A_20WAXB_IE.OPJ

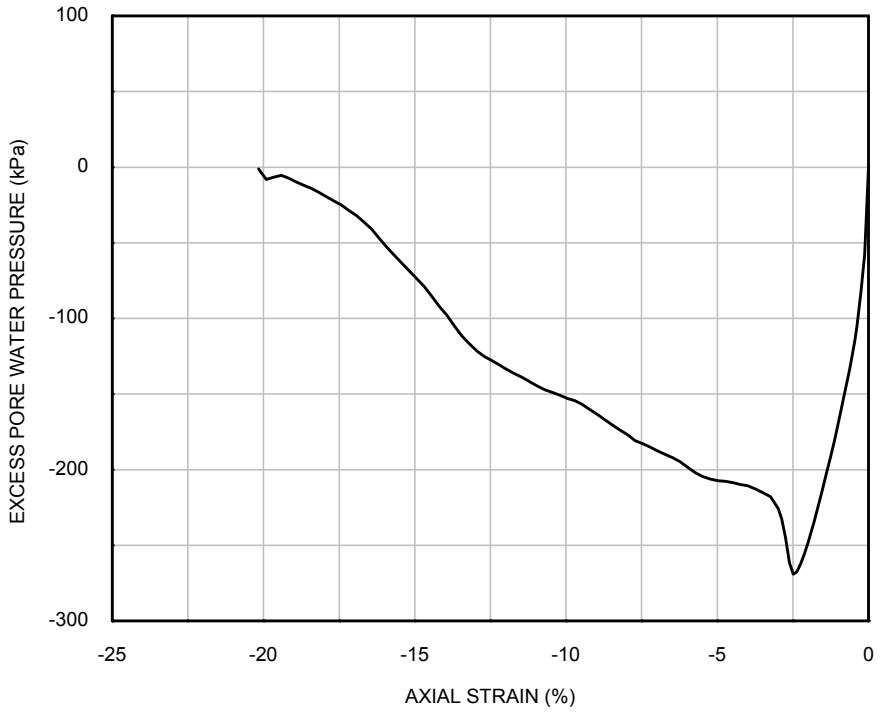
Date : 04/08/2015 Date : 04/08/2015

Checked by: PH Approved by: PH





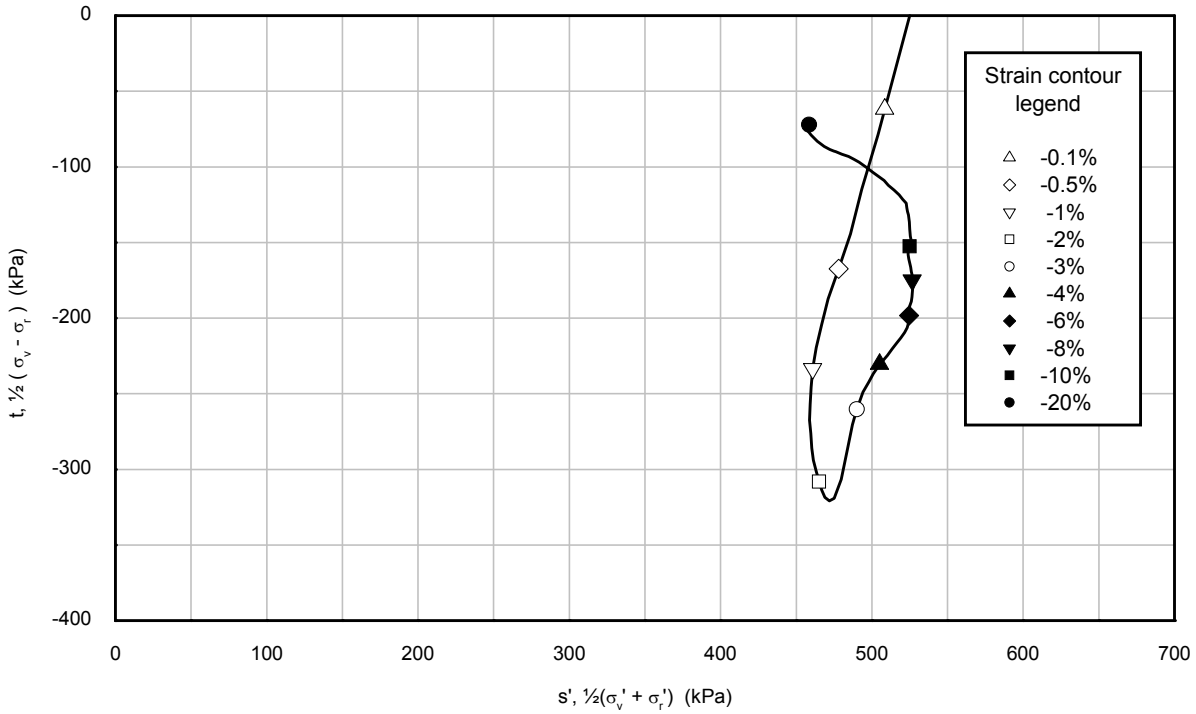


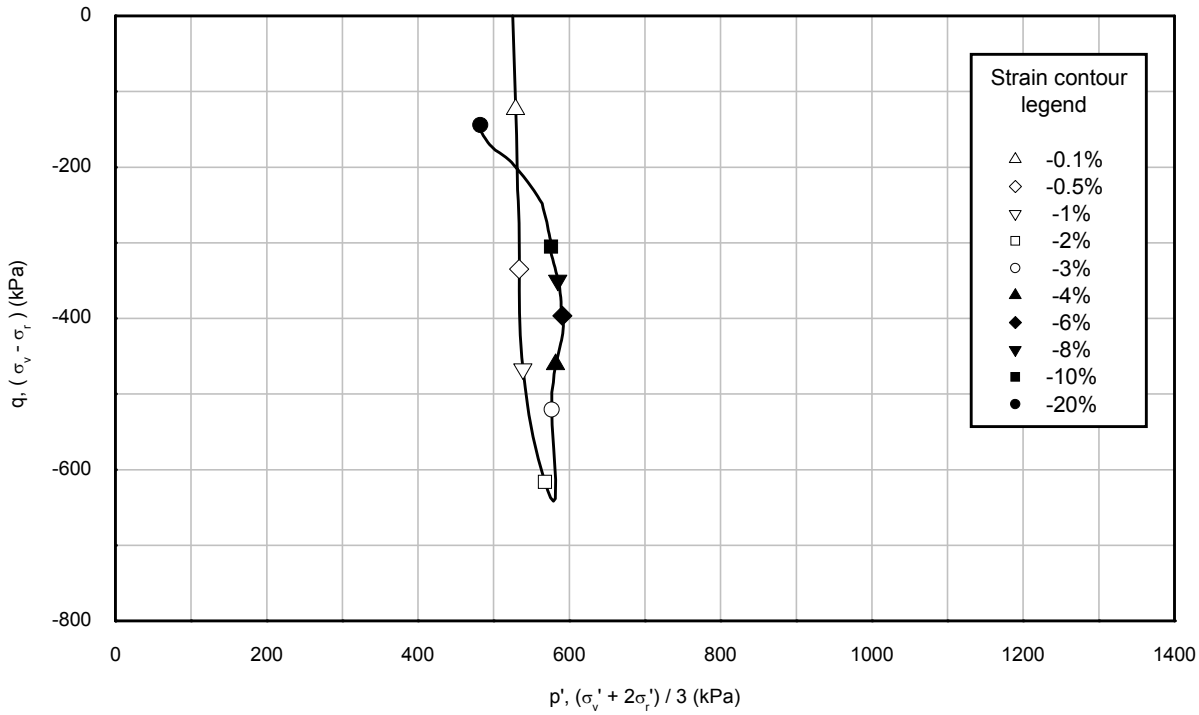


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	525	525	BH-WFS2-6A	20WAXB	54.37

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	525	525	BH-WFS2-6A	20WAXB	54.37

Drawn by: ALB Date: 03/07/2015

Filename: J11286 \ EFFECTIV \ BH-WFS2-6A_20WAXB_IE.OPJ

Template Issue: 4.1

Date : 04/08/2015

Checked by: PH

Date : 04/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 03/07/2015
Drawn by: ALB
Filename: J11286 / EFFECTIV / BH-WFS2-7_21WAXD_IE.XLS
Template Issue: 2
Date: 04/07/2015
Checked by: RB
Date: 04/08/2015
Approved by: PH

VISUAL DESCRIPTION
Hard dark greenish grey CLAY.

GENERAL	
Date test started	18/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical
Type of drains fitted	Radial & one end

INITIAL		
Diameter	(mm)	71.6
Length	(mm)	124.7
Moisture content	(%)	39.4
Bulk density	(Mg/m³)	1.84
Dry density	(Mg/m³)	1.32
Void ratio		1.050
Degree of saturation	(%)	100

SATURATION		
Pressure increments applied	(kPa)	100
Differential pressure used	(kPa)	N/A
Pore pressure on completion	(kPa)	984
Cell pressure on completion	(kPa)	1150
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	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	

*Air conditioning failure mid test resulted in laboratory temperature being out of specification (±2˚C)

Borehole	BH-WFS2-7
Sample	21WAXD
Depth (m)	28.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 03/07/2015
Drawn by: ALB
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS2-7_21WAXD_IE.XLS
Date: 04/07/2015
Checked by: RB
Date: 04/08/2015
Approved by: PH

CONSOLIDATION : ISOTROPIC		
Cell pressure	(kPa)	1150
Back pressure	(kPa)	800
Effective cell pressure	(kPa)	350
Pore pressure on completion	(kPa)	800
Pore pressure dissipation	(%)	100
Moisture content	(%)	39.0
Bulk density	(Mg/m³)	1.84
Dry density	(Mg/m³)	1.32
Void ratio		1.040
Degree of saturation	(%)	100
Volumetric strain	(%)	0.51

Mode of failure: Necking failure

Borehole	BH-WFS2-7
Sample	21WAXD
Depth (m)	28.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Date: 03/07/2015
Drawn by: ALB
Template Issue: 2
Filename: J11286 / EFFECTIV / BH-WFS2-7_21WAXD_IE.XLS
Date: 04/07/2015
Checked by: RB
Date: 04/08/2015
Approved by: PH

SHEARING		
Initial pore pressure	(kPa)	800
Initial effective cell pressure	(kPa)	350
Rate of strain	(%/hour)	1.33
At peak deviator stress		
Corrected deviator stress	(kPa)	-227
Membrane correction applied	(kPa)	-0.3
Drain correction applied	(kPa)	0
Axial strain	(%)	-2.50
Excess pore pressure	(kPa)	-94
Major principal effective stress	(kPa)	218
Minor principal effective stress	(kPa)	444
Principal effective stress ratio		0.49
Epsilon 50 (ε 50)	(%)	-0.17
Secant modulus (E50) at ε 50	(kPa)	65536
At peak principal effective stress ratio		
Corrected deviator stress	(kPa)	-226
Membrane correction applied	(kPa)	-0.3
Drain correction applied	(kPa)	0
Axial strain	(%)	-2.63
Excess pore pressure	(kPa)	-93
Major principal effective stress	(kPa)	217
Minor principal effective stress	(kPa)	443
Principal effective stress ratio		0.49
At -10% axial strain		
Corrected deviator stress	(kPa)	-190
Membrane correction applied	(kPa)	-1.1
Drain correction applied	(kPa)	0
Axial strain	(%)	-10.00
Excess pore pressure	(kPa)	-80
Major principal effective stress	(kPa)	240
Minor principal effective stress	(kPa)	431
Principal effective stress ratio		0.56

FINAL CONDITIONS		
Moisture content	(%)	39.0
Bulk density	(Mg/m³)	1.84
Dry density	(Mg/m³)	1.32

Borehole	BH-WFS2-7
Sample	21WAXD
Depth (m)	28.52

SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST : SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

Drawn by: ALB Date: 03/07/2015

Template Issue: 2

Filename: J11286 / EFFECTIV / BH-WFS2-7_21WAXD_IE.XLS

Checked by: RB Date: 04/07/2015

Approved by: PH Date: 04/08/2015

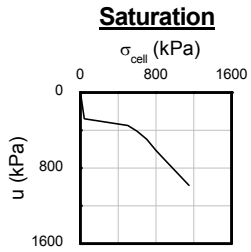
SPECIMEN PHOTOGRAPHS

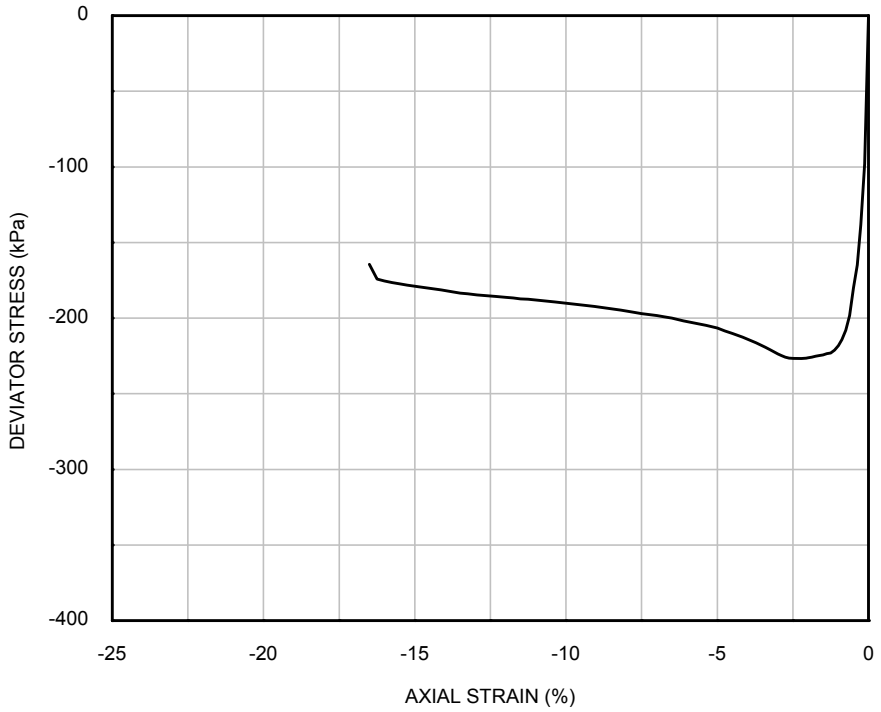
Borehole	BH-WFS2-7
Sample	21WAXD
Depth (m)	28.52

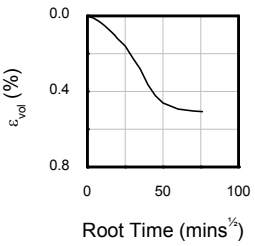
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

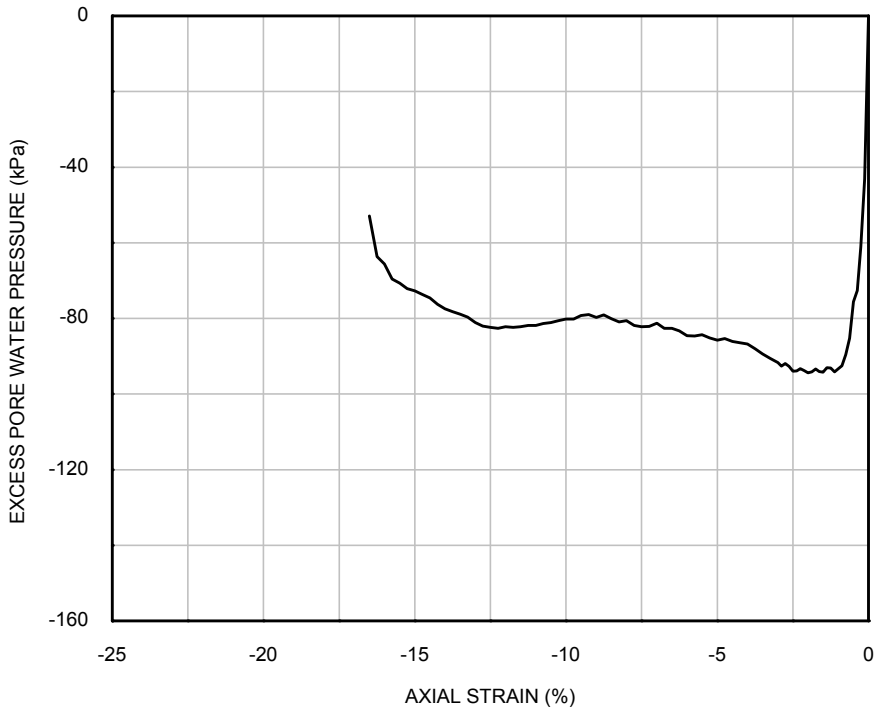
Drawn by: ALB Date: 03/07/2015
Template Issue: 4.1
Filename: J11286 \ EFFECTIV \ BH-WFS2-7_21WAXD_IE.OPJ
Date : 04/07/2015
Checked by: RMB
Date : 04/08/2015
Approved by: PH







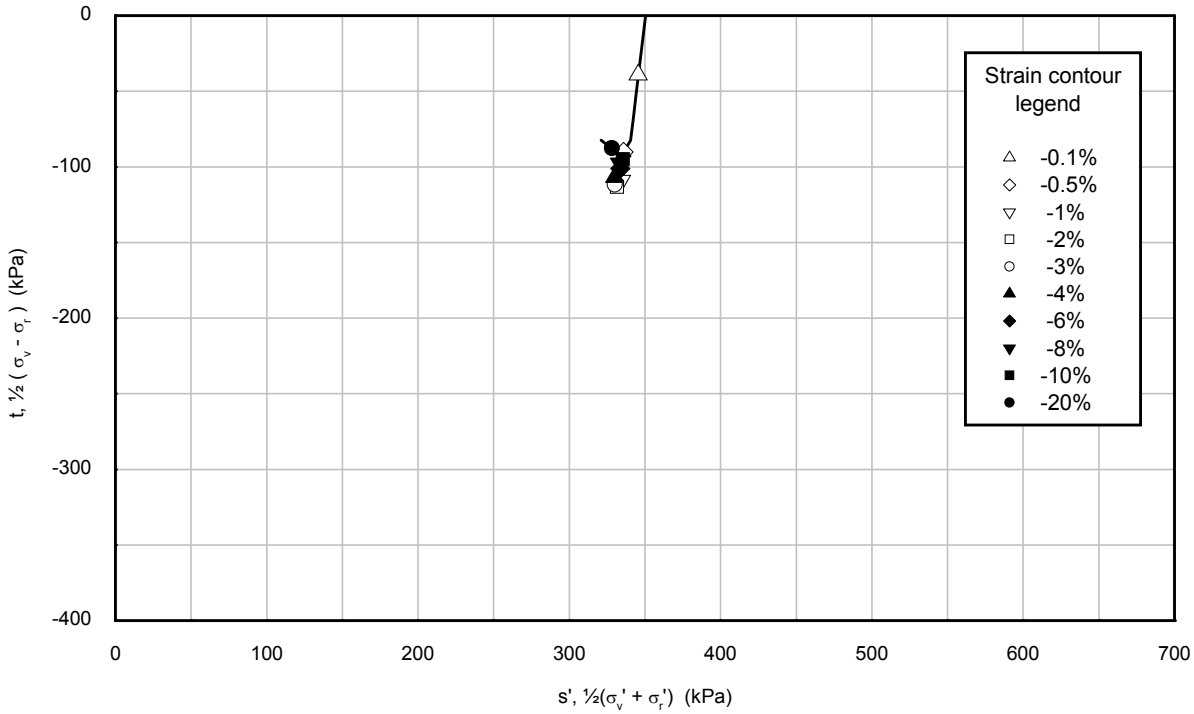
Consolidation

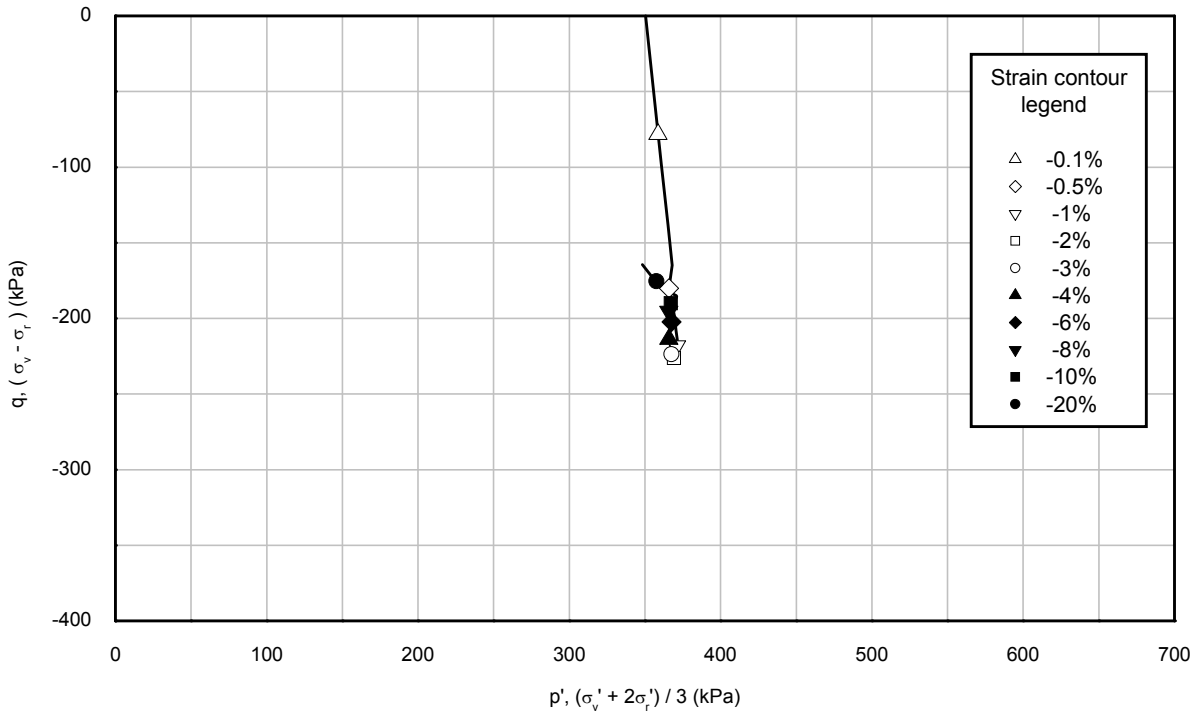


Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	350	350	BH-WFS2-7	21WAXD	28.52

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Curve	Specimen	σ_{rc}' (kPa)	σ_{vc}' (kPa)	Borehole	Sample	Depth (m)
——	1	350	350	BH-WFS2-7	21WAXD	28.52

Drawn by: ALB Date: 03/07/2015

Filename: J11286 \ EFFECTIV \ BH-WFS2-7_21WAXD_IE.OPJ

Template Issue: 4.1

Date : 04/07/2015

Checked by: RMB

Date : 04/08/2015

Approved by: PH

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL EXTENSION TEST: SINGLE SPECIMEN

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SECTION A5: STATIC DIRECT SIMPLE SHEAR TESTS

LIST OF PLATES IN SECTION A5: Plate

VISUAL DESCRIPTION
High strength very dark grey slightly sandy CLAY

GENERAL	
Date test started	24/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.0
Moisture content	[%]	28.1
Bulk density	[Mg/m³]	1.98
Dry density	[Mg/m³]	1.54
Void ratio	[-]	0.749
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	225
Pocket penetrometer	[kPa]	375
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS2-3_9WAXB_DSS02
Template issue	1.2
Processed by Date	RN 30/06/2015
Checked by Date	PH 01/07/2015
Approved by Date	PH 01/07/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-3
Sample	9WAXB
Depth [m]	18.06
Test number	DSS02

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	185
Vertical strain	[%]	1.10
Bulk density	[Mg/m^3]	1.99
Dry density	[Mg/m^3]	1.56
Void ratio	[-]	0.735
Moisture content	[%]	27.6

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	180
Shear strain	[%]	9.75
Shear induced $\Delta\sigma'_v$	[kPa]	-79
Vertical stress	[kPa]	264
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.00
At 15 % shear strain		
Shear stress	[kPa]	176
Shear induced $\Delta\sigma'_v$	[kPa]	-151
Vertical stress	[kPa]	336
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS2-3
Sample	9WAXB
Depth [m]	18.06
Test number	DSS02

SUMMARY OF CONSOLIDATED DSS TEST

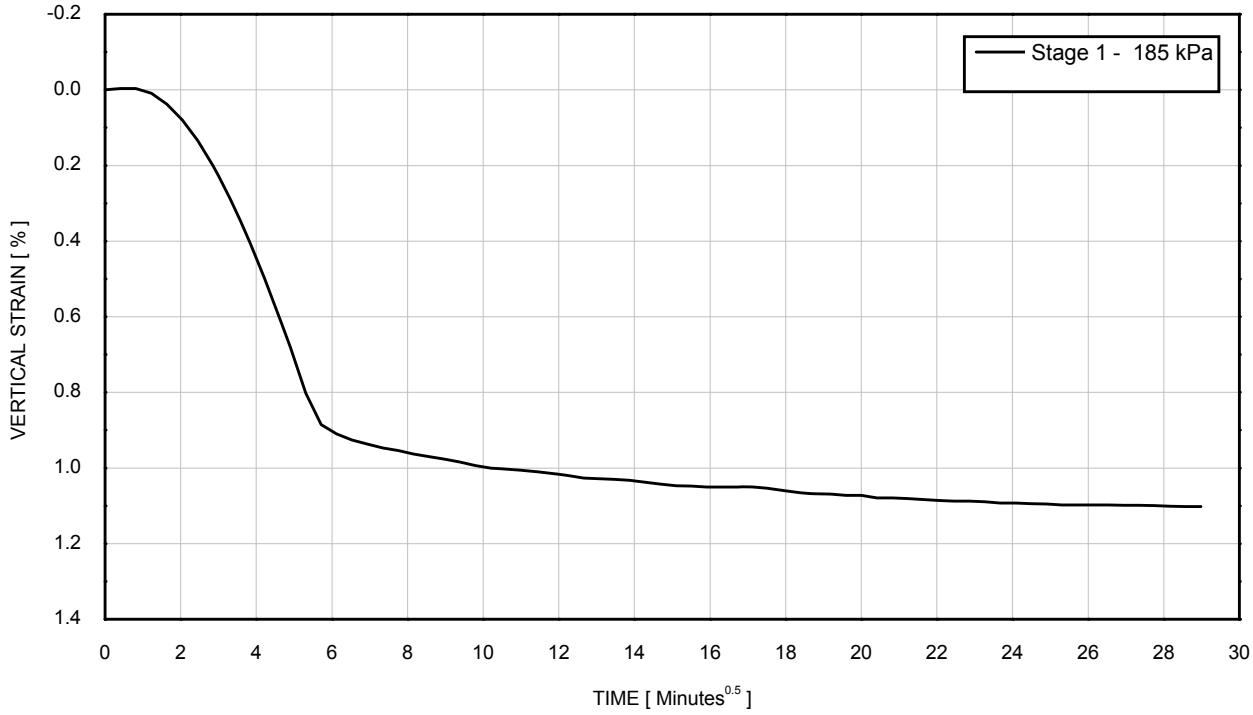
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

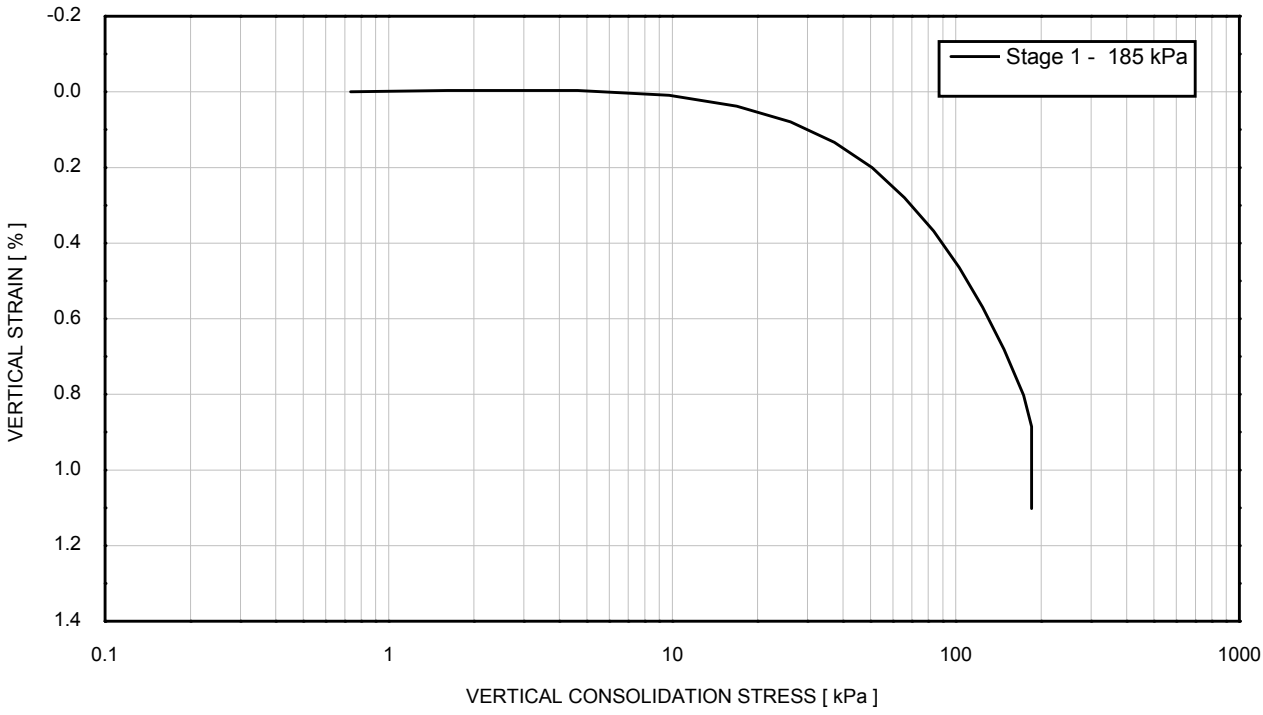
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS2-3
Sample	9WAXB
Depth [m]	18.06
Test number	DSS02

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

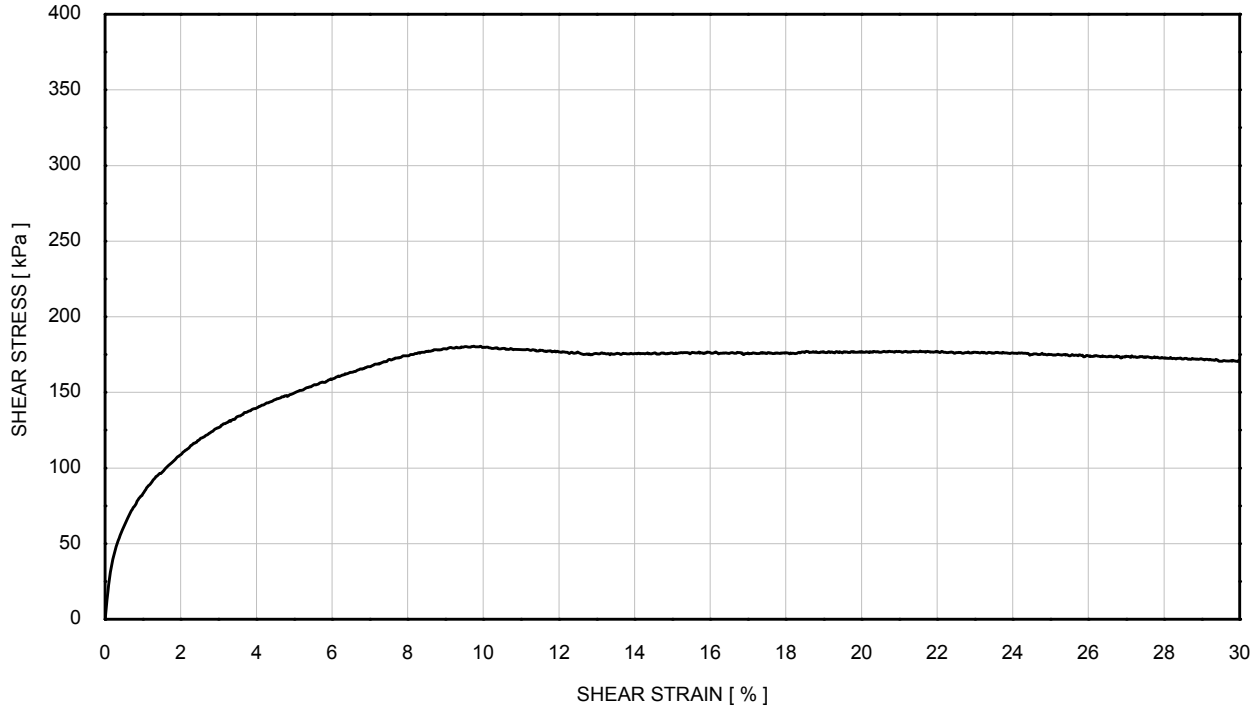


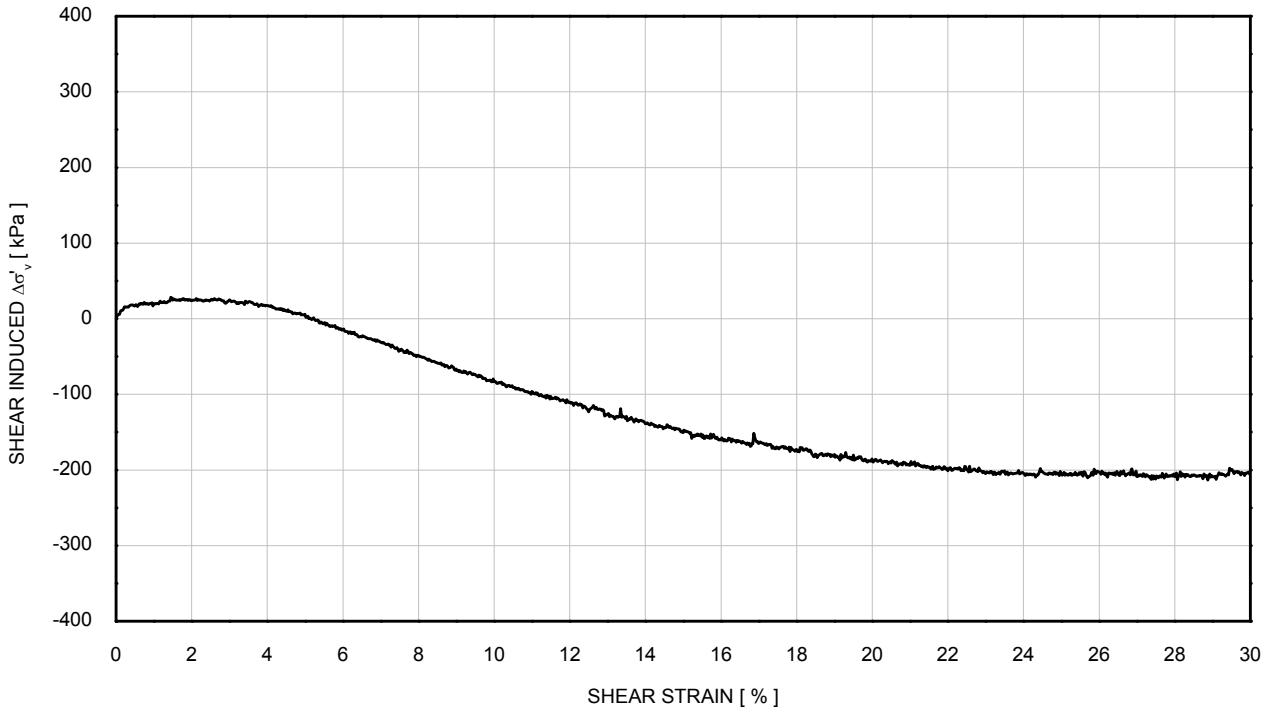


σ'_{vc}	: 185 kPa	Borehole	: BH-WFS2-3
		Sample	: 9WAXB
		Depth [m]	: 18.06
		Test No.	: DSS02

CONSOLIDATED DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

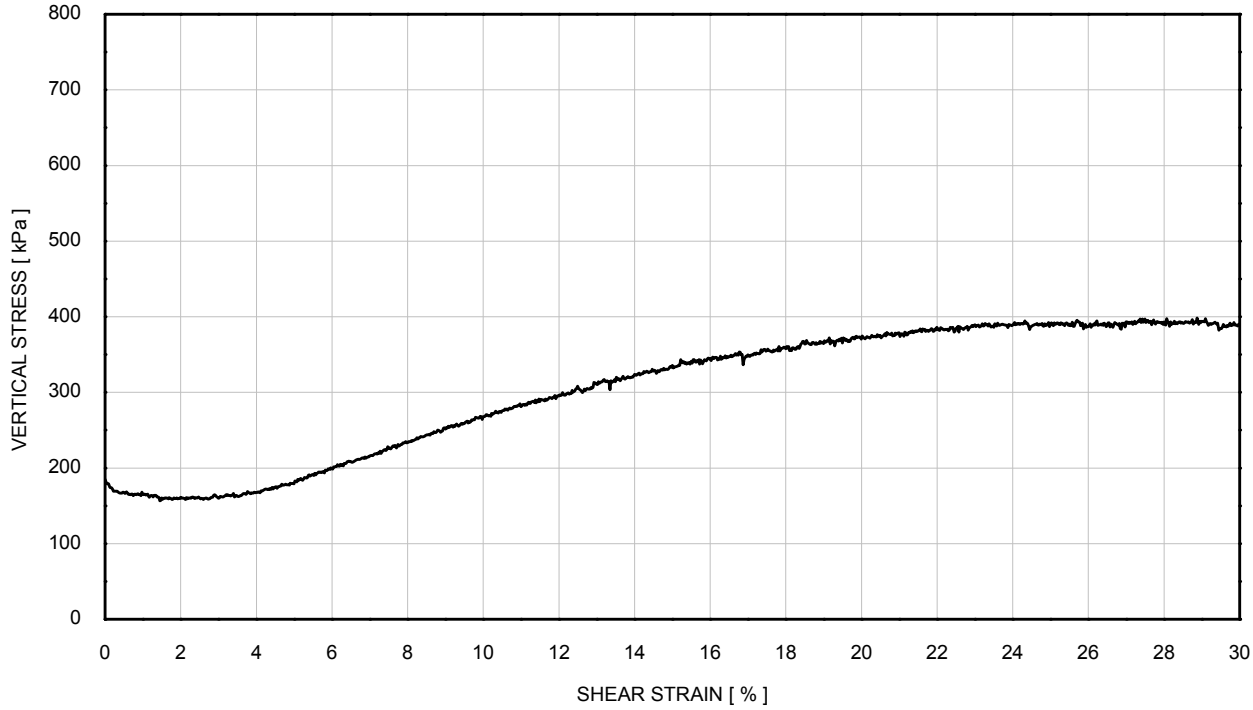


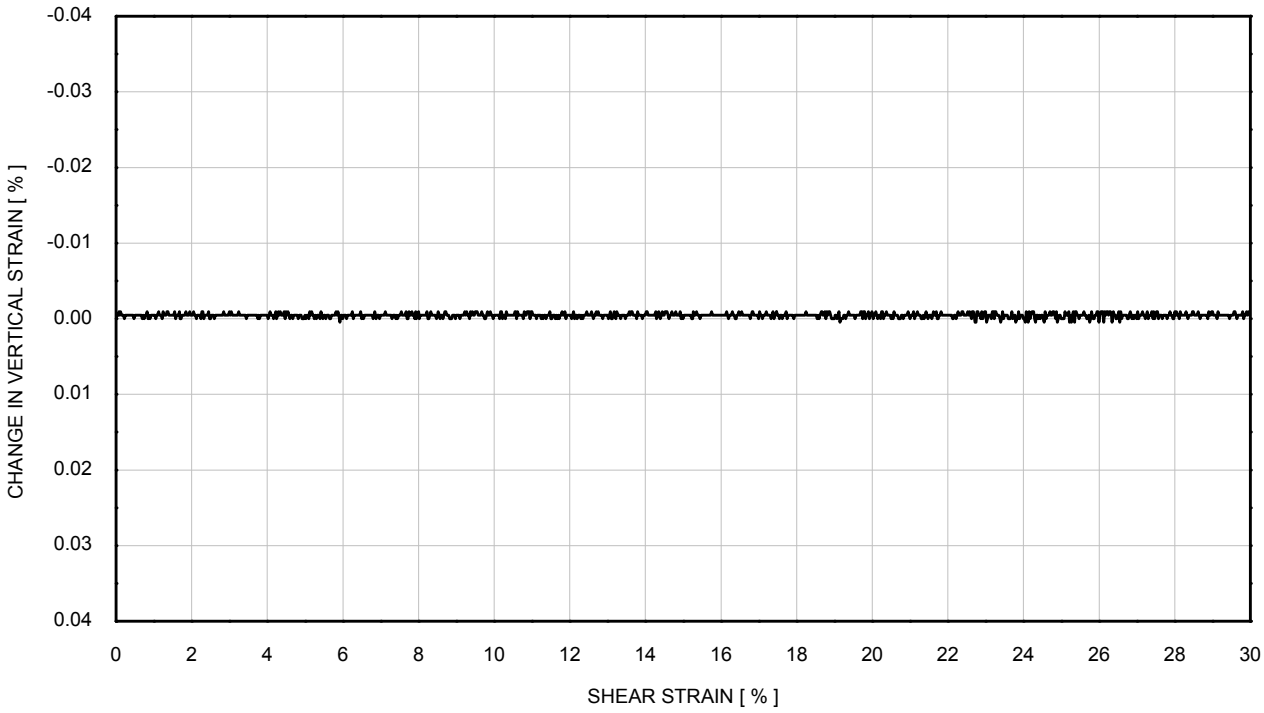


σ'_{vc}	:	185 kPa	Borehole	: BH-WFS2-3
τ_{peak}	:	180 kPa	Sample	: 9WAXB
γ at τ_{peak}	:	9.75 %	Depth [m]	: 18.06
Rate of strain	:	3.00 %/hour	Test No.	: DSS02

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

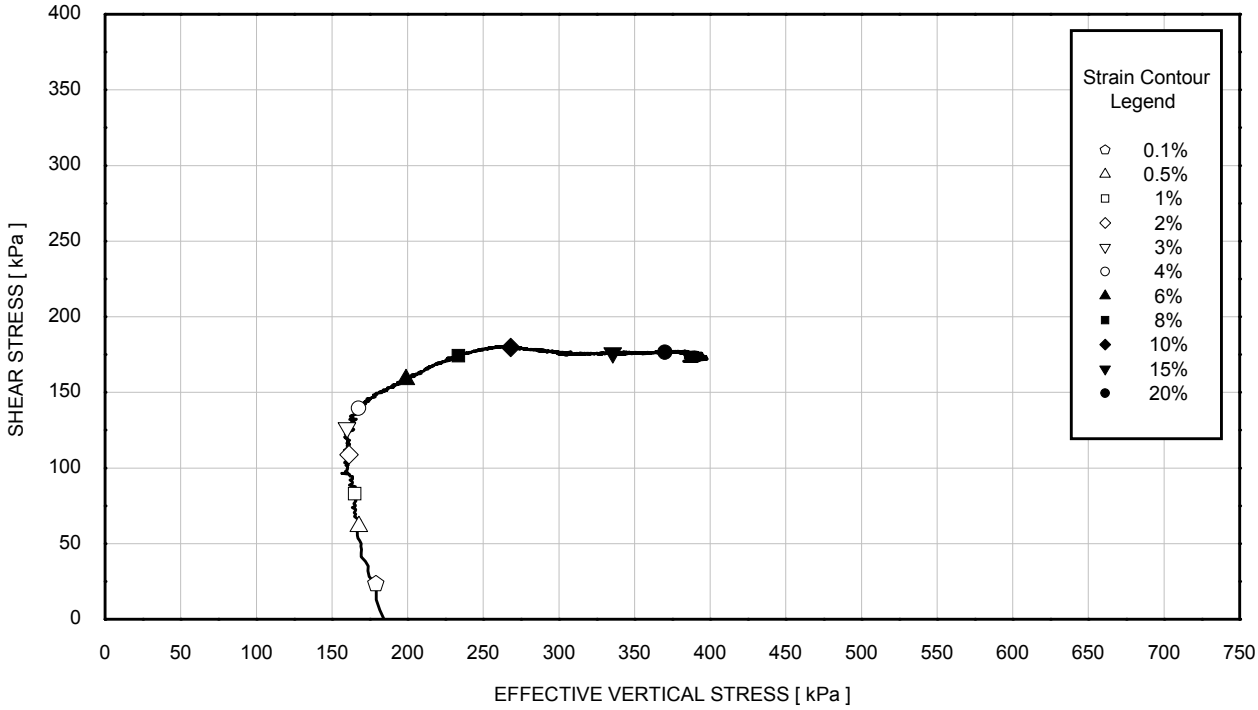


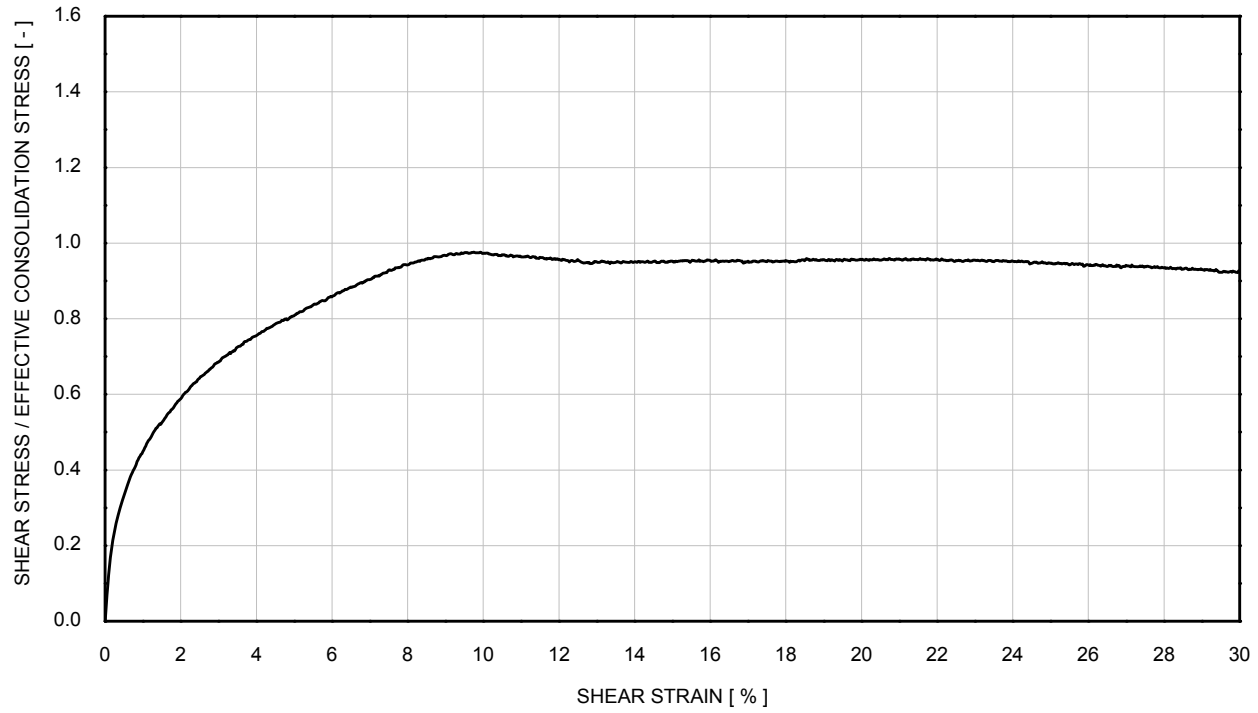


σ'_{vc}	:	185 kPa	Borehole	: BH-WFS2-3
τ_{peak}	:	180 kPa	Sample	: 9WAXB
γ at τ_{peak}	:	9.75 %	Depth [m]	: 18.06
Rate of strain	:	3.00 %/hour	Test No.	: DSS02

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

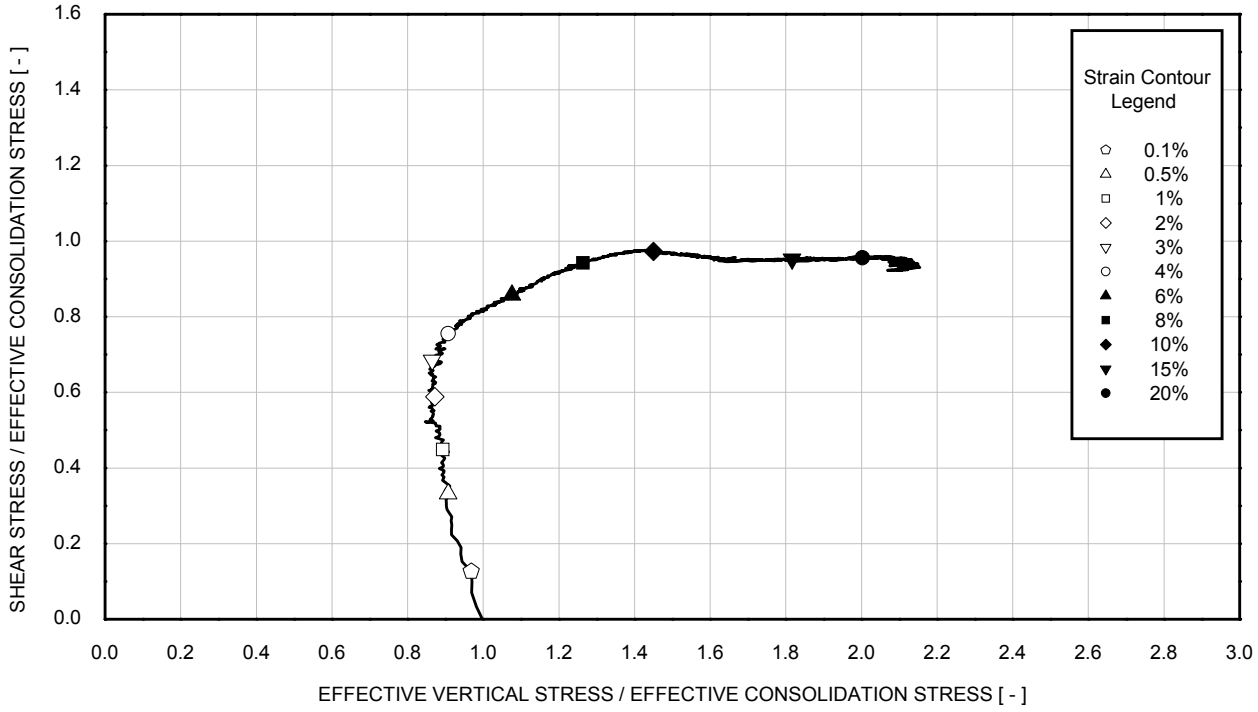


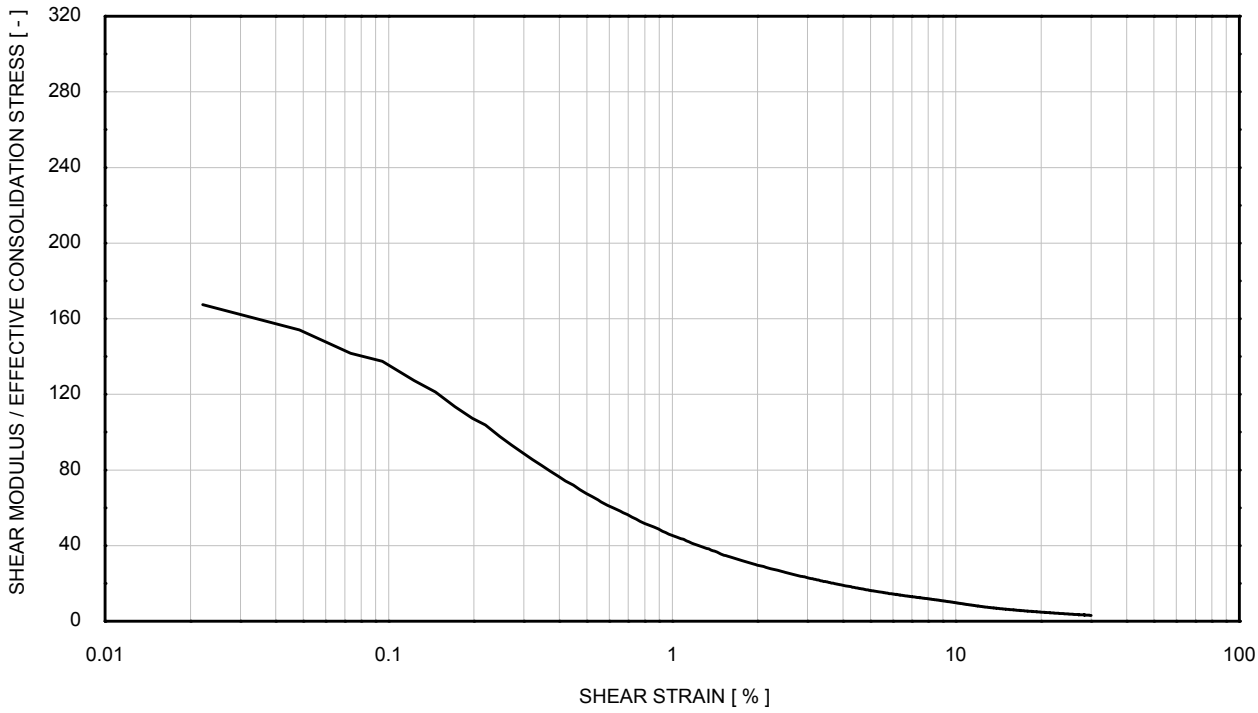


σ'_{vc}	:	185 kPa	Borehole	:	BH-WFS2-3
τ_{peak}	:	180 kPa	Sample	:	9WAXB
γ at τ_{peak}	:	9.75 %	Depth [m]	:	18.06
Rate of strain	:	3.00 %/hour	Test No.	:	DSS02

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	:	185	kPa	Borehole	: BH-WFS2-3
τ_{peak}	:	180	kPa	Sample	: 9WAXB
γ at τ_{peak}	:	9.75	%	Depth [m]	: 18.06
Rate of strain	:	3.00	%/hour	Test No.	: DSS02

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Extremely high strength dark olive brown CLAY

GENERAL	
Date test started	15/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.1
Moisture content	[%]	22.6
Bulk density	[Mg/m³]	2.05
Dry density	[Mg/m³]	1.67
Void ratio	[-]	0.612
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	375
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS1-4_17WAXC_DSS01
Template issue	1.2
Processed by Date	RN 18/06/2015
Checked by Date	PH 22/06/2015
Approved by Date	PH 23/06/2015

TEST IDENTIFICATION	
Borehole	BH-WFS1-4
Sample	17WAXC
Depth [m]	34.76
Test number	DSS01

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	350
Vertical strain	[%]	1.39
Bulk density	[Mg/m^3]	2.06
Dry density	[Mg/m^3]	1.69
Void ratio	[-]	0.597
Moisture content	[%]	22.0

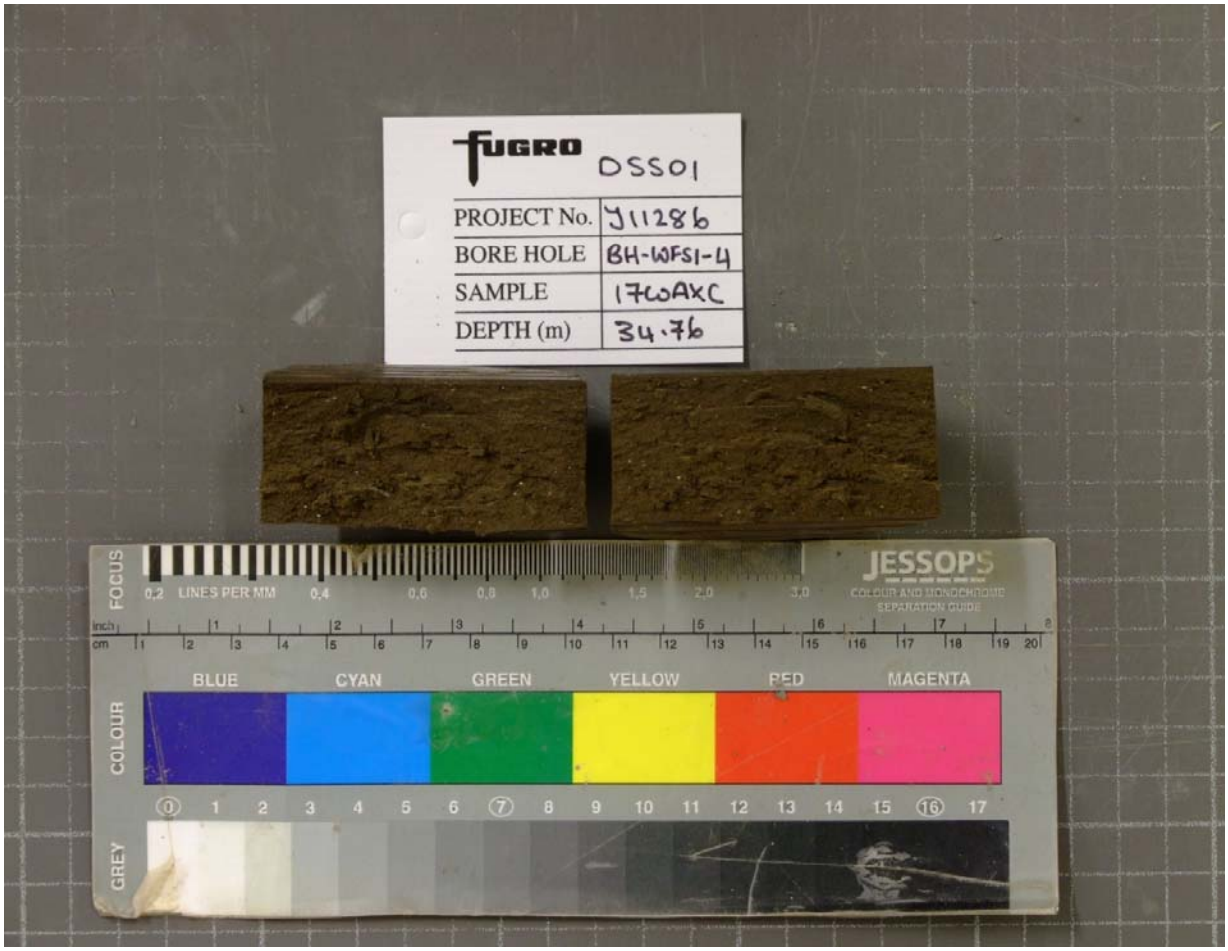
SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	316
Shear strain	[%]	27.47
Shear induced $\Delta\sigma'_v$	[kPa]	-76
Vertical stress	[kPa]	427
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.00
At 15 % shear strain		
Shear stress	[kPa]	288
Shear induced $\Delta\sigma'_v$	[kPa]	-50
Vertical stress	[kPa]	400
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS1-4
Sample	17WAXC
Depth [m]	34.76
Test number	DSS01

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

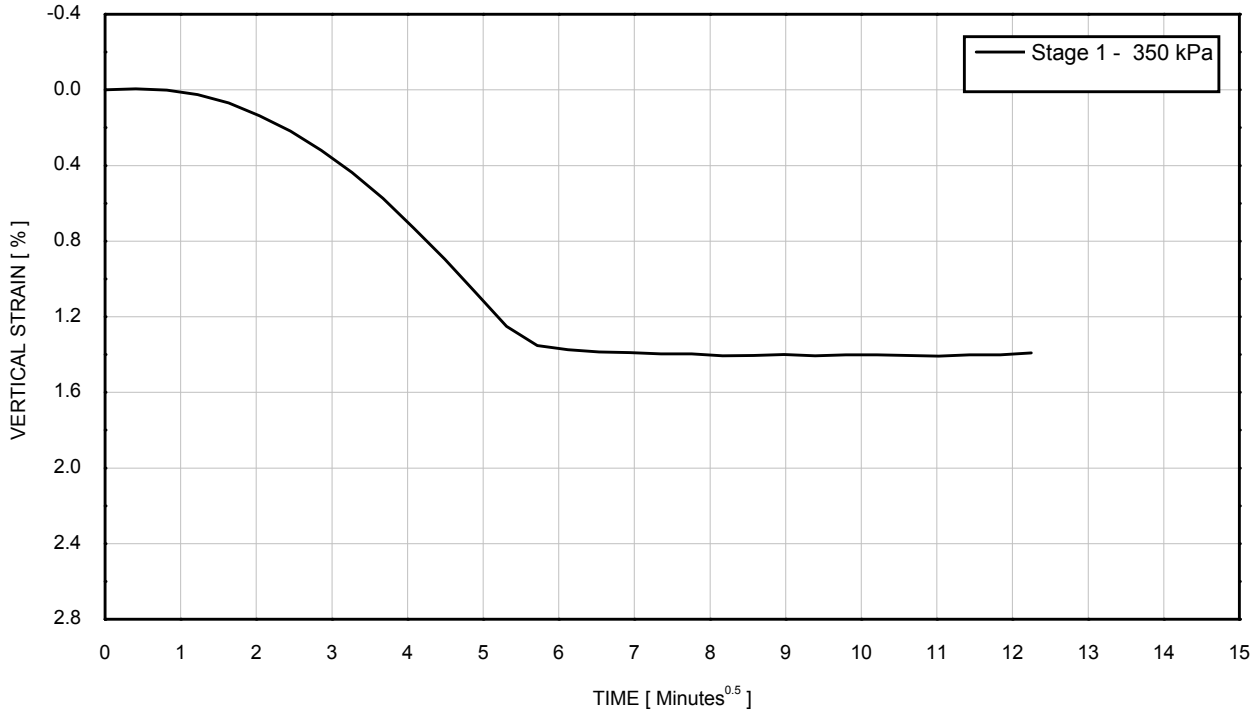
SPECIMEN PHOTOGRAPH

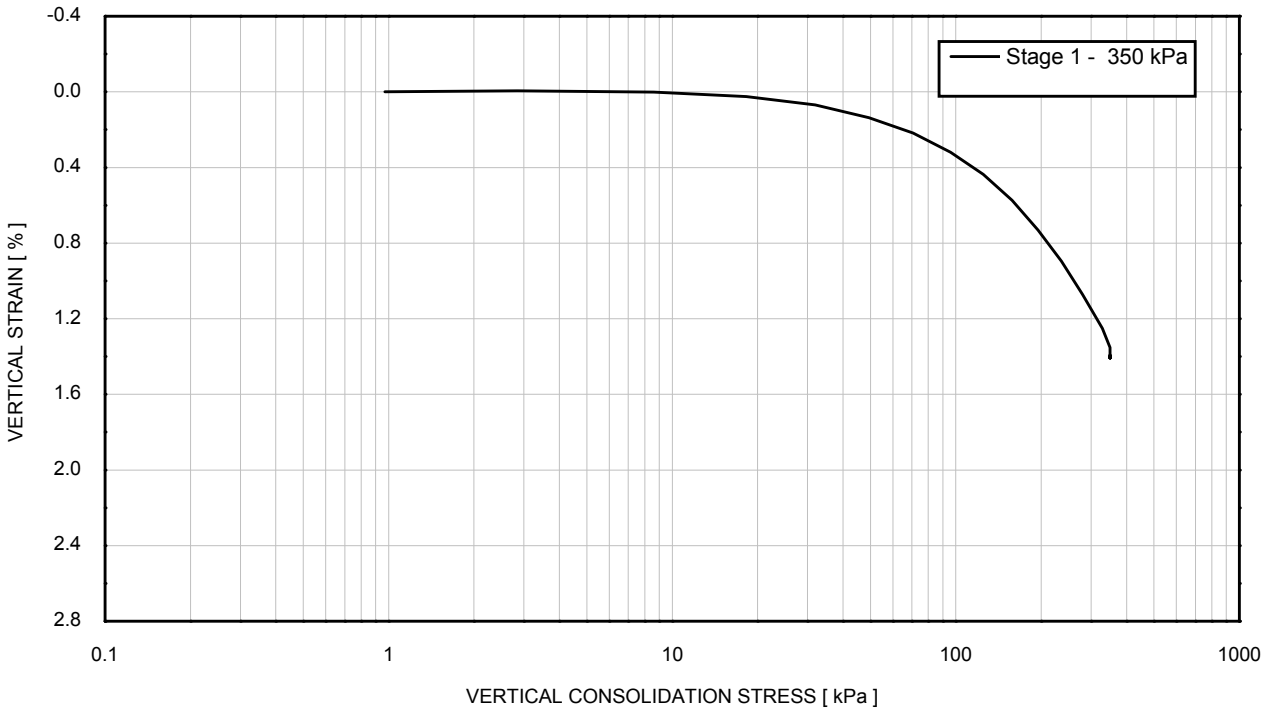


TEST IDENTIFICATION	
Borehole	BH-WFS1-4
Sample	17WAXC
Depth [m]	34.76
Test number	DSS01

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

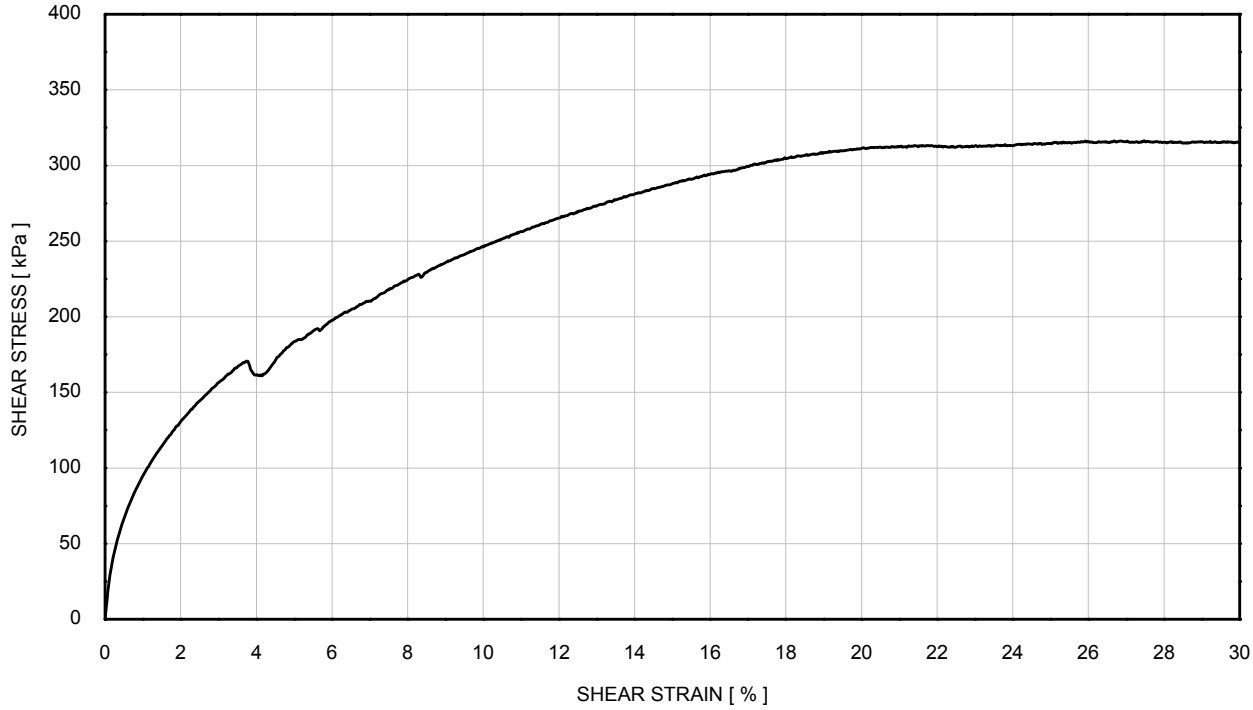


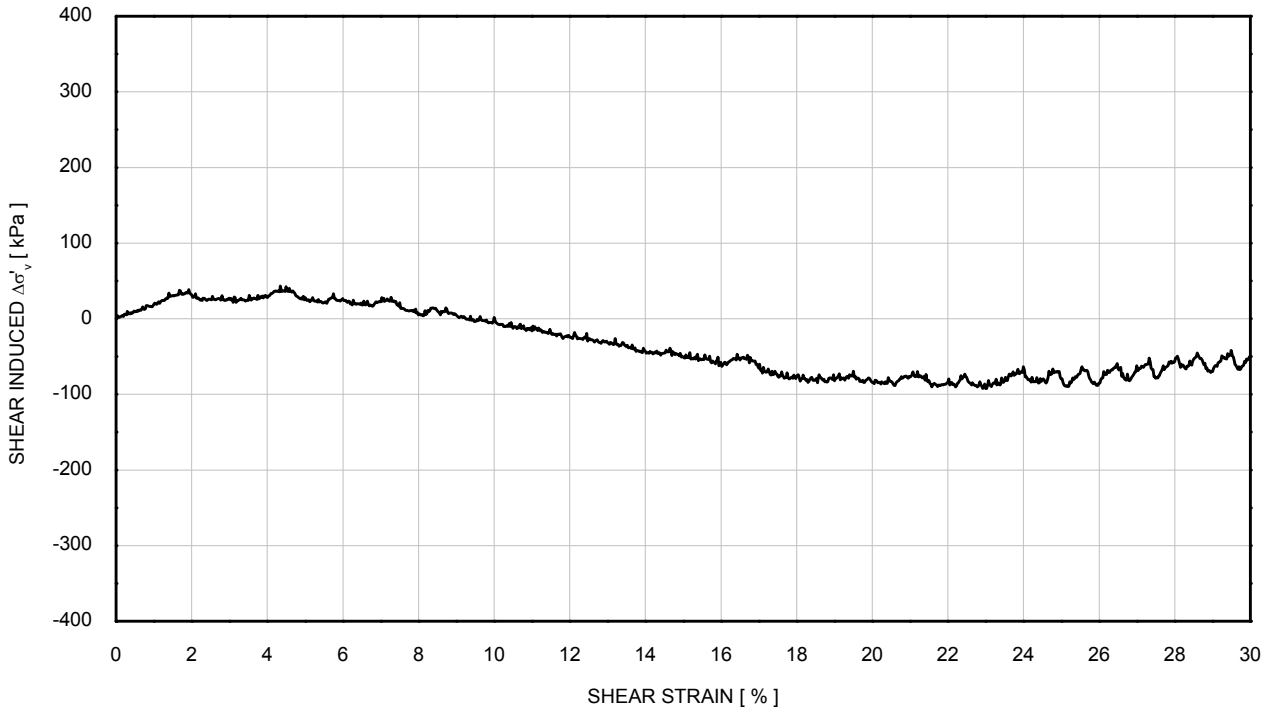


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS1-4
		Sample	: 17WAXC
		Depth [m]	: 34.76
		Test No.	: DSS01

CONSOLIDATED DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

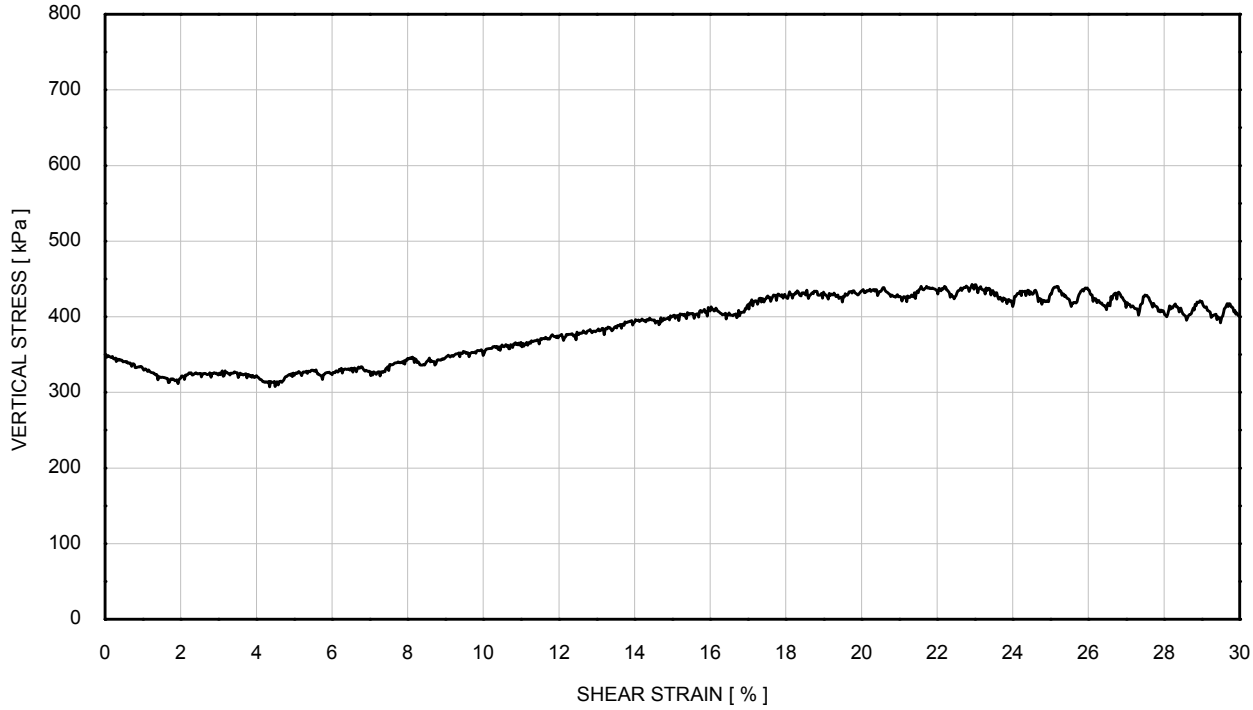


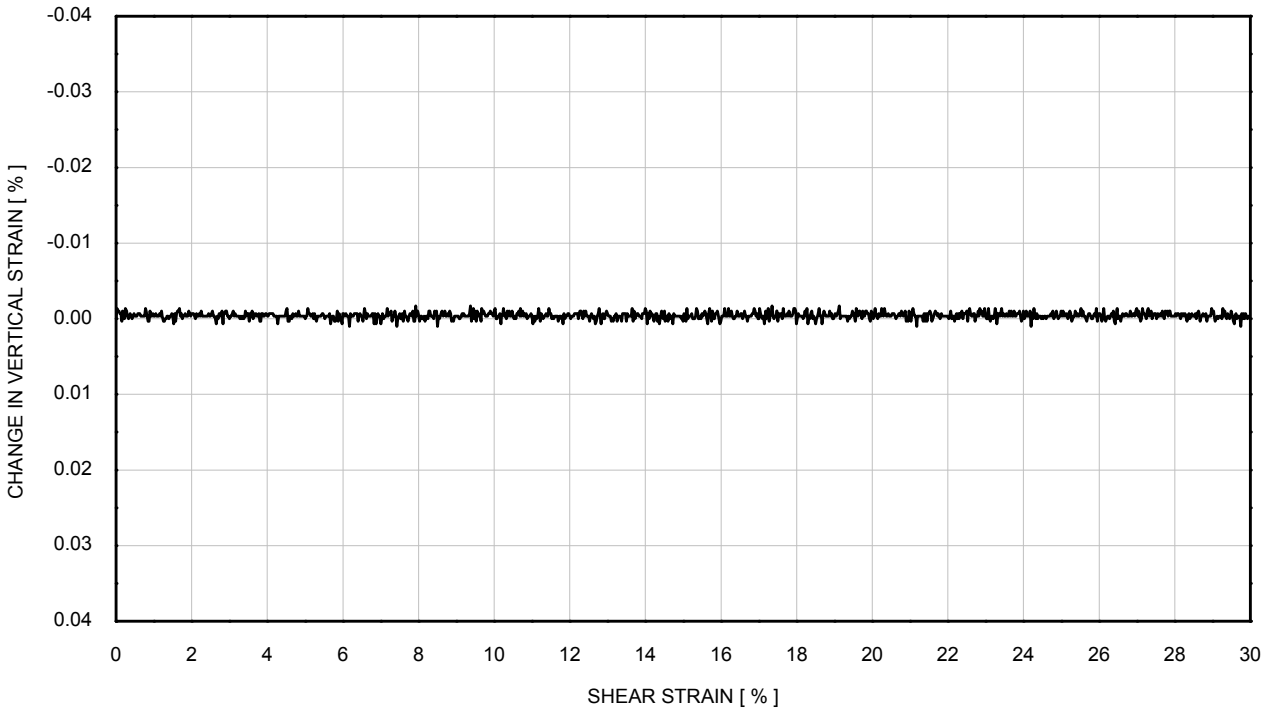


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS1-4
τ_{peak}	: 316 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.47 %	Depth [m]	: 34.76
Rate of strain	: 3.00 %/hour	Test No.	: DSS01

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

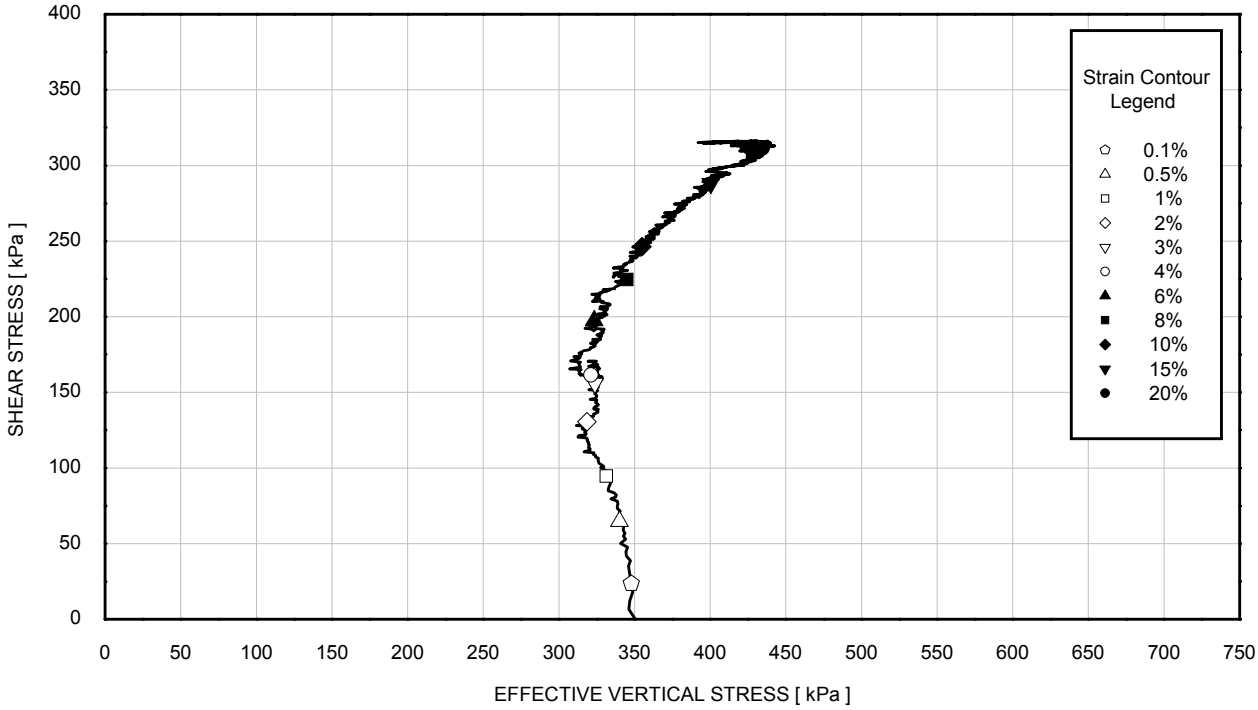


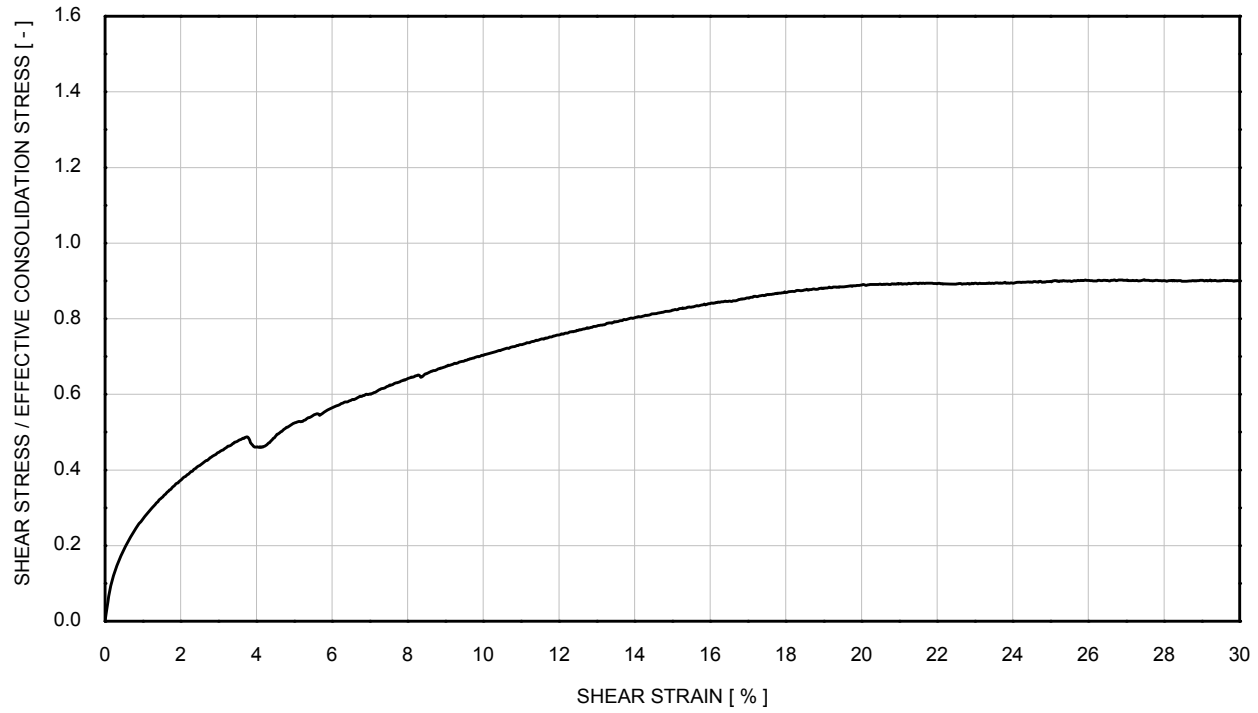


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS1-4
τ_{peak}	: 316 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.47 %	Depth [m]	: 34.76
Rate of strain	: 3.00 %/hour	Test No.	: DSS01

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

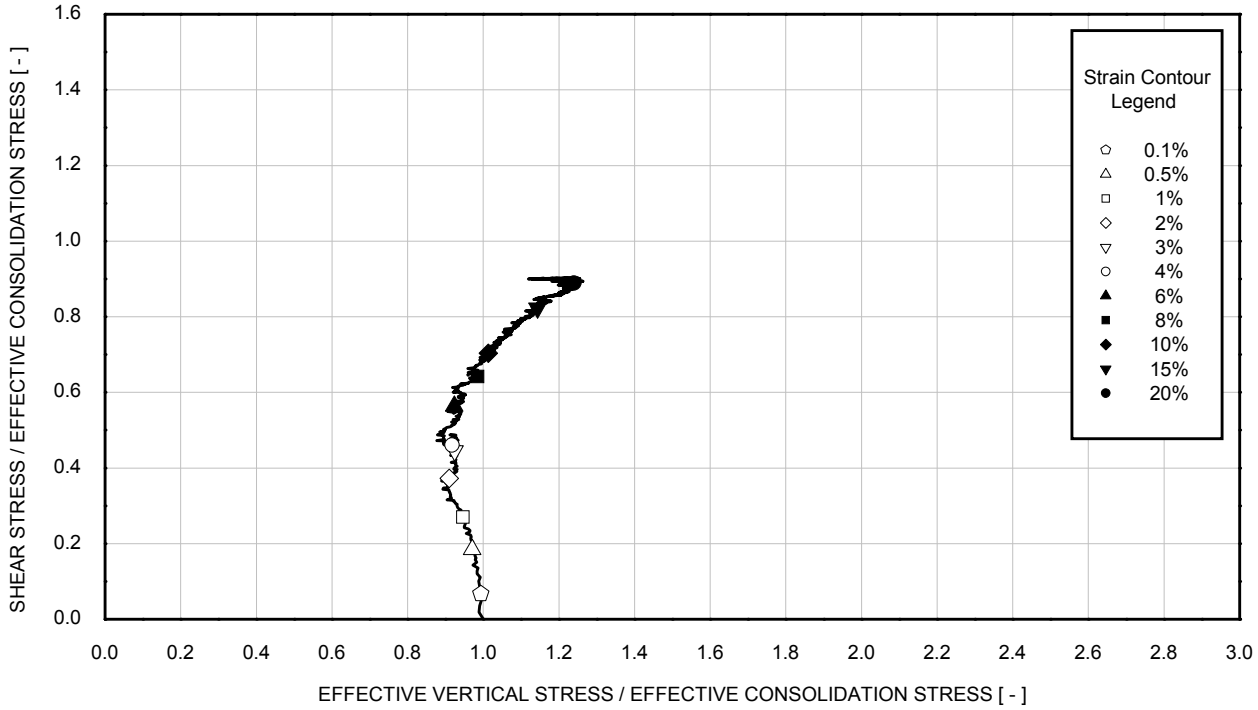


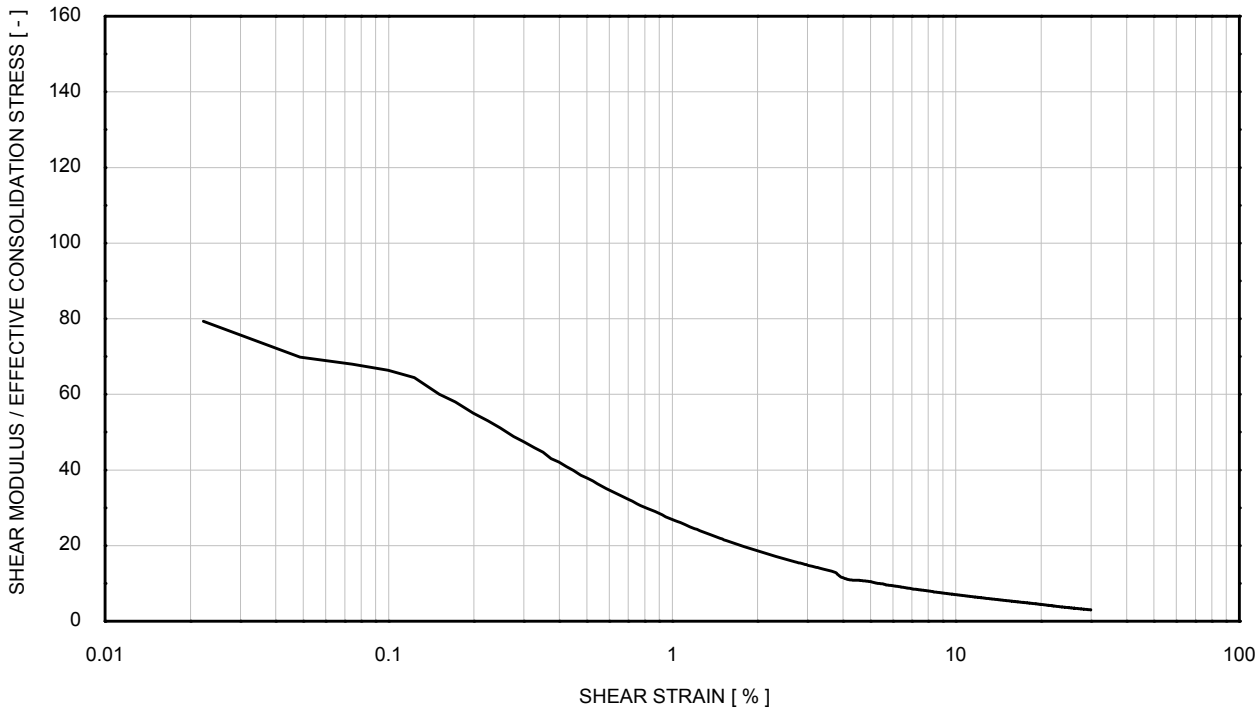


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS1-4
τ_{peak}	: 316 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.47 %	Depth [m]	: 34.76
Rate of strain	: 3.00 %/hour	Test No.	: DSS01

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	:	350 kPa	Borehole	: BH-WFS1-4
τ_{peak}	:	316 kPa	Sample	: 17WAXC
γ at τ_{peak}	:	27.47 %	Depth [m]	: 34.76
Rate of strain	:	3.00 %/hour	Test No.	: DSS01

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength dark grey sandy CLAY

GENERAL	
Date test started	15/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	66.1
Length	[mm]	30.1
Moisture content	[%]	23.8
Bulk density	[Mg/m³]	1.91
Dry density	[Mg/m³]	1.54
Void ratio	[-]	0.751
Degree of saturation	[%]	85
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	40
Pocket penetrometer	[kPa]	175
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS2-6A_15WAXB_DSS03
Template issue	1.2
Processed by Date	RN 18/06/2015
Checked by Date	PH 23/06/2015
Approved by Date	PH 23/06/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	15WAXB
Depth [m]	40.06
Test number	DSS03

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	400
Vertical strain	[%]	6.22
Bulk density	[Mg/m^3]	1.95
Dry density	[Mg/m^3]	1.61
Void ratio	[-]	0.676
Moisture content	[%]	21.0

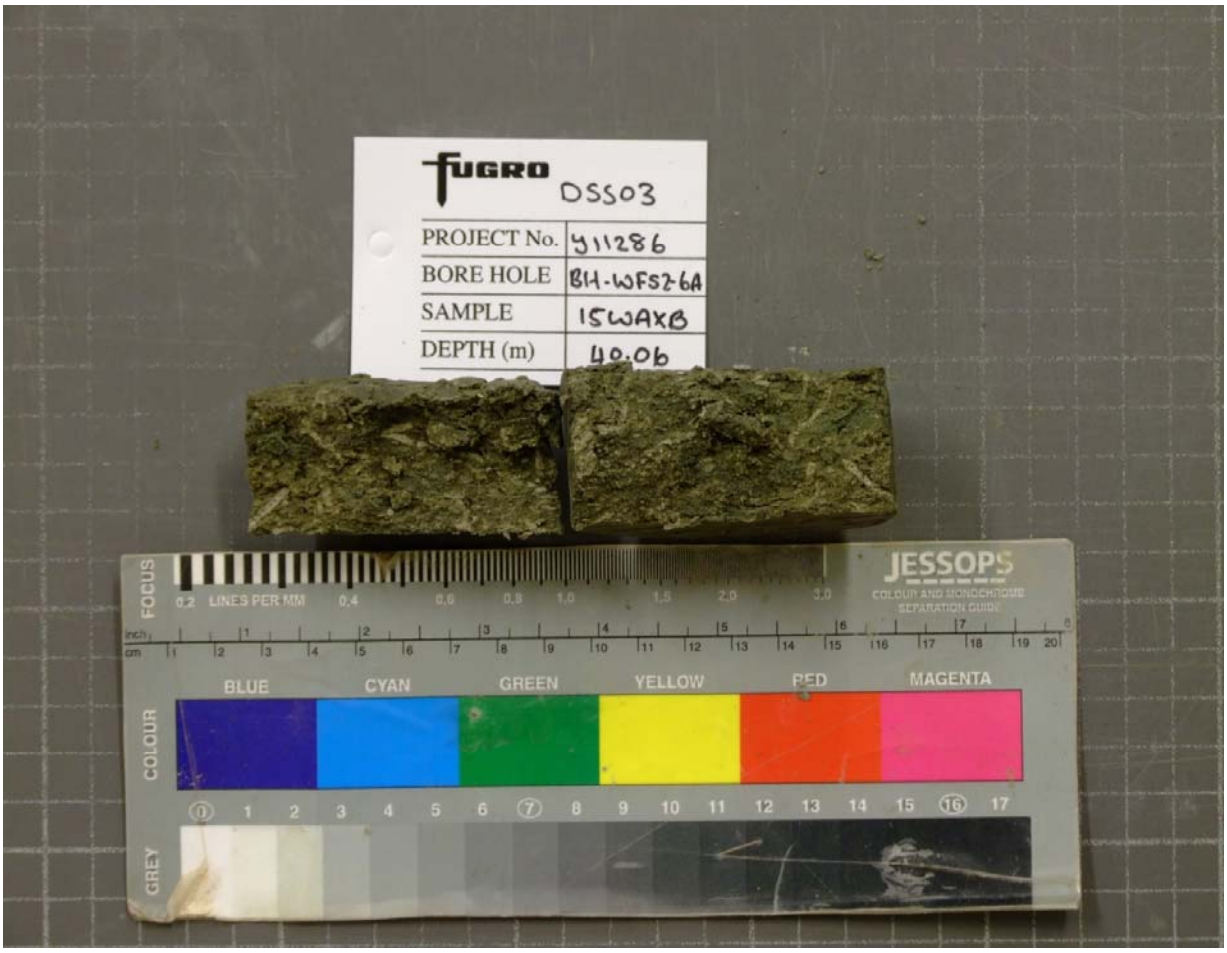
SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	152
Shear strain	[%]	14.65
Shear induced $\Delta\sigma'_v$	[kPa]	115
Vertical stress	[kPa]	285
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.00
At 15 % shear strain		
Shear stress	[kPa]	151
Shear induced $\Delta\sigma'_v$	[kPa]	117
Vertical stress	[kPa]	283
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	15WAXB
Depth [m]	40.06
Test number	DSS03

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

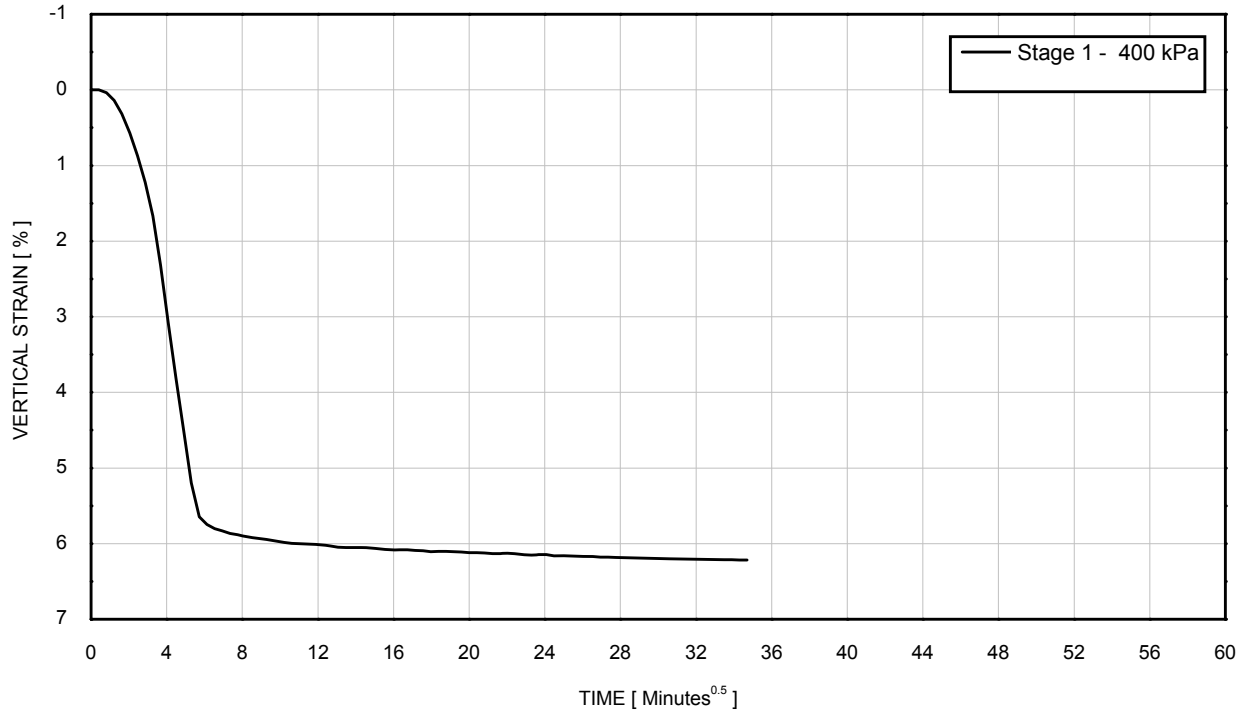
SPECIMEN PHOTOGRAPH

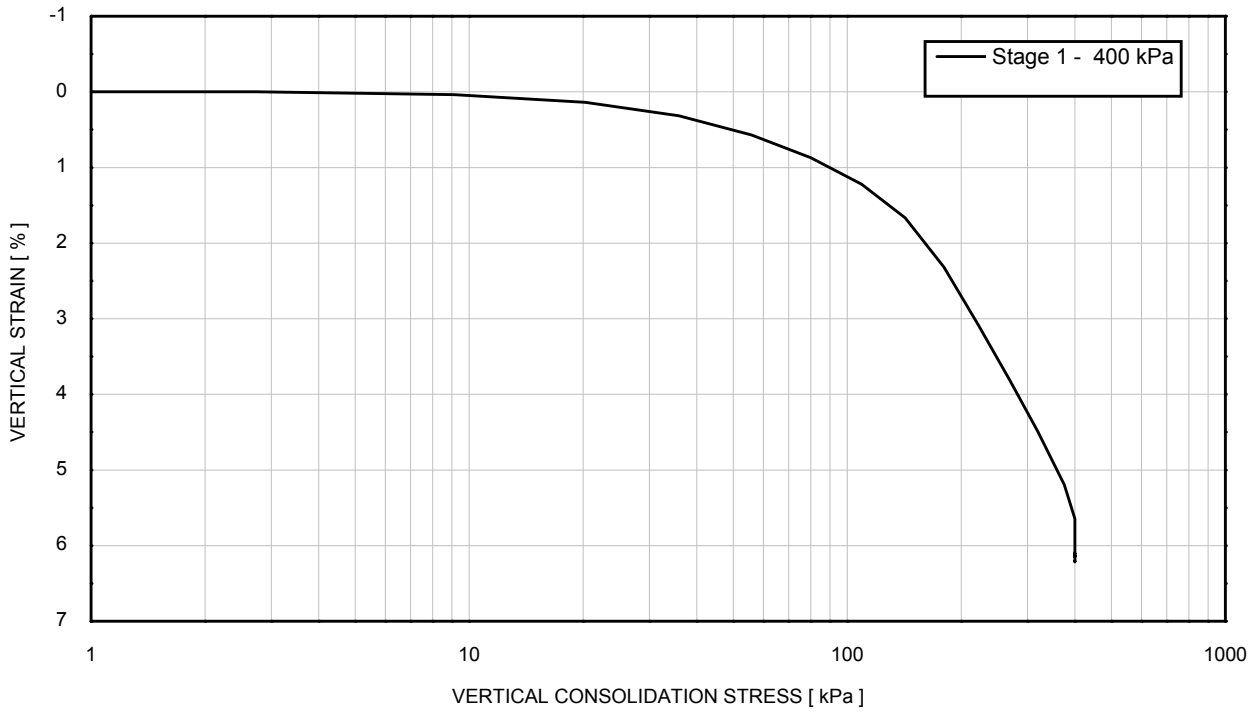


TEST IDENTIFICATION	
Borehole	BH-WFS2-6A
Sample	15WAXB
Depth [m]	40.06
Test number	DSS03

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

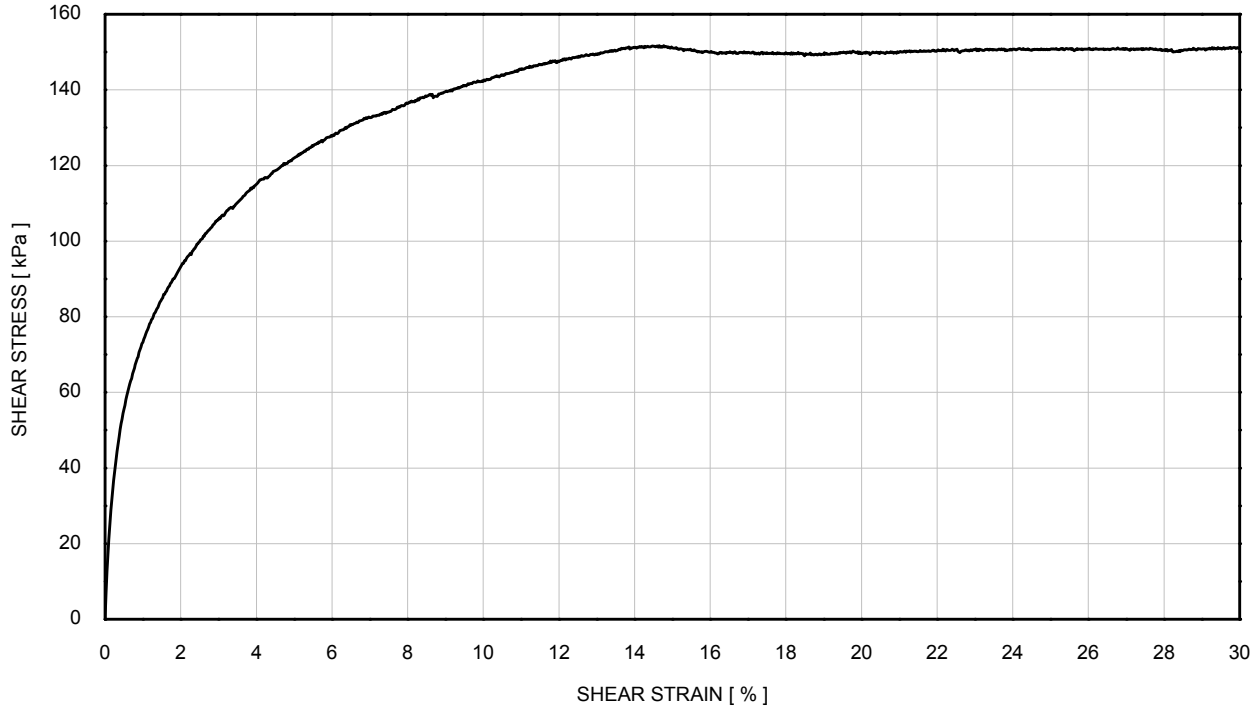


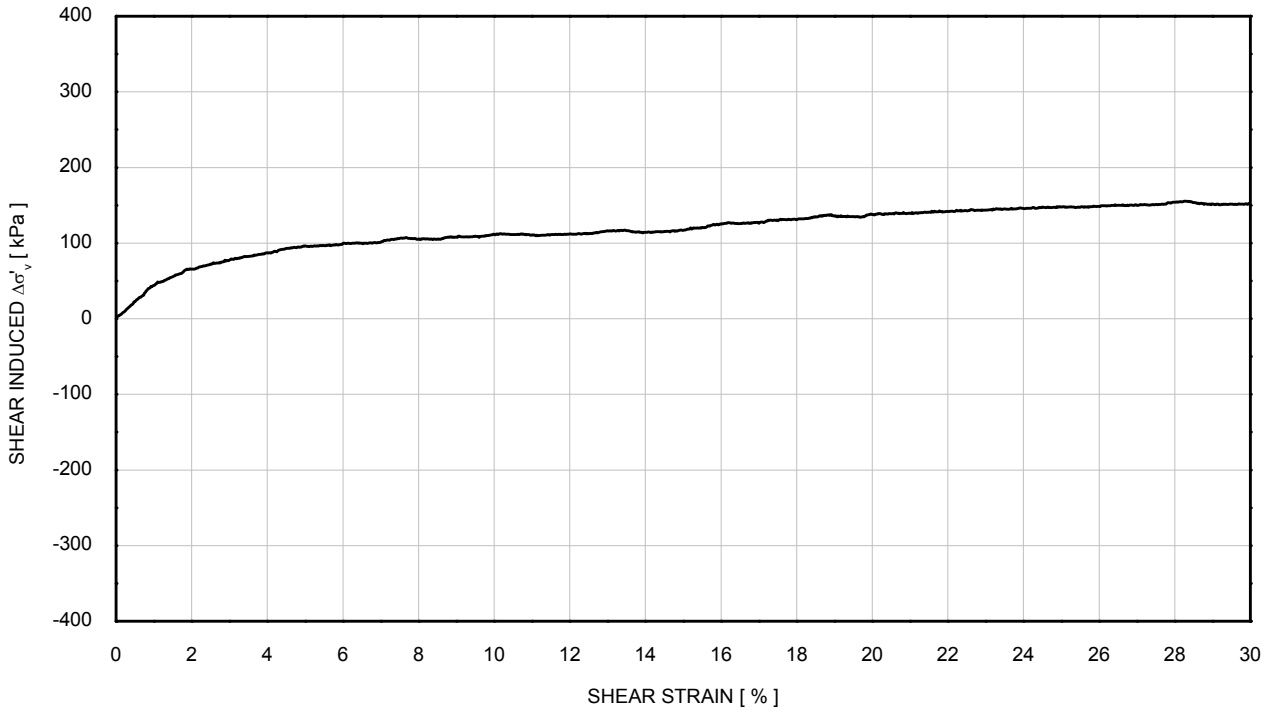


σ'_{vc}	: 400 kPa	Borehole	: BH-WFS2-6A
		Sample	: 15WAXB
		Depth [m]	: 40.06
		Test No.	: DSS03

CONSOLIDATED DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

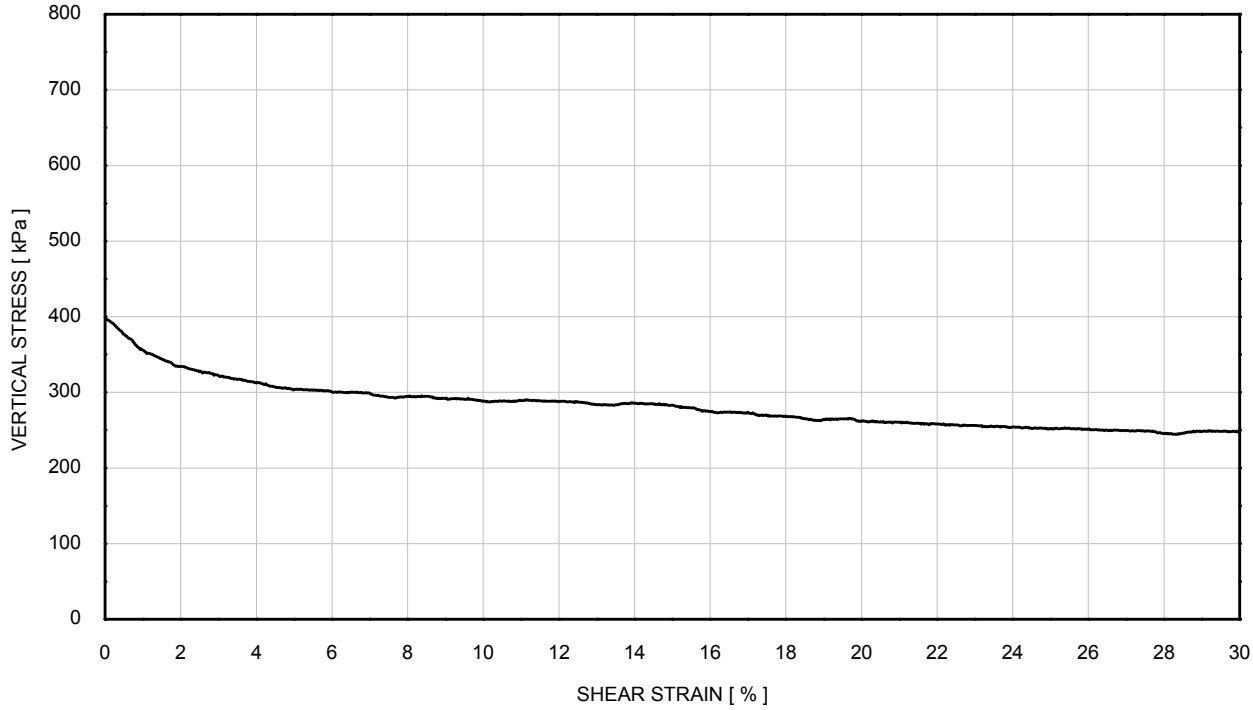


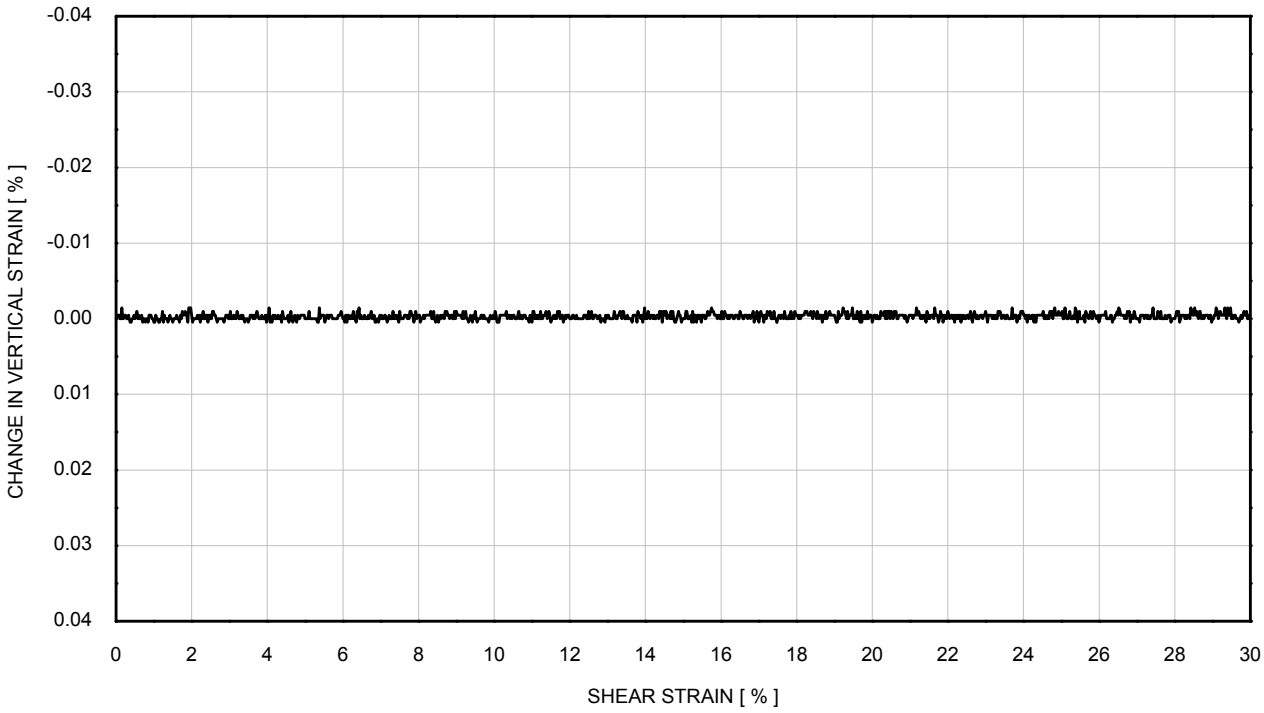


σ'_{vc}	: 400 kPa	Borehole	: BH-WFS2-6A
τ_{peak}	: 152 kPa	Sample	: 15WAXB
γ at τ_{peak}	: 14.65 %	Depth [m]	: 40.06
Rate of strain	: 3.00 %/hour	Test No.	: DSS03

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

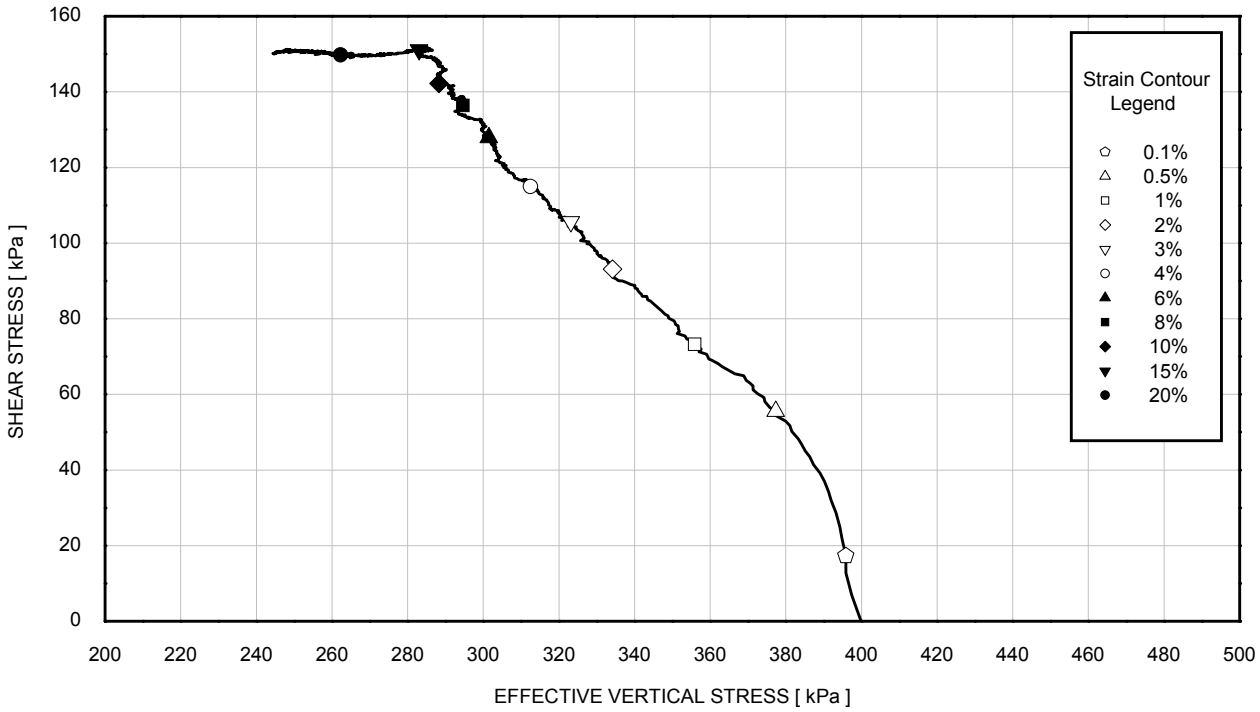


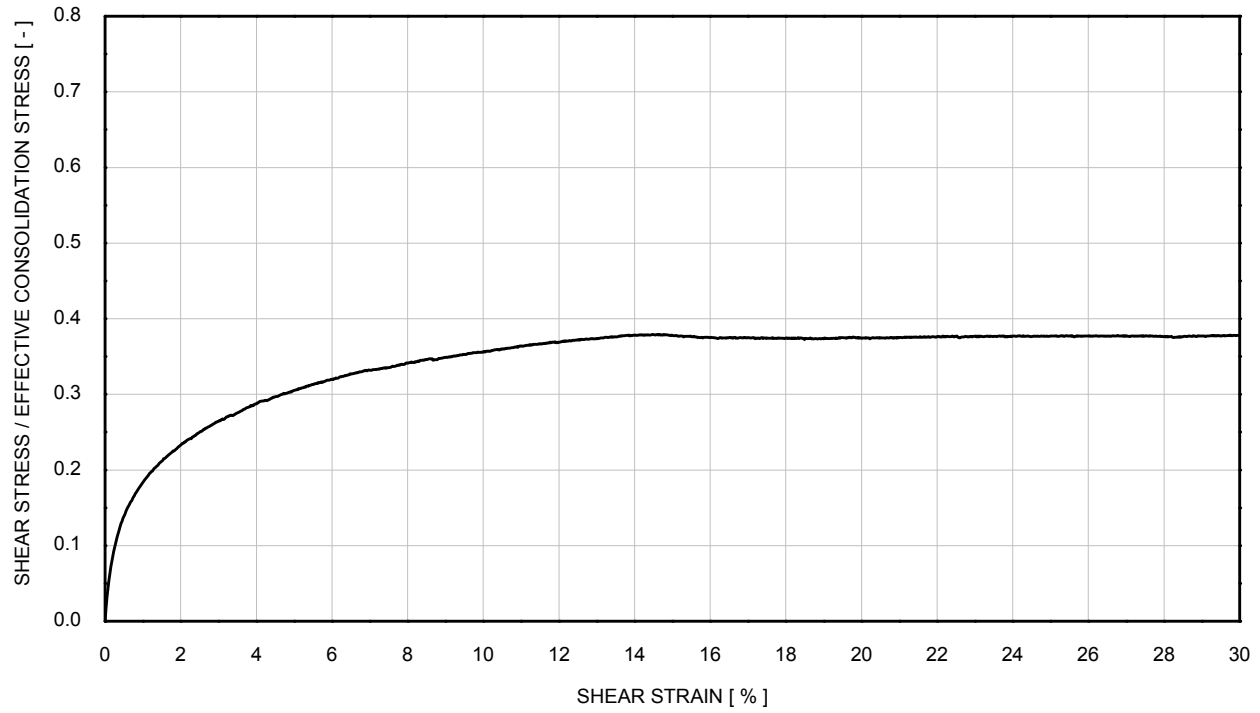


σ'_{vc}	: 400 kPa	Borehole	: BH-WFS2-6A
τ_{peak}	: 152 kPa	Sample	: 15WAXB
γ at τ_{peak}	: 14.65 %	Depth [m]	: 40.06
Rate of strain	: 3.00 %/hour	Test No.	: DSS03

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

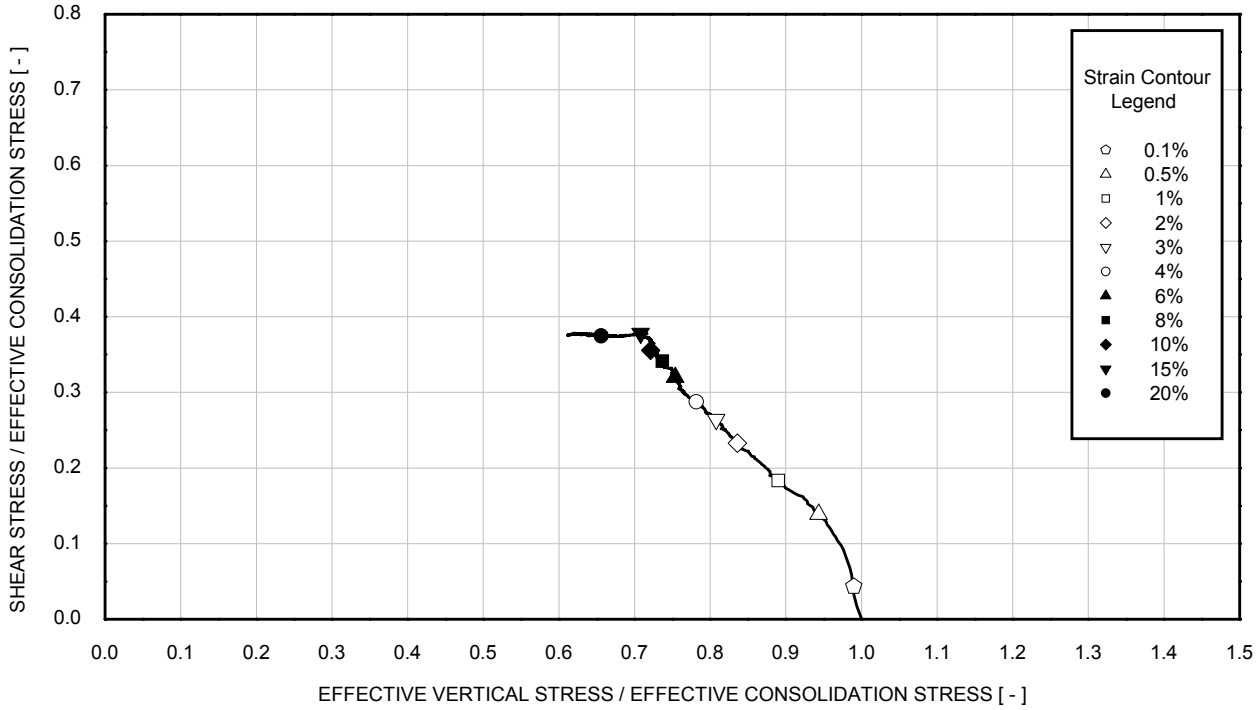


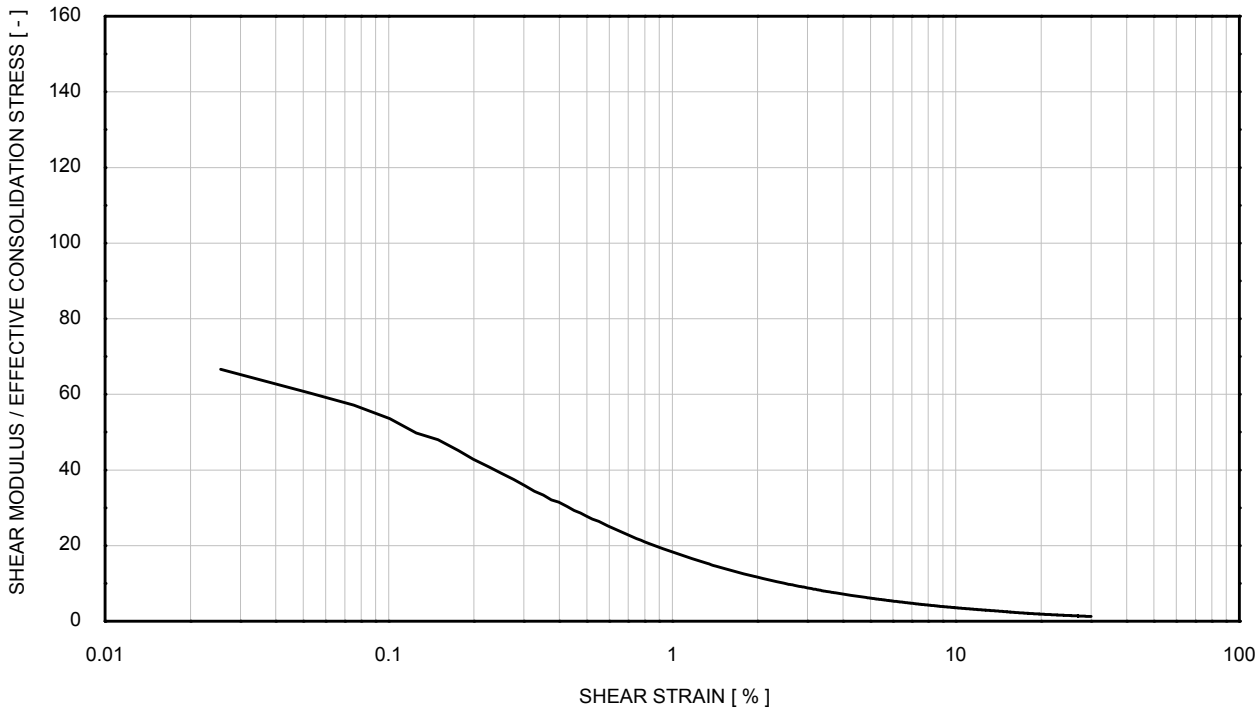


σ'_{vc}	: 400 kPa	Borehole	: BH-WFS2-6A
τ_{peak}	: 152 kPa	Sample	: 15WAXB
γ at τ_{peak}	: 14.65 %	Depth [m]	: 40.06
Rate of strain	: 3.00 %/hour	Test No.	: DSS03

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 400 kPa	Borehole	: BH-WFS2-6A
τ_{peak}	: 152 kPa	Sample	: 15WAXB
γ at τ_{peak}	: 14.65 %	Depth [m]	: 40.06
Rate of strain	: 3.00 %/hour	Test No.	: DSS03

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength dark greenish grey CLAY

GENERAL	
Date test started	15/06/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	66.0
Length	[mm]	30.2
Moisture content	[%]	40.4
Bulk density	[Mg/m³]	1.80
Dry density	[Mg/m³]	1.28
Void ratio	[-]	1.105
Degree of saturation	[%]	99
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	80
Pocket penetrometer	[kPa]	283
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS2-7_19WAXC_DSS04
Template issue	1.2
Processed by Date	HB 18/06/2015
Checked by Date	PH 23/06/2015
Approved by Date	PH 23/06/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXC
Depth [m]	33.31
Test number	DSS04

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.56
Bulk density	[Mg/m^3]	1.81
Dry density	[Mg/m^3]	1.30
Void ratio	[-]	1.082
Moisture content	[%]	39.5

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	253
Shear strain	[%]	11.50
Shear induced $\Delta\sigma'_v$	[kPa]	-109
Vertical stress	[kPa]	419
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.00
At 15 % shear strain		
Shear stress	[kPa]	242
Shear induced $\Delta\sigma'_v$	[kPa]	-131
Vertical stress	[kPa]	441
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXC
Depth [m]	33.31
Test number	DSS04

SUMMARY OF CONSOLIDATED DSS TEST

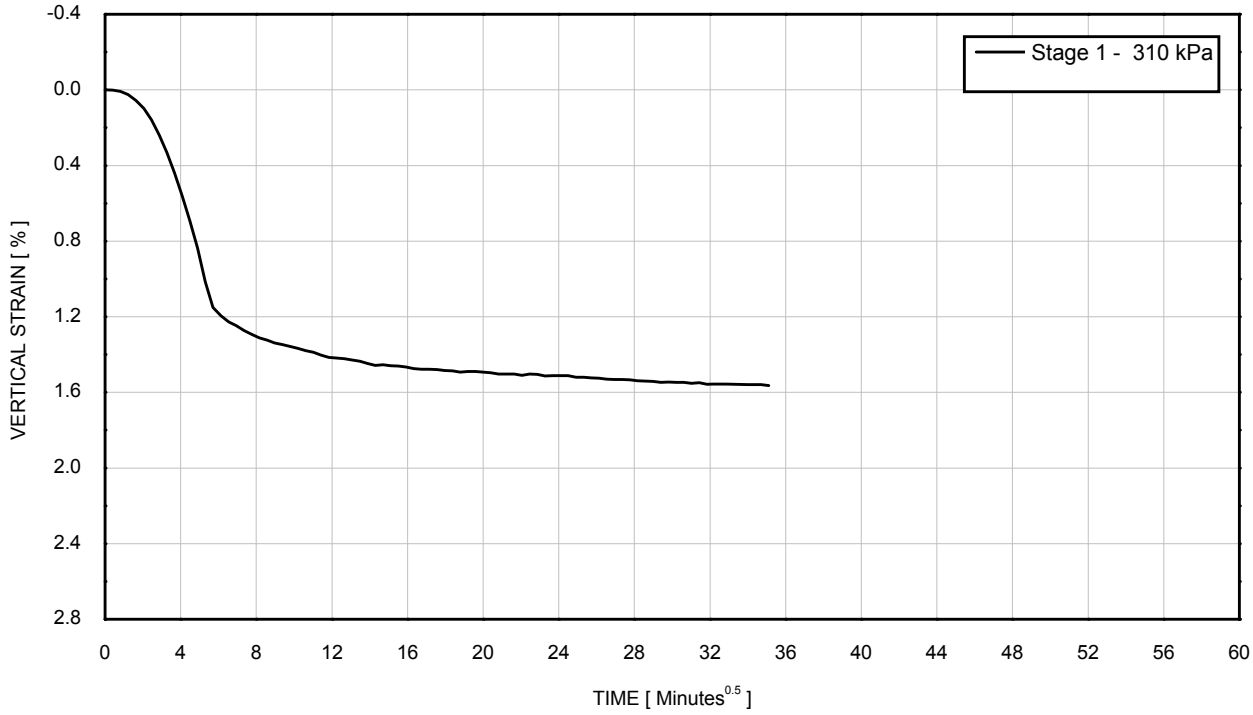
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

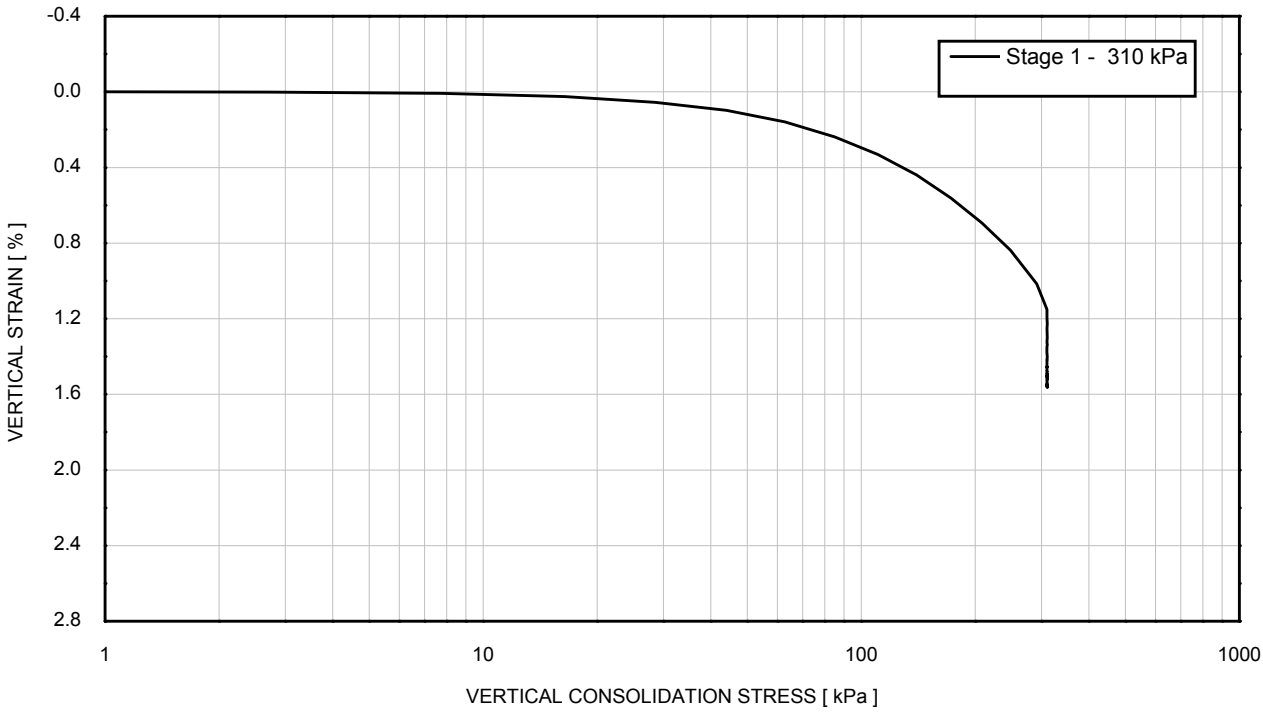
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXC
Depth [m]	33.31
Test number	DSS04

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

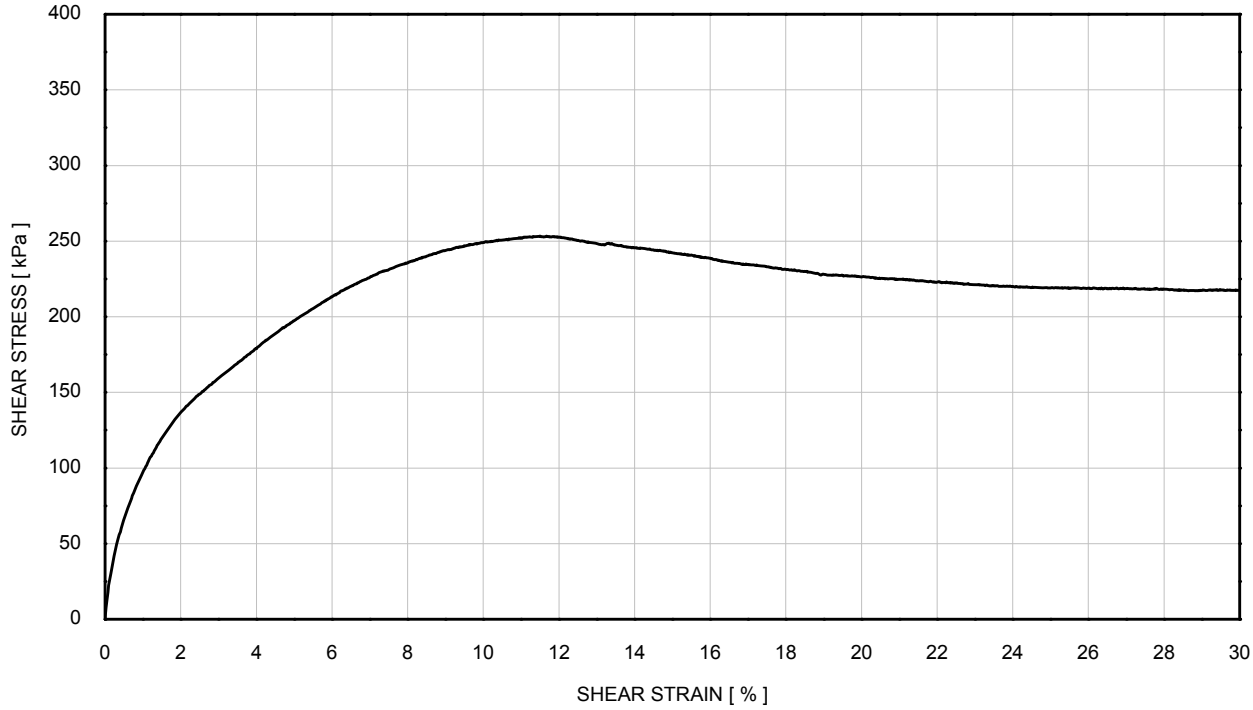


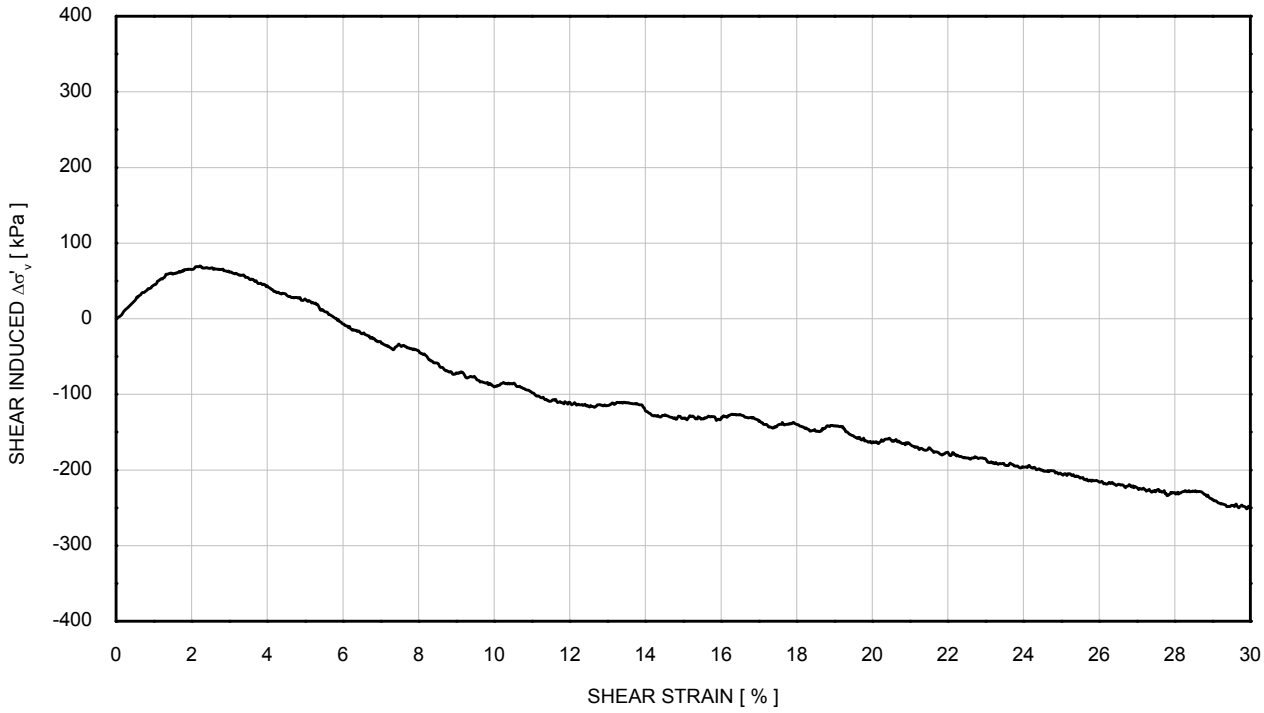


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
		Sample	: 19WAXC
		Depth [m]	: 33.31
		Test No.	: DSS04

CONSOLIDATED DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

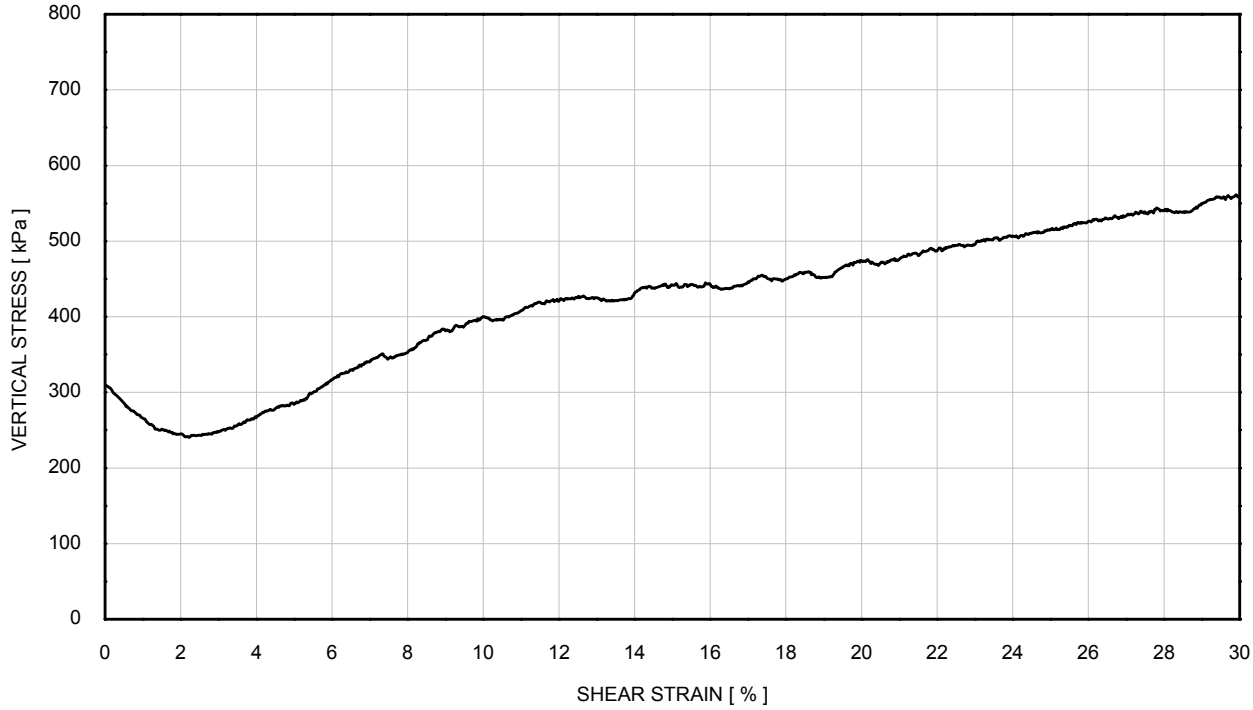


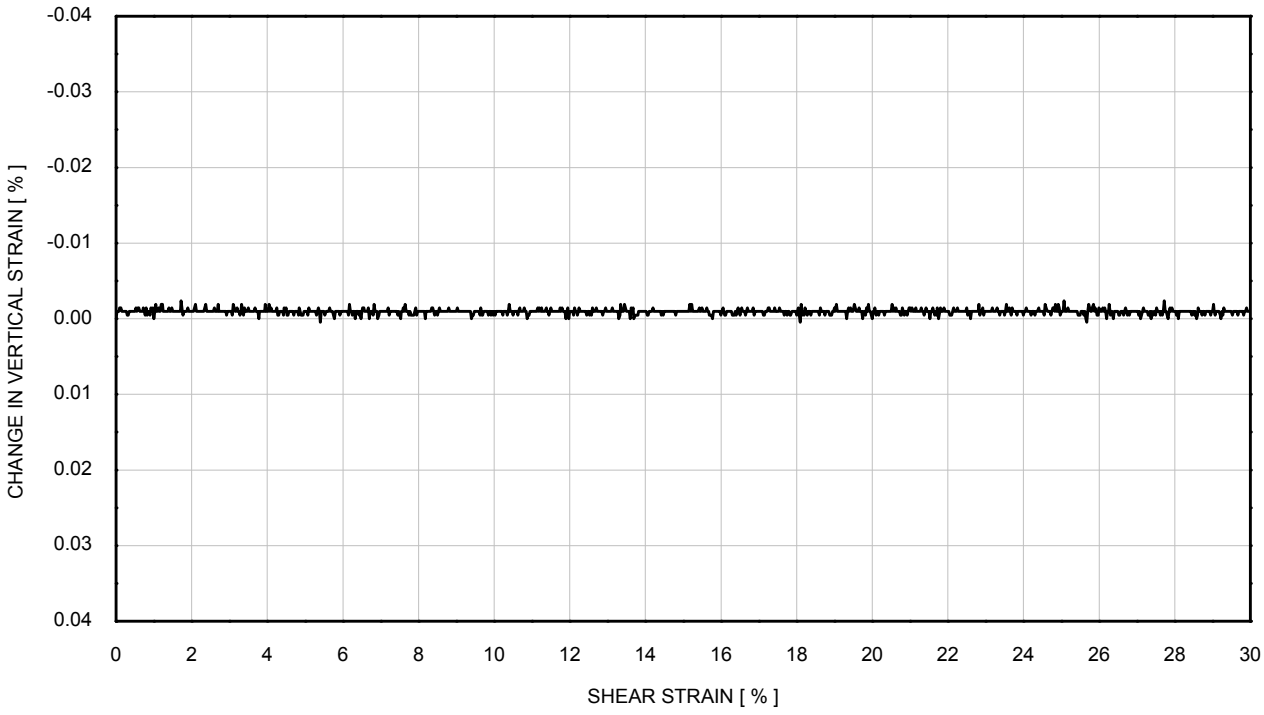


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 253 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 11.50 %	Depth [m]	: 33.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS04

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

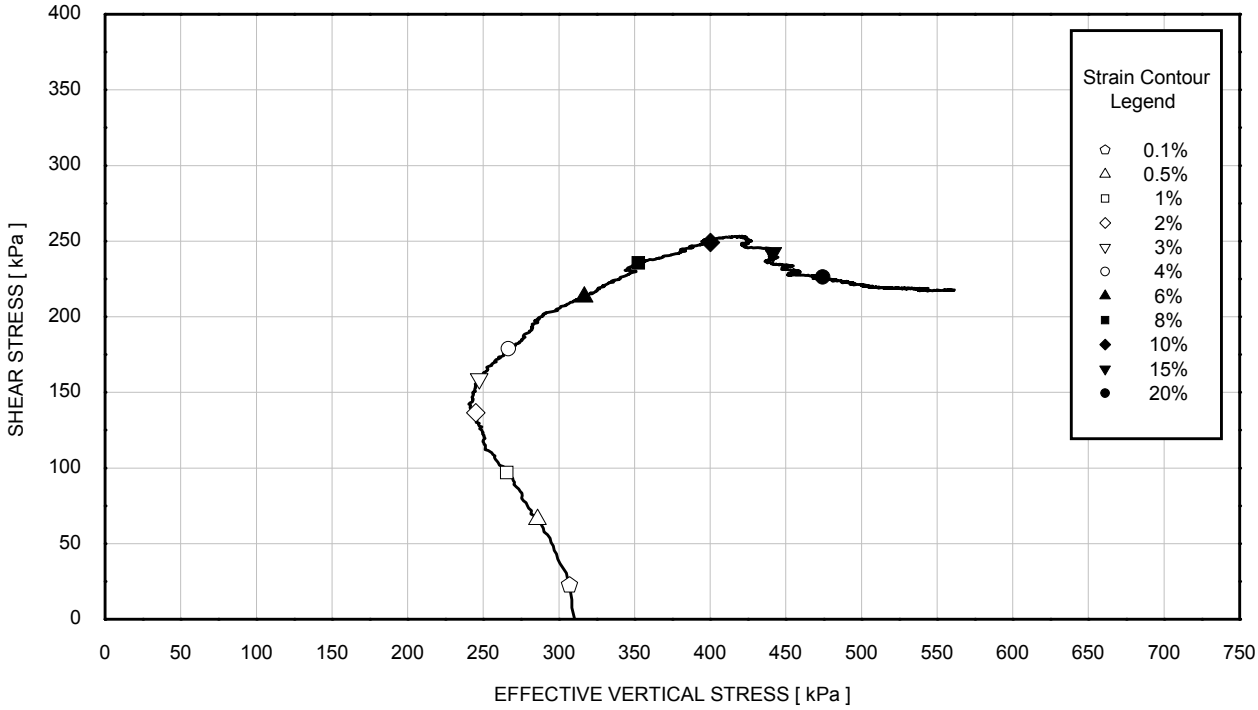


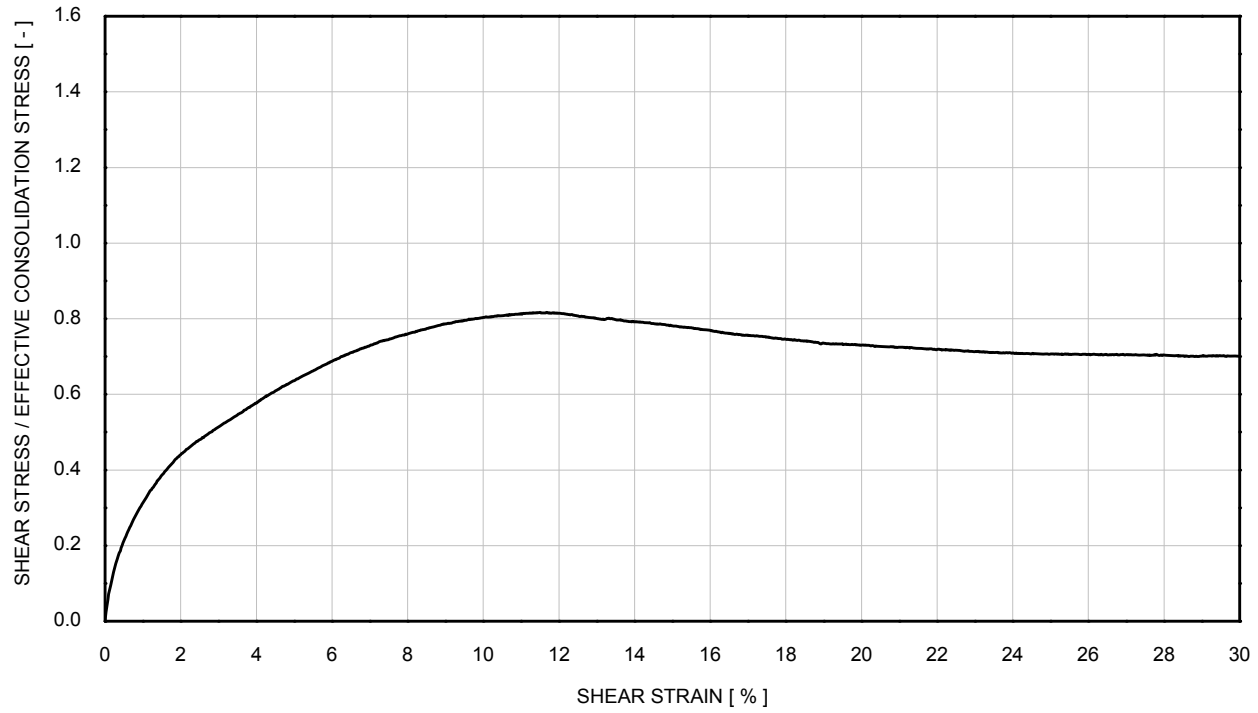


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 253 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 11.50 %	Depth [m]	: 33.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS04

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

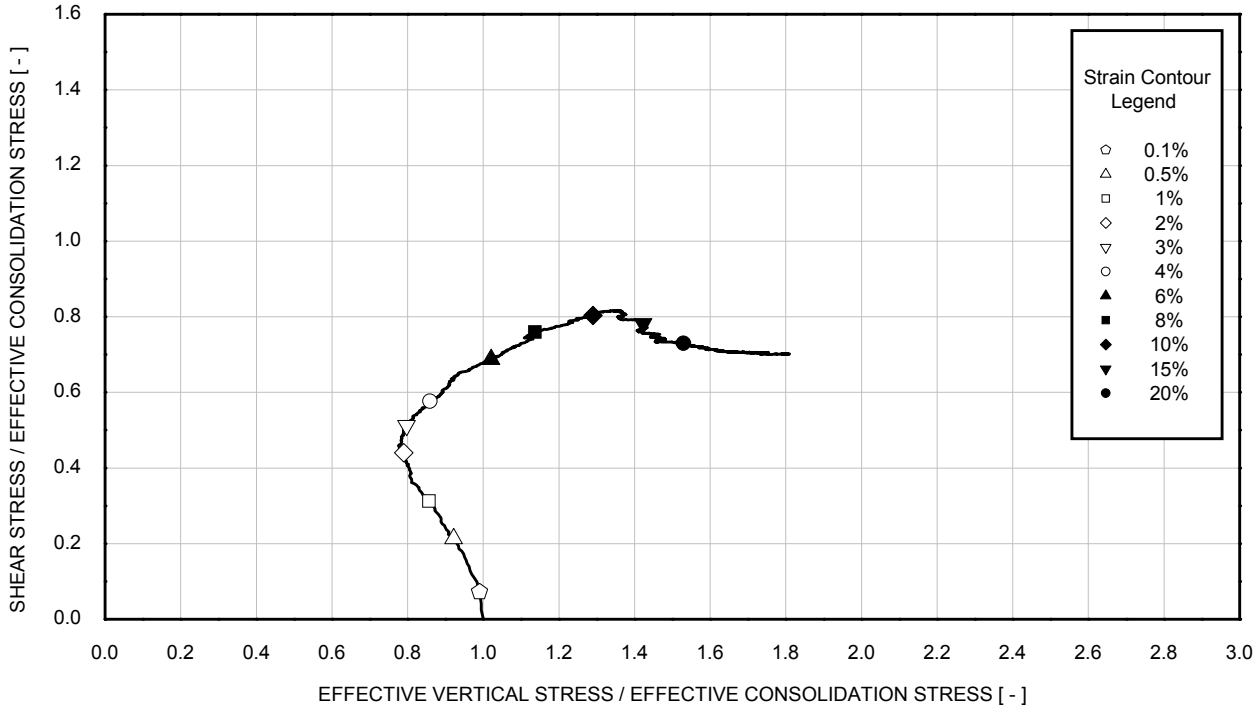


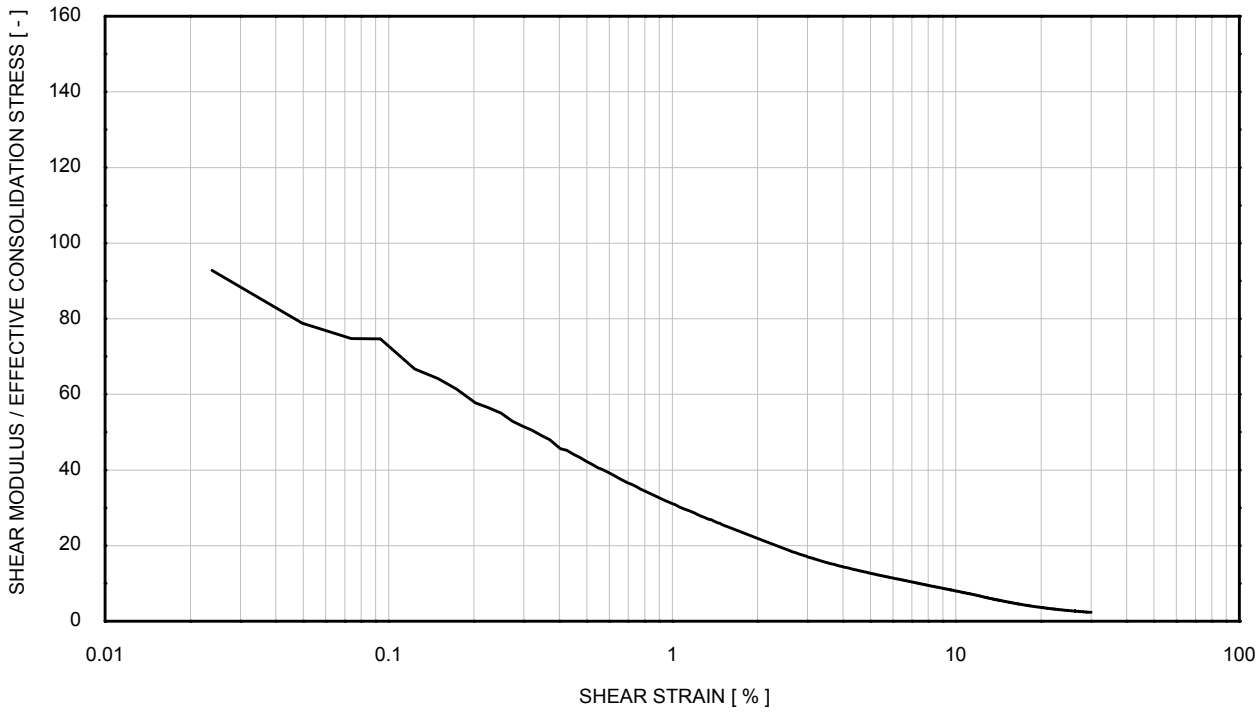


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 253 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 11.50 %	Depth [m]	: 33.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS04

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 253 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 11.50 %	Depth [m]	: 33.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS04

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark greenish grey slightly sandy CLAY with medium spaced partings of fine sand

GENERAL	
Date test started	13/08/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	29.9
Moisture content	[%]	40.8
Bulk density	[Mg/m³]	1.78
Dry density	[Mg/m³]	1.27
Void ratio	[-]	1.134
Degree of saturation	[%]	97
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	350
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J1286 \ BH-WFS2-7_20WAXC_DSS05
Template issue	1.3
Processed by Date	RN 18/08/2015
Checked by Date	LJ 18/08/2015
Approved by Date	PH 18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	20WAXC
Depth [m]	34.31
Test number	DSS05

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	316
Vertical strain	[%]	1.39
Bulk density	[Mg/m^3]	1.79
Dry density	[Mg/m^3]	1.28
Void ratio	[-]	1.105
Moisture content	[%]	39.7

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	240
Shear strain	[%]	10.08
Shear induced -$\Delta\sigma'_v$	[kPa]	-44
Vertical stress	[kPa]	360
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.00
At 15 % shear strain		
Shear stress	[kPa]	226
Shear induced -$\Delta\sigma'_v$	[kPa]	-100
Vertical stress	[kPa]	416
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	20WAXC
Depth [m]	34.31
Test number	DSS05

SUMMARY OF CONSOLIDATED DSS TEST

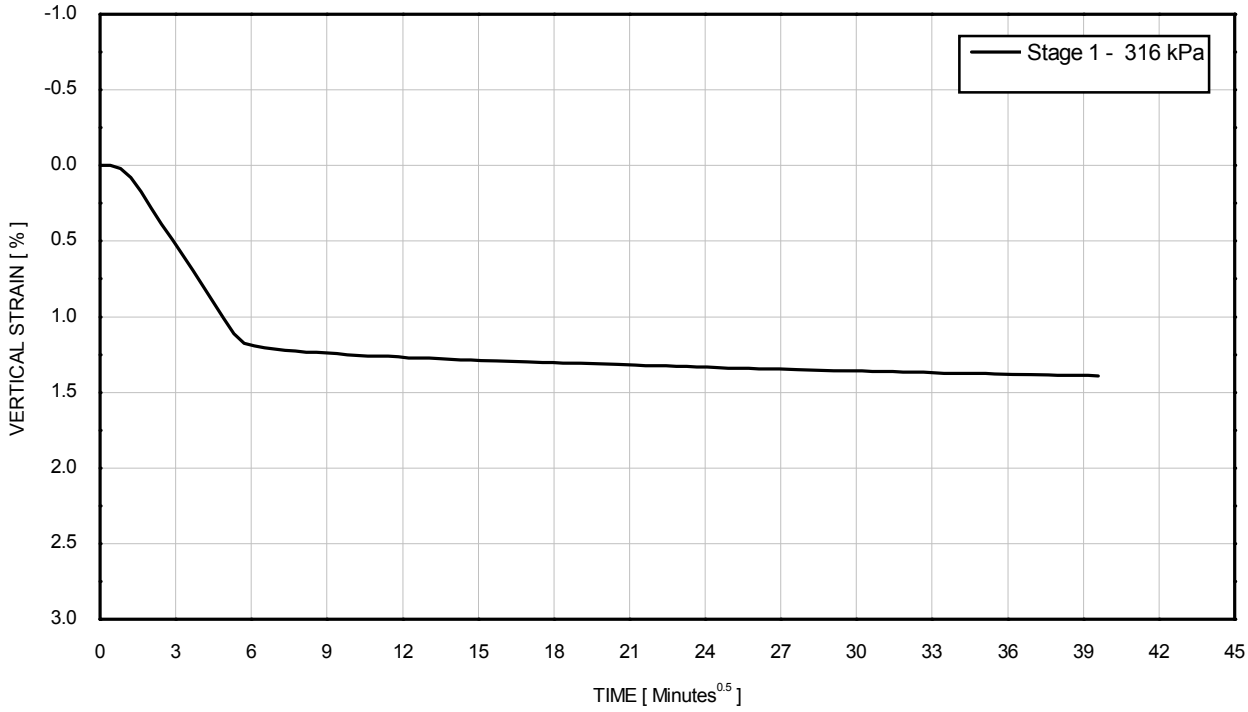
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

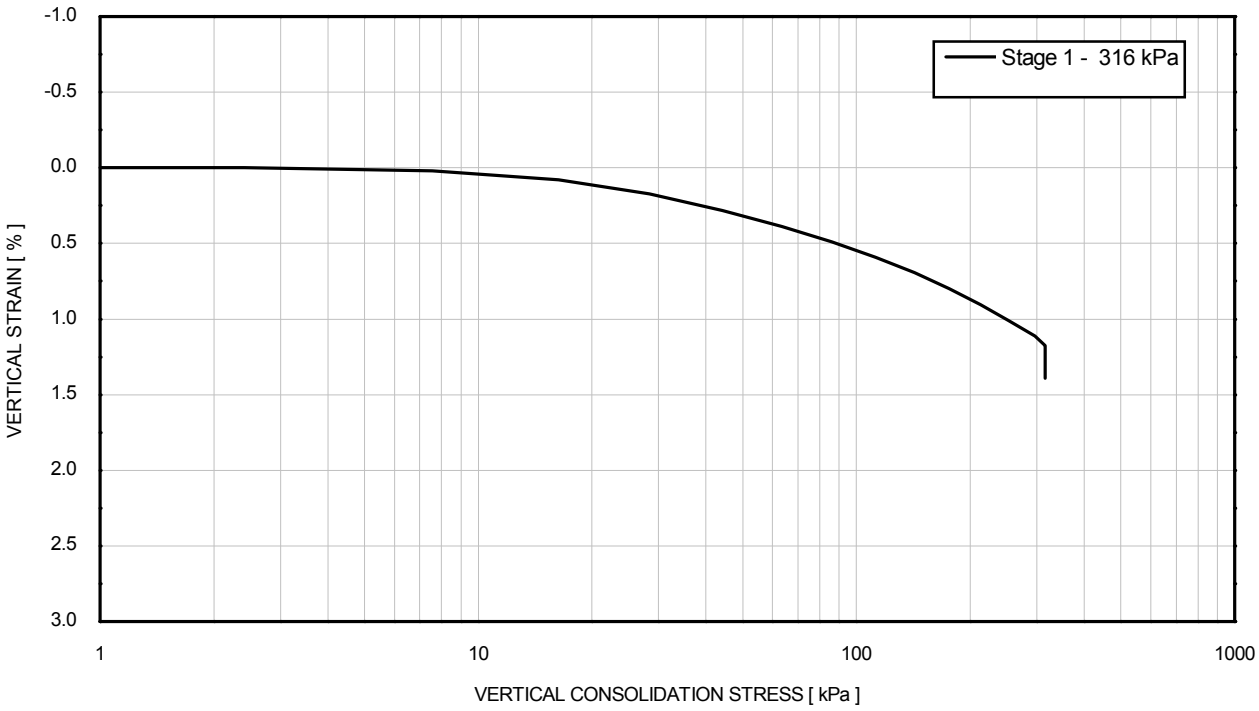
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	20WAXC
Depth [m]	34.31
Test number	DSS05

SUMMARY OF CONSOLIDATED DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

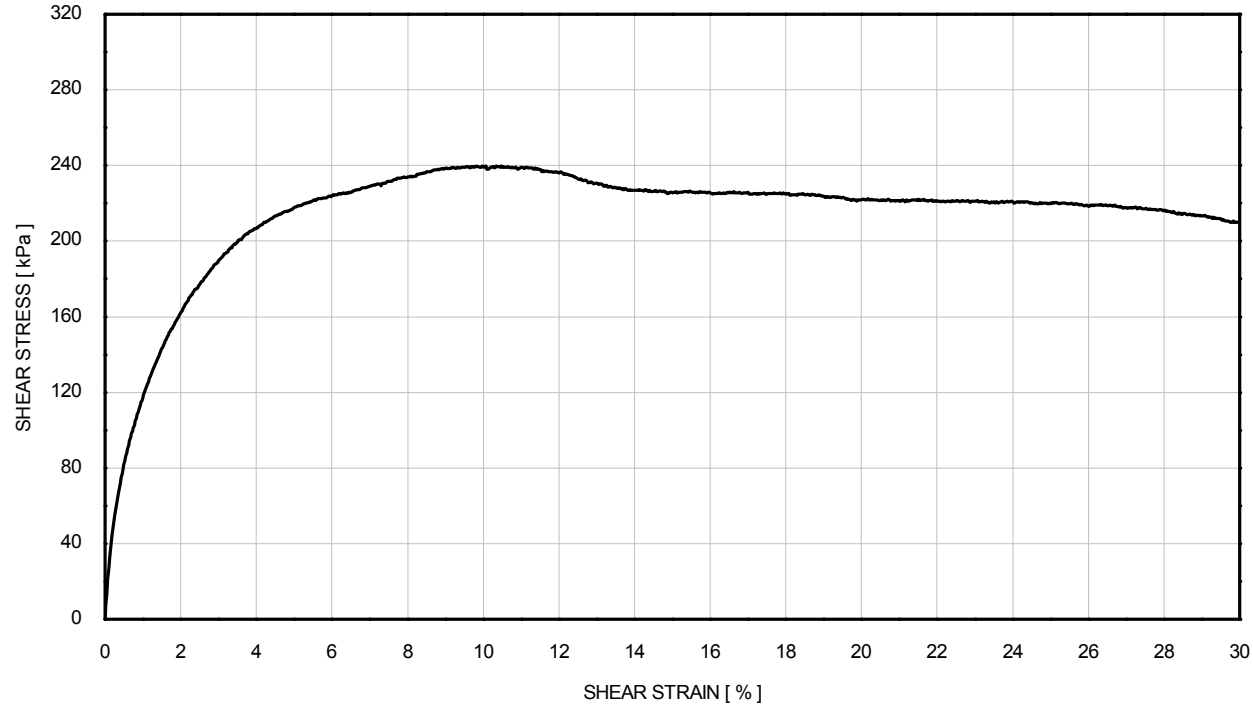


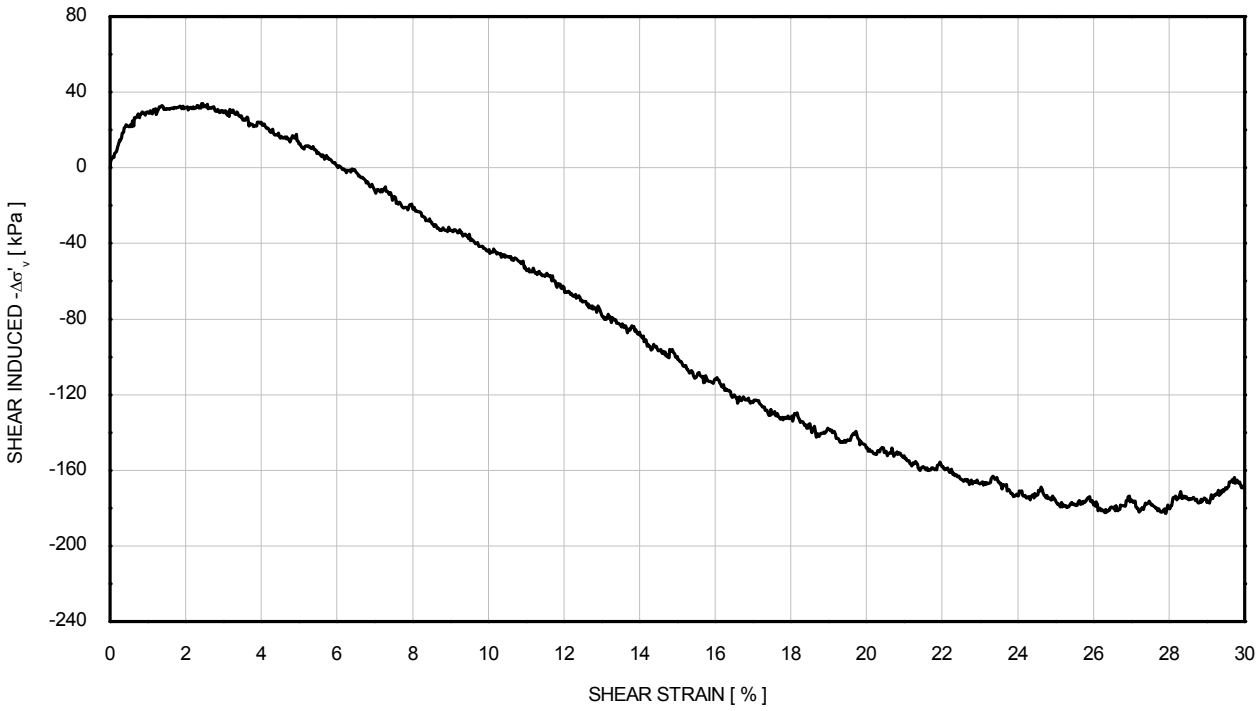


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS2-7
		Sample	: 20WAXC
		Depth [m]	: 34.31
		Test No.	: DSS05

CONSOLIDATED DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

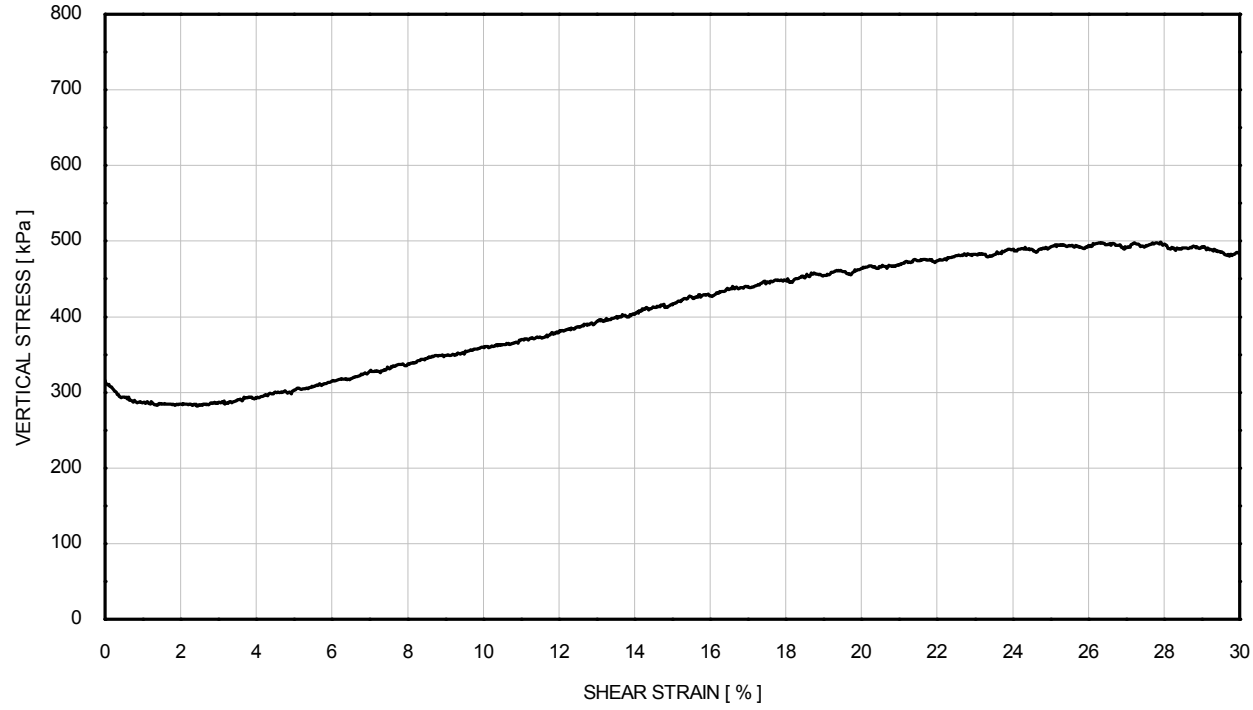


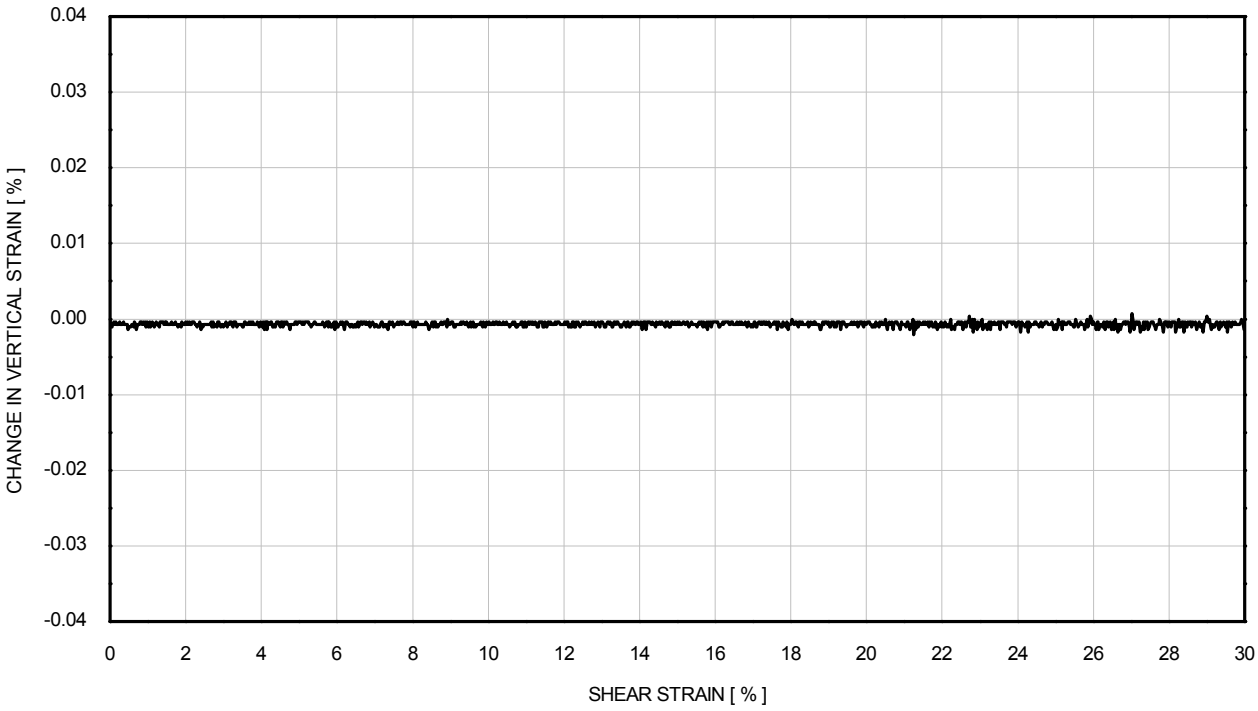


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 240 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 10.08 %	Depth [m]	: 34.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS05

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

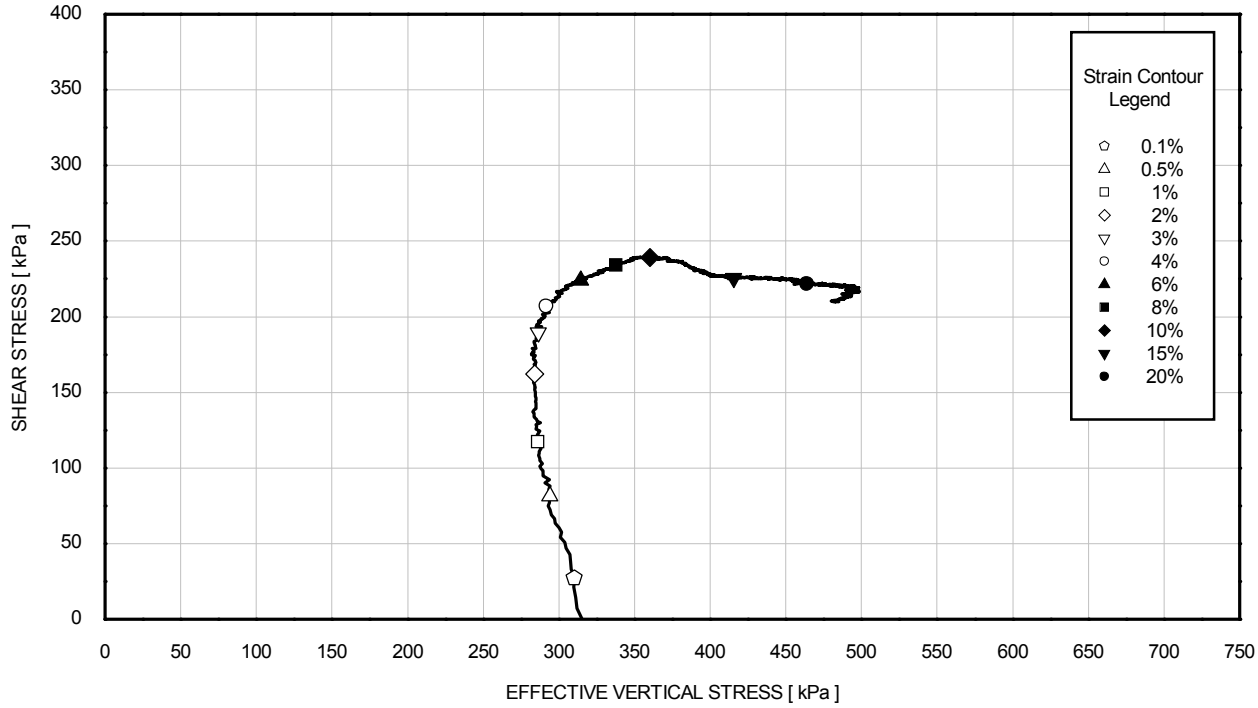


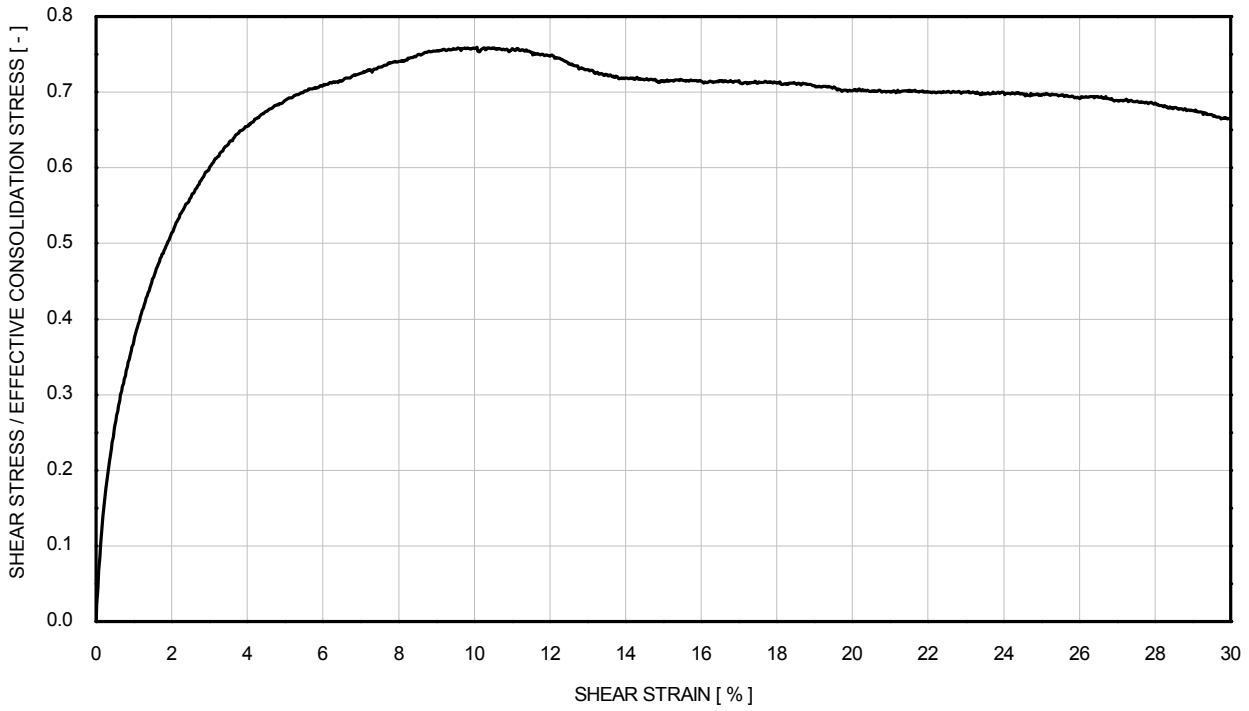


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 240 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 10.08 %	Depth [m]	: 34.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS05

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

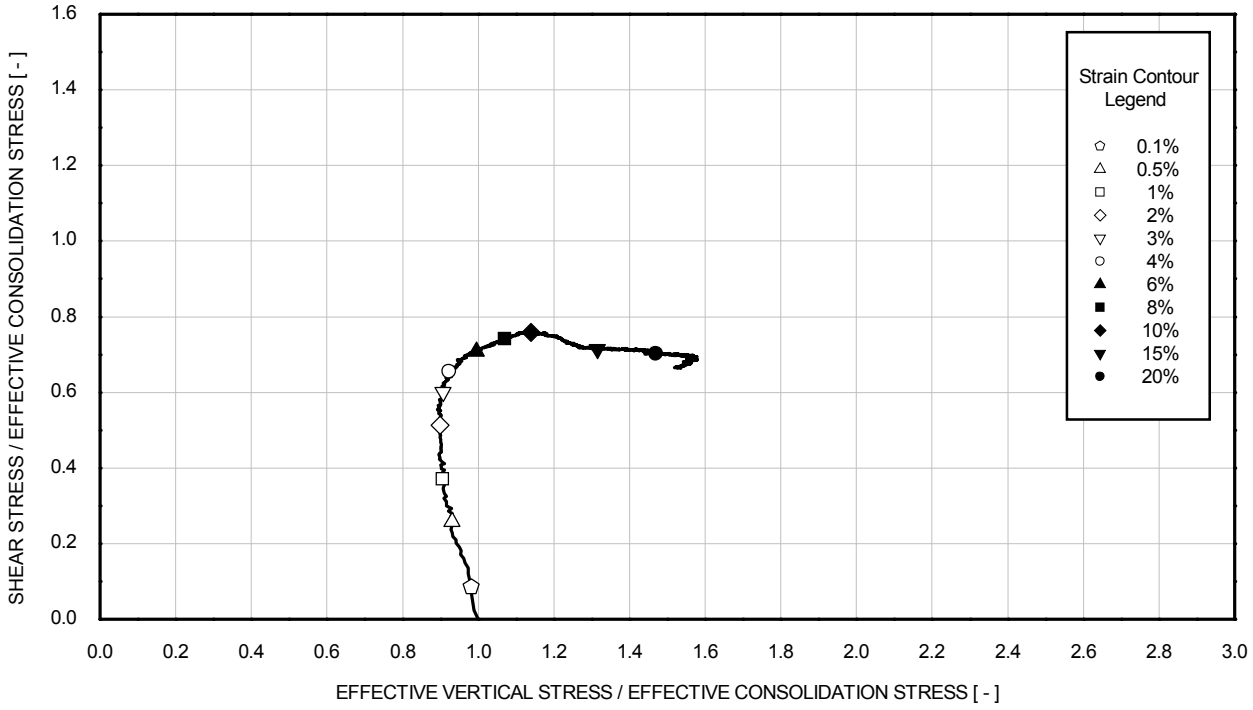


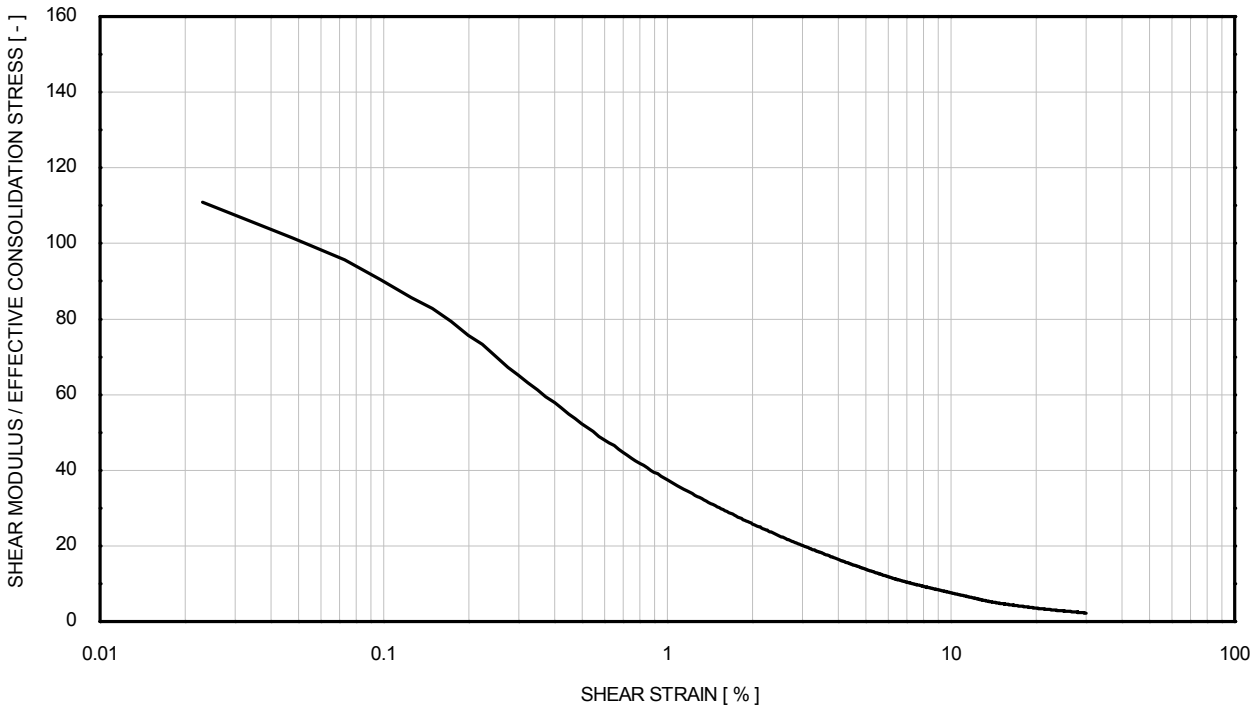


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 240 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 10.08 %	Depth [m]	: 34.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS05

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 316 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 240 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 10.08 %	Depth [m]	: 34.31
Rate of strain	: 3.00 %/hour	Test No.	: DSS05

CONSOLIDATED DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SECTION A6: CYCLIC TRIAXIAL TESTS

LIST OF PLATES IN SECTION A6: Plate

VISUAL DESCRIPTION
Light olive brown fine to medium SAND with traces of shell fragments

GENERAL	
Date test started	23/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	10.5
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.635
Degree of saturation	[%]	44
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic Consolidation - Anisotropic	Fugro in house procedure
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern_Bight_CTXL1
Processed by Date	LJ 12/08/2015
Checked by Date	PH 12/08/2015
Approved by Date	PH 15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL1

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1012
Mid height PWP	[kPa]	-
B value achieved	[-]	0.97

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	25
Effective axial pressure	[kPa]	25
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.16
External axial strain	[%]	0.04
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	23.9
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.632
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL1

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	25
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	15
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	4
External ε_{av} at N_f	[%]	-3.28
External ε_{cy} at N_f	[%]	4.41
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	12
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	23.9
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.632
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	-0.12	0.17	9.0	-	21.10	-
2	-0.34	0.32	4.6	-	22.61	-
3	-0.84	0.91	1.6	-	19.17	-
4	-3.28	4.41	0.3	-	9.66	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL1

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	3.2
Initial effective axial pressure	[kPa]	4.1
Rate of strain	[%/hour]	1.42
At peak deviator stress		
Corrected deviator stress	[kPa]	2.2
Membrane correction applied	[kPa]	1.6
Drain correction applied	[kPa]	0
External axial strain	[%]	18.68
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	23
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1.6
Effective axial pressure	[kPa]	3.8
Principal effective stress ratio	[-]	2.42
ε_{50}	[%]	15.86
Secant modulus (E_{50}) at ε_{50}	[kPa]	2.5
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	1.5
Membrane correction applied	[kPa]	1.4
Drain correction applied	[kPa]	0
External axial strain	[%]	14.98
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0.1
Effective axial pressure	[kPa]	1.6
Principal effective stress ratio	[-]	10.80
At 10% axial strain		
Corrected deviator stress	[kPa]	1.2
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	23
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1.7
Effective axial pressure	[kPa]	2.9
Principal effective stress ratio	[-]	1.67

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL1

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

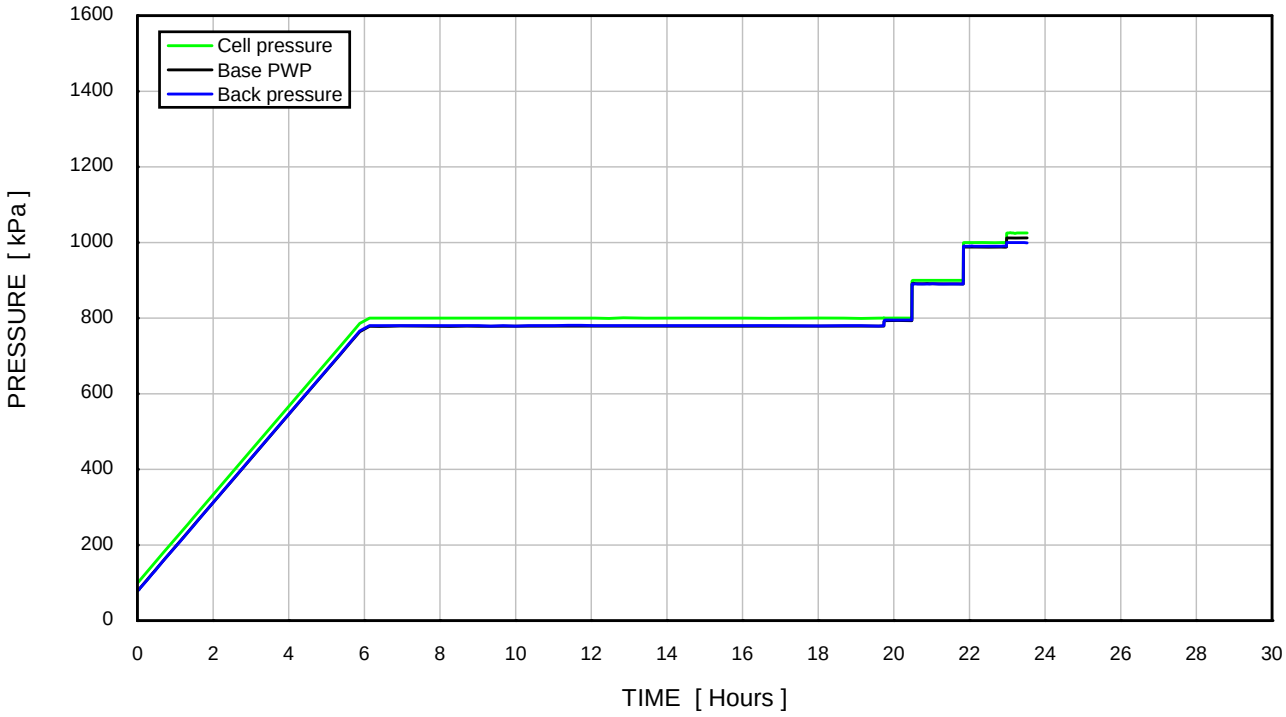
SPECIMEN PHOTOGRAPHS

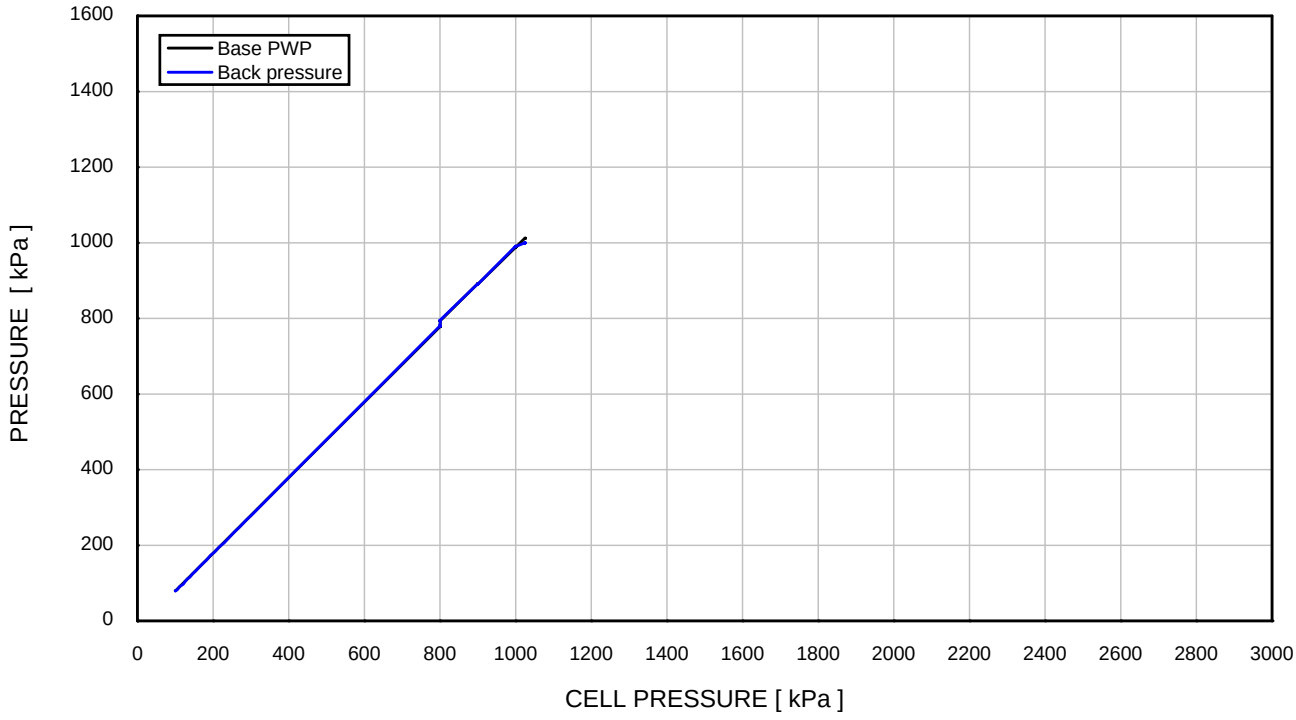
FINAL CONDITIONS		
Moisture content	[%]	23.9
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.62

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL1

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

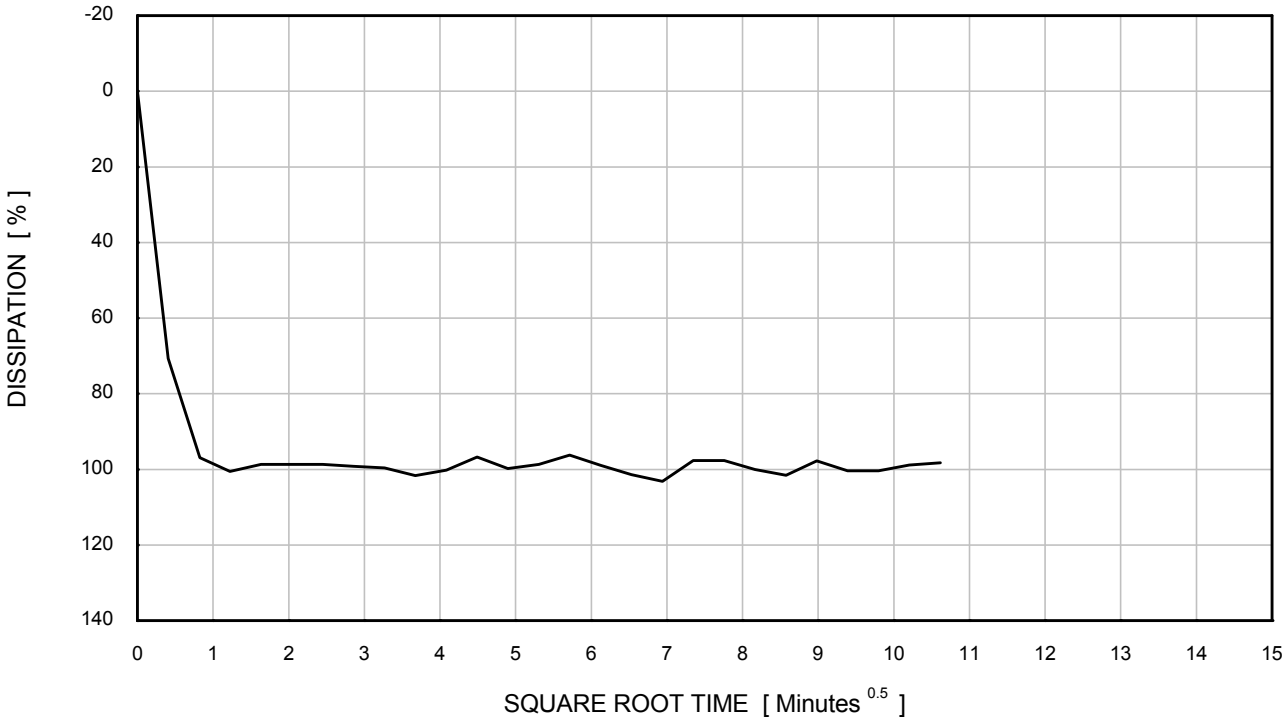


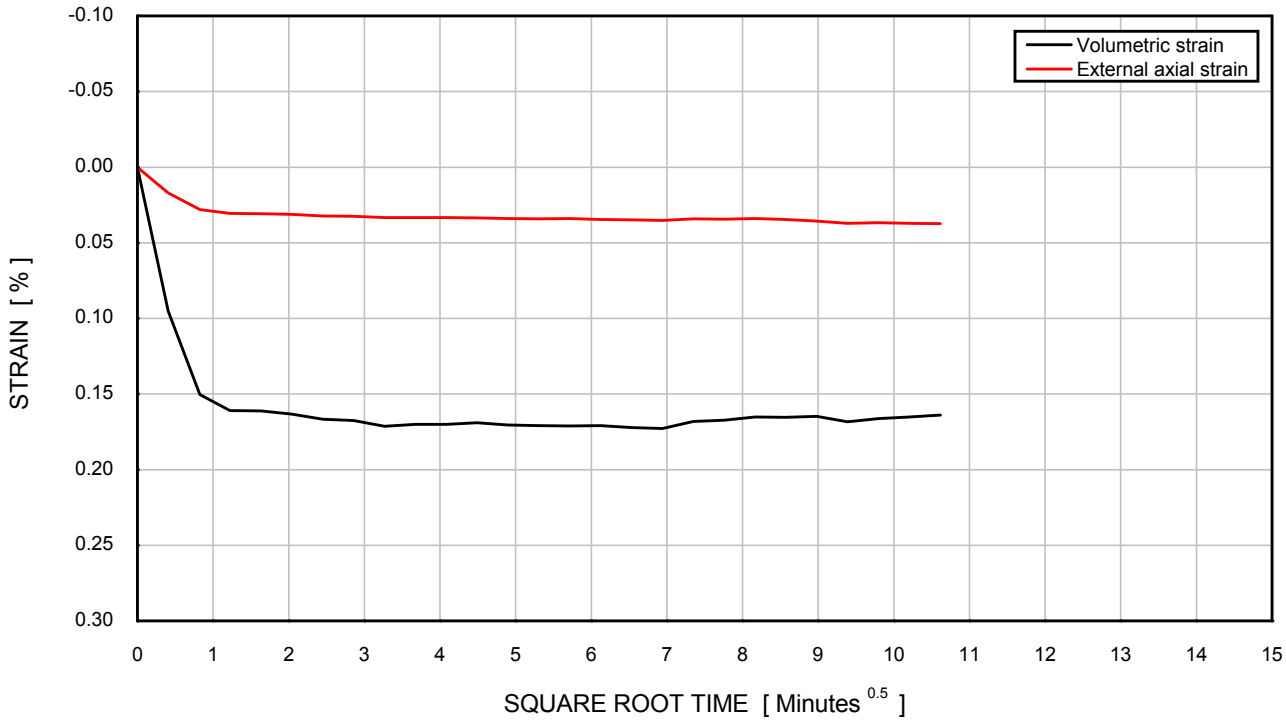


B value	:	0.97			
Initial σ'_r	:	20	kPa	Borehole	: Batch
Initial σ'_a	:	20	kPa	Sample	: Southern Bight
Final σ'_r	:	13	kPa	Depth [m]	: -
Final σ'_a	:	13	kPa	Test No.	: CTXL1

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

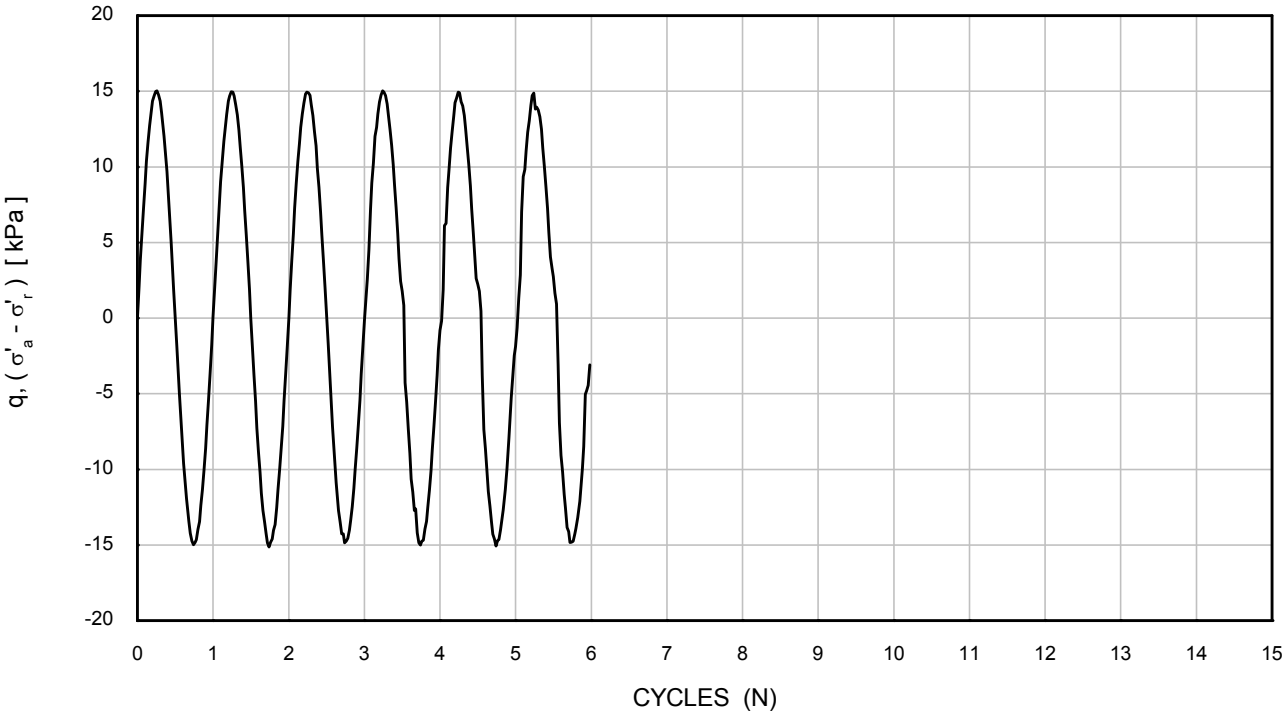


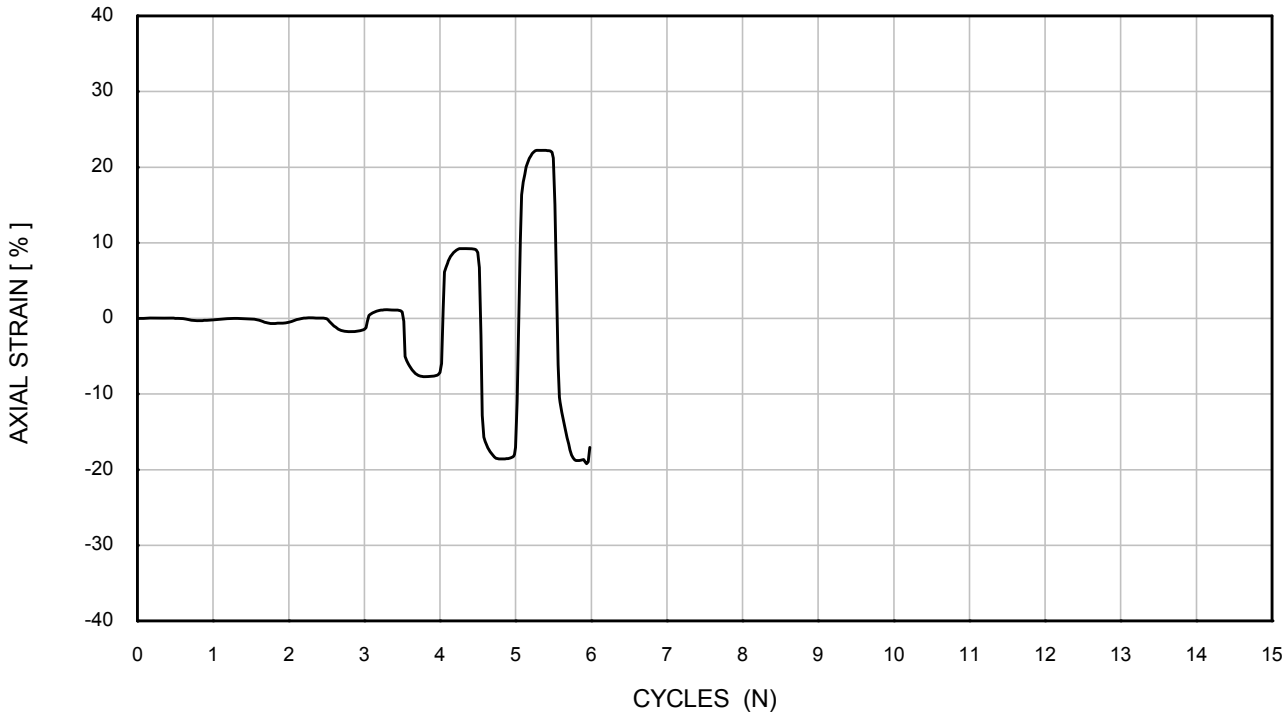


σ'_{rc}	:	25 kPa	Borehole	: Batch
σ'_{ac}	:	25 kPa	Sample	: Southern Bight
			Depth [m]	: -
			Test No.	: CTXL1

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

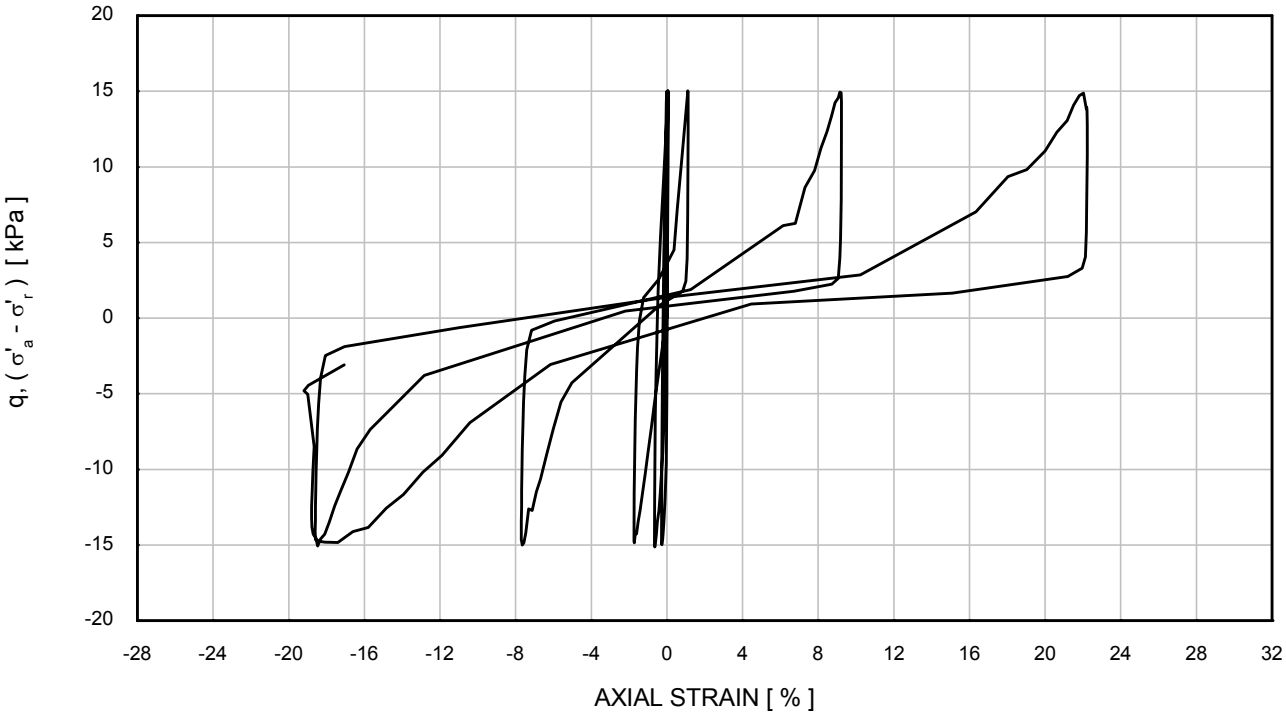


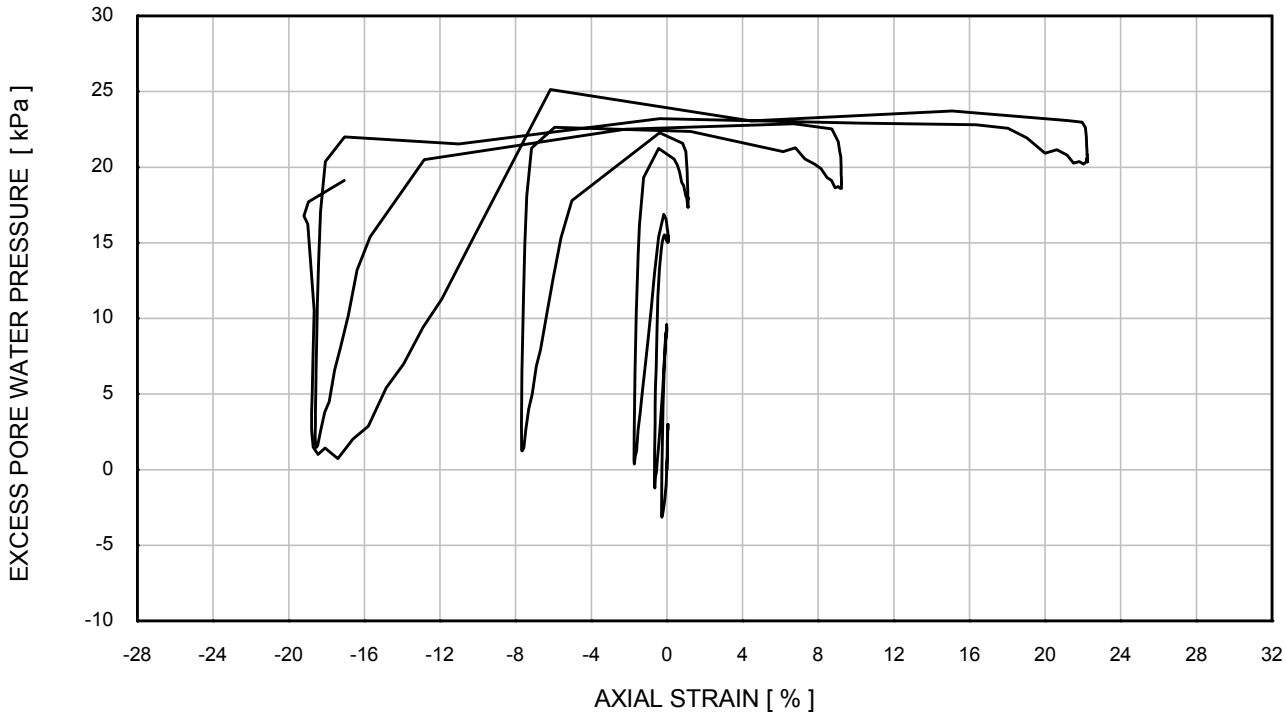


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	15	kPa	Test No.	: CTXL1
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

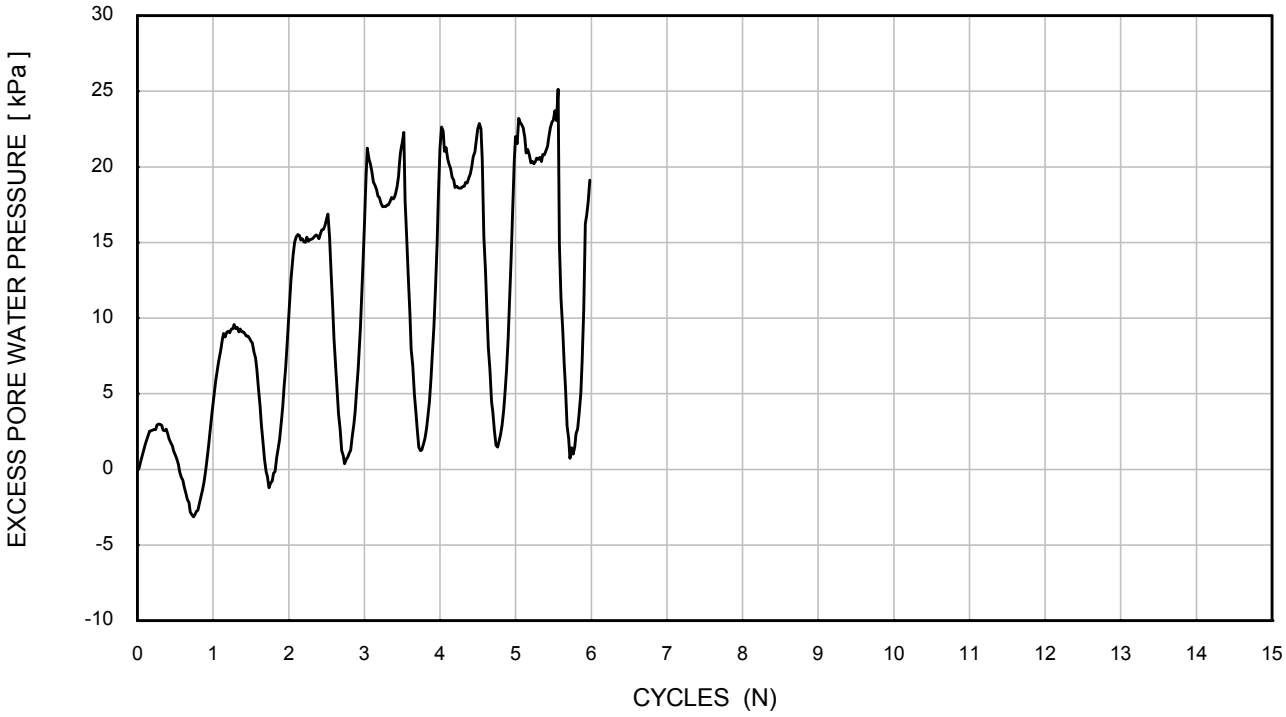


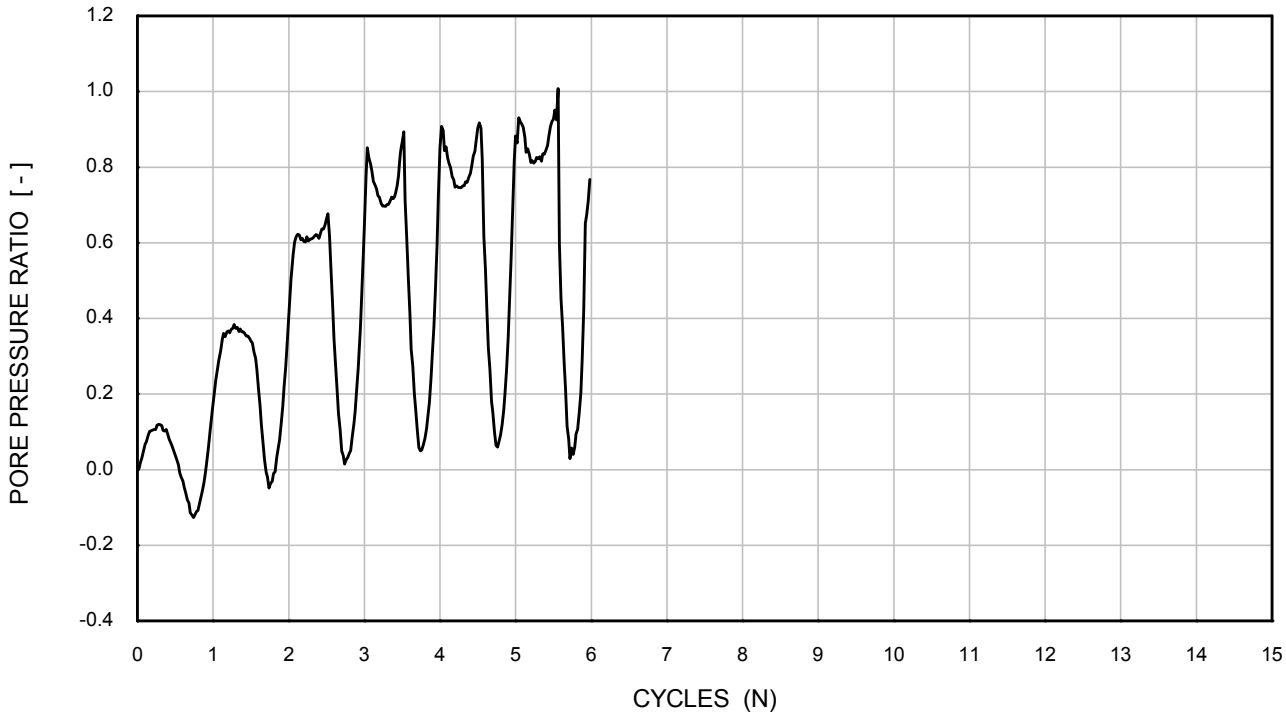


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	15	kPa	Test No.	: CTXL1
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

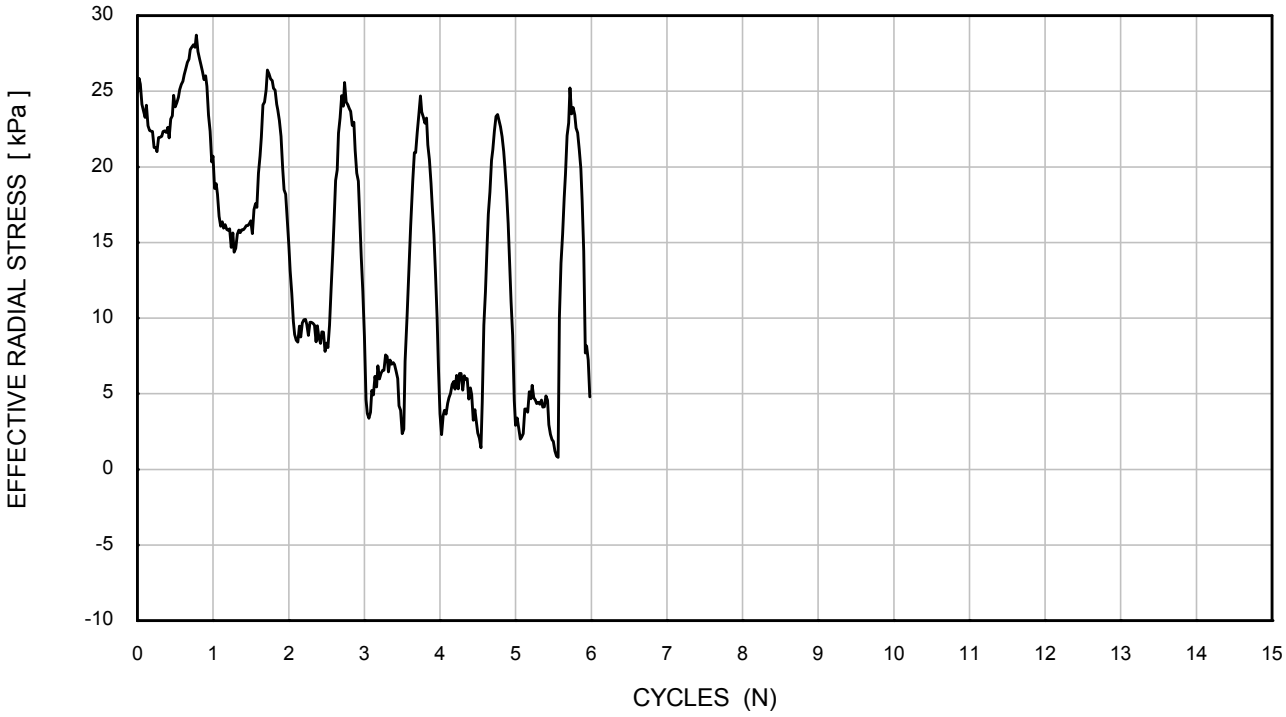


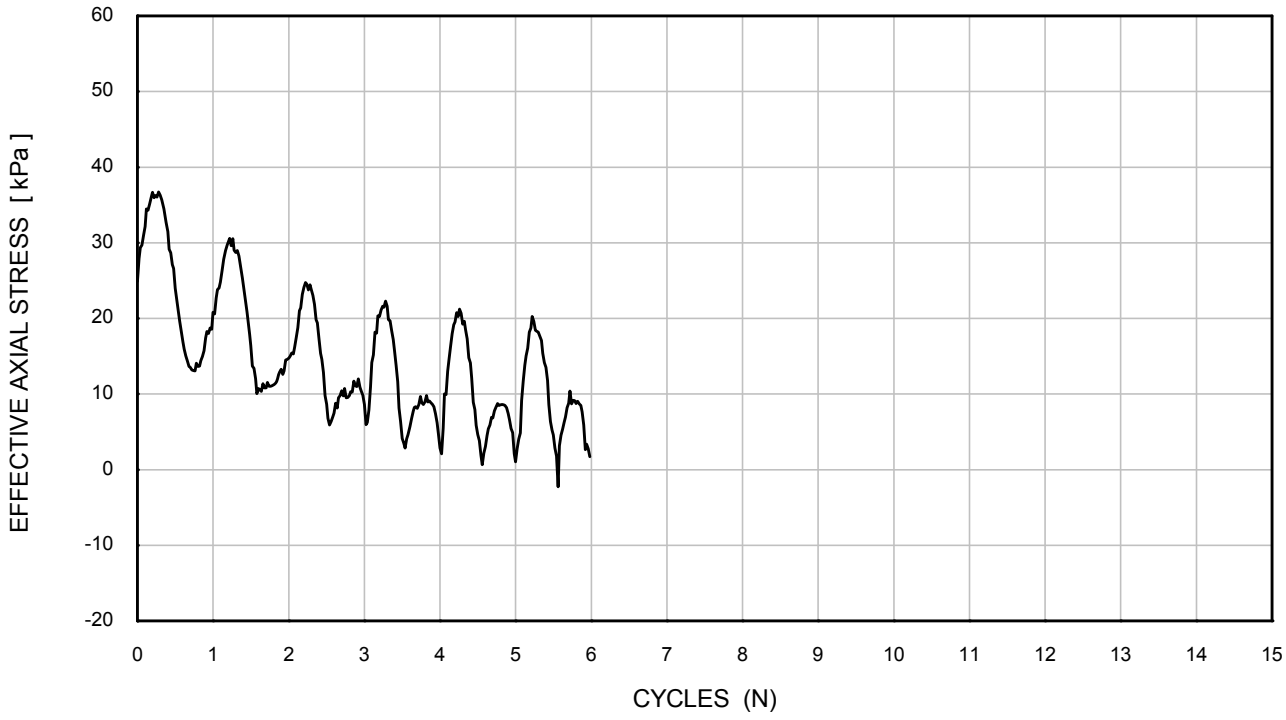


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	15 kPa	Test No.	:	CTXL1
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

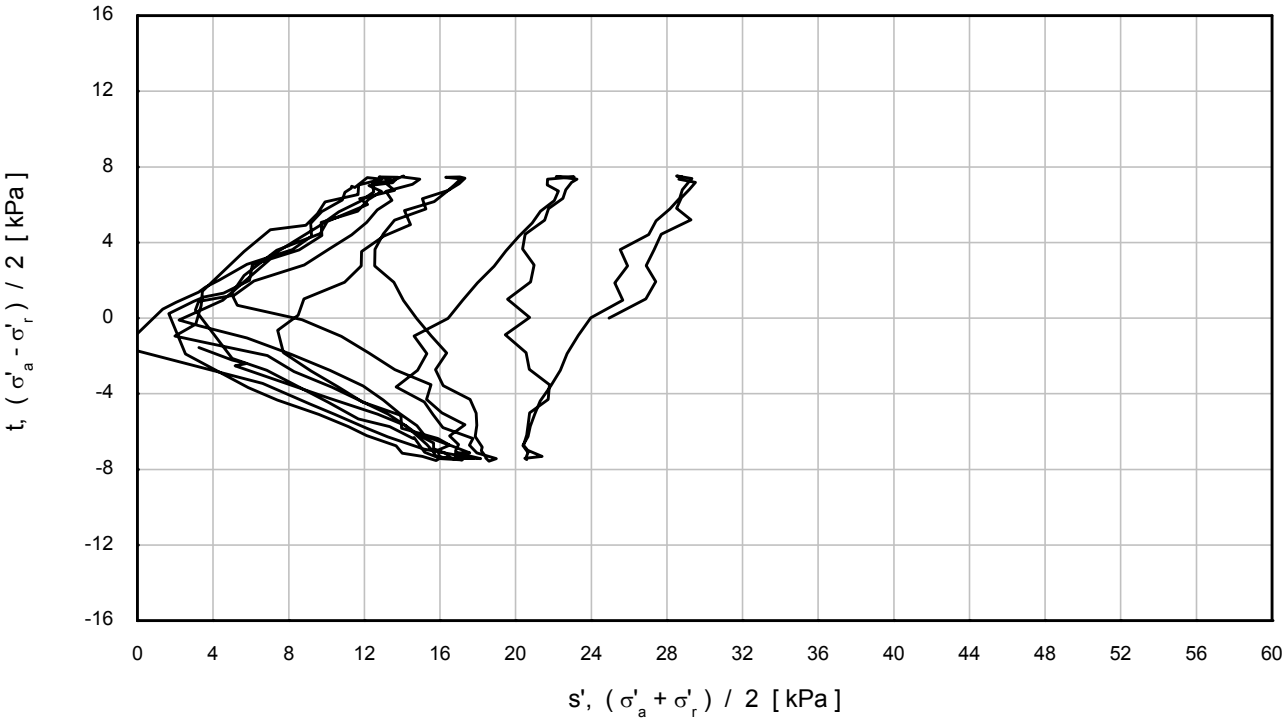


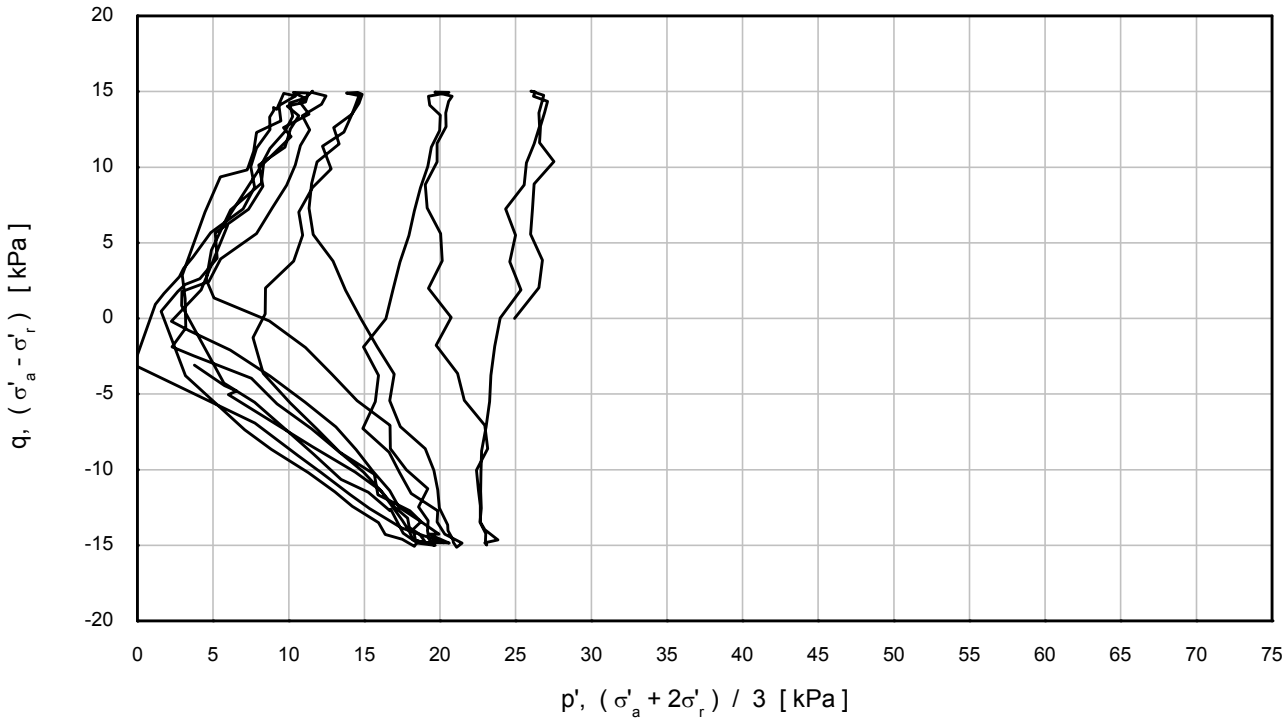


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	15	kPa	Test No.	: CTXL1
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

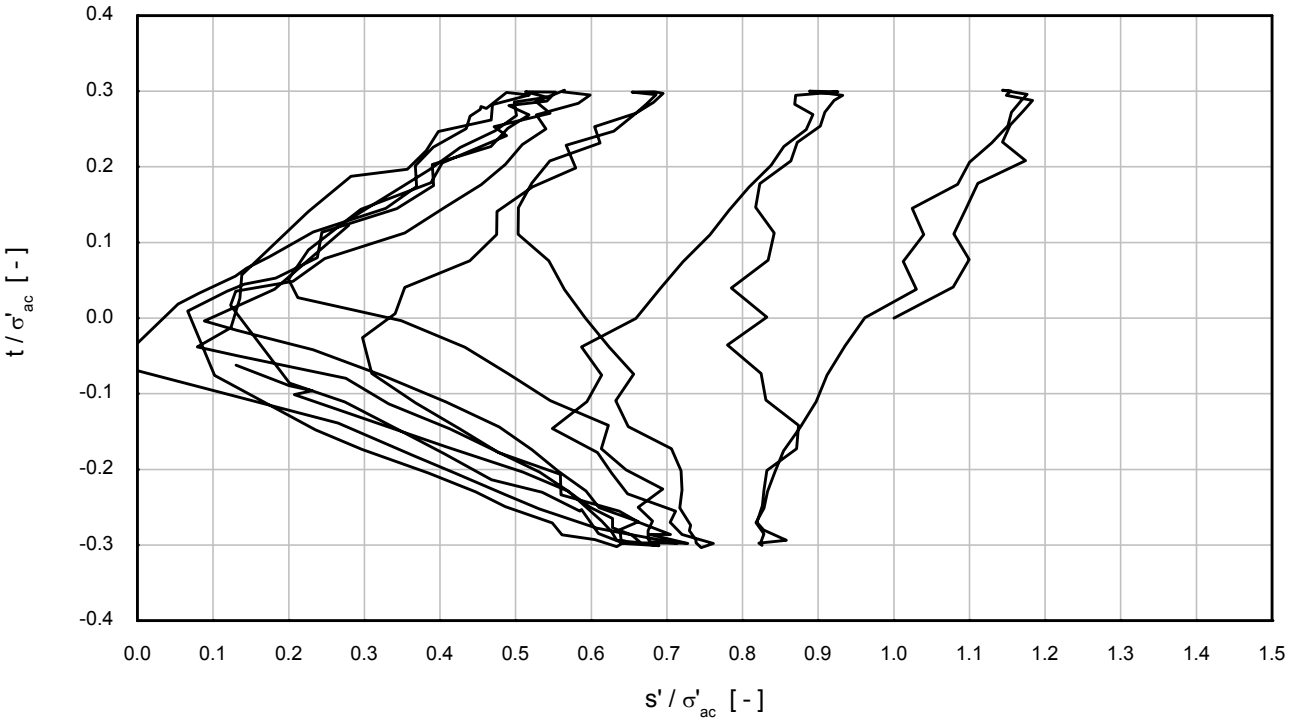


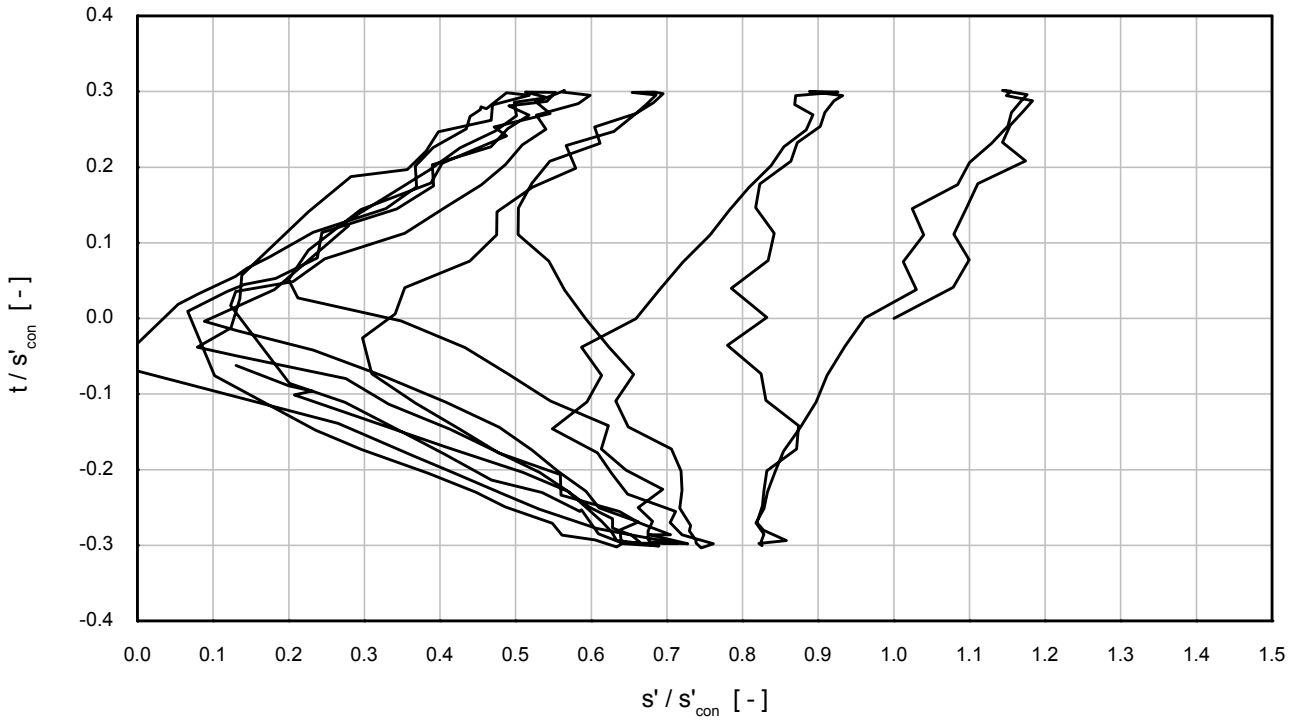


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	15 kPa	Test No.	:	CTXL1
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

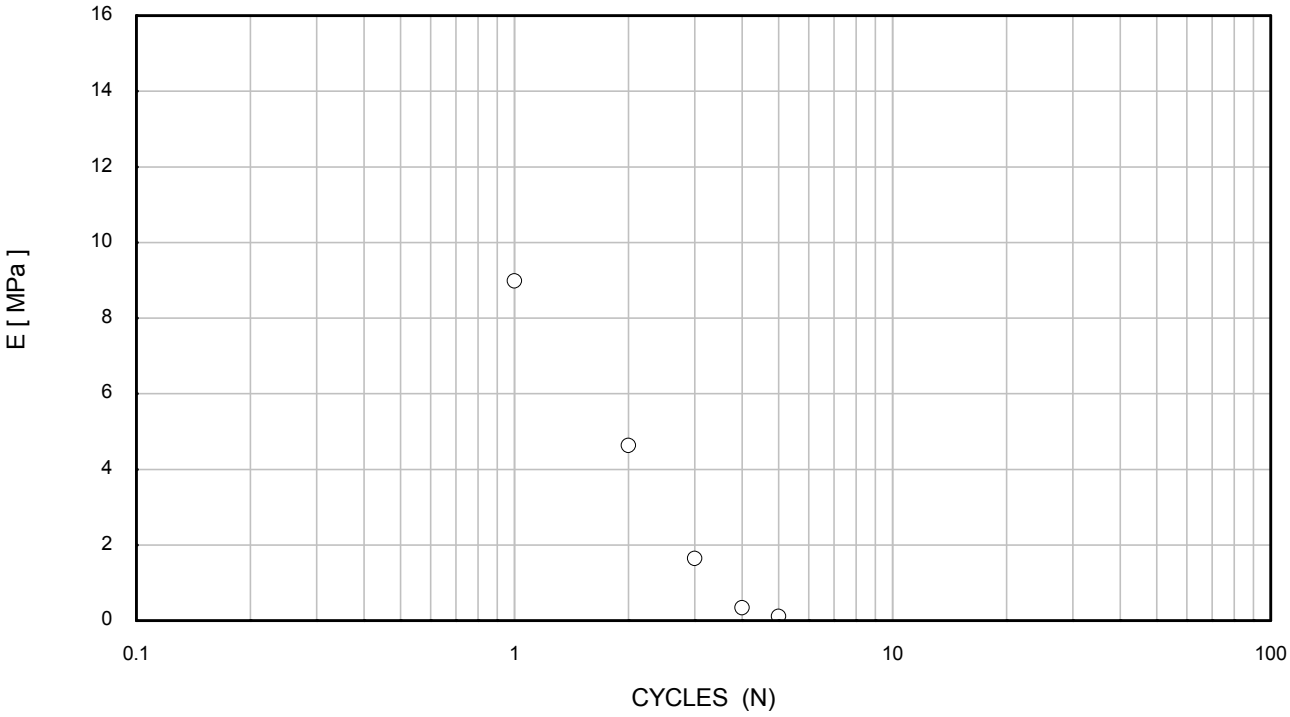


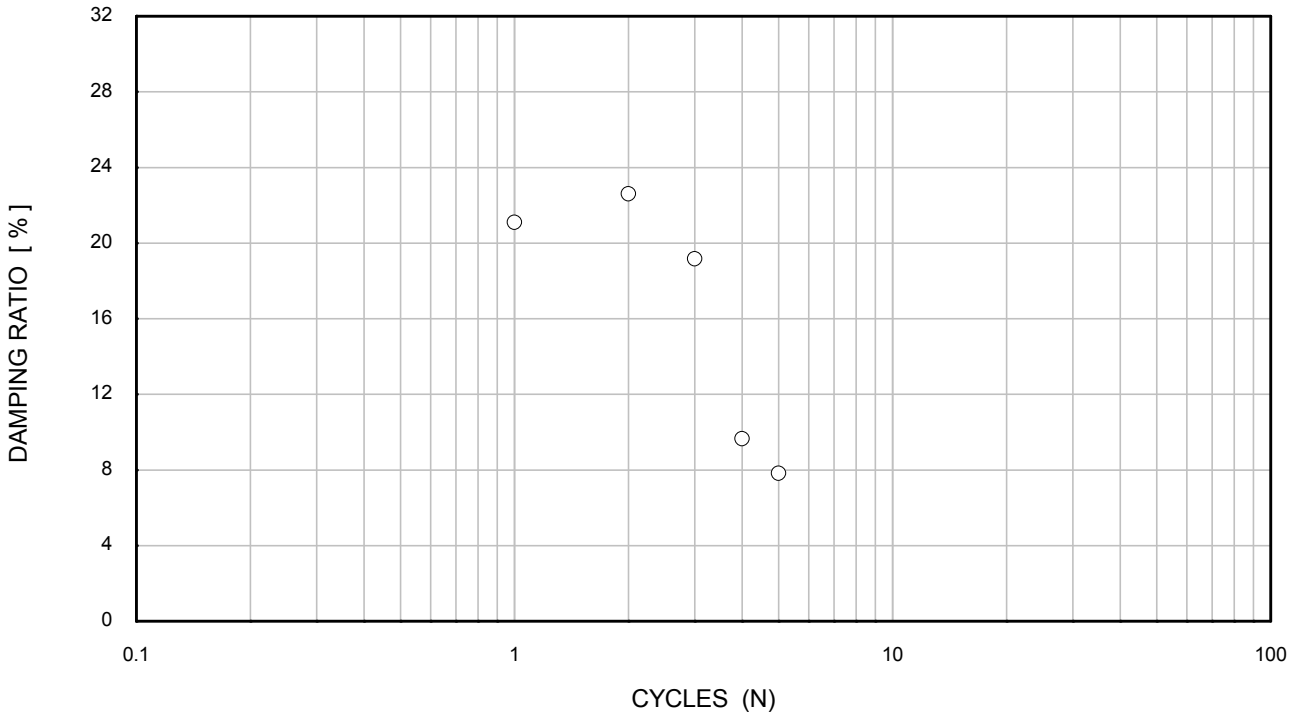


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	15	kPa	Test No.	: CTXL1
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

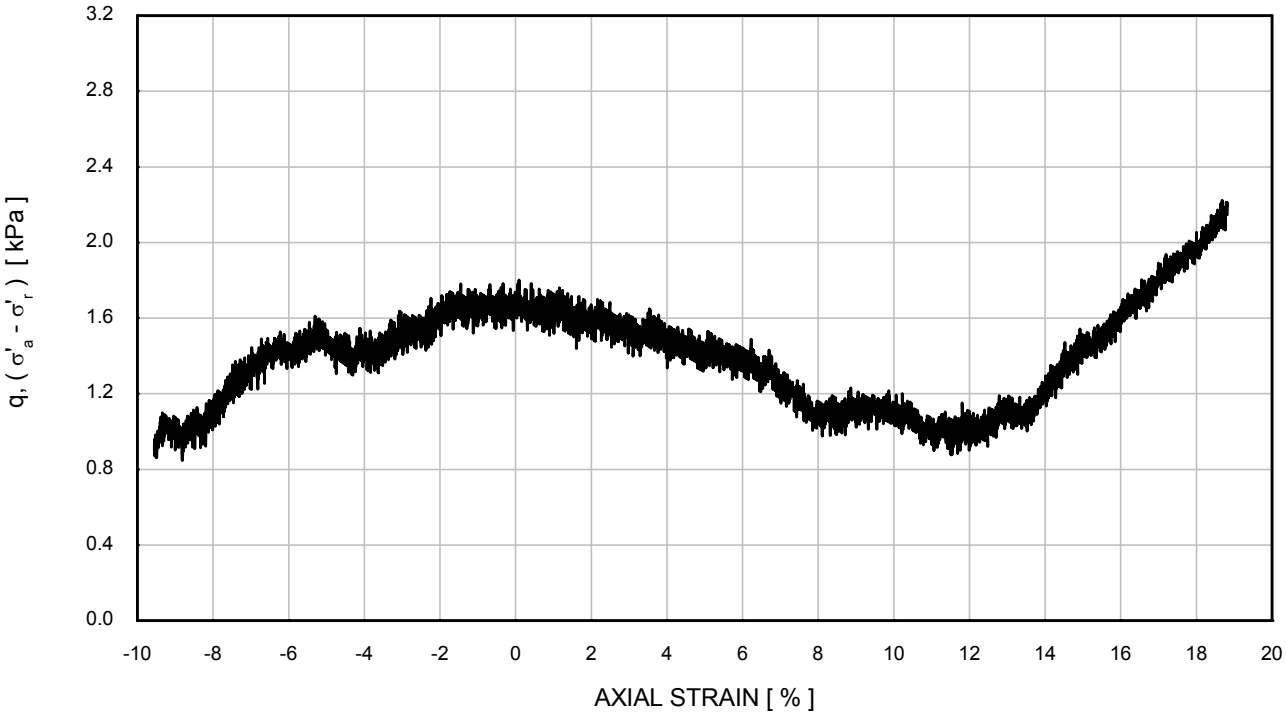


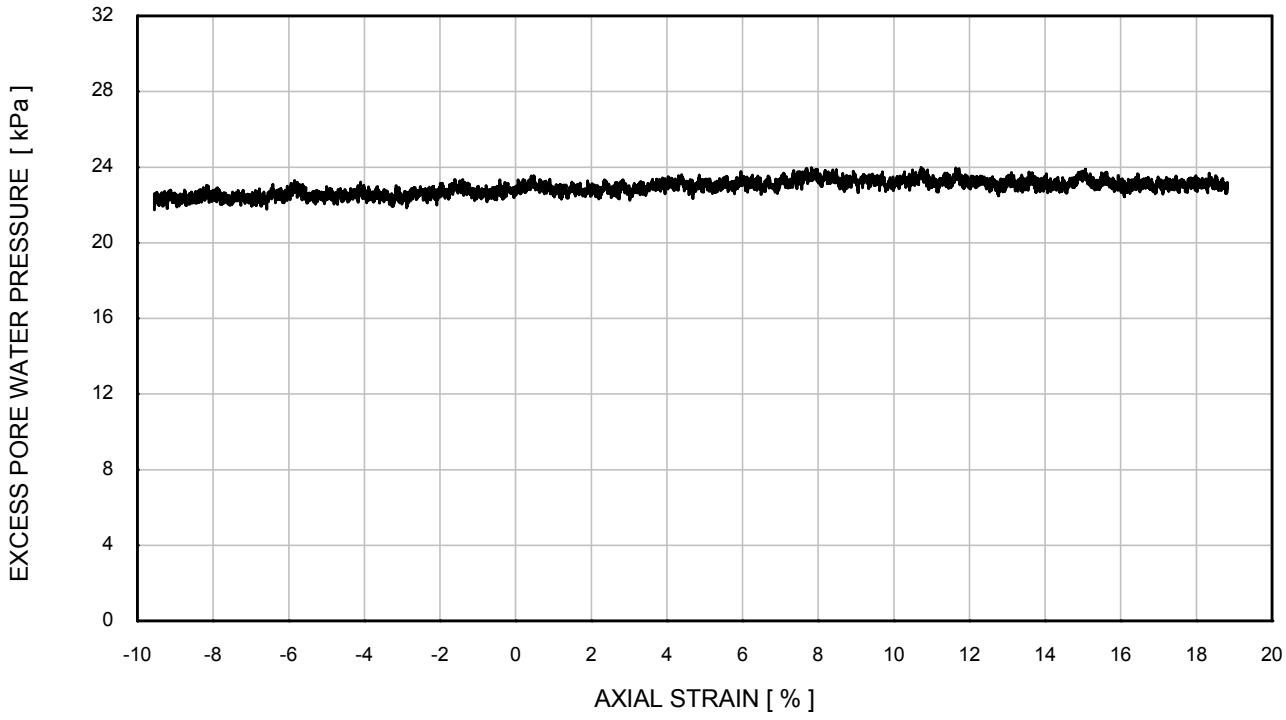


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	15	kPa	Test No.	: CTXL1
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

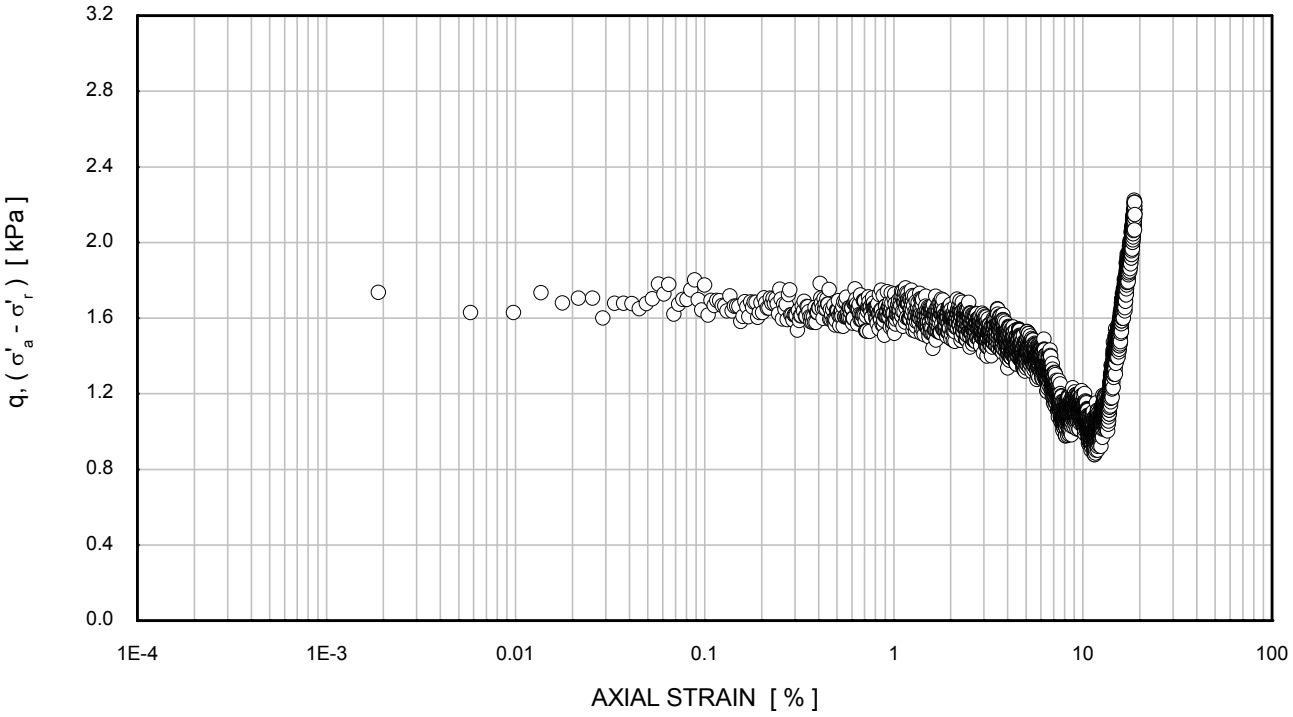


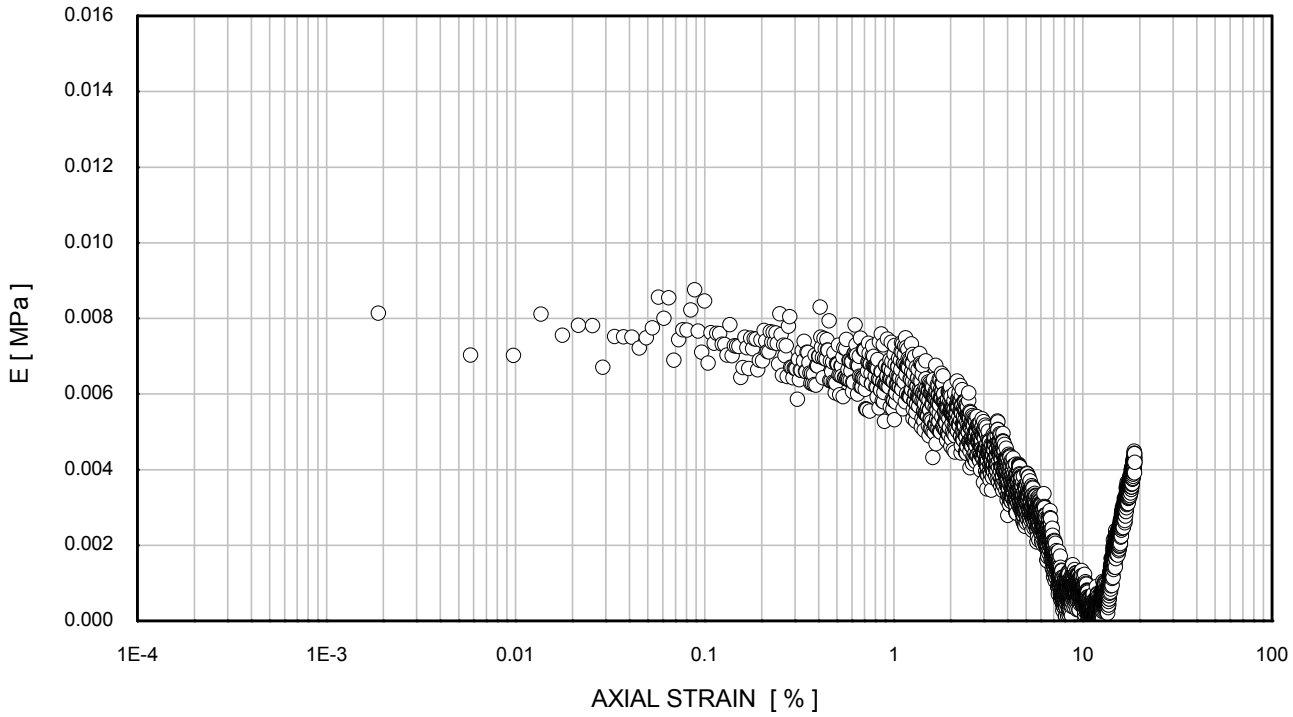


Initial σ'_r	:	3.2 kPa	Borehole	:	Batch
Initial σ'_a	:	4.1 kPa	Sample	:	Southern Bight
q_{peak}	:	2.2 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	18.68 %	Test No.	:	CTXL1
Rate of strain	:	1.42 %/hour			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

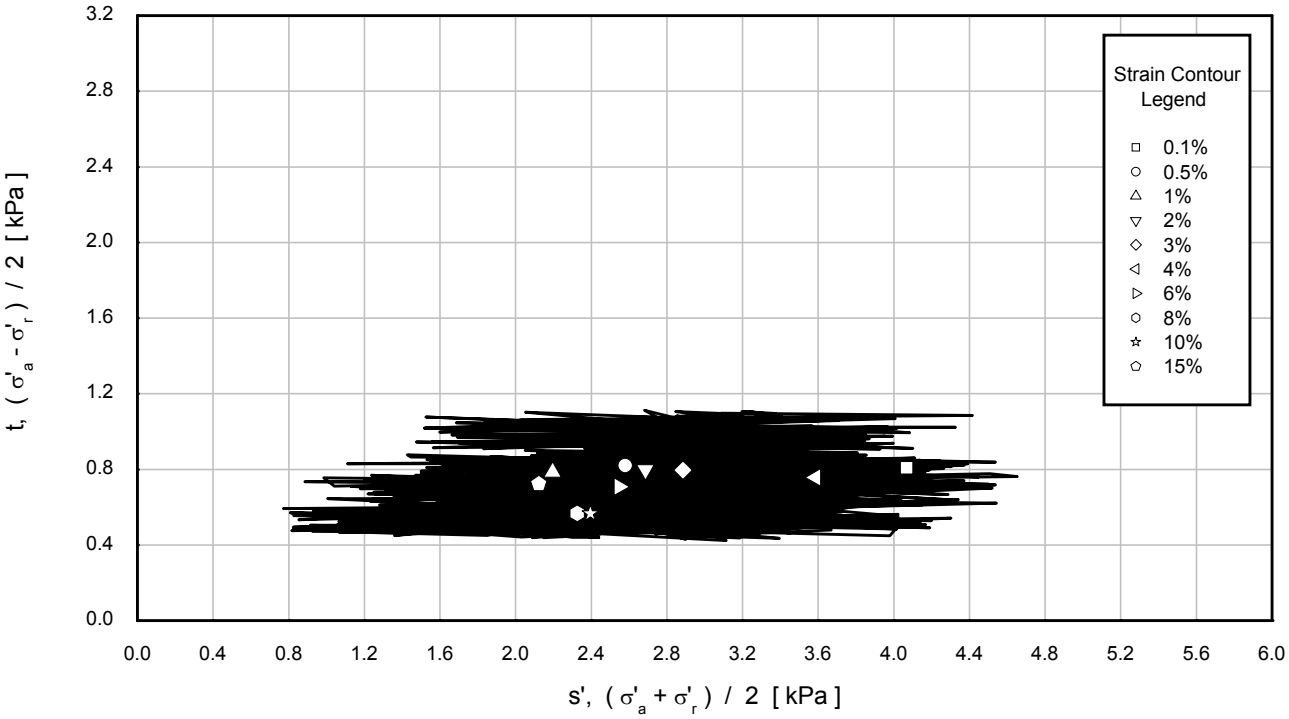


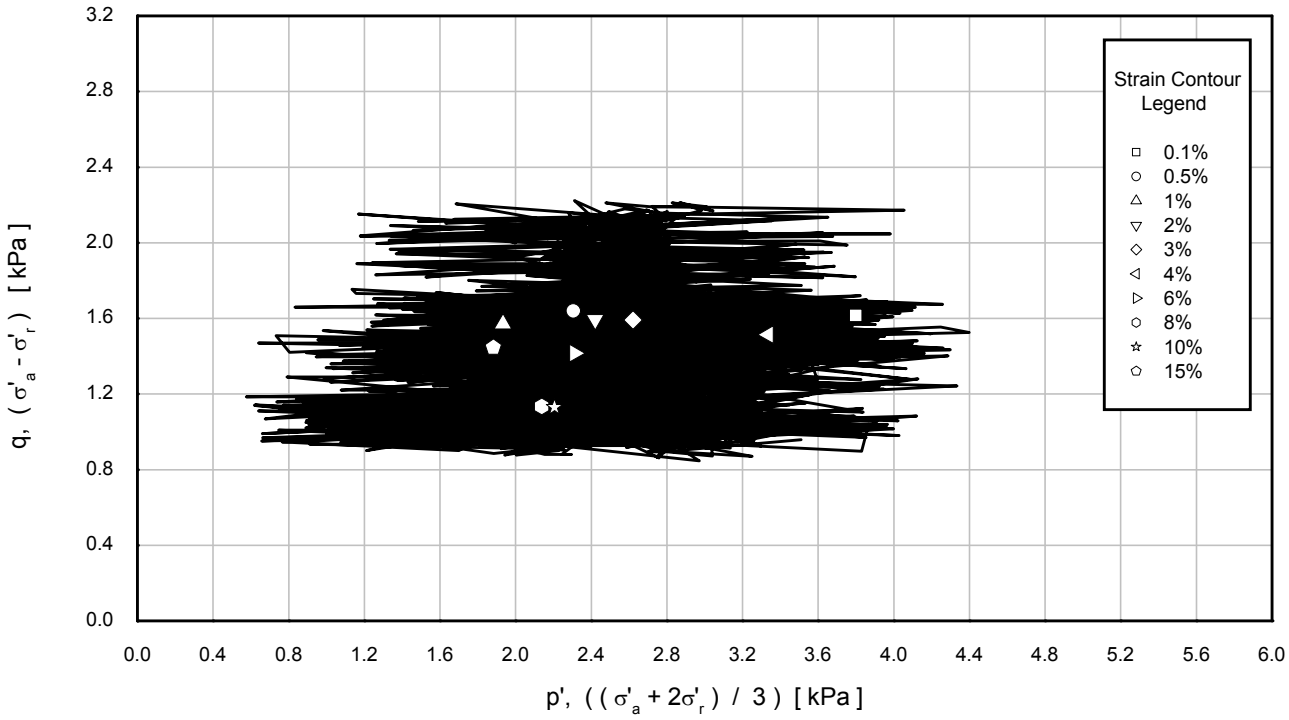


Initial σ'_r	:	3.2 kPa	Borehole	:	Batch
Initial σ'_a	:	4.1 kPa	Sample	:	Southern Bight
q_{peak}	:	2.2 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	18.68 %	Test No.	:	CTXL1
Rate of strain	:	1.42 %/hour			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	3.2	kPa	Borehole	: Batch
Initial σ'_a	:	4.1	kPa	Sample	: Southern Bight
q_{peak}	:	2.2	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	18.68	%	Test No.	: CTXL1
Rate of strain	:	1.42	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND with traces of shell fragments

GENERAL	
Date test started	27/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	10.0
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.627
Degree of saturation	[%]	42
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	n/a
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern_Bight_CTXL2
Processed by	LJ
Date	12/08/2015
Checked by	PH
Date	14/08/2015
Approved by	PH
Date	14/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL2

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1013
Mid height PWP	[kPa]	-
B value achieved	[-]	0.97

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	25
Effective axial pressure	[kPa]	25
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.18
External axial strain	[%]	0.04
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	23.6
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.624
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL2

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	25
Mean q_{av}	[kPa]	0.0
Mean q_{cy}	[kPa]	7.5
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	181
External ε_{av} at N_f	[%]	-3.81
External ε_{cy} at N_f	[%]	13.17
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	19
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	23.6
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.624
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.02	41	-	7.16	-
2	0.00	0.02	43	-	5.67	-
5	0.00	0.02	42	-	4.42	-
10	0.00	0.02	42	-	4.55	-
20	0.00	0.02	40	-	4.60	-
30	0.00	0.02	39	-	4.44	-
40	0.00	0.02	38	-	4.45	-
50	0.00	0.02	37	-	4.67	-
100	-0.01	0.02	32	-	6.02	-
181	-3.81	13.17	0	-	8.22	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL2

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	1.6
Initial effective axial pressure	[kPa]	2.3
Rate of strain	[%/hour]	0.93
At peak deviator stress		
Corrected deviator stress	[kPa]	42
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	23.28
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	8
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	17
Effective axial pressure	[kPa]	59
Principal effective stress ratio	[-]	3.48
ε_{50}	[%]	20.97
Secant modulus (E_{50}) at ε_{50}	[kPa]	82
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	1.4
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	9.44
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0.2
Effective axial pressure	[kPa]	1.6
Principal effective stress ratio	[-]	9.46
At 10% axial strain		
Corrected deviator stress	[kPa]	1.5
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	9.99
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1.7
Effective axial pressure	[kPa]	3.2
Principal effective stress ratio	[-]	1.92

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL2

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

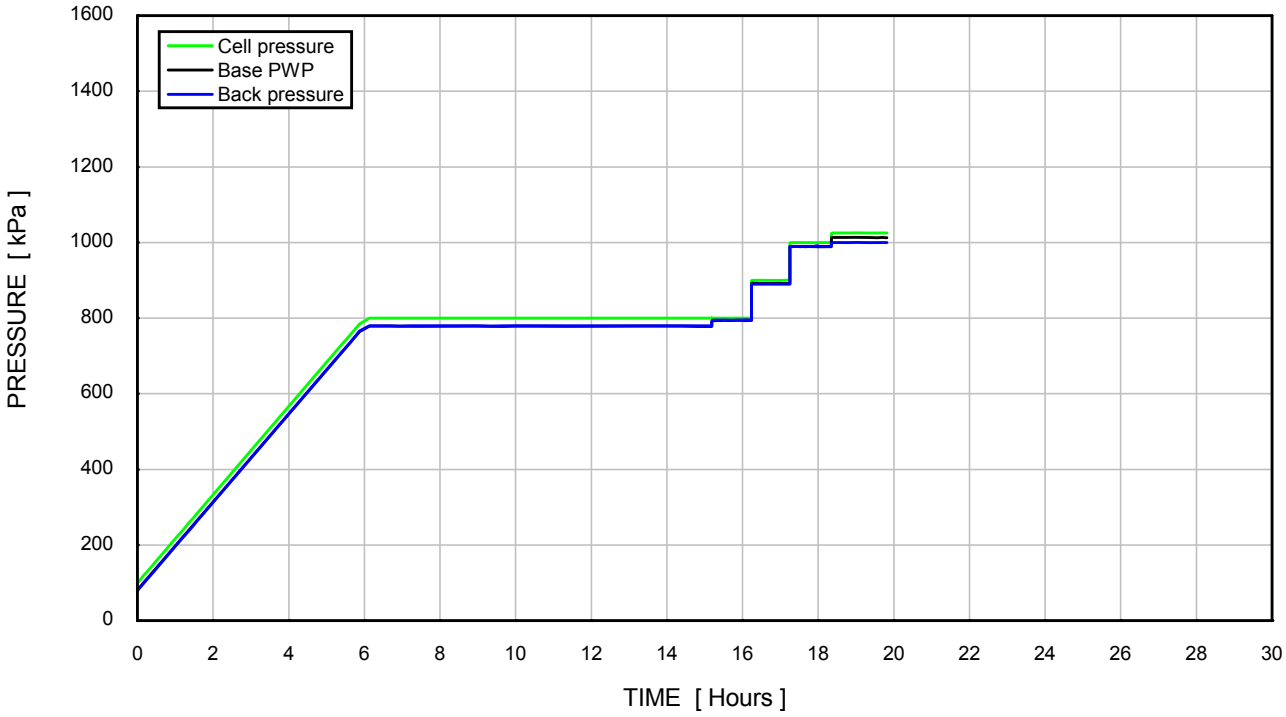
Moisture content	[%]	23.6
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.63

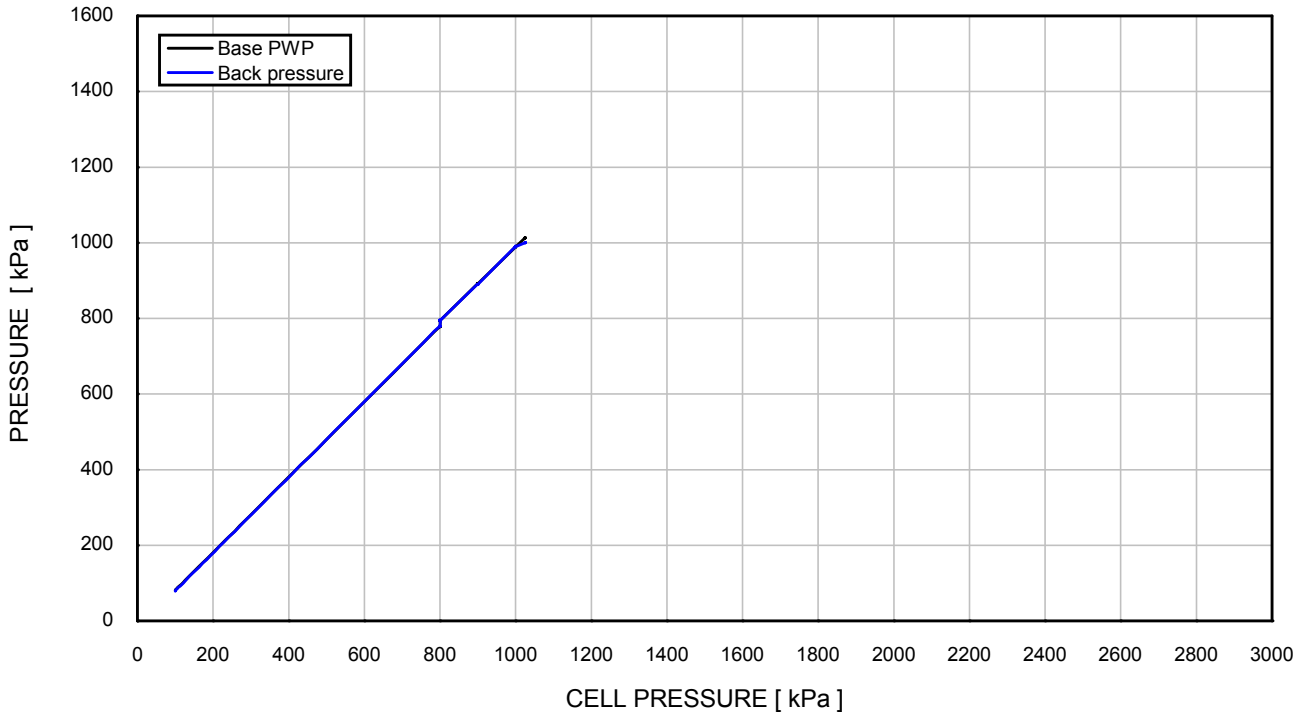
TEST IDENTIFICATION

Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL2

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

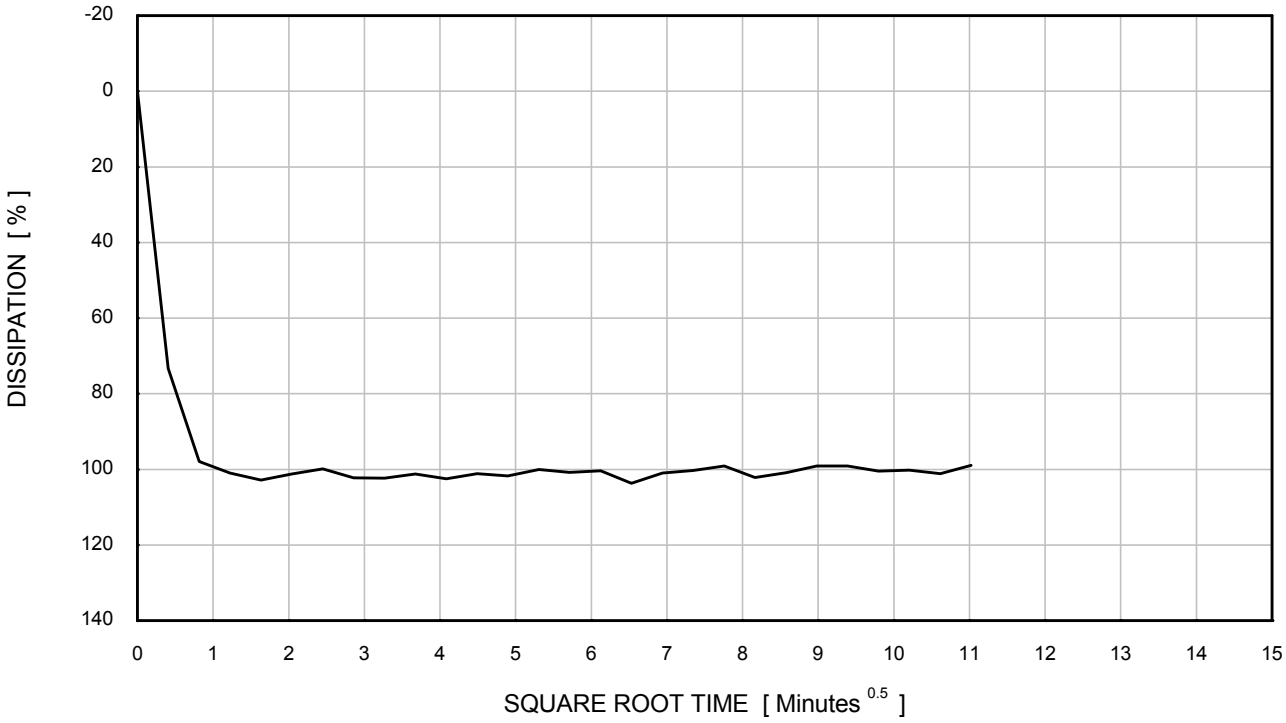


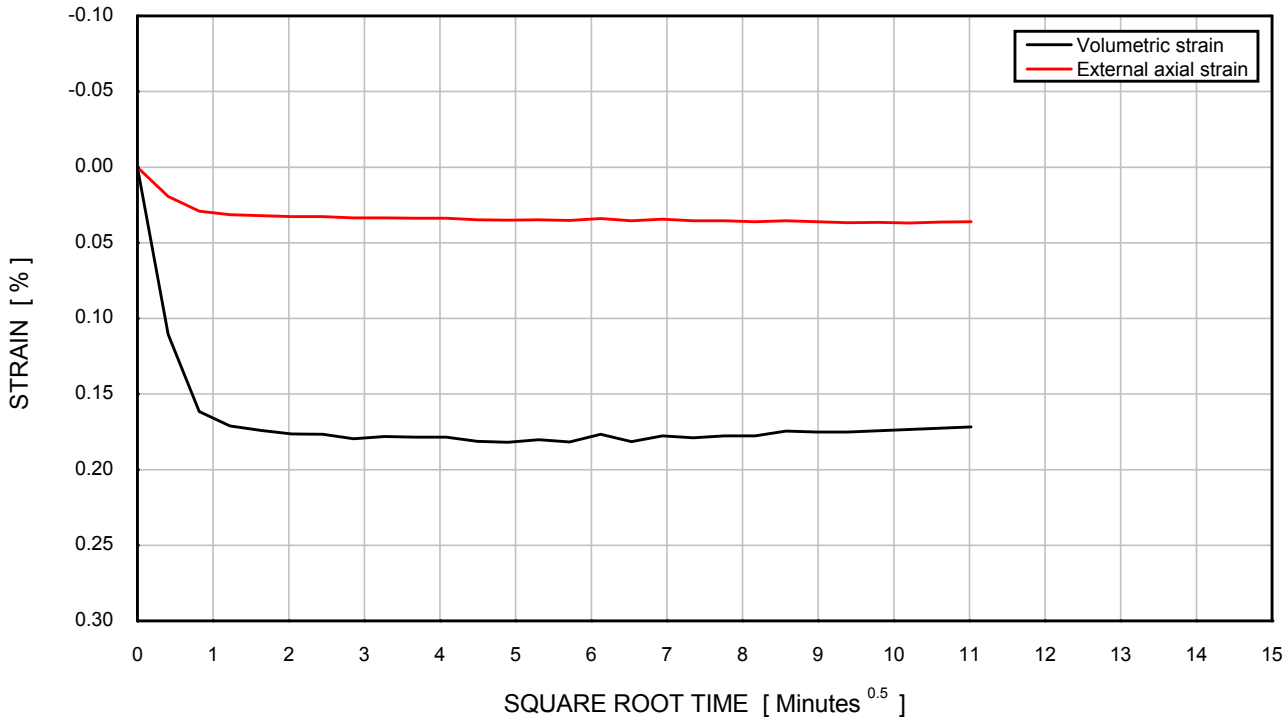


B value	:	0.97			
Initial σ'_r	:	19	kPa	Borehole	: Batch
Initial σ'_a	:	19	kPa	Sample	: Southern Bight
Final σ'_r	:	12	kPa	Depth [m]	: -
Final σ'_a	:	12	kPa	Test No.	: CTXL2

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

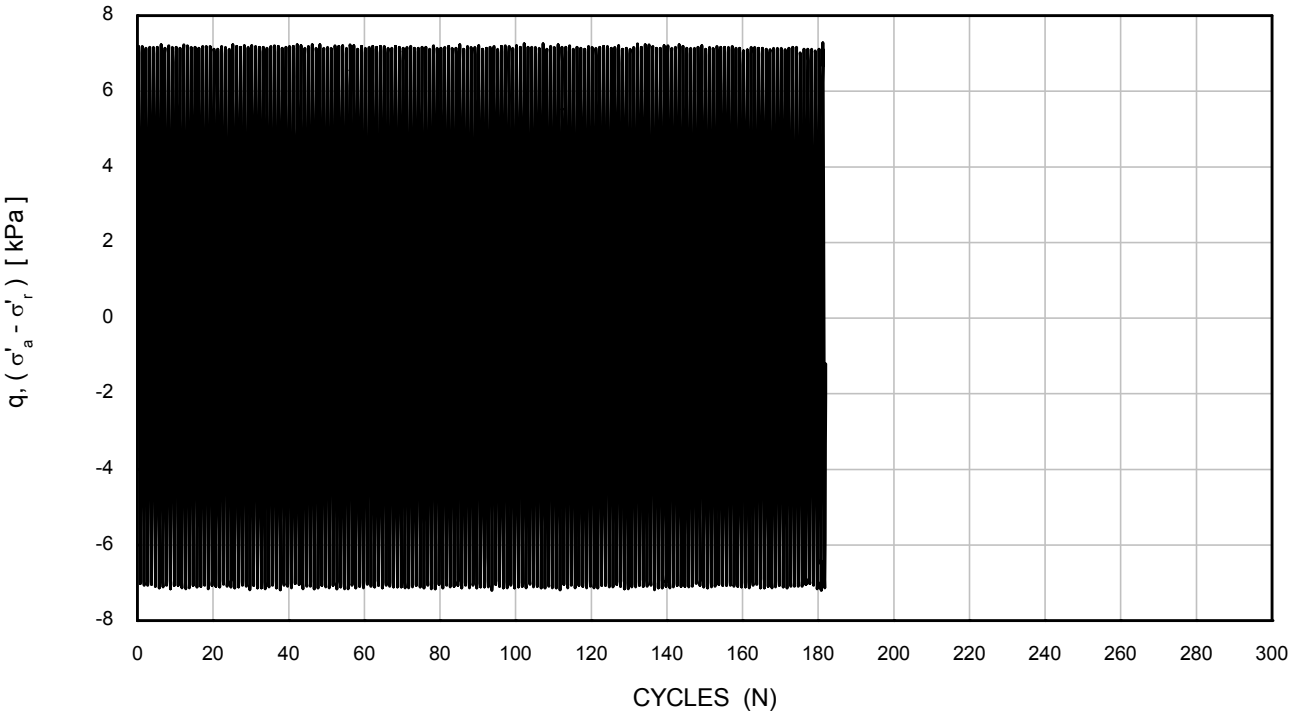


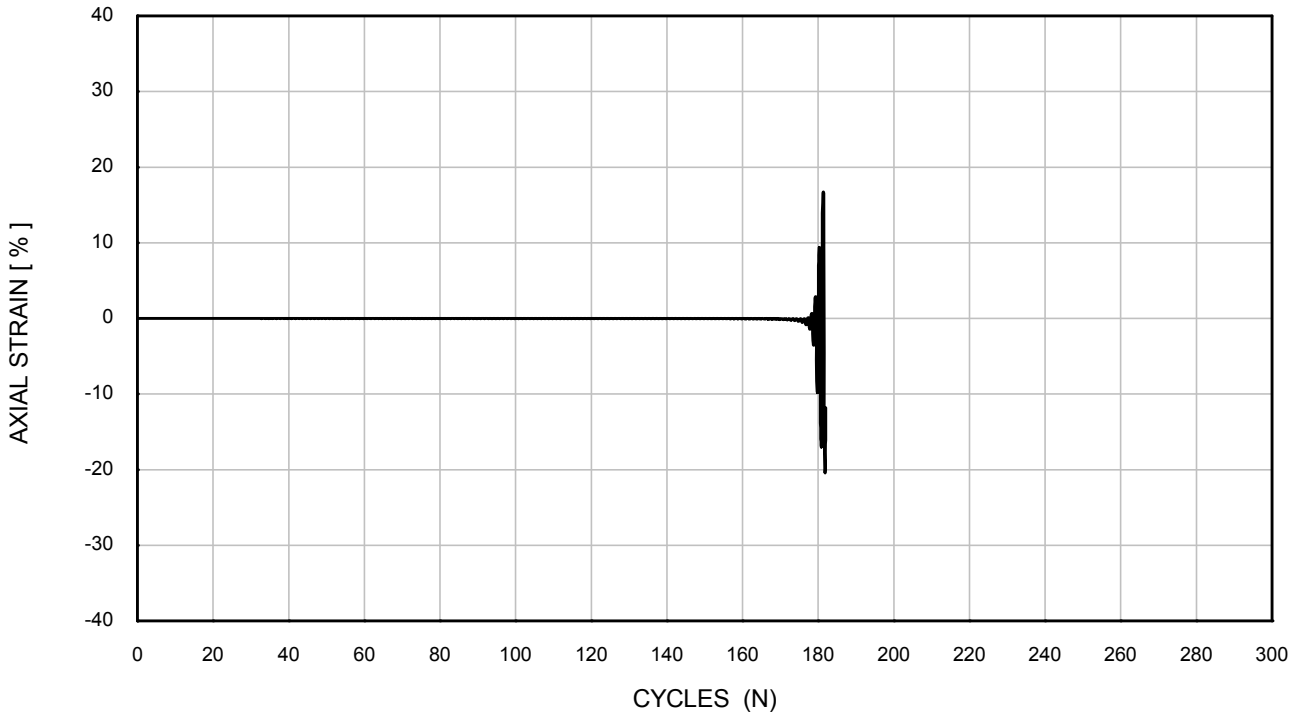


σ'_{rc}	:	25 kPa	Borehole	: Batch
σ'_{ac}	:	25 kPa	Sample	: Southern Bight
			Depth [m]	: -
			Test No.	: CTXL2

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

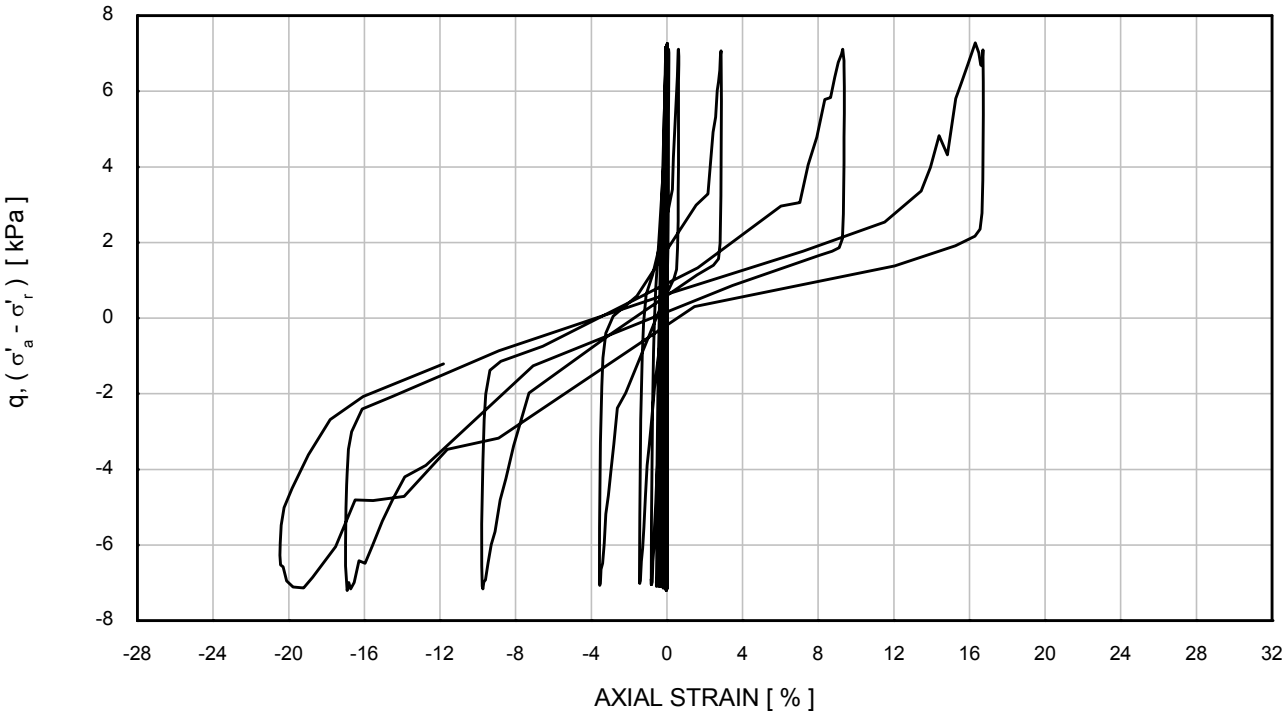


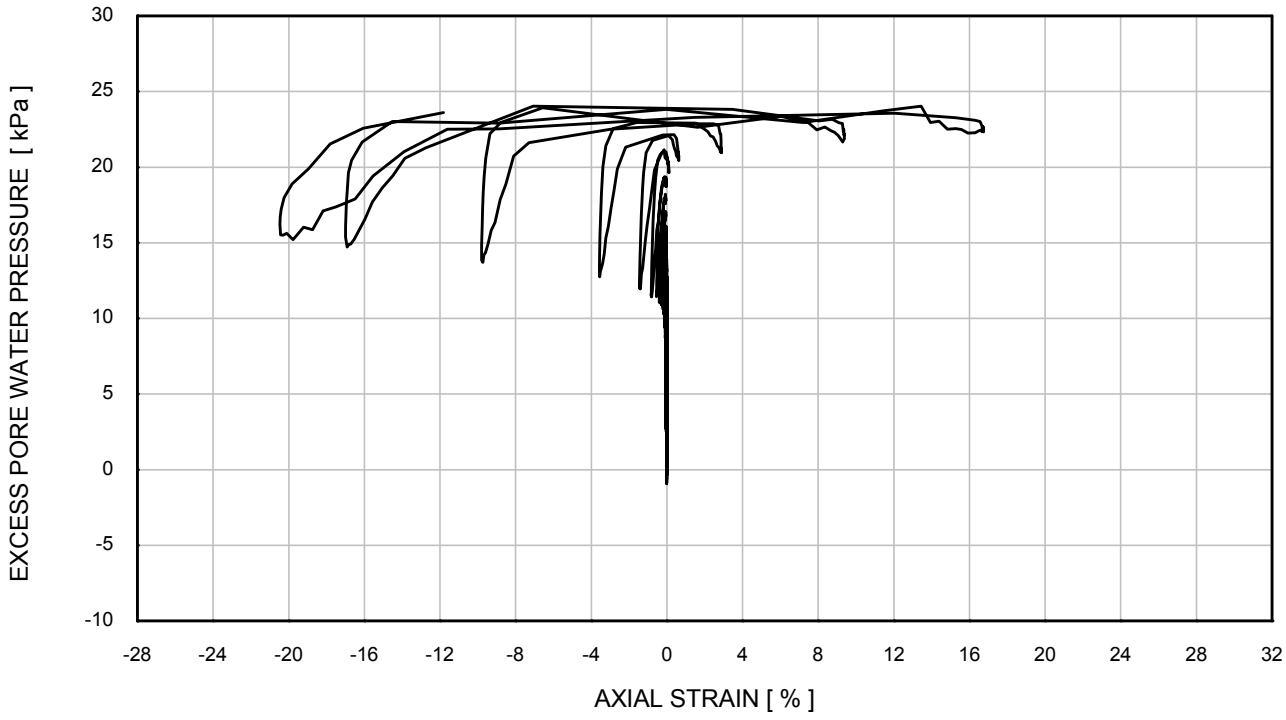


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0.0	kPa	Depth [m]	: -
q_{cy}	:	7.1	kPa	Test No.	: CTXL2
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

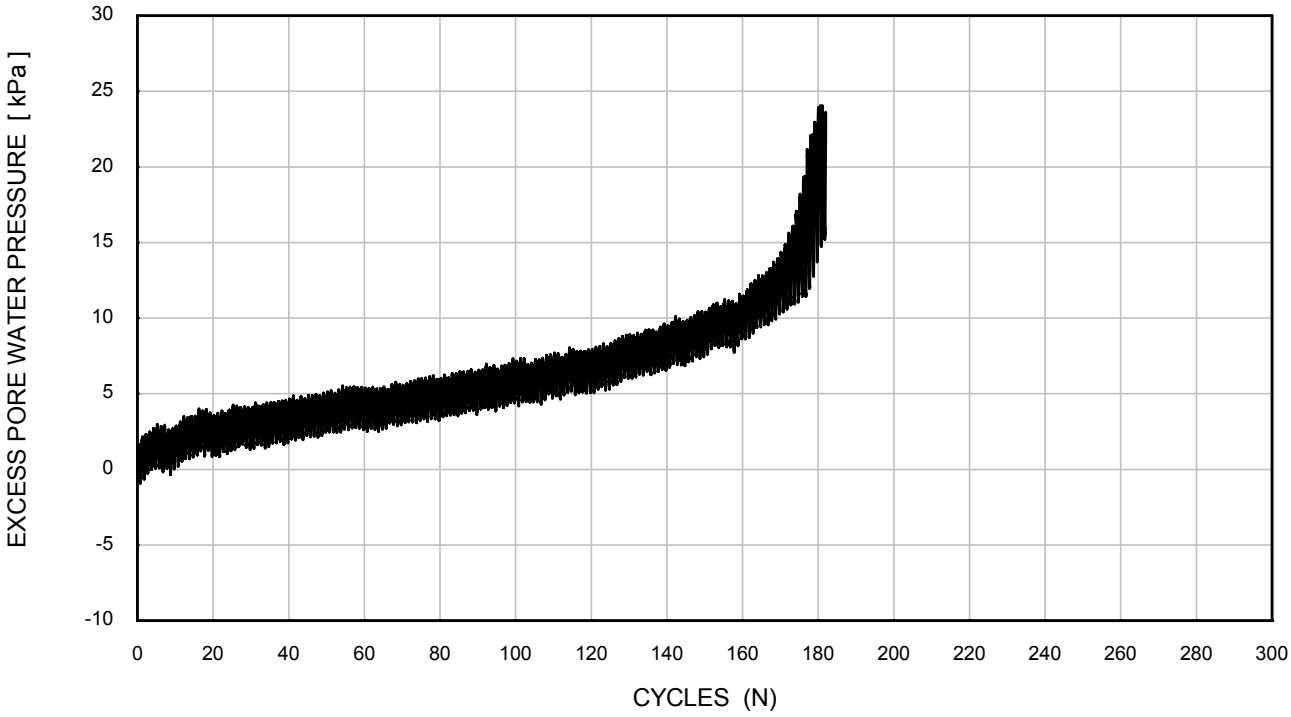


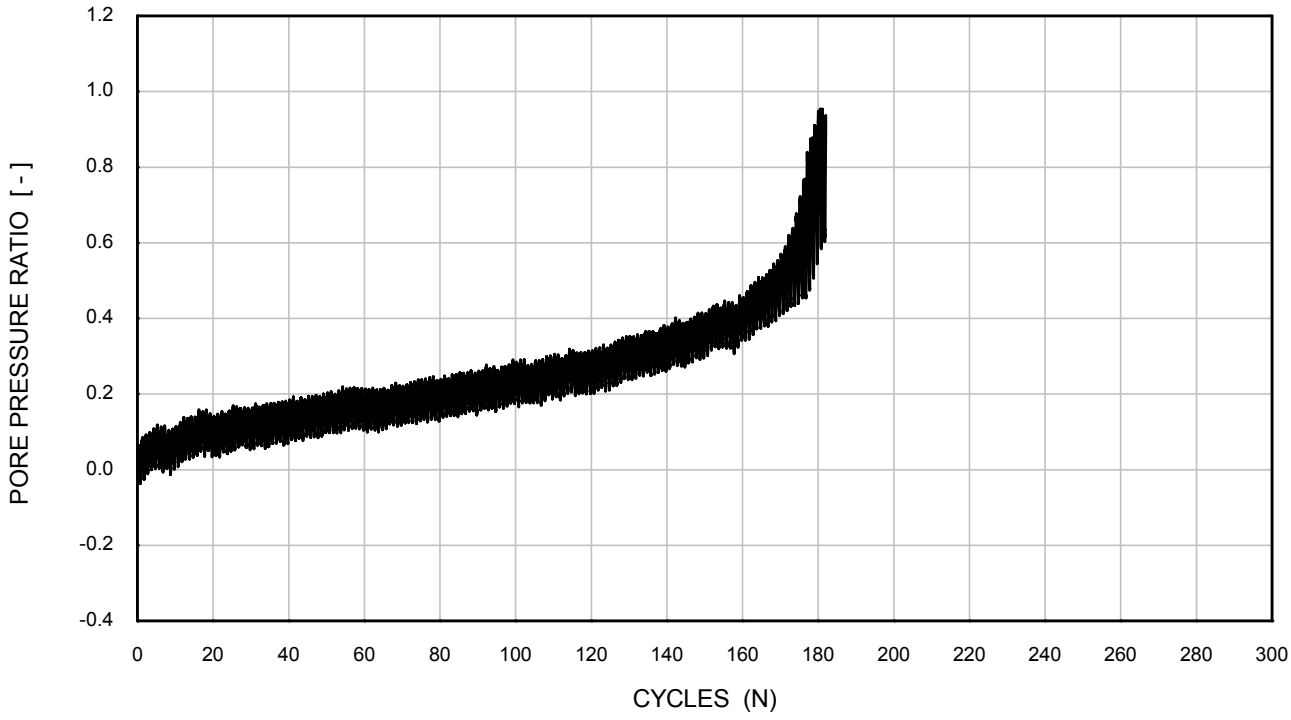


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	7.1 kPa	Test No.	:	CTXL2
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

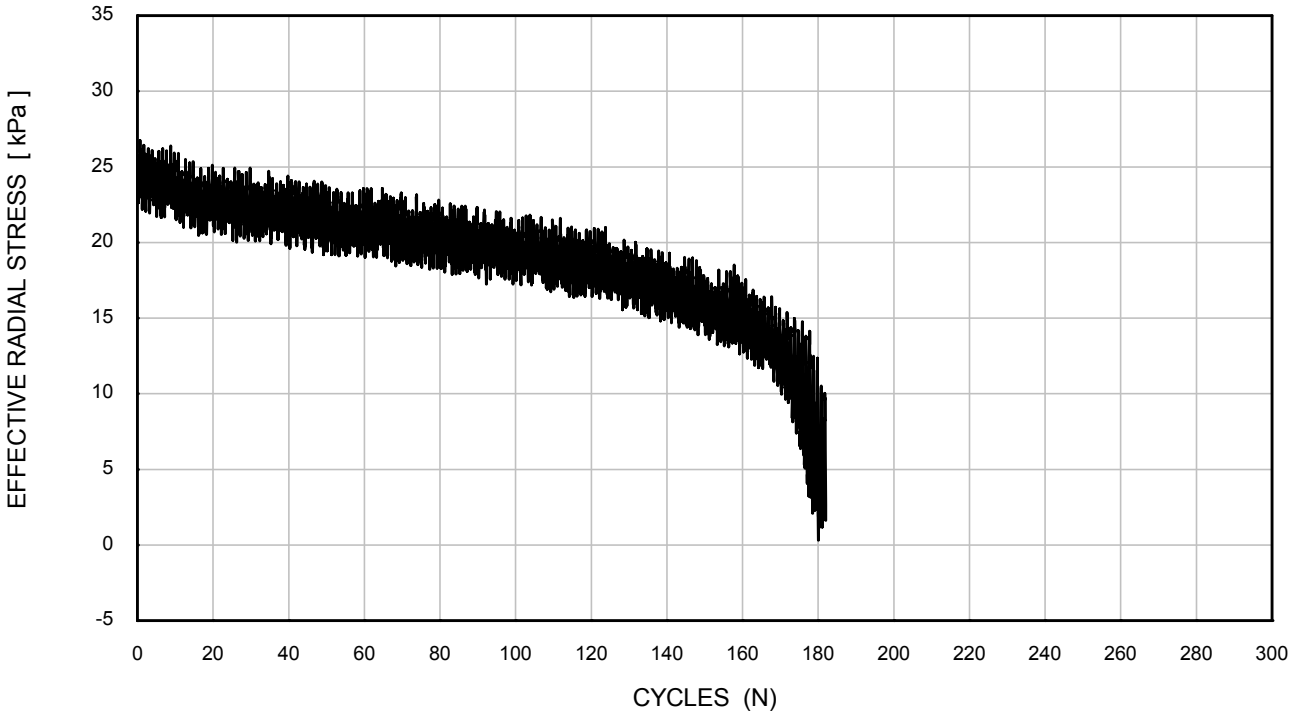


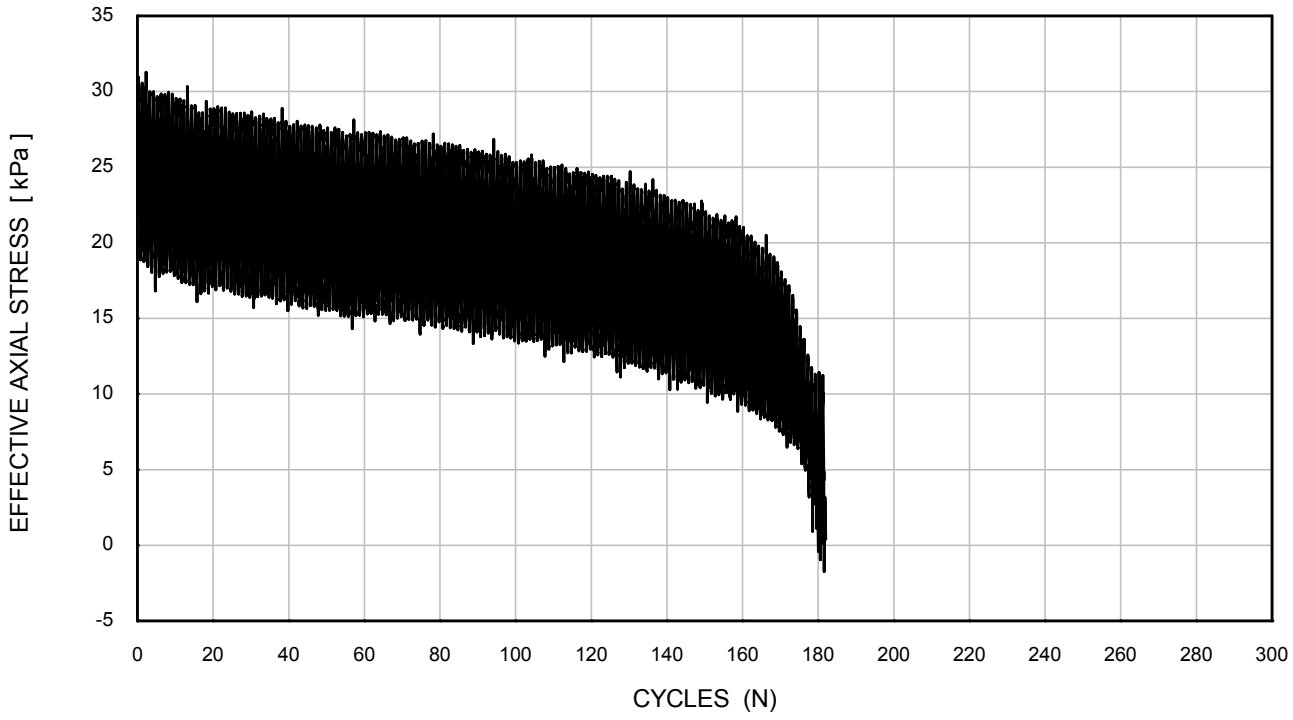


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	7.1 kPa	Test No.	:	CTXL2
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

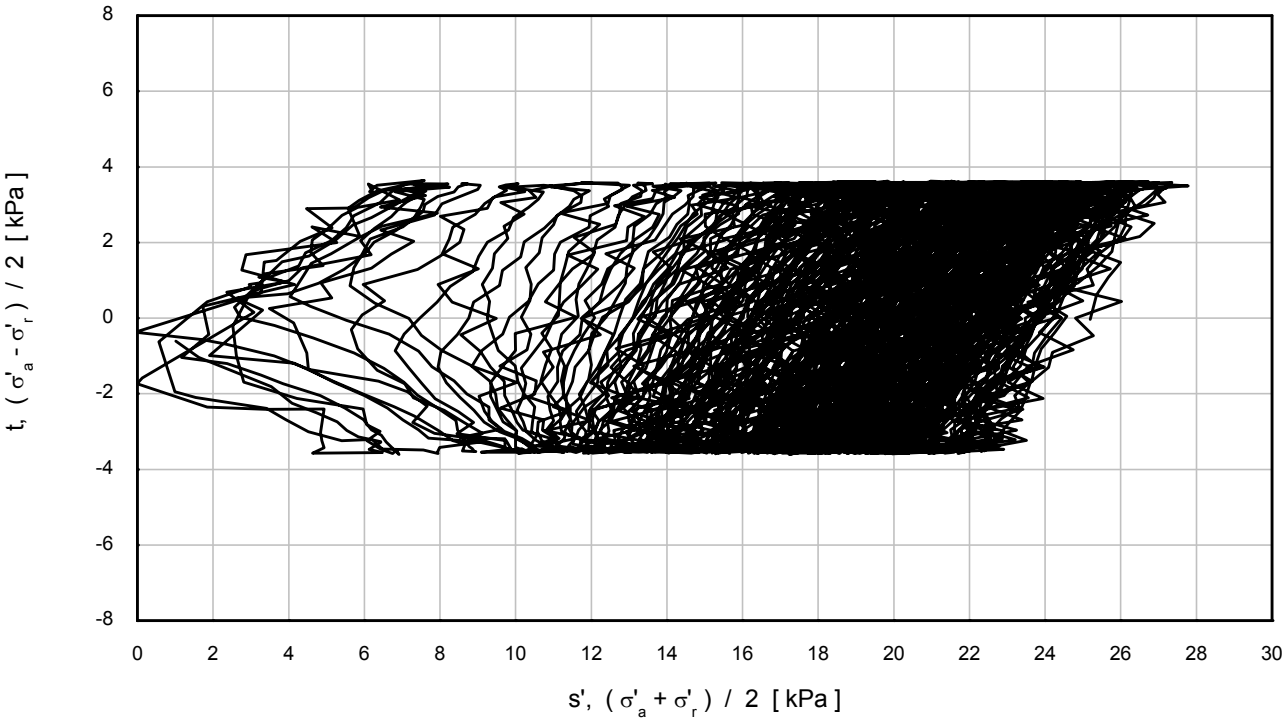


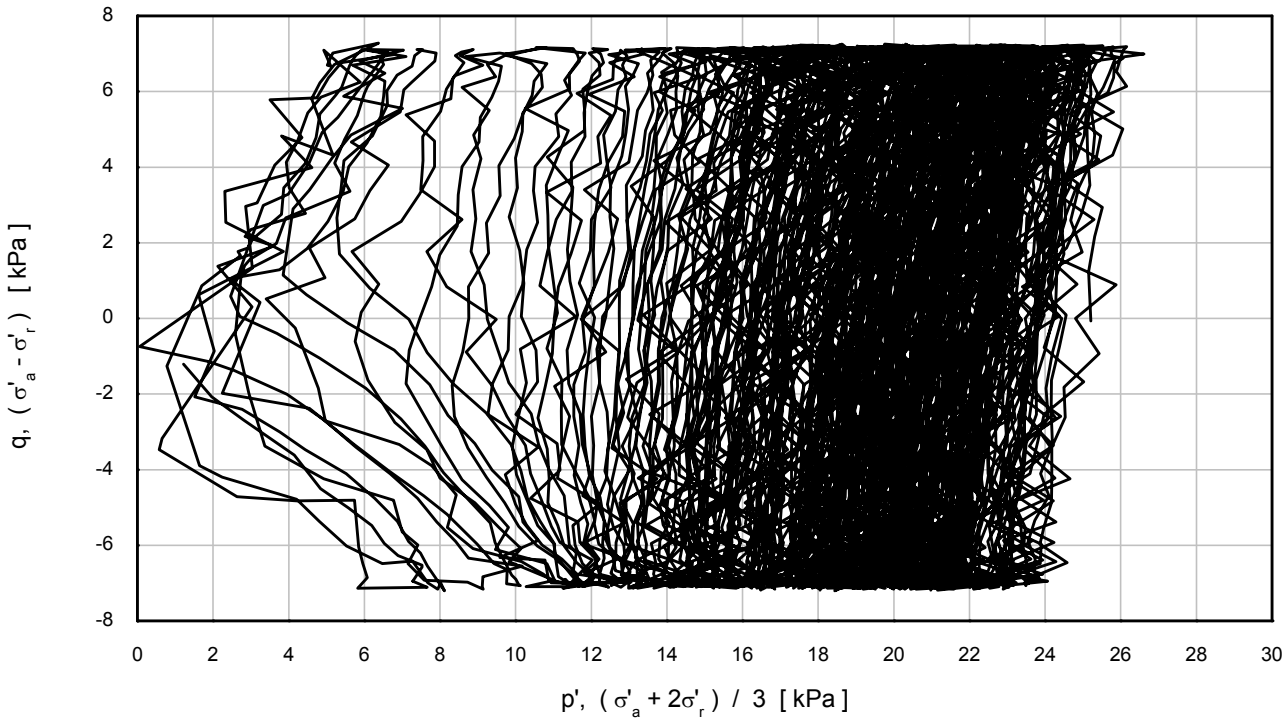


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	7.1 kPa	Test No.	:	CTXL2
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

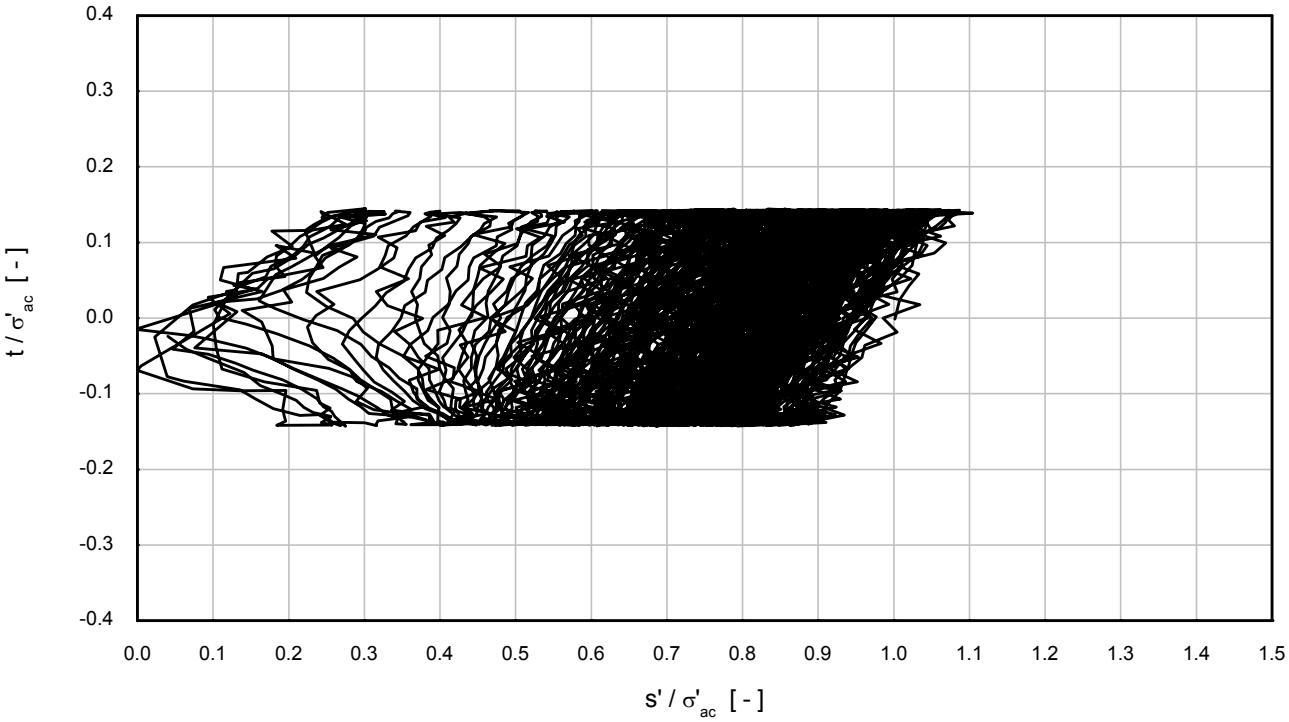


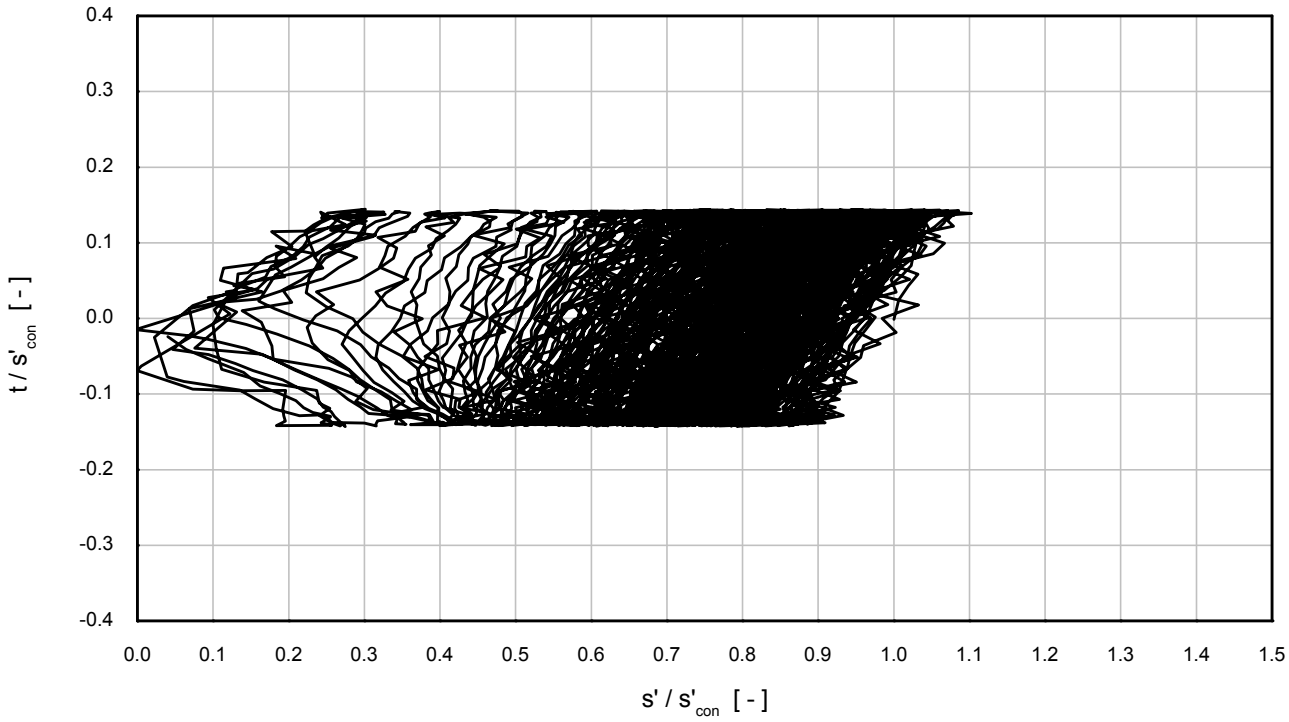


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	7.1 kPa	Test No.	:	CTXL2
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

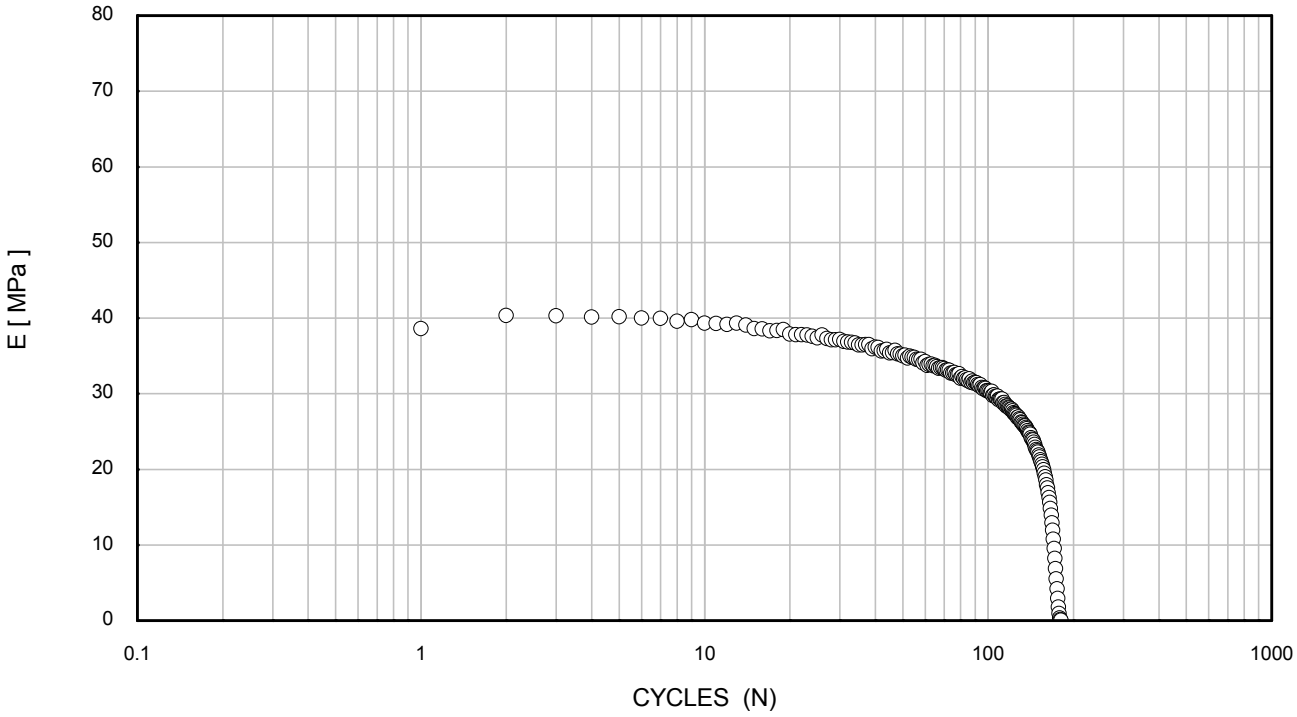


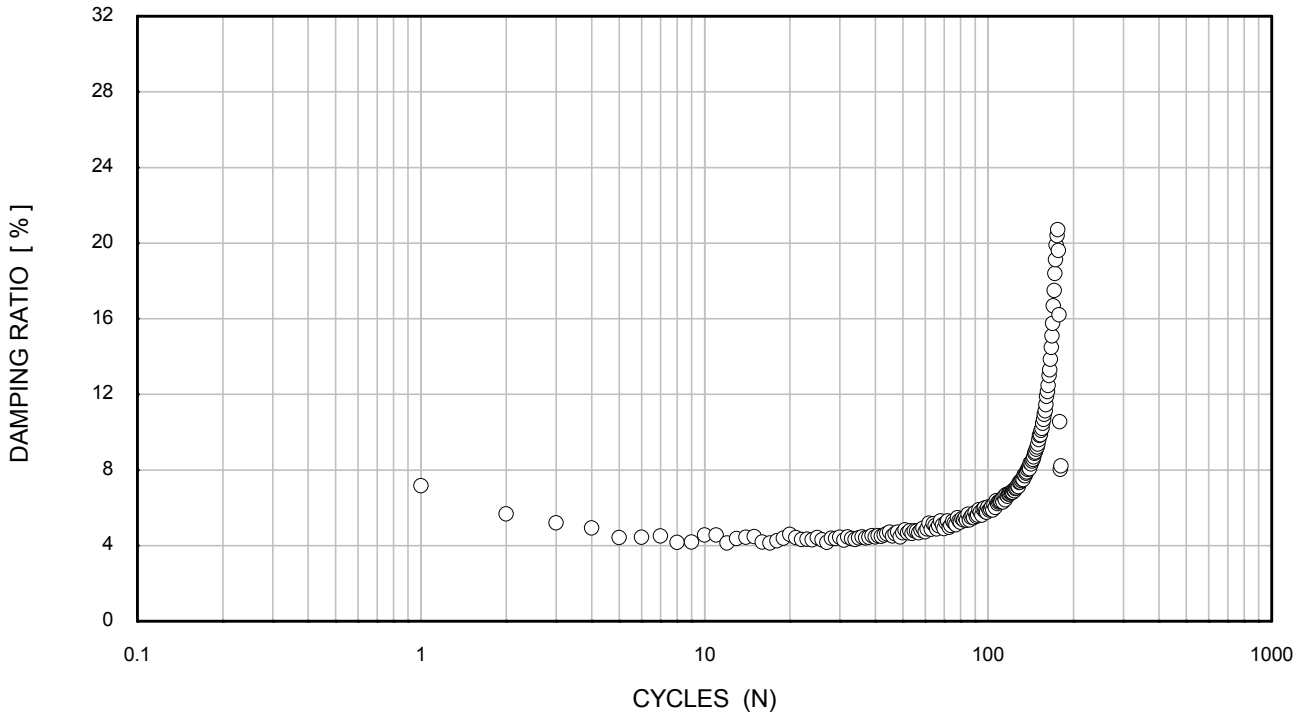


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0.0	kPa	Depth [m]	: -
q_{cy}	:	7.1	kPa	Test No.	: CTXL2
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

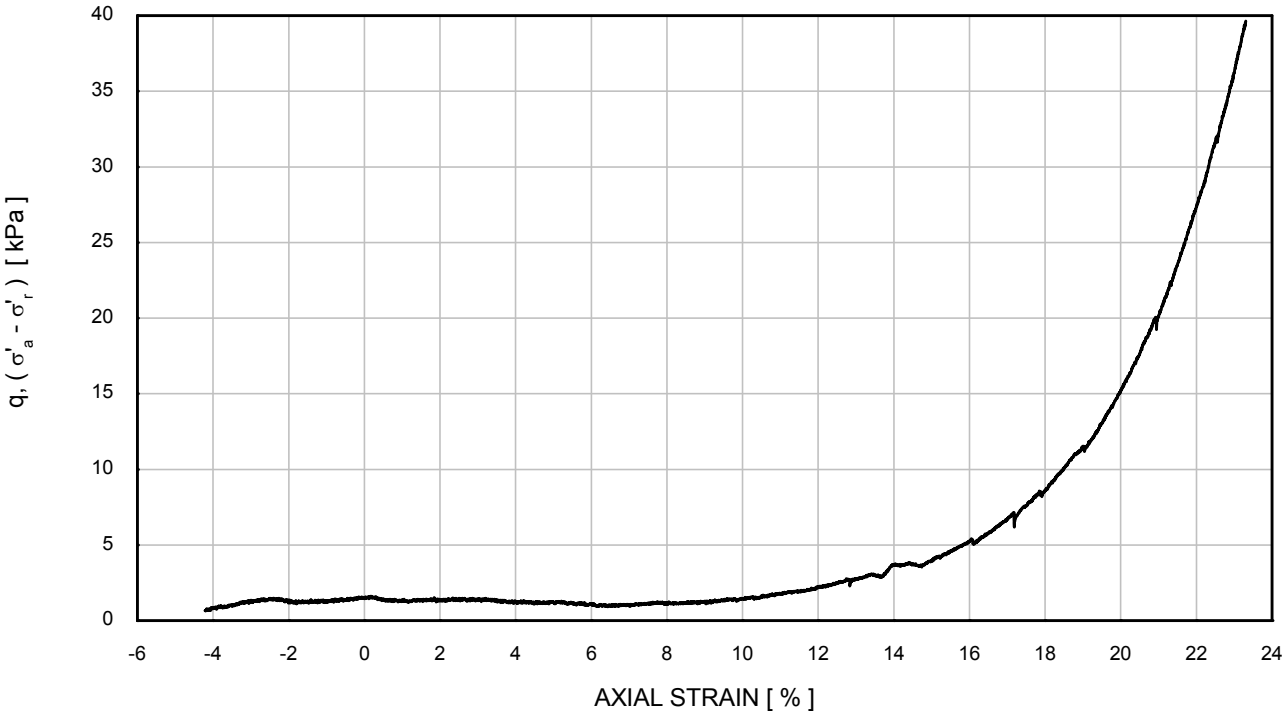


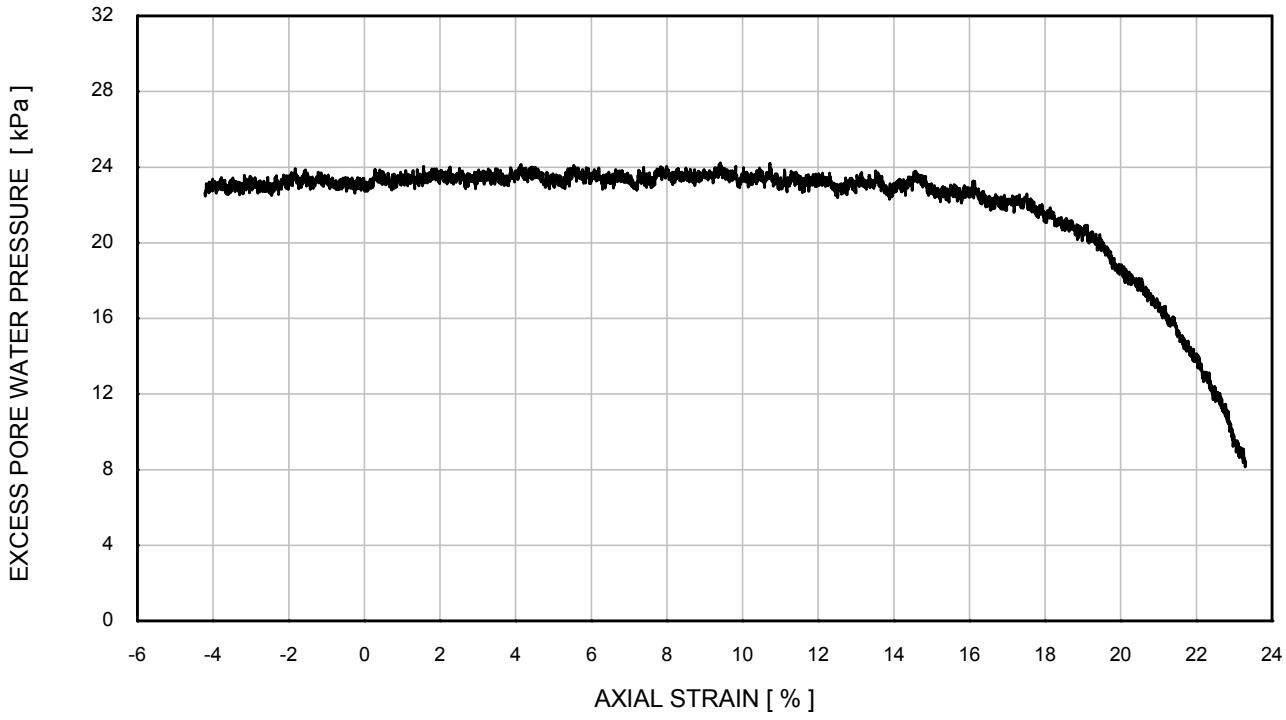


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	7.1 kPa	Test No.	:	CTXL2
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

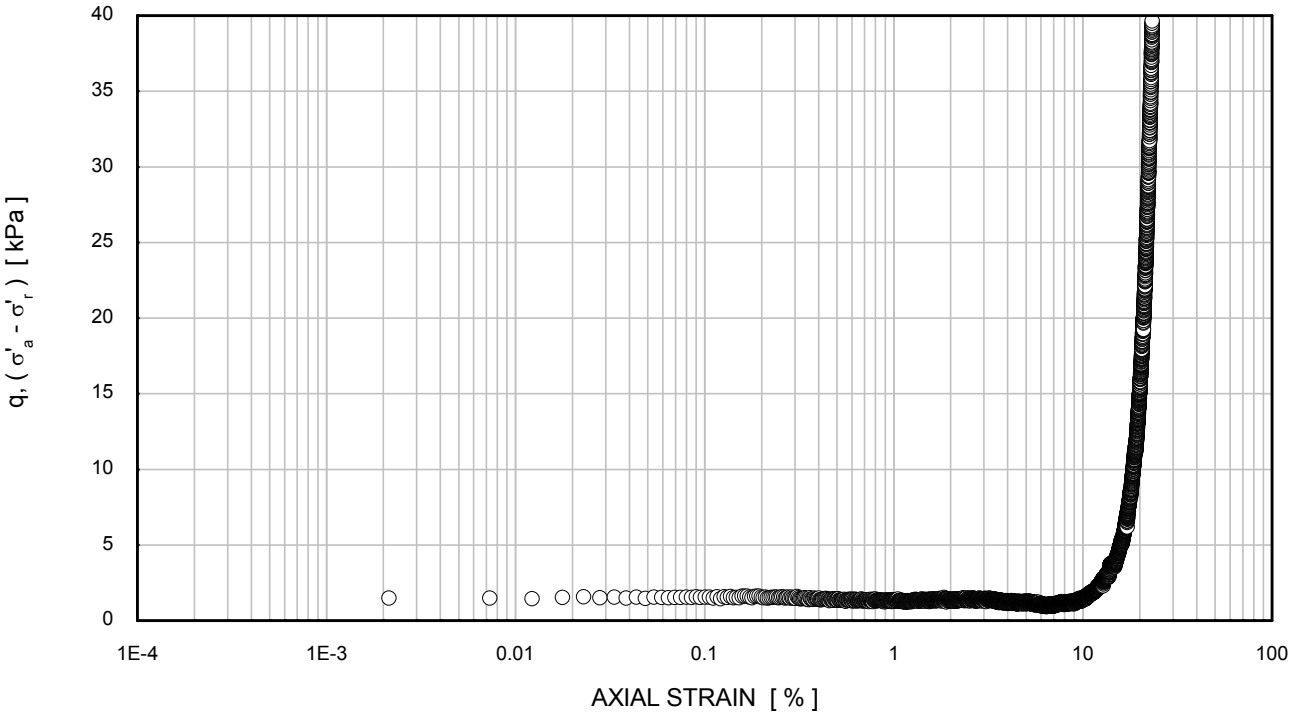


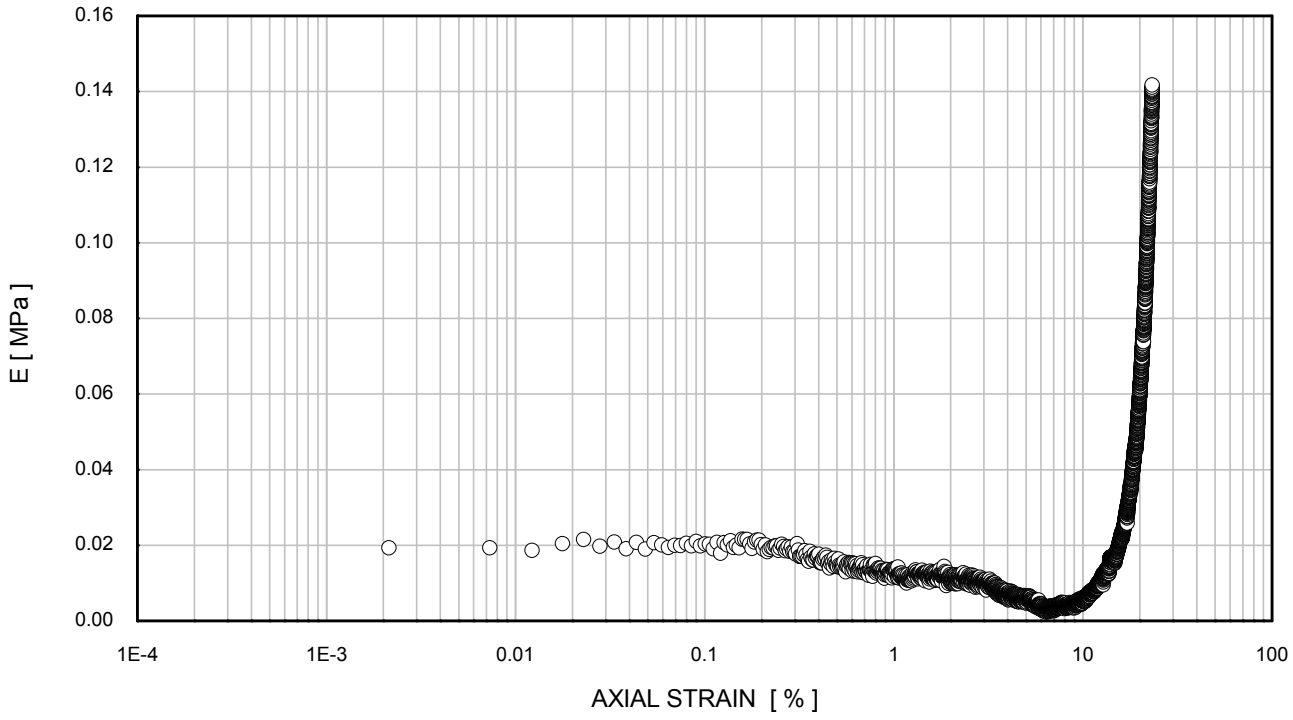


Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	40	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.3	%	Test No.	: CTXL2
Rate of strain	:	0.93	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

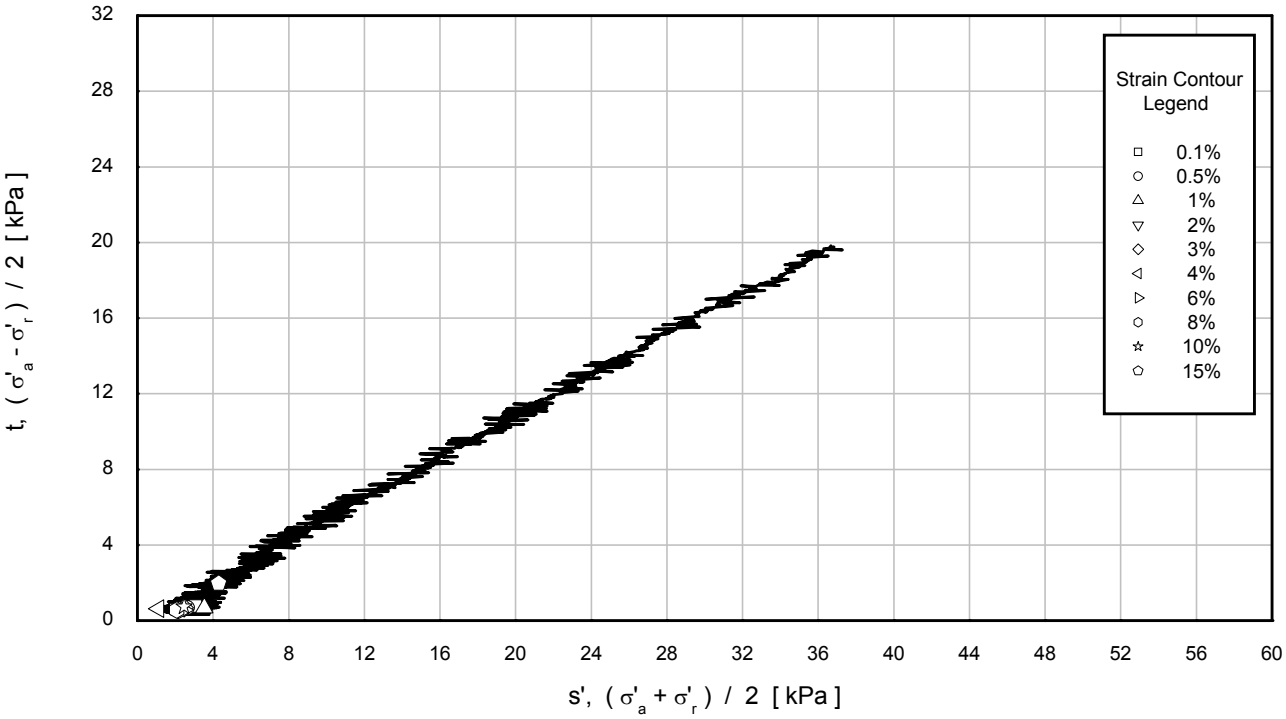


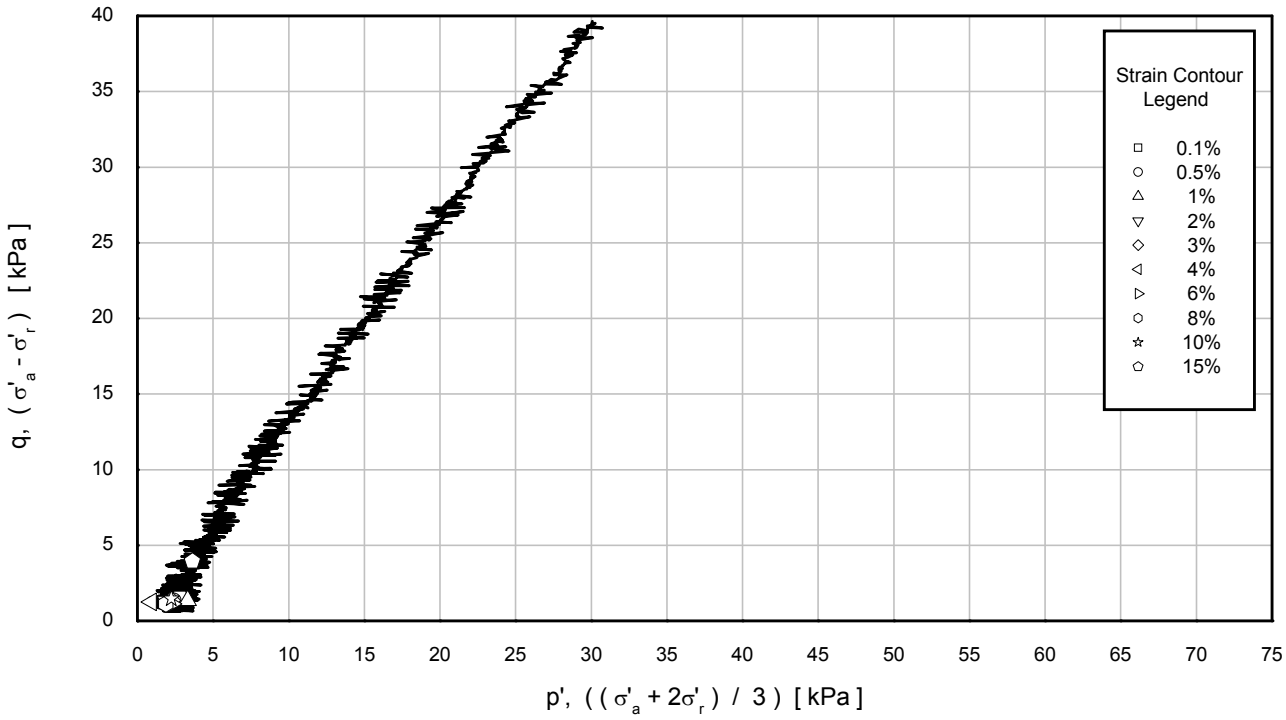


Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	40	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.3	%	Test No.	: CTXL2
Rate of strain	:	0.93	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	40	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.3	%	Test No.	: CTXL2
Rate of strain	:	0.93	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND with traces of shell fragments

GENERAL	
Date test started	31/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	10.3
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.633
Degree of saturation	[%]	43
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern_Bight_CTXL3
Processed by	LJ
Date	12/08/2015
Checked by	PH
Date	15/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL3

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1012
Mid height PWP	[kPa]	-
B value achieved	[-]	0.97

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	25
Effective axial pressure	[kPa]	25
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.14
External axial strain	[%]	0.04
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	23.8
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.631
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL3

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	25
Mean q_{av}	[kPa]	0.0
Mean q_{cy}	[kPa]	5.0
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	196
External ε_{av} at N_f	[%]	-3.89
External ε_{cy} at N_f	[%]	16.58
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	23
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	23.8
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.631
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.01	39	-	6.09	-
2	0.00	0.01	39	-	3.98	-
5	0.00	0.01	39	-	2.82	-
10	0.00	0.01	38	-	2.53	-
20	0.00	0.01	37	-	2.41	-
30	0.00	0.01	36	-	2.70	-
40	0.00	0.01	35	-	2.25	-
50	0.00	0.01	34	-	2.96	-
100	0.00	0.02	30	-	3.85	-
196	-3.89	16.58	0	-	12.48	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL3

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	1.5
Initial effective axial pressure	[kPa]	1.6
Rate of strain	[%/hour]	0.98
At peak deviator stress		
Corrected deviator stress	[kPa]	3.8
Membrane correction applied	[kPa]	1.8
Drain correction applied	[kPa]	0
External axial strain	[%]	24.27
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	23
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1.9
Effective axial pressure	[kPa]	5.6
Principal effective stress ratio	[-]	3.02
ε_{50}	[%]	16.79
Secant modulus (E_{50}) at ε_{50}	[kPa]	5
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	2.2
Membrane correction applied	[kPa]	1.6
Drain correction applied	[kPa]	0
External axial strain	[%]	18.42
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0.0
Effective axial pressure	[kPa]	2.2
Principal effective stress ratio	[-]	218.07
At 10% axial strain		
Corrected deviator stress	[kPa]	0.9
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0.6
Effective axial pressure	[kPa]	1.5
Principal effective stress ratio	[-]	2.48

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL3

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

Specimen photo unavailable

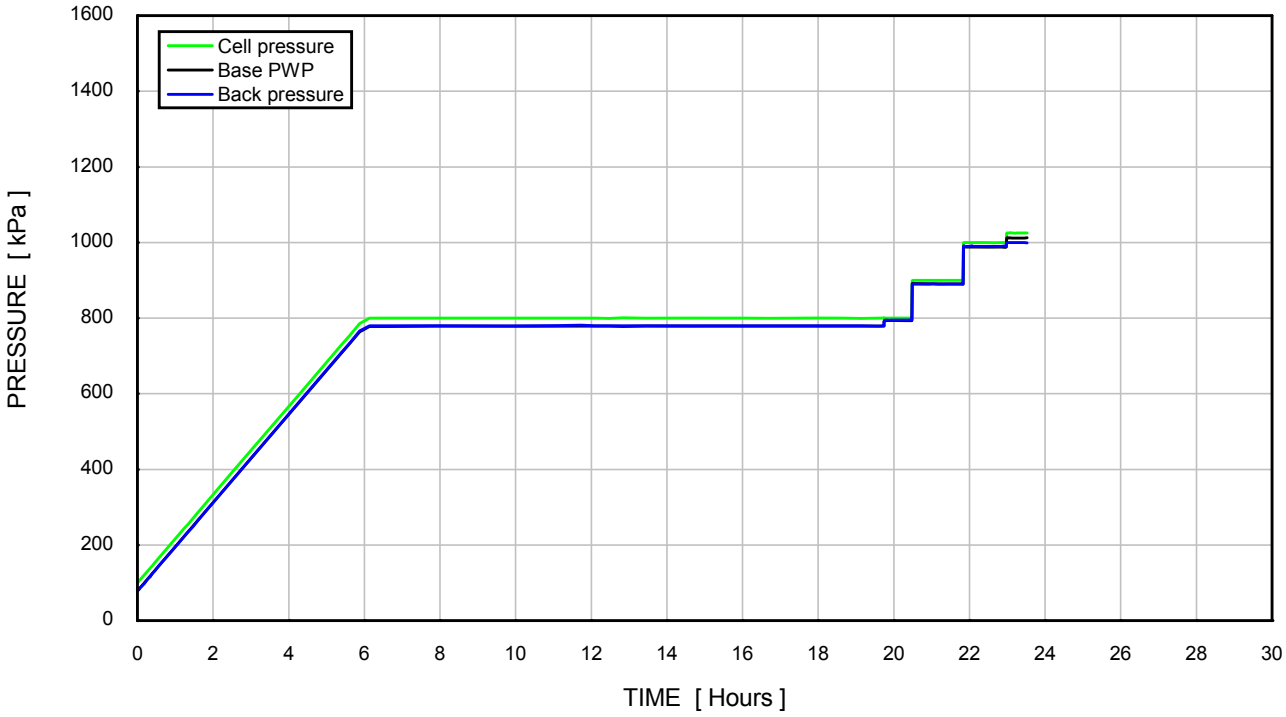
Specimen photo unavailable

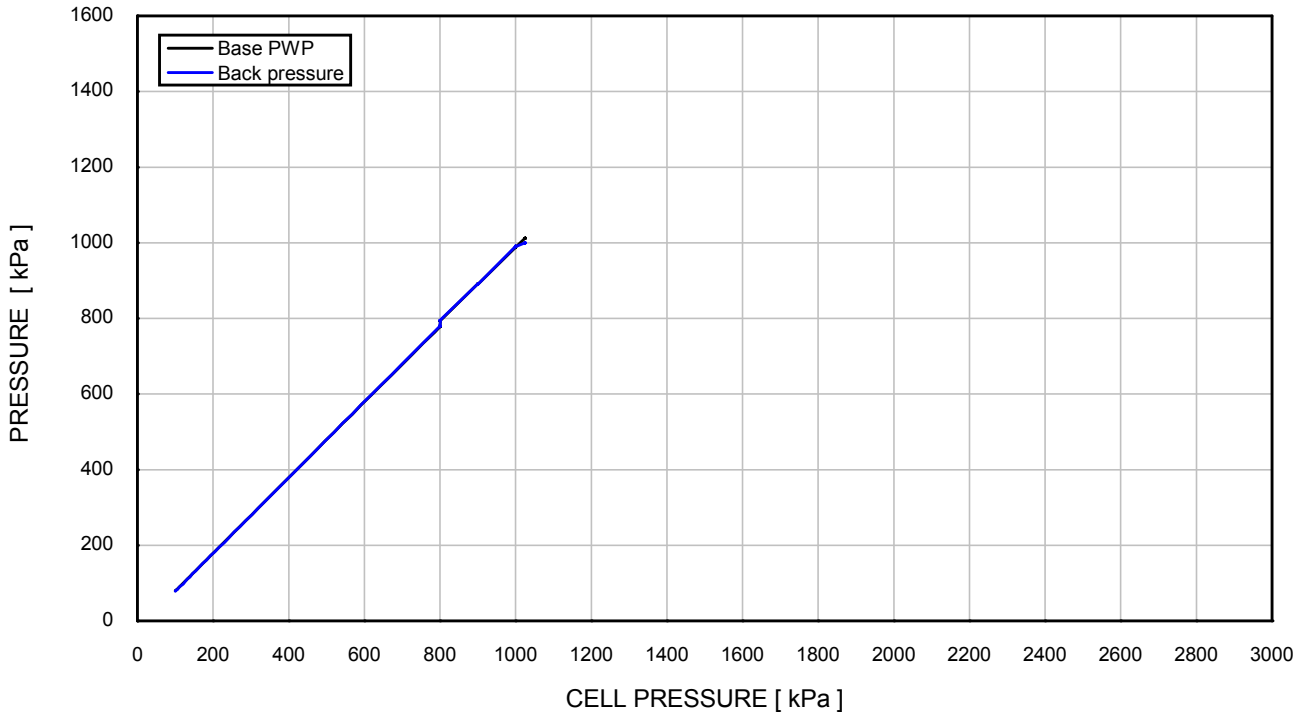
FINAL CONDITIONS		
Moisture content	[%]	23.8
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL3

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

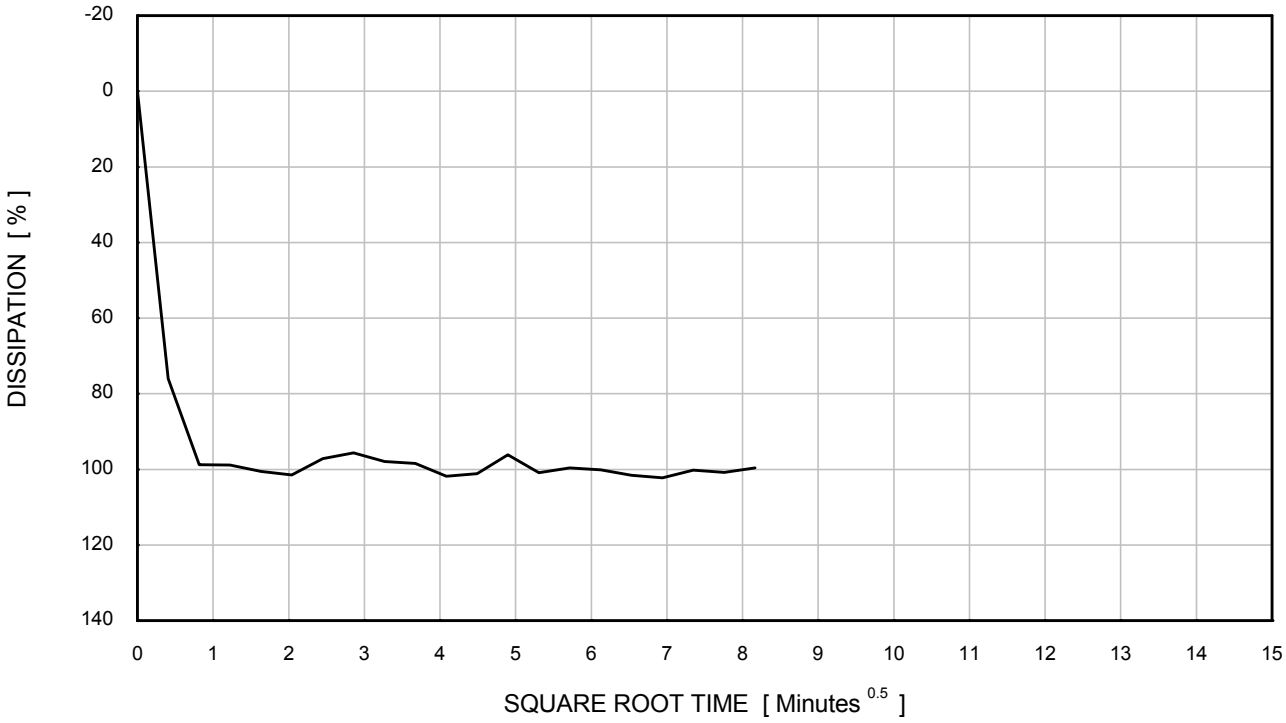


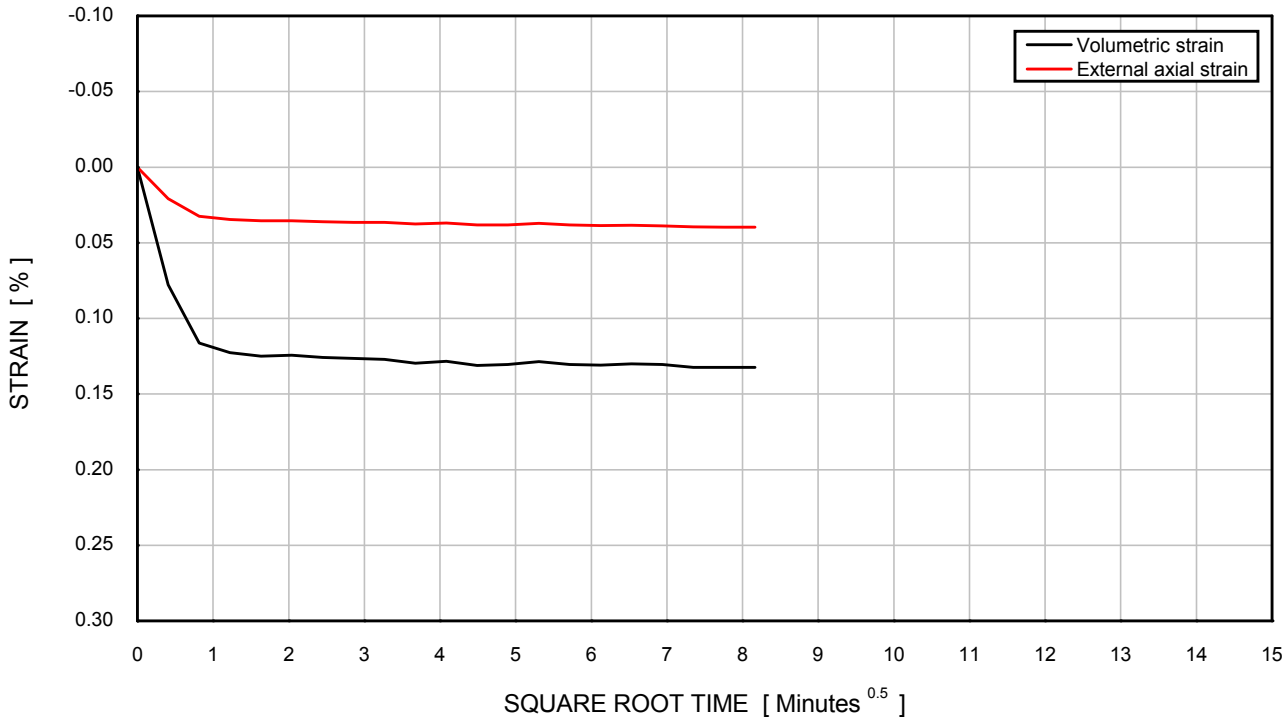


B value	:	0.97			
Initial σ'_r	:	20	kPa	Borehole	: Batch
Initial σ'_a	:	20	kPa	Sample	: Southern Bight
Final σ'_r	:	13	kPa	Depth [m]	: -
Final σ'_a	:	13	kPa	Test No.	: CTXL3

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

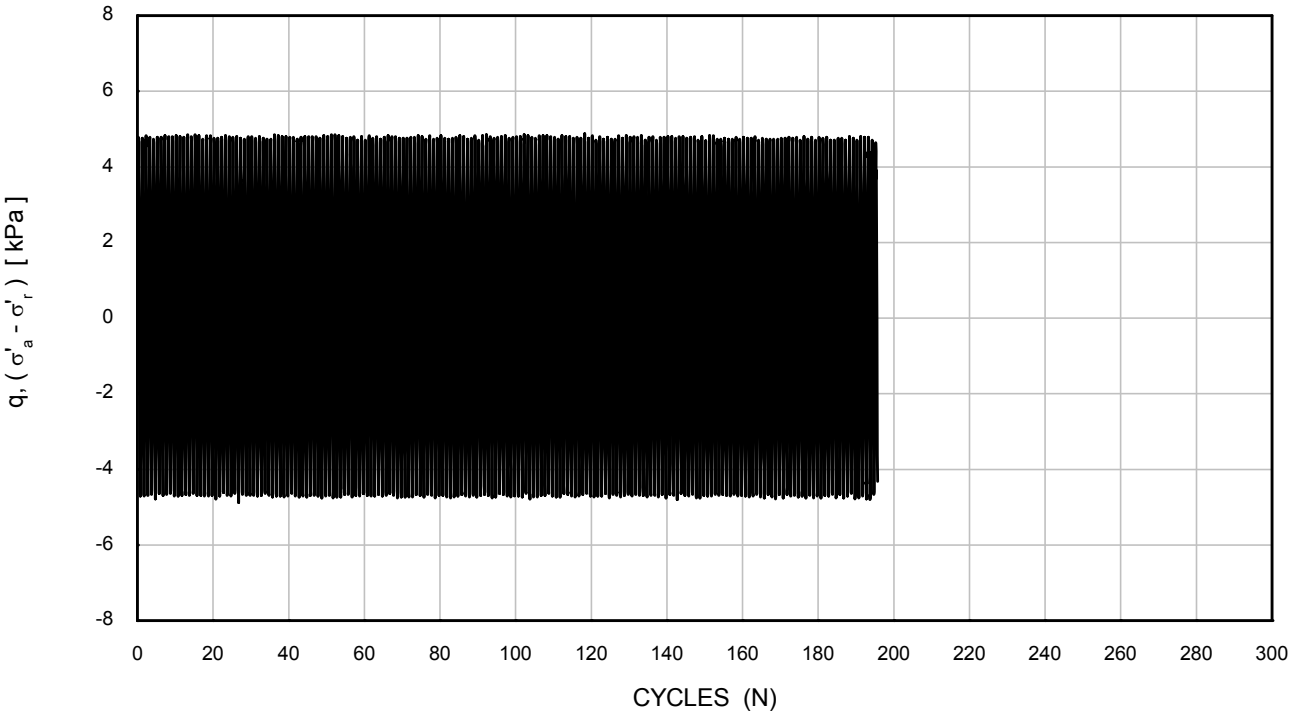


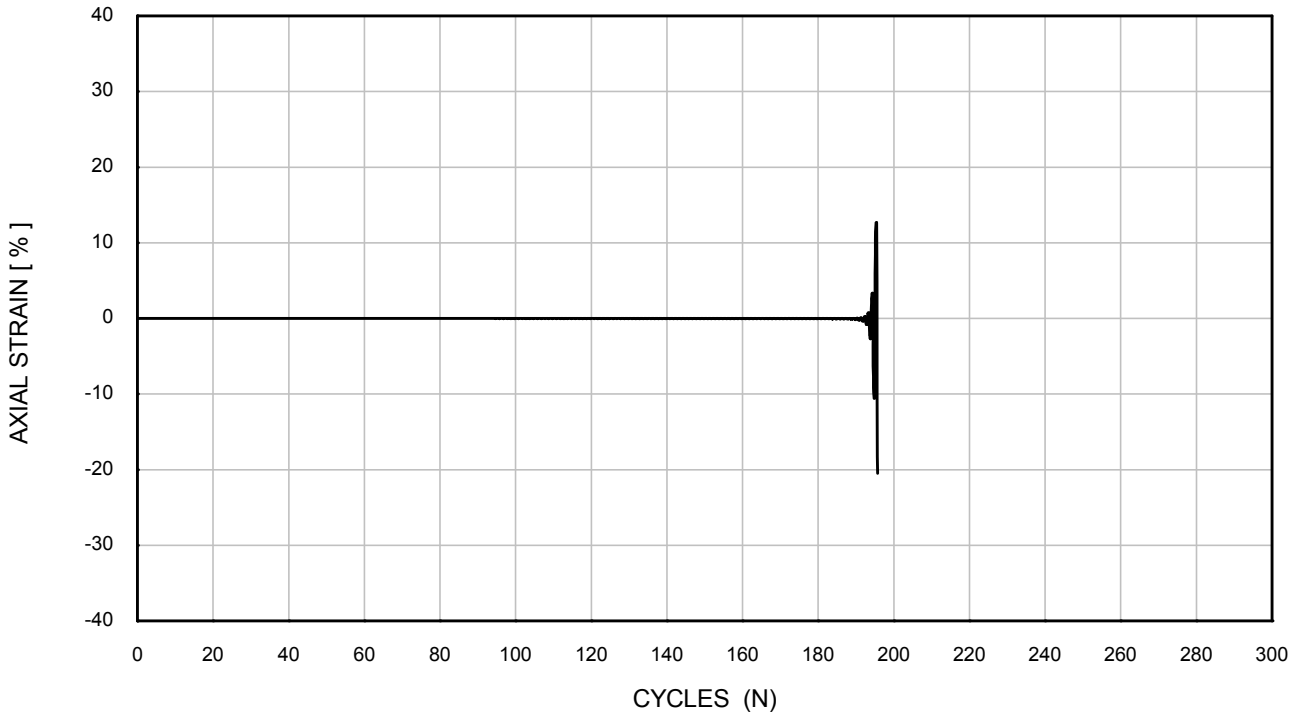


σ'_{rc}	:	25 kPa	Borehole	: Batch
σ'_{ac}	:	25 kPa	Sample	: Southern Bight
			Depth [m]	: -
			Test No.	: CTXL3

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

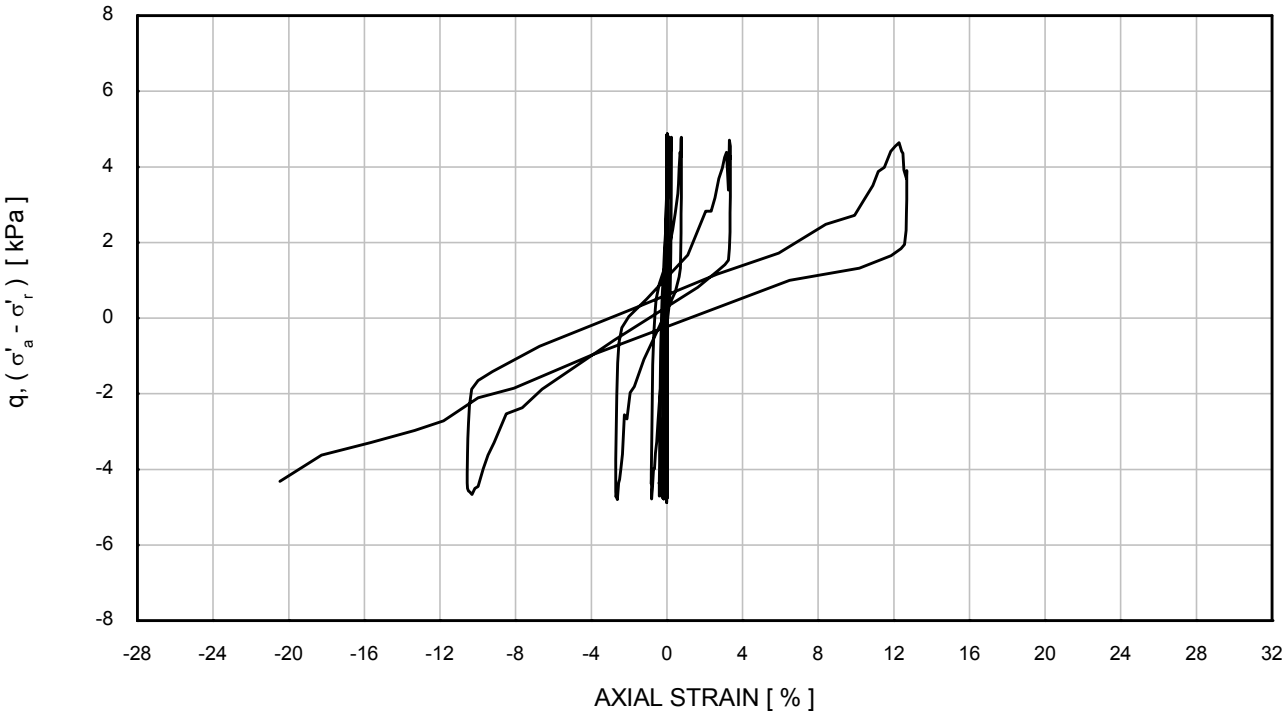


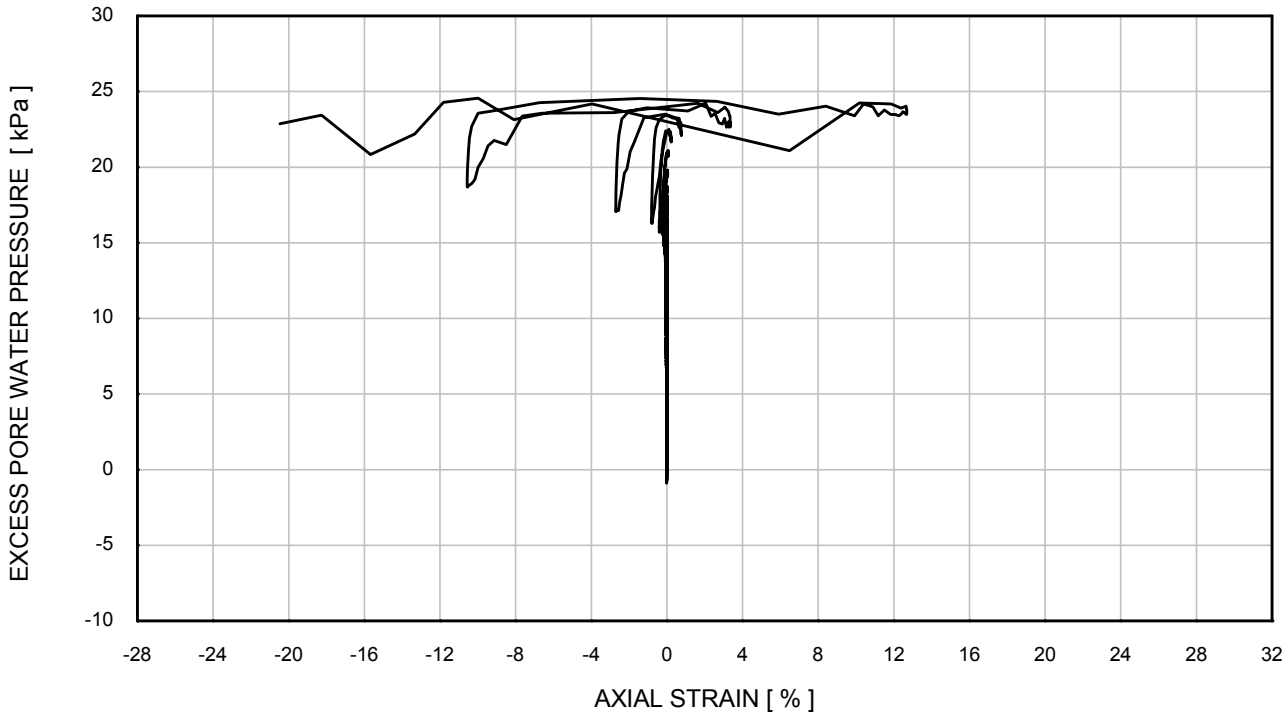


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

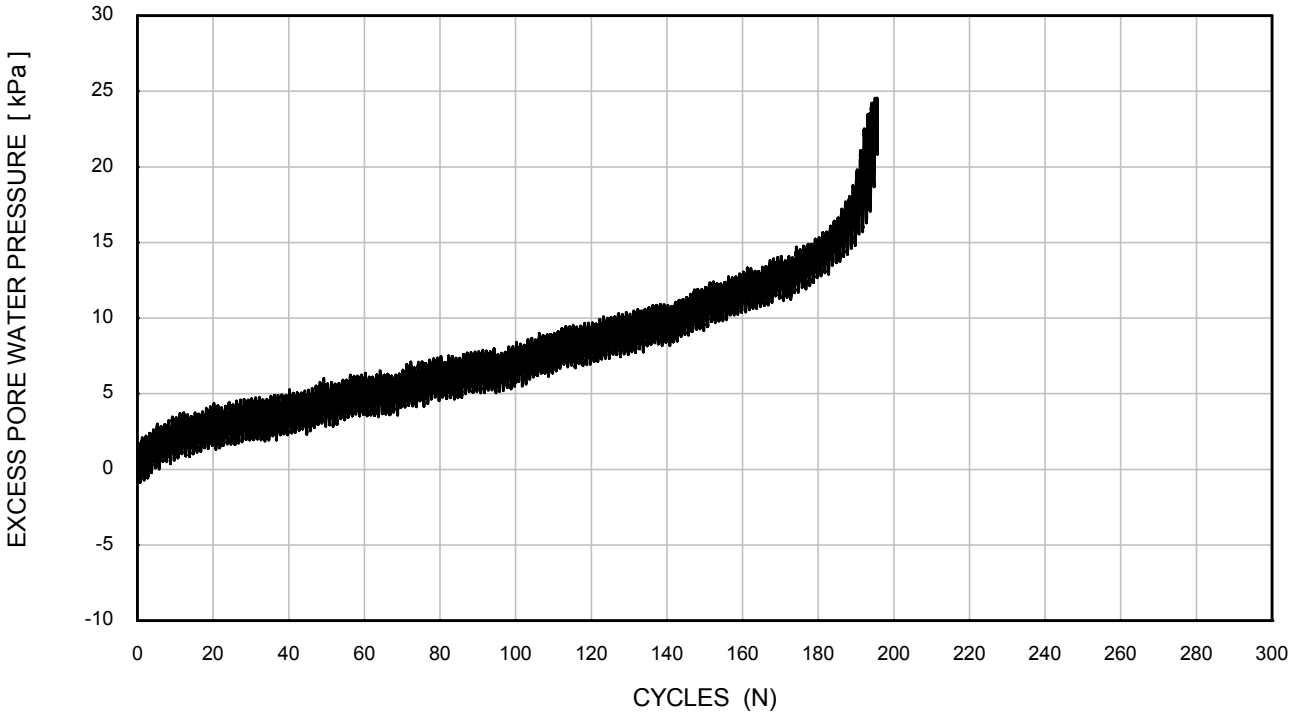


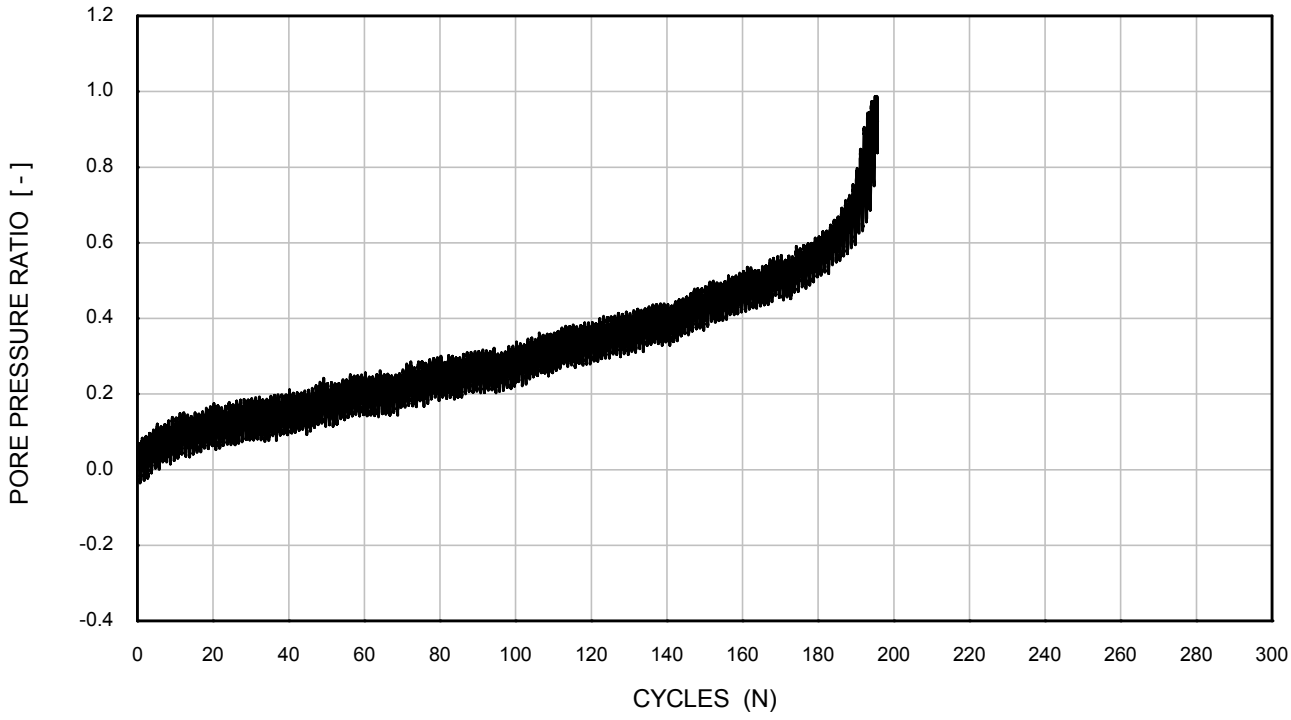


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

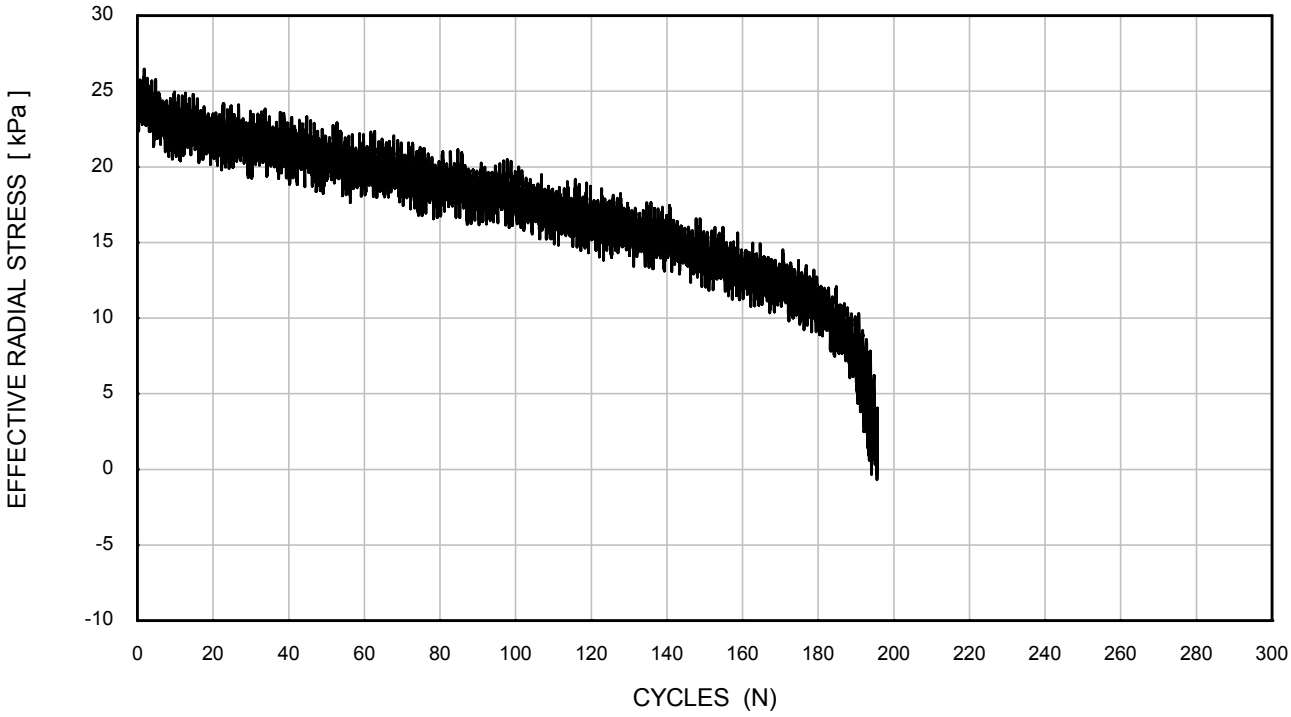


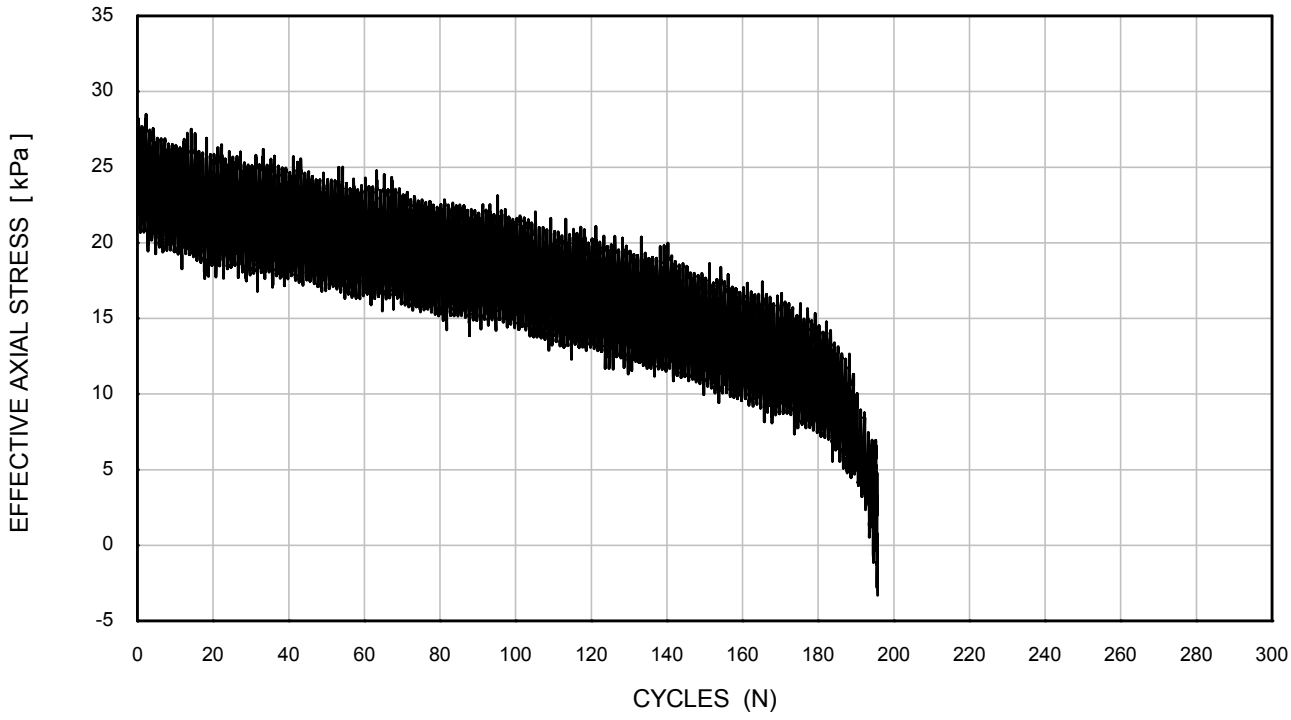


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

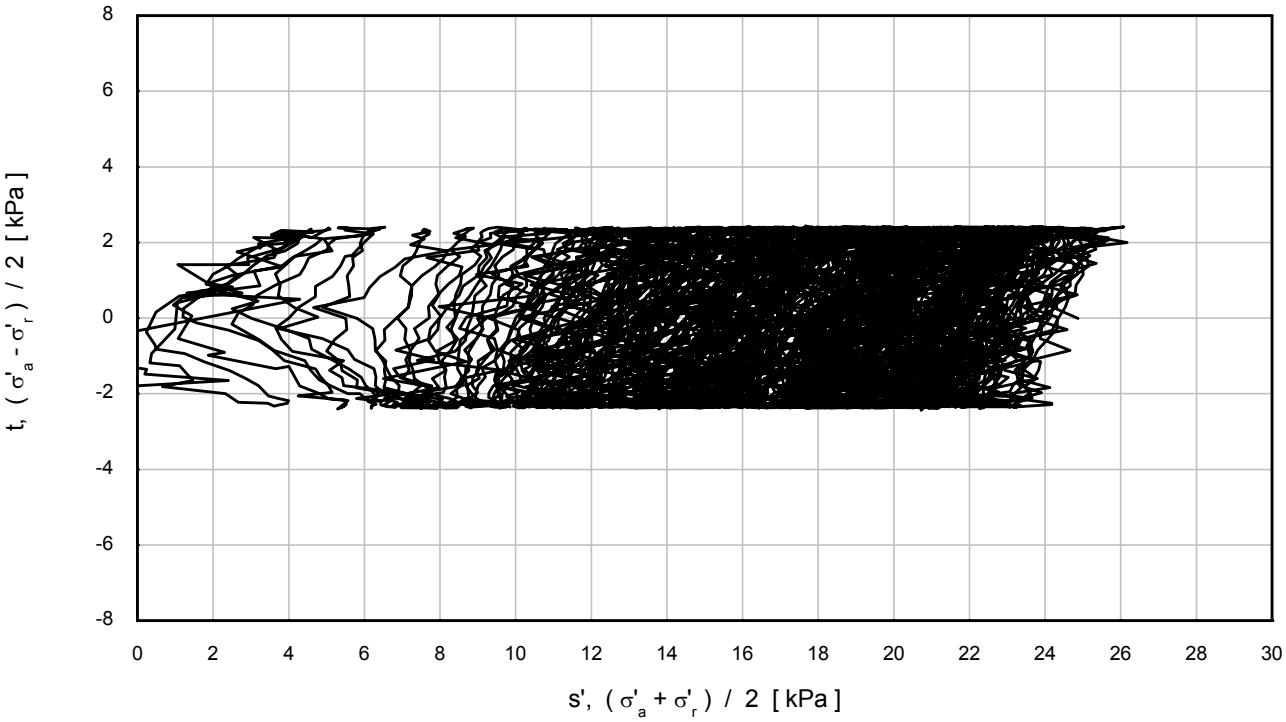


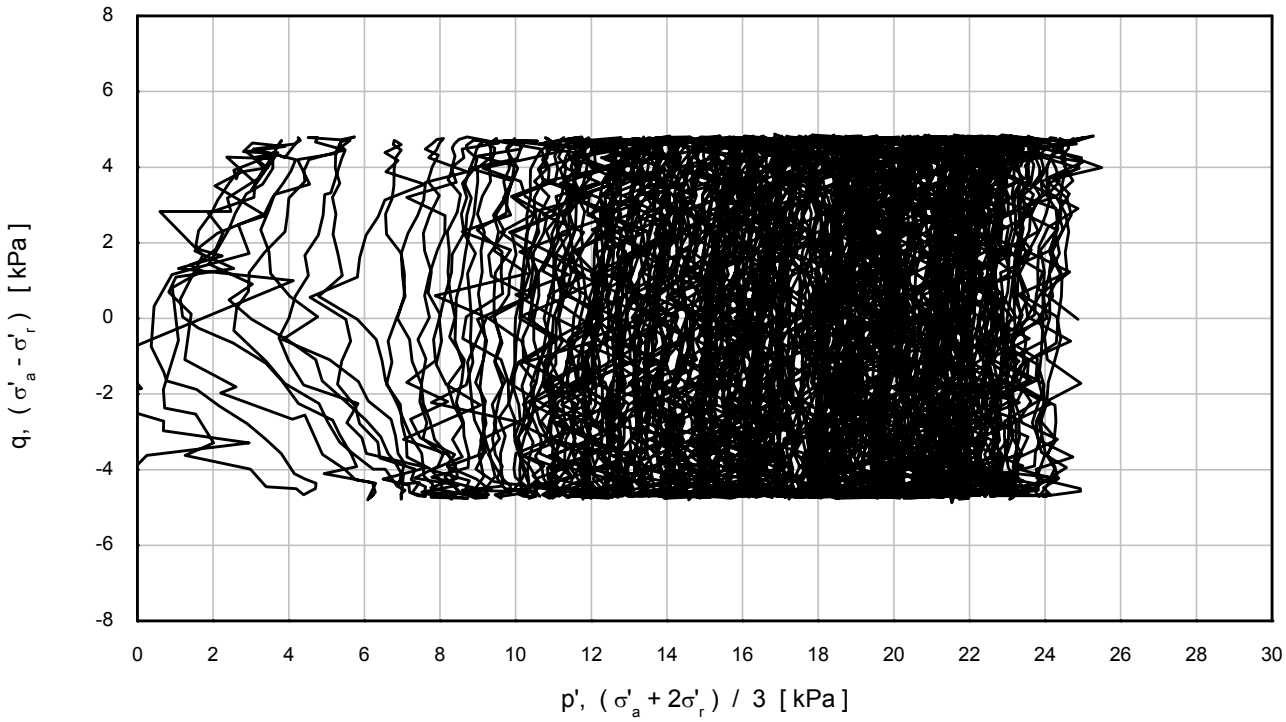


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

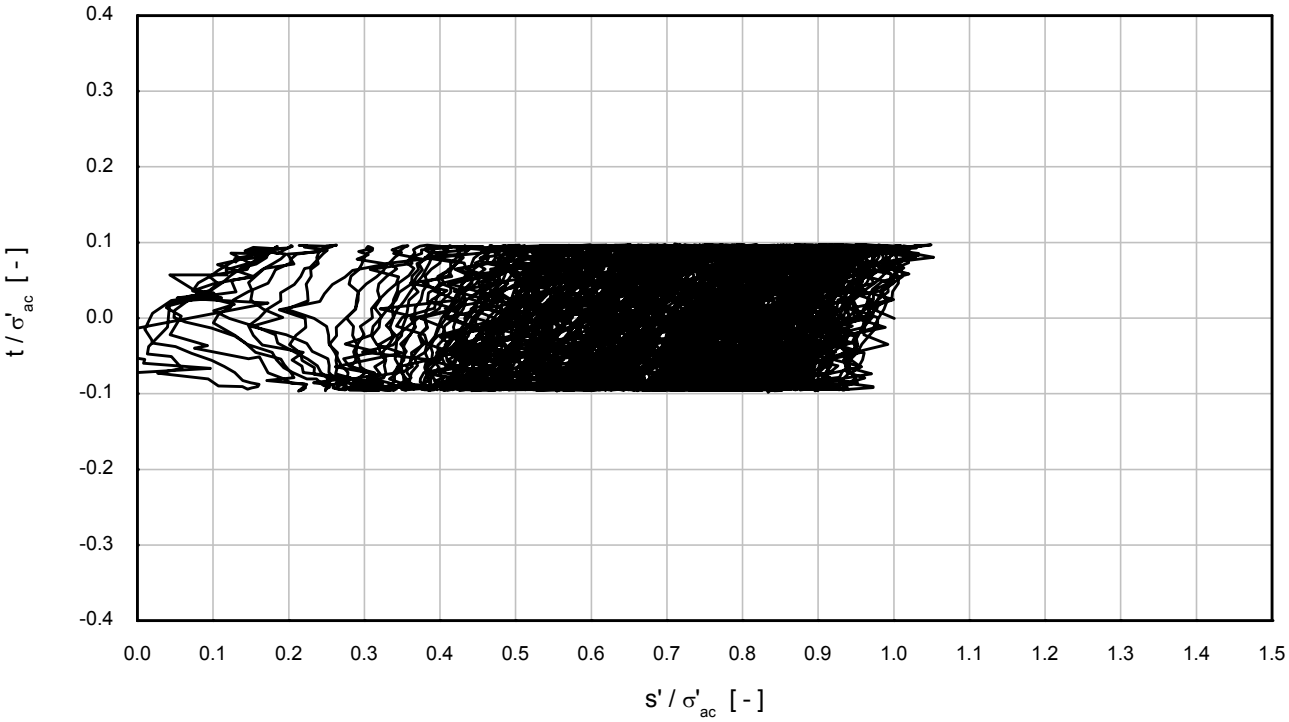


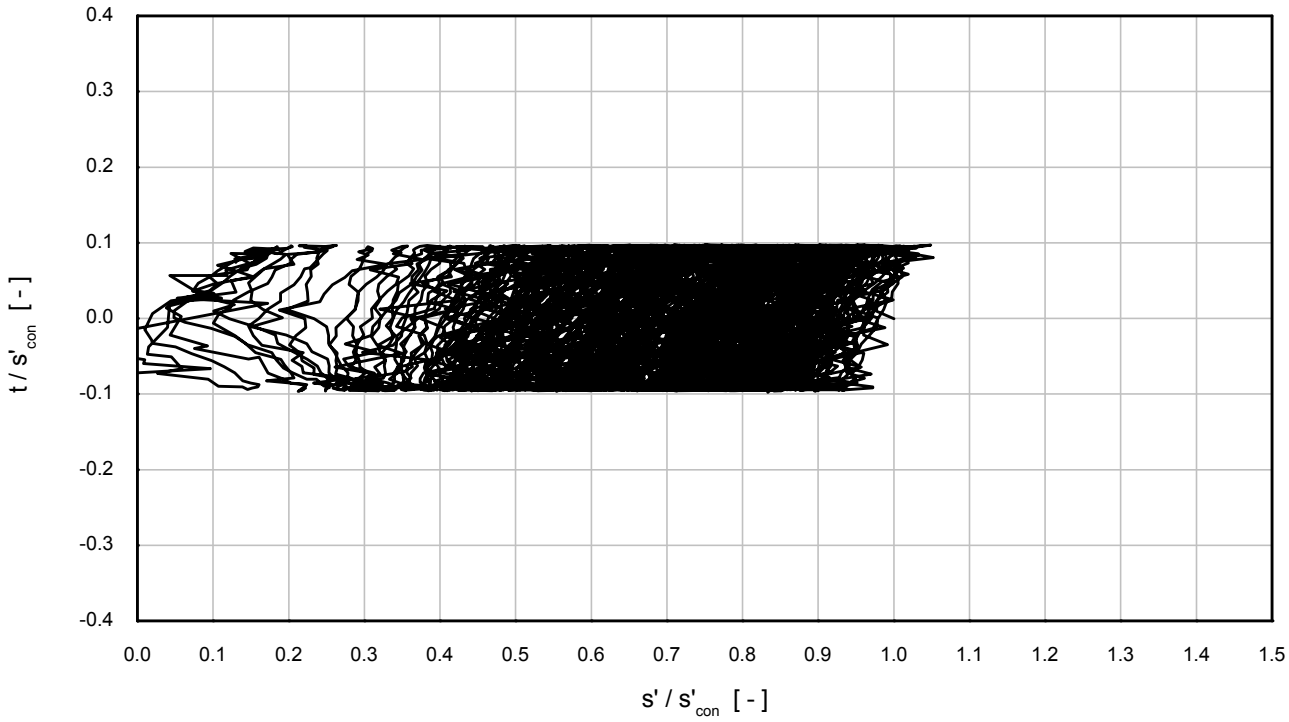


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

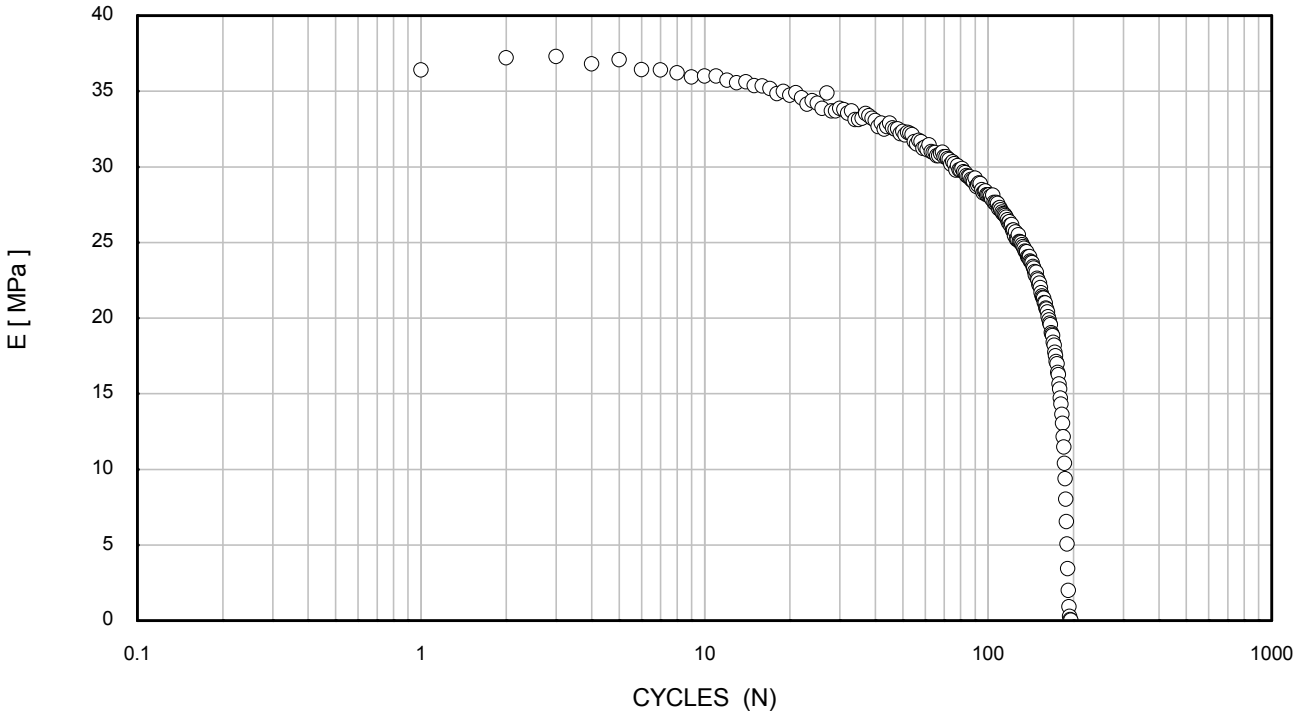


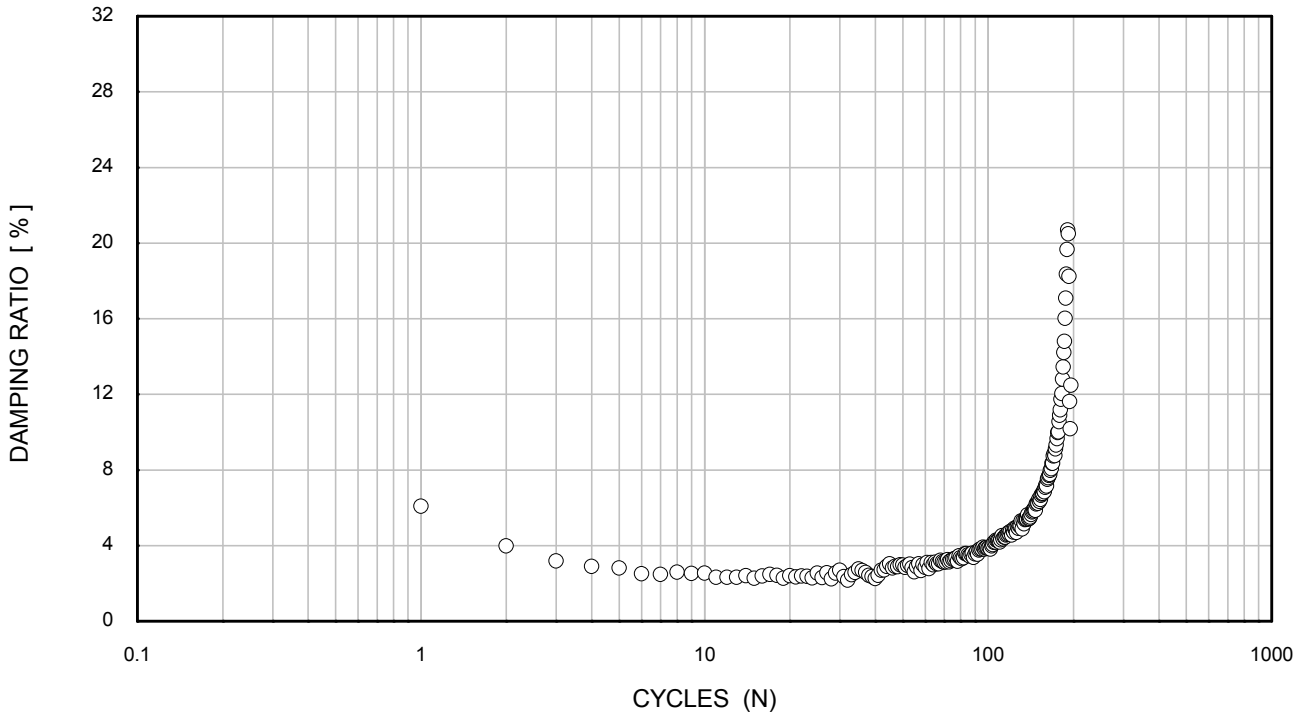


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0.0	kPa	Depth [m]	: -
q_{cy}	:	4.7	kPa	Test No.	: CTXL3
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

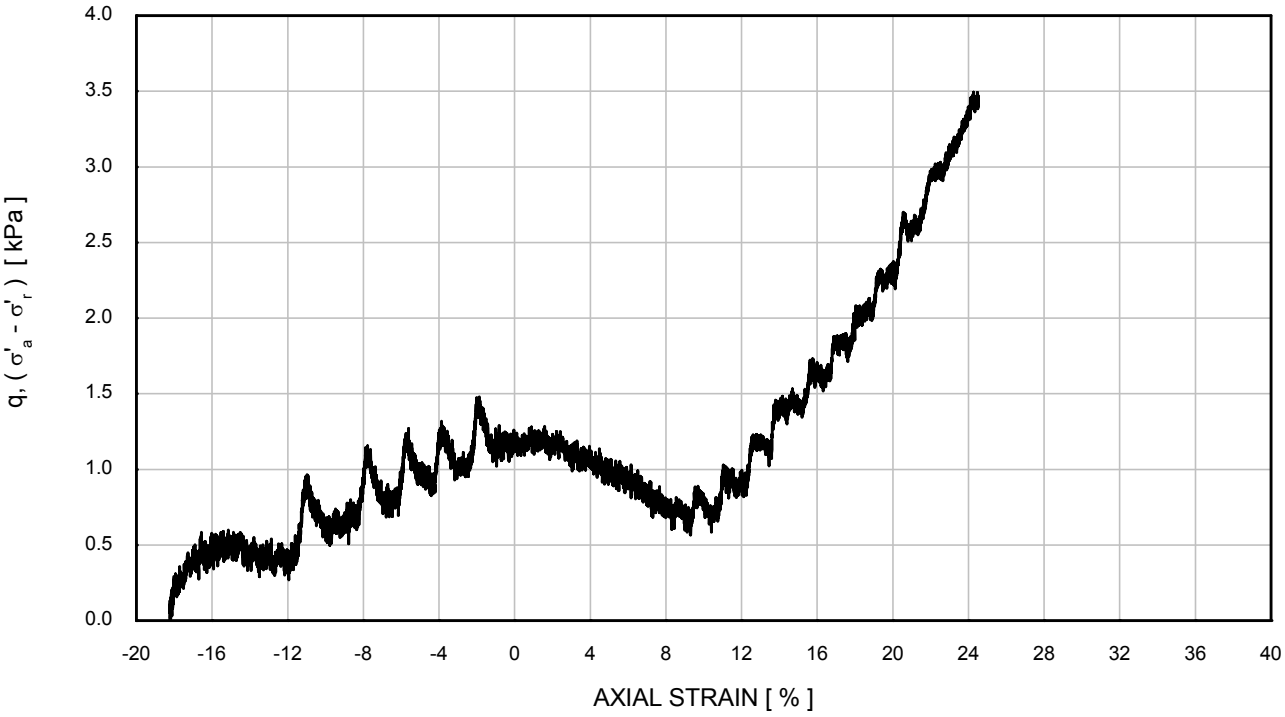


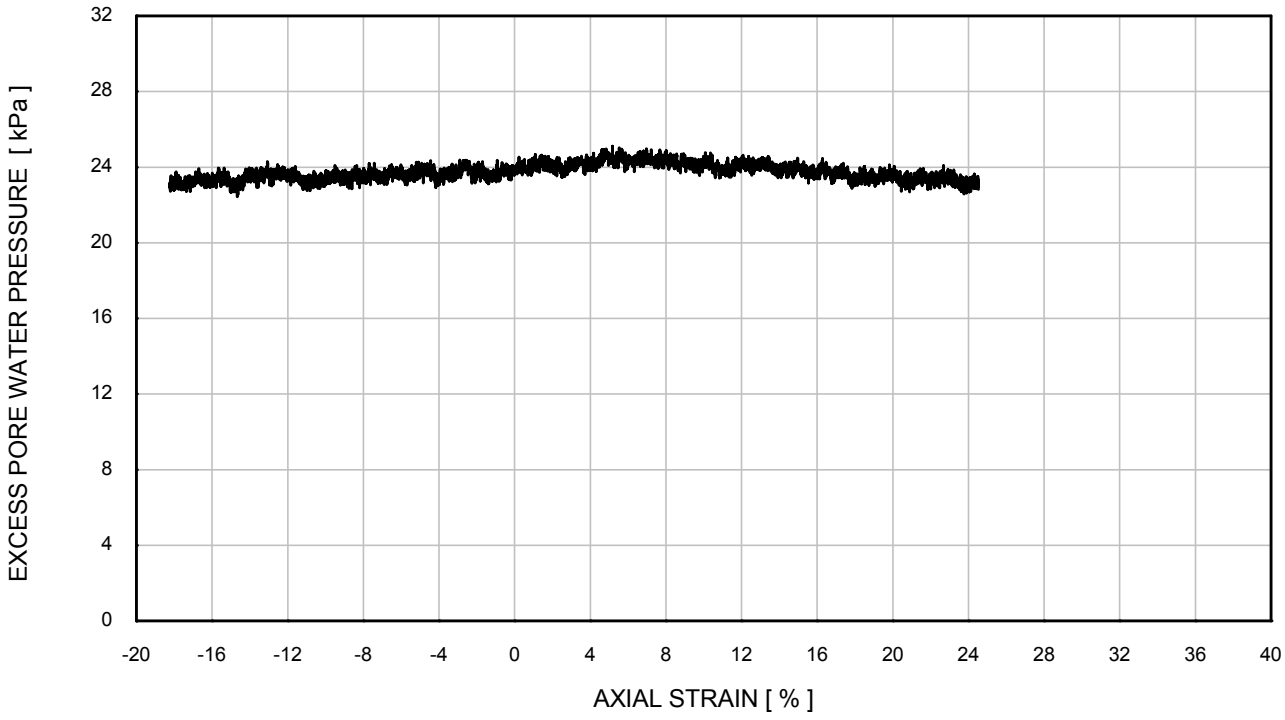


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	4.7 kPa	Test No.	:	CTXL3
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

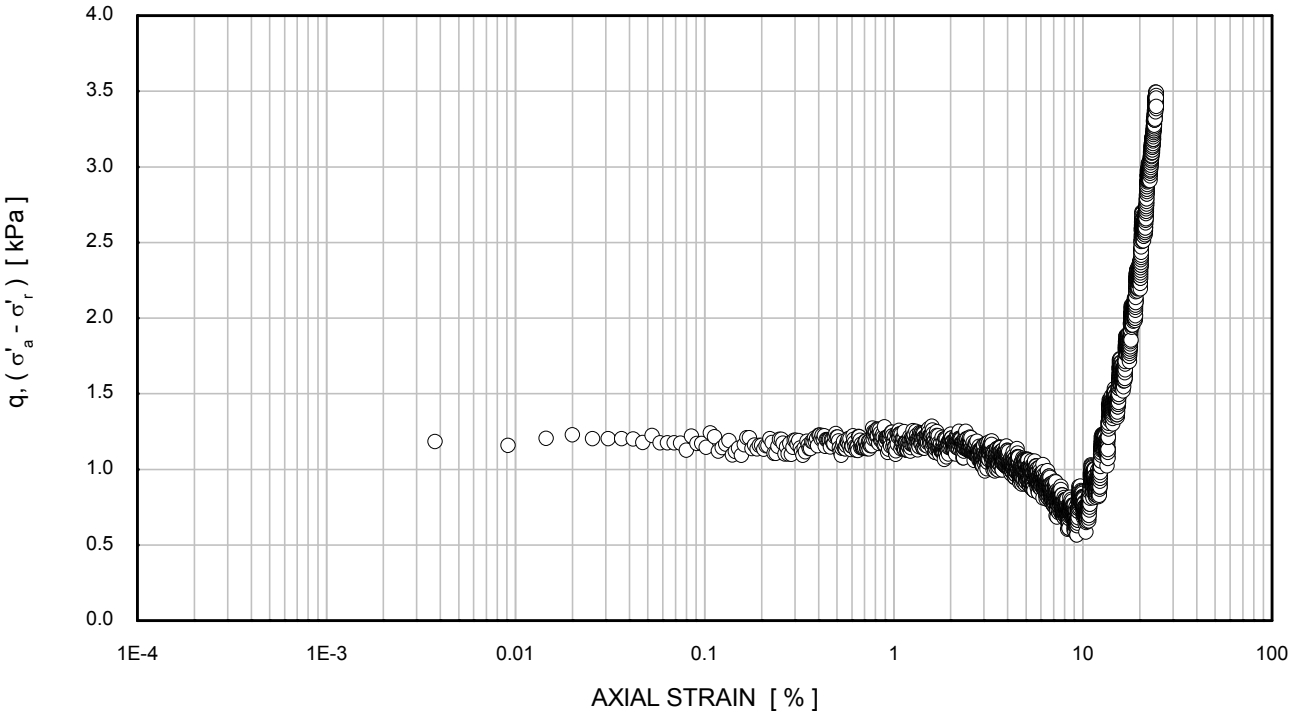


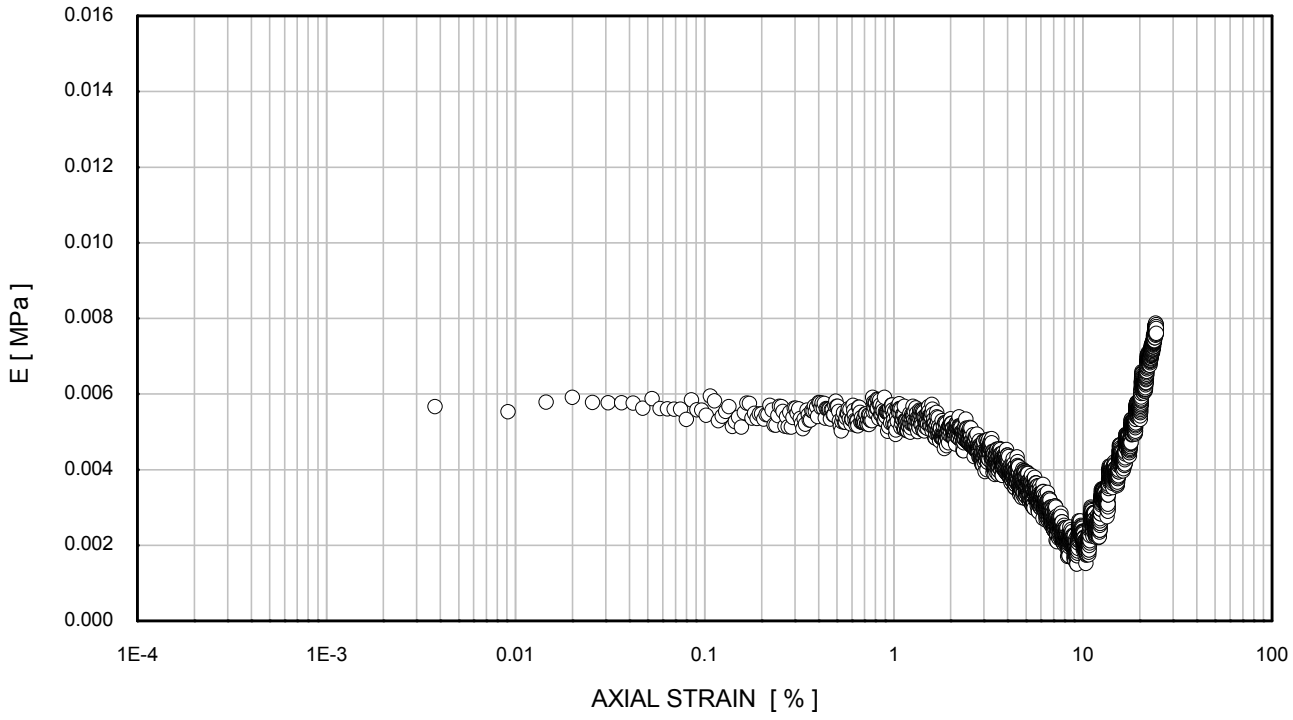


Initial σ'_r	:	1.5	kPa	Borehole	: Batch
Initial σ'_a	:	1.7	kPa	Sample	: Southern Bight
q_{peak}	:	3.5	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	24.3	%	Test No.	: CTXL3
Rate of strain	:	0.98	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

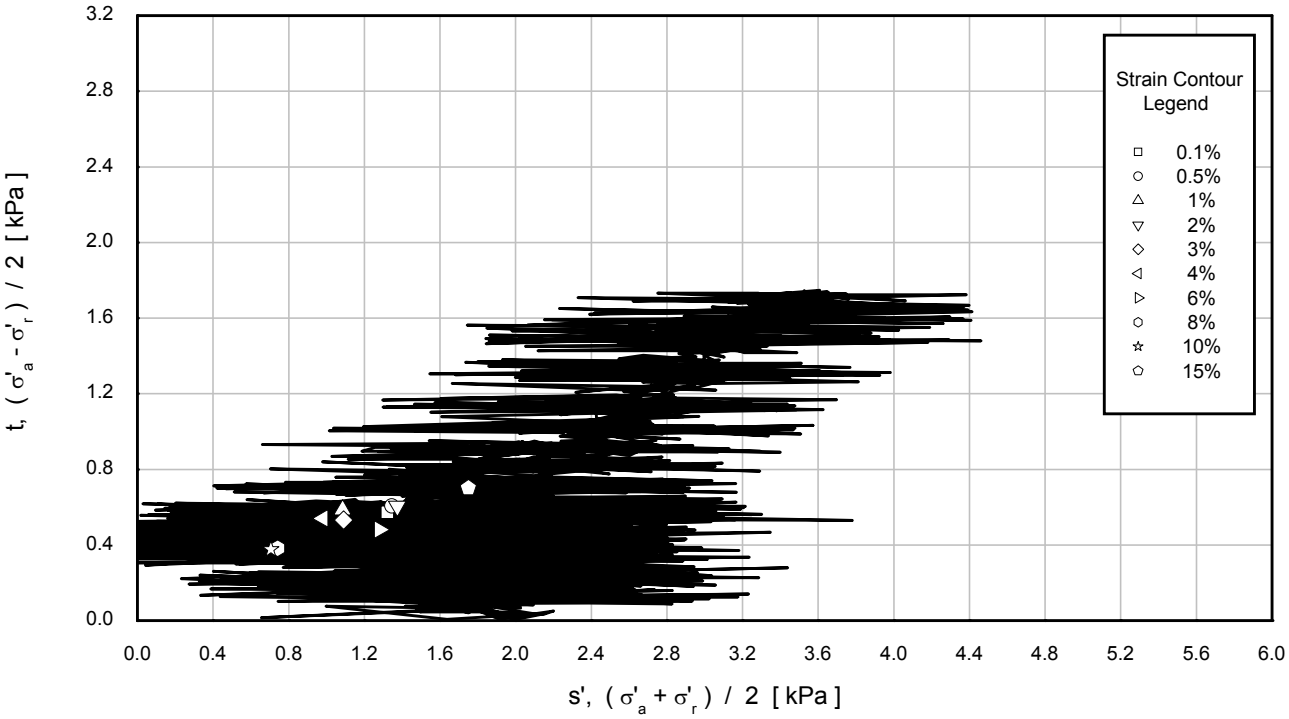


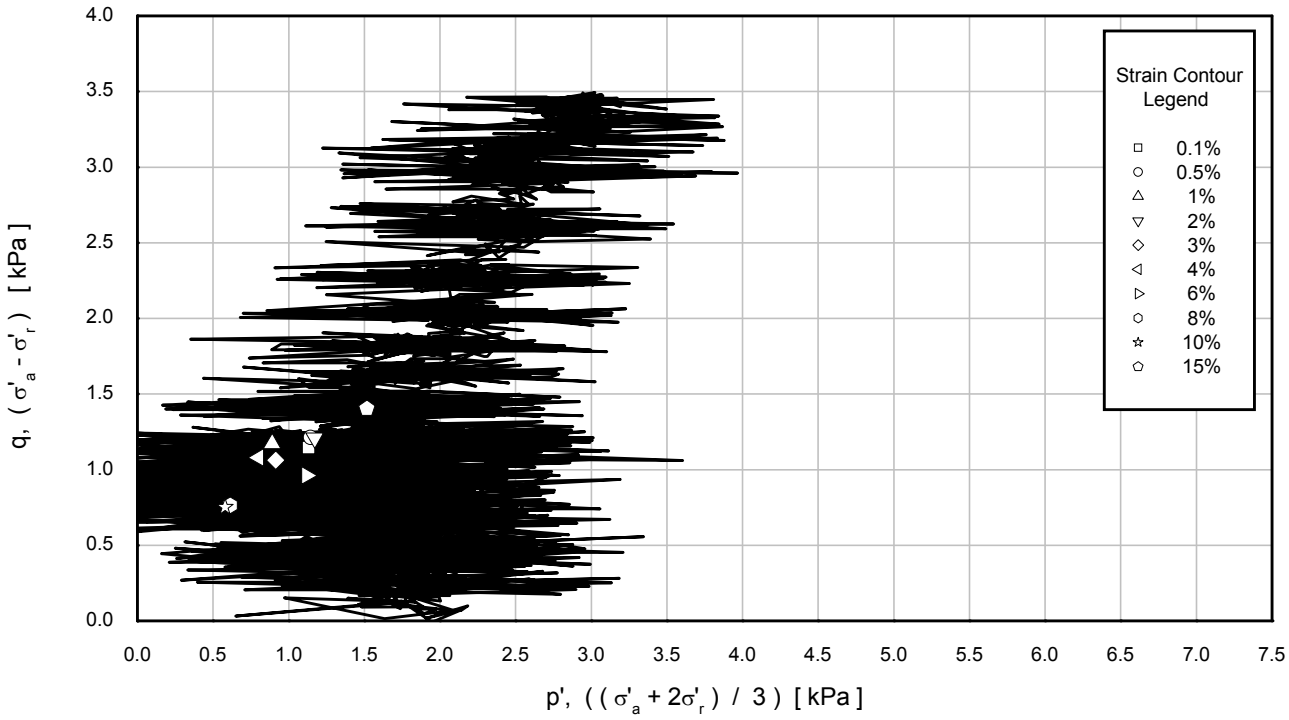


Initial σ'_r	:	1.5 kPa	Borehole	:	Batch
Initial σ'_a	:	1.7 kPa	Sample	:	Southern Bight
q_{peak}	:	3.5 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	24.3 %	Test No.	:	CTXL3
Rate of strain	:	0.98 %/hour			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	1.5	kPa	Borehole	: Batch
Initial σ'_a	:	1.7	kPa	Sample	: Southern Bight
q_{peak}	:	3.5	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	24.3	%	Test No.	: CTXL3
Rate of strain	:	0.98	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND with traces of shell fragments

GENERAL	
Date test started	08/05/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.1
Length	[mm]	144.0
Moisture content	[%]	10.0
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.629
Degree of saturation	[%]	42
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern_Bight_CTXL4
Processed by	LJ
Date	13/08/2015
Checked by	PH
Date	14/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL4

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1024
Mid height PWP	[kPa]	-
B value achieved	[-]	0.99

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	25
Effective axial pressure	[kPa]	25
Deviator stress	[kPa]	0
Volumetric strain	[%]	8.59
External axial strain	[%]	7.18
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	18.4
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.78
Void ratio	[-]	0.489
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL4

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	25
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	9
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	5
External ε_{av} at N_f	[%]	-0.45
External ε_{cy} at N_f	[%]	12.33
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	19
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	18.4
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.78
Void ratio	[-]	0.489
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	-0.71	0.76	1	-	23.47	-
2	-1.19	1.89	0	-	12.09	-
3	-2.27	4.53	0	-	11.00	-
4	-2.53	8.74	0	-	8.19	-
5	-0.45	12.33	0	-	7.02	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL4

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	1.5
Initial effective axial pressure	[kPa]	1.6
Rate of strain	[%/hour]	1.05
At peak deviator stress		
Corrected deviator stress	[kPa]	1.1
Membrane correction applied	[kPa]	-0.3
Drain correction applied	[kPa]	0
External axial strain	[%]	-2.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	23
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	2.0
Effective axial pressure	[kPa]	3.1
Principal effective stress ratio	[-]	1.58
ε_{50}	[%]	-3.93
Secant modulus (E_{50}) at ε_{50}	[kPa]	-349637
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	0.6
Membrane correction applied	[kPa]	0.5
Drain correction applied	[kPa]	0
External axial strain	[%]	4.84
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0.6
Effective axial pressure	[kPa]	1.2
Principal effective stress ratio	[-]	2.10
At 10% axial strain		
Corrected deviator stress	[kPa]	0.5
Membrane correction applied	[kPa]	1.0
Drain correction applied	[kPa]	0
External axial strain	[%]	9.99
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1.1
Effective axial pressure	[kPa]	1.6
Principal effective stress ratio	[-]	1.44

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL4

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

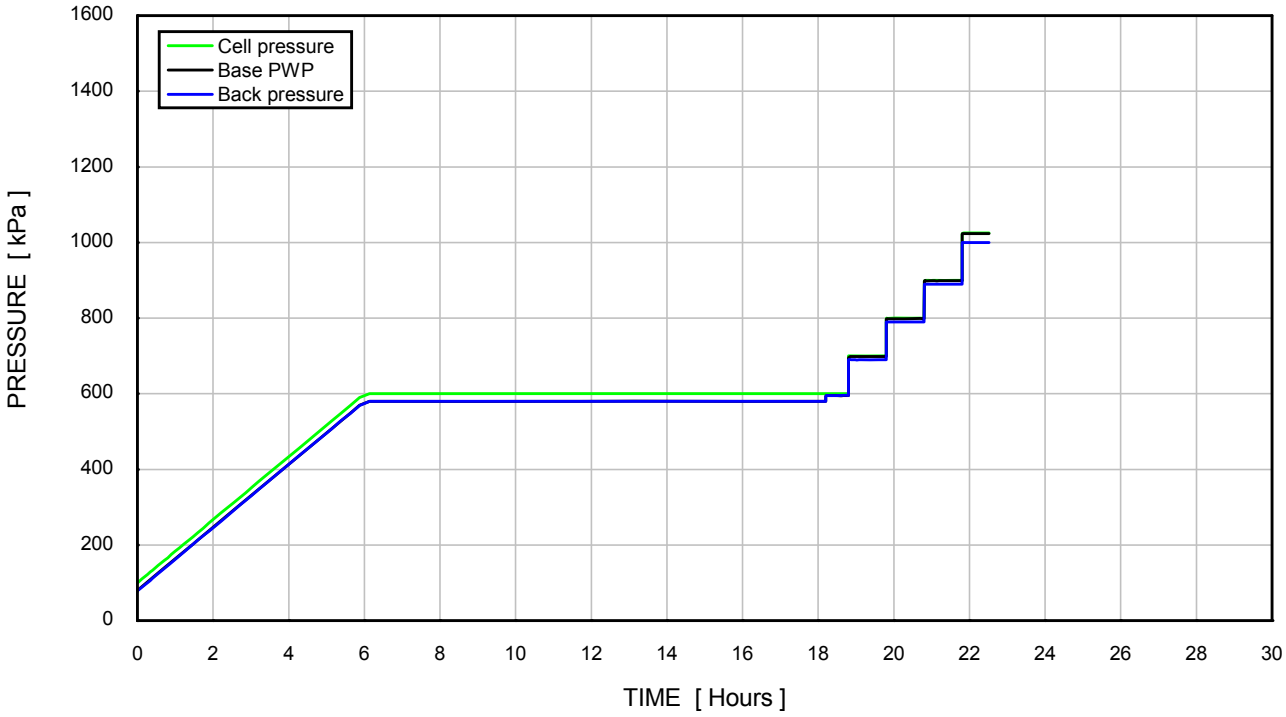
Moisture content	[%]	18.4
Bulk density	[Mg/m³]	2.11
Dry density	[Mg/m³]	1.78

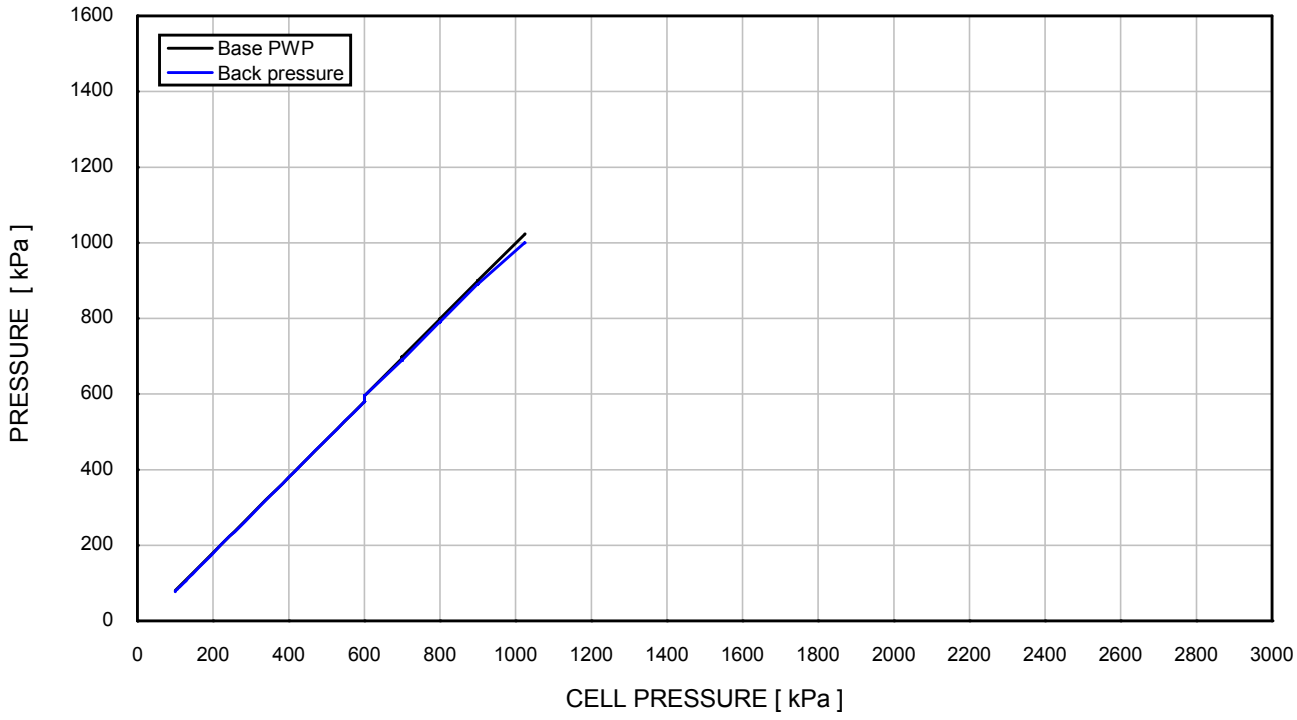
TEST IDENTIFICATION

Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL4

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

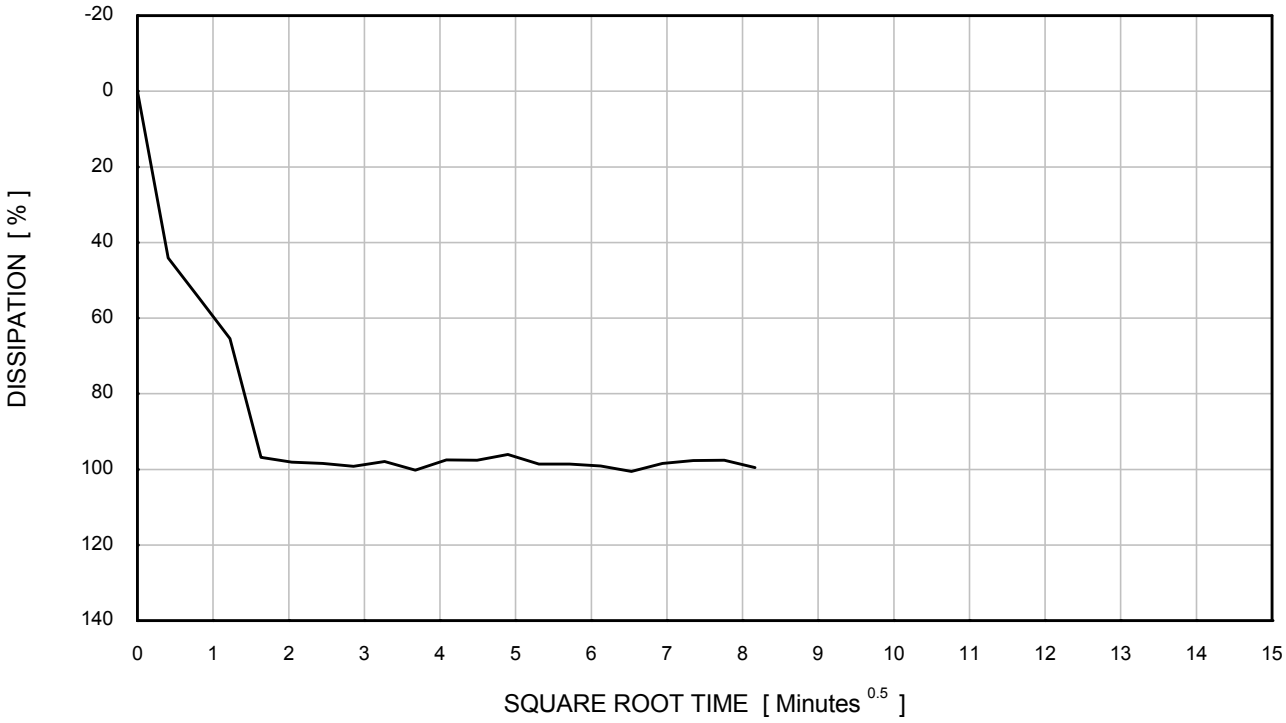


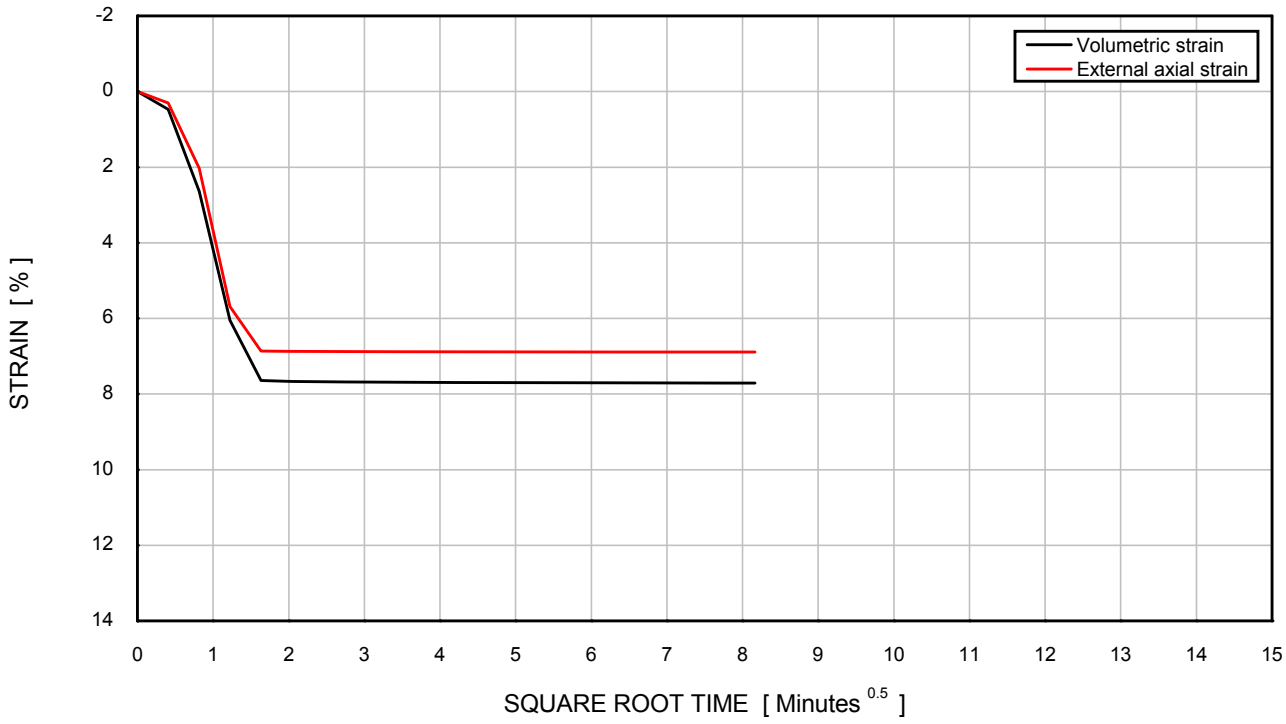


B value	:	0.99			
Initial σ'_r	:	20	kPa	Borehole	: Batch
Initial σ'_a	:	20	kPa	Sample	: Southern Bight
Final σ'_r	:	1.1	kPa	Depth [m]	: -
Final σ'_a	:	1.1	kPa	Test No.	: CTXL4

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

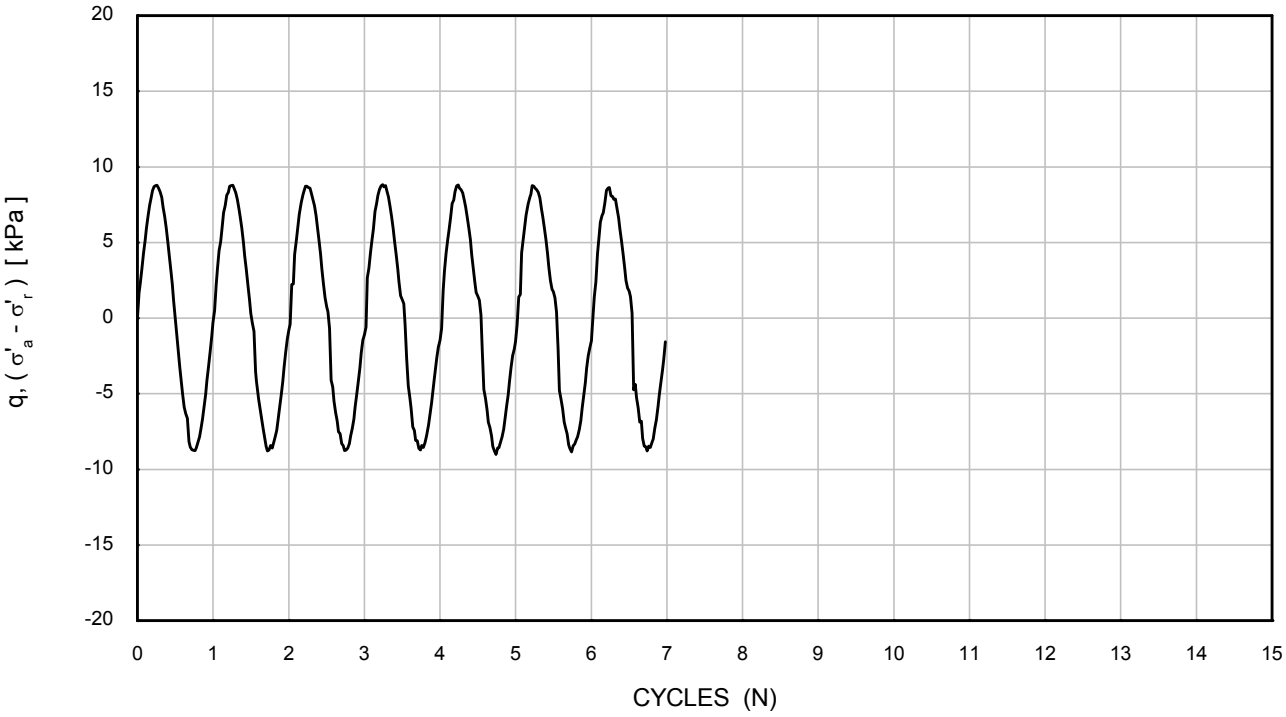


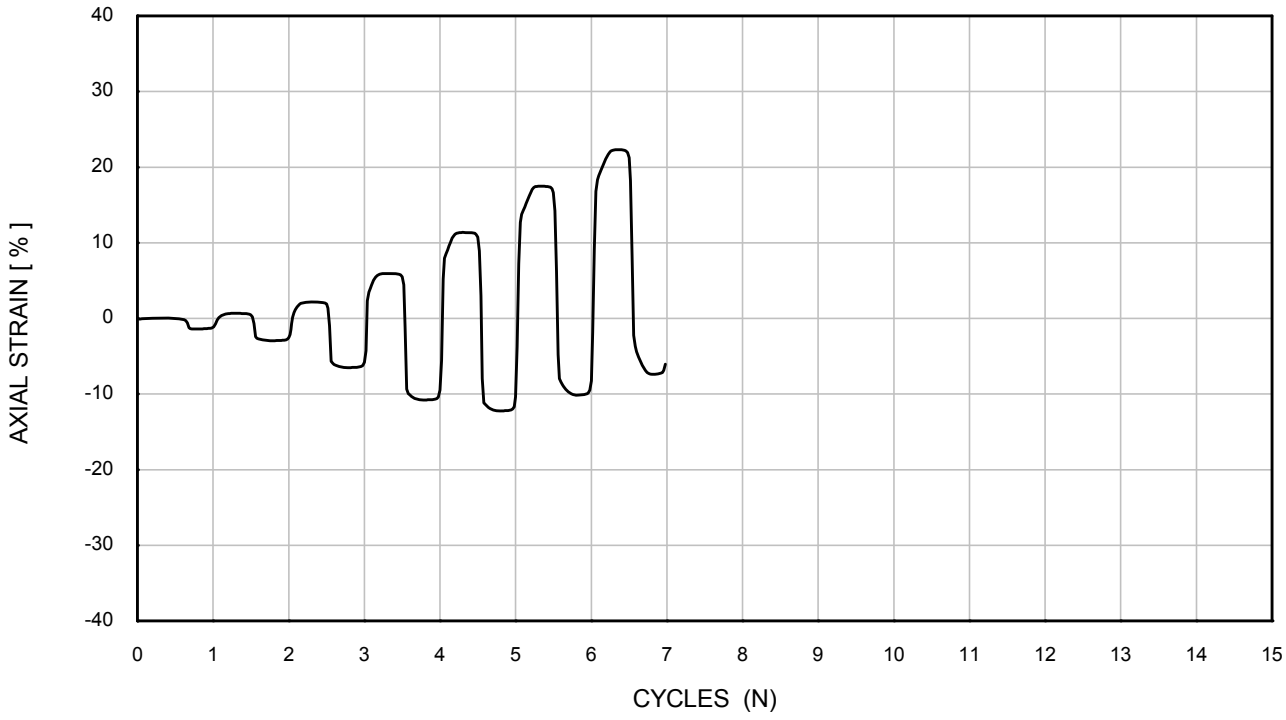


σ'_{rc}	:	25 kPa	Borehole	:	Batch
σ'_{ac}	:	25 kPa	Sample	:	Southern Bight
			Depth [m]	:	-
			Test No.	:	CTXL4

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

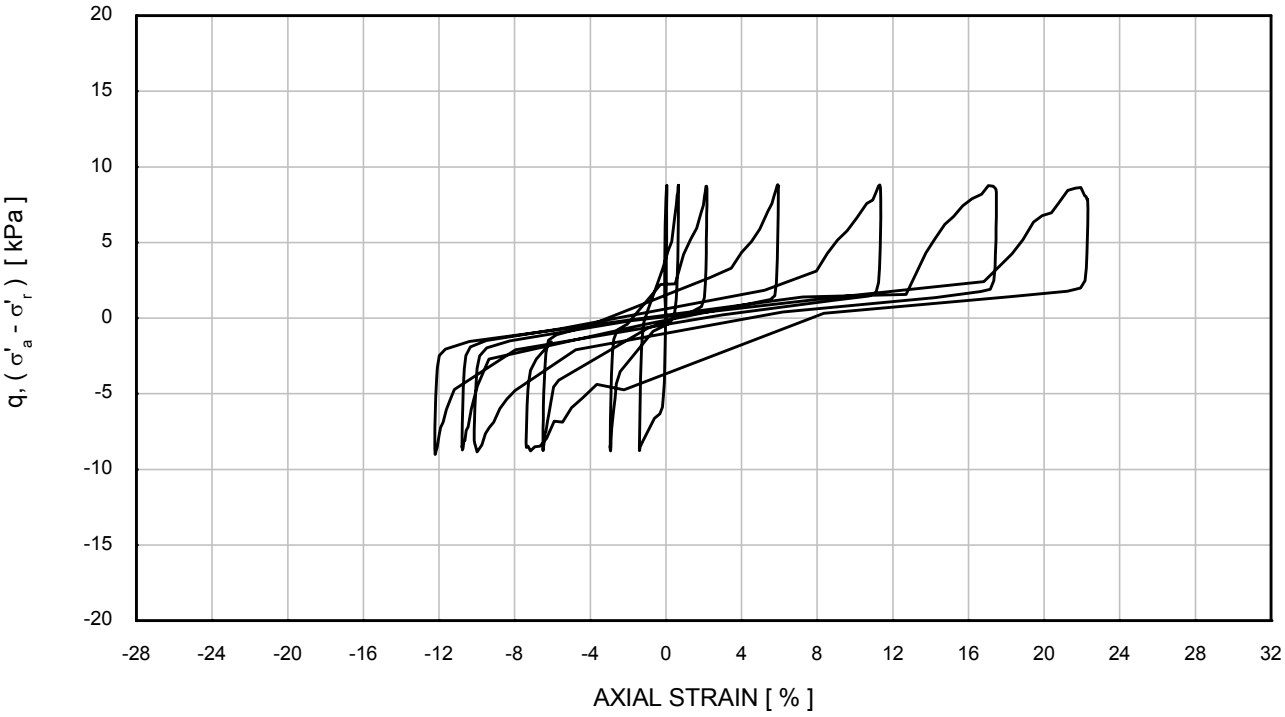


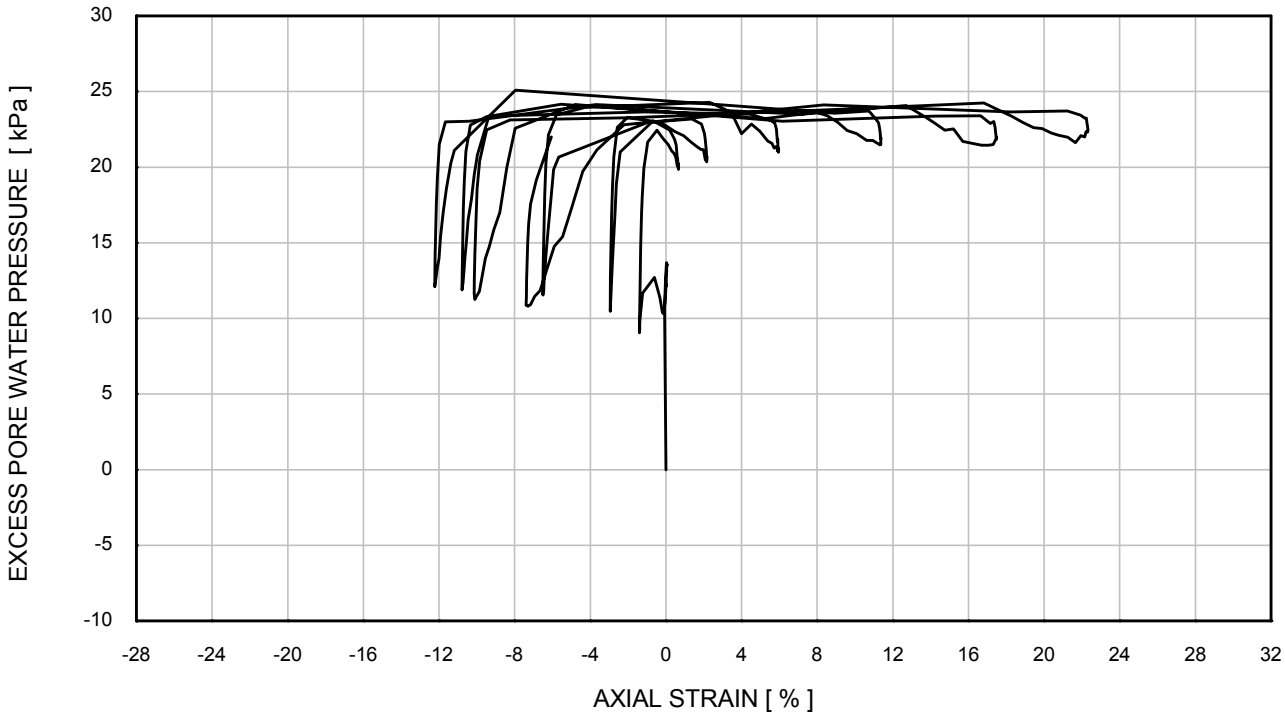


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

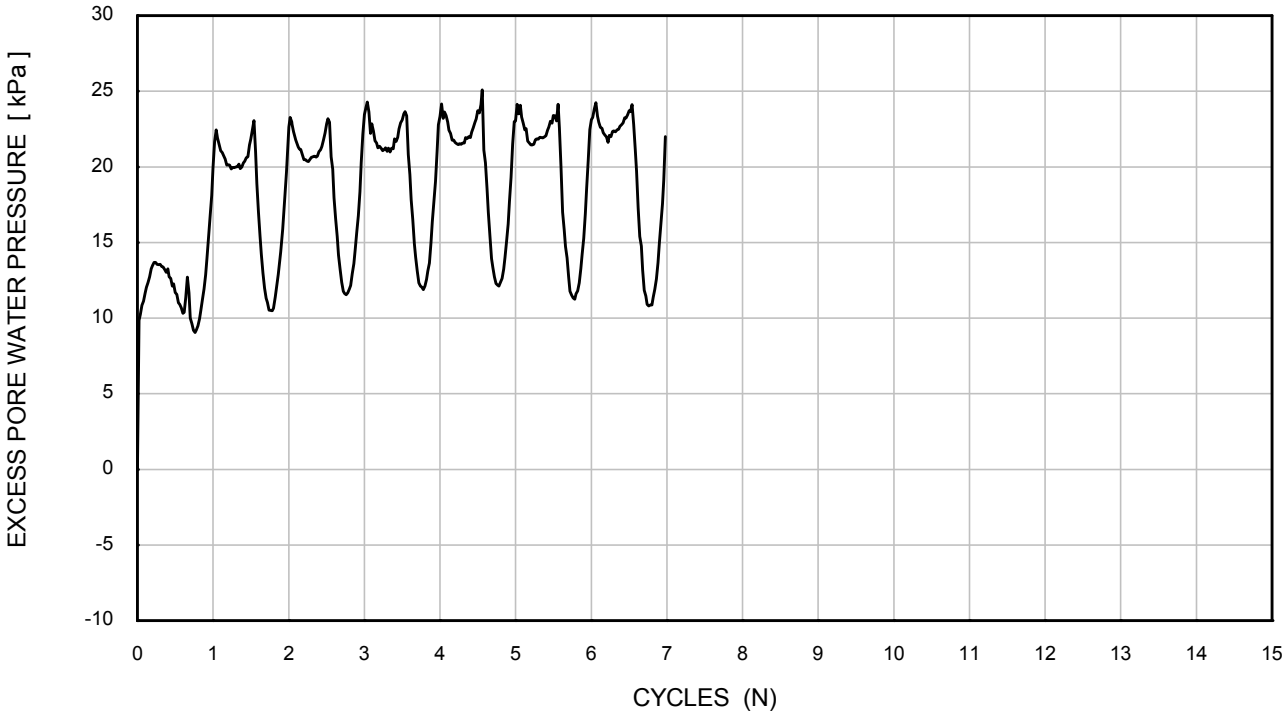


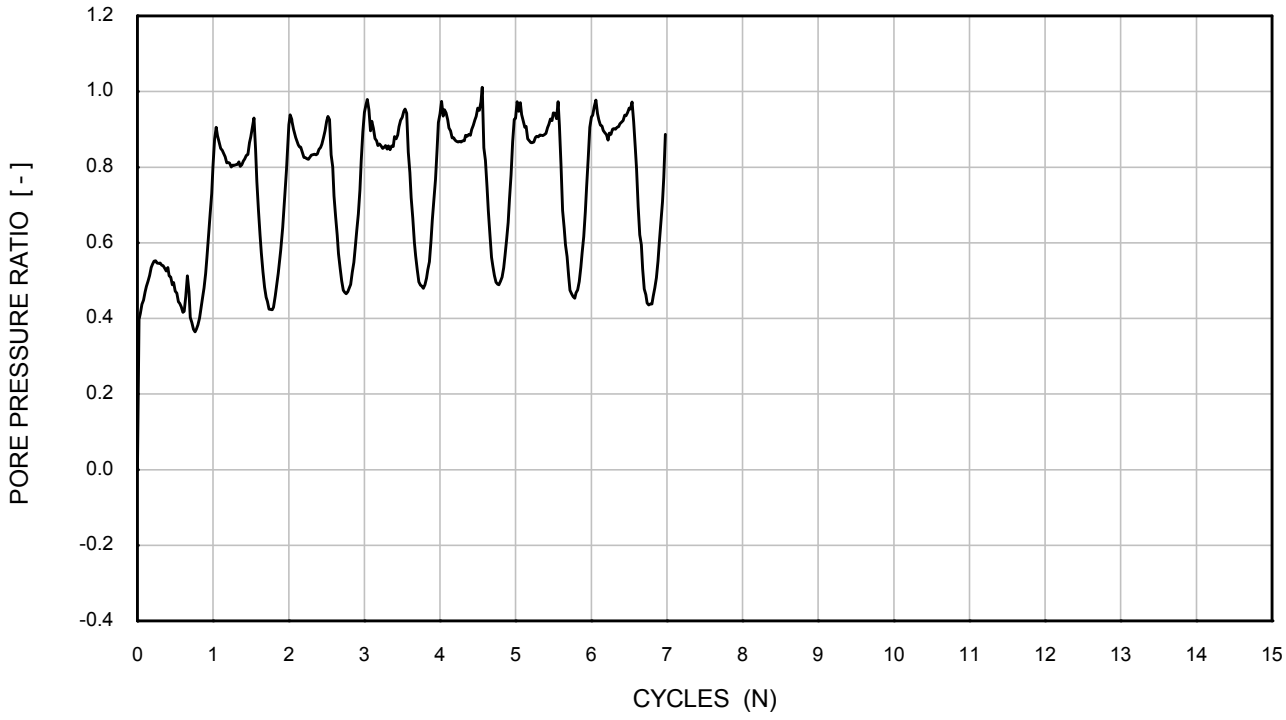


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

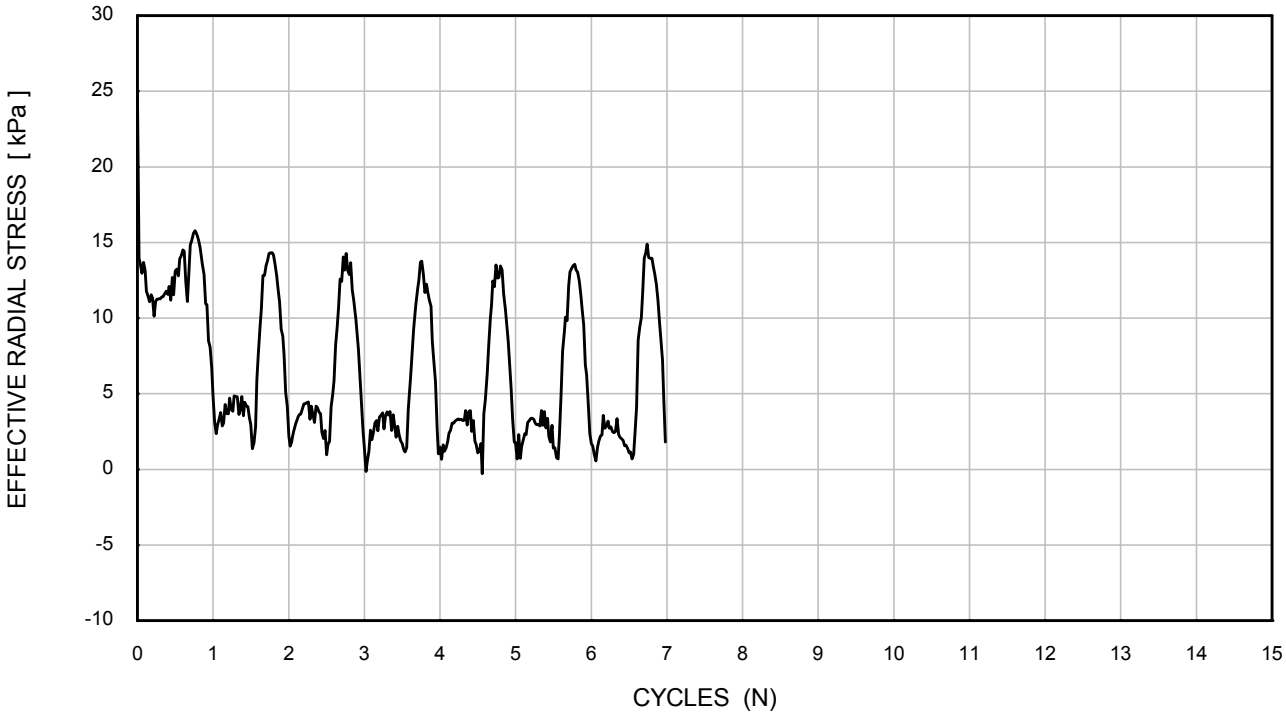


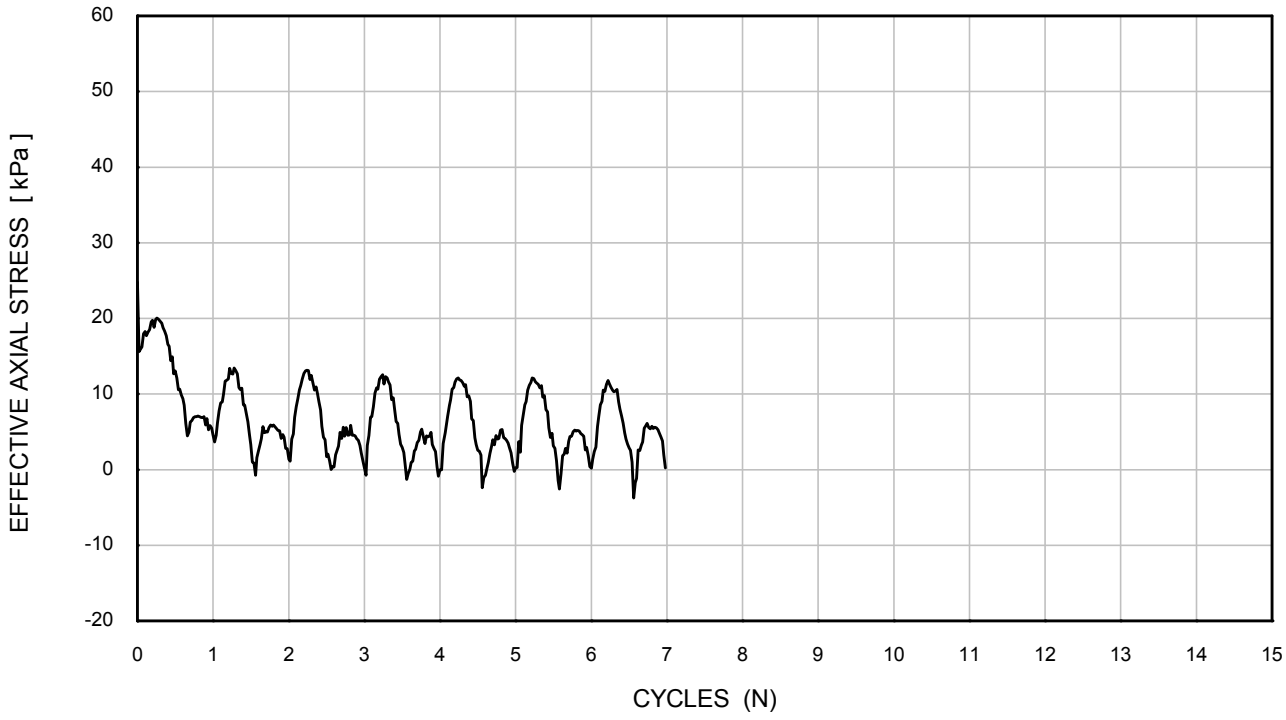


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0.0	kPa	Depth [m]	: -
q_{cy}	:	8.8	kPa	Test No.	: CTXL4
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

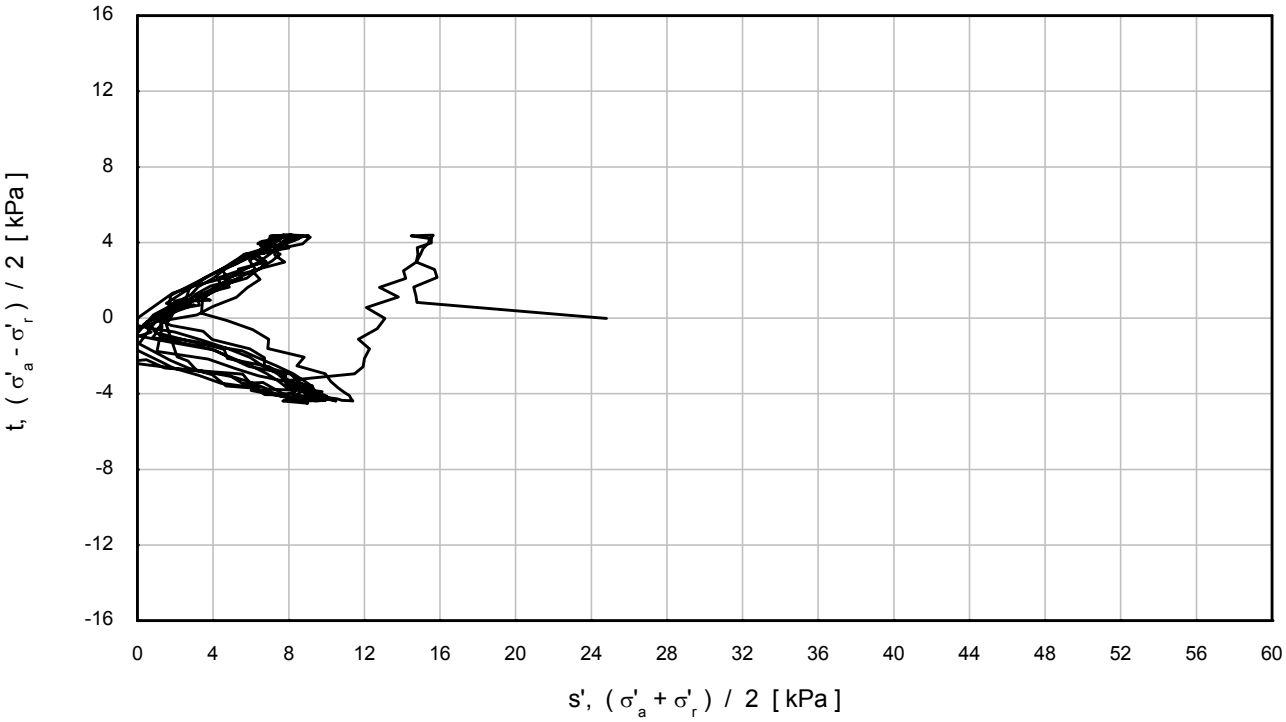


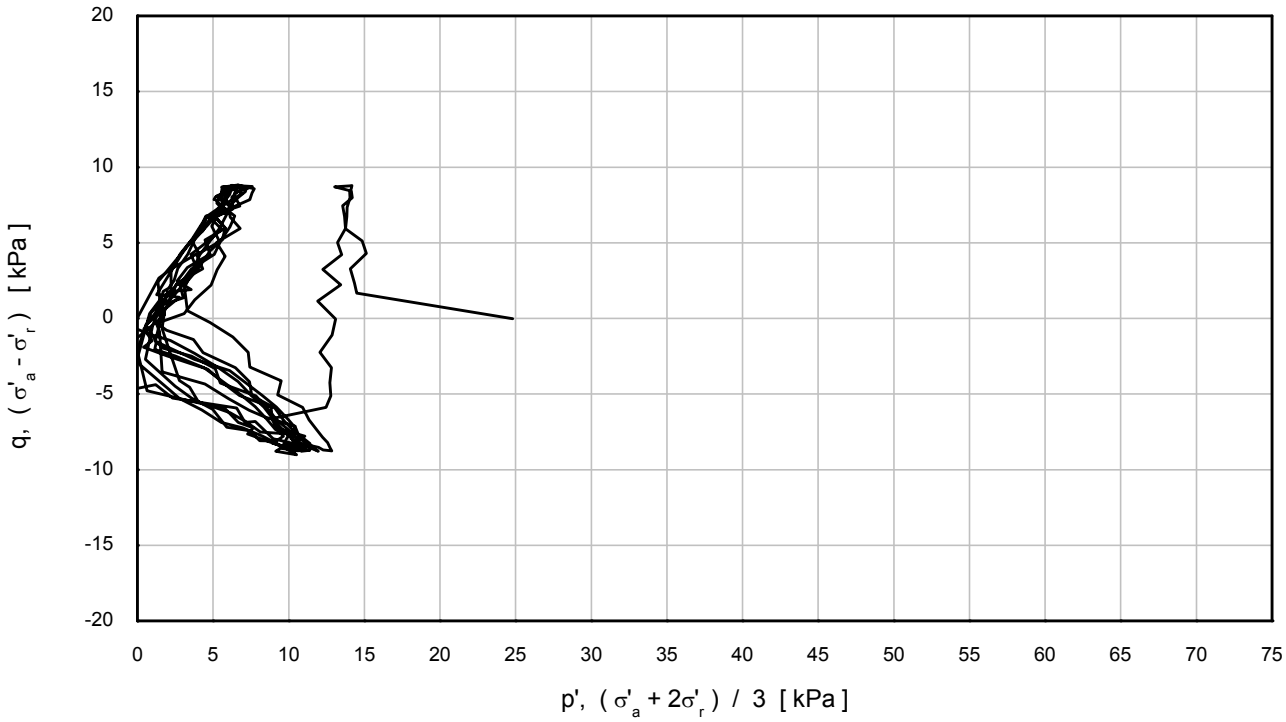


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

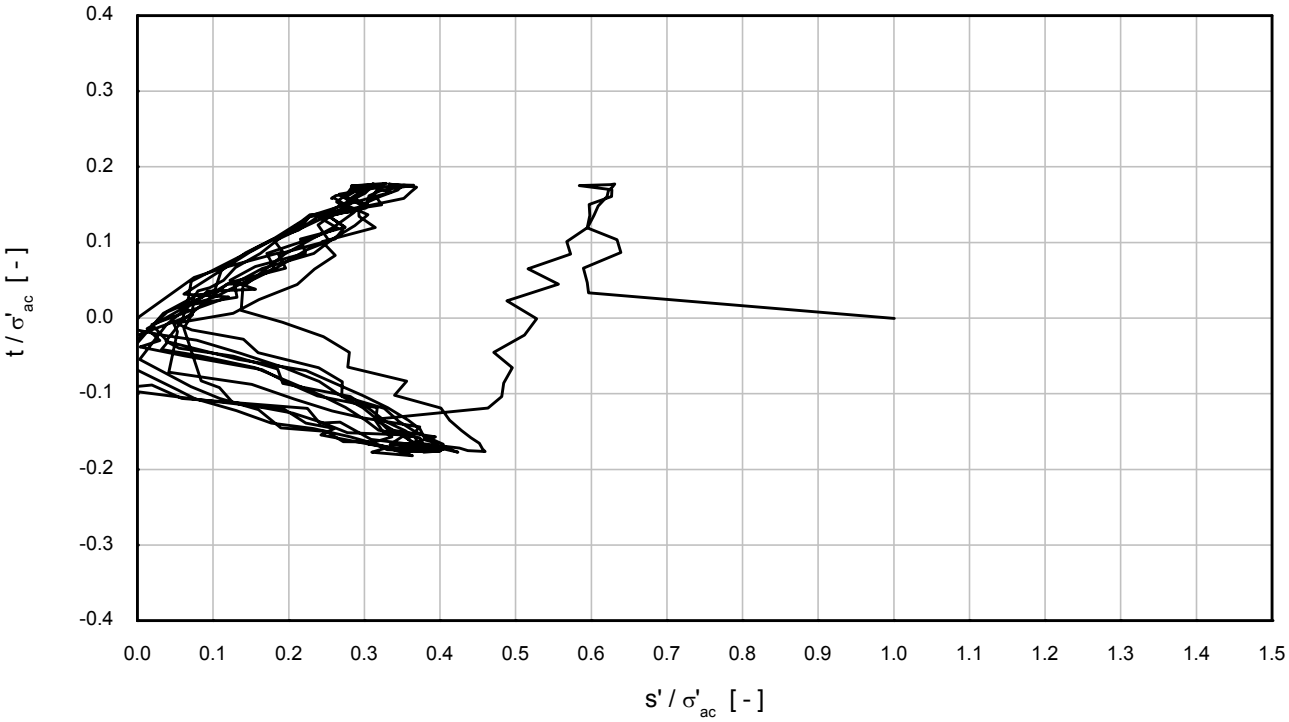


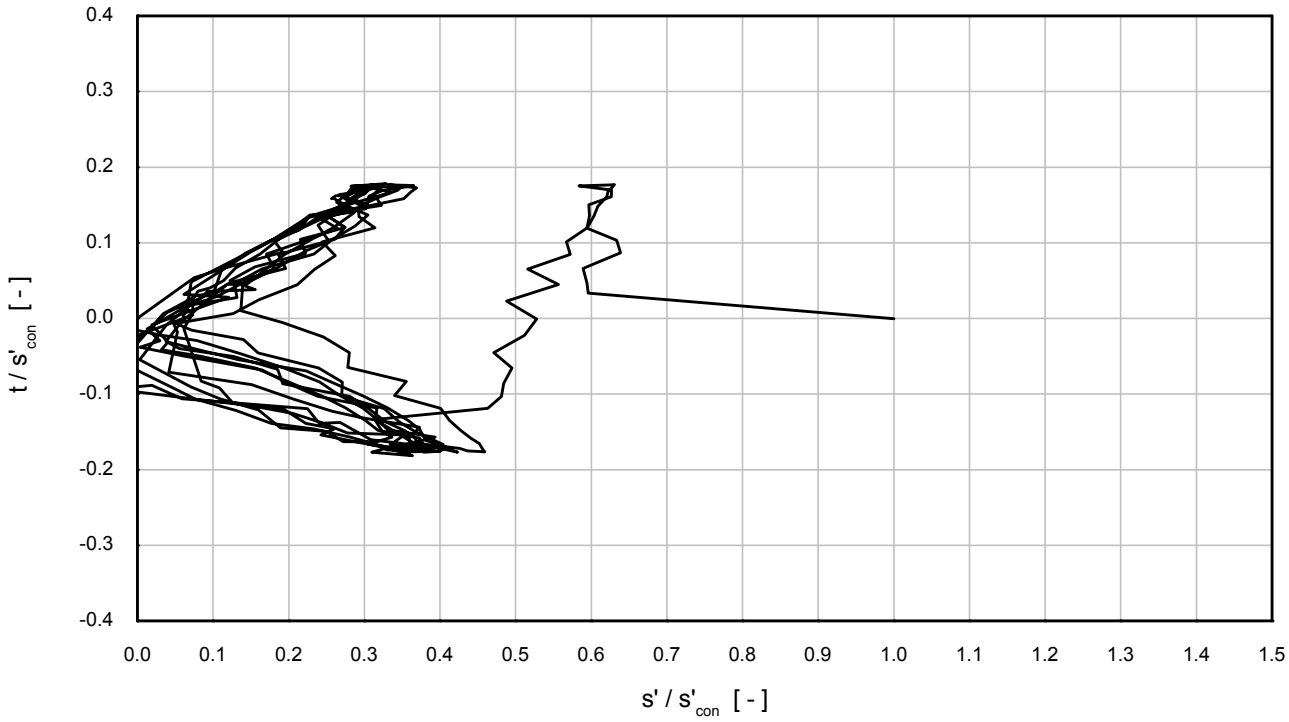


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

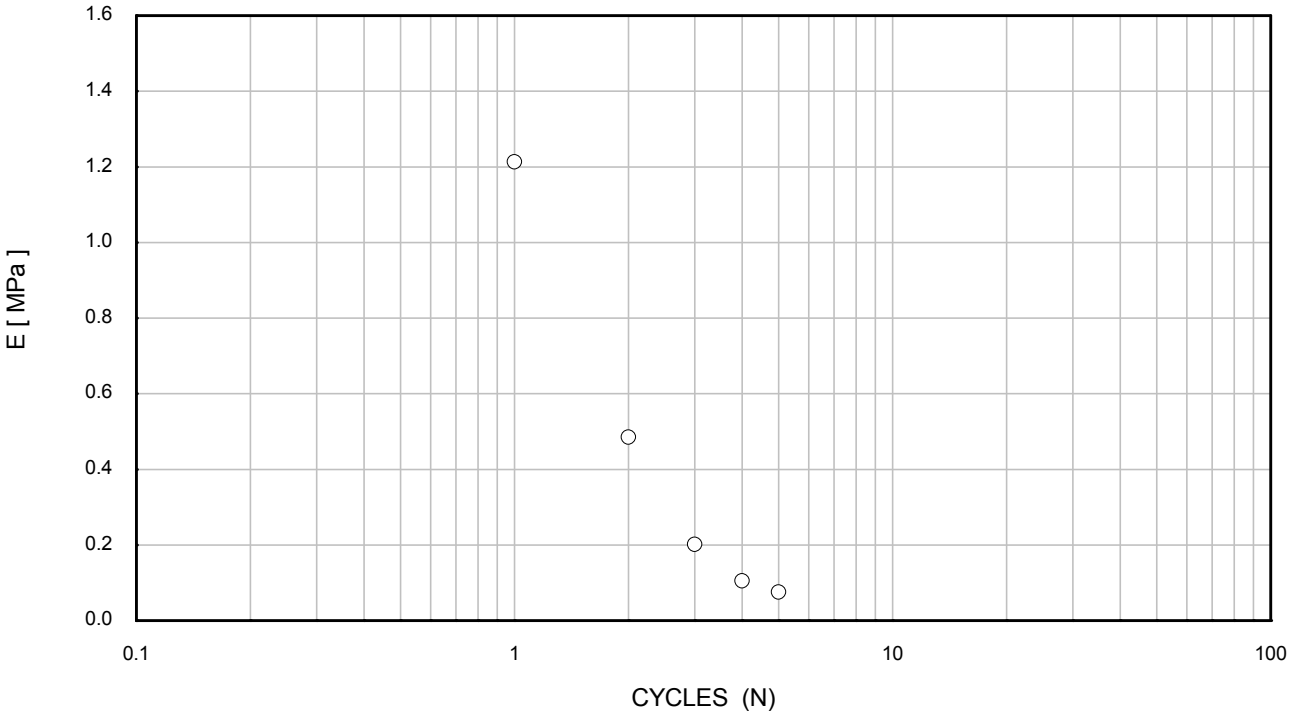


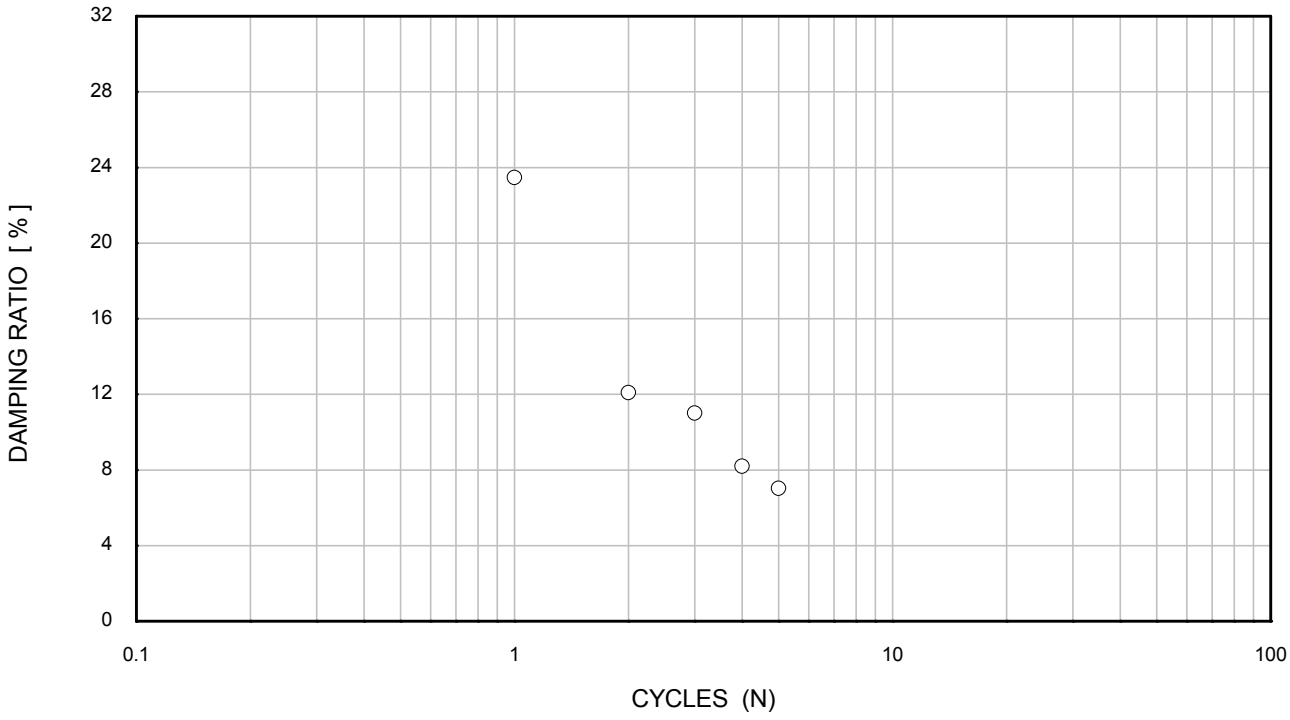


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

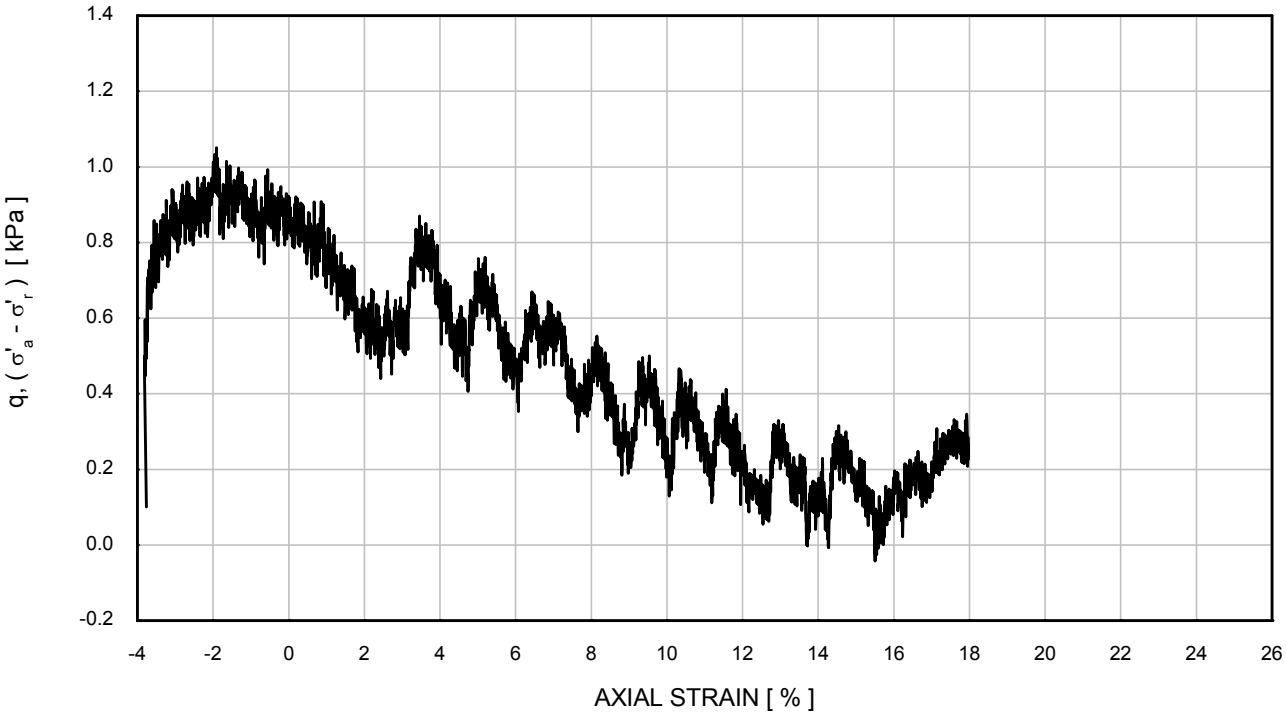


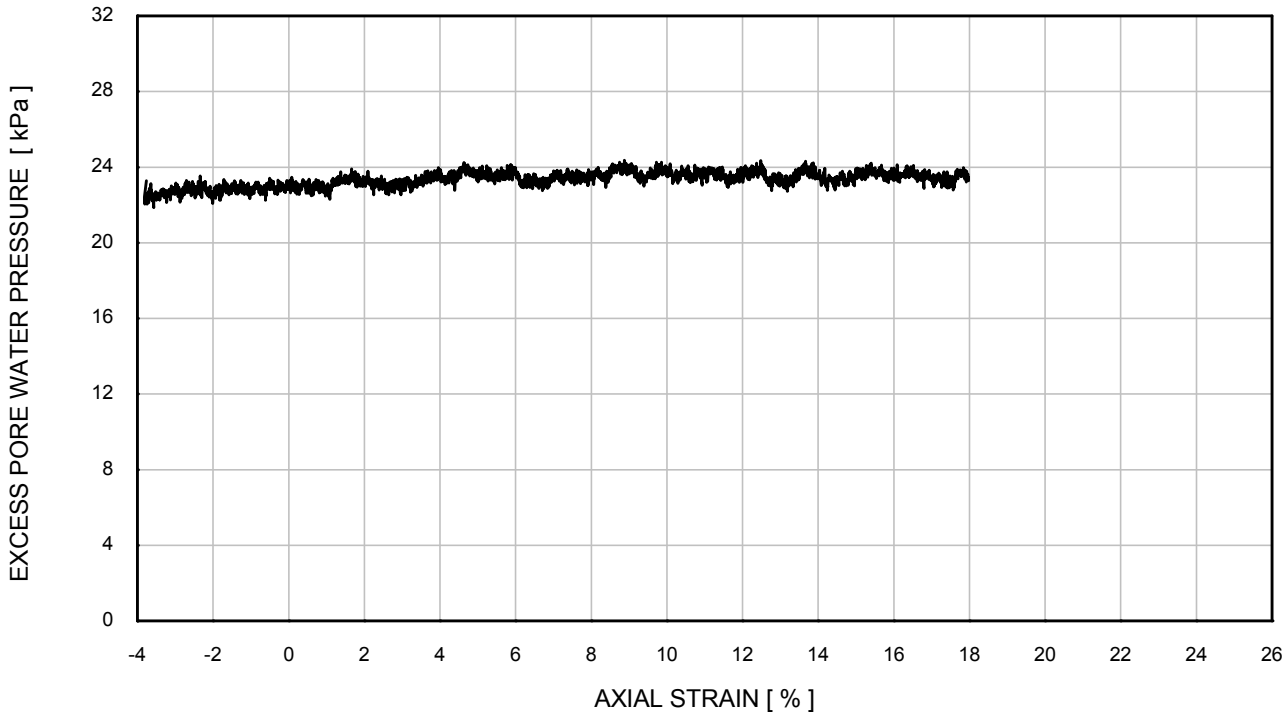


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0.0 kPa	Depth [m]	:	-
q_{cy}	:	8.8 kPa	Test No.	:	CTXL4
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

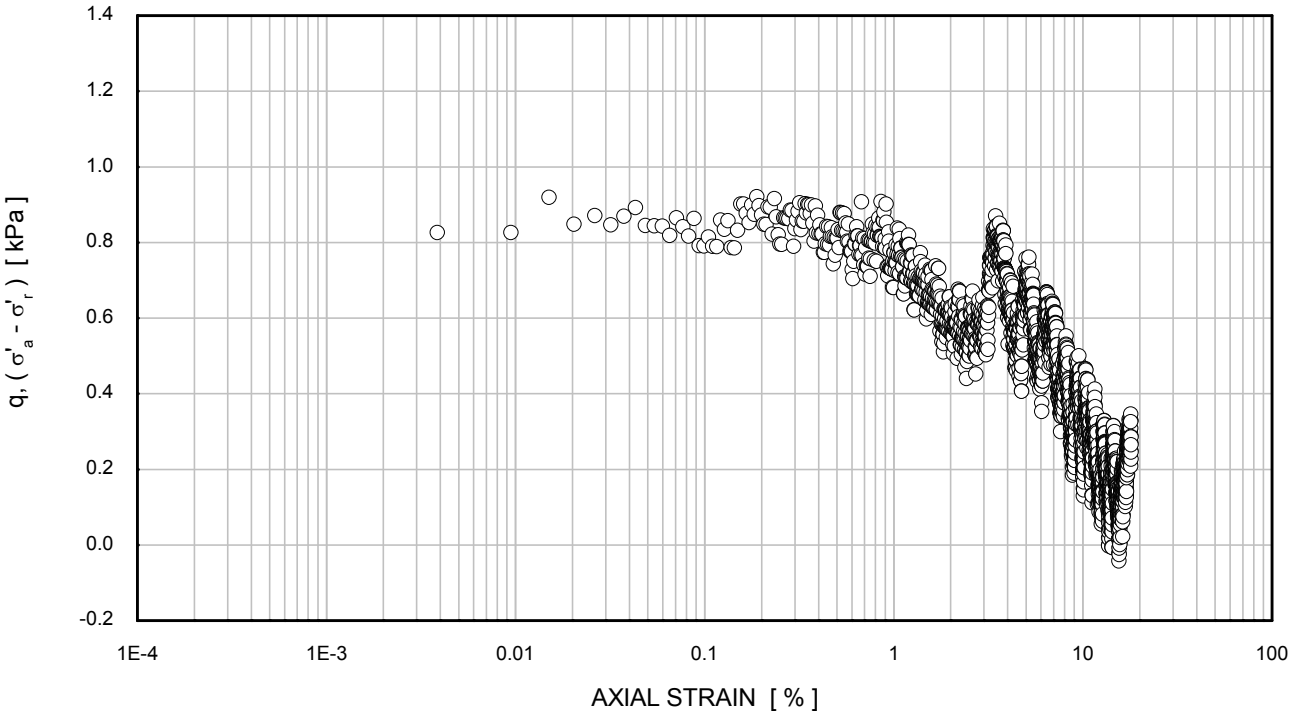


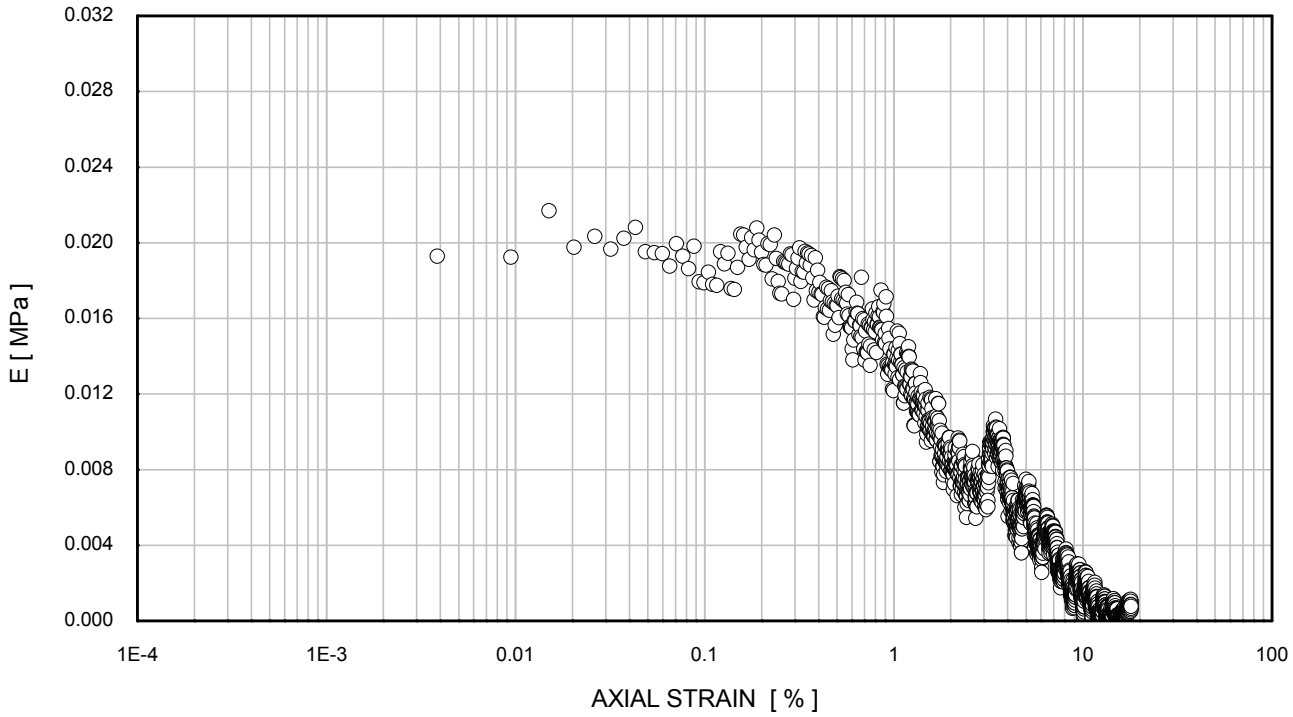


Initial σ'_r	:	1.5	kPa	Borehole	: Batch
Initial σ'_a	:	1.6	kPa	Sample	: Southern Bight
q_{peak}	:	1.1	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	-1.9	%	Test No.	: CTXL4
Rate of strain	:	1.01	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

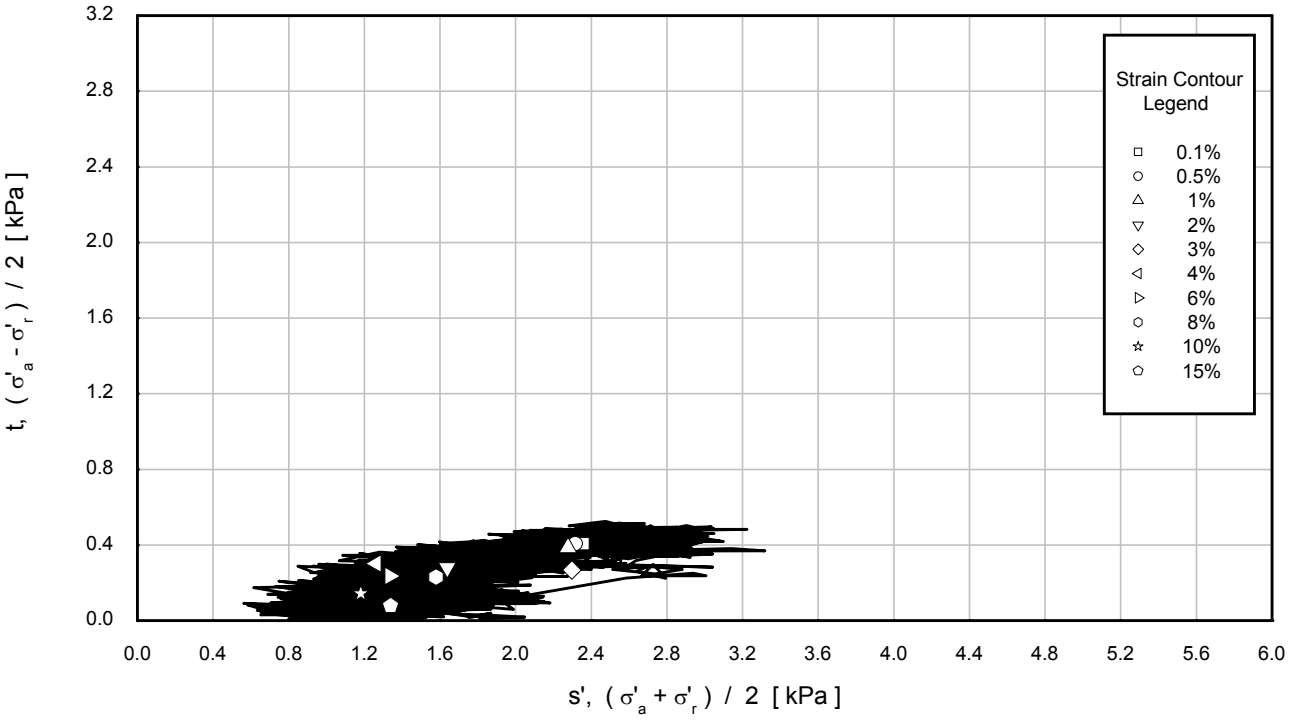


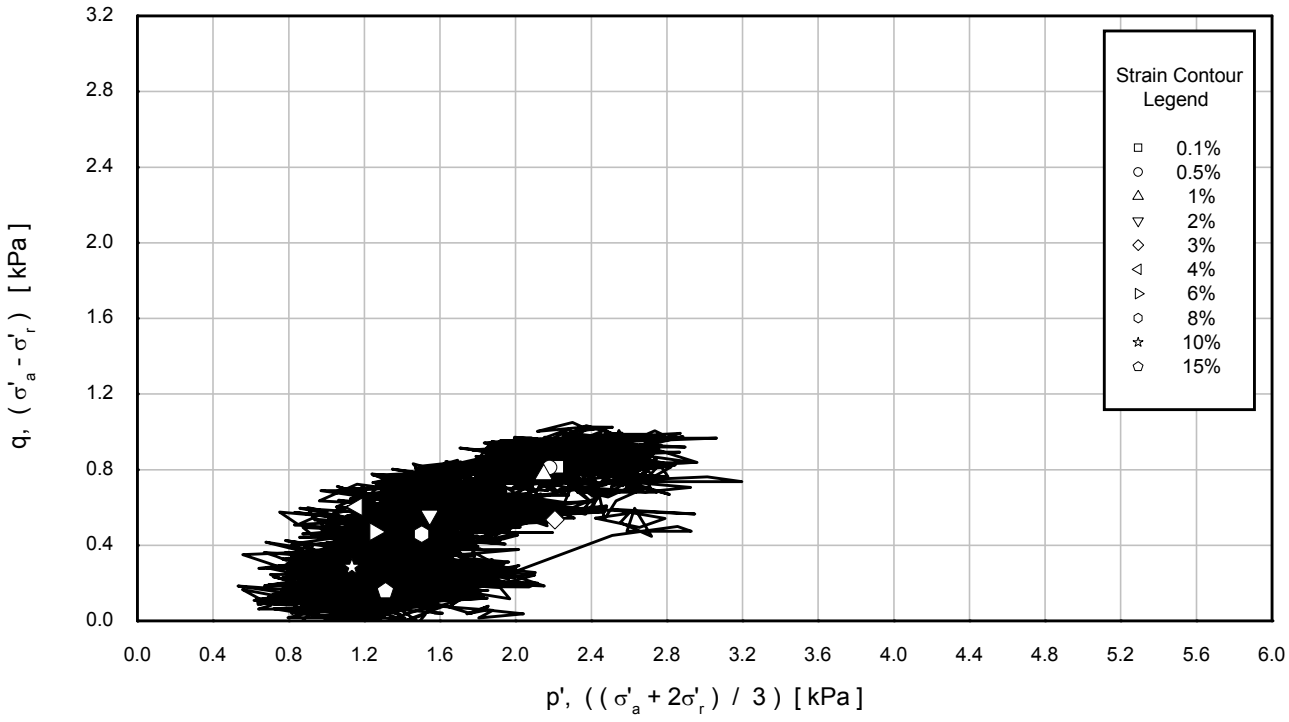


Initial σ'_r	:	1.5	kPa	Borehole	: Batch
Initial σ'_a	:	1.6	kPa	Sample	: Southern Bight
q_{peak}	:	1.1	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	-1.9	%	Test No.	: CTXL4
Rate of strain	:	1.01	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	1.5	kPa	Borehole	: Batch
Initial σ'_a	:	1.6	kPa	Sample	: Southern Bight
q_{peak}	:	1.1	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	-1.9	%	Test No.	: CTXL4
Rate of strain	:	1.01	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND with traces of shell fragments

GENERAL	
Date test started	08/12/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	71.1
Length	[mm]	144.0
Moisture content	[%]	10.1
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.631
Degree of saturation	[%]	43
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Southern_Bight_CTXL13
Processed by	LC
Date	18/08/2015
Checked by	LJ
Date	19/08/2015
Approved by	PH
Date	20/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL13

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1025
Base PWP	[kPa]	1015
Mid height PWP	[kPa]	-
B value achieved	[-]	0.96

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1025
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	25
Effective axial pressure	[kPa]	25
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.16
External axial strain	[%]	0.05
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	23.7
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.628
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL13

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	25
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	9
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	90
External ε_{av} at N_f	[%]	-2.06
External ε_{cy} at N_f	[%]	15.13
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	21
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	23.7
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63
Void ratio	[-]	0.628
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.02	47	-	8.65	-
2	0.00	0.02	49	-	7.09	-
5	0.00	0.02	47	-	6.06	-
10	0.00	0.02	46	-	5.85	-
20	0.00	0.02	43	-	5.92	-
30	0.00	0.02	40	-	6.40	-
40	0.00	0.02	38	-	6.85	-
50	0.00	0.02	34	-	7.76	-
90	-2.06	15.13	0	-	5.61	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL13

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	1
Initial effective axial pressure	[kPa]	2
Rate of strain	[%/hour]	0.94
At peak deviator stress		
Corrected deviator stress	[kPa]	37
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	23.42
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	12
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	14
Effective axial pressure	[kPa]	50
Principal effective stress ratio	[-]	3.65
ε_{50}	[%]	21.37
Secant modulus (E_{50}) at ε_{50}	[kPa]	83
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	3
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	15.06
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0
Effective axial pressure	[kPa]	3
Principal effective stress ratio	[-]	300.31
At 10% axial strain		
Corrected deviator stress	[kPa]	1
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	24
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	1
Effective axial pressure	[kPa]	2
Principal effective stress ratio	[-]	1.57

TEST IDENTIFICATION	
Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL13

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

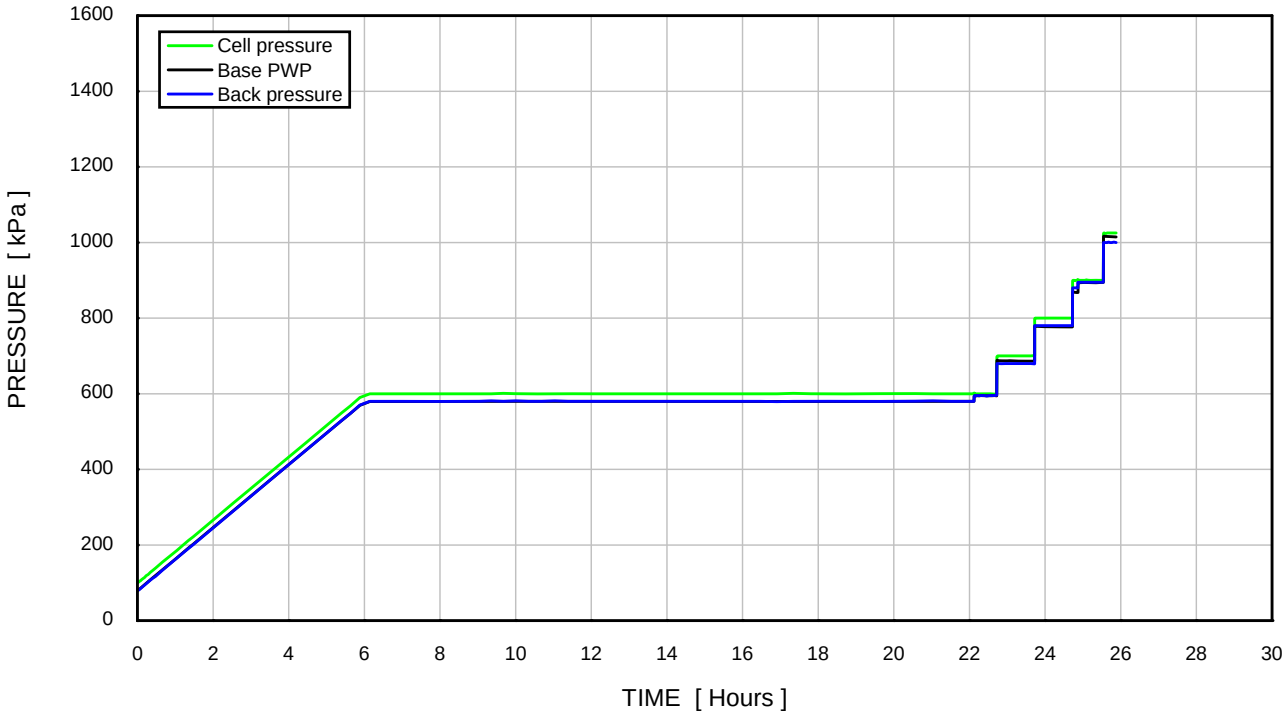
Moisture content	[%]	23.7
Bulk density	[Mg/m³]	2.01
Dry density	[Mg/m³]	1.63

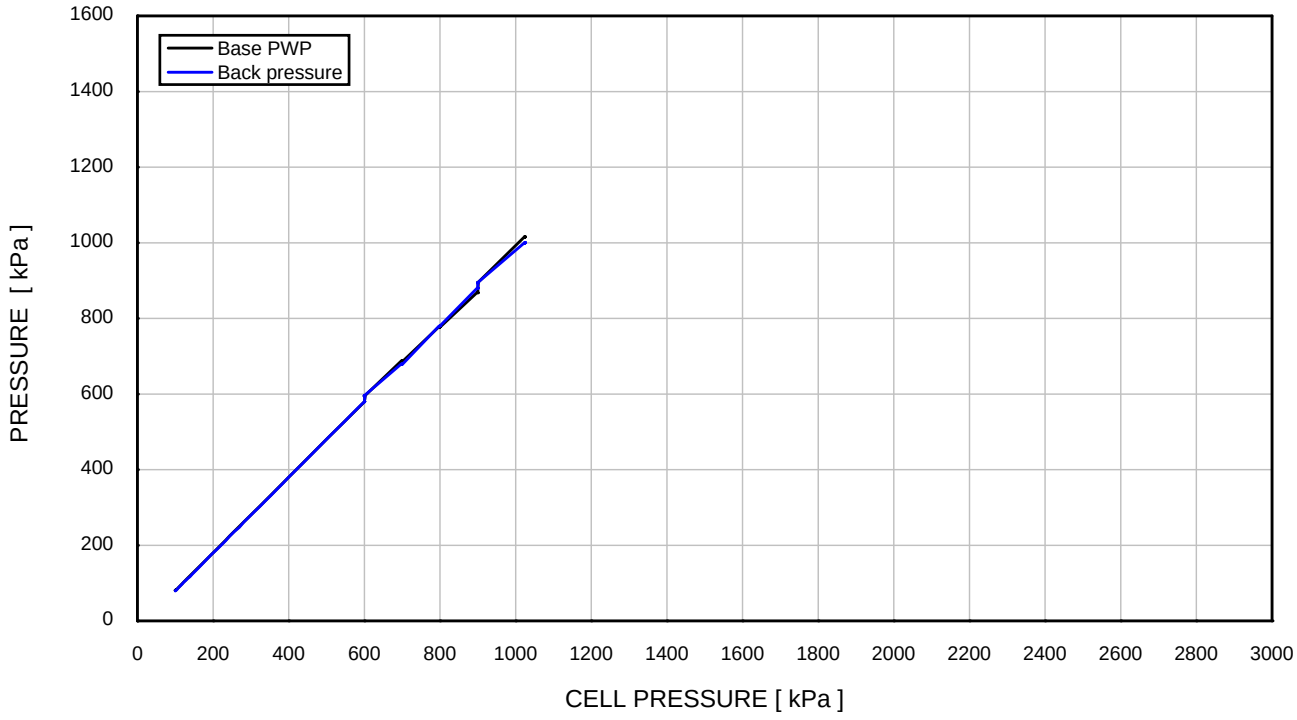
TEST IDENTIFICATION

Borehole	Batch
Sample	Southern Bight
Depth [m]	-
Test number	CTXL13

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

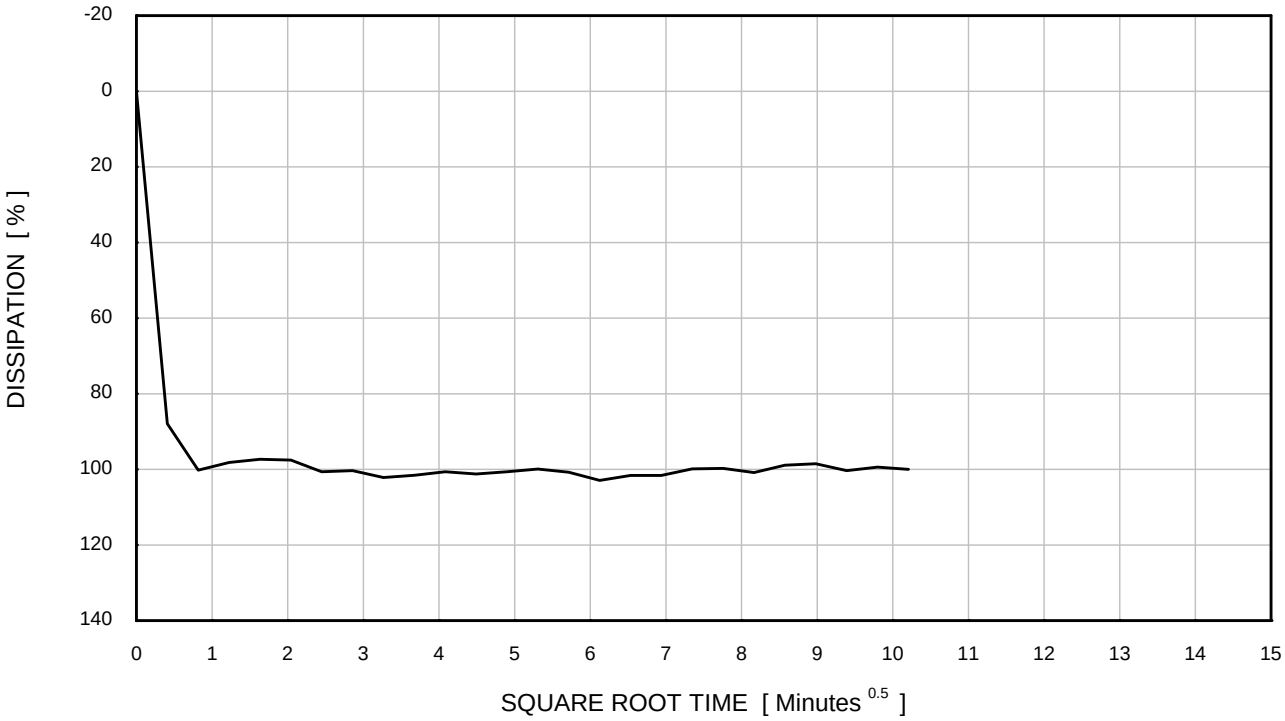


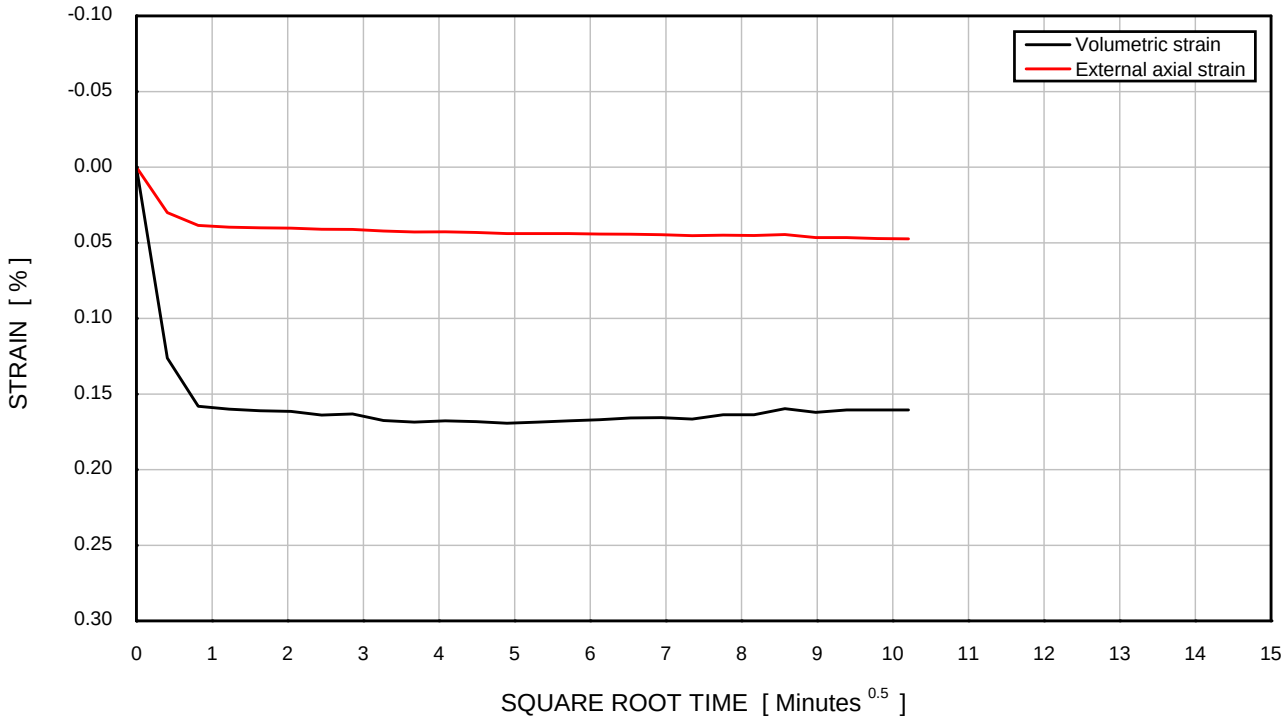


B value	:	0.96			
Initial σ'_r	:	19	kPa	Borehole	: Batch
Initial σ'_a	:	19	kPa	Sample	: Southern Bight
Final σ'_r	:	10	kPa	Depth [m]	: -
Final σ'_a	:	10	kPa	Test No.	: CTXL13

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

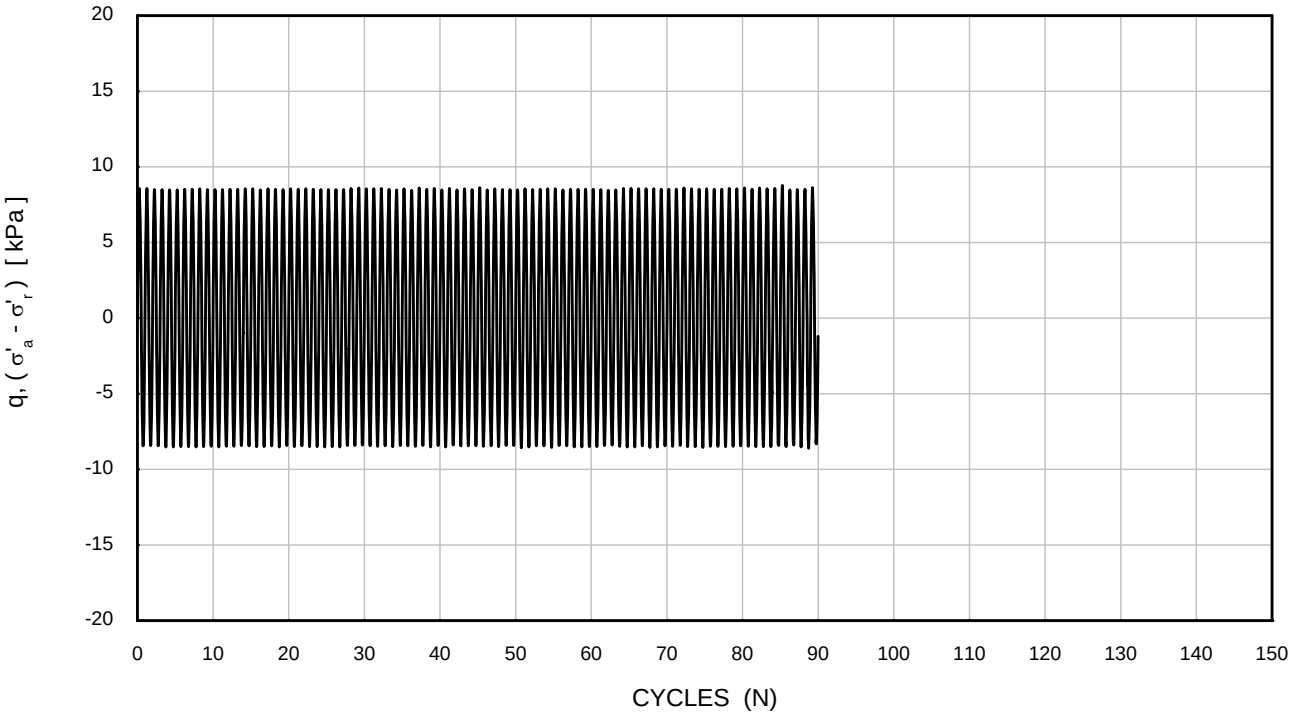


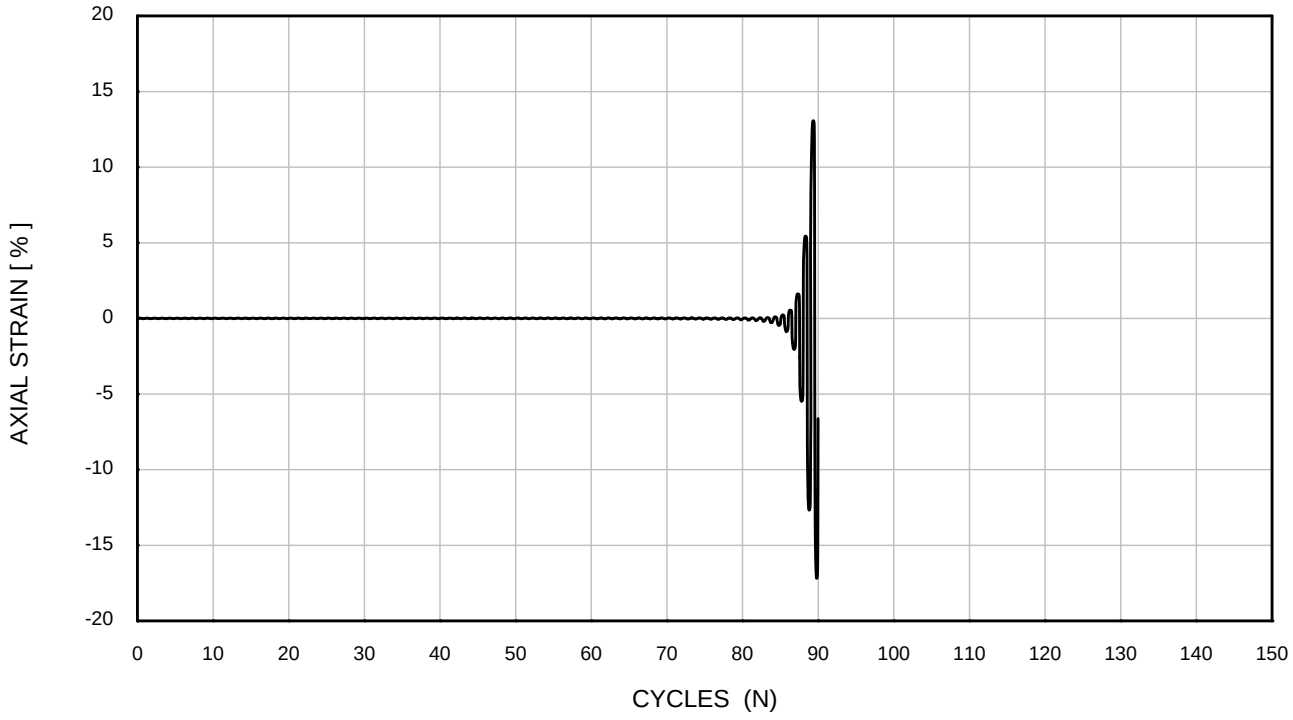


σ'_{rc}	:	25 kPa	Borehole	: Batch
σ'_{ac}	:	25 kPa	Sample	: Southern Bight
			Depth [m]	: -
			Test No.	: CTXL13

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

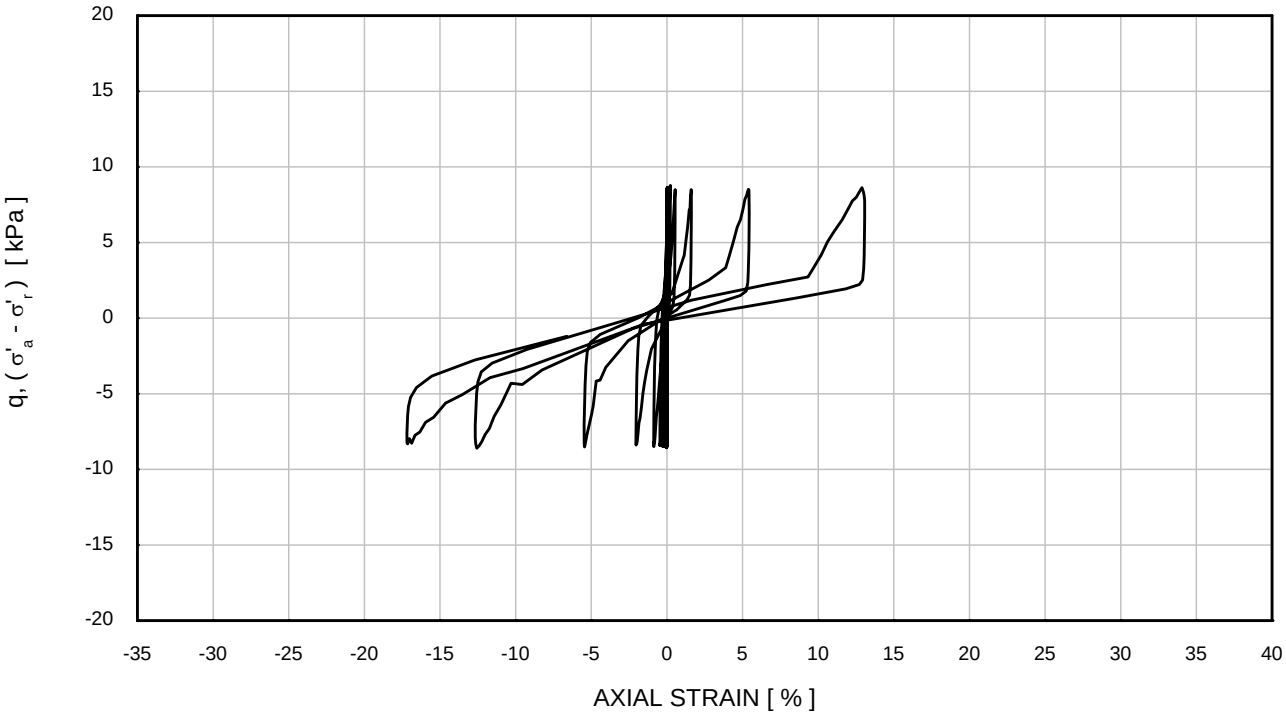


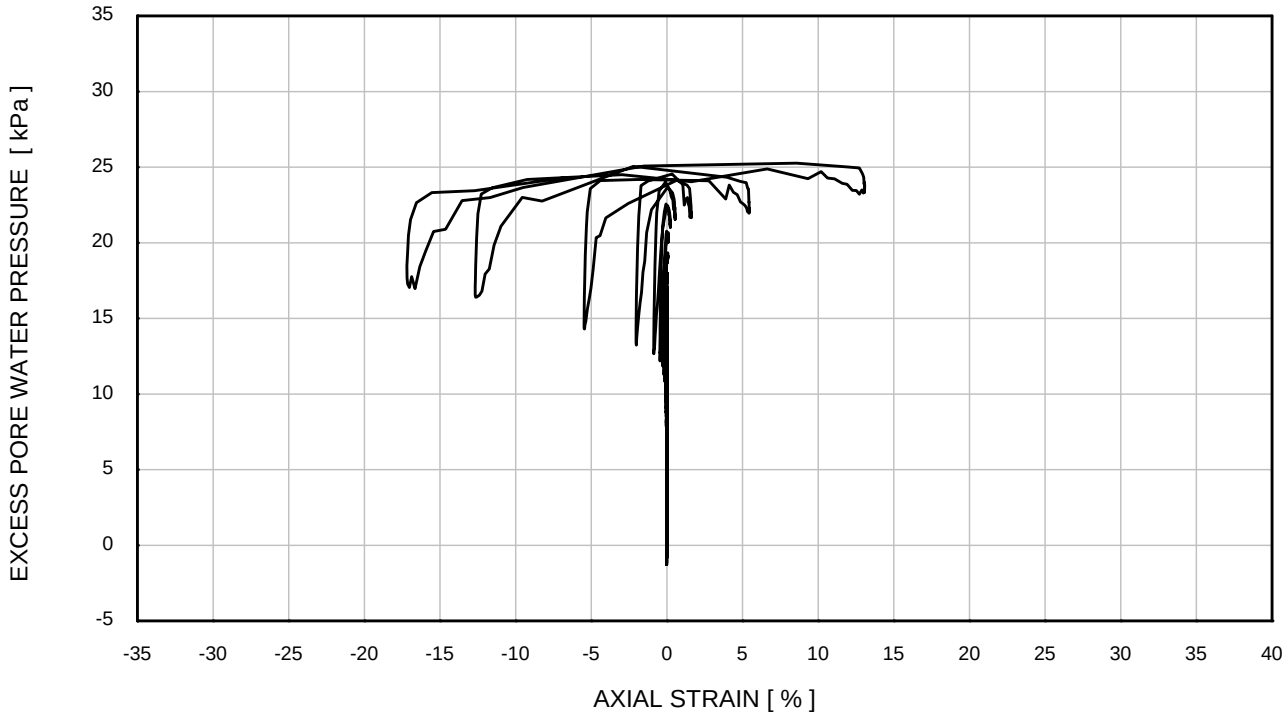


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

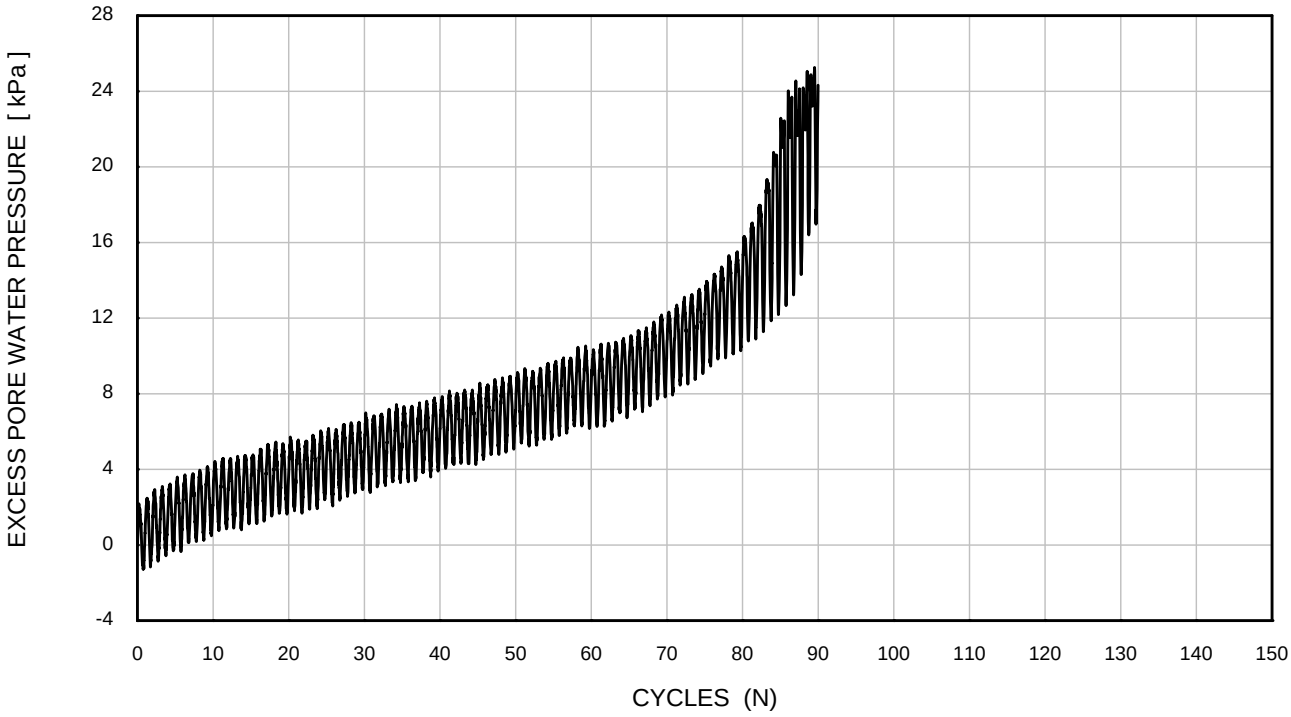


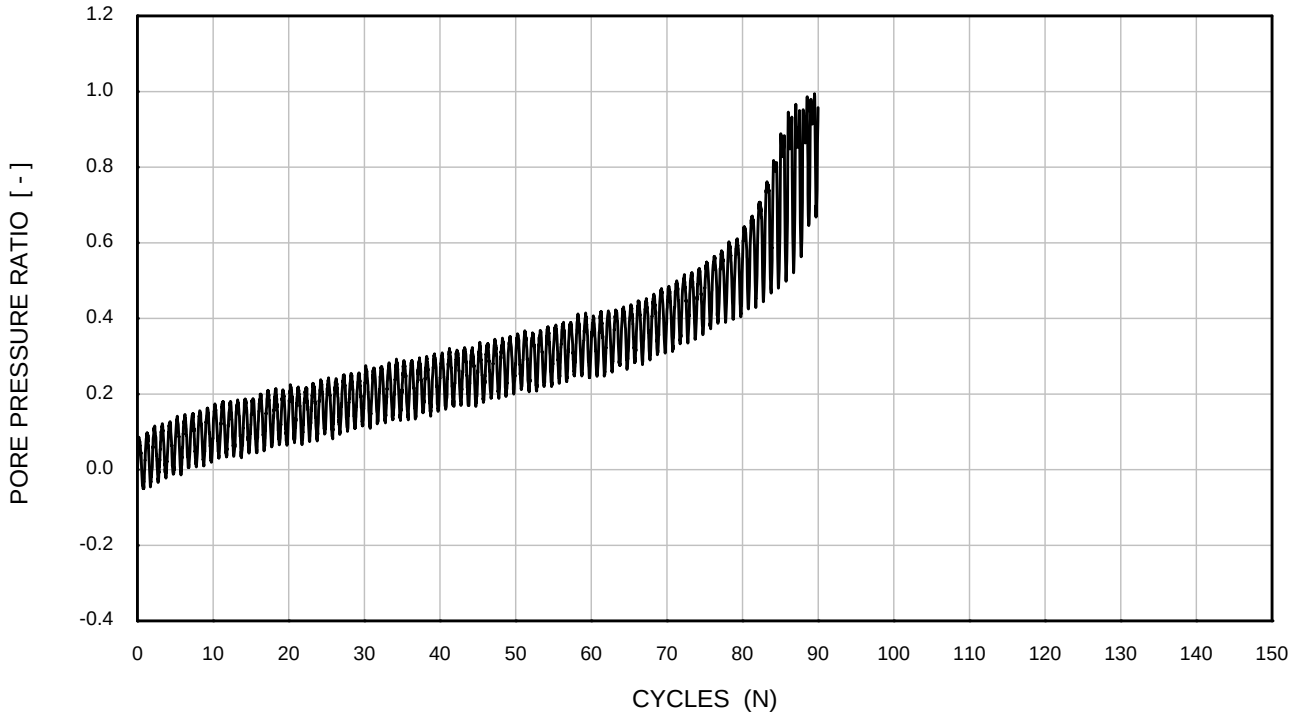


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

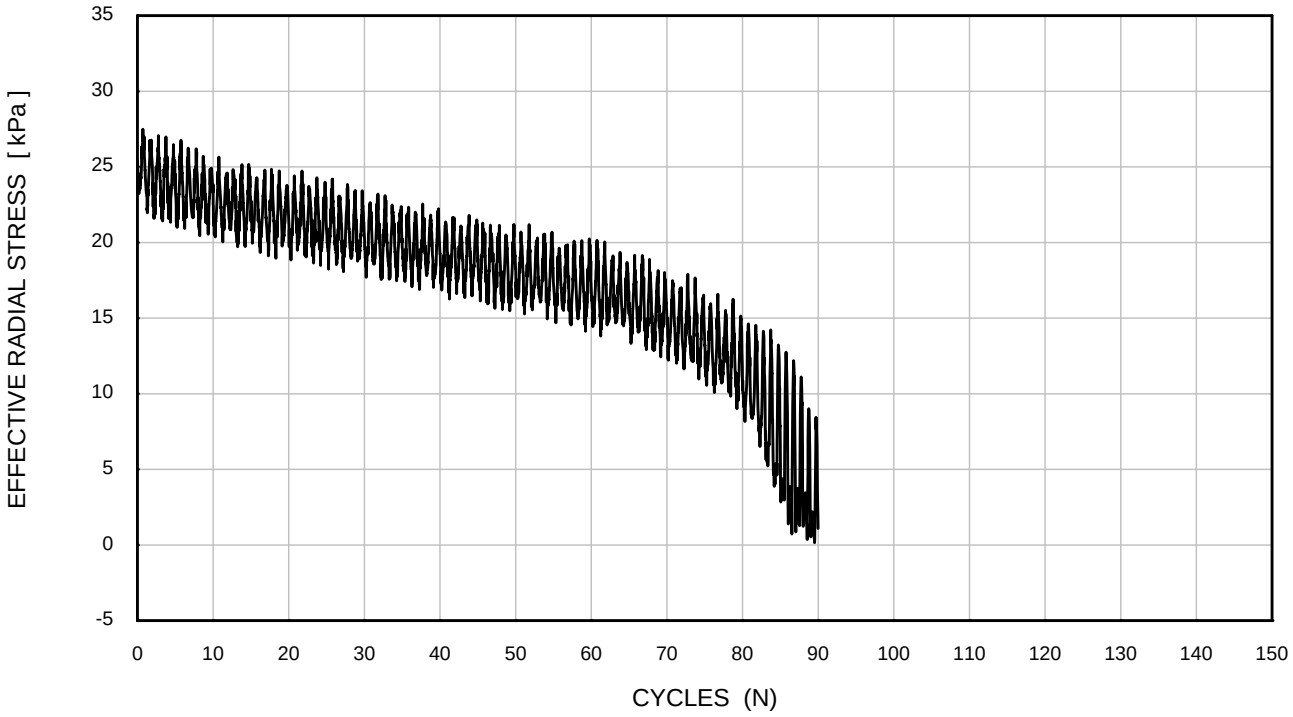


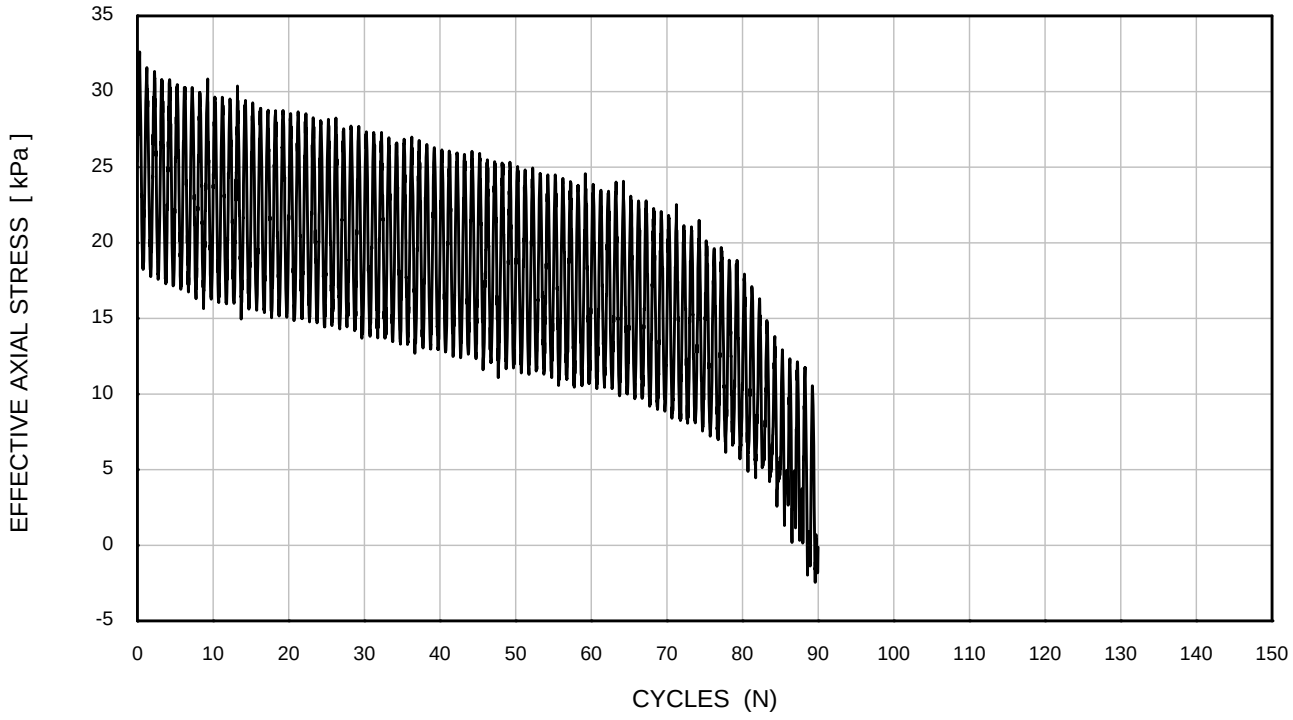


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

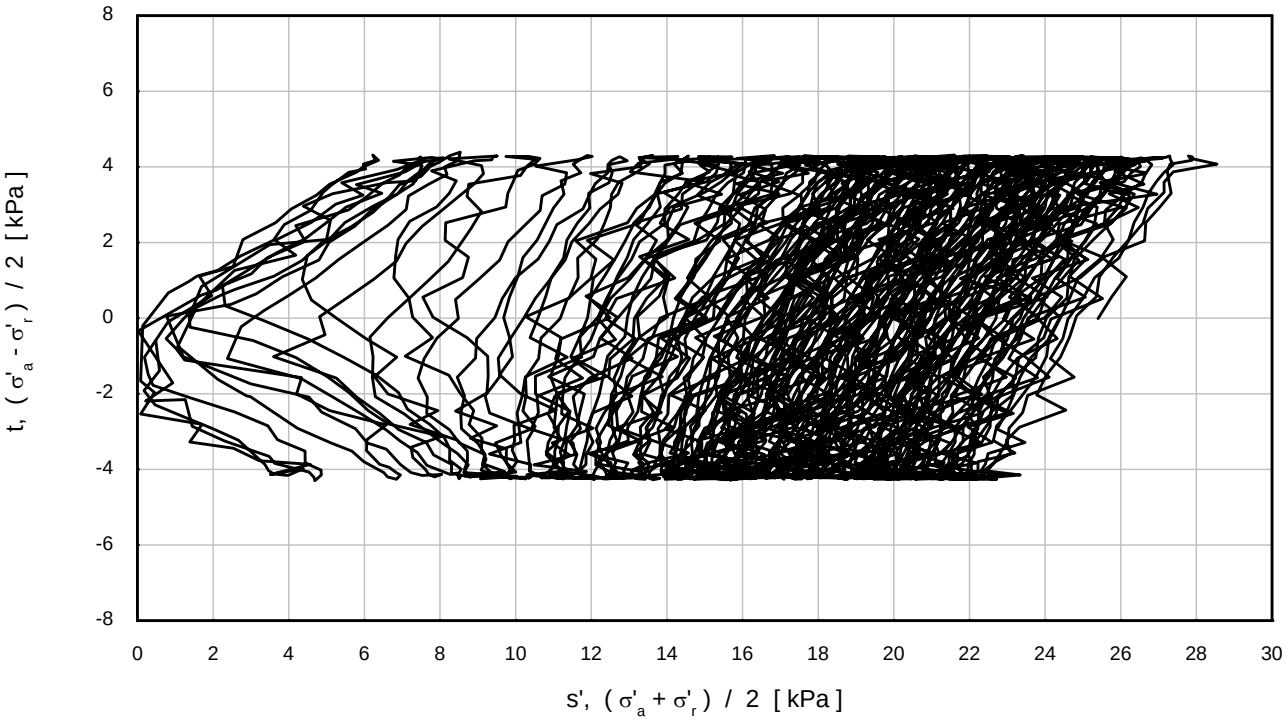


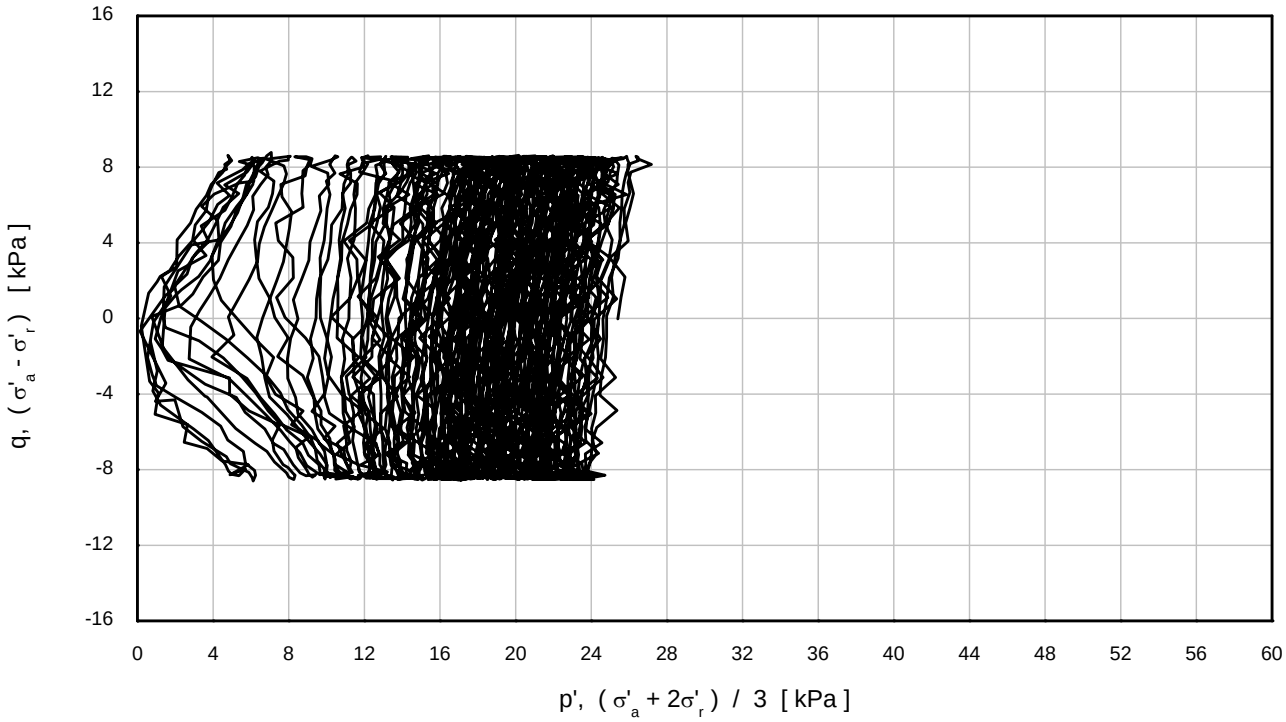


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

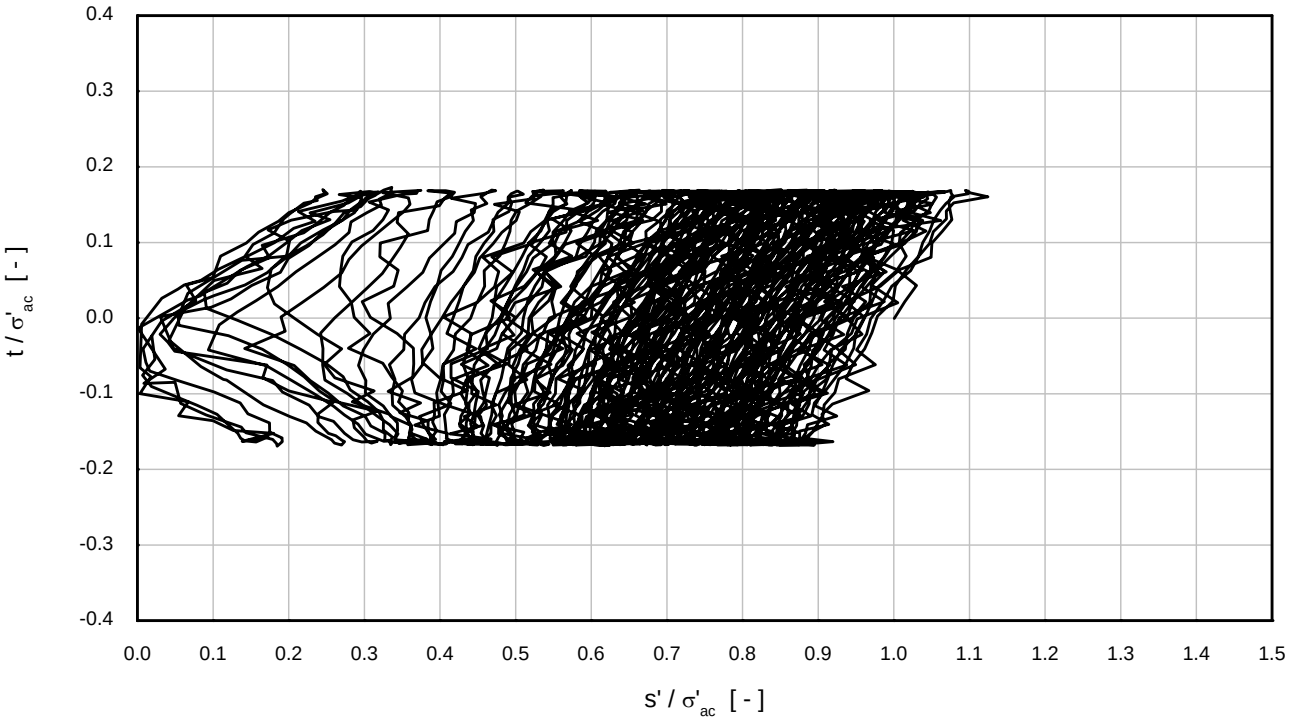


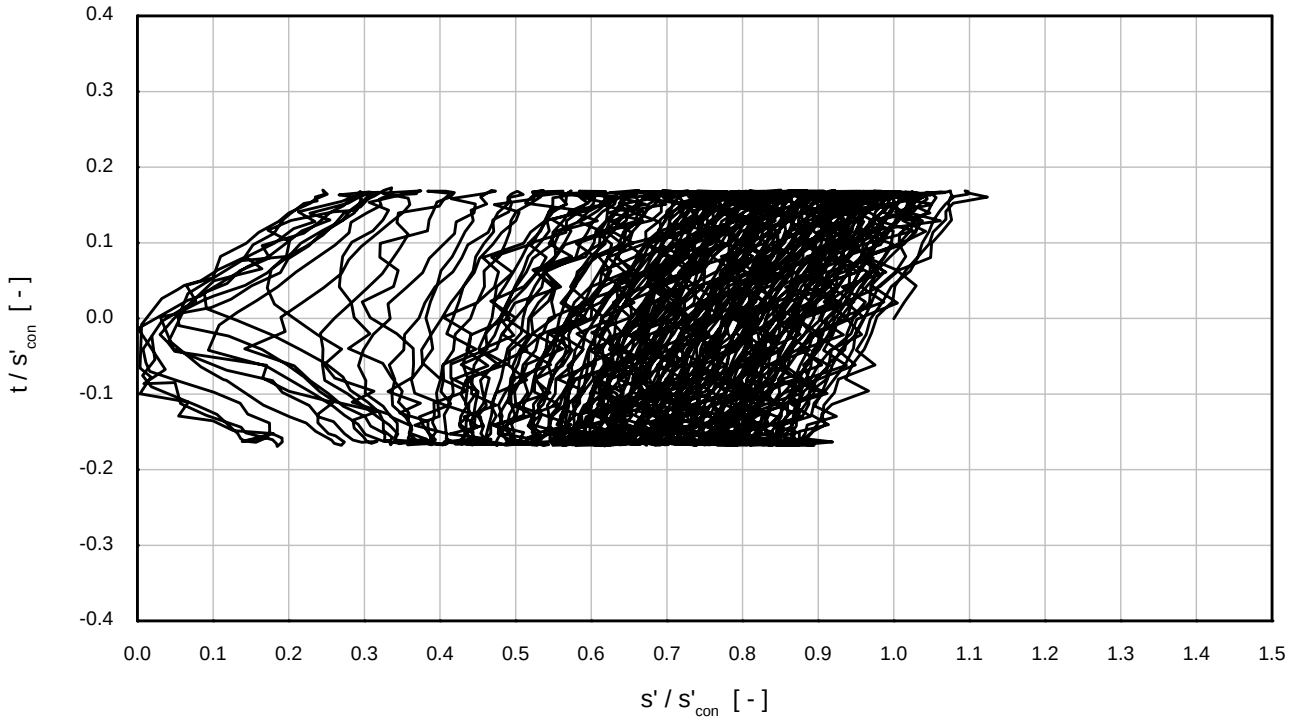


Initial σ'_r	:	25 kPa	Borehole	:	Batch
Initial σ'_a	:	25 kPa	Sample	:	Southern Bight
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	9 kPa	Test No.	:	CTXL13
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

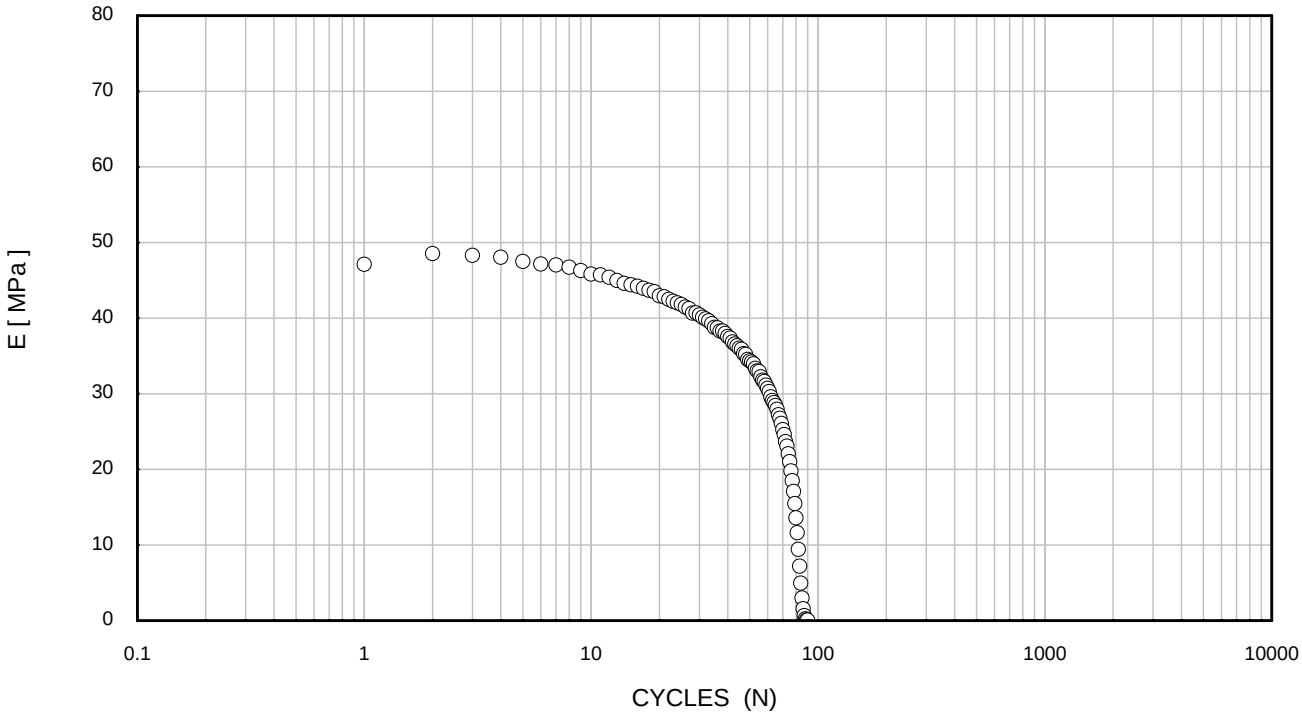


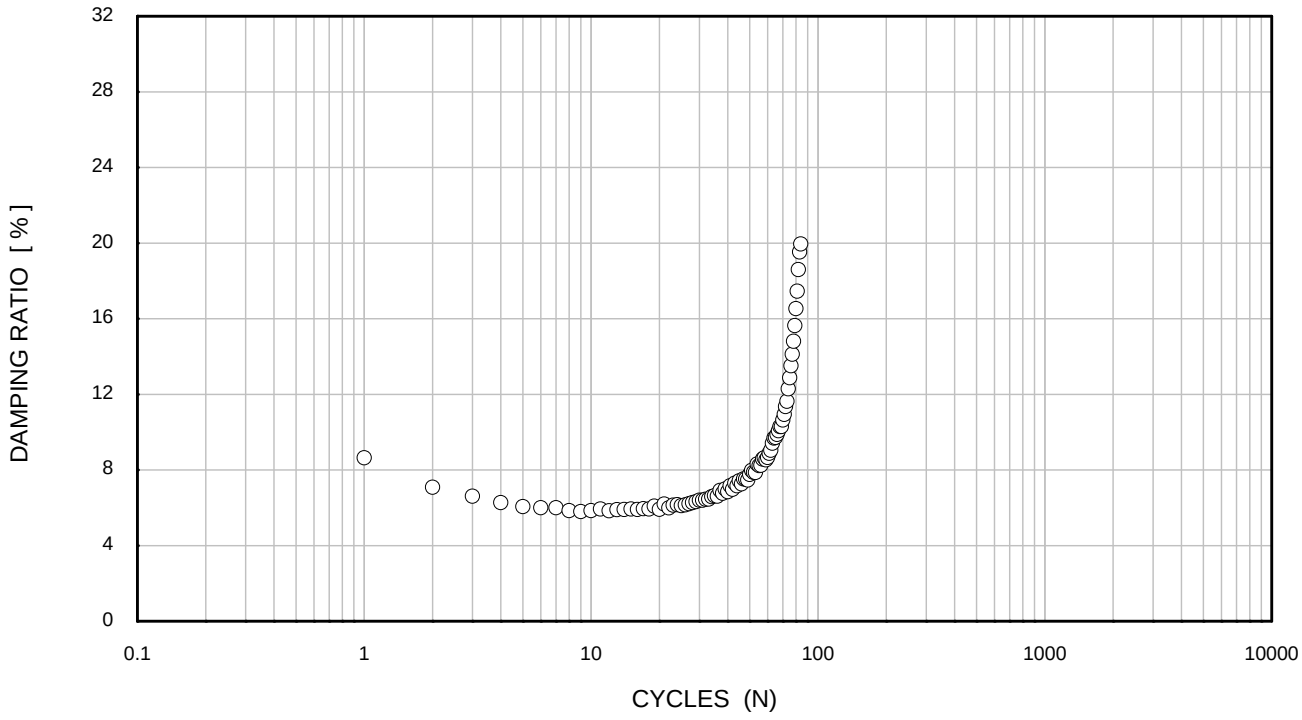


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

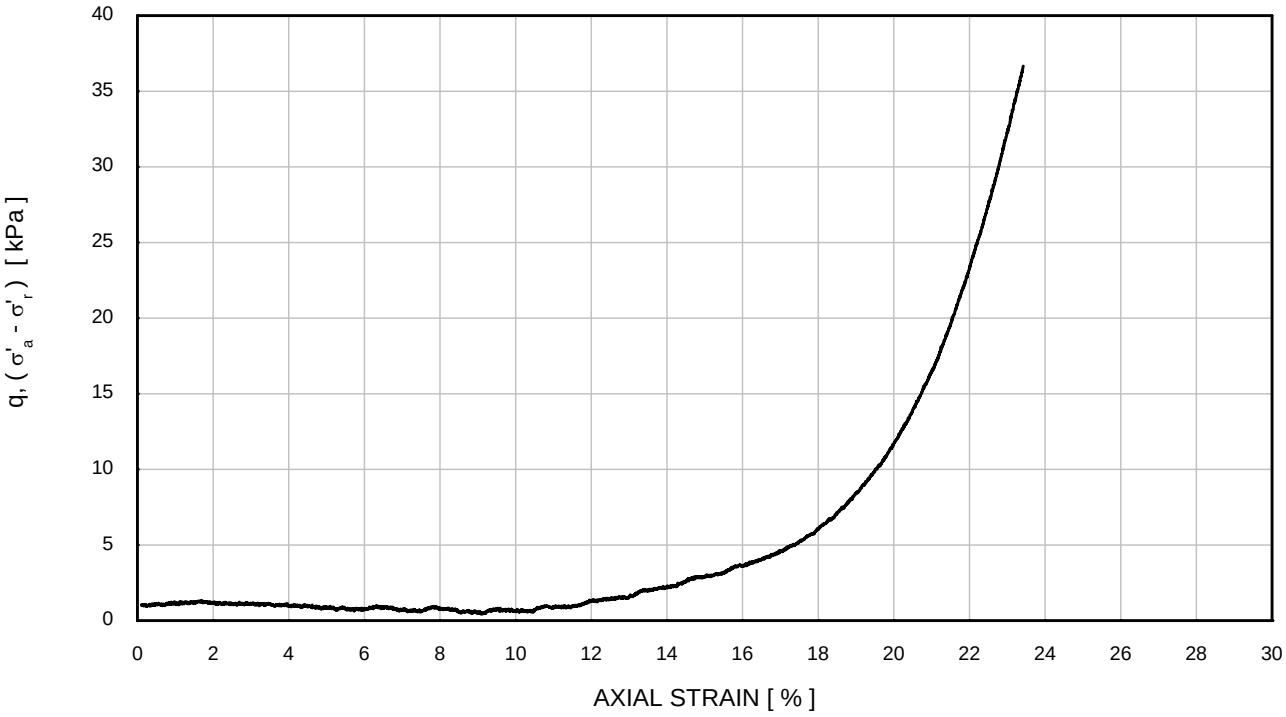


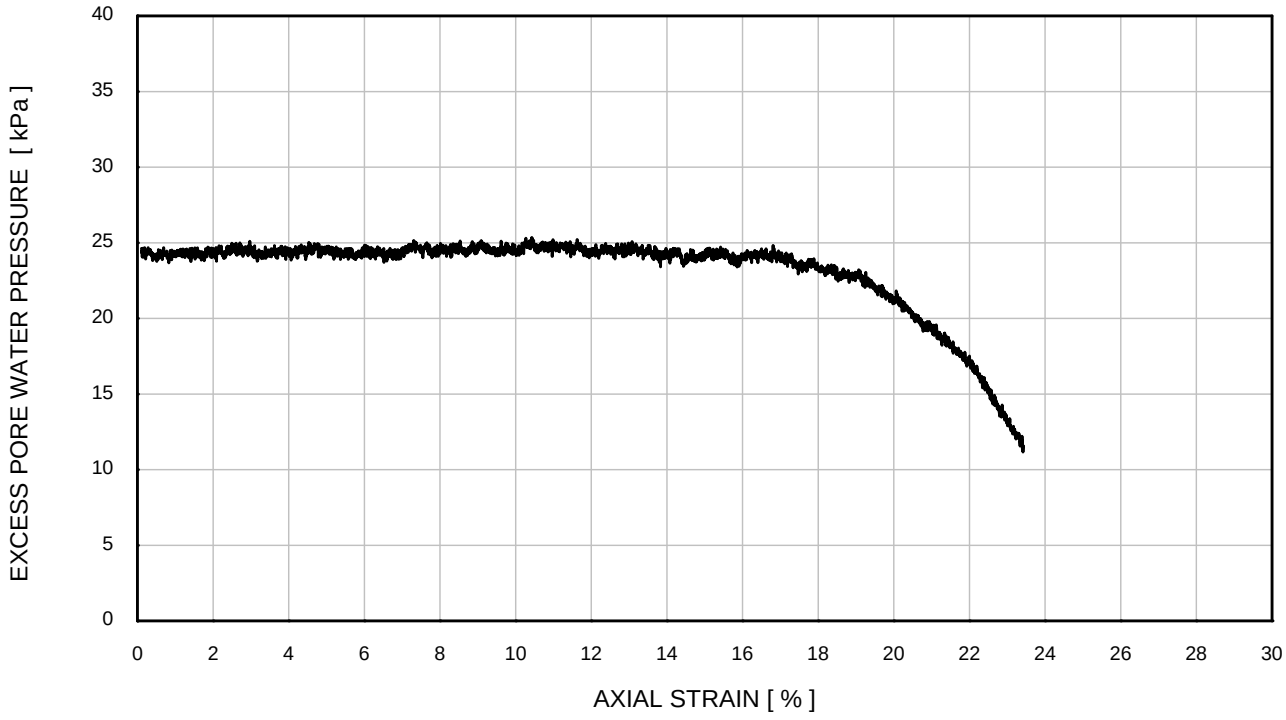


Initial σ'_r	:	25	kPa	Borehole	: Batch
Initial σ'_a	:	25	kPa	Sample	: Southern Bight
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	9	kPa	Test No.	: CTXL13
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

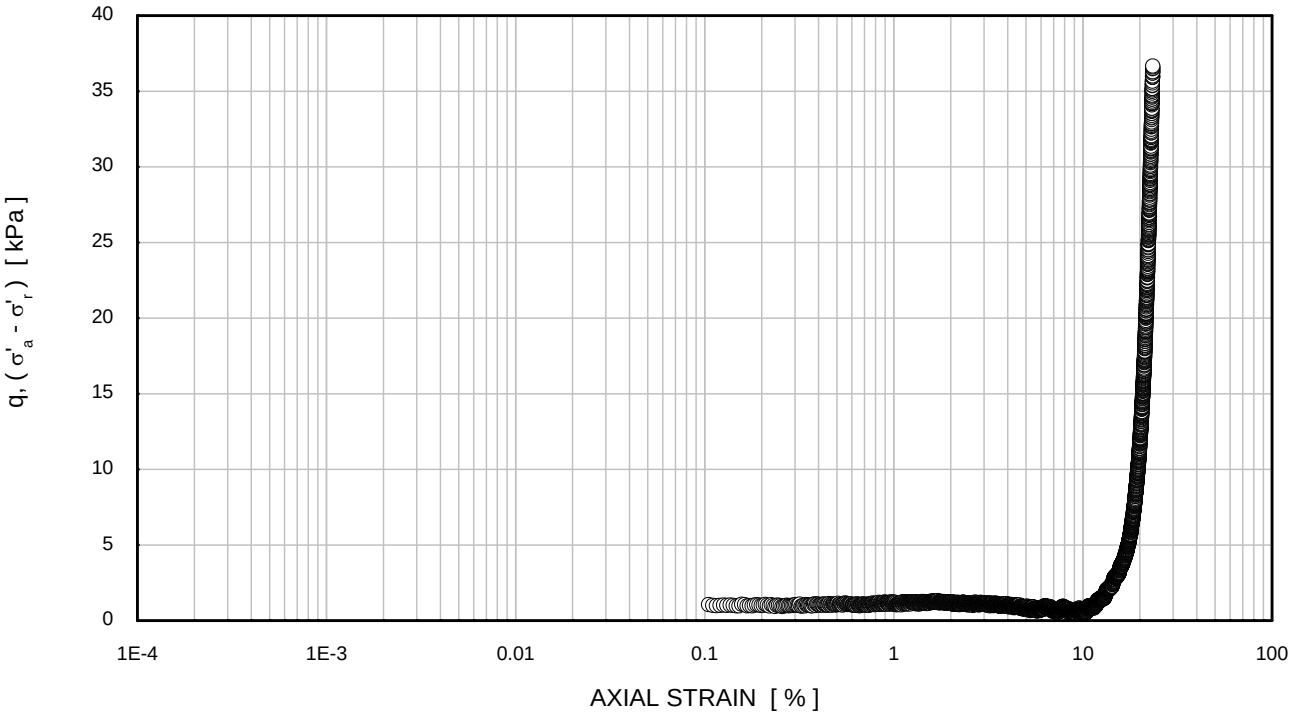


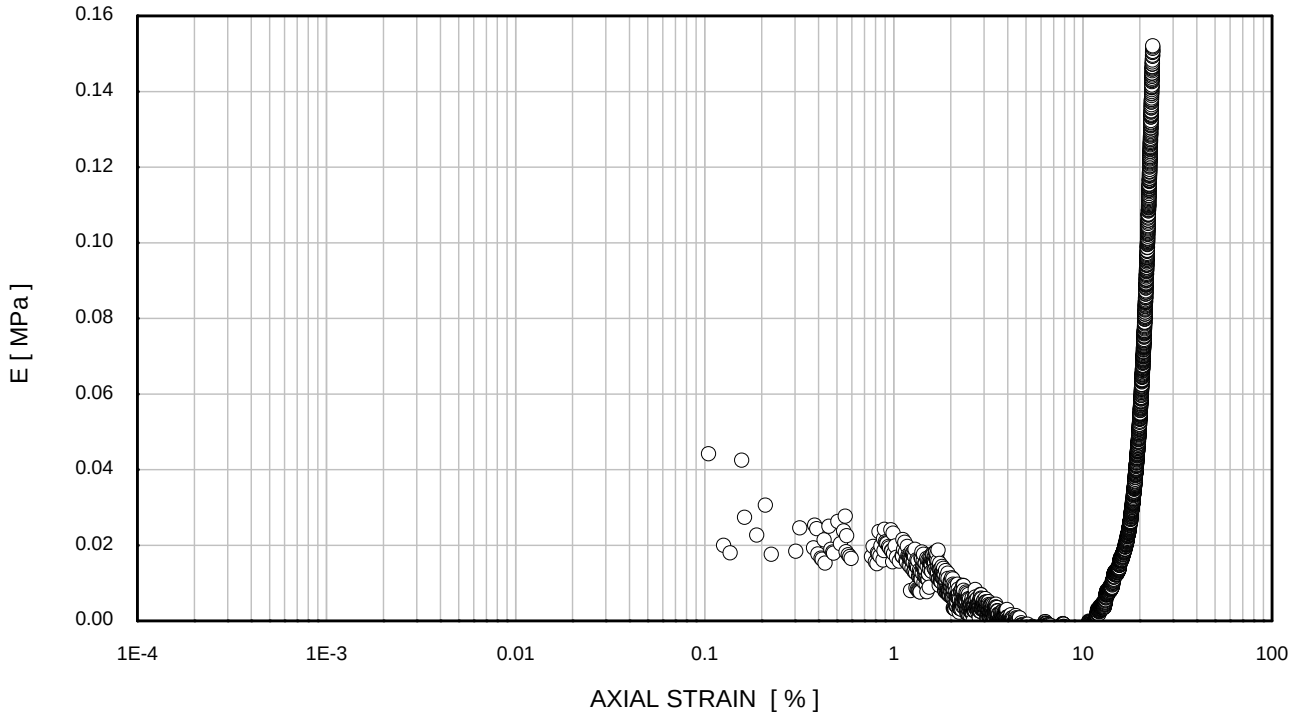


Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	37	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.4	%	Test No.	: CTXL13
Rate of strain	:	0.94	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

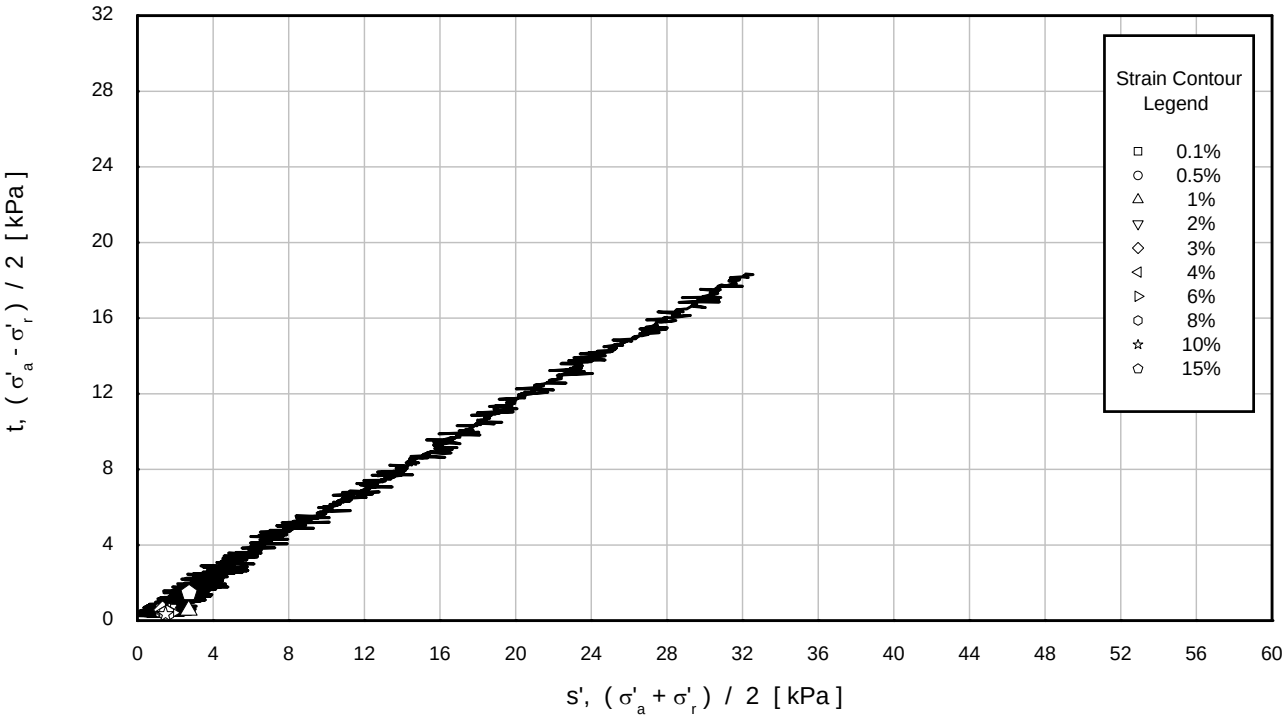


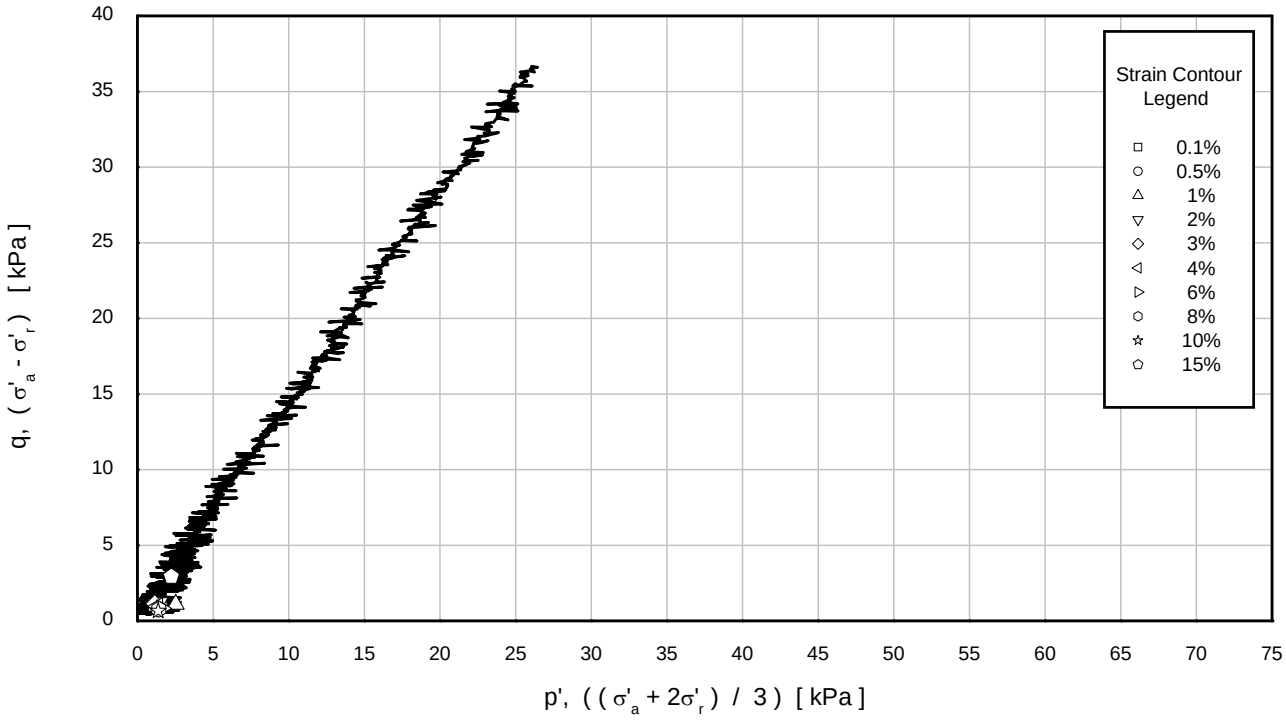


Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	37	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.4	%	Test No.	: CTXL13
Rate of strain	:	0.94	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Southern Bight
q_{peak}	:	37	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	23.4	%	Test No.	: CTXL13
Rate of strain	:	0.94	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND

GENERAL	
Date test started	23/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	9.9
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.560
Degree of saturation	[%]	47
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Eem_Kreftenheye_CTXL5
Processed by	LC
Date	11/08/2015
Checked by	LJ
Date	13/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL5

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1480
Base PWP	[kPa]	1400
Mid height PWP	[kPa]	-
B value achieved	[-]	0.95

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1480
Back pressure	[kPa]	1400
Base PWP	[kPa]	1400
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.00
External axial strain	[%]	0.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	21.1
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.560
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL5

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	80
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	48
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	33
External ε_{av} at N_f	[%]	0.26
External ε_{cy} at N_f	[%]	9.93
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	47
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	21.1
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.560
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.03	96	-	4.33	-
2	0.01	0.07	66	-	13.34	-
5	0.01	0.08	59	-	13.21	-
10	0.00	0.10	46	-	15.19	-
20	-0.36	0.71	7	-	17.04	-
30	-1.18	8.66	1	-	5.42	-
33	0.26	9.93	0	-	6.60	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL5

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

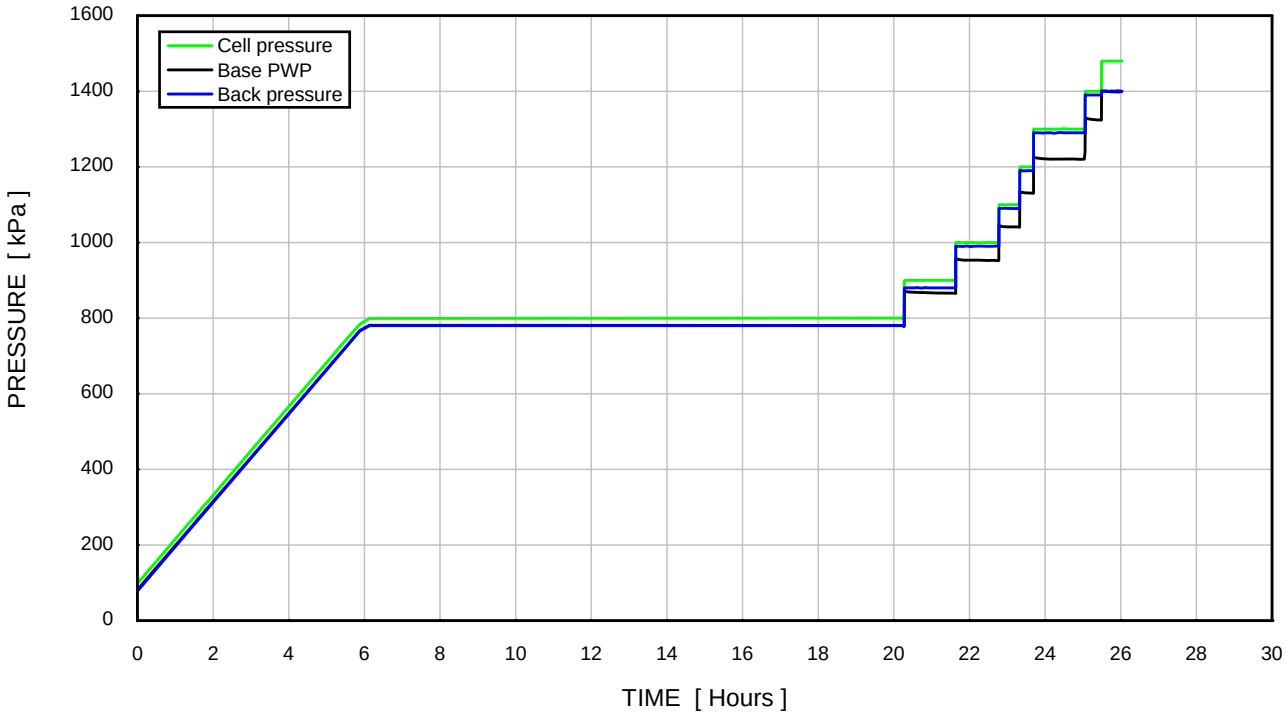
SPECIMEN PHOTOGRAPHS

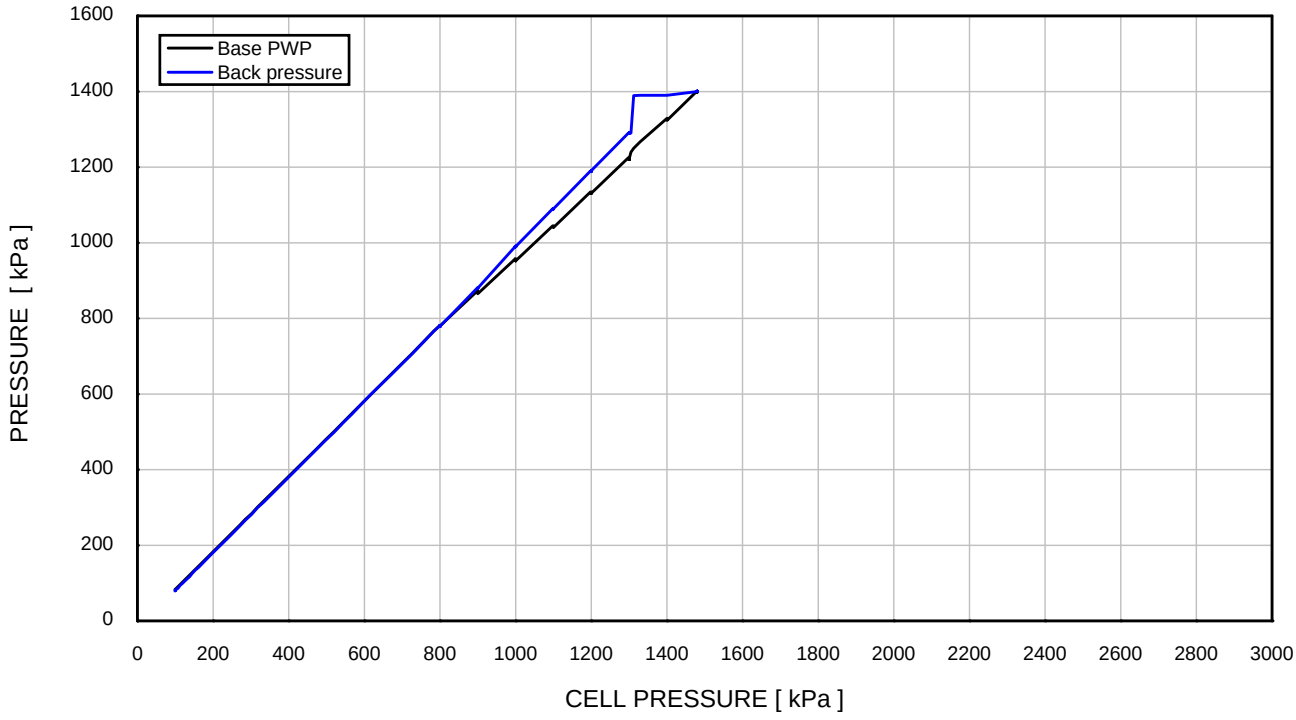
FINAL CONDITIONS		
Moisture content	[%]	21.1
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL5

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

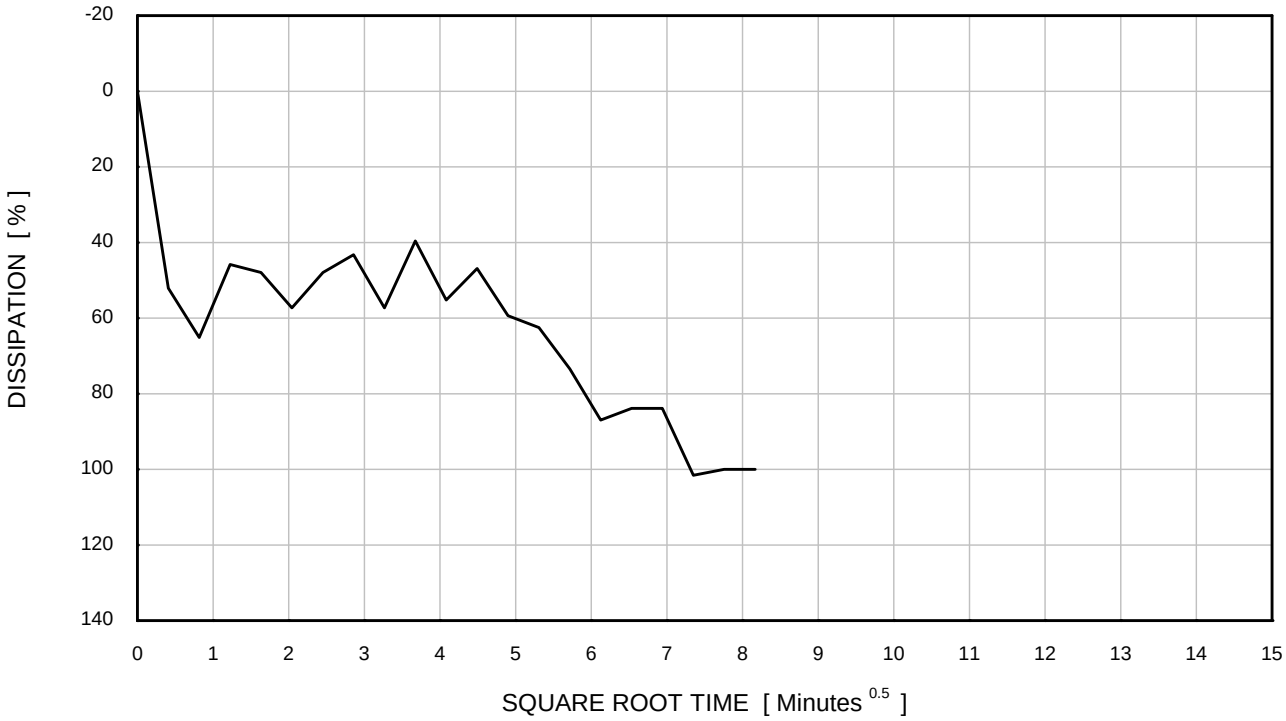


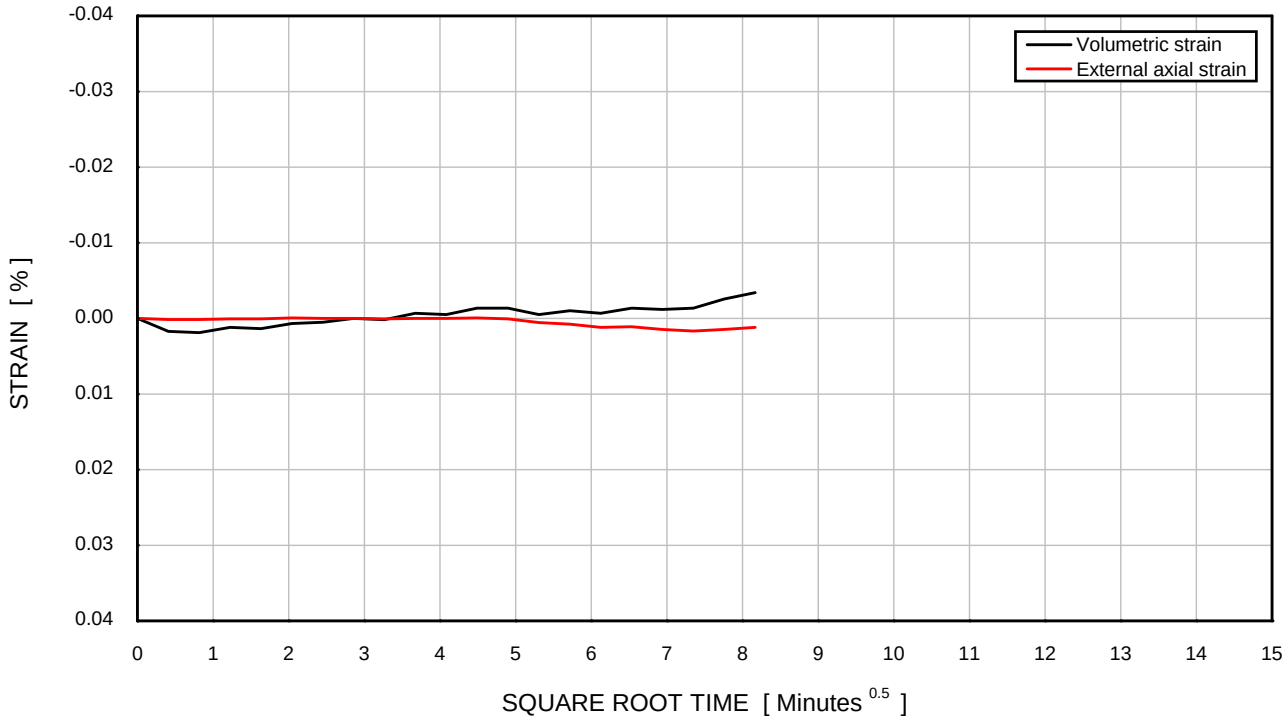


B value	:	0.95			
Initial σ'_r	:	18	kPa	Borehole	: Batch
Initial σ'_a	:	18	kPa	Sample	: Eem / Kreftenheye
Final σ'_r	:	80	kPa	Depth [m]	: -
Final σ'_a	:	80	kPa	Test No.	: CTXL5

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

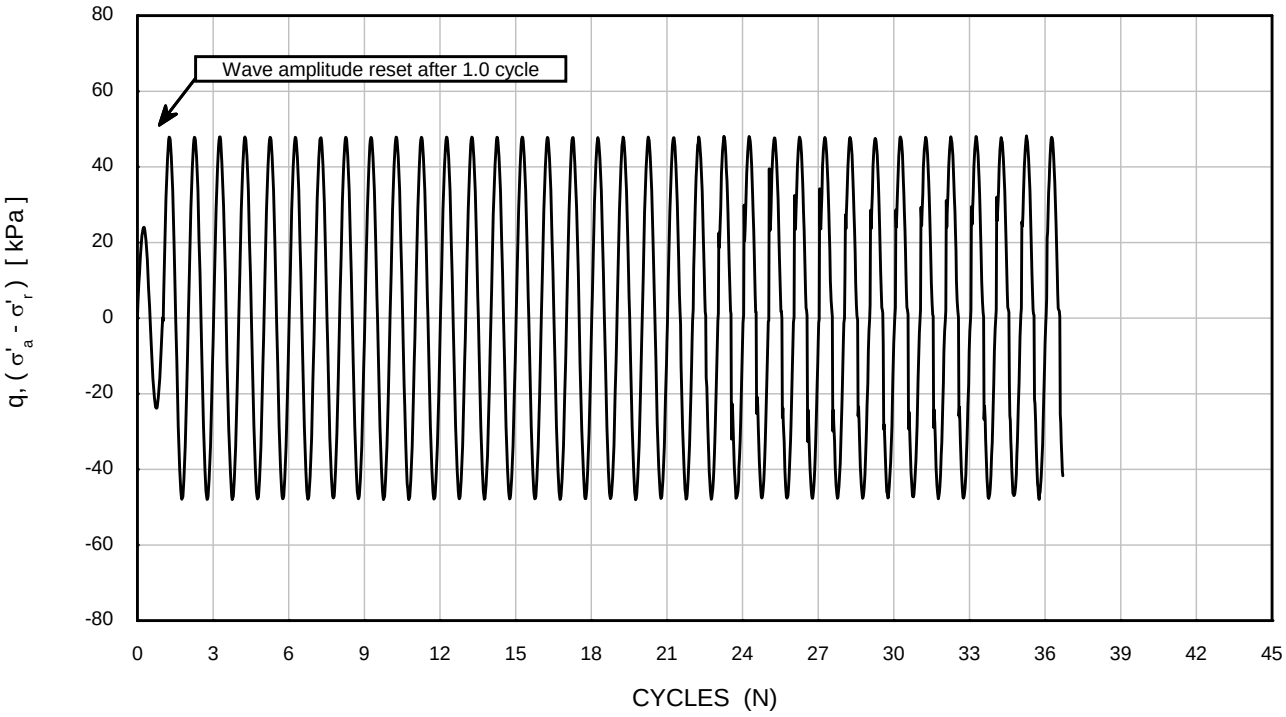


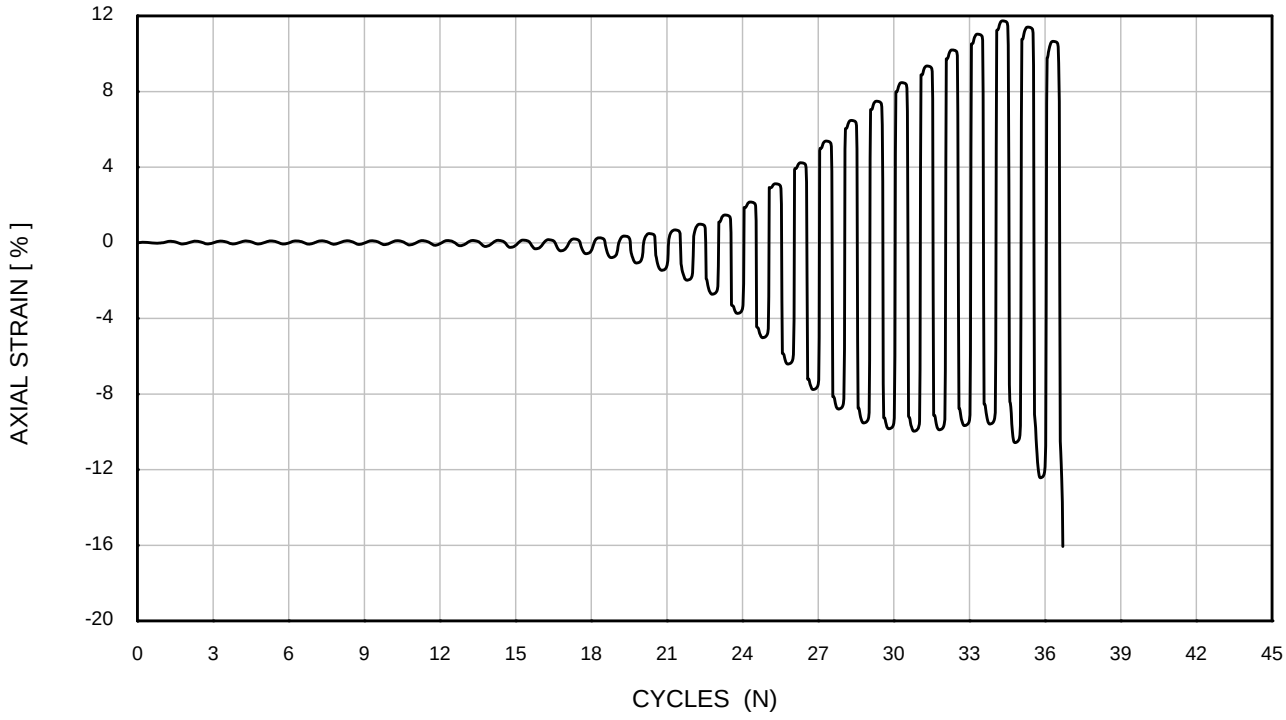


σ'_{rc}	: 80 kPa	Borehole	: Batch
σ'_{ac}	: 80 kPa	Sample	: Eem / Kreftenheye
		Depth [m]	: -
		Test No.	: CTXL5

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

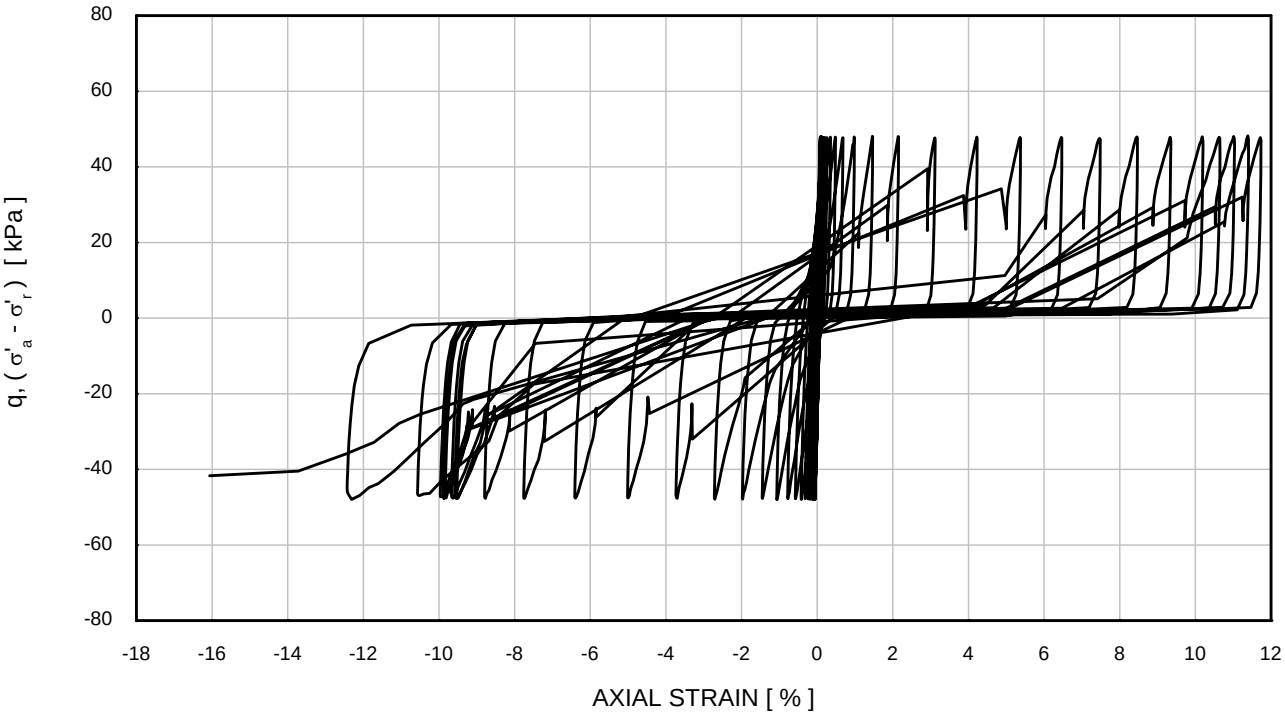


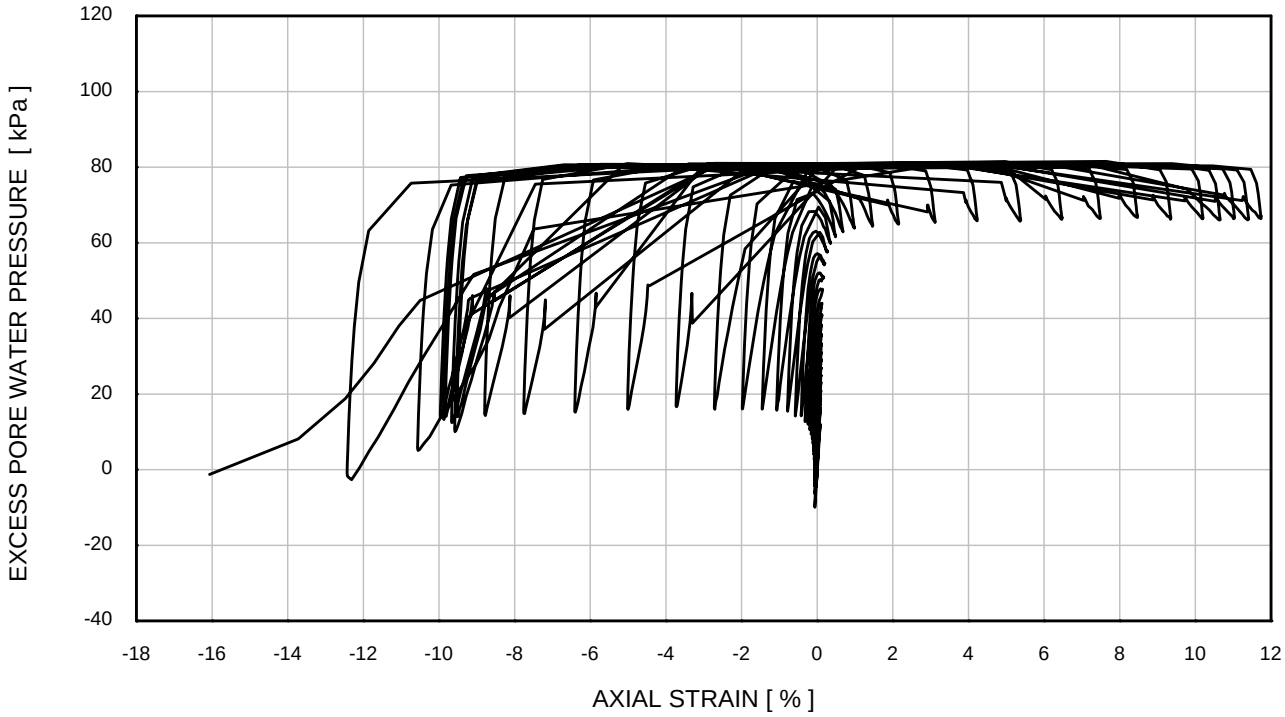


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

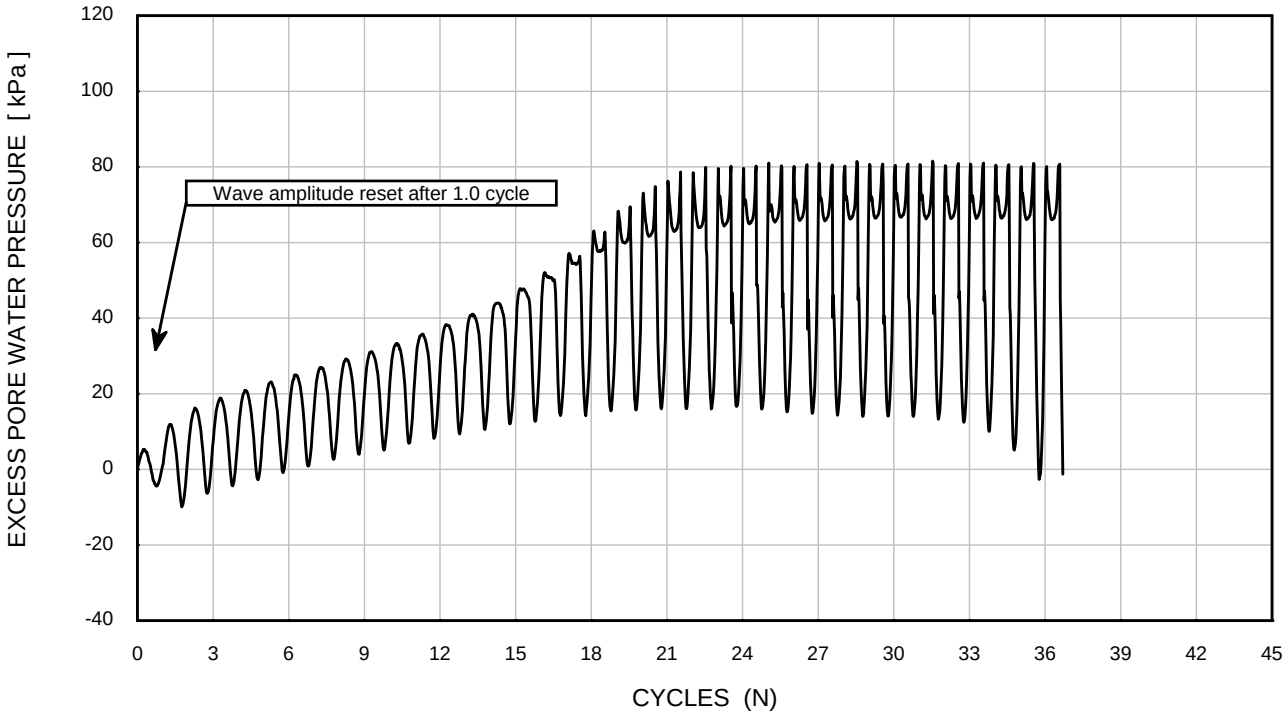


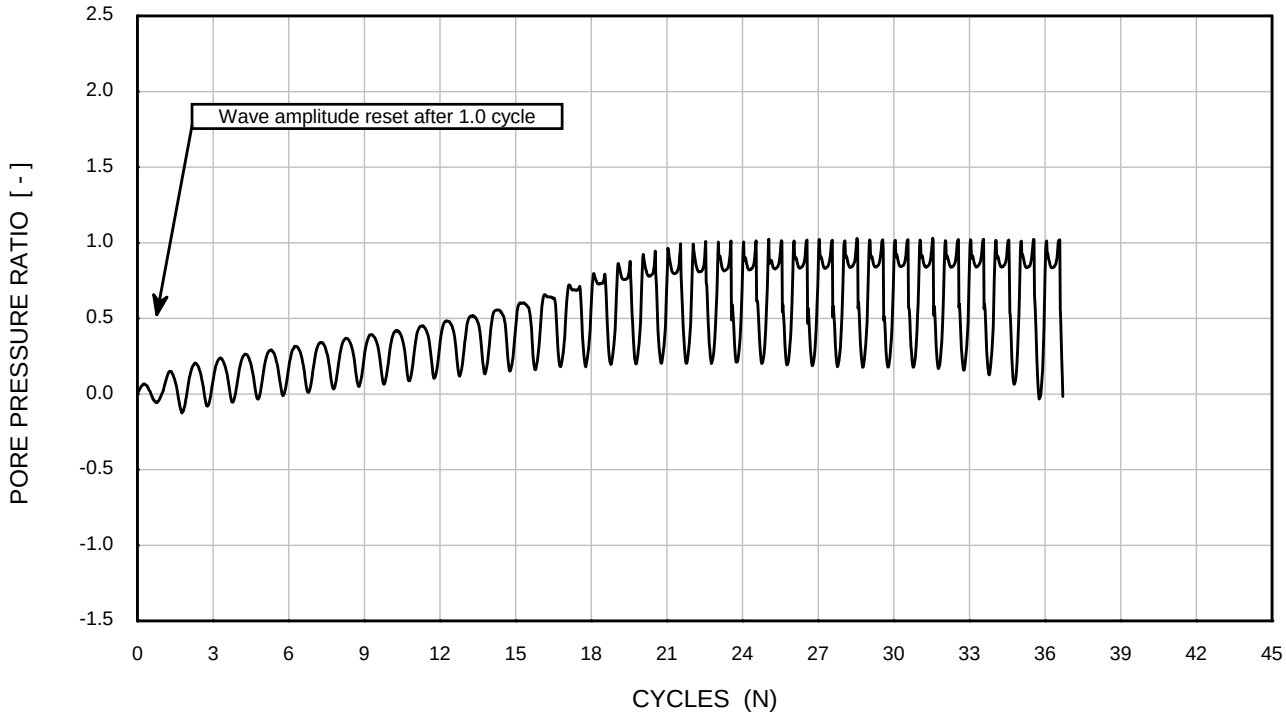


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

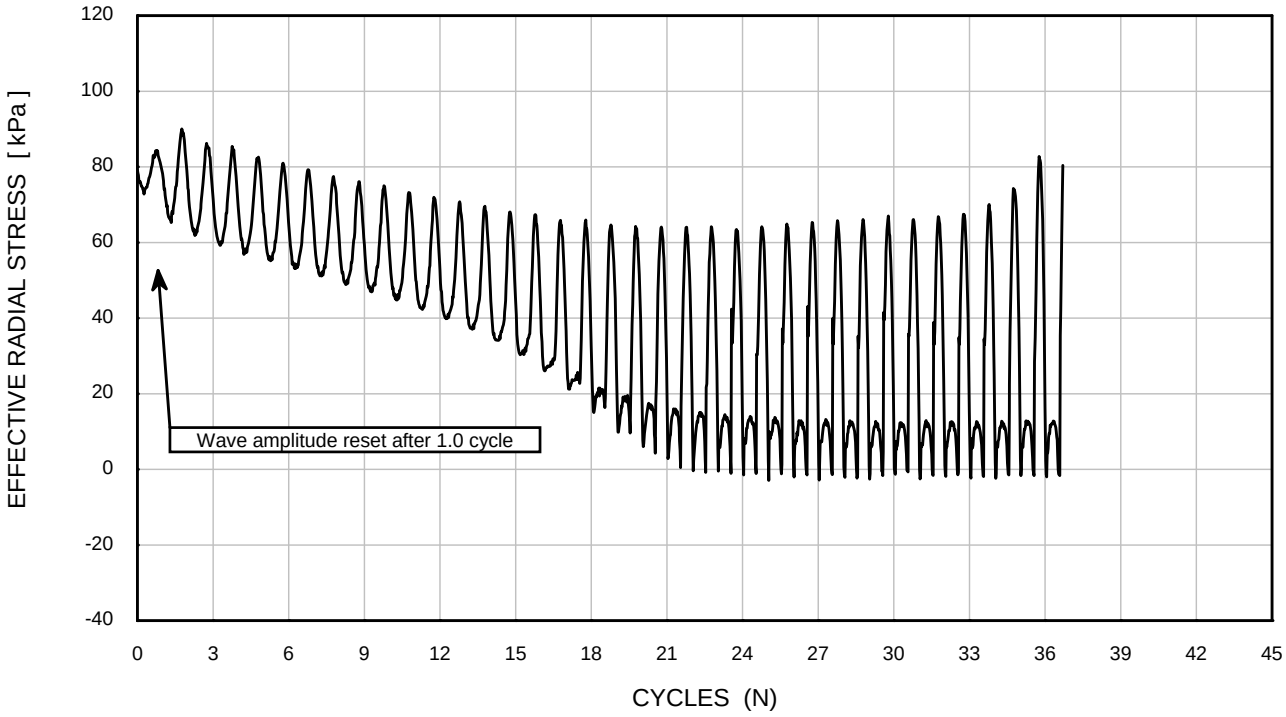


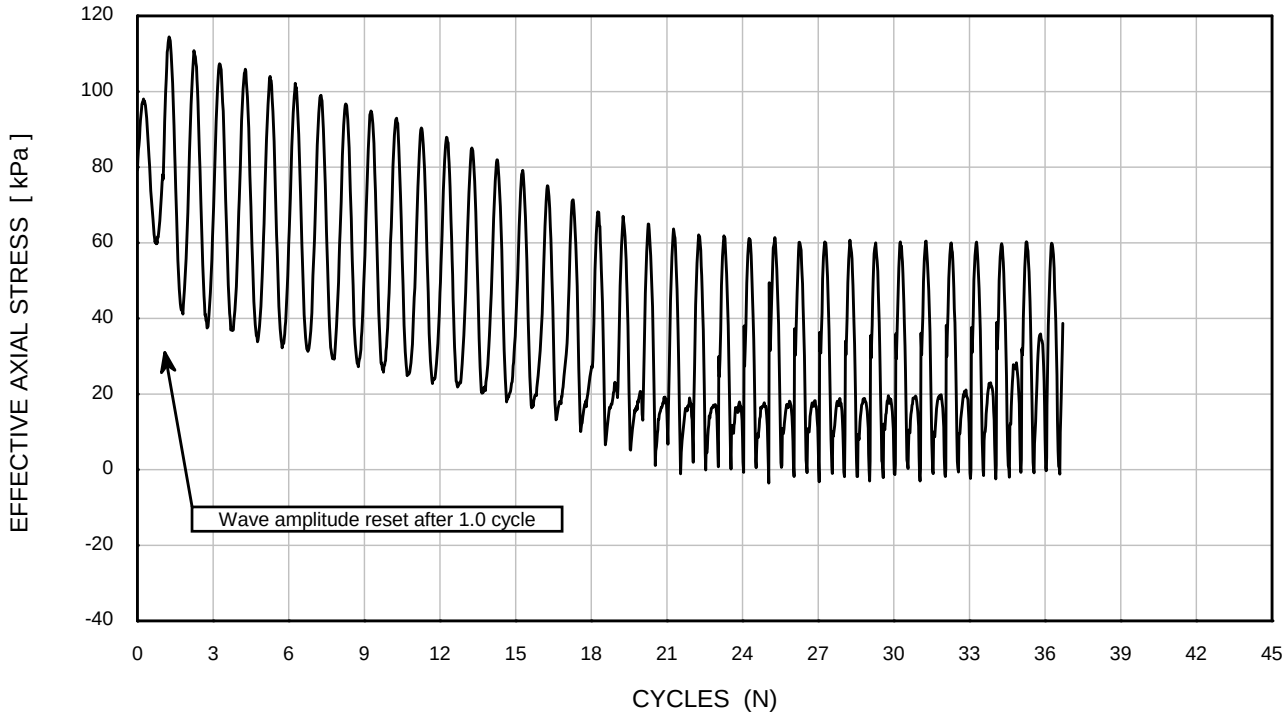


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

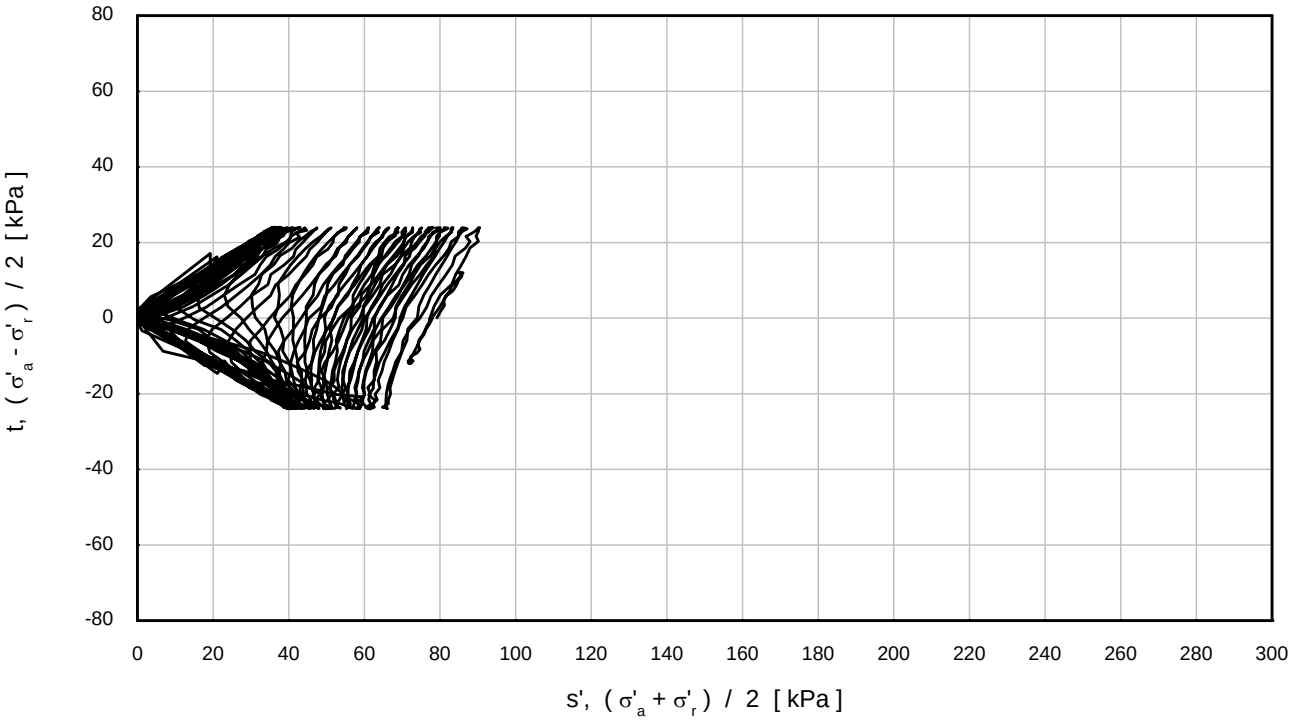


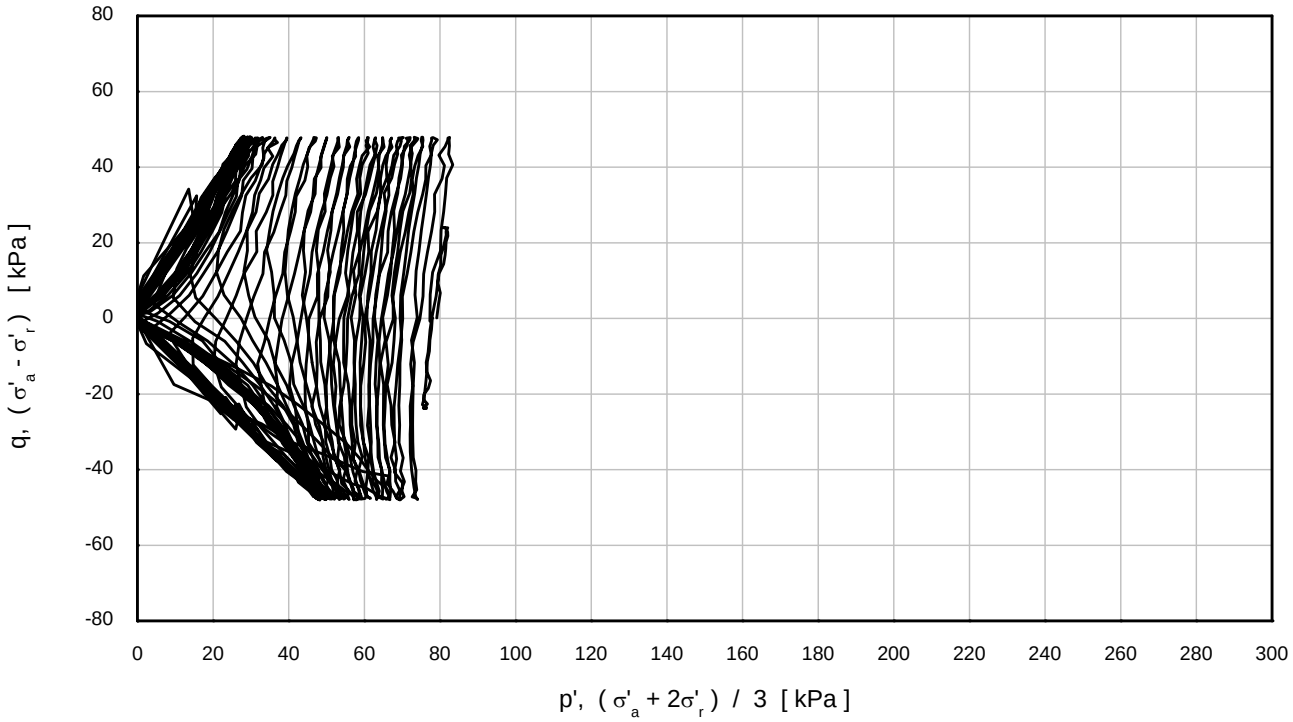


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

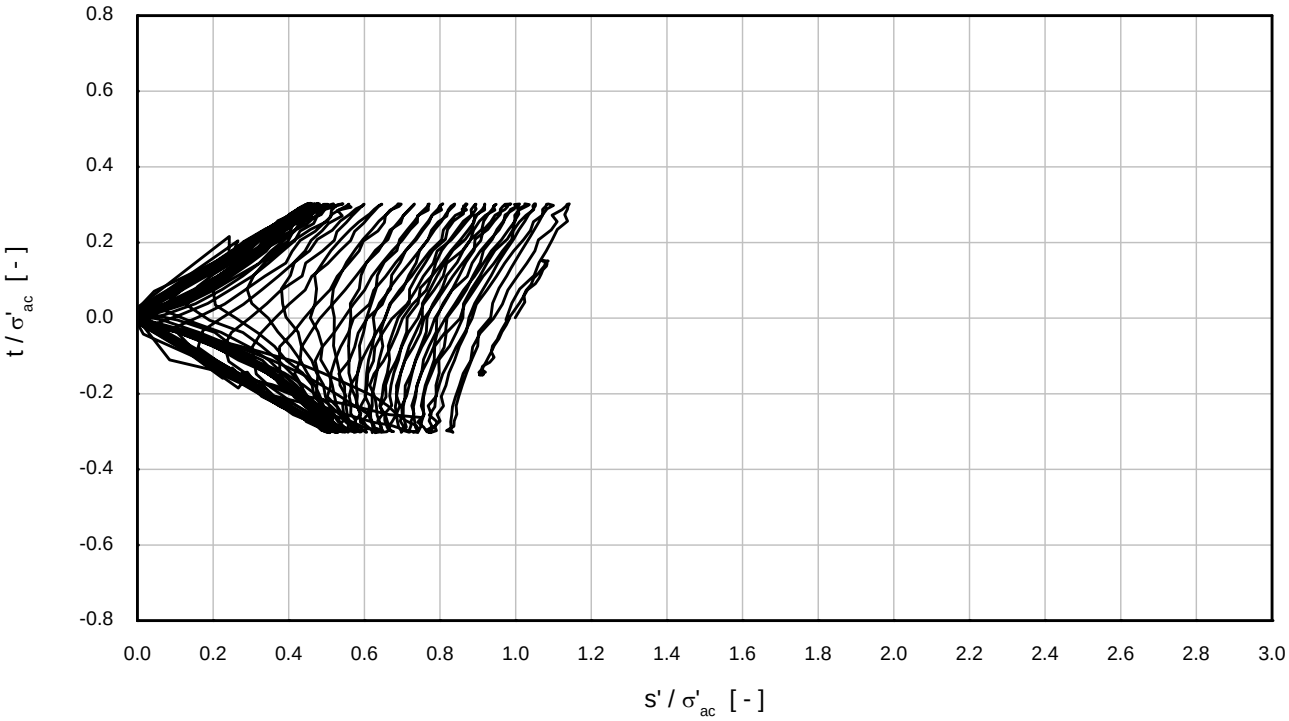


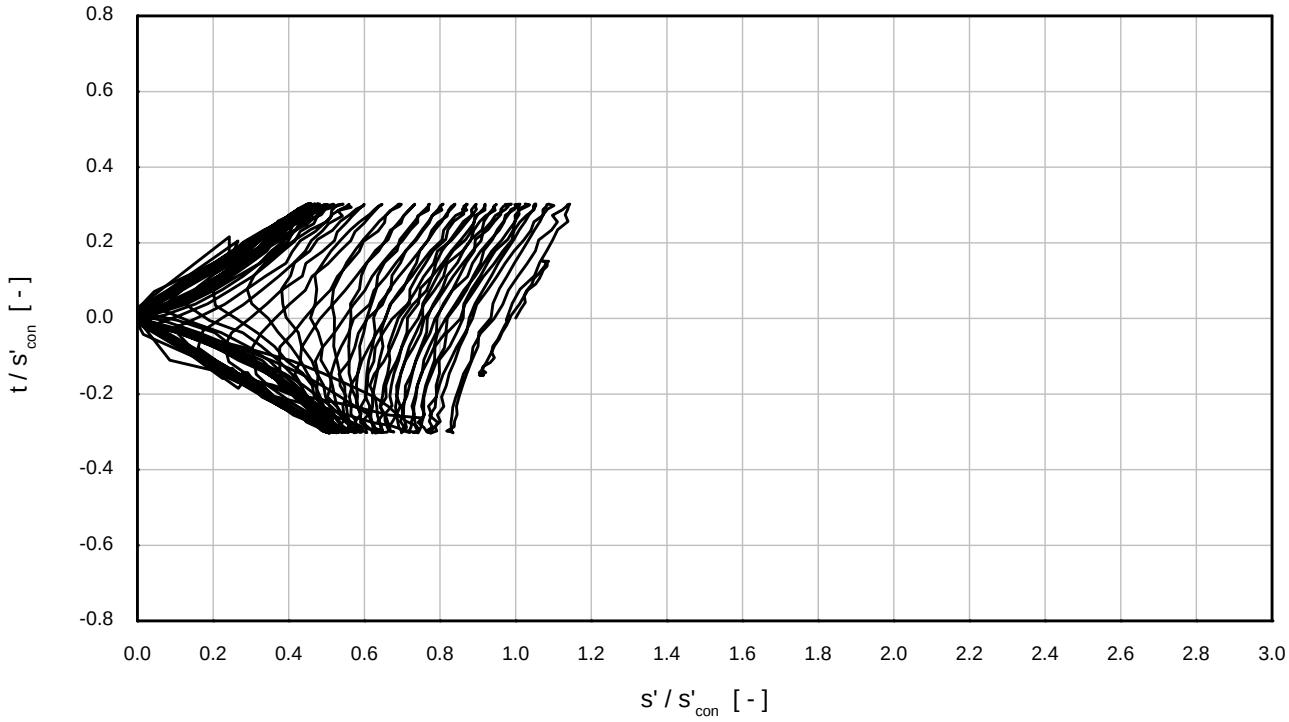


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem / Kreftenheye
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	48 kPa	Test No.	:	CTXL5
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

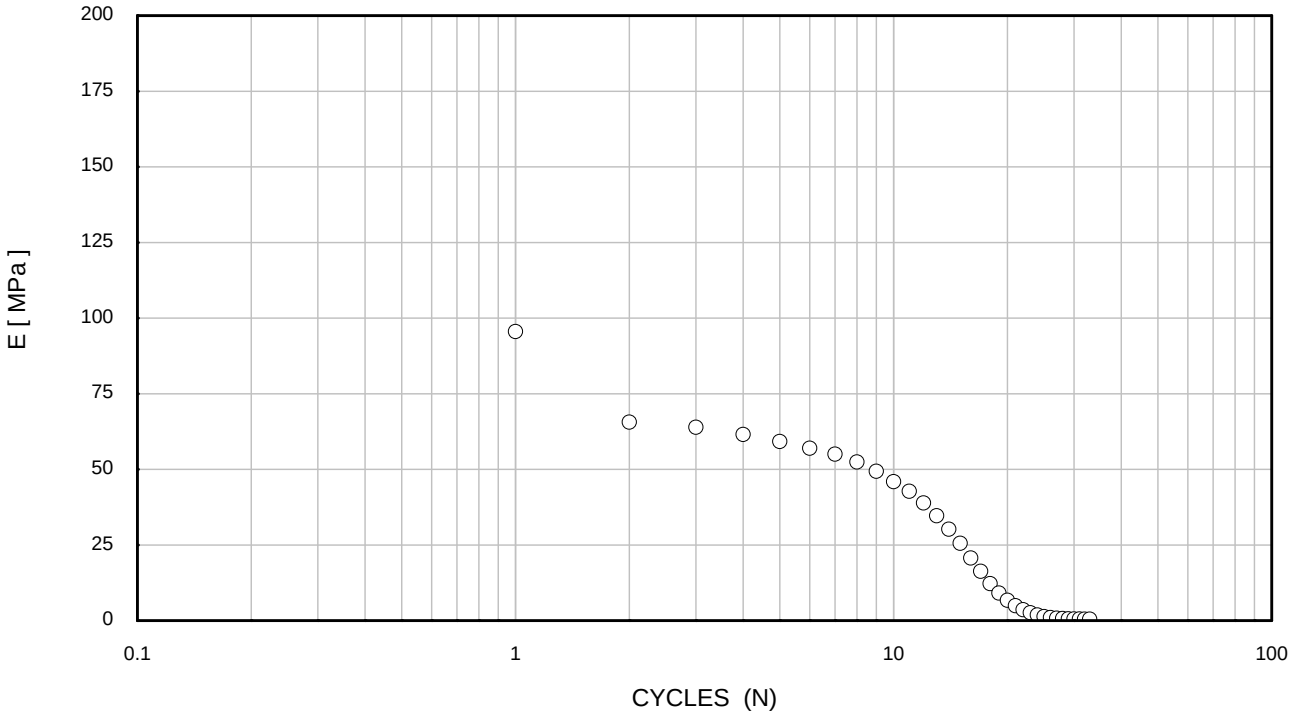


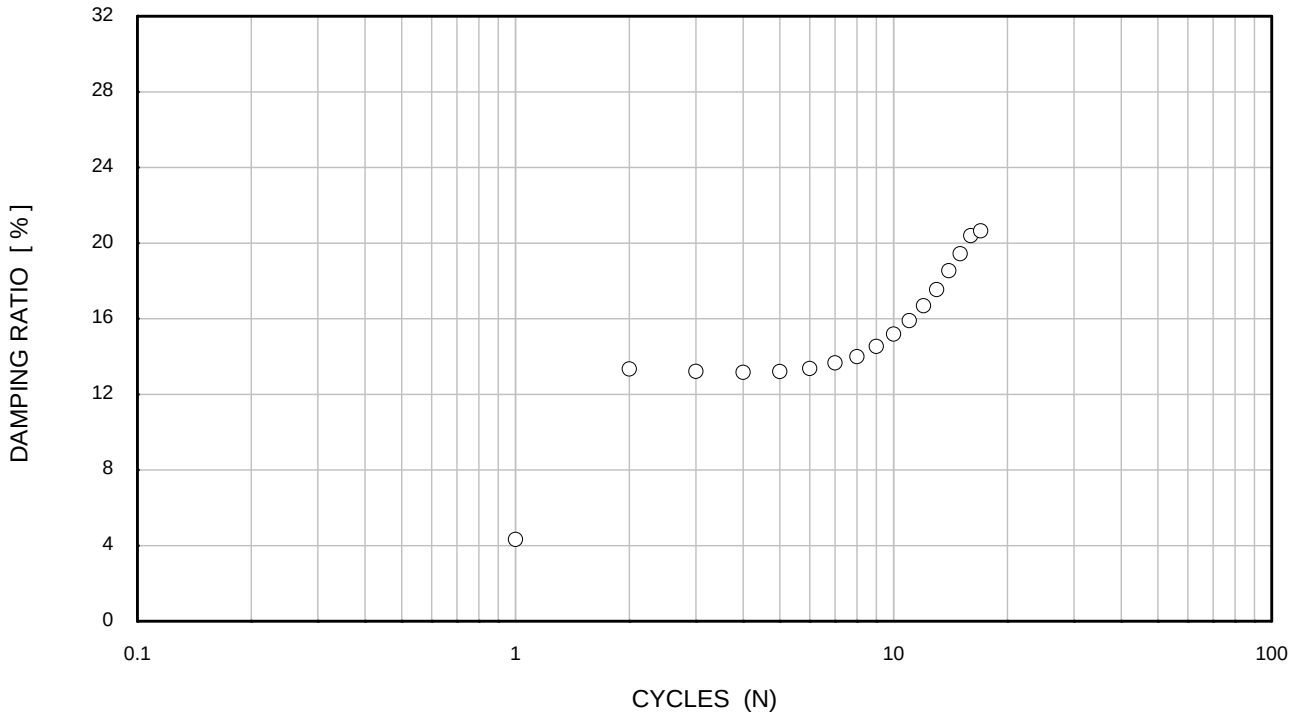


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem / Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	48	kPa	Test No.	: CTXL5
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND

GENERAL	
Date test started	31/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	10.0
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.560
Degree of saturation	[%]	47
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Eem_Krefteneye_CTXL6
Processed by	LJ
Date	13/08/2015
Checked by	PH
Date	15/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL6

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1079
Base PWP	[kPa]	1037
Mid height PWP	[kPa]	-
B value achieved	[-]	0.96

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1080
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.17
External axial strain	[%]	0.04
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.557
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL6

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	80
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	24
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
External ε_{av} at N_f	[%]	0.00
External ε_{cy} at N_f	[%]	0.03
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	17
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.557
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.03	89	-	4.04	-
2	0.00	0.03	93	-	2.52	-
5	0.00	0.03	92	-	2.54	-
10	0.00	0.03	93	-	1.09	-
20	0.00	0.03	92	-	0.80	-
30	0.00	0.03	91	-	0.70	-
40	0.00	0.03	90	-	0.61	-
50	0.00	0.03	90	-	0.61	-
100	0.00	0.03	88	-	0.50	-
500	0.00	0.03	82	-	0.38	-
1000	0.00	0.03	77	-	0.57	-
1500	0.00	0.03	74	-	0.75	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL6

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	63
Initial effective axial pressure	[kPa]	63
Rate of strain	[%/hour]	1.00
At peak deviator stress		
Corrected deviator stress	[kPa]	1652
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	19.15
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-680
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	741
Effective axial pressure	[kPa]	2394
Principal effective stress ratio	[-]	3.23
ε_{50}	[%]	3.48
Secant modulus (E_{50}) at ε_{50}	[kPa]	23748
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	321
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	1.36
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-50
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	111
Effective axial pressure	[kPa]	432
Principal effective stress ratio	[-]	3.89
At 10% axial strain		
Corrected deviator stress	[kPa]	1501
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-568
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	629
Effective axial pressure	[kPa]	2130
Principal effective stress ratio	[-]	3.39

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL6

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

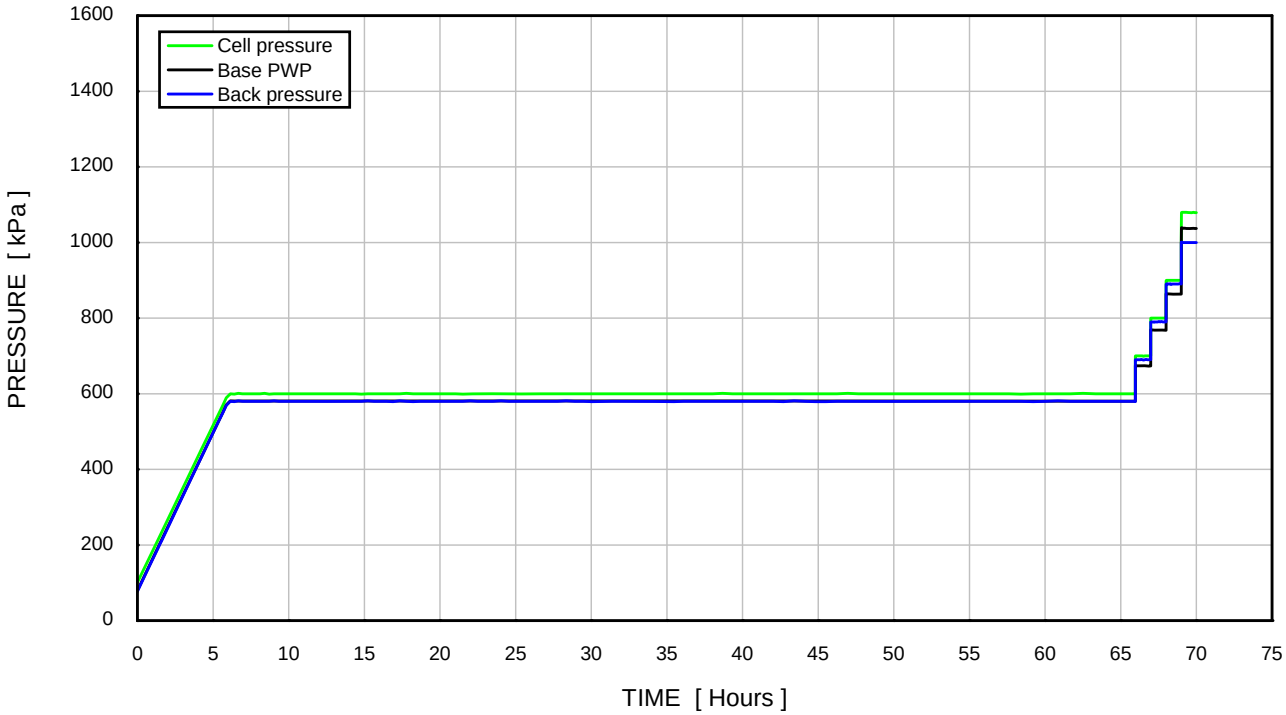
SPECIMEN PHOTOGRAPHS

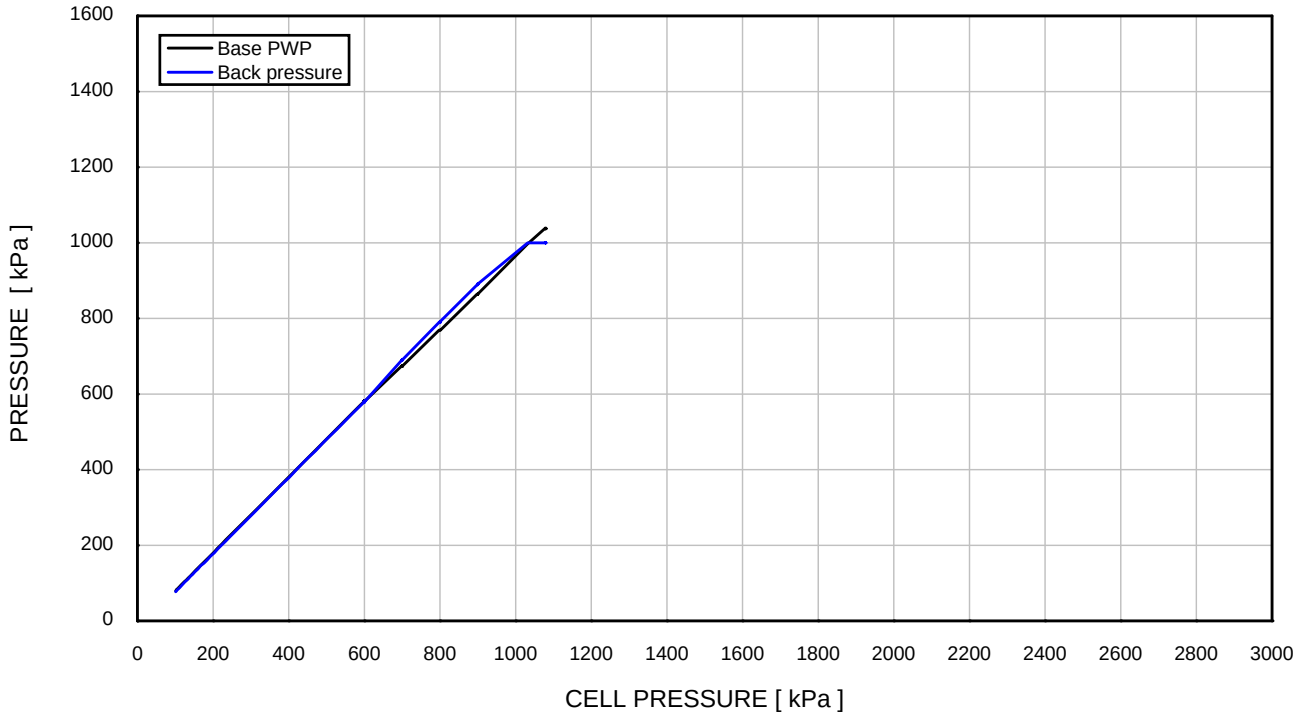
FINAL CONDITIONS		
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL6

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

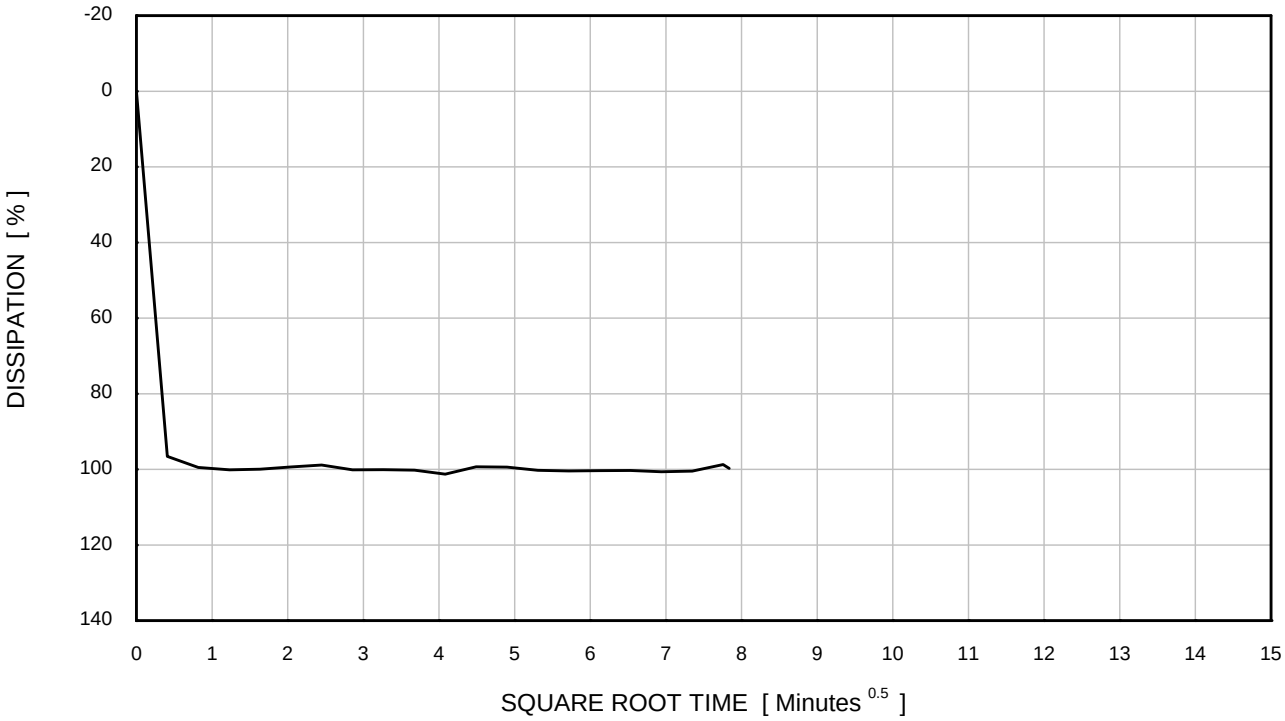


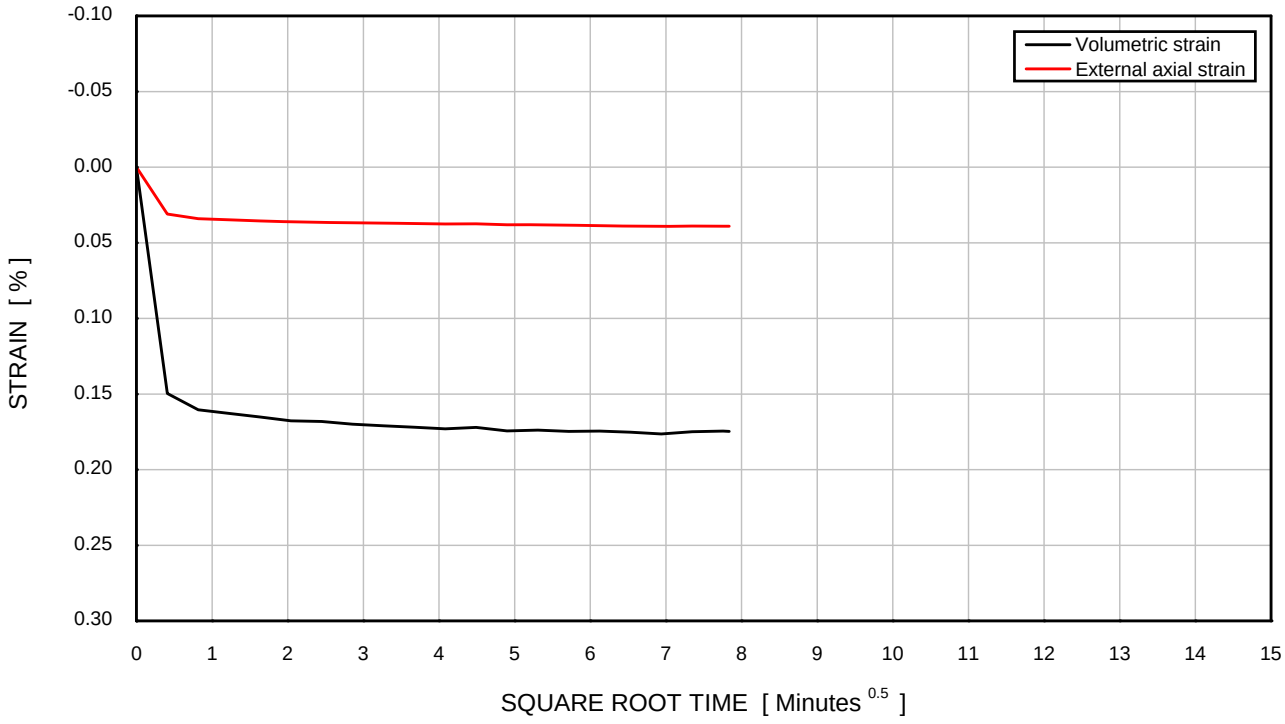


B value	:	0.96			
Initial σ'_r	:	22	kPa	Borehole	: Batch
Initial σ'_a	:	22	kPa	Sample	: Eem/Kreftenheye
Final σ'_r	:	42	kPa	Depth [m]	: -
Final σ'_a	:	42	kPa	Test No.	: CTXL6

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

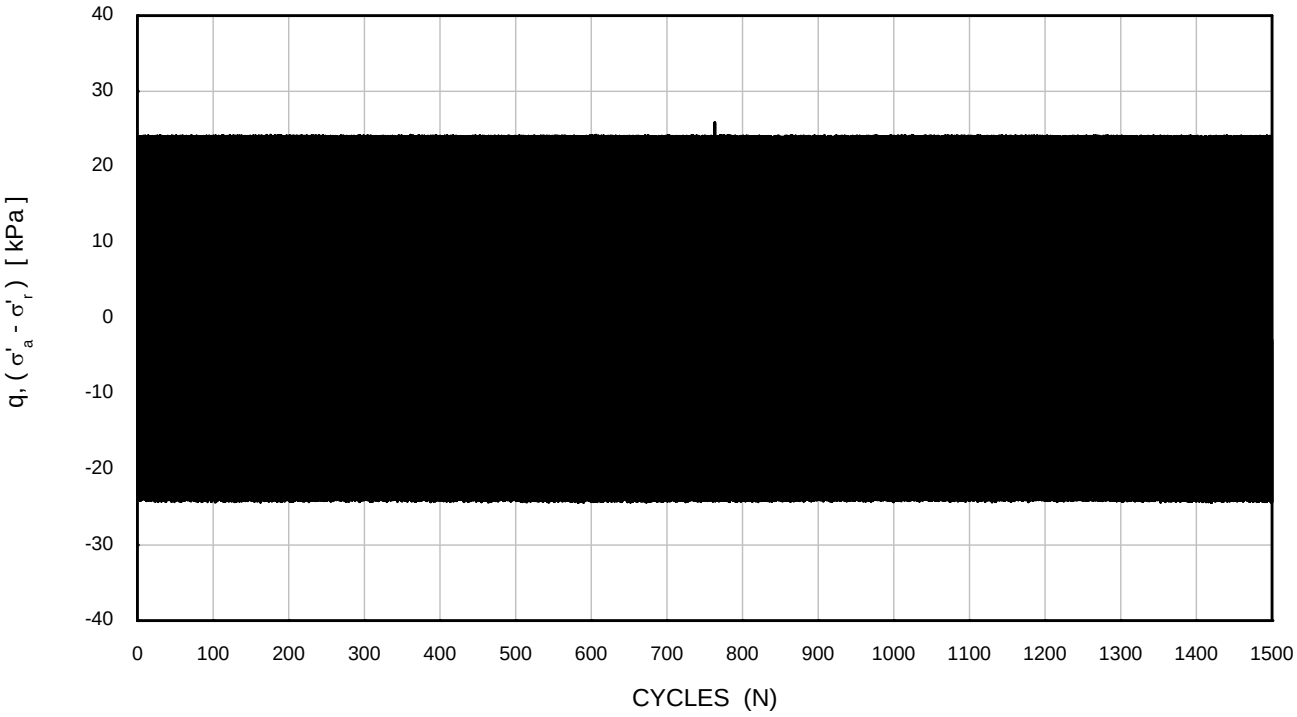


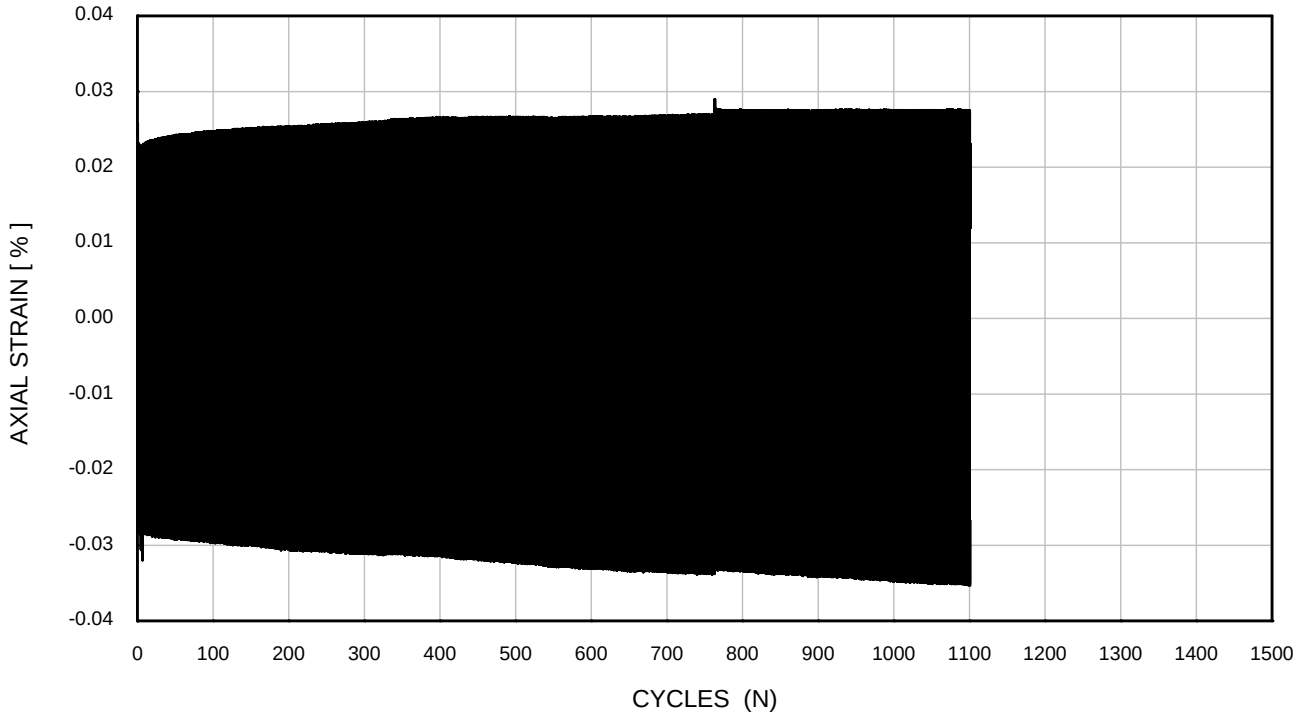


σ'_{rc}	: 80 kPa	Borehole	: Batch
σ'_{ac}	: 80 kPa	Sample	: Eem/Kreftenheye
		Depth [m]	: -
		Test No.	: CTXL6

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

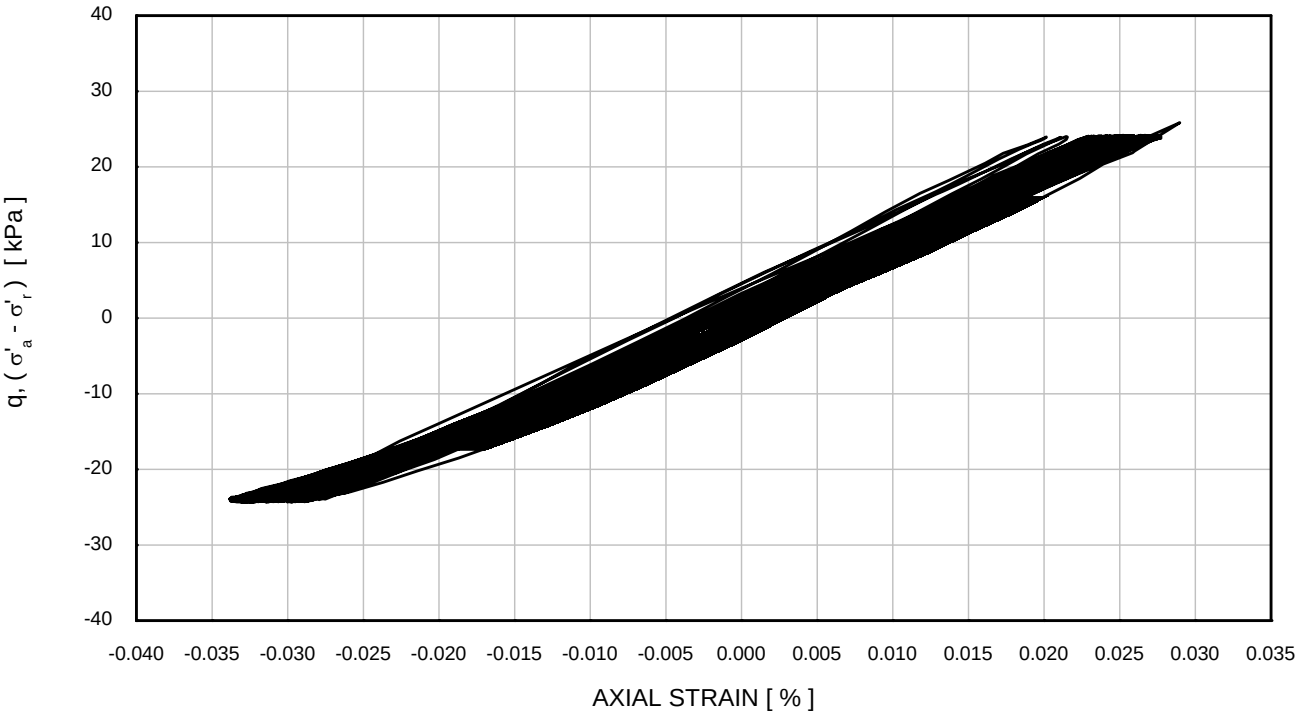


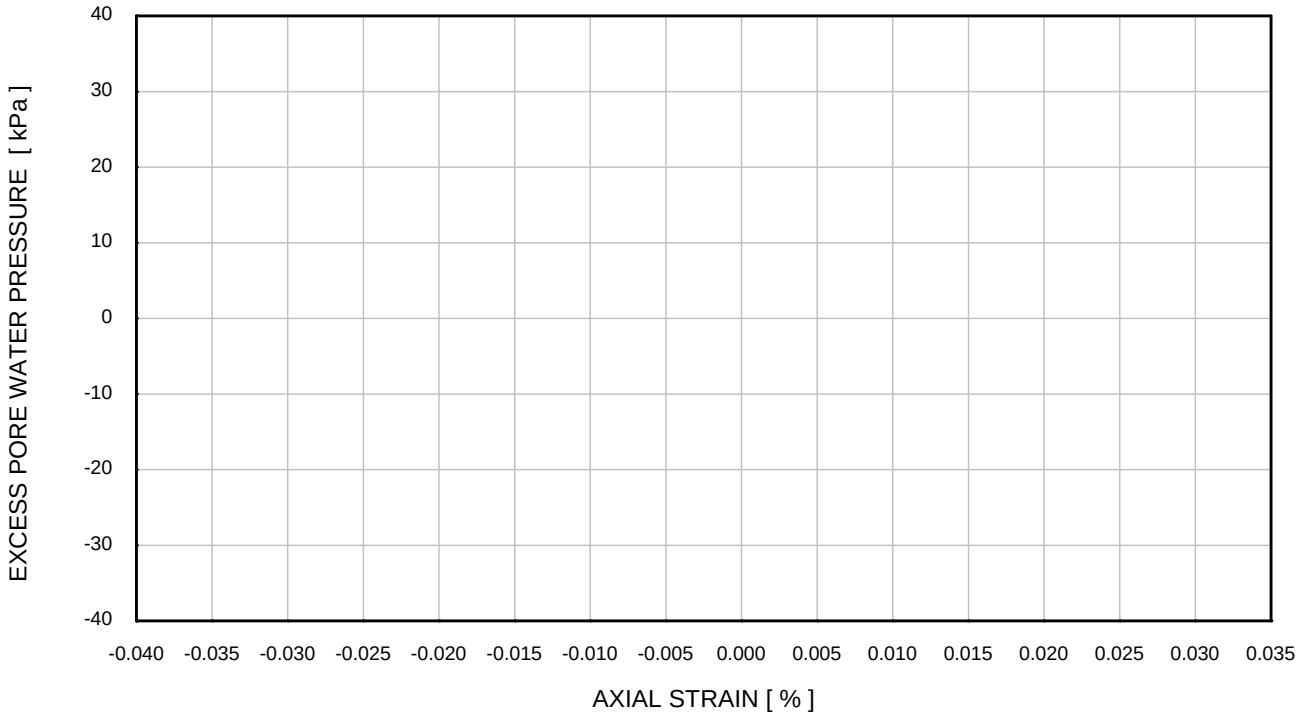


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	24	kPa	Test No.	: CTXL6
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

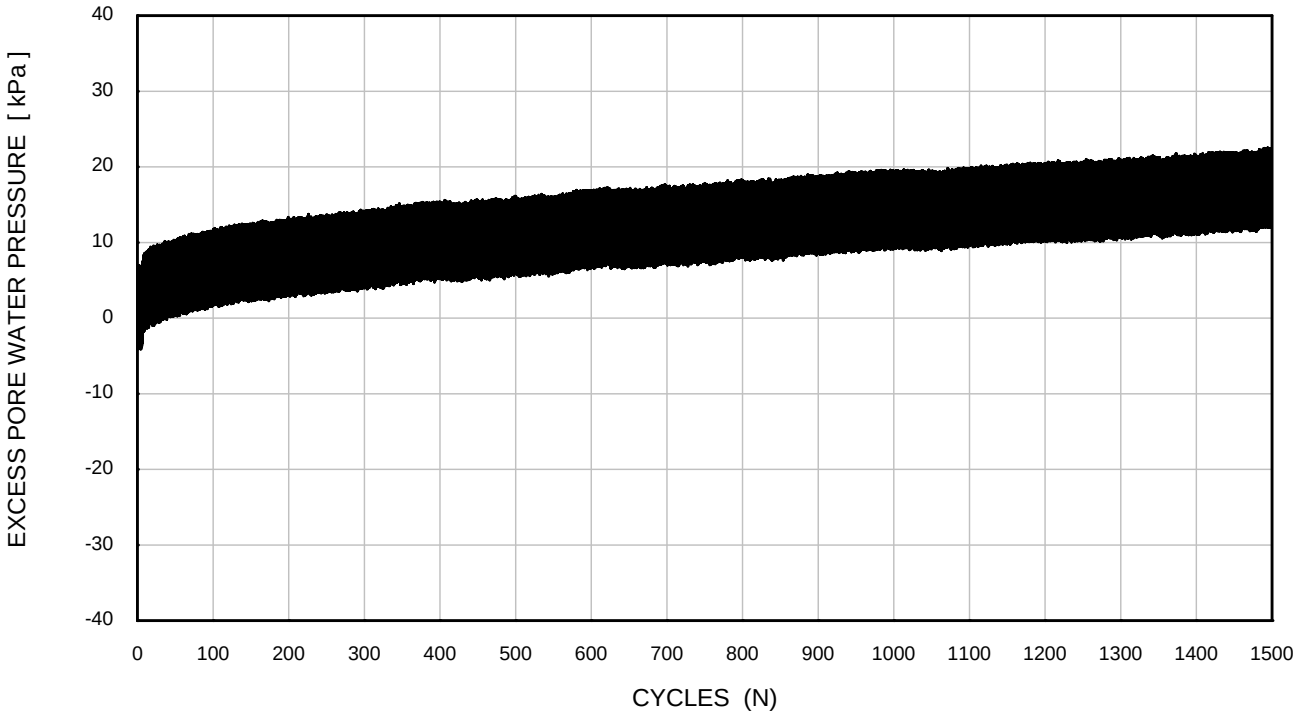


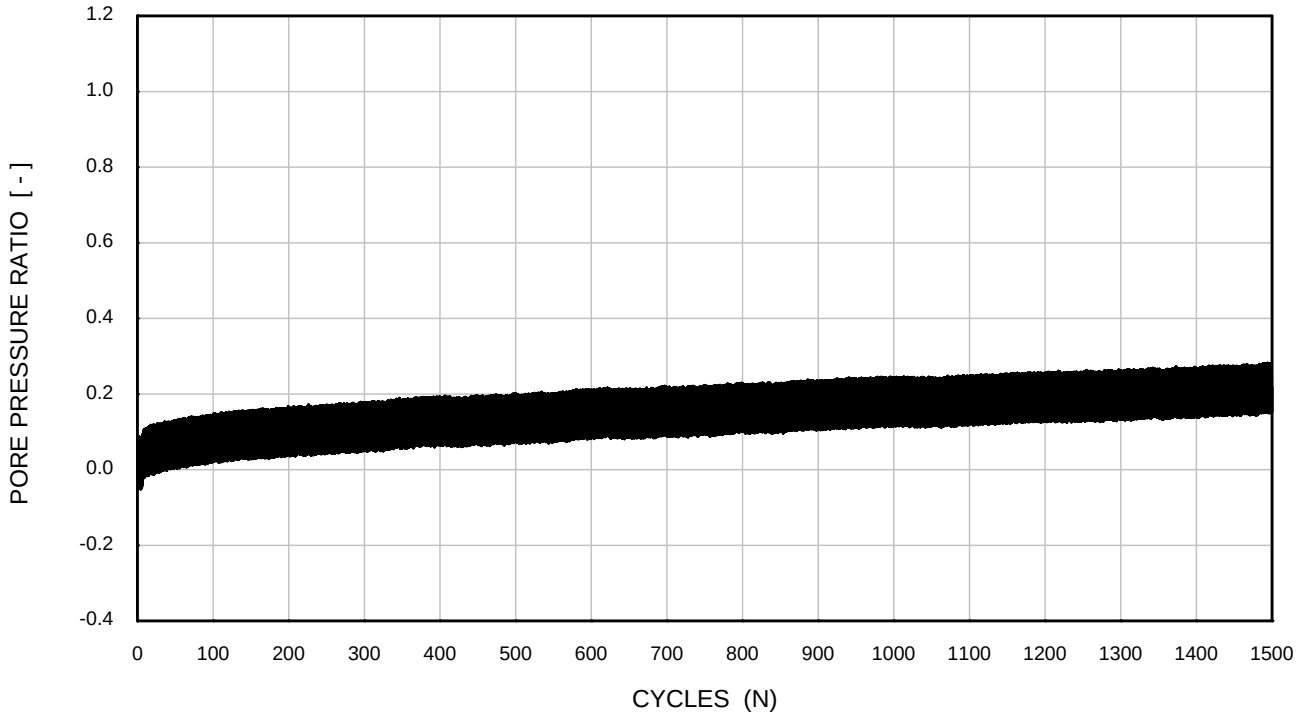


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem/Kreftenheye
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	24 kPa	Test No.	:	CTXL6
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

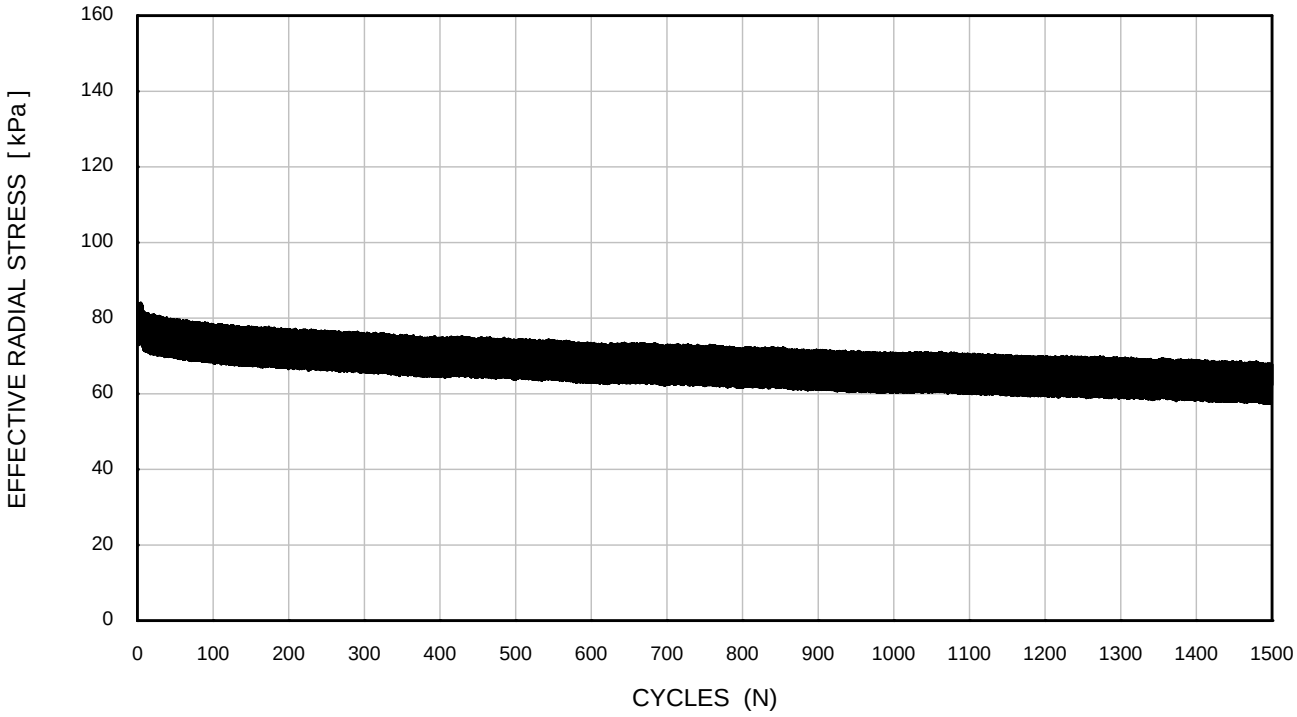


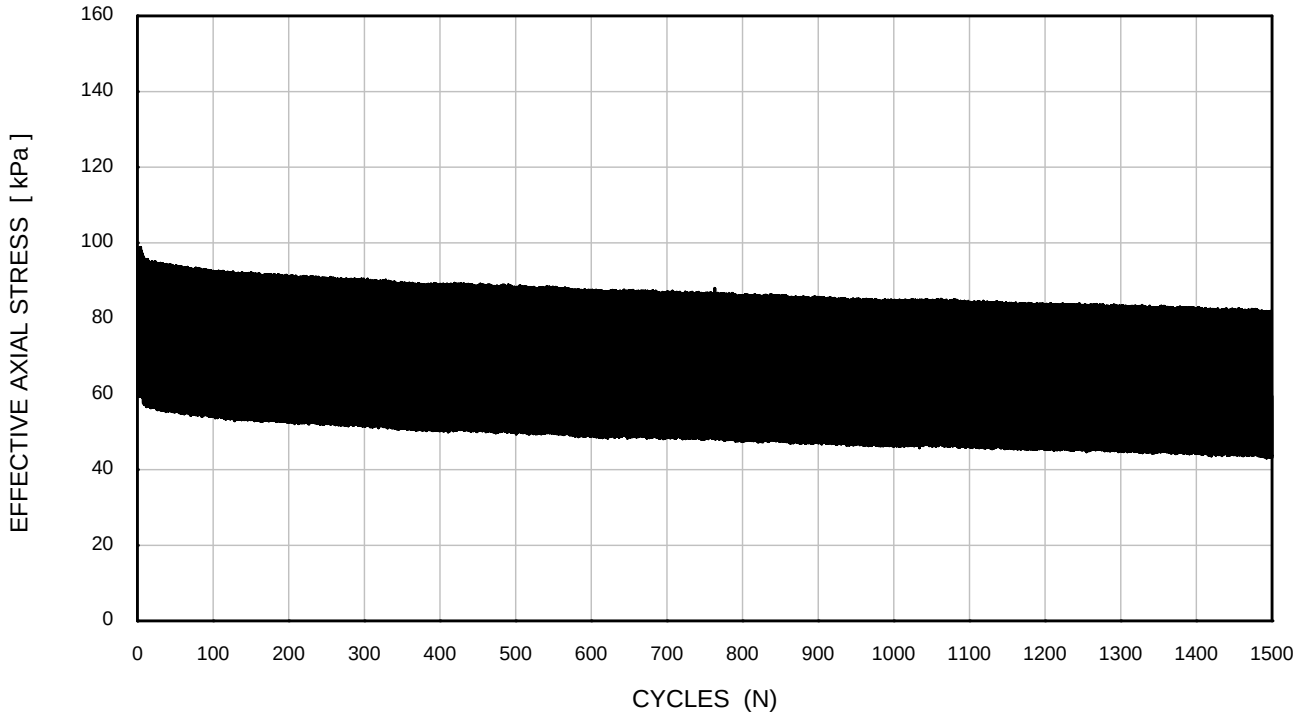


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	24	kPa	Test No.	: CTXL6
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

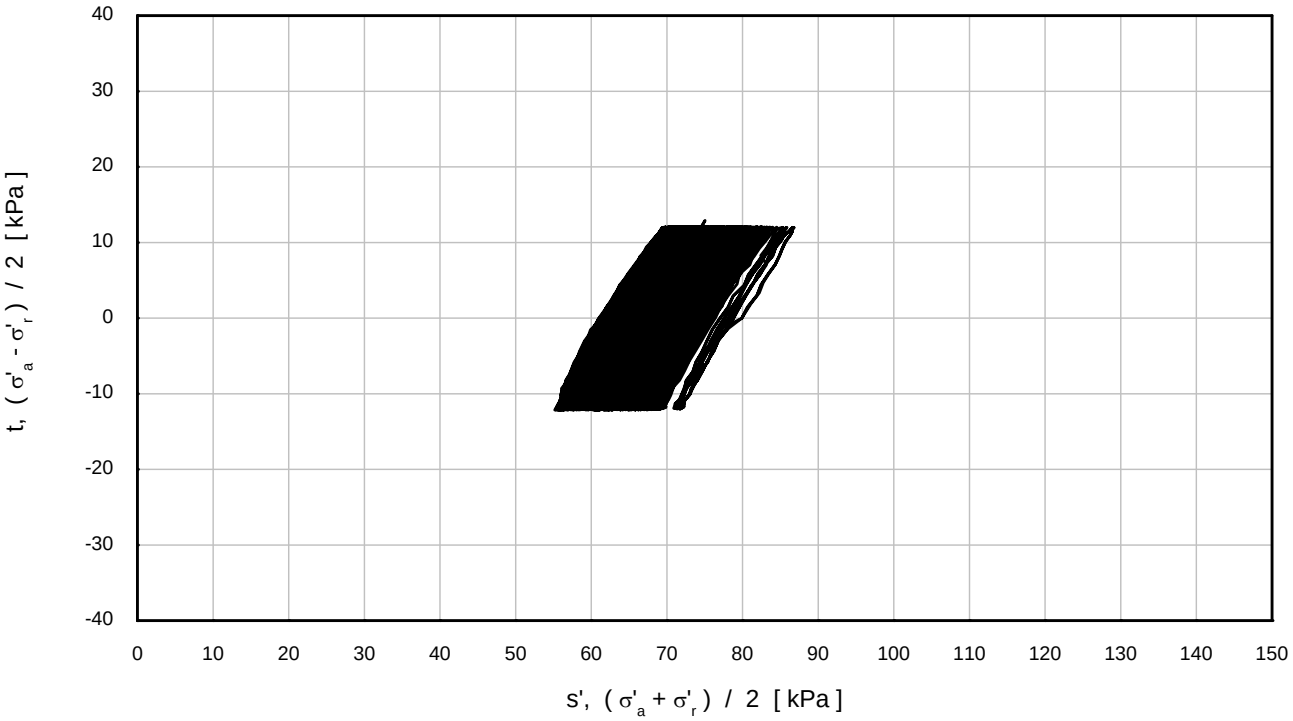


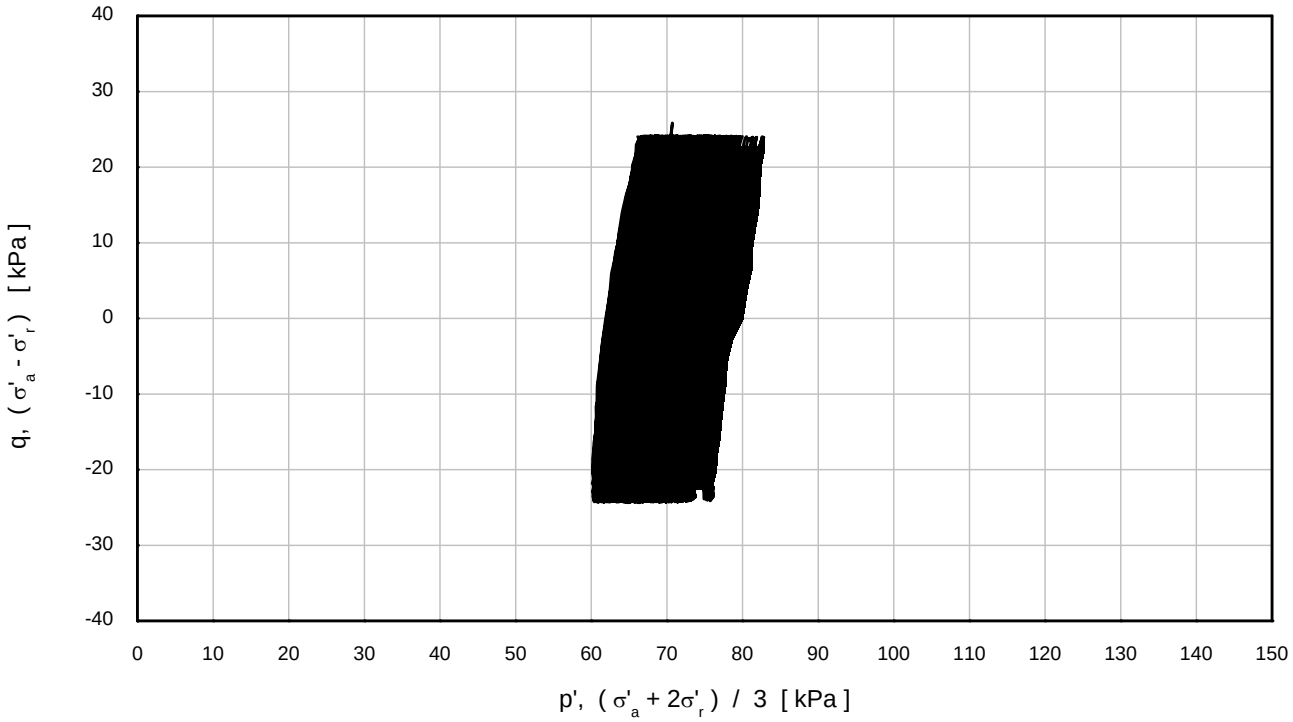


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem/Kreftenheye
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	24 kPa	Test No.	:	CTXL6
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

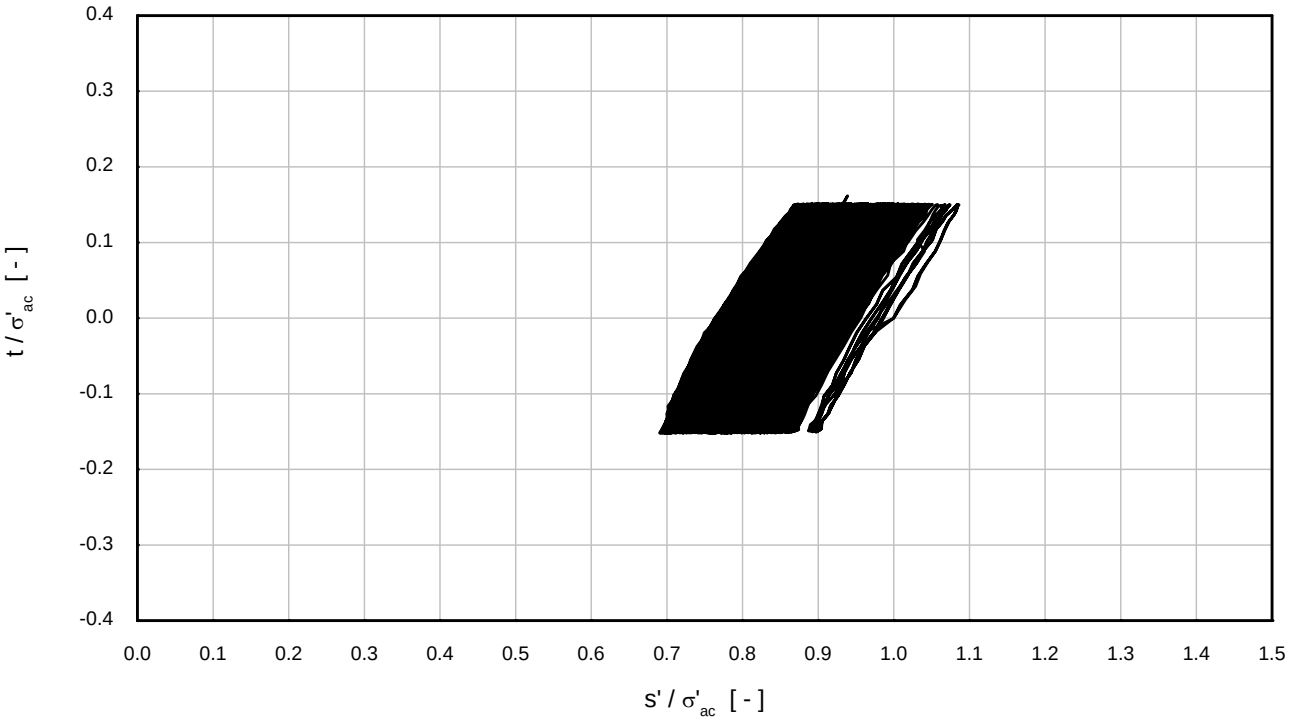


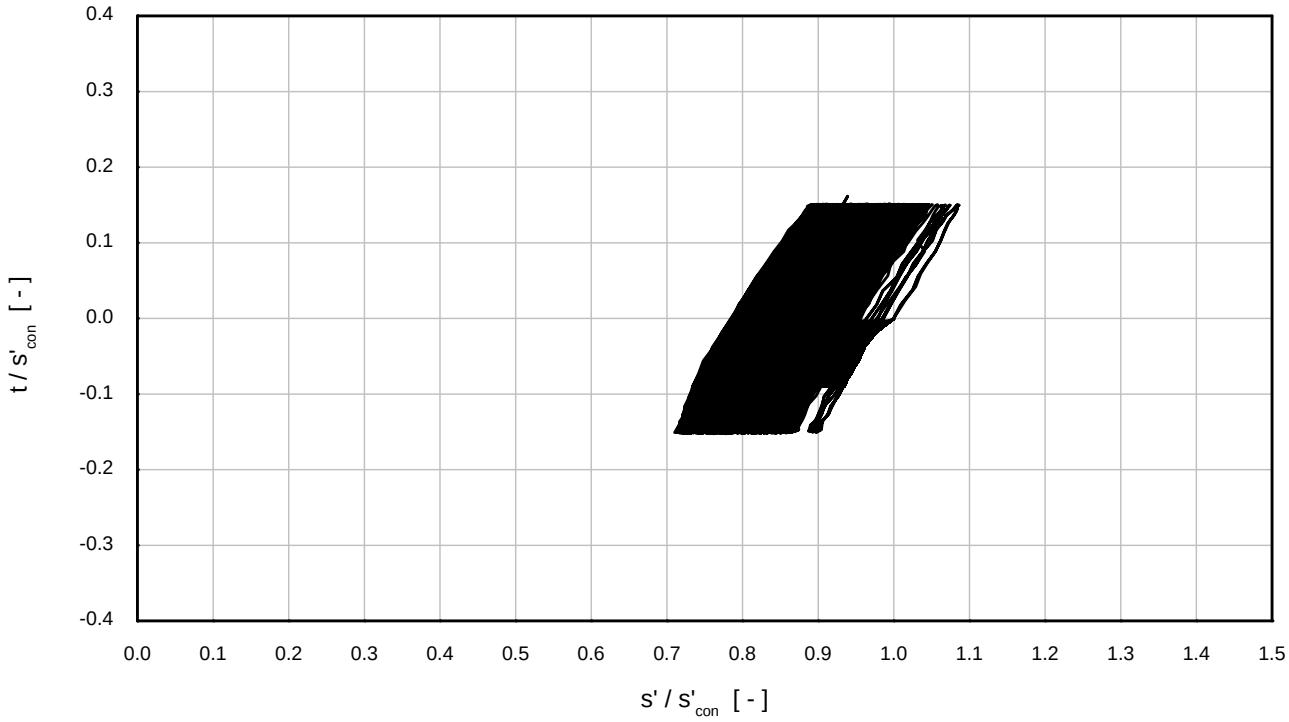


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem/Kreftenheye
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	24 kPa	Test No.	:	CTXL6
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

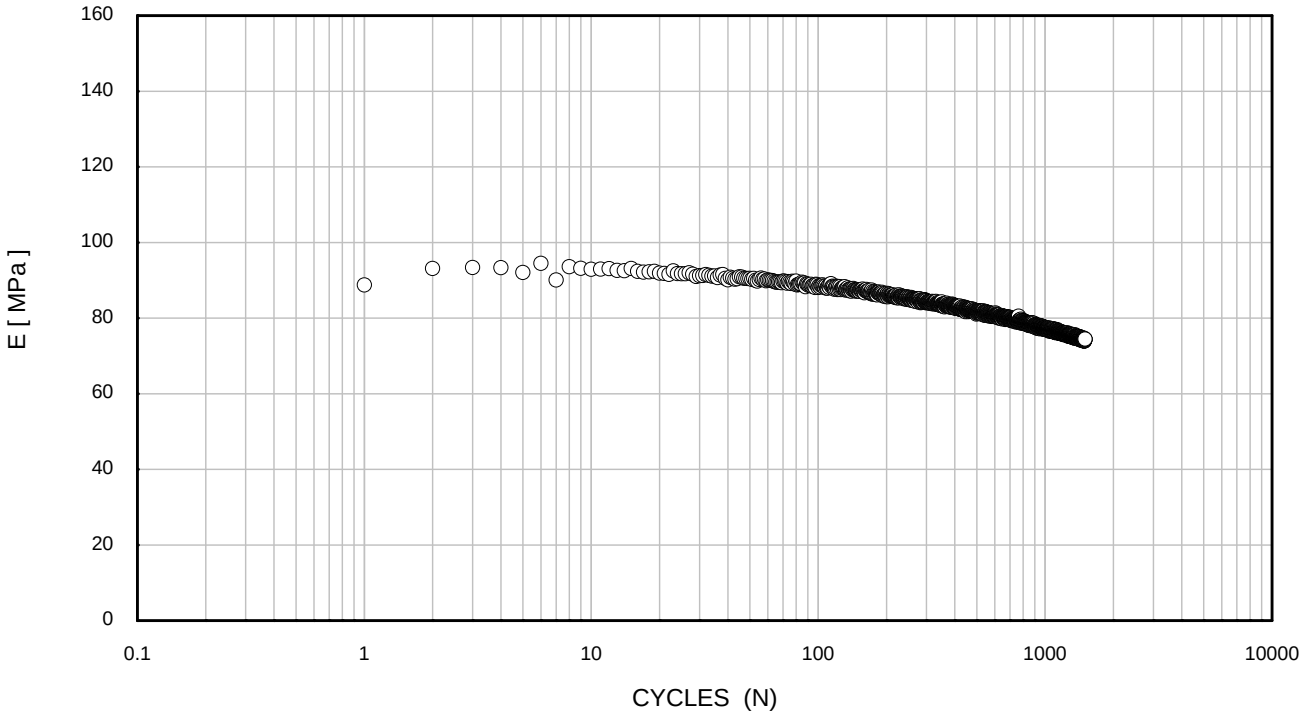


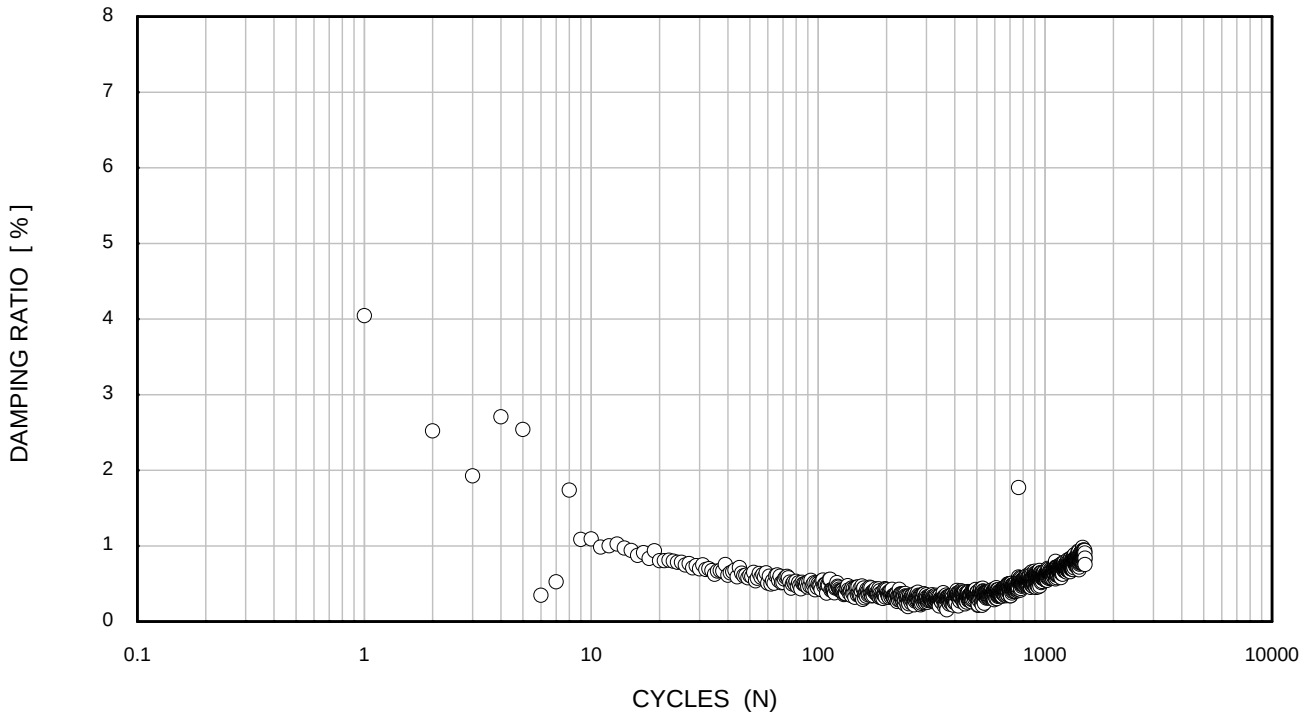


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	24	kPa	Test No.	: CTXL6
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

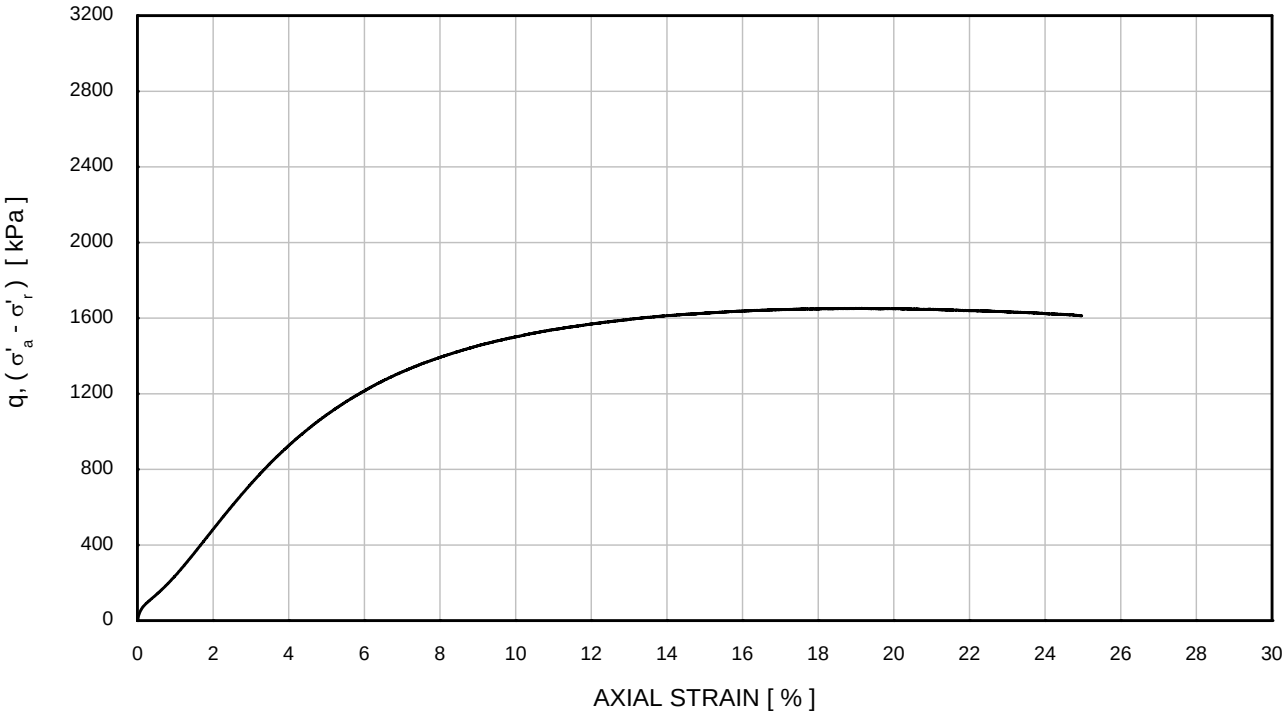


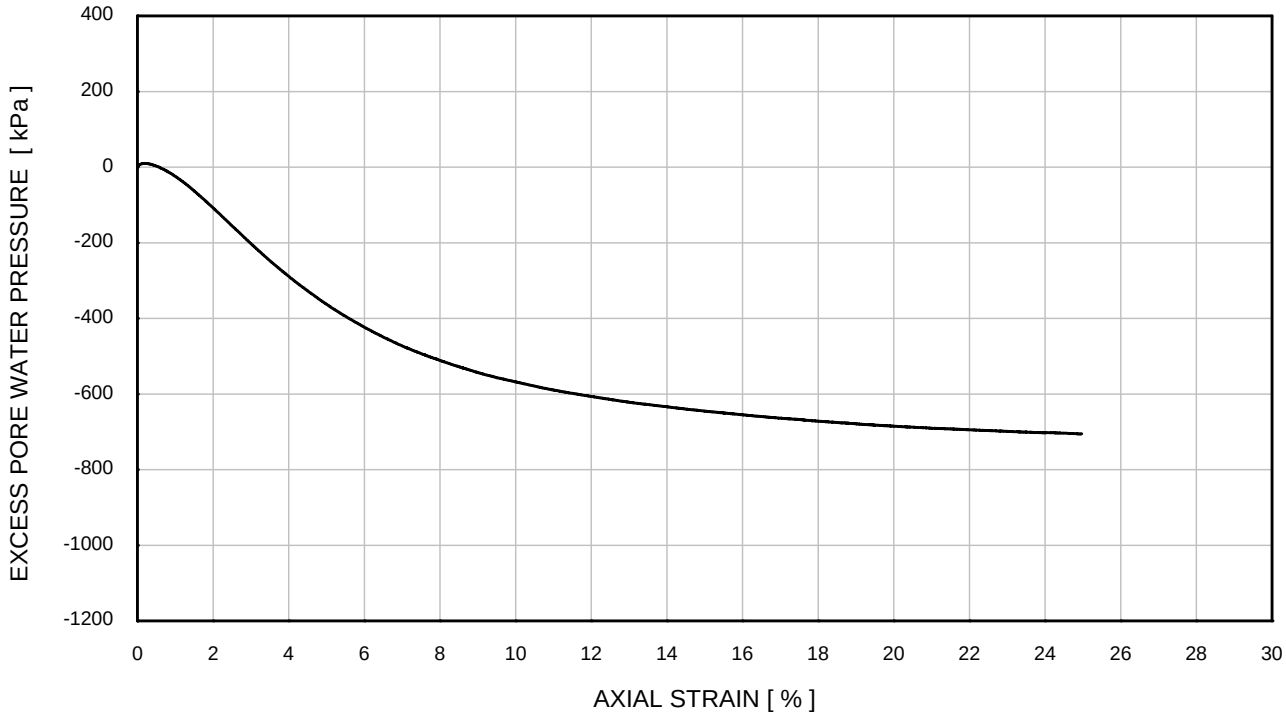


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	24	kPa	Test No.	: CTXL6
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

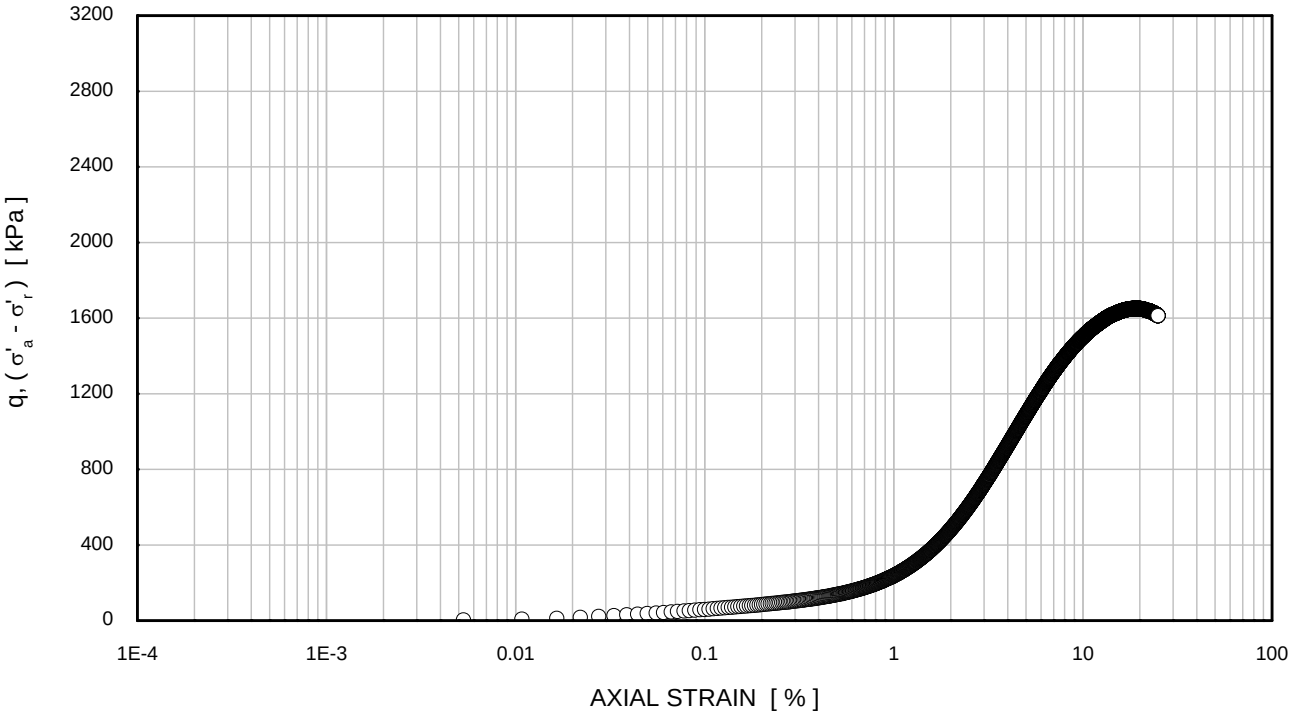


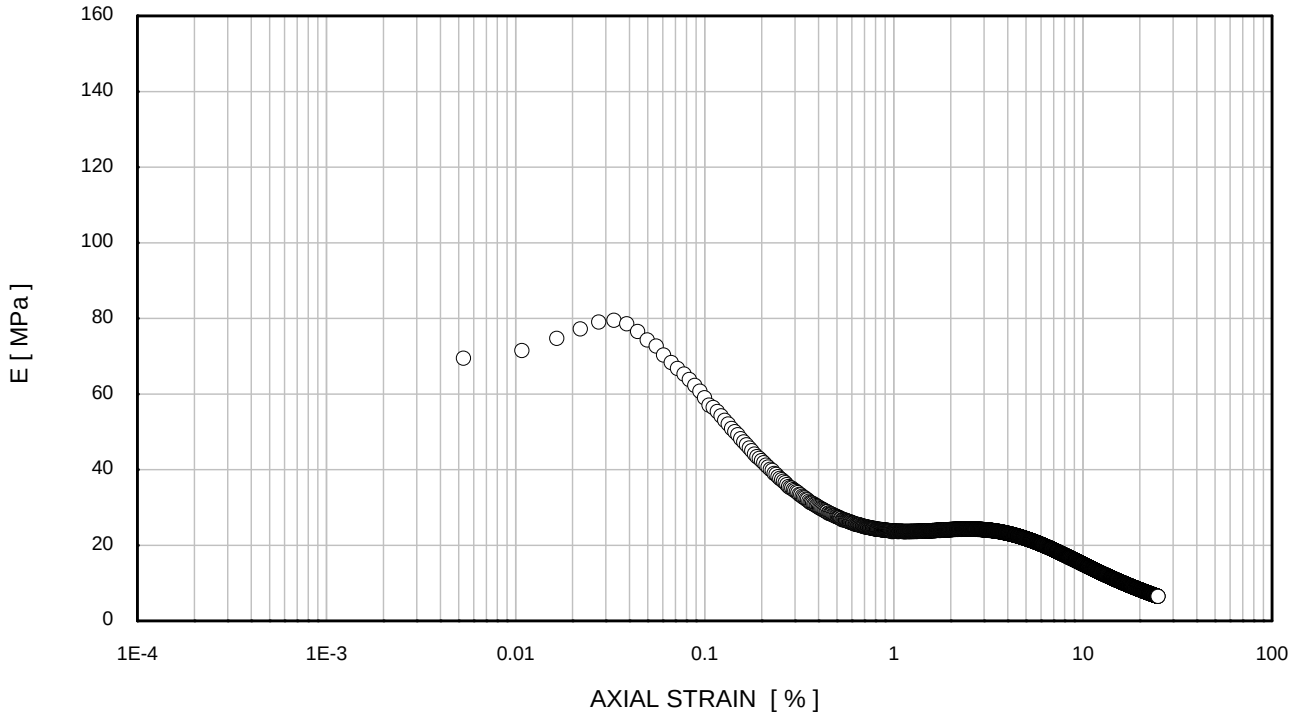


Initial σ'_r	:	63	kPa	Borehole	: Batch
Initial σ'_a	:	63	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1652	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	19.2	%	Test No.	: CTXL2
Rate of strain	:	1.00	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

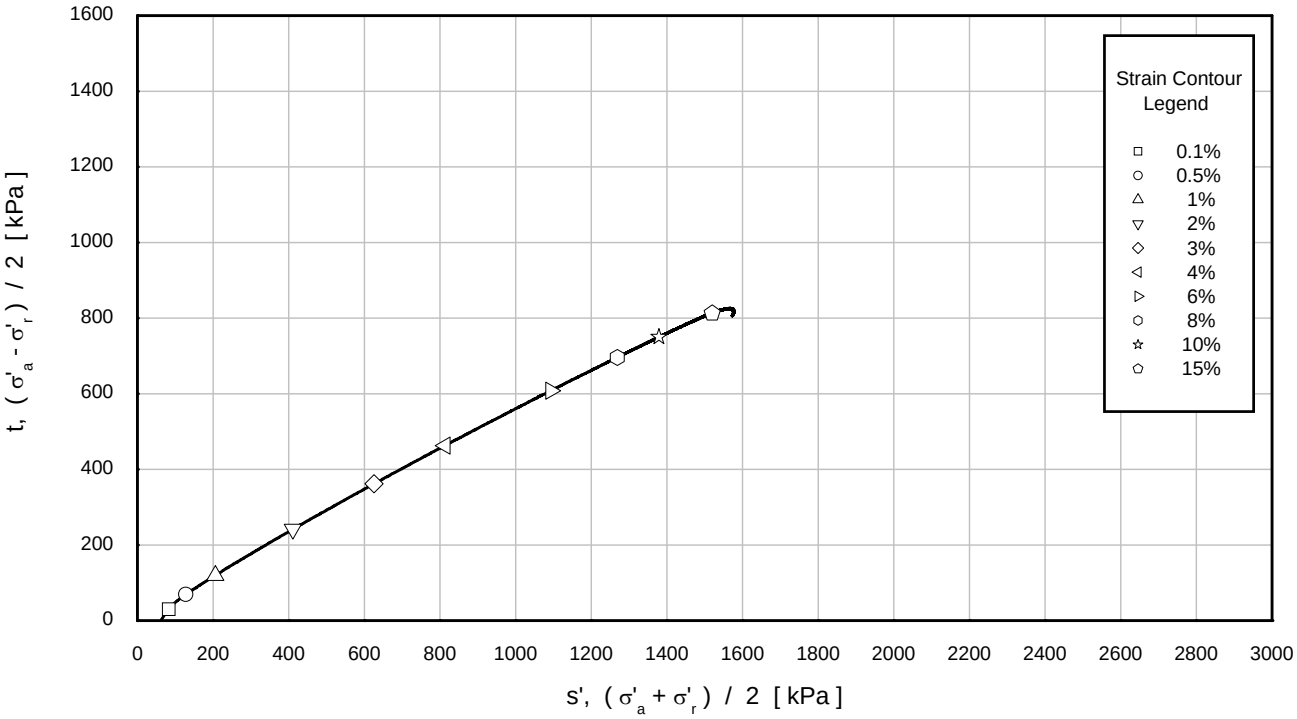


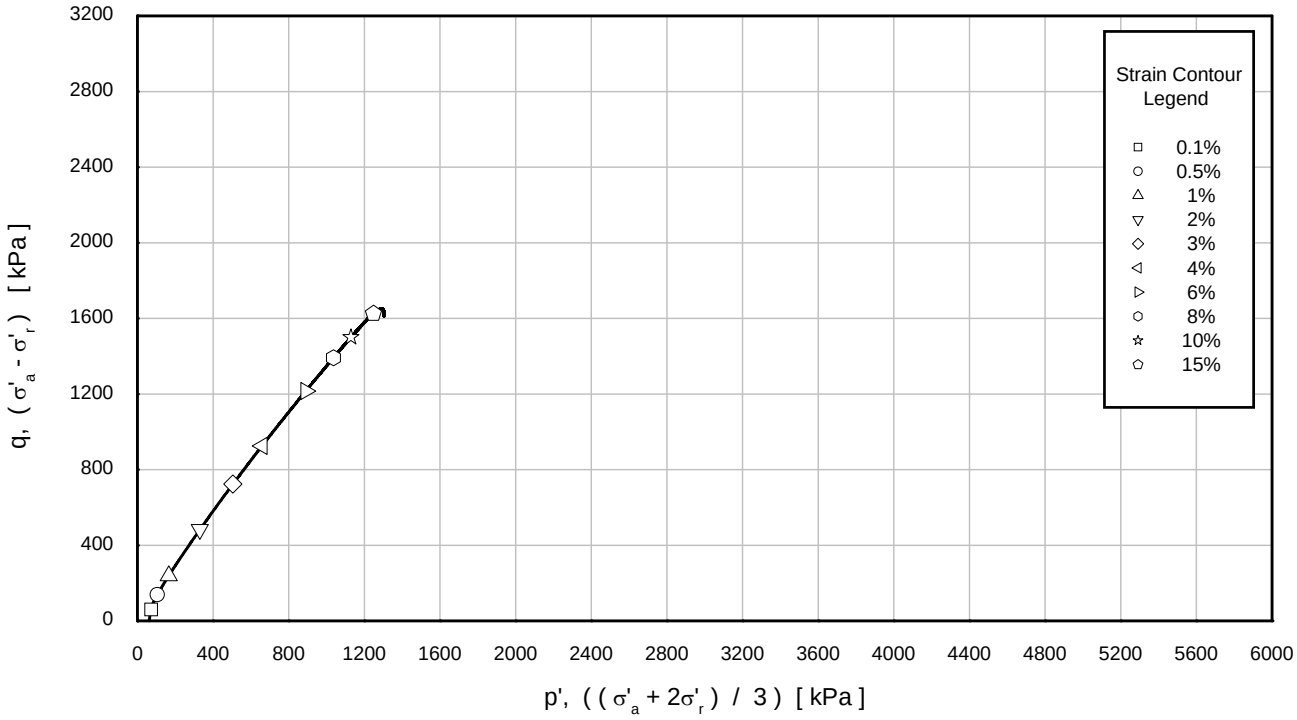


Initial σ'_r	:	63	kPa	Borehole	: Batch
Initial σ'_a	:	63	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1652	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	19.2	%	Test No.	: CTXL2
Rate of strain	:	1.00	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	63	kPa	Borehole	: Batch
Initial σ'_a	:	63	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1652	kPa		
Ext. ε at q_{peak}	:	19.2	%	Depth [m]	: -
Rate of strain	:	1.00	%/hour	Test No.	: CTXL2

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND

GENERAL	
Date test started	08/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.1
Length	[mm]	144.0
Moisture content	[%]	9.6
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.71
Void ratio	[-]	0.554
Degree of saturation	[%]	46
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Eem_Krefteneye_CTXL7
Processed by	LC
Date	12/08/2015
Checked by	LJ
Date	13/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL7

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	880
Base PWP	[kPa]	853
Mid height PWP	[kPa]	-
B value achieved	[-]	0.99

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	880
Back pressure	[kPa]	800
Base PWP	[kPa]	800
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.23
External axial strain	[%]	0.08
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	20.8
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.71
Void ratio	[-]	0.551
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL7

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	80
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	35
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	195
External ε_{av} at N_f	[%]	-1.94
External ε_{cy} at N_f	[%]	7.80
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	56
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	20.8
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.71
Void ratio	[-]	0.551
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.04	94	-	8.51	-
2	-0.01	0.04	99	-	7.21	-
5	-0.01	0.04	98	-	6.14	-
10	-0.01	0.04	96	-	5.72	-
20	-0.01	0.04	92	-	5.60	-
30	-0.02	0.04	90	-	5.62	-
40	-0.02	0.04	87	-	5.77	-
50	-0.02	0.04	84	-	6.02	-
100	-0.04	0.05	73	-	7.05	-
195	-1.94	7.80	0	-	9.61	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL7

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	2
Initial effective axial pressure	[kPa]	2
Rate of strain	[%/hour]	0.87
At peak deviator stress		
Corrected deviator stress	[kPa]	1585
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	24.01
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-674
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	755
Effective axial pressure	[kPa]	2340
Principal effective stress ratio	[-]	3.10
ε_{50}	[%]	12.75
Secant modulus (E_{50}) at ε_{50}	[kPa]	3697
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	2
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	3.09
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	80
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0
Effective axial pressure	[kPa]	2
Principal effective stress ratio	[-]	45.97
At 10% axial strain		
Corrected deviator stress	[kPa]	326
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-36
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	116
Effective axial pressure	[kPa]	442
Principal effective stress ratio	[-]	3.80

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL7

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

Photograph unavailable

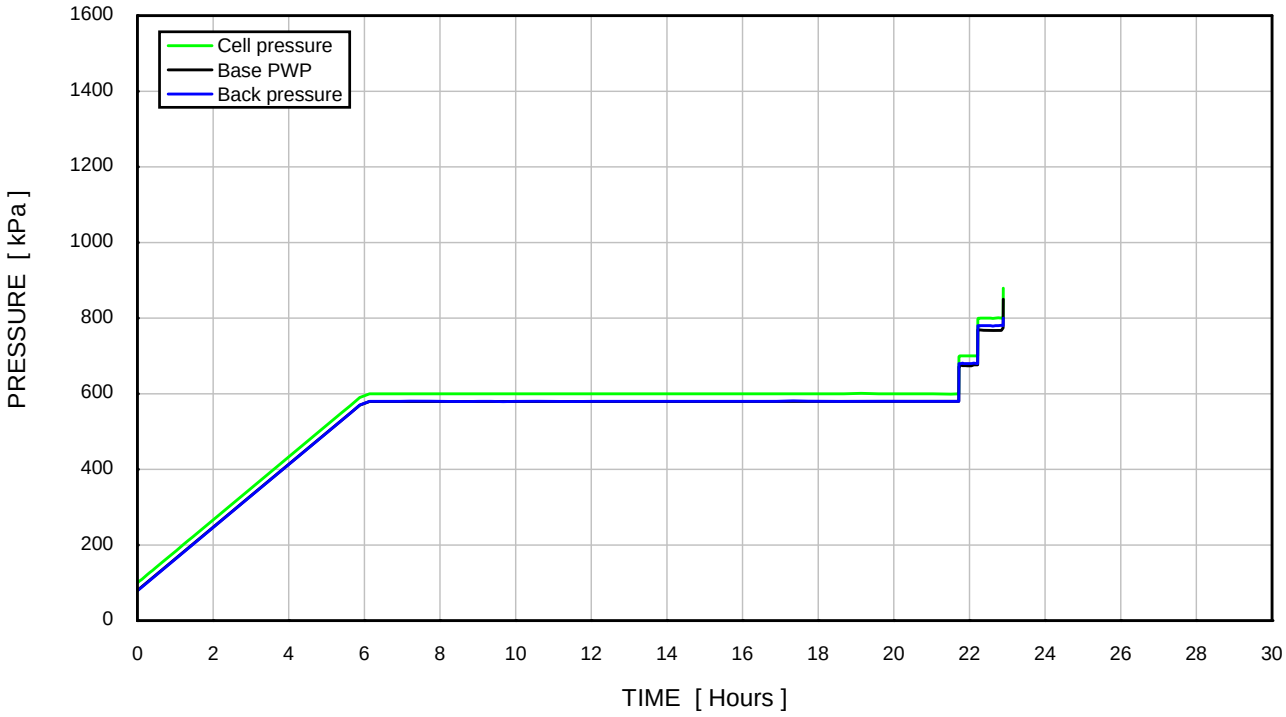
Photograph unavailable

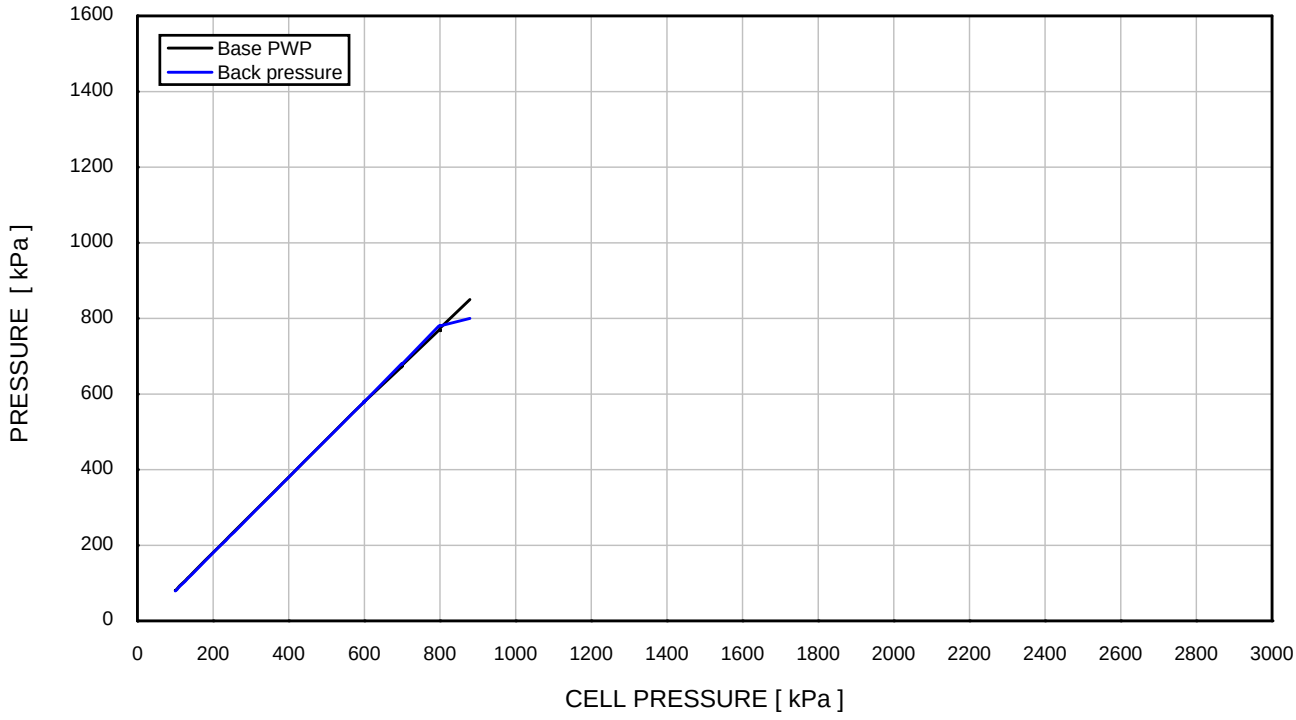
FINAL CONDITIONS		
Moisture content	[%]	20.8
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.71

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem / Kreftenheye
Depth [m]	-
Test number	CTXL7

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

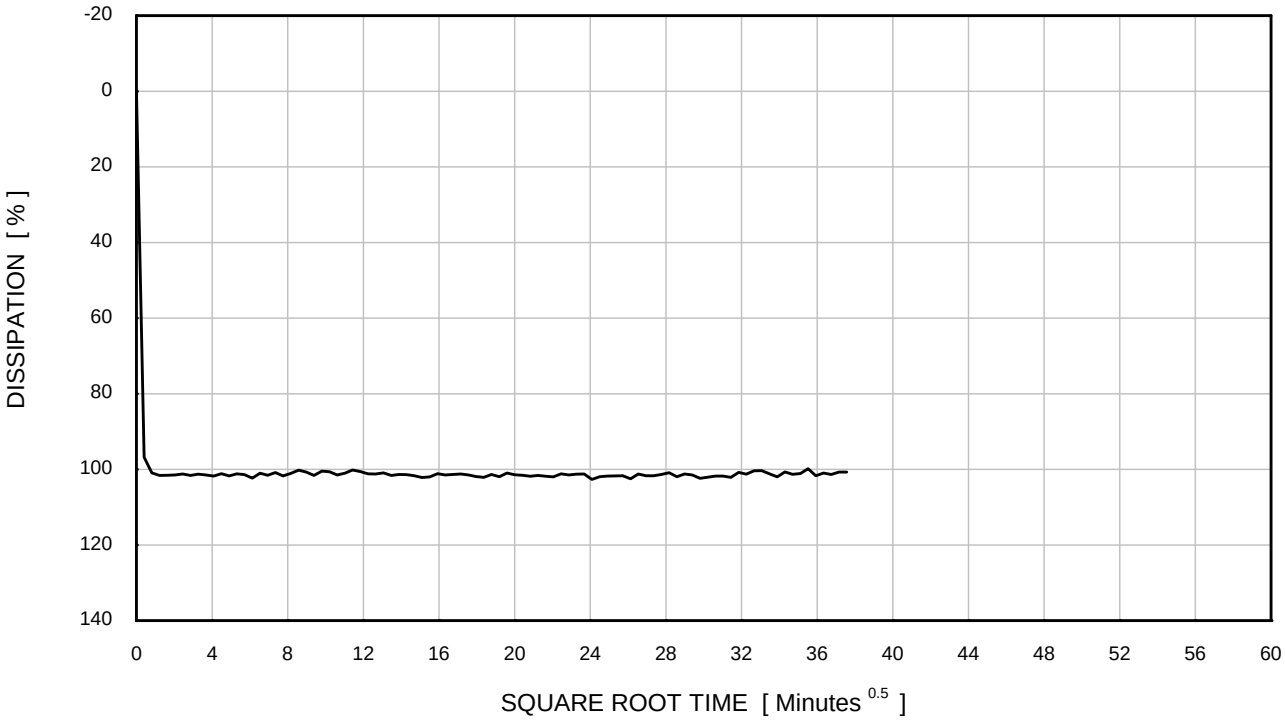


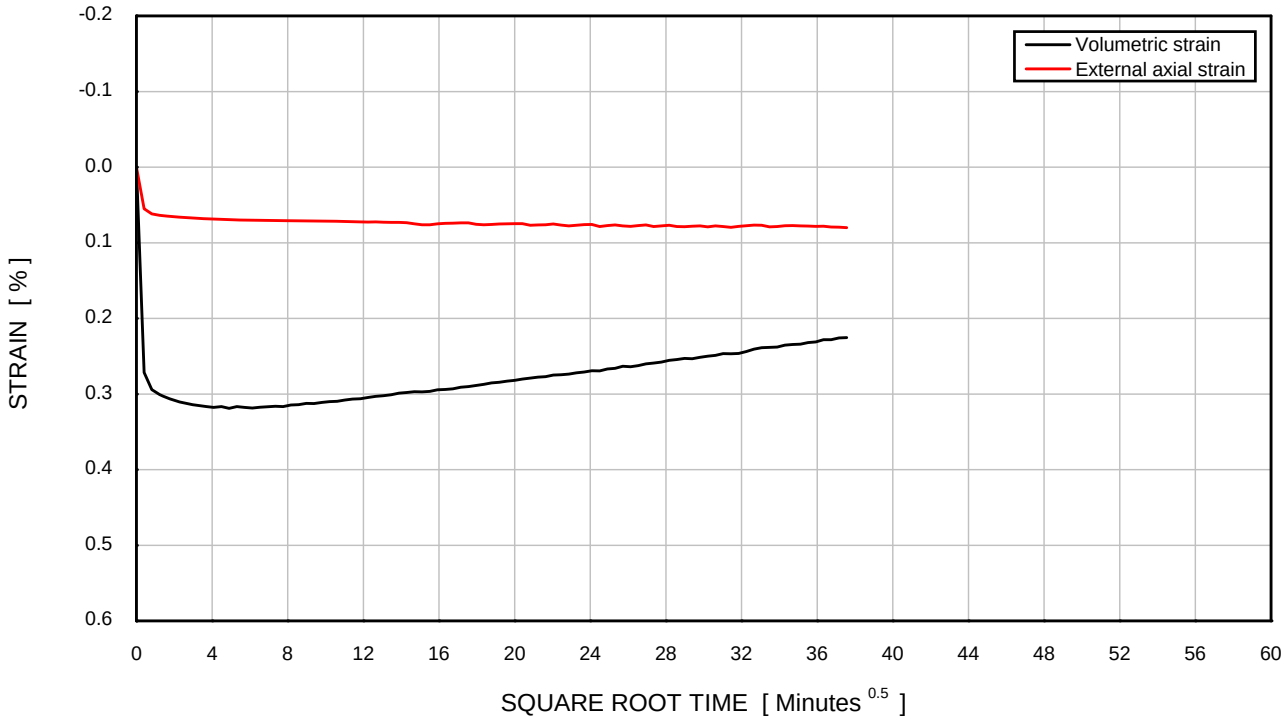


B value	:	0.96			
Initial σ'_r	:	19	kPa	Borehole	: Batch
Initial σ'_a	:	19	kPa	Sample	: Eem/Kreftenheye
Final σ'_r	:	29	kPa	Depth [m]	: -
Final σ'_a	:	29	kPa	Test No.	: CTXL7

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

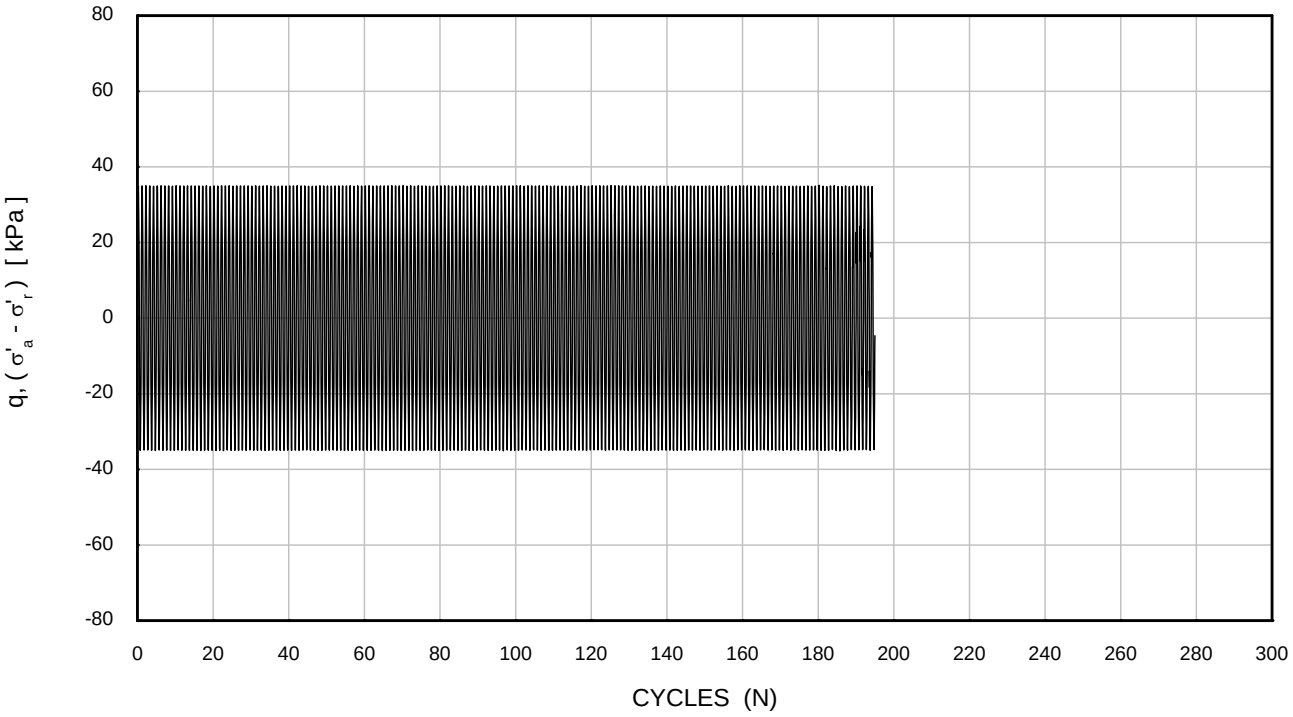


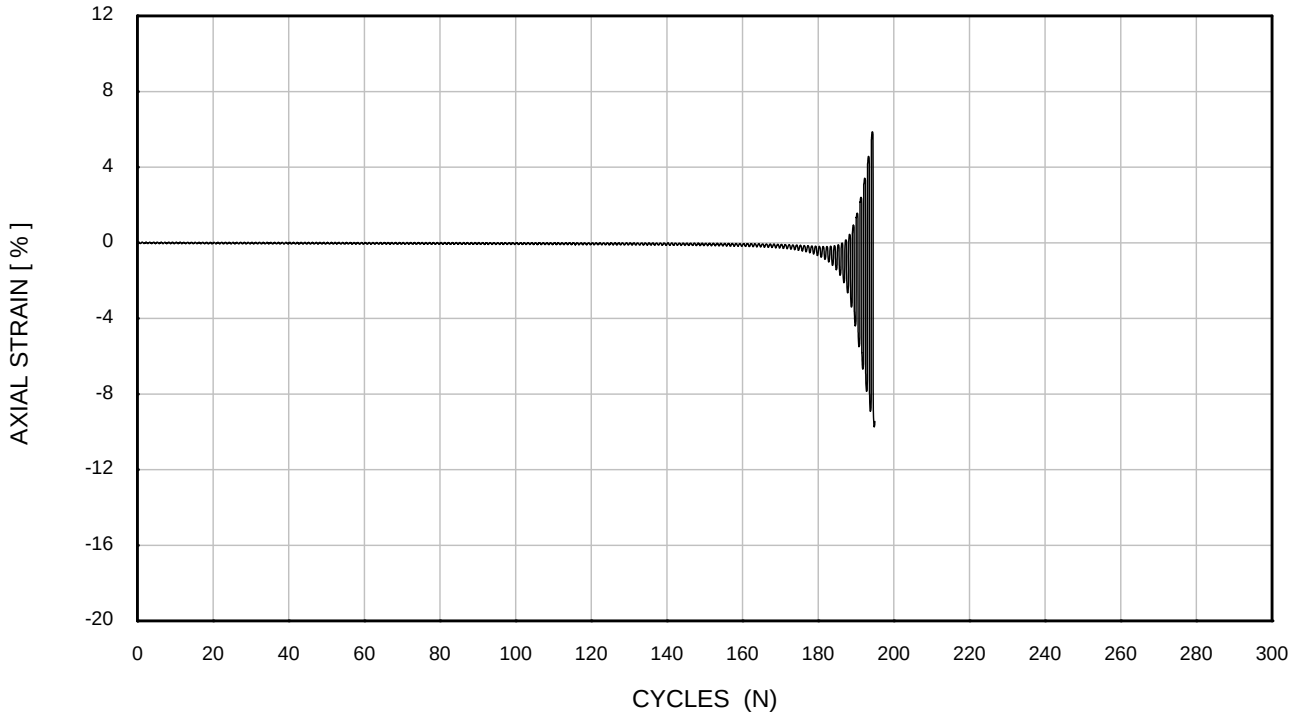


σ'_{rc}	:	80 kPa	Borehole	:	Batch
σ'_{ac}	:	80 kPa	Sample	:	Eem/Kreftenheye
			Depth [m]	:	-
			Test No.	:	CTXL7

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

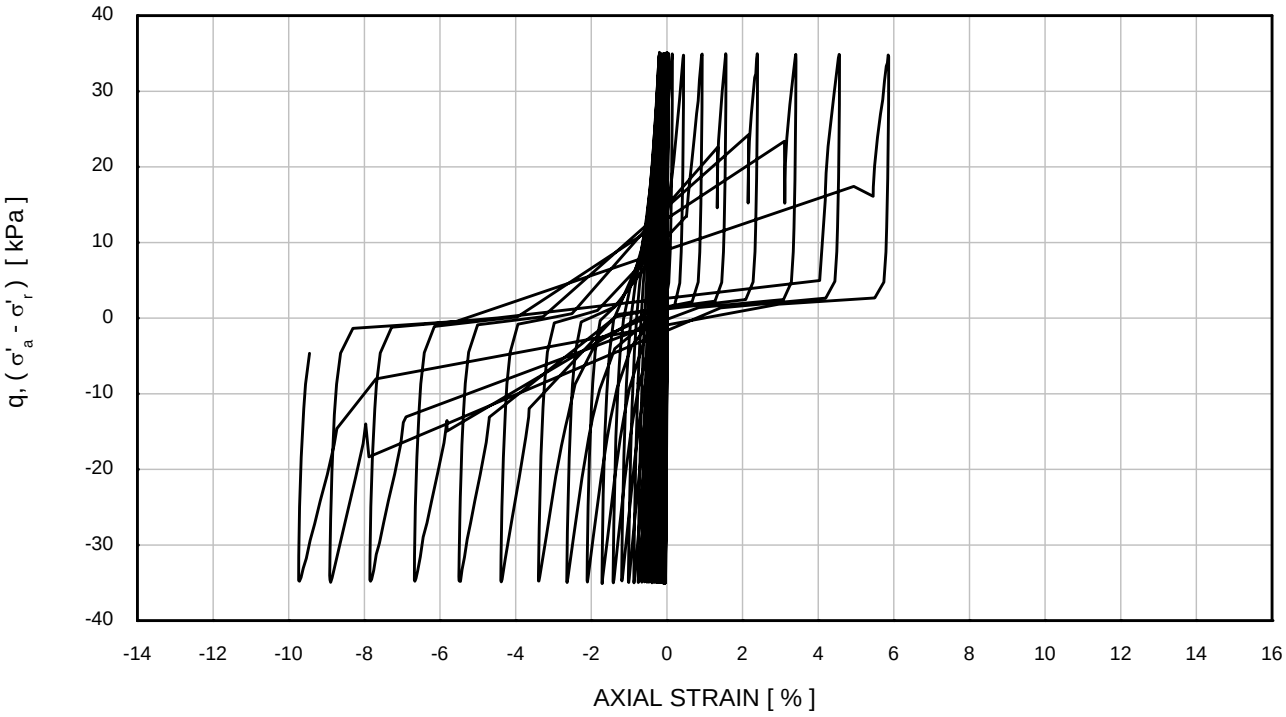


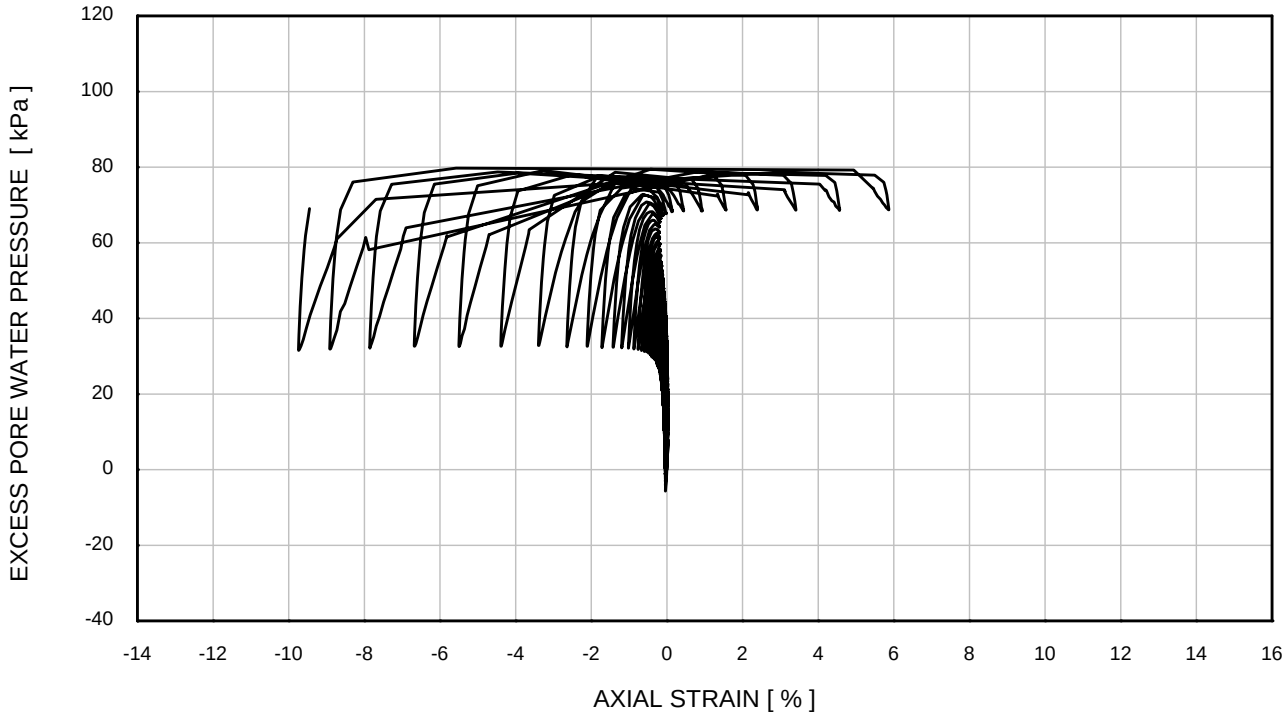


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

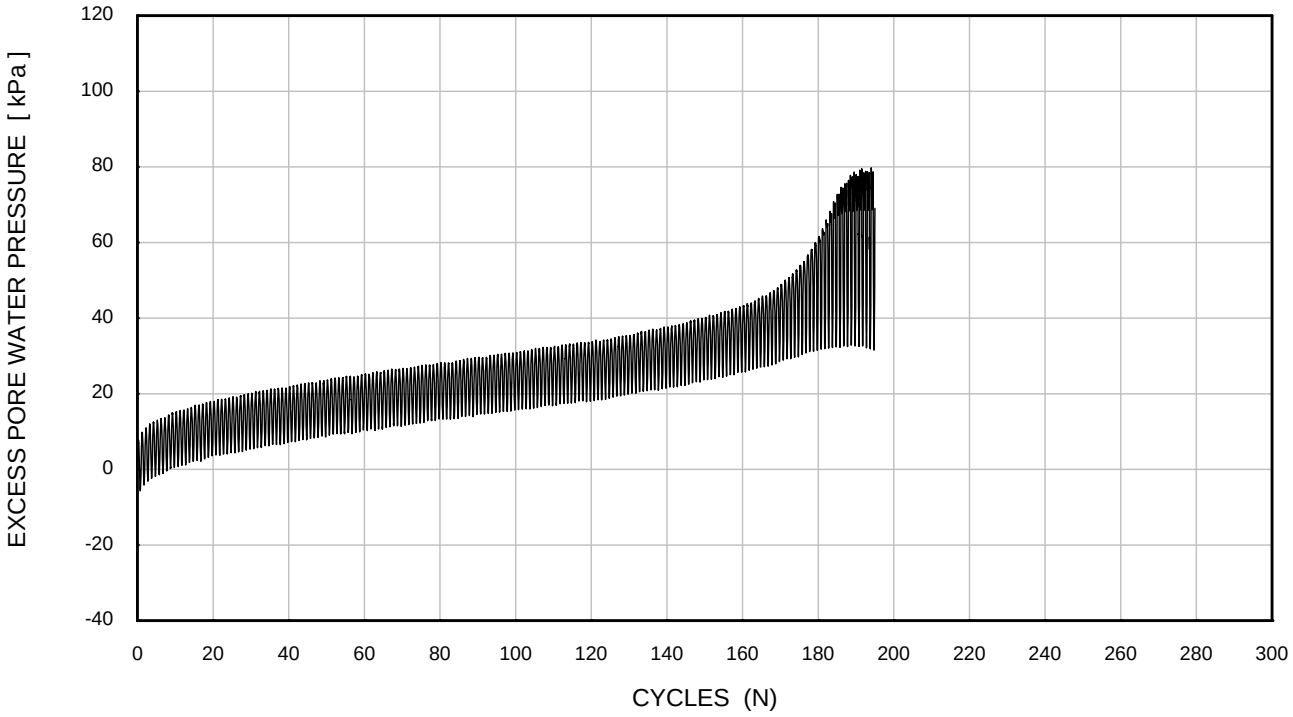


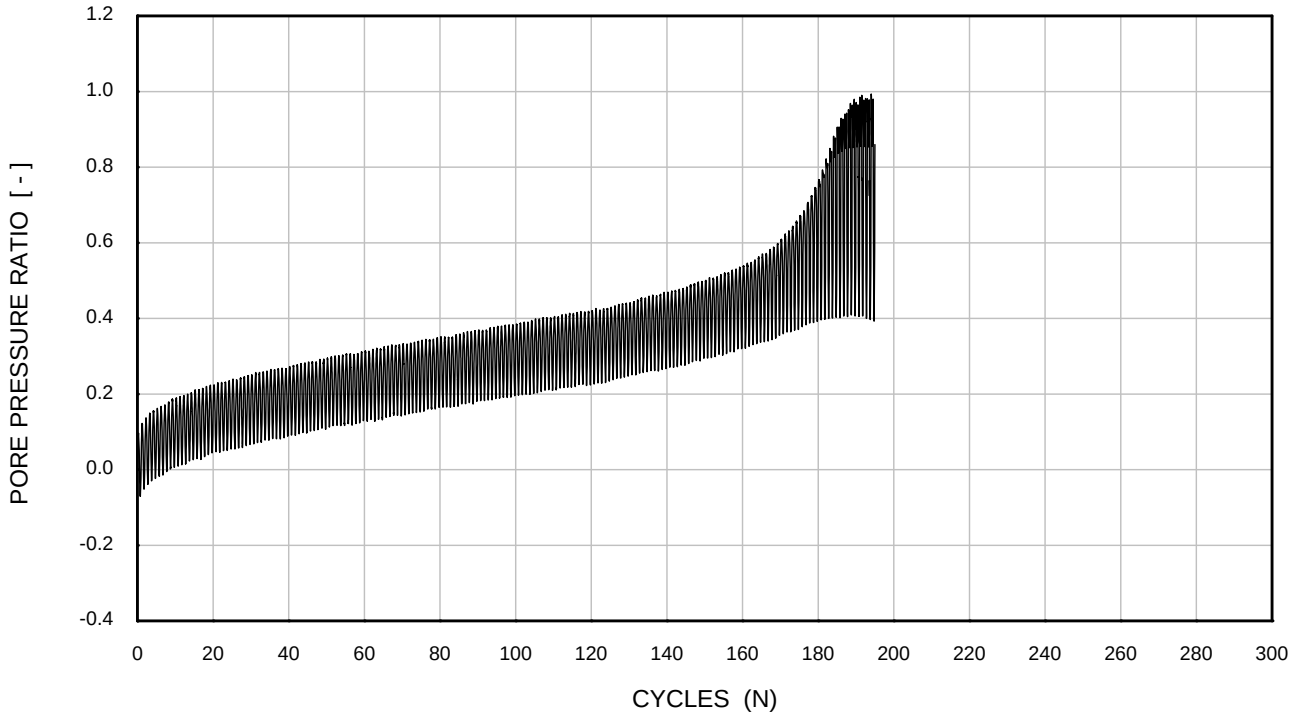


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

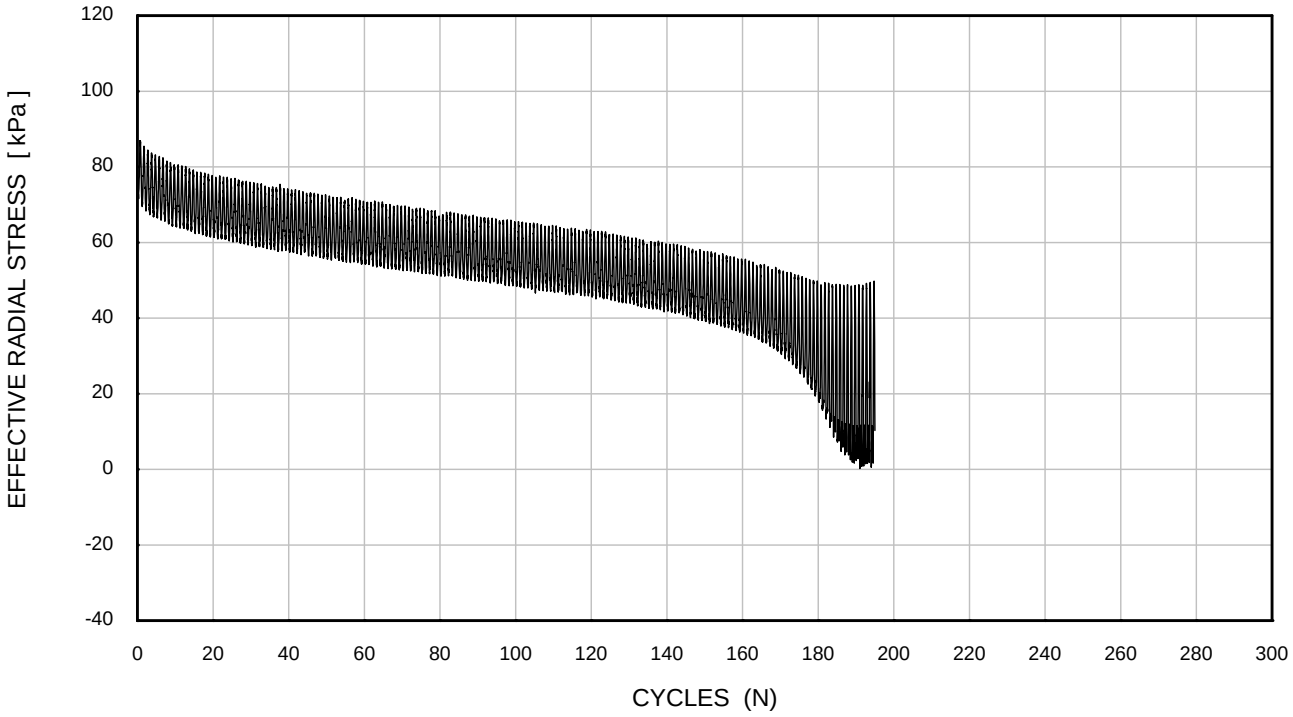


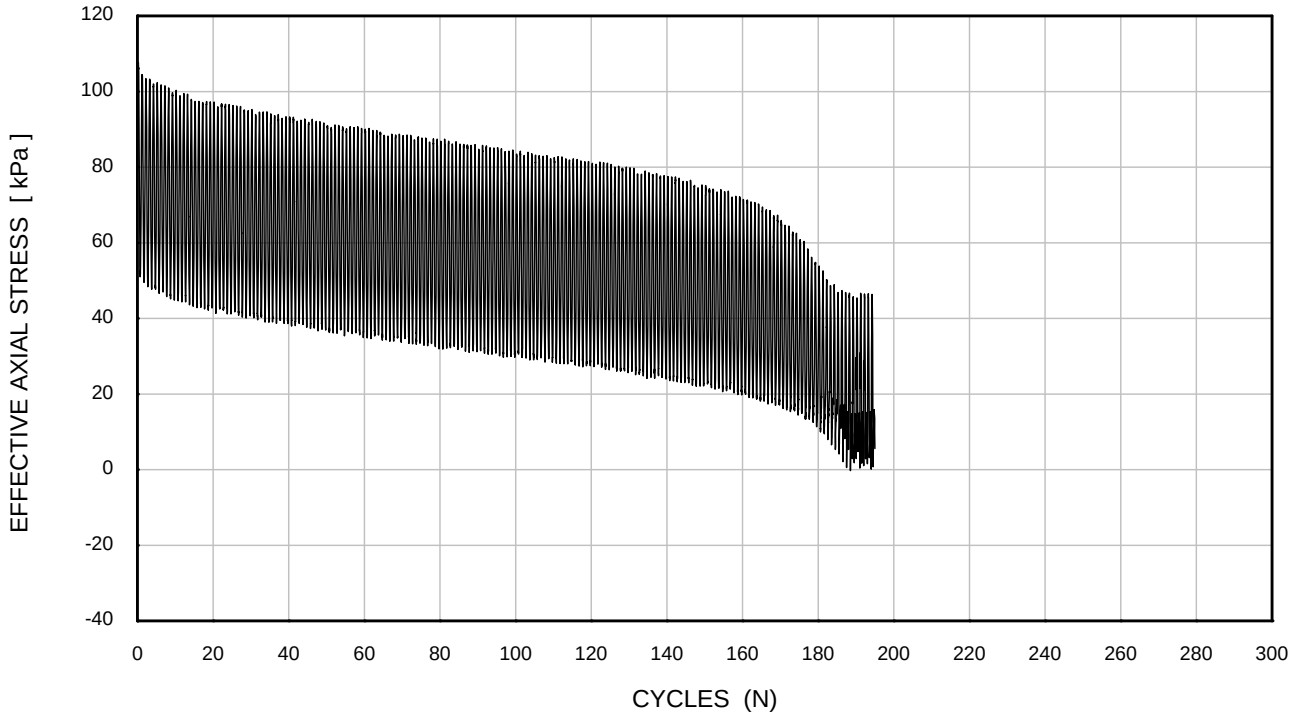


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

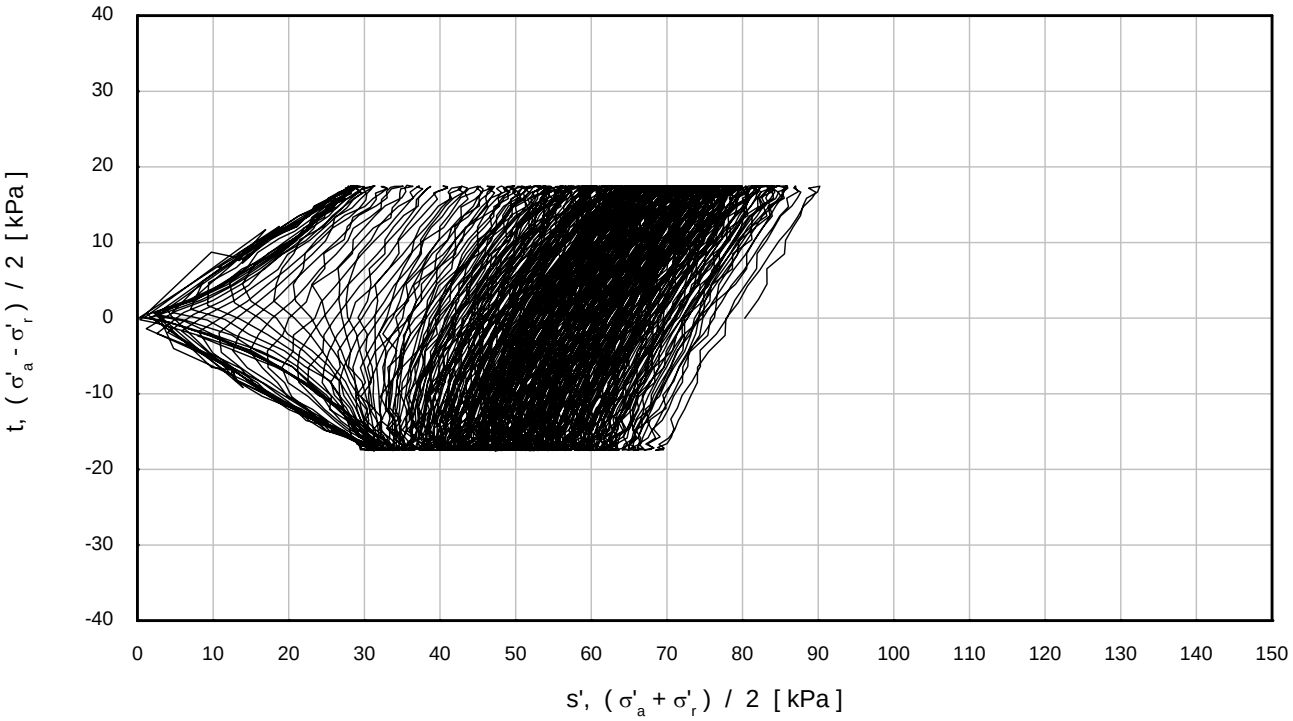


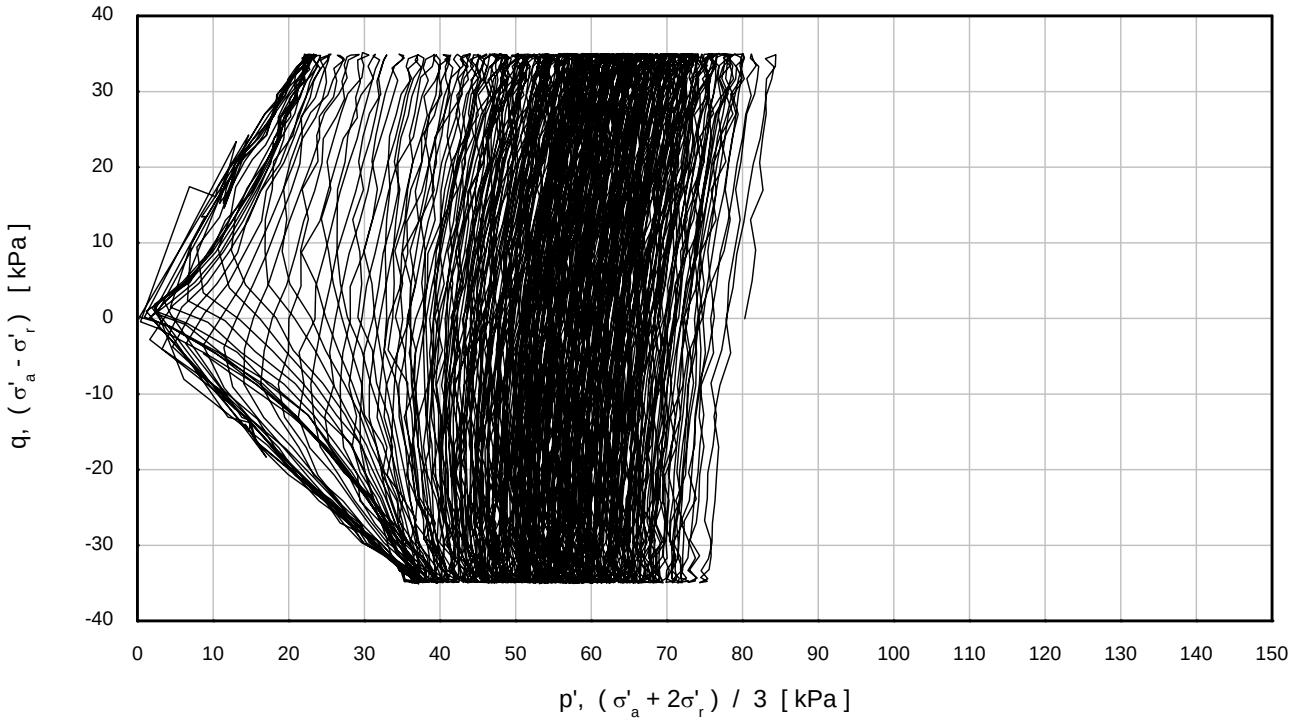


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

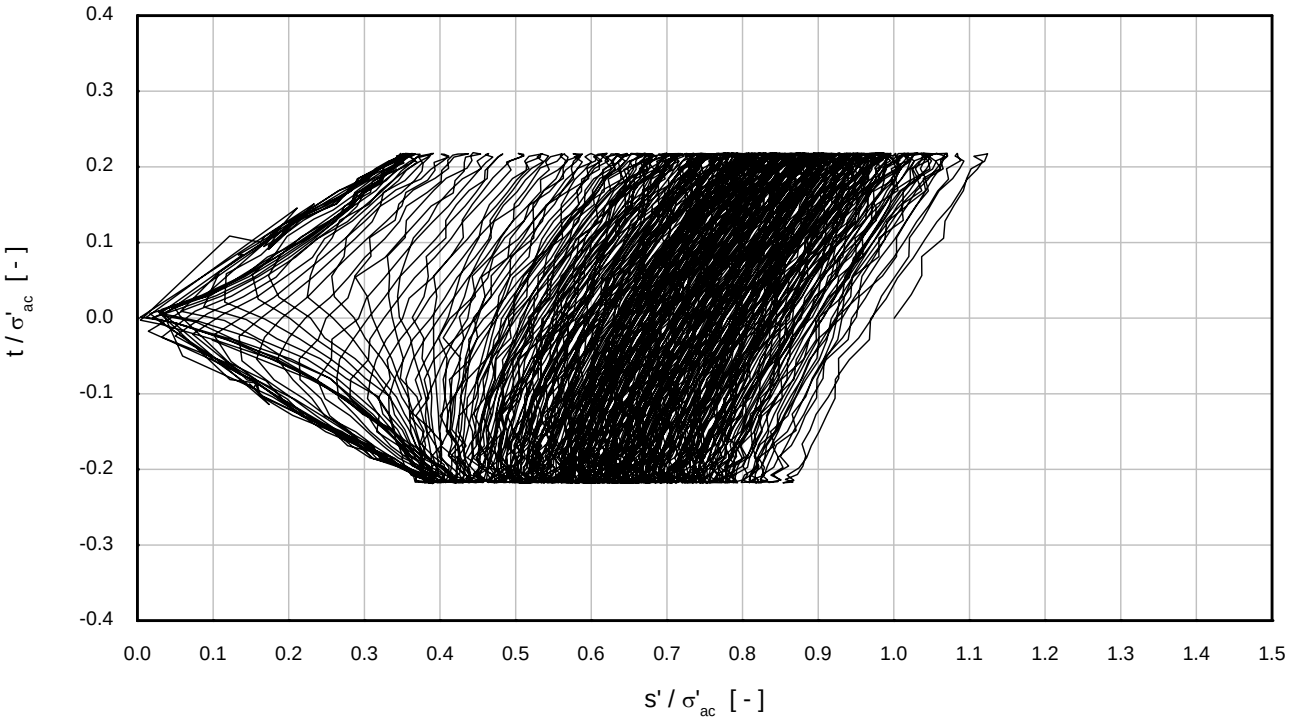


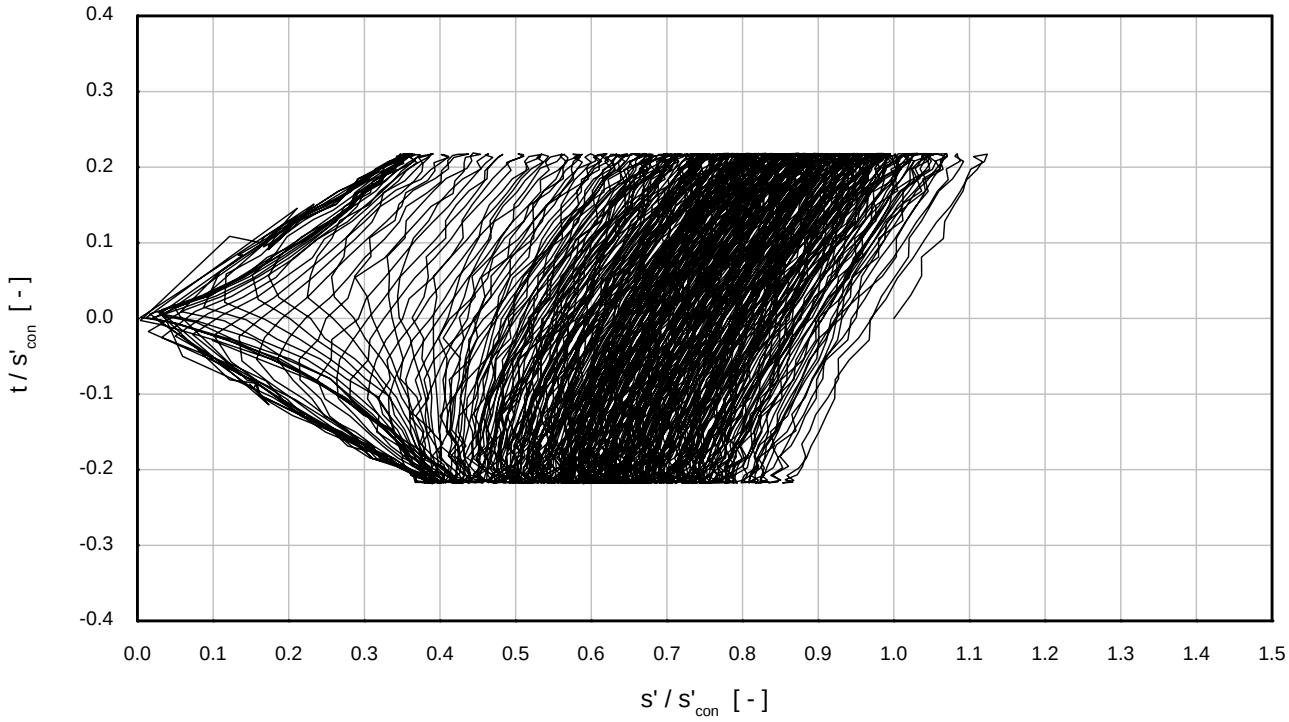


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

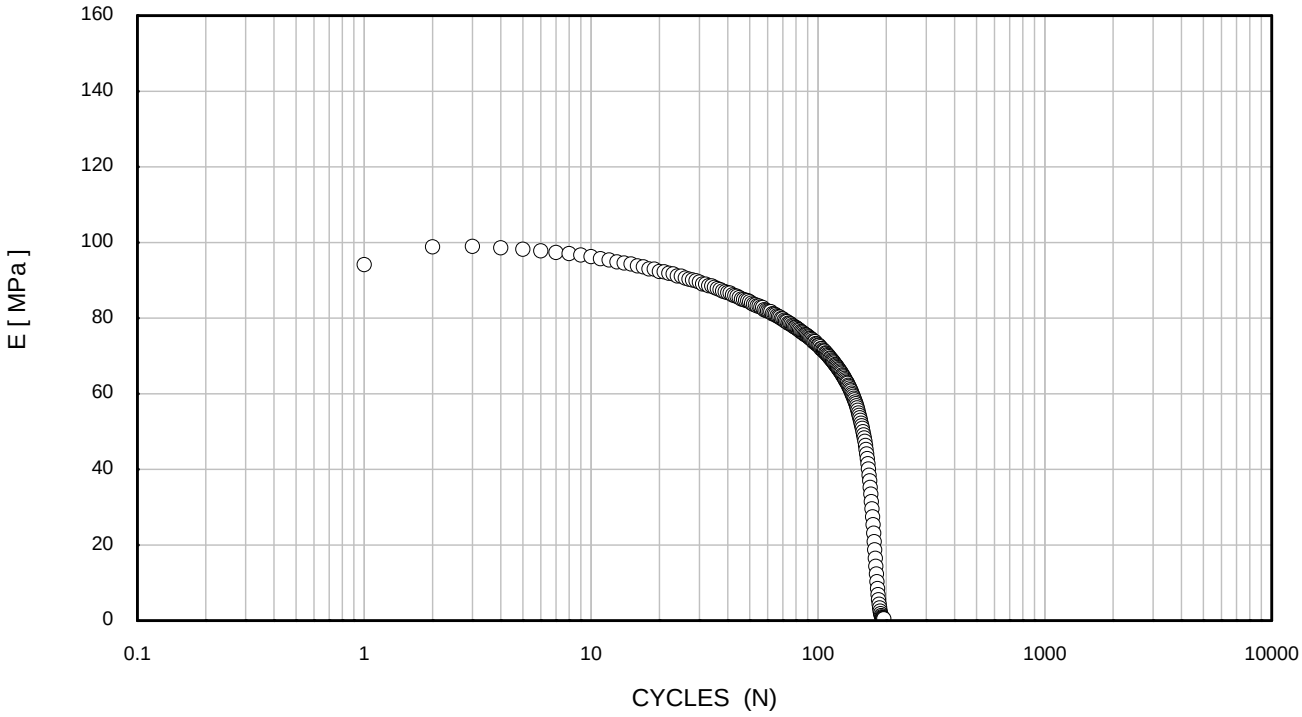


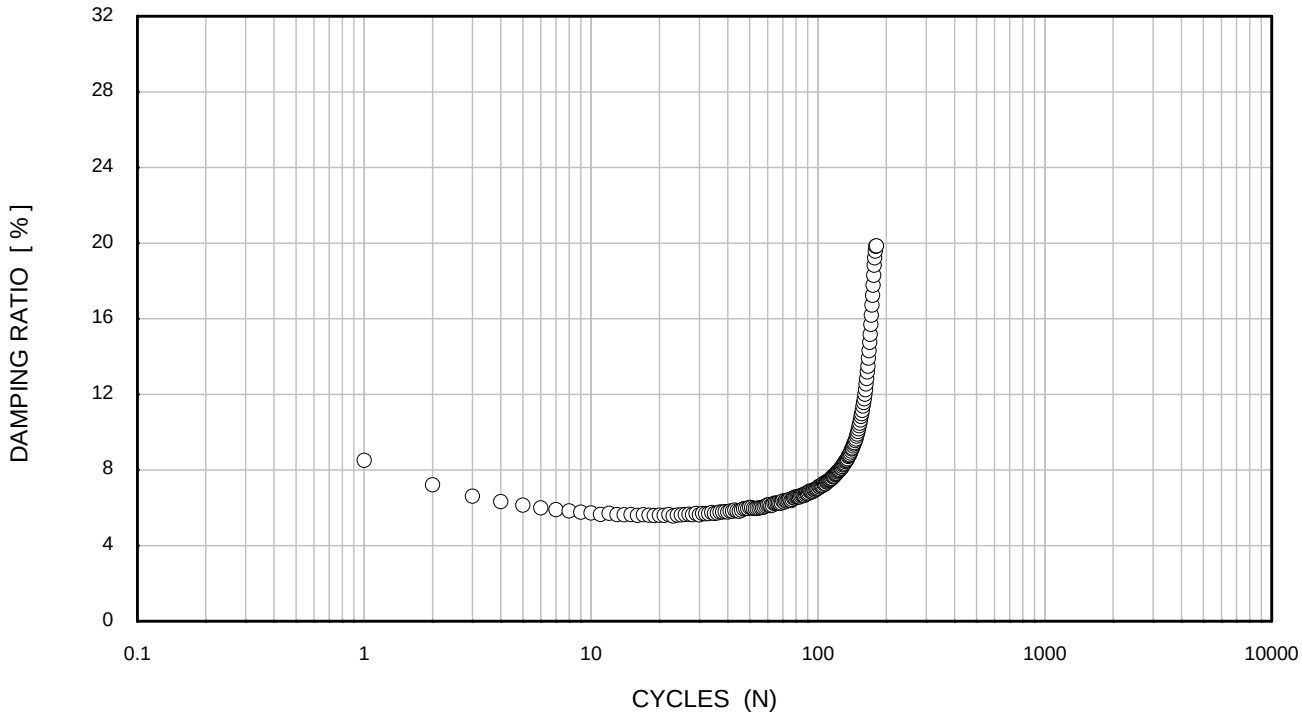


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

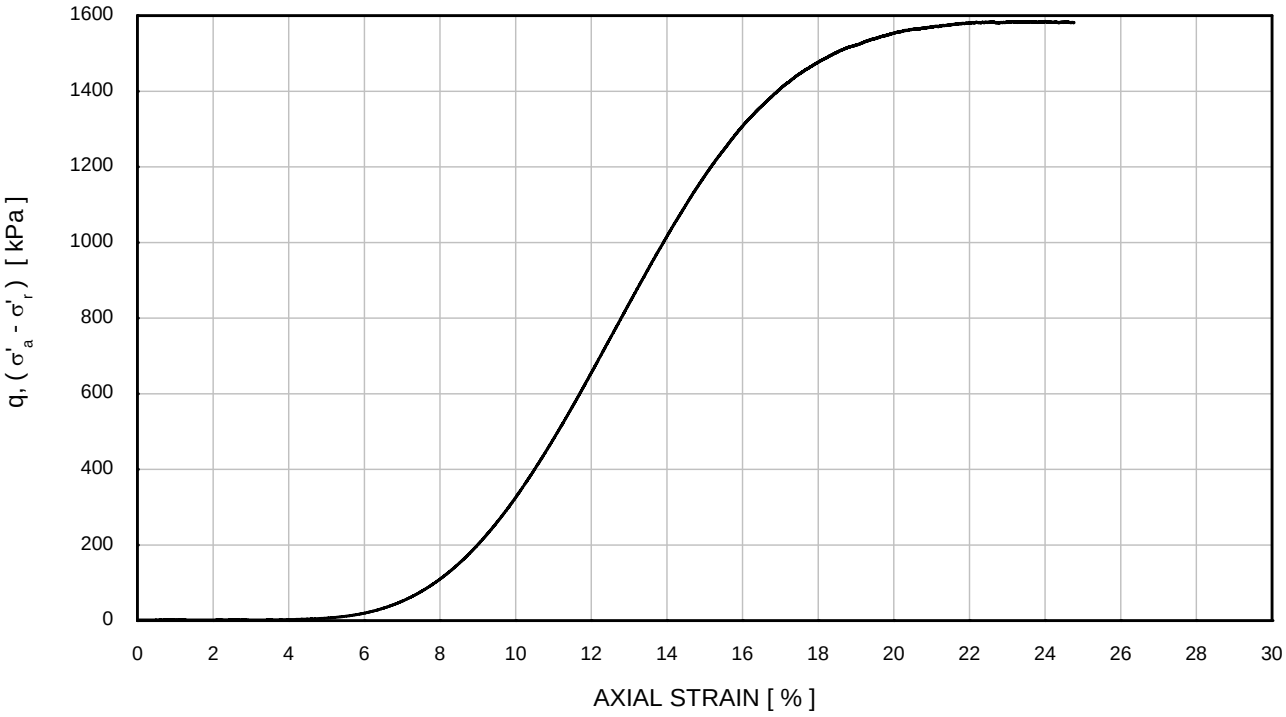


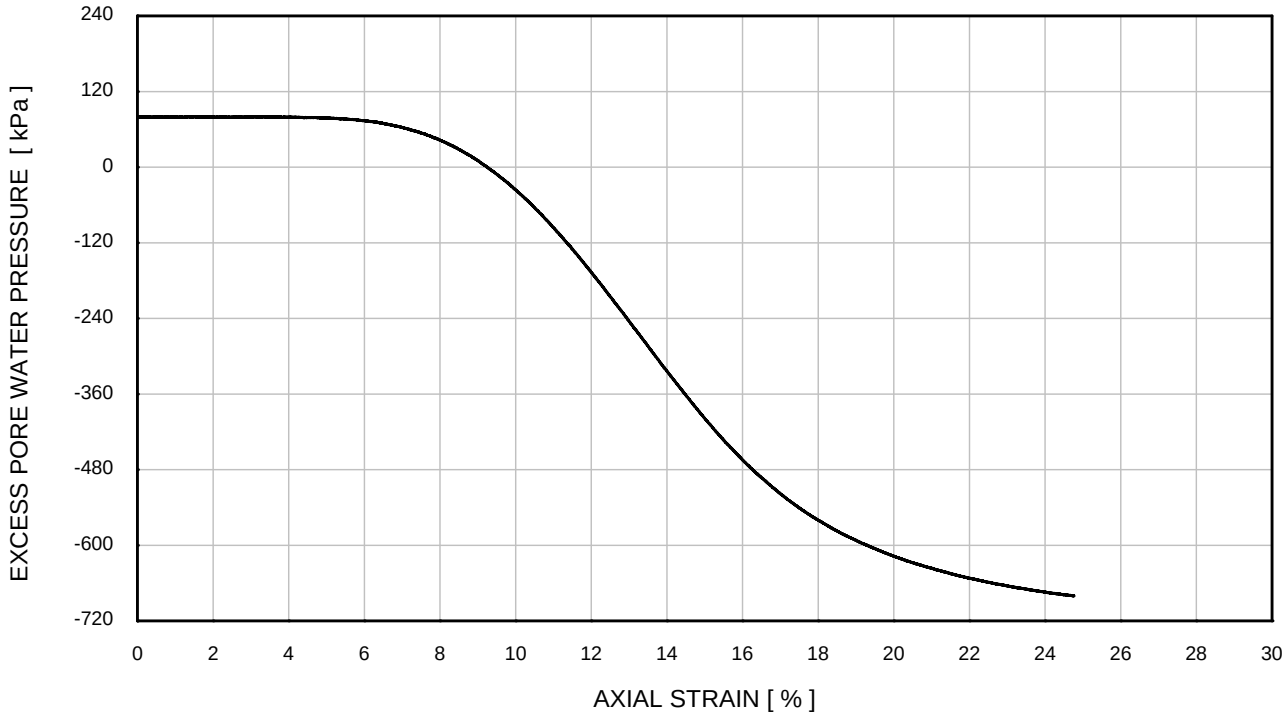


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	35	kPa	Test No.	: CTXL7
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

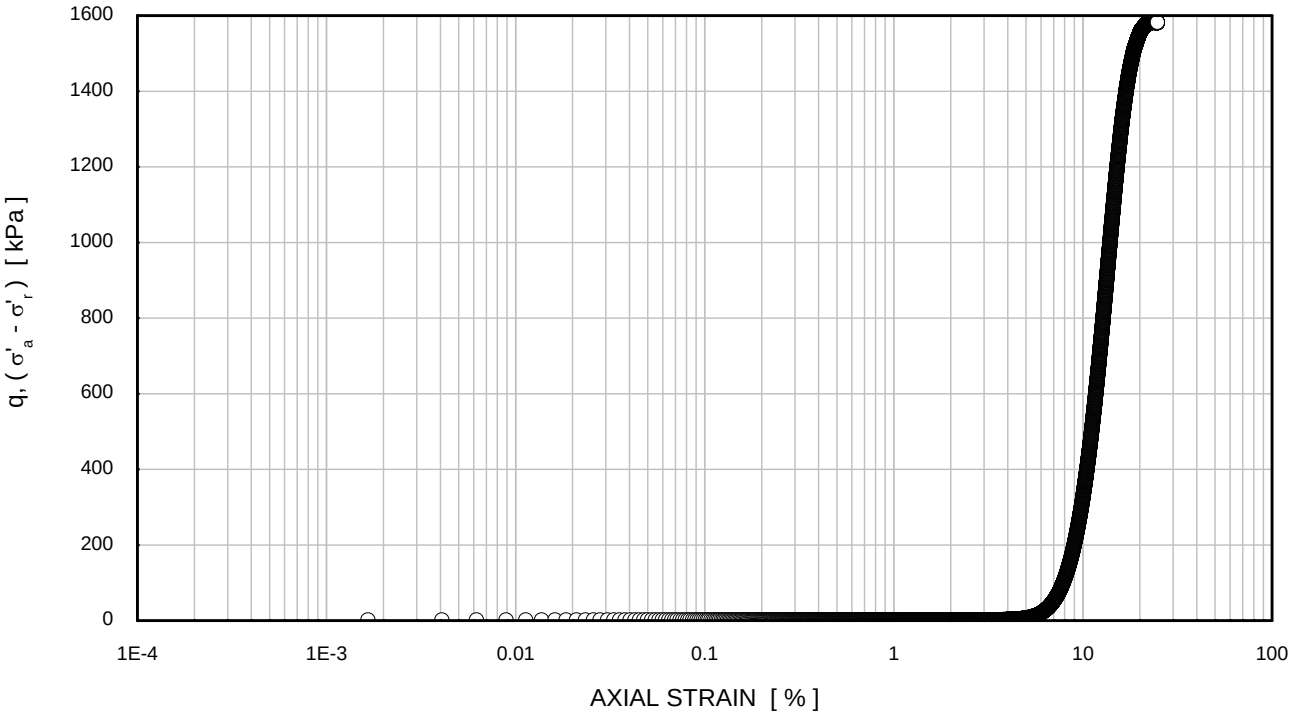


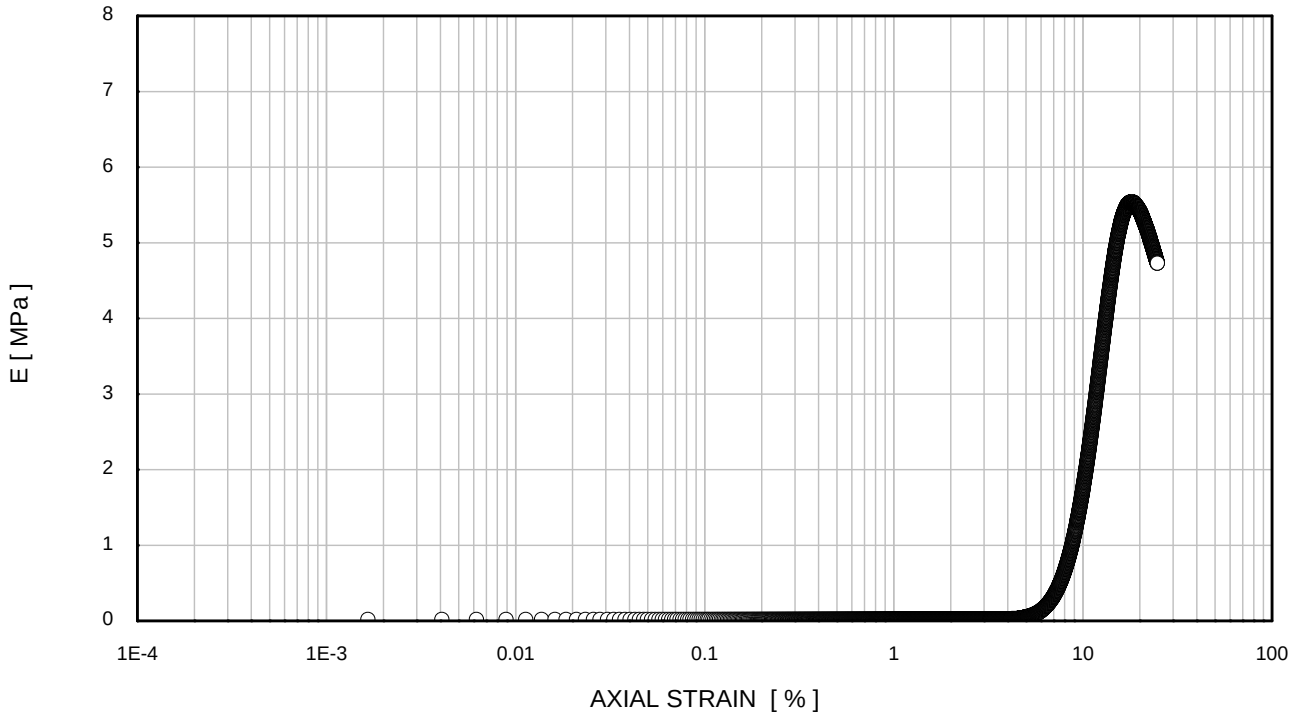


Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1585	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	24.0	%	Test No.	: CTXL7
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

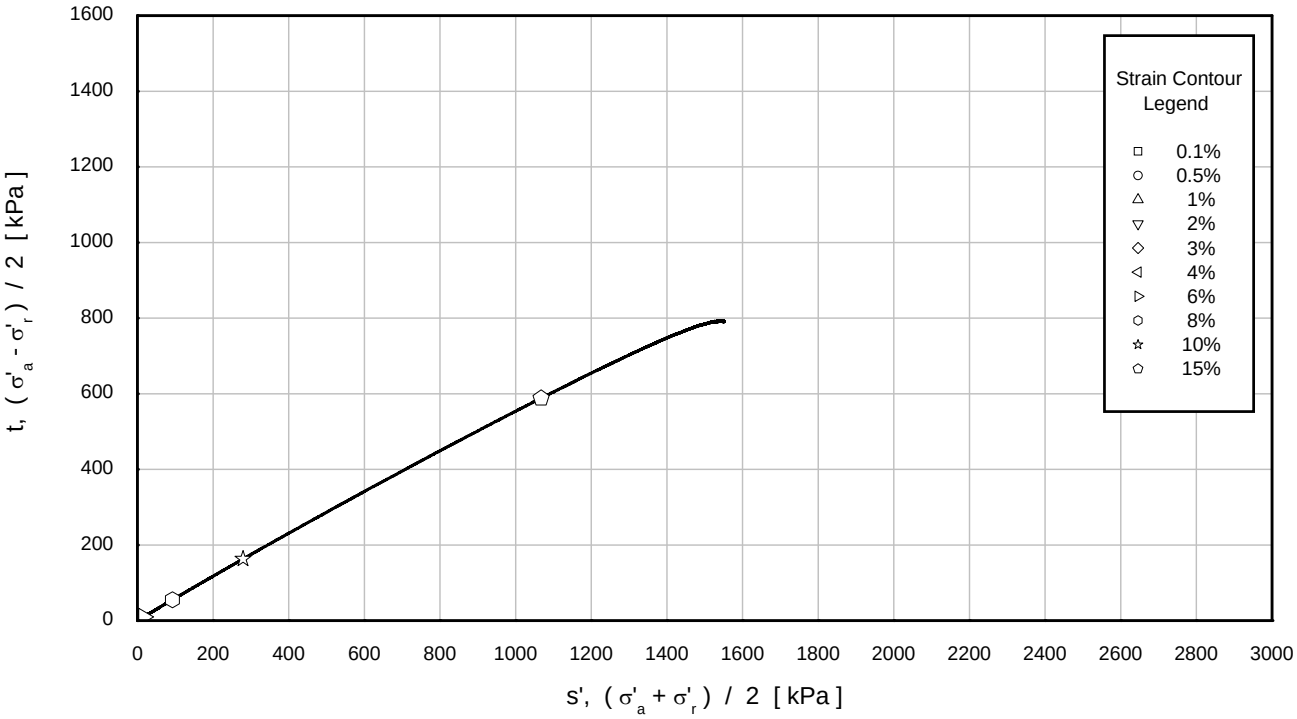


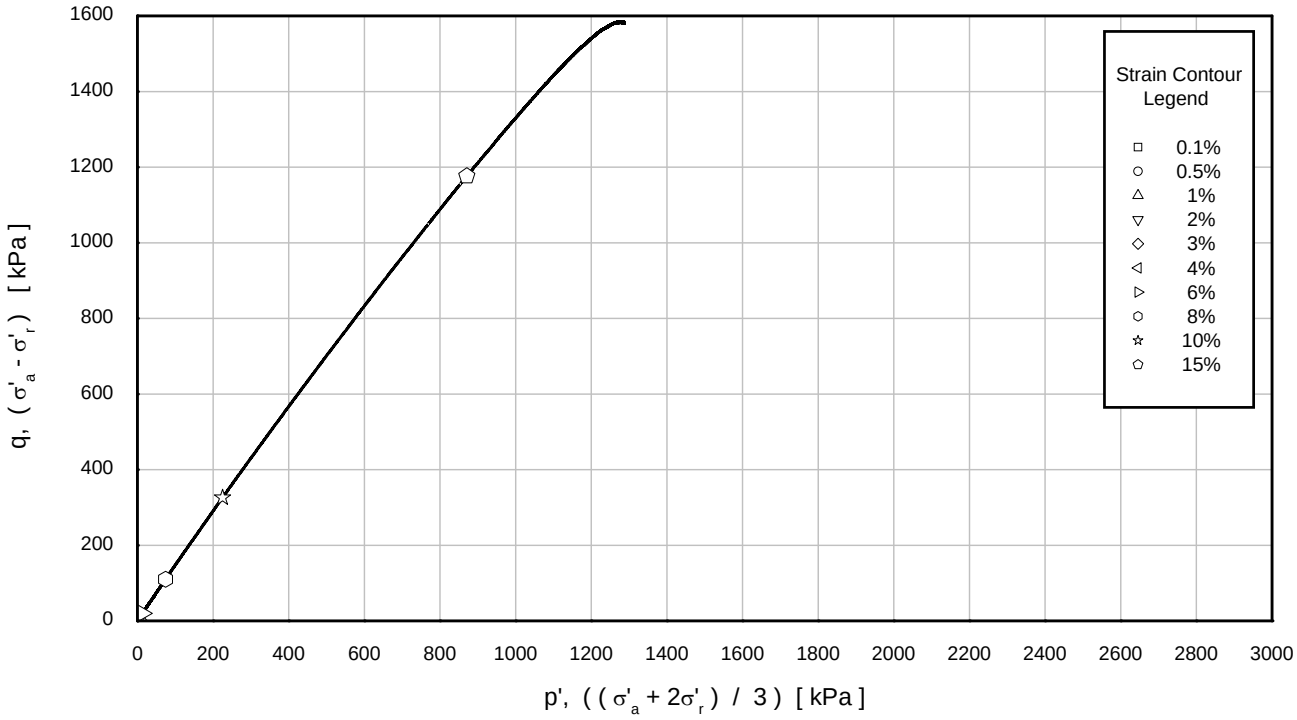


Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1585	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	24.0	%	Test No.	: CTXL7
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	2	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	1585	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	24.0	%	Test No.	: CTXL7
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Light olive brown fine to medium SAND

GENERAL	
Date test started	13/08/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	71.1
Length	[mm]	144.0
Moisture content	[%]	10.0
Bulk density	[Mg/m³]	1.87
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.557
Degree of saturation	[%]	48
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Eem_Kreftenheye_CTXL8
Processed by	LC
Date	19/08/2015
Checked by	LJ
Date	20/08/2015
Approved by	PH
Date	20/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem/Kreftenheye
Depth [m]	-
Test number	CTXL8

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1080
Base PWP	[kPa]	1025
Mid height PWP	[kPa]	-
B value achieved	[-]	0.95

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1080
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	80
Deviator stress	[kPa]	0
Volumetric strain	[%]	0.08
External axial strain	[%]	0.03
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.556
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem/Kreftenheye
Depth [m]	-
Test number	CTXL8

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	80
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	30
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	75
External ε_{av} at N_f	[%]	-2.77
External ε_{cy} at N_f	[%]	11.67
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	60
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.556
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.04	79	-	9.97	-
2	0.00	0.04	85	-	7.20	-
5	-0.01	0.04	83	-	6.02	-
10	-0.01	0.04	80	-	5.67	-
20	-0.01	0.04	73	-	6.11	-
30	-0.01	0.05	67	-	6.83	-
40	-0.02	0.05	59	-	8.23	-
50	-0.04	0.06	50	-	10.09	-
75	-2.77	11.67	0	-	6.61	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem/Kreftenheye
Depth [m]	-
Test number	CTXL8

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	-2
Initial effective axial pressure	[kPa]	-3
Rate of strain	[%/hour]	0.84
At peak deviator stress		
Corrected deviator stress	[kPa]	787
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	20.97
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	-210
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	290
Effective axial pressure	[kPa]	1076
Principal effective stress ratio	[-]	3.72
ε_{50}	[%]	15.85
Secant modulus (E_{50}) at ε_{50}	[kPa]	2442
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	6
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	7.78
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	80
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0
Effective axial pressure	[kPa]	6
Principal effective stress ratio	[-]	564.91
At 10% axial strain		
Corrected deviator stress	[kPa]	35
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	71
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	9
Effective axial pressure	[kPa]	43
Principal effective stress ratio	[-]	4.98

TEST IDENTIFICATION	
Borehole	Batch
Sample	Eem/Kreftenheye
Depth [m]	-
Test number	CTXL8

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

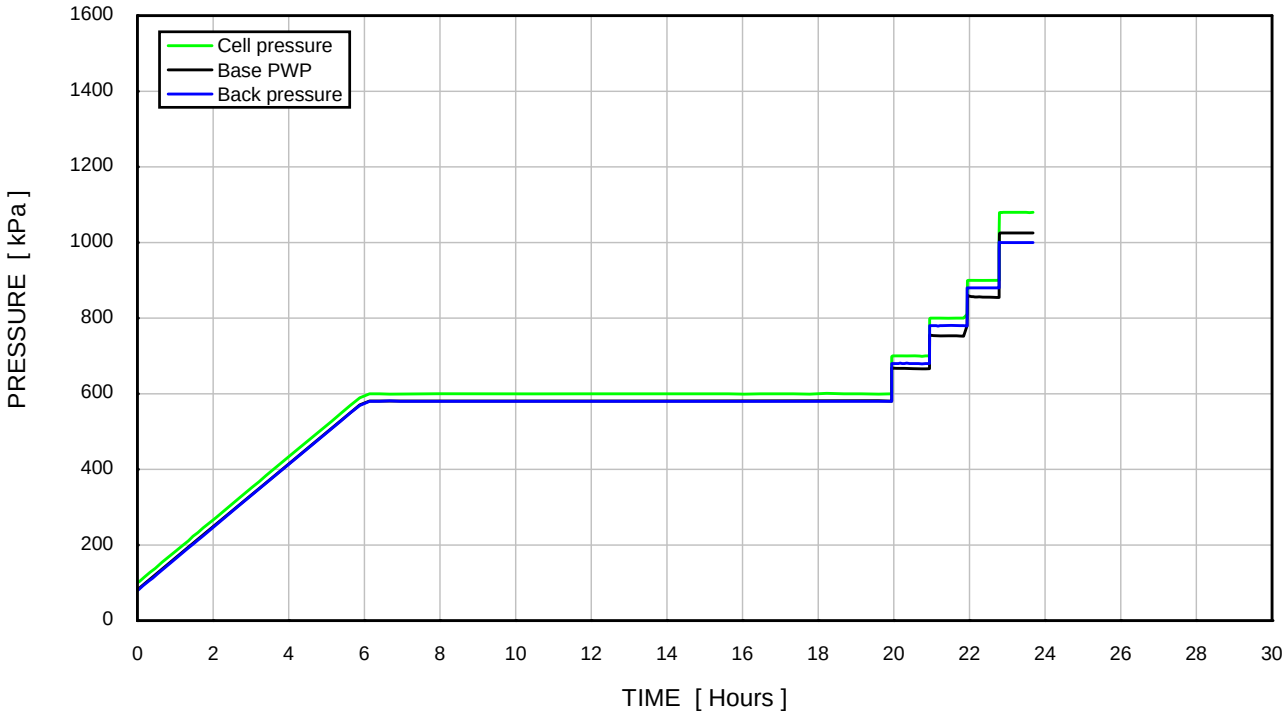
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70

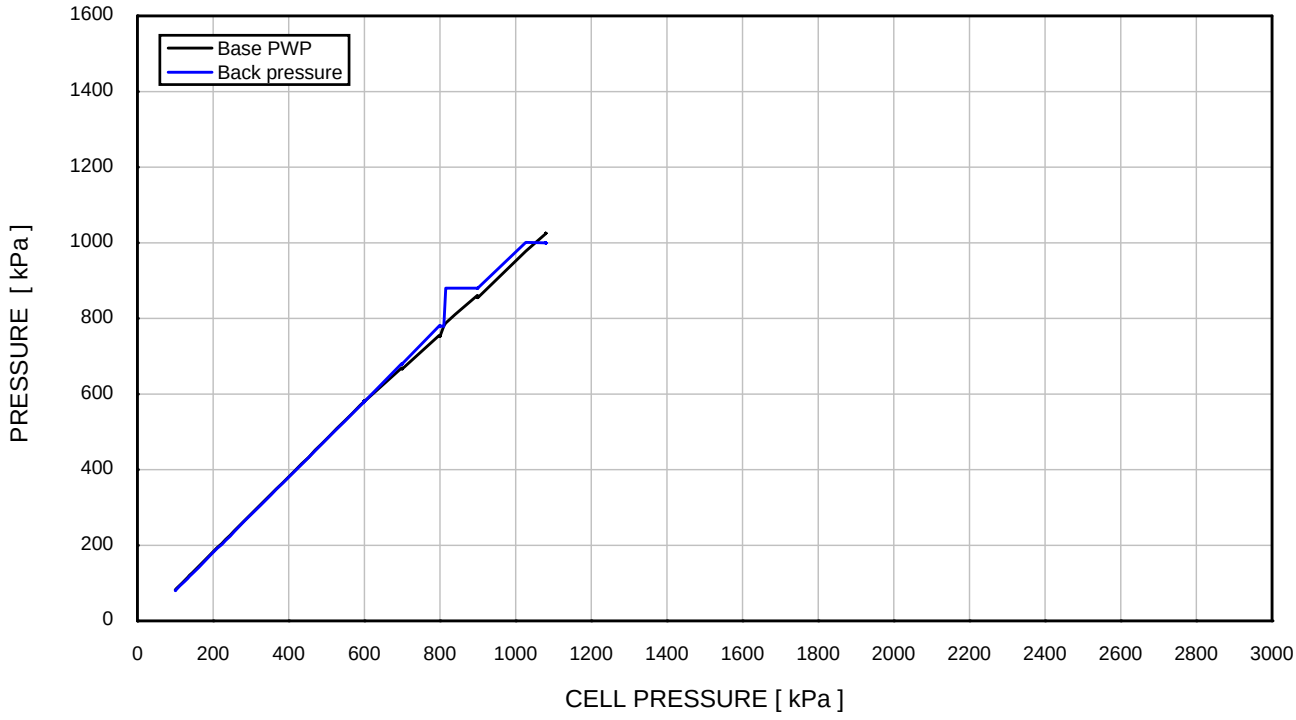
TEST IDENTIFICATION

Borehole	Batch
Sample	Eem/Kreftenheye
Depth [m]	-
Test number	CTXL8

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

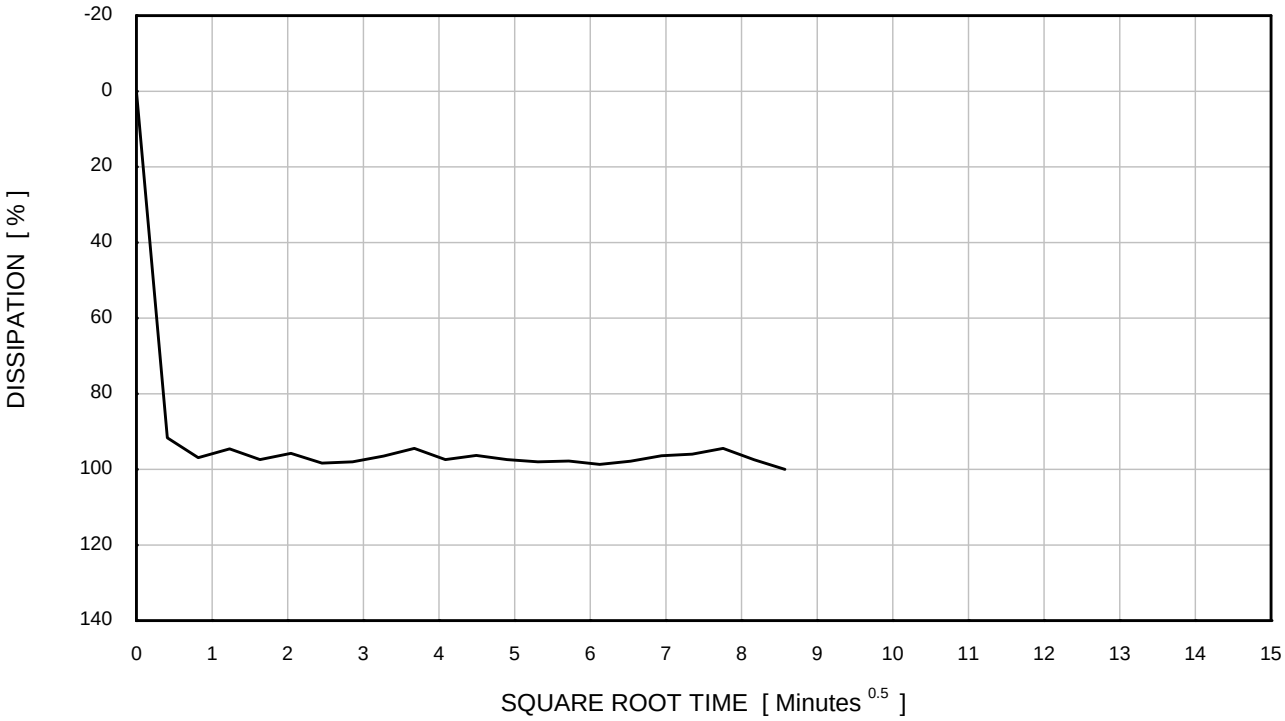


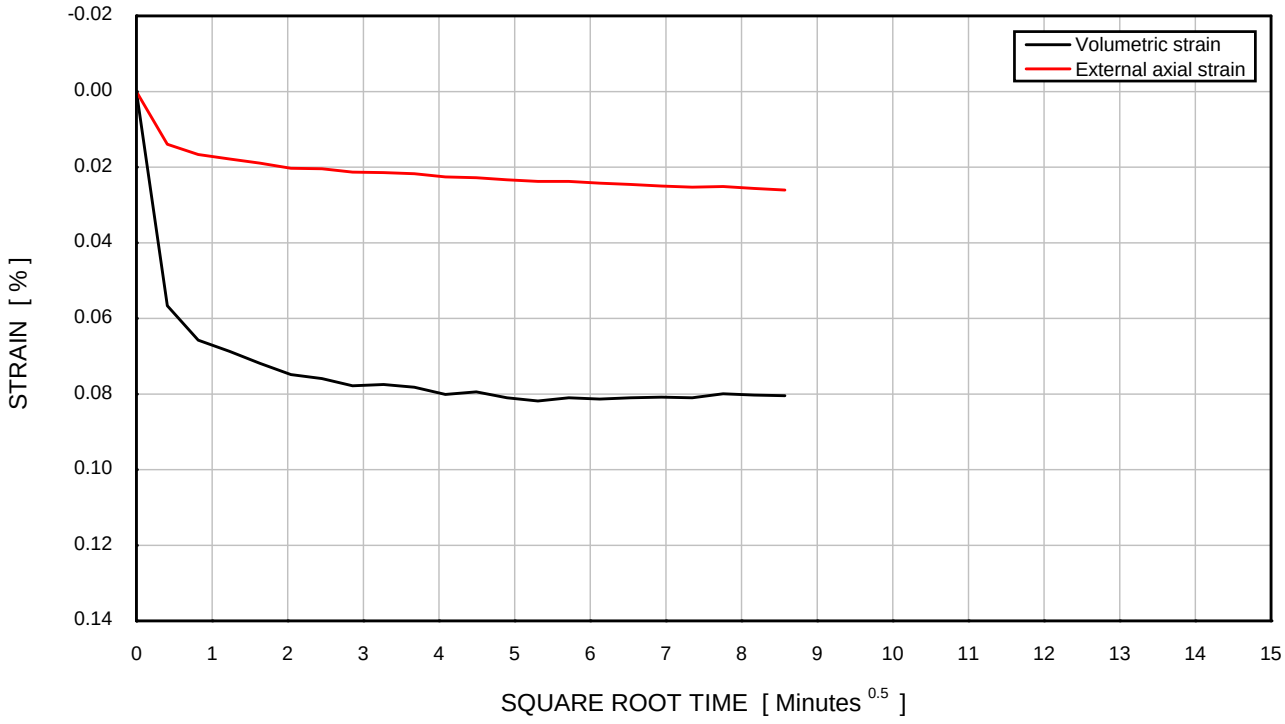


B value	:	0.95			
Initial σ'_r	:	17	kPa	Borehole	: Batch
Initial σ'_a	:	18	kPa	Sample	: Eem/Kreftenheye
Final σ'_r	:	55	kPa	Depth [m]	: -
Final σ'_a	:	55	kPa	Test No.	: CTXL8

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

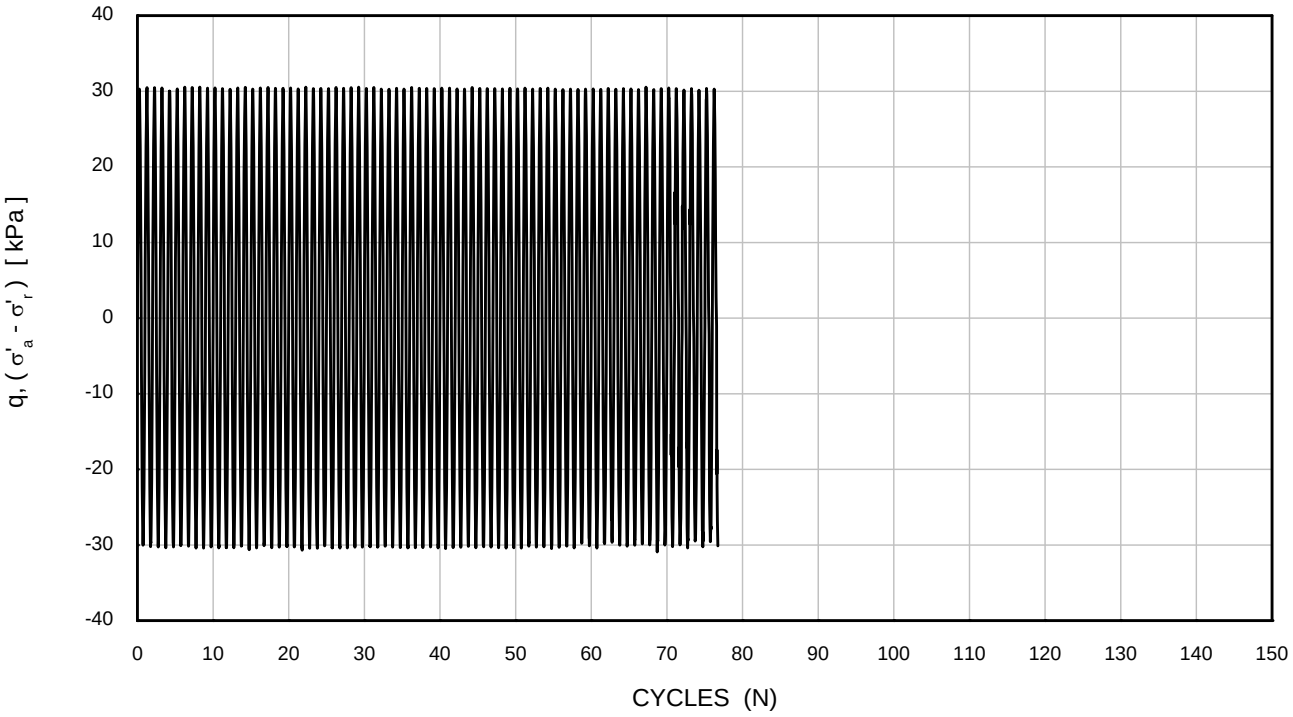


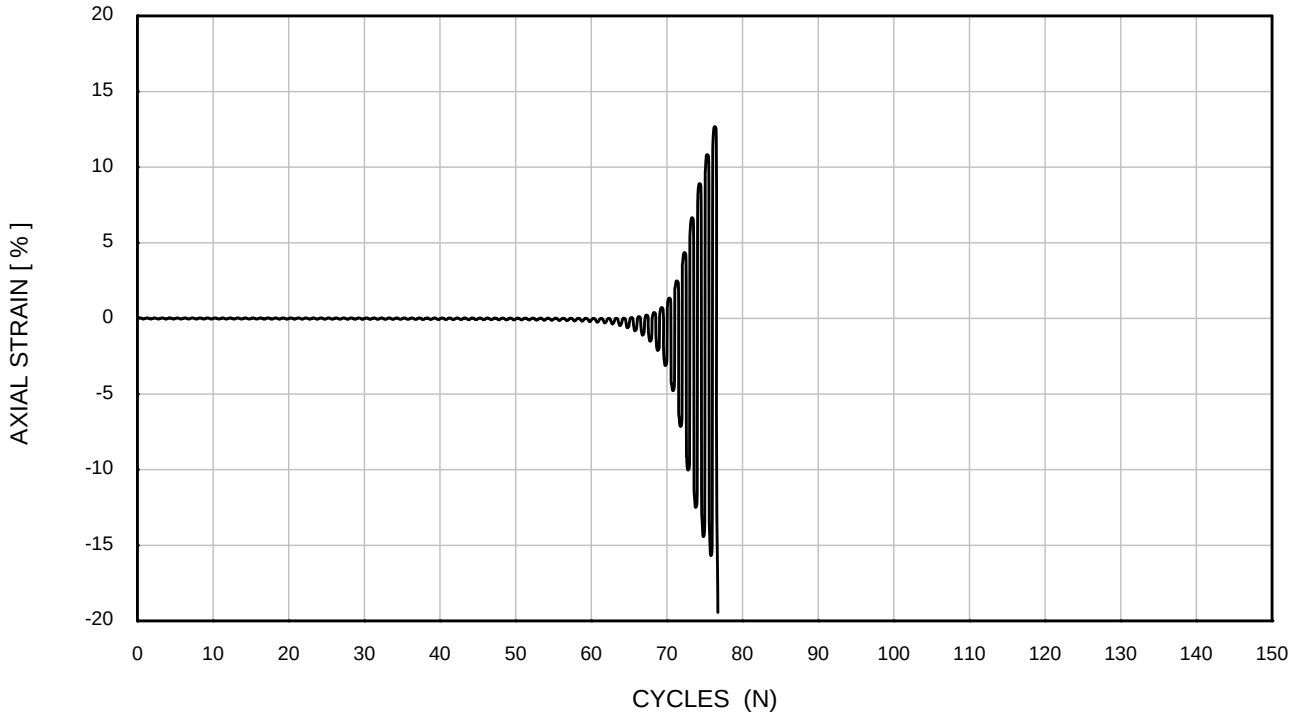


σ'_{rc}	:	80	kPa	Borehole	: Batch
σ'_{ac}	:	80	kPa	Sample	: Eem/Kreftenheye
				Depth [m]	: -
				Test No.	: CTXL8

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

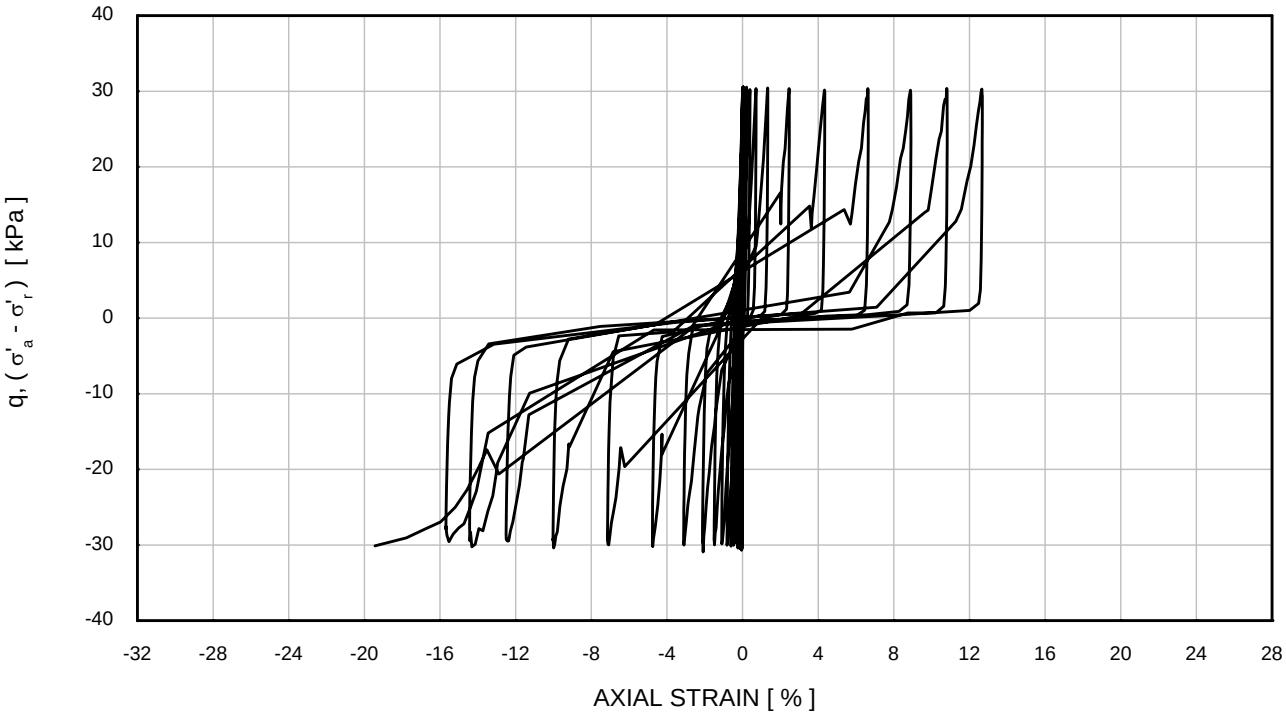


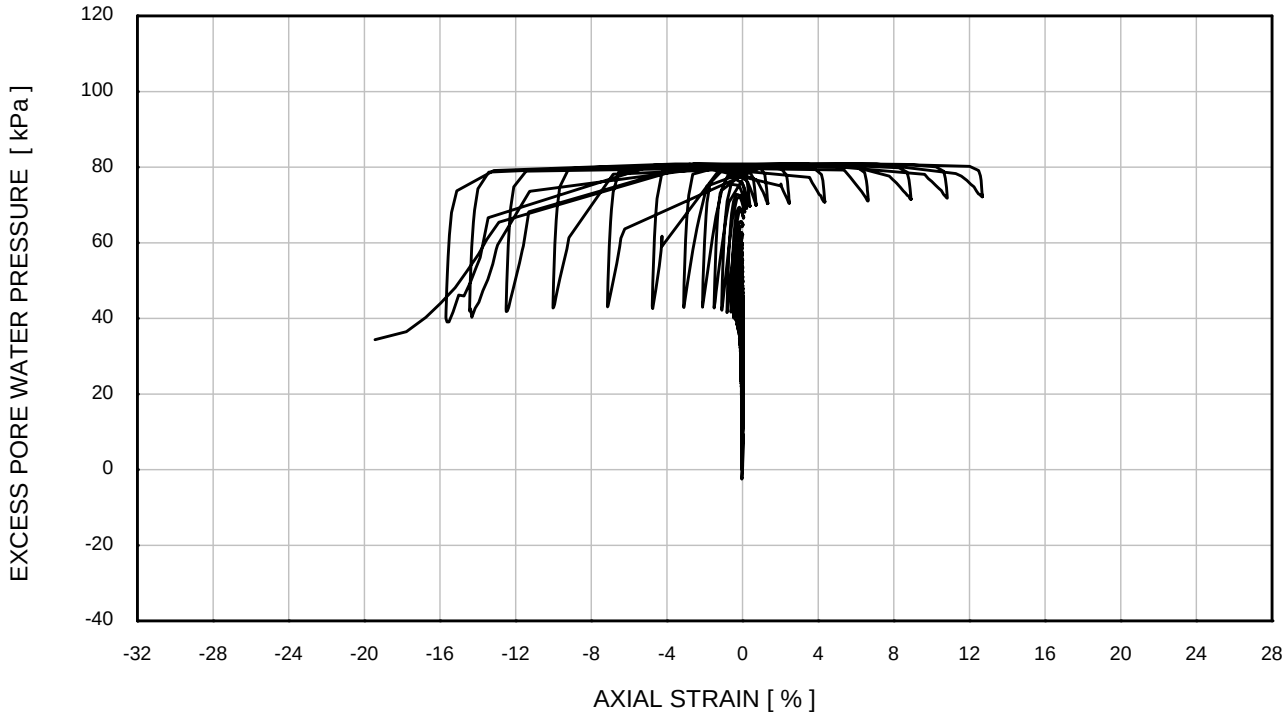


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

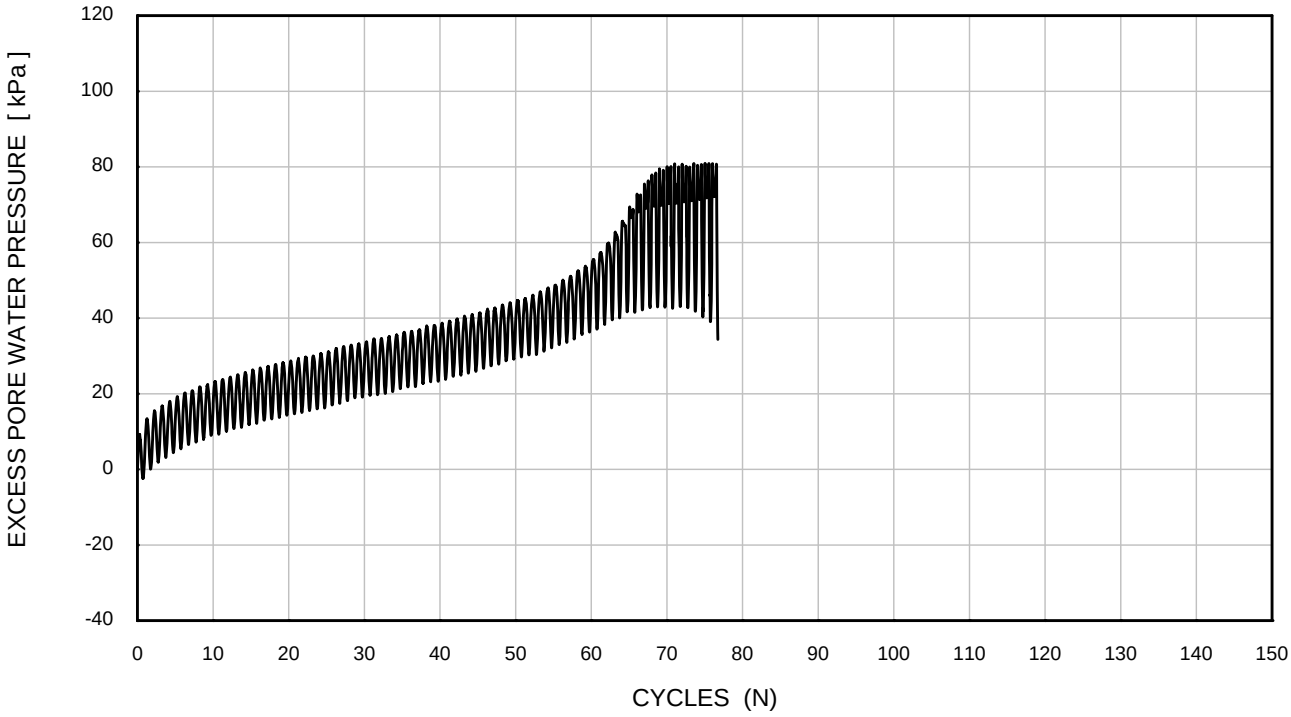


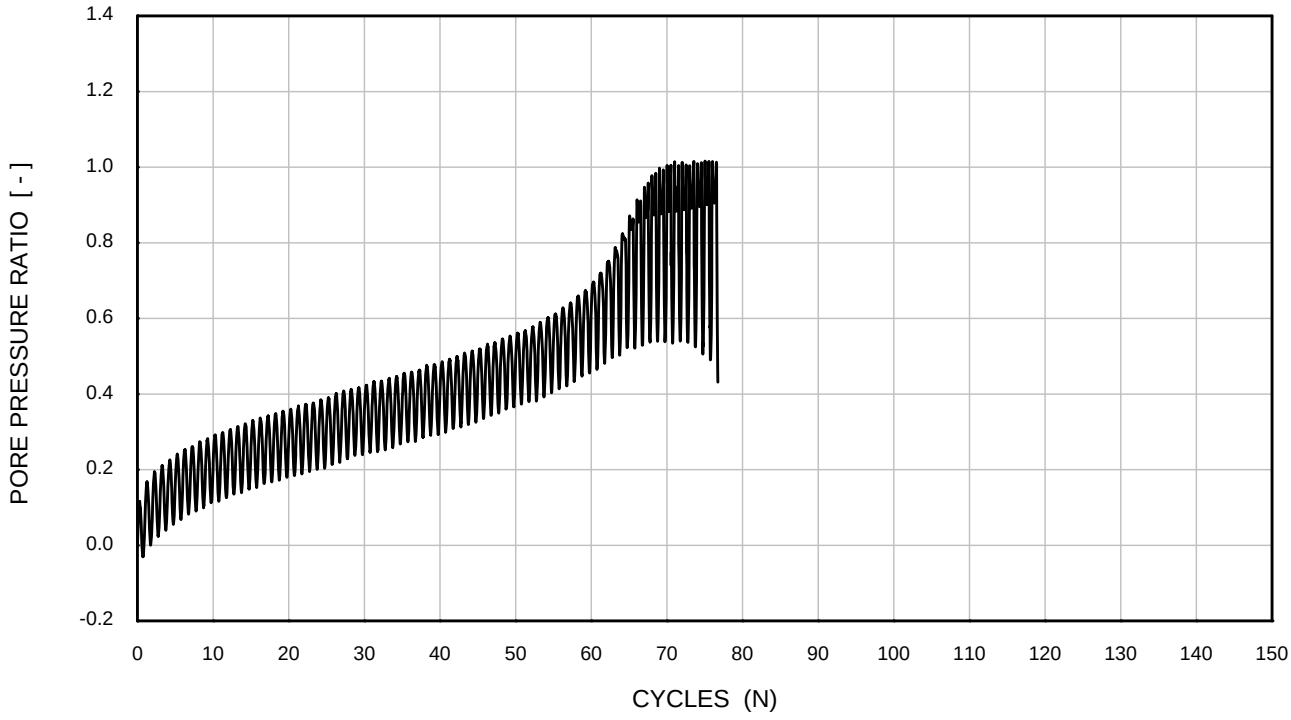


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

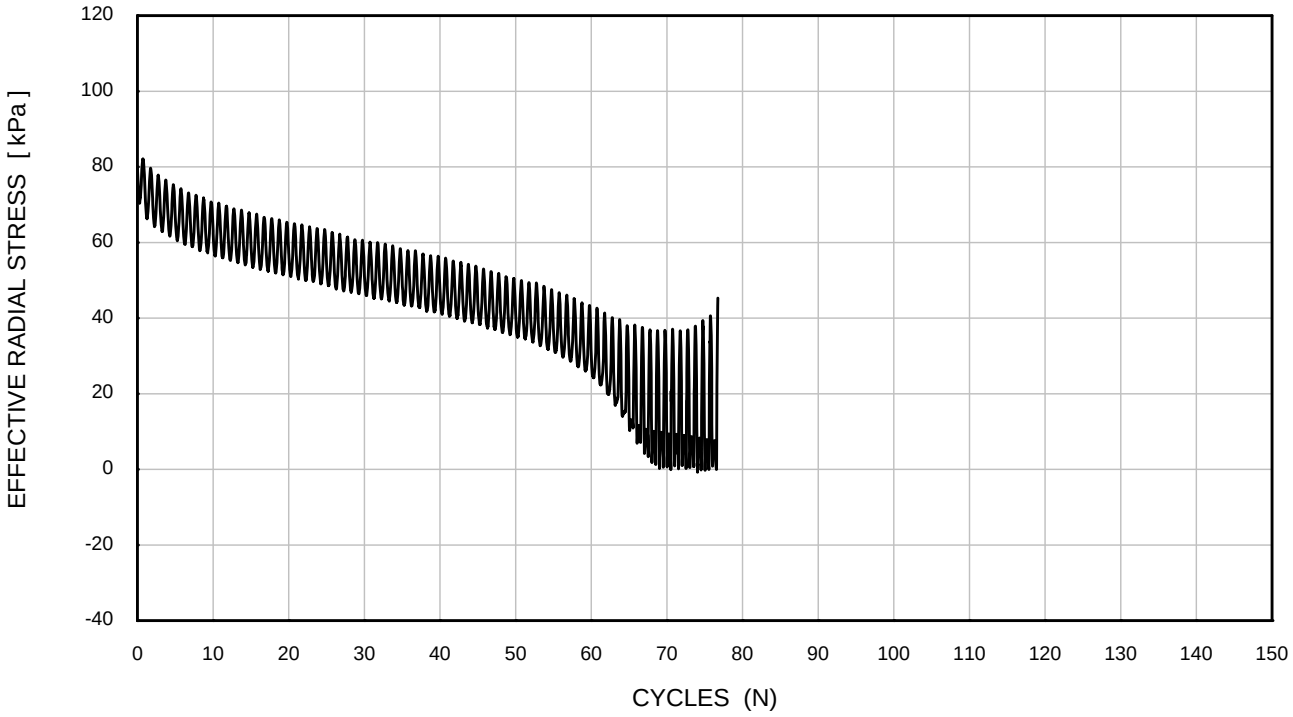


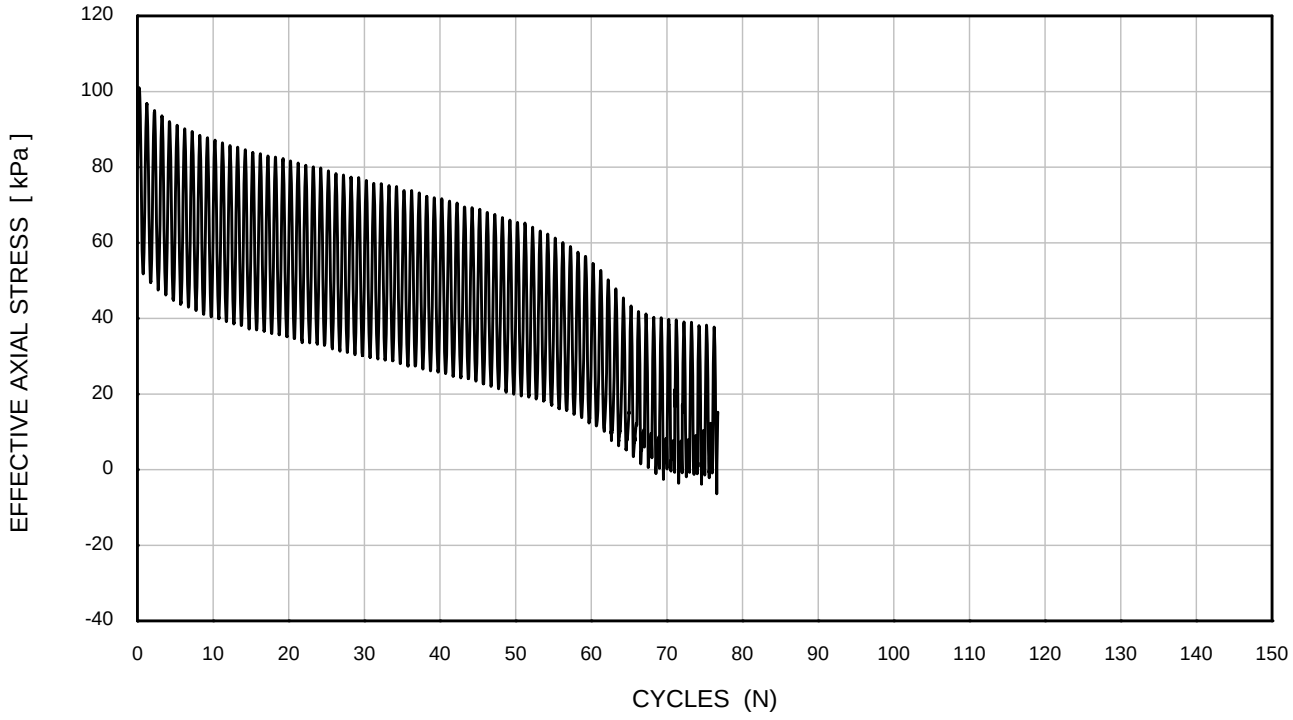


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

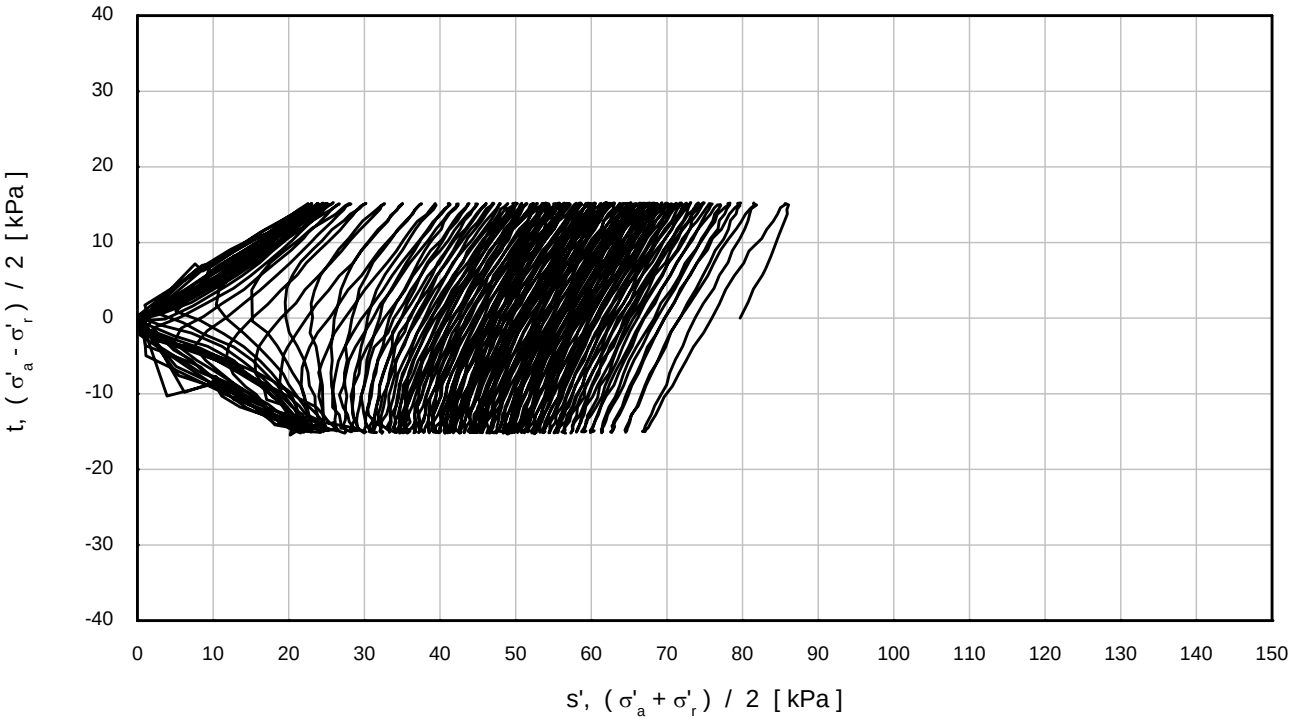


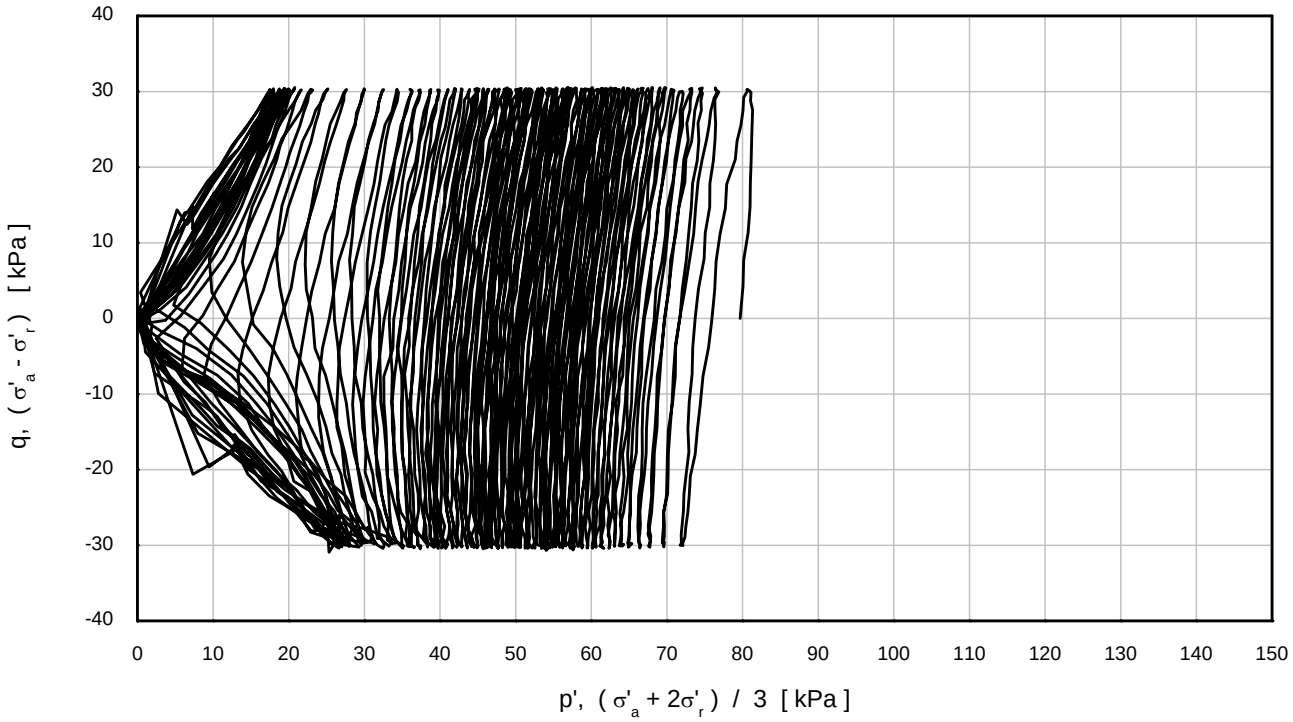


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

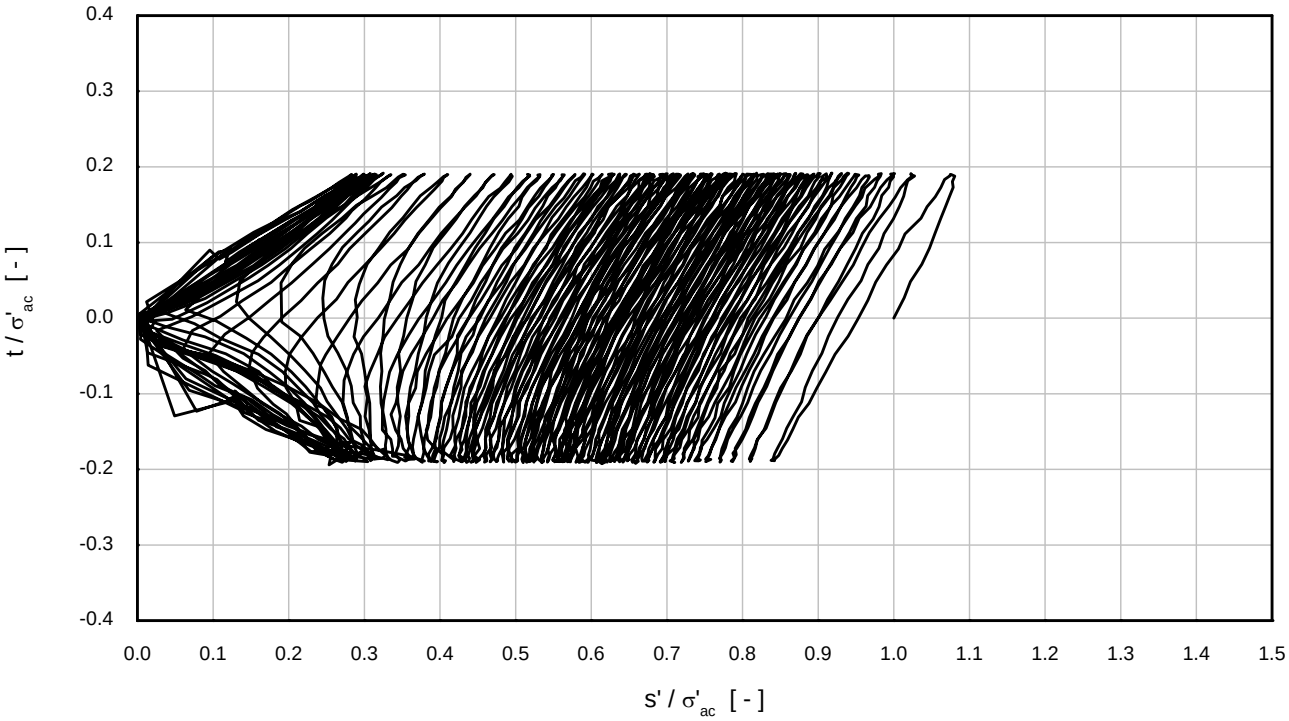


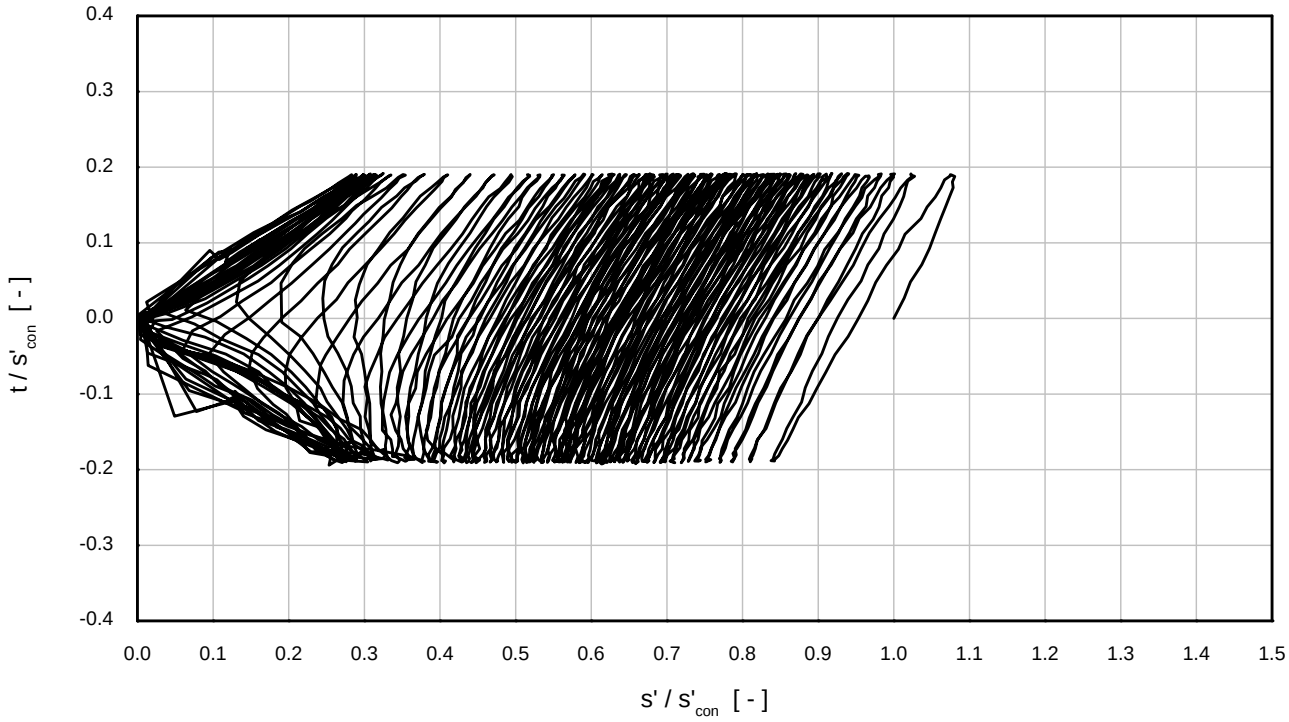


Initial σ'_r	:	80 kPa	Borehole	:	Batch
Initial σ'_a	:	80 kPa	Sample	:	Eem/Kreftenheye
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	30 kPa	Test No.	:	CTXL8
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

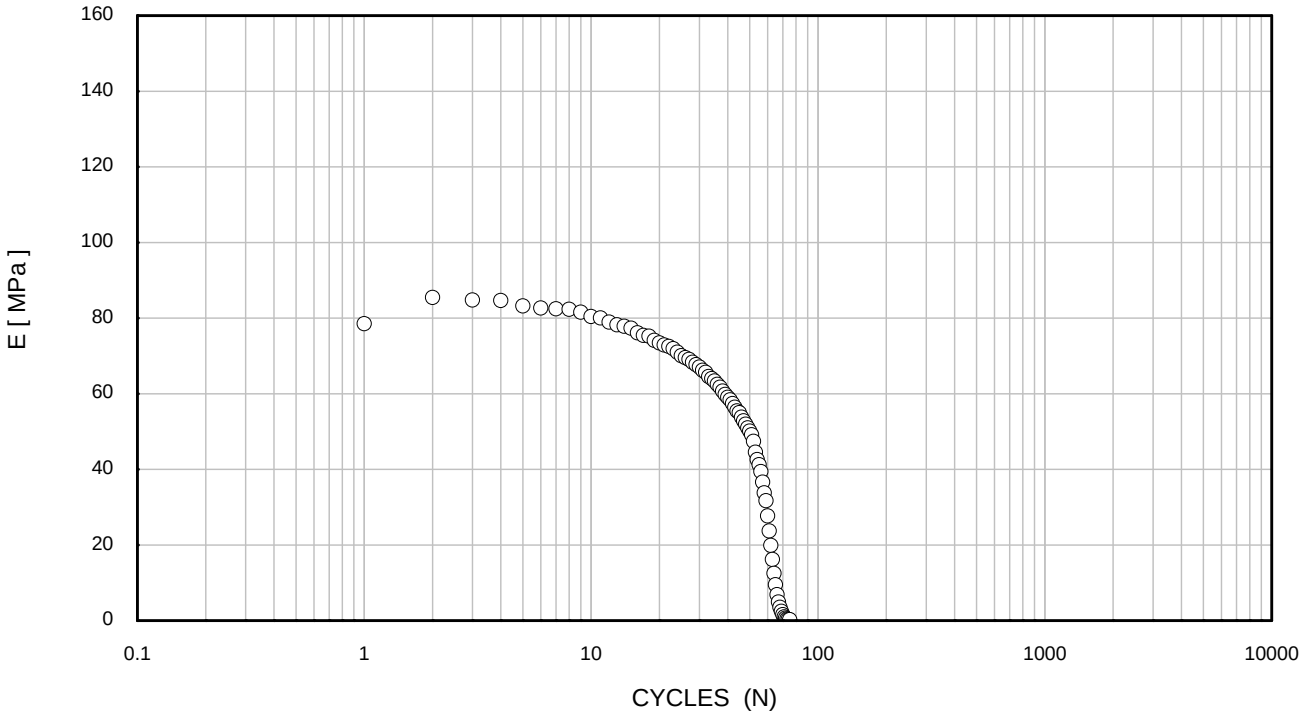


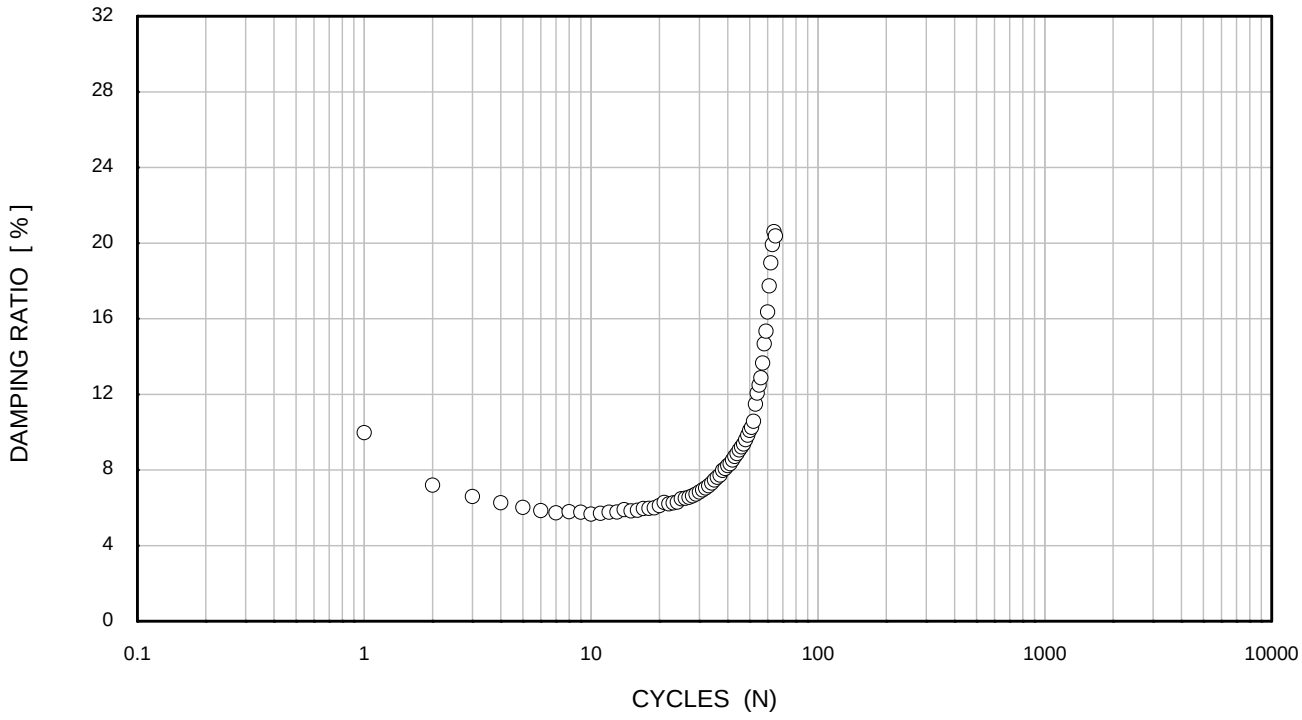


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

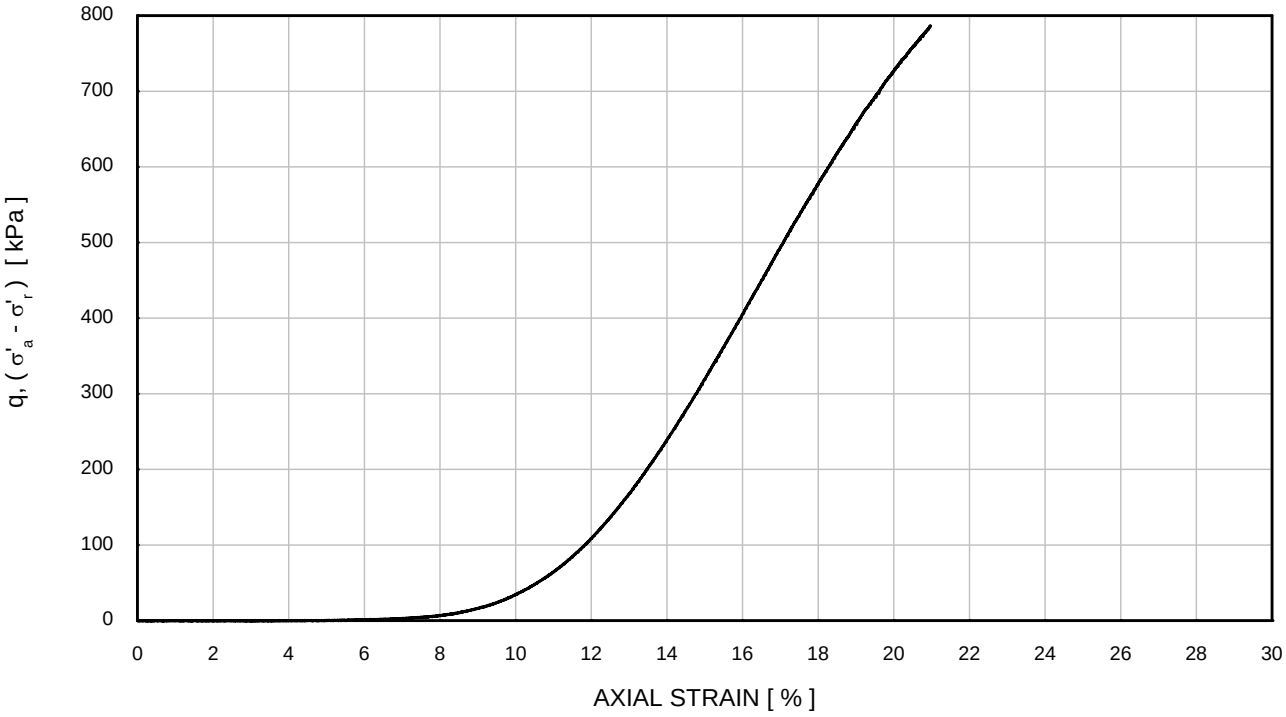


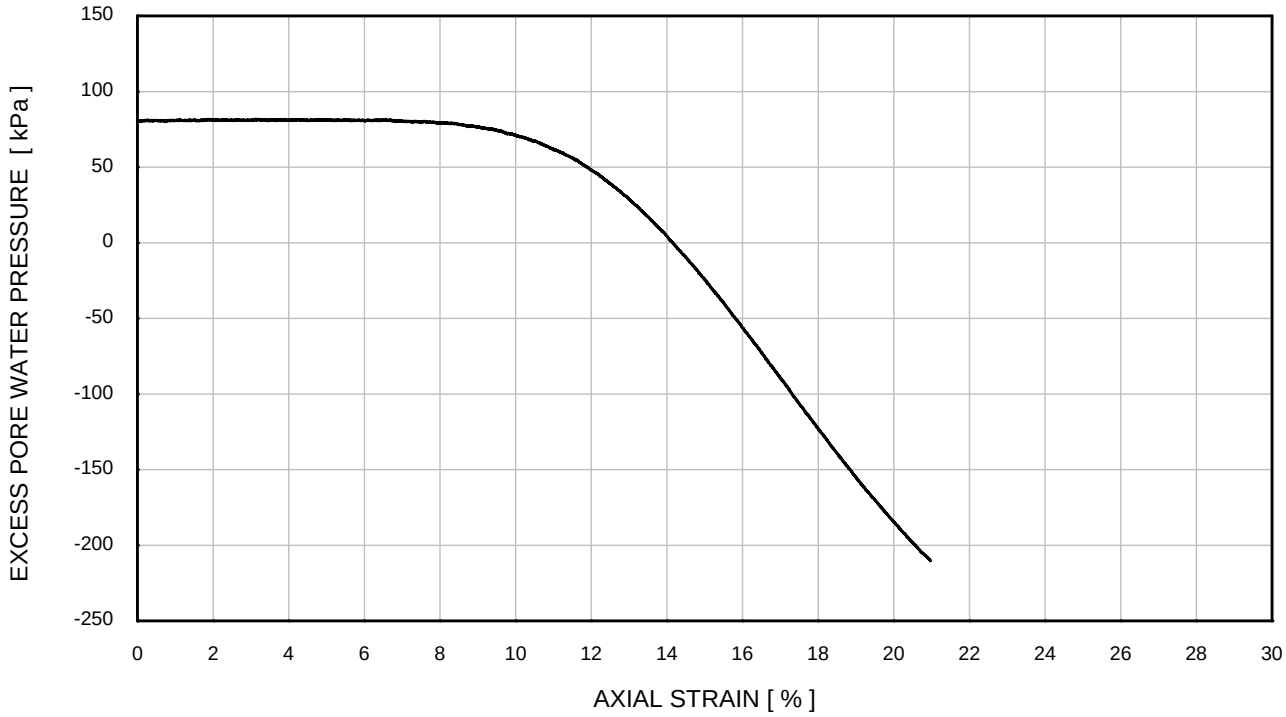


Initial σ'_r	:	80	kPa	Borehole	: Batch
Initial σ'_a	:	80	kPa	Sample	: Eem/Kreftenheye
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	30	kPa	Test No.	: CTXL8
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

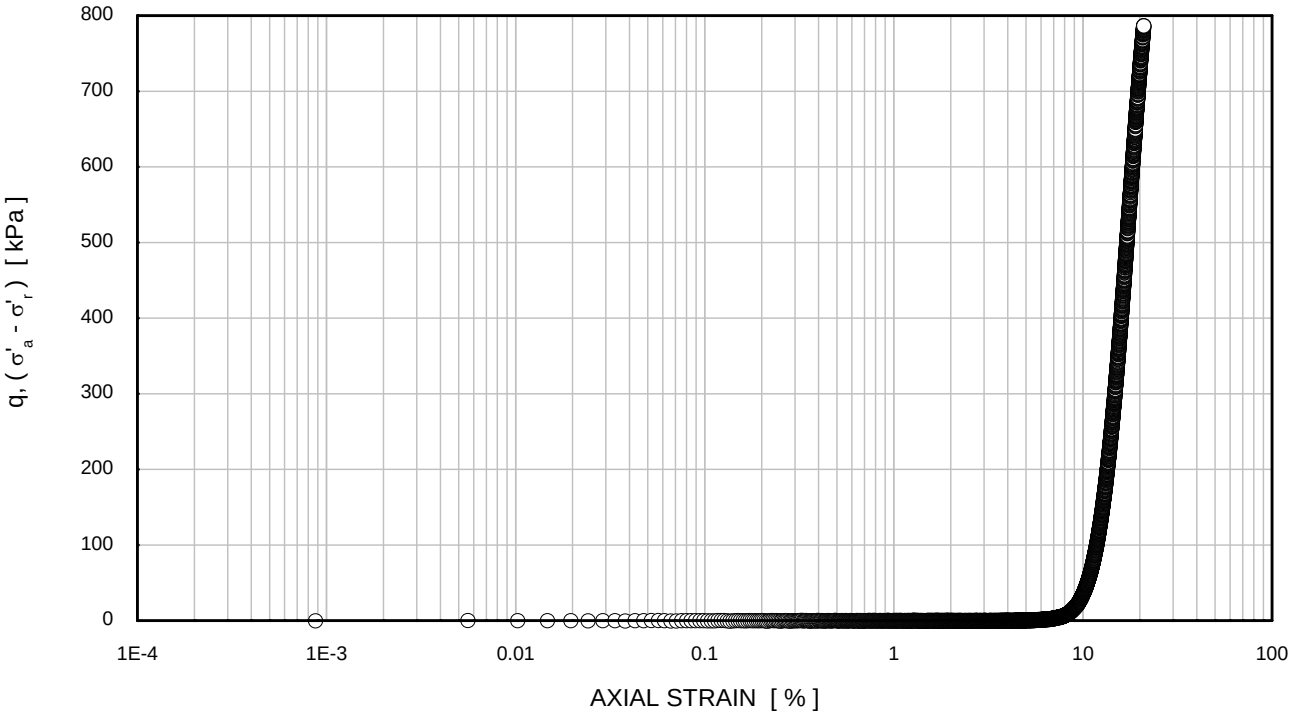


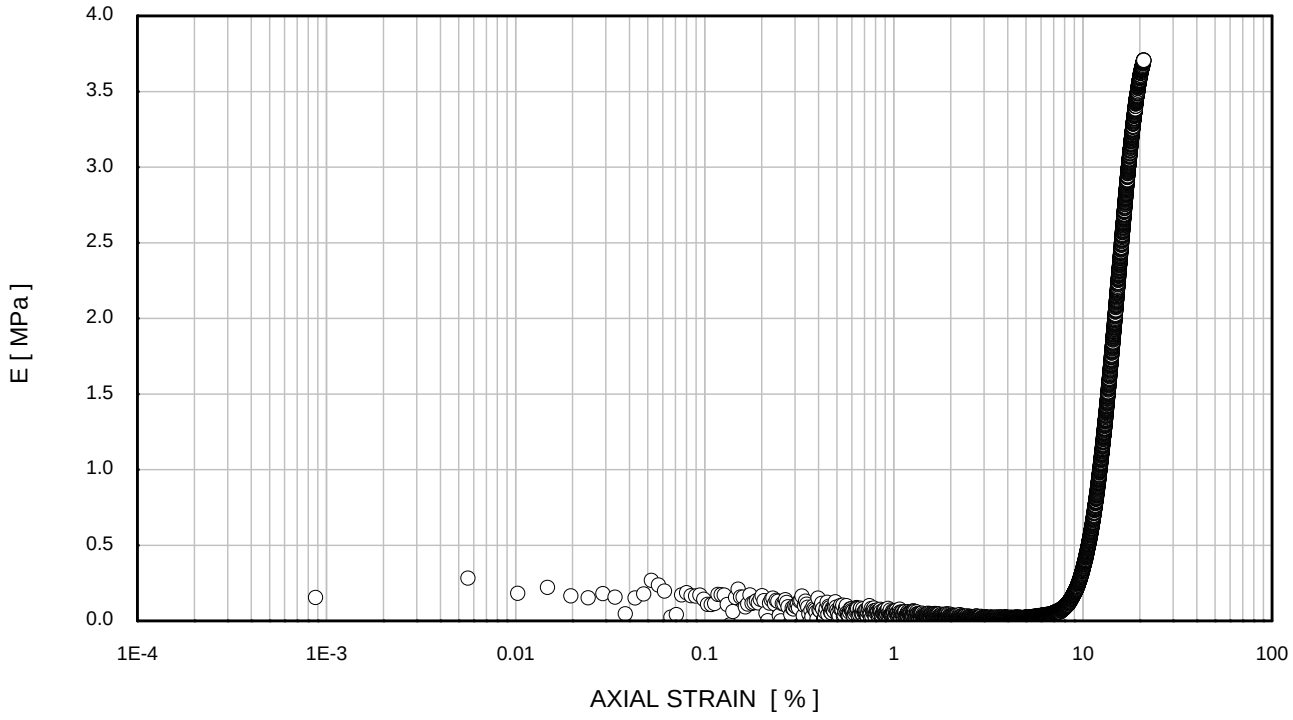


Initial σ'_r	:	-2	kPa	Borehole	: Batch
Initial σ'_a	:	-3	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	787	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	21.0	%	Test No.	: CTXL8
Rate of strain	:	0.84	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

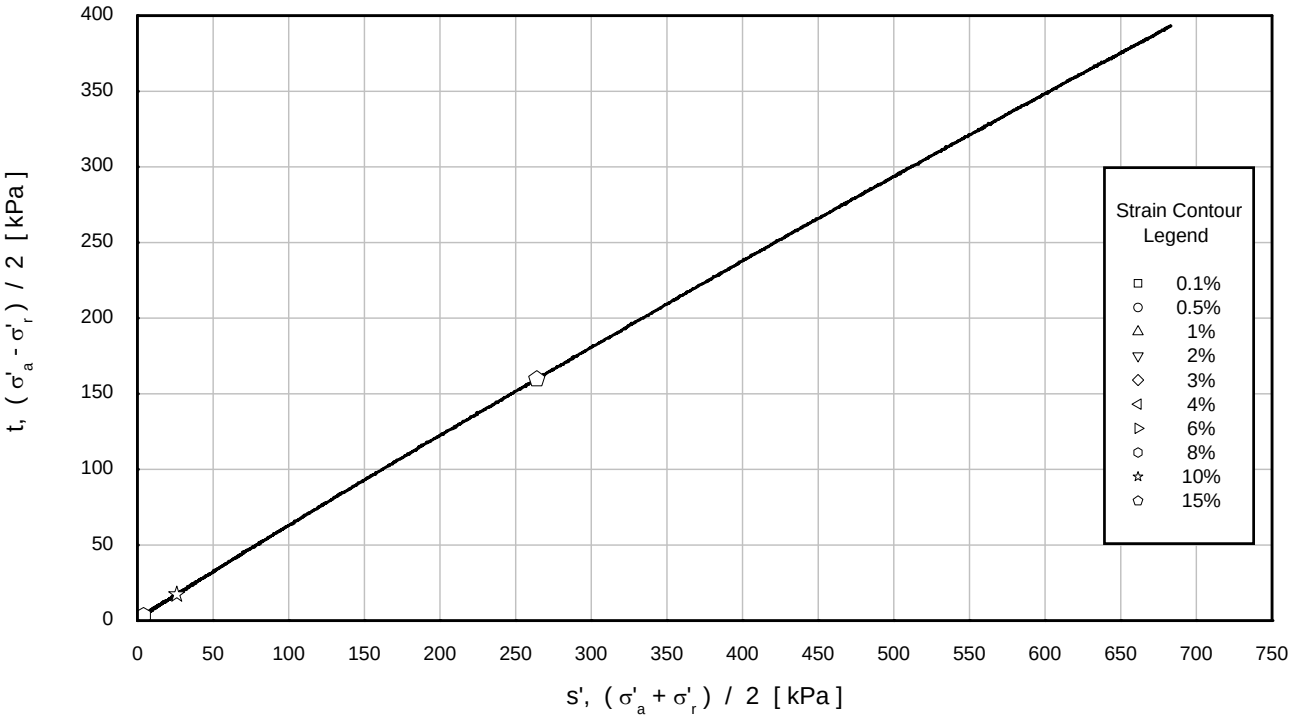


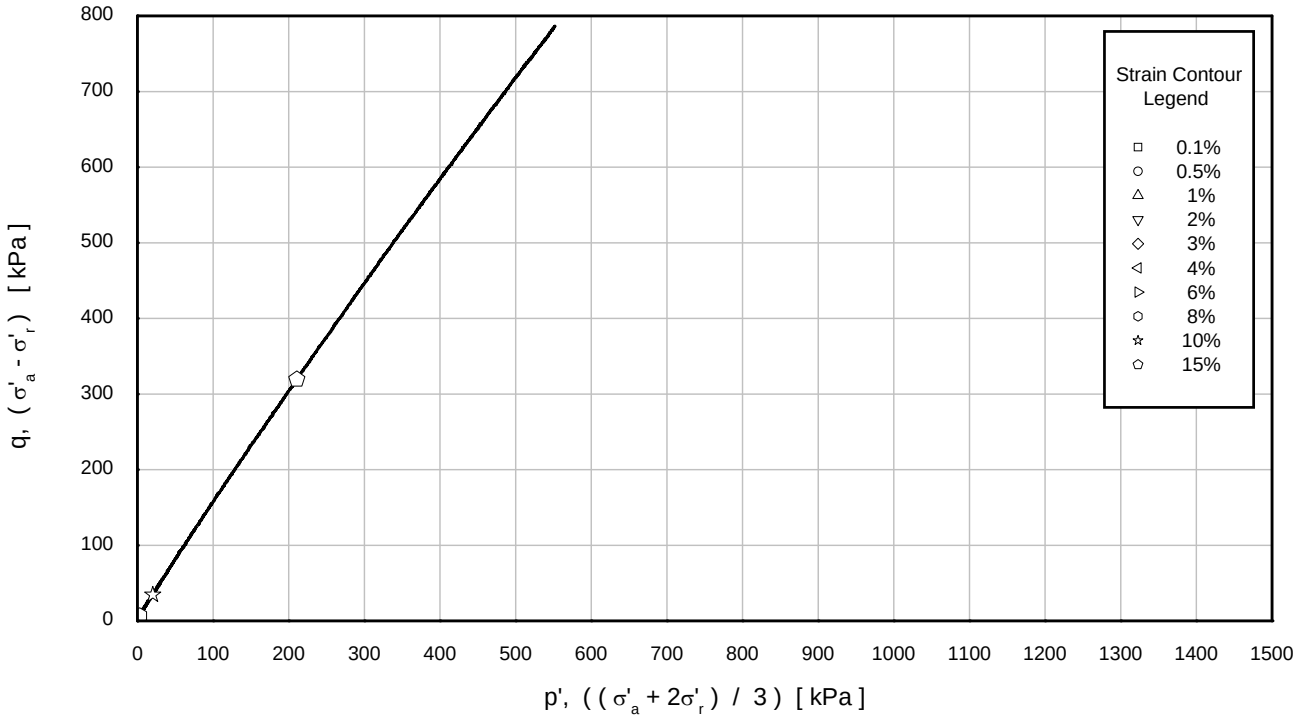


Initial σ'_r	:	-2	kPa	Borehole	: Batch
Initial σ'_a	:	-3	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	787	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	21.0	%	Test No.	: CTXL8
Rate of strain	:	0.84	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	-2	kPa	Borehole	: Batch
Initial σ'_a	:	-3	kPa	Sample	: Eem/Kreftenheye
q_{peak}	:	787	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	21.0	%	Test No.	: CTXL8
Rate of strain	:	0.84	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Olive grey silty fine SAND

GENERAL	
Date test started	27/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	10.1
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.61
Void ratio	[-]	0.645
Degree of saturation	[%]	41
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Tongeren_CTXL9
Processed by	LJ
Date	13/08/2015
Checked by	PH
Date	18/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL9

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1500
Base PWP	[kPa]	1449
Mid height PWP	[kPa]	-
B value achieved	[-]	0.97

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1500
Back pressure	[kPa]	1099
Base PWP	[kPa]	1100
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	400
Effective axial pressure	[kPa]	400
Deviator stress	[kPa]	0
Volumetric strain	[%]	2.07
External axial strain	[%]	0.48
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	23.1
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.65
Void ratio	[-]	0.611
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL9

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	400
Mean q_{av}	[kPa]	55
Mean q_{cy}	[kPa]	184
Frequency	[Hz]	0.16
Number of cycles at failure (N_f)	[-]	1
External ε_{av} at N_f	[%]	-7.92
External ε_{cy} at N_f	[%]	8.29
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	122
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	23.1
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.65
Void ratio	[-]	0.611
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	-7.92	8.29	2	-	19.87	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL9

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS

FINAL CONDITIONS

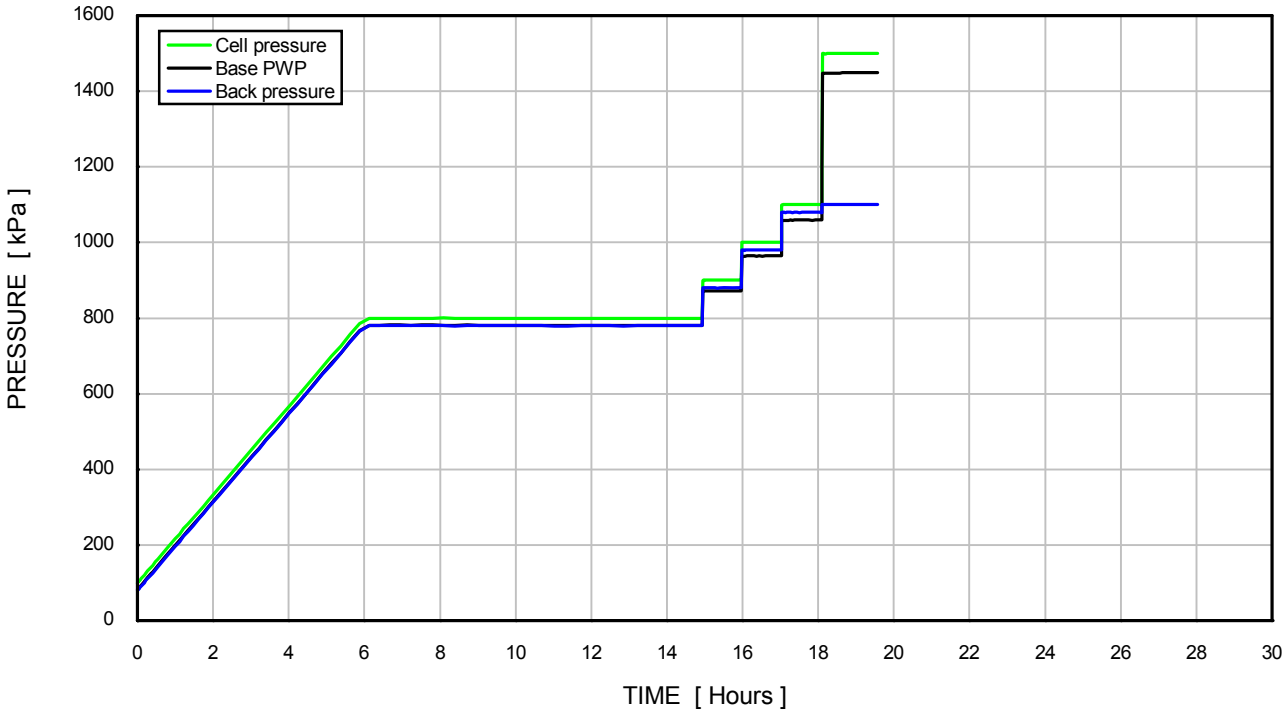
Moisture content	[%]	23.1
Bulk density	[Mg/m³]	2.02
Dry density	[Mg/m³]	1.65

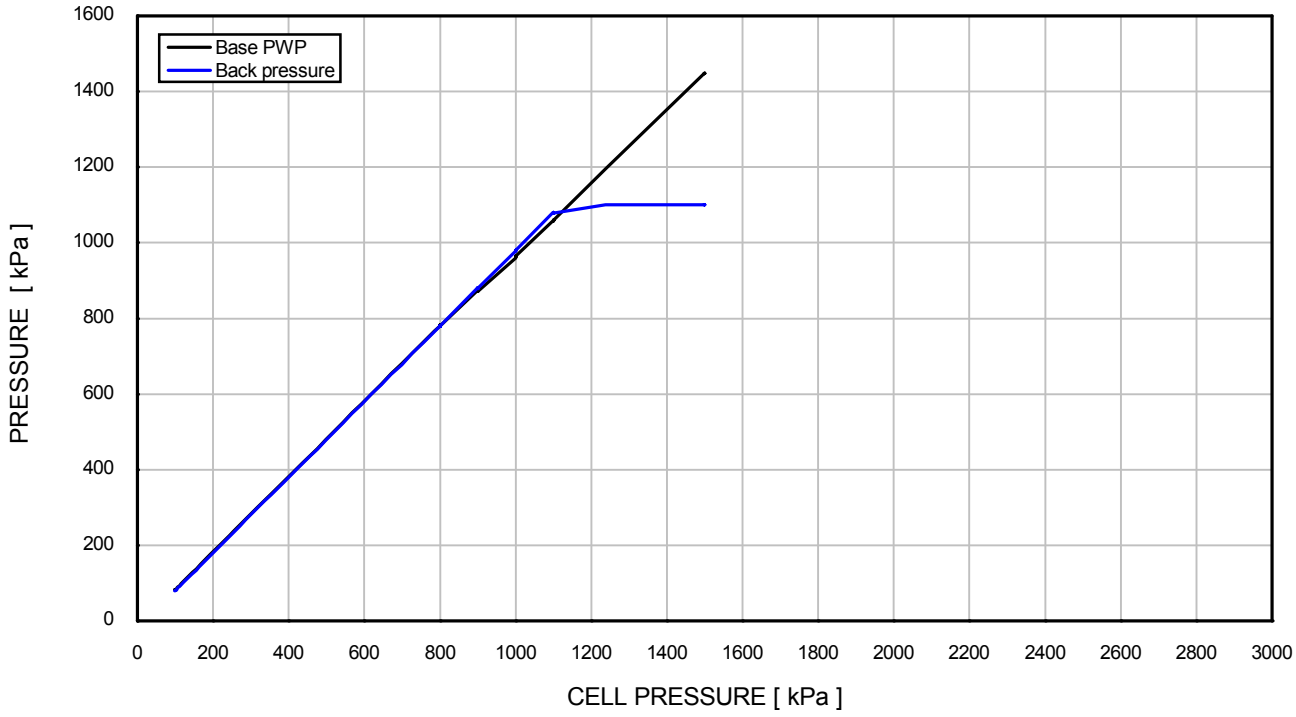
TEST IDENTIFICATION

Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL9

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

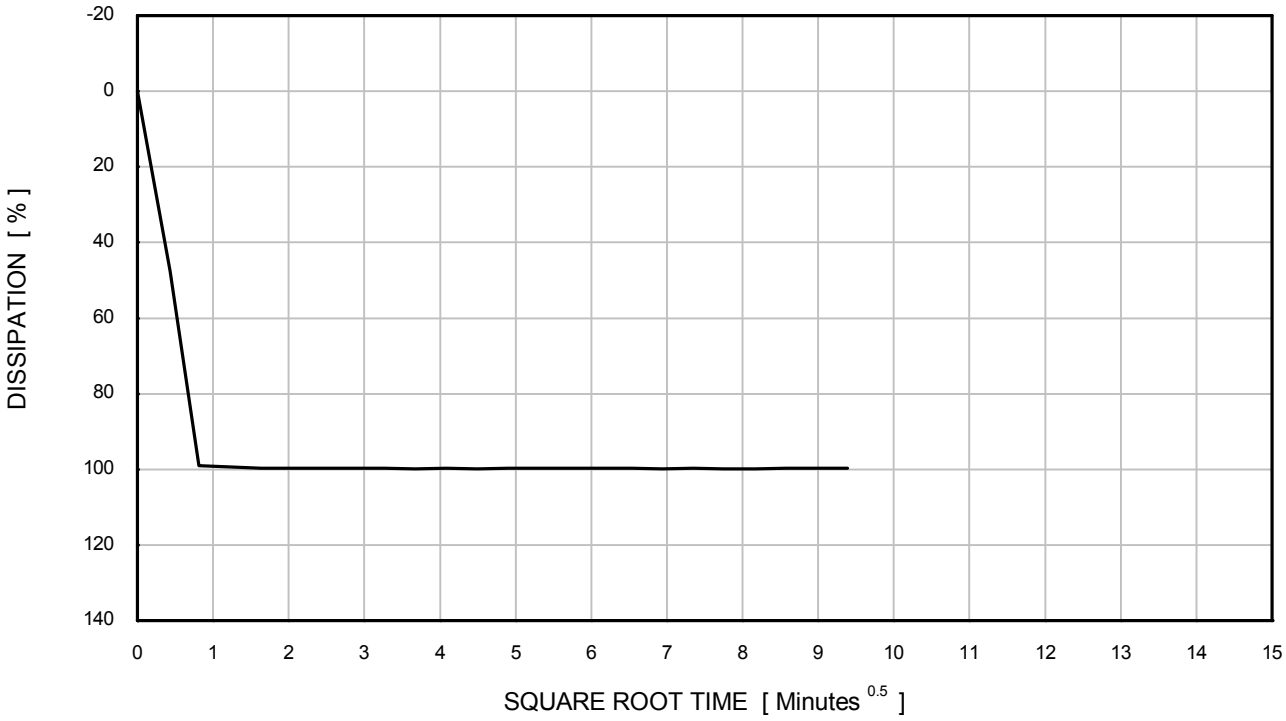


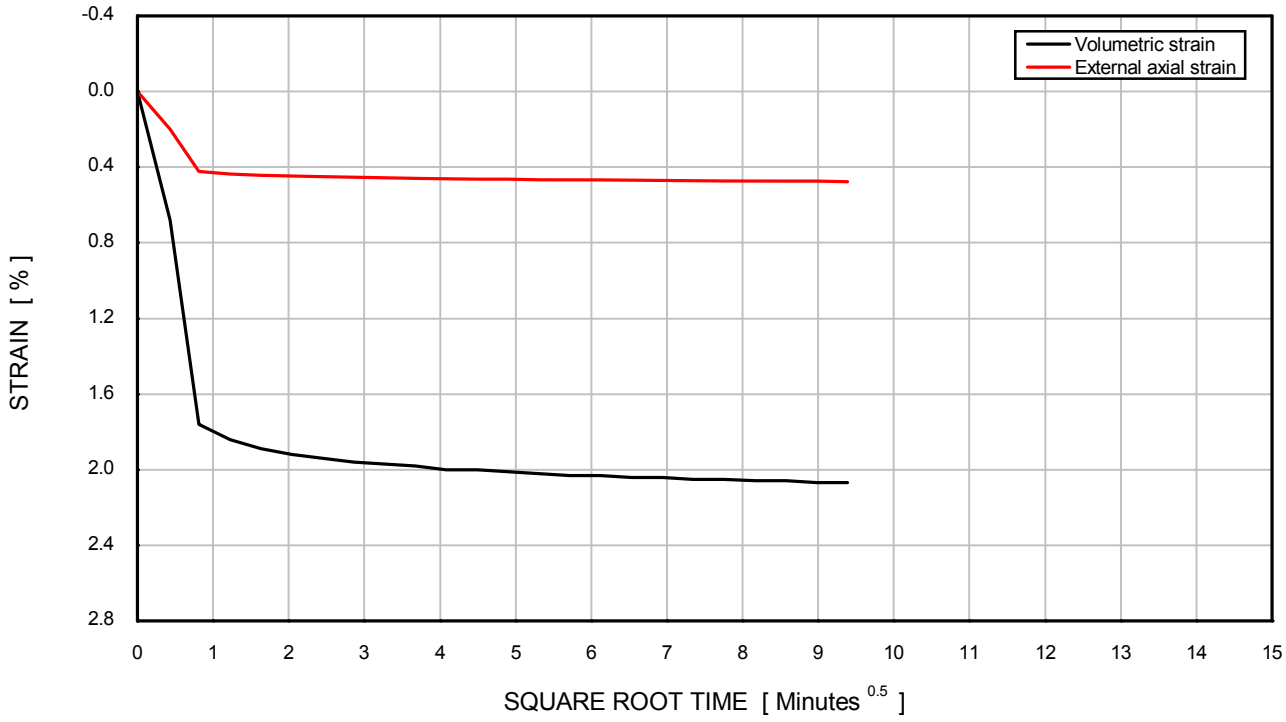


B value	:	0.97			
Initial σ'_r	:	16	kPa	Borehole	: Batch
Initial σ'_a	:	16	kPa	Sample	: Tongeren
Final σ'_r	:	51	kPa	Depth [m]	: -
Final σ'_a	:	51	kPa	Test No.	: CTXL9

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

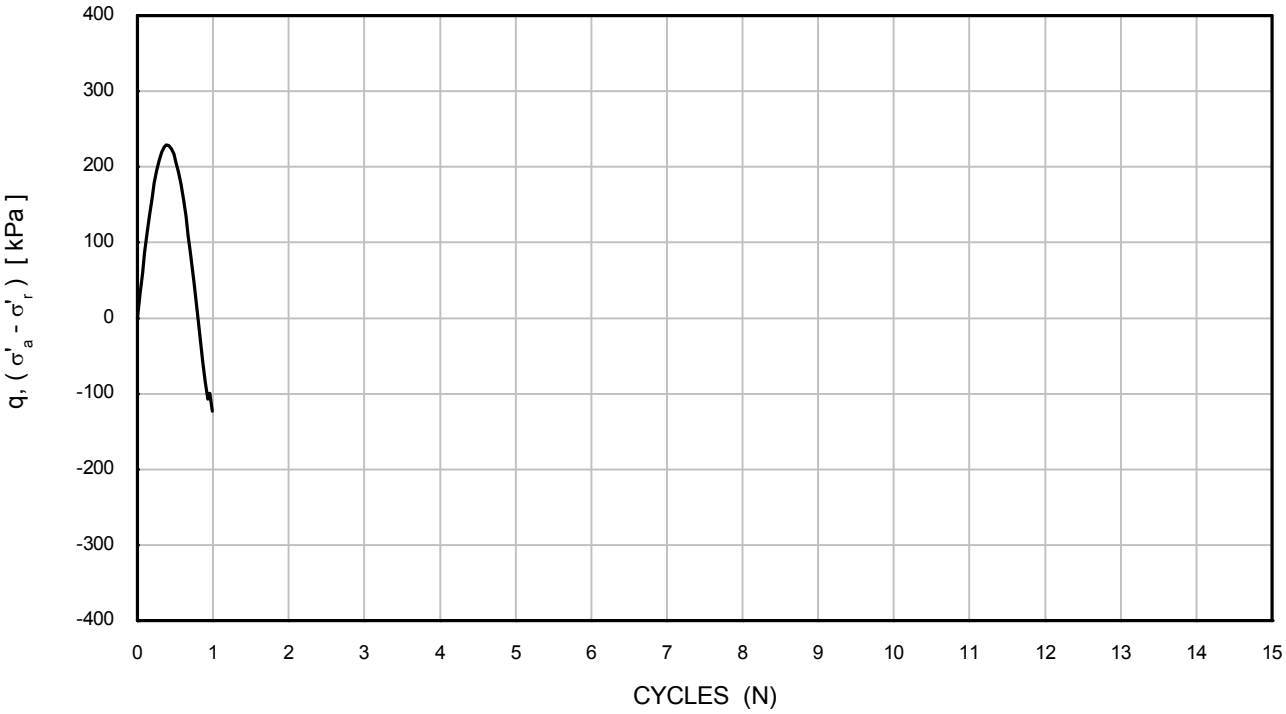


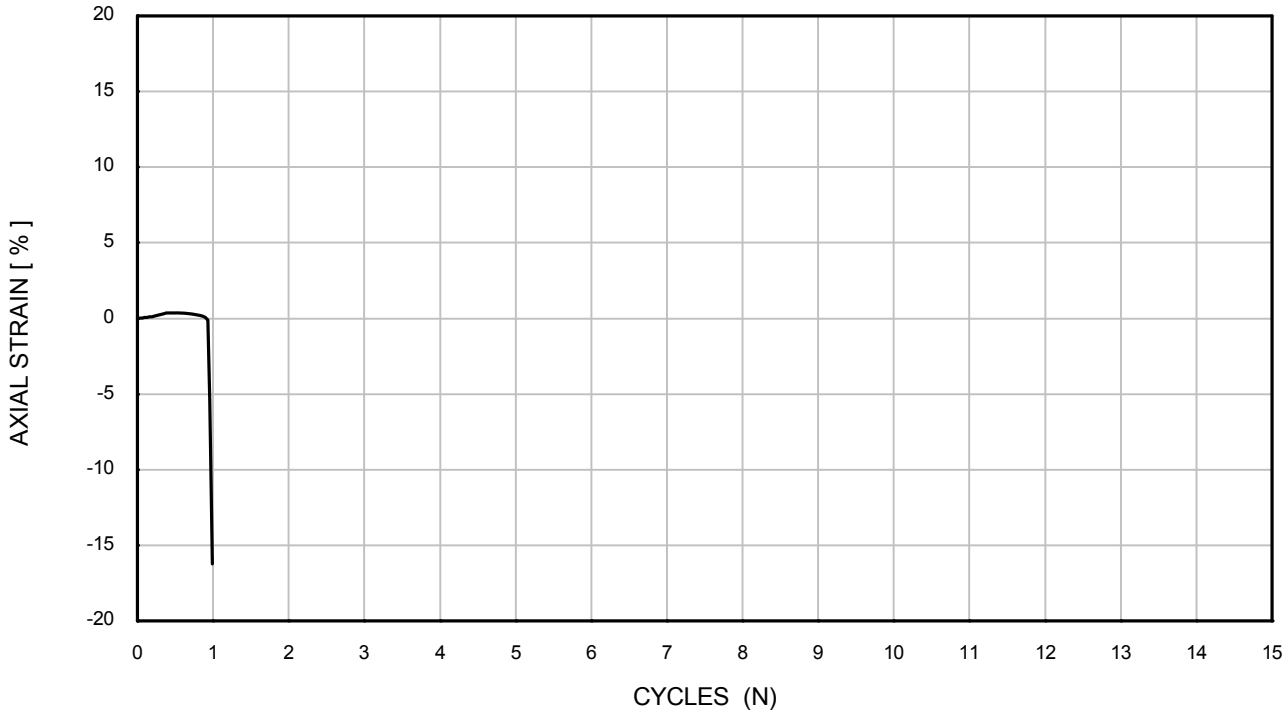


σ'_{rc}	: 400 kPa	Borehole	: Batch
σ'_{ac}	: 400 kPa	Sample	: Tongeren
		Depth [m]	: -
		Test No.	: CTXL9

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

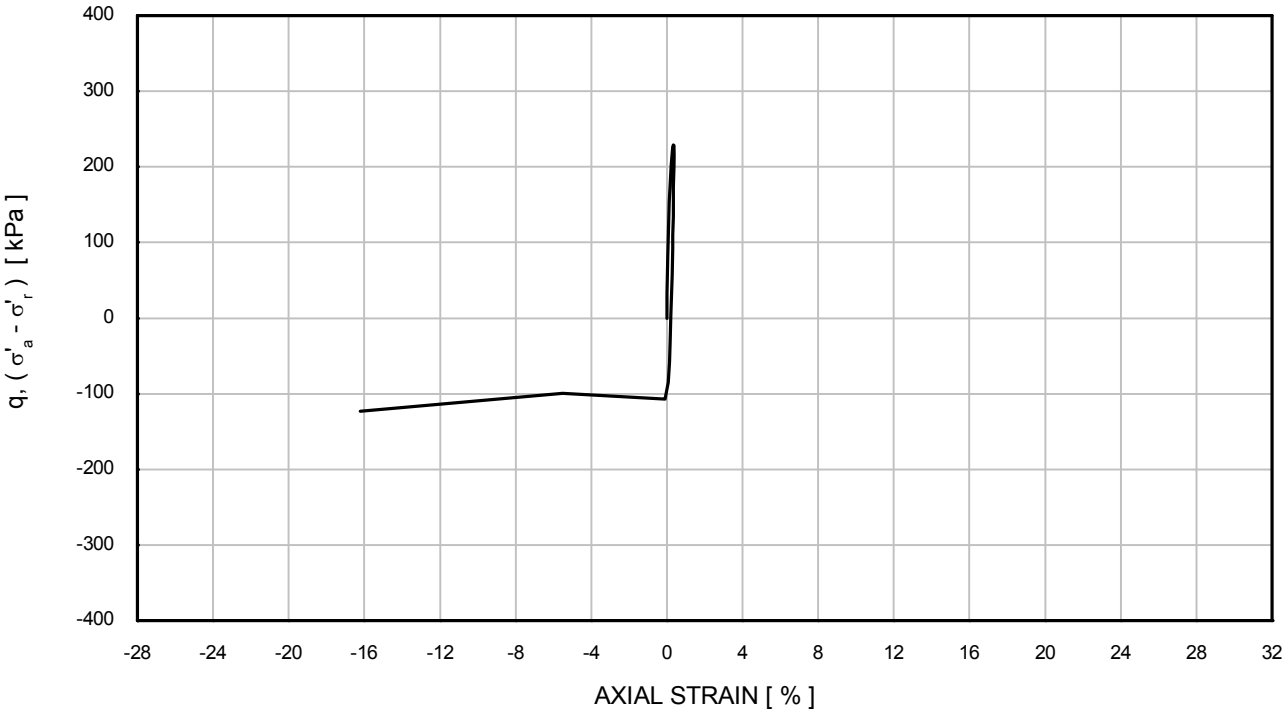


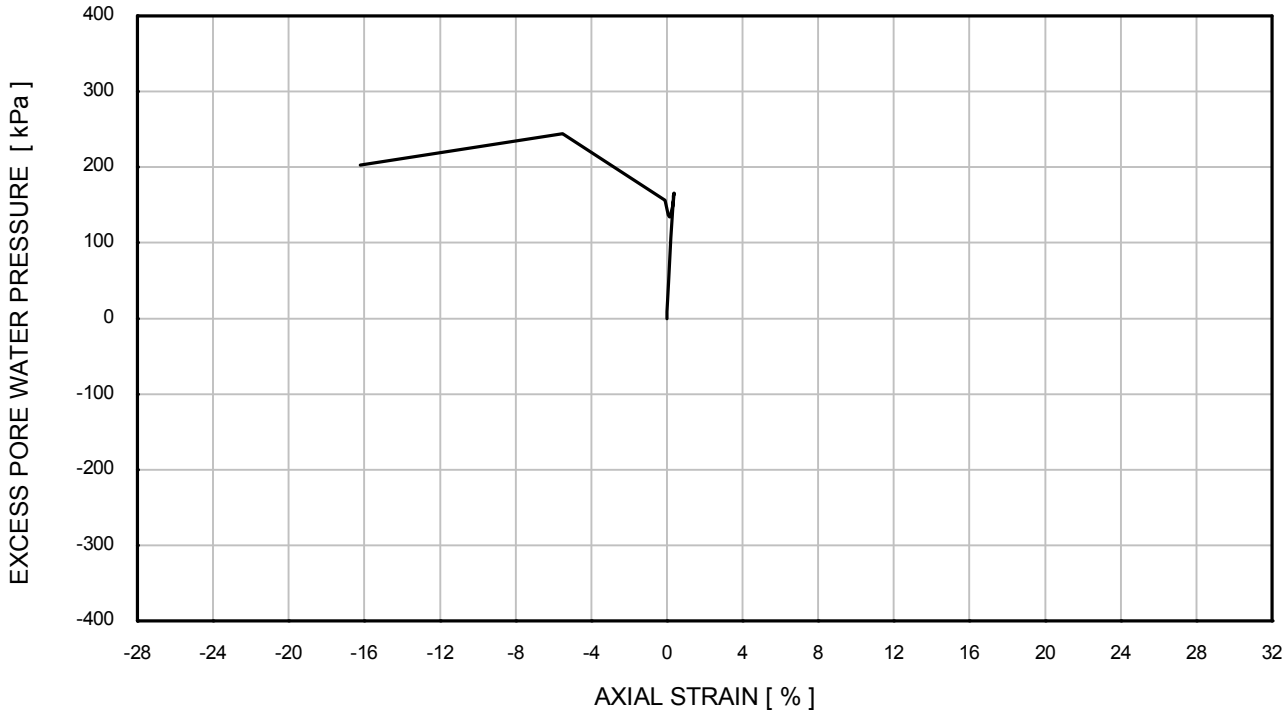


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	53 kPa	Depth [m]	:	-
q_{cy}	:	176 kPa	Test No.	:	CTXL9
Frequency	:	0.16 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

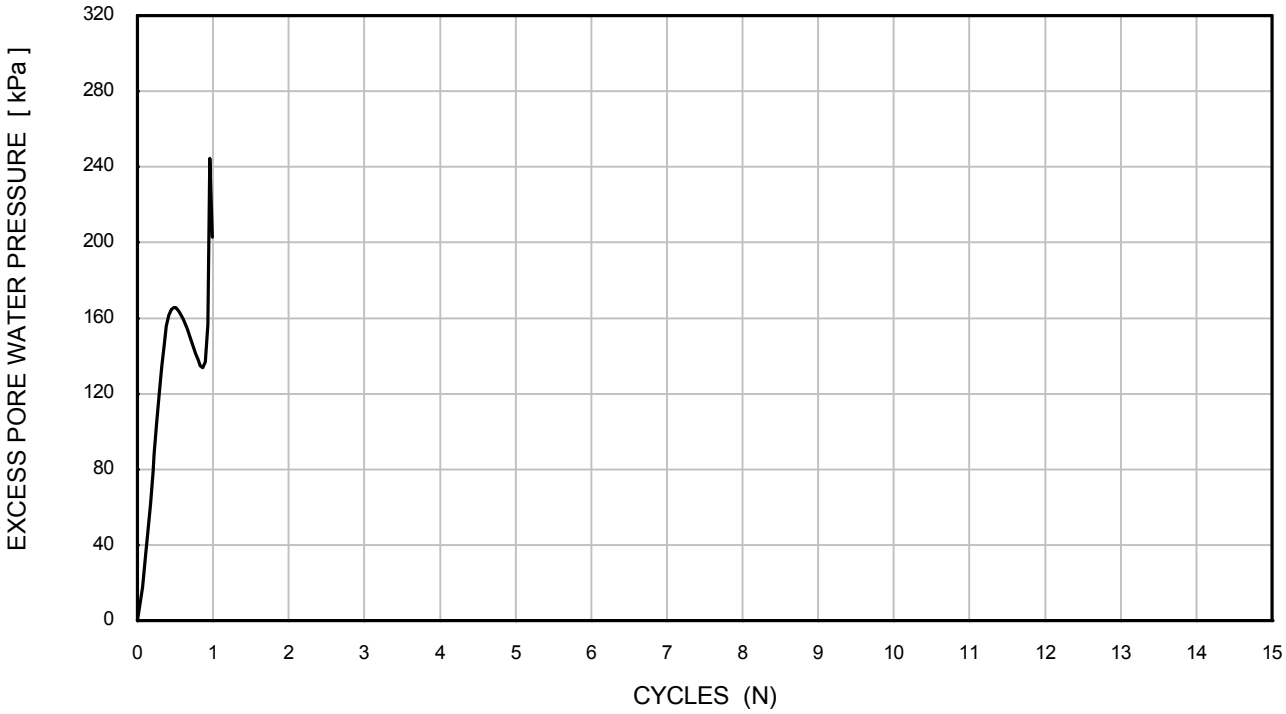


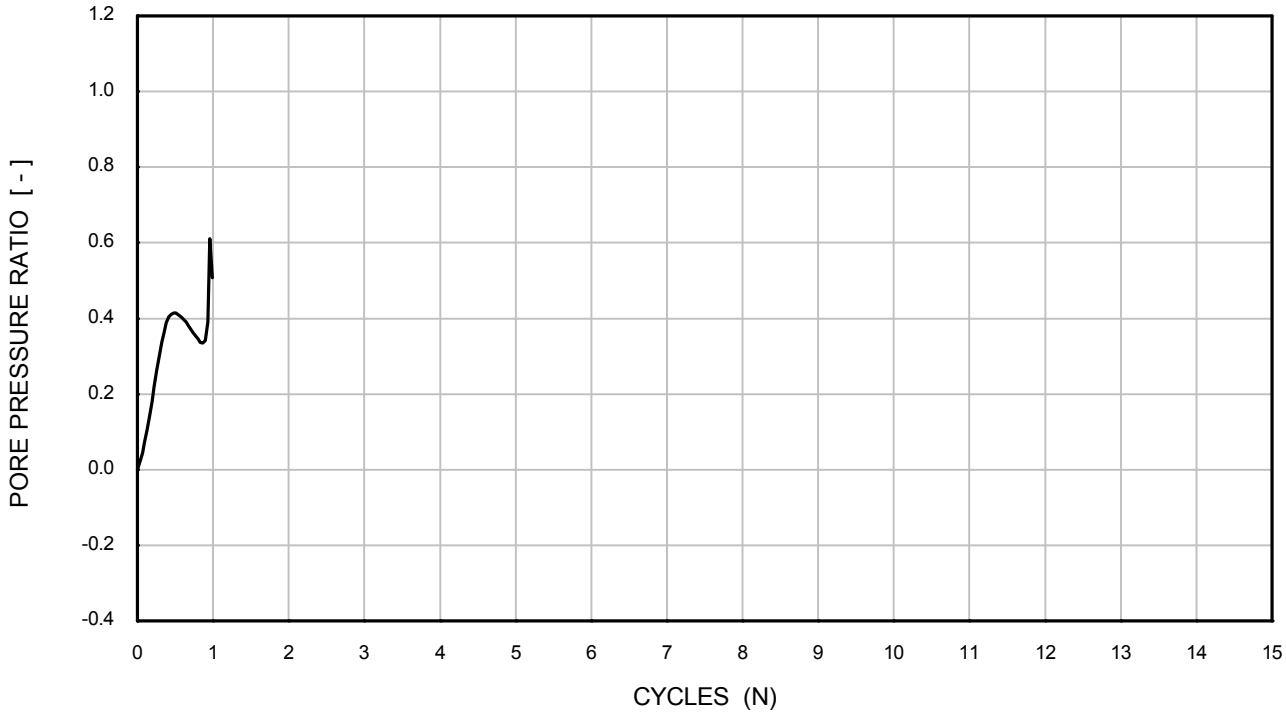


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	53 kPa	Depth [m]	:	-
q_{cy}	:	176 kPa	Test No.	:	CTXL9
Frequency	:	0.16 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

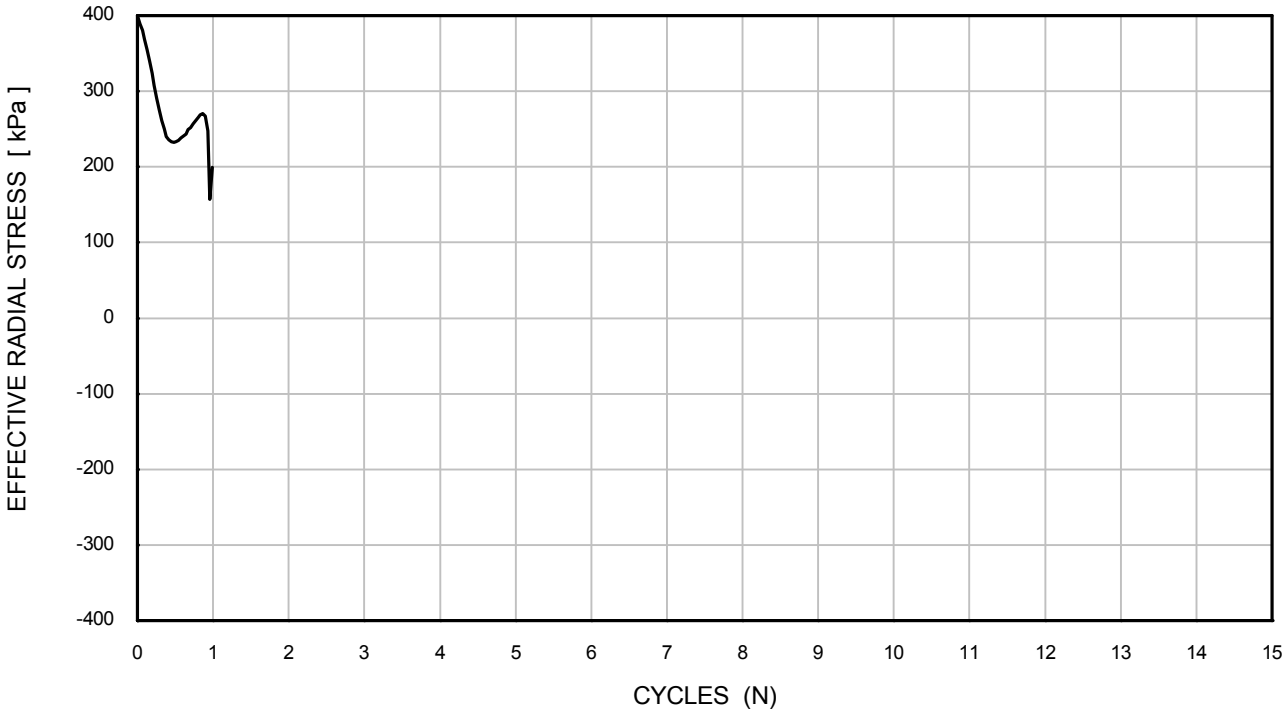


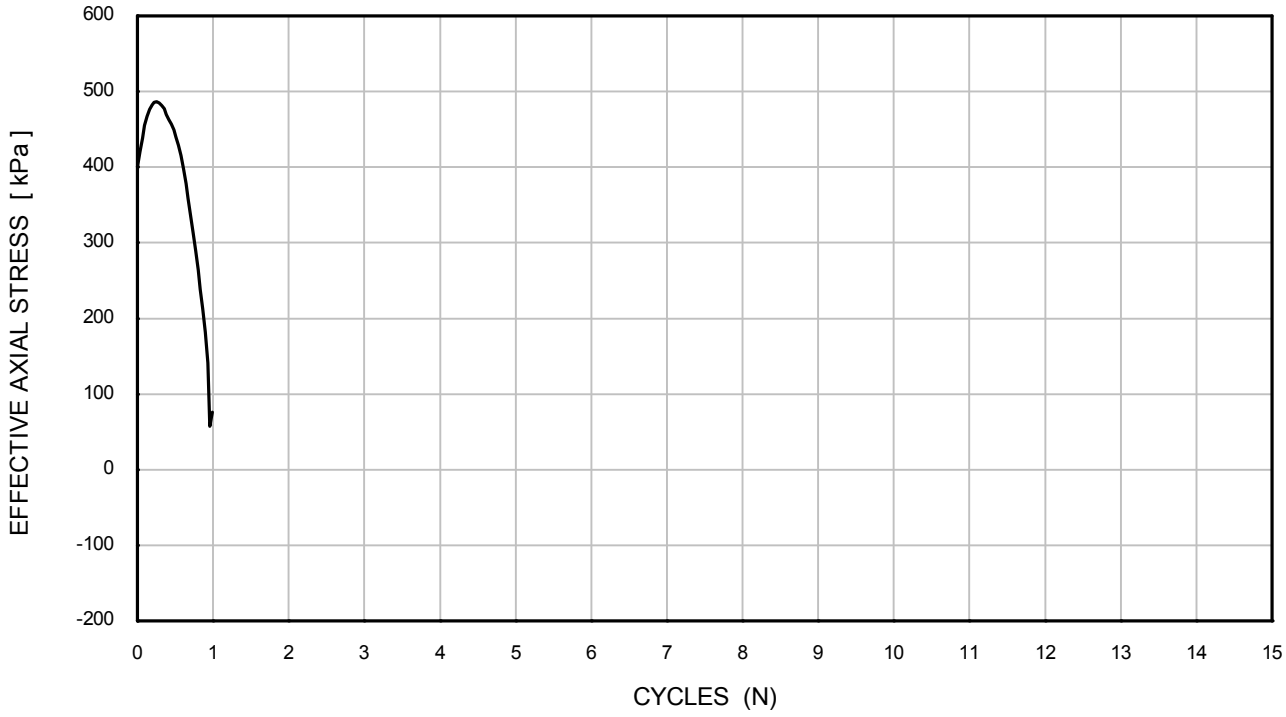


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	53 kPa	Depth [m]	:	-
q_{cy}	:	176 kPa	Test No.	:	CTXL9
Frequency	:	0.16 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

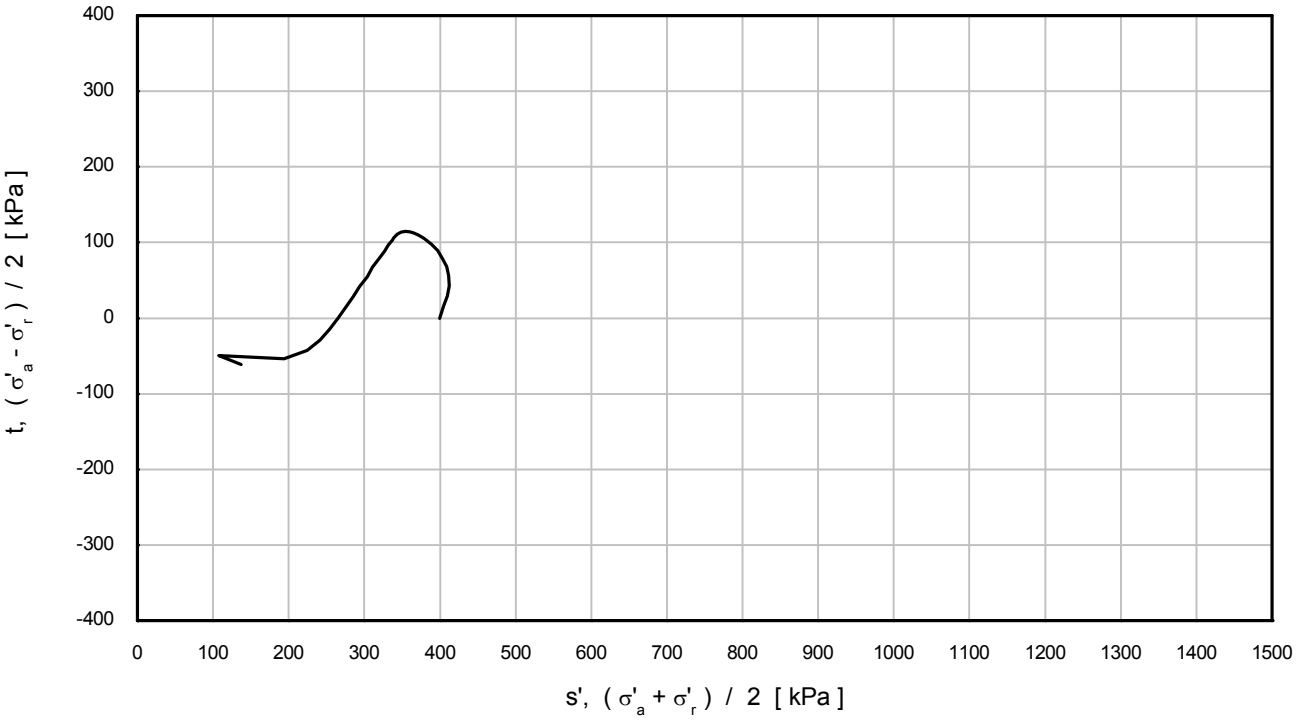


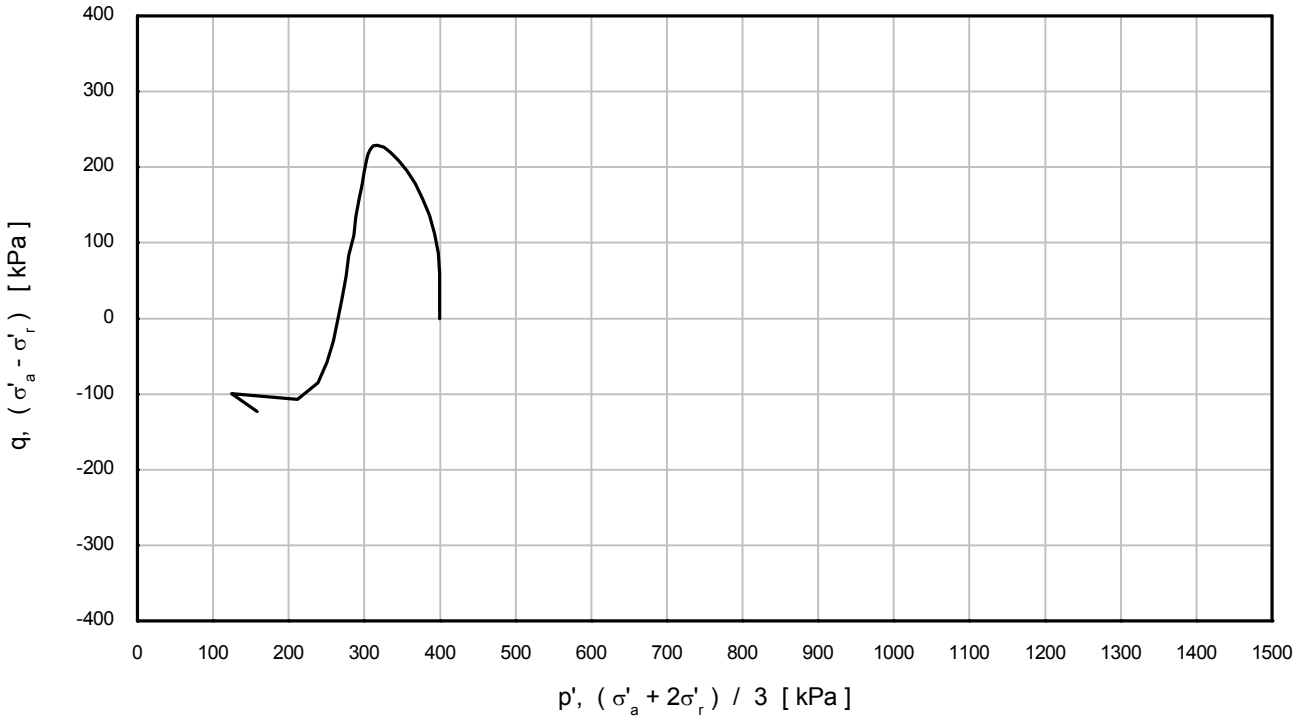


Initial σ'_r	: 400 kPa	Borehole	: Batch
Initial σ'_a	: 400 kPa	Sample	: Tongeren
q_{av}	: 53 kPa	Depth [m]	: -
q_{cy}	: 176 kPa	Test No.	: CTXL9
Frequency	: 0.16 Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

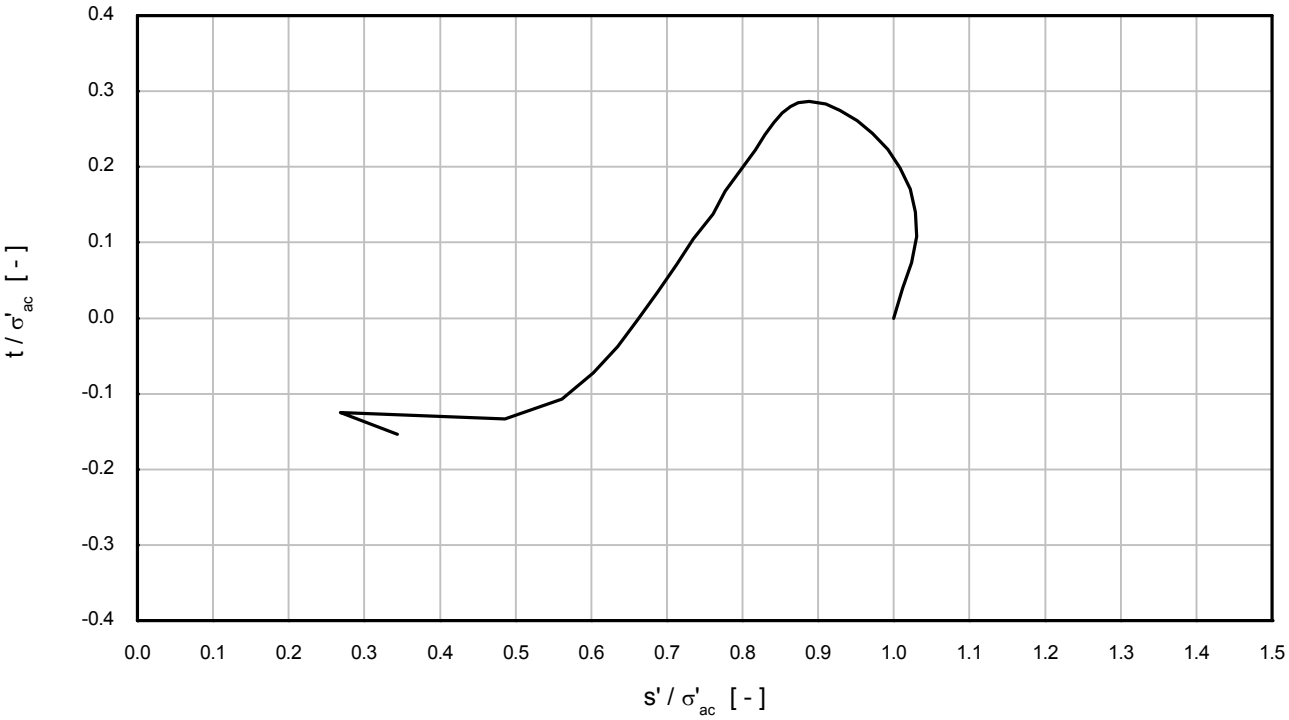


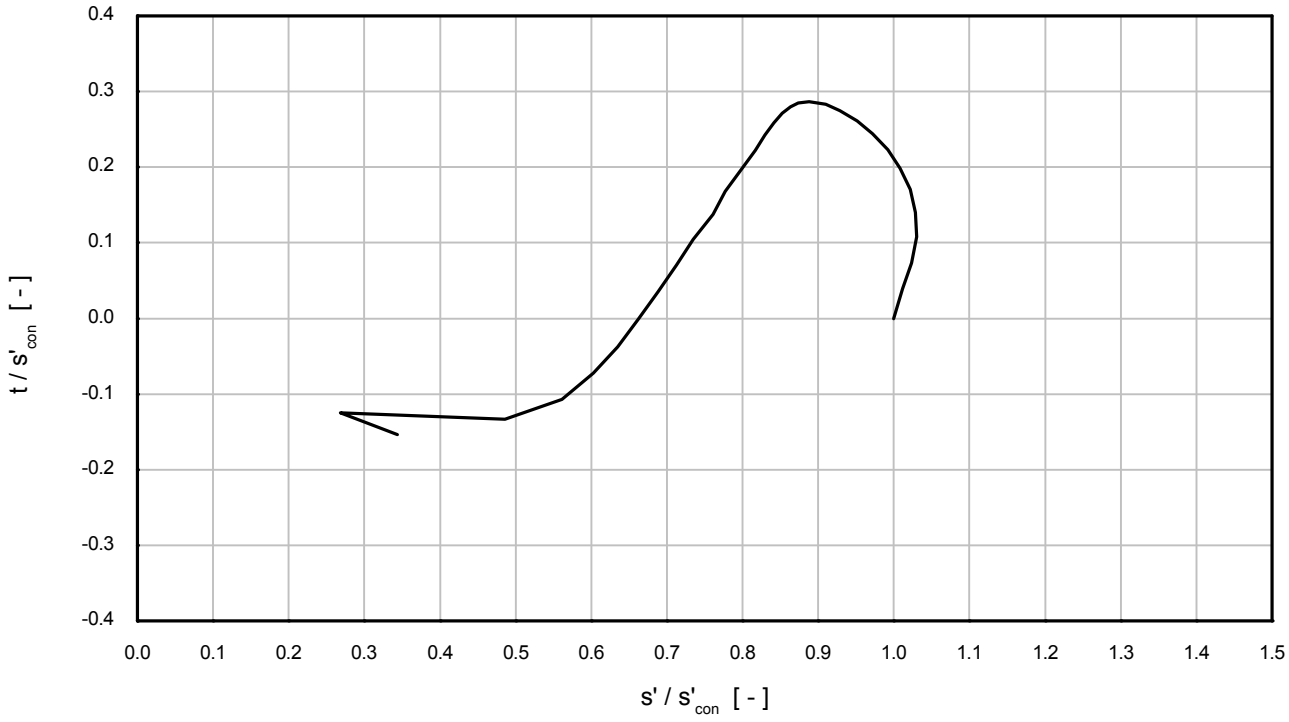


Initial σ'_r	: 400 kPa	Borehole	: Batch
Initial σ'_a	: 400 kPa	Sample	: Tongeren
q_{av}	: 53 kPa	Depth [m]	: -
q_{cy}	: 176 kPa	Test No.	: CTXL9
Frequency	: 0.16 Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

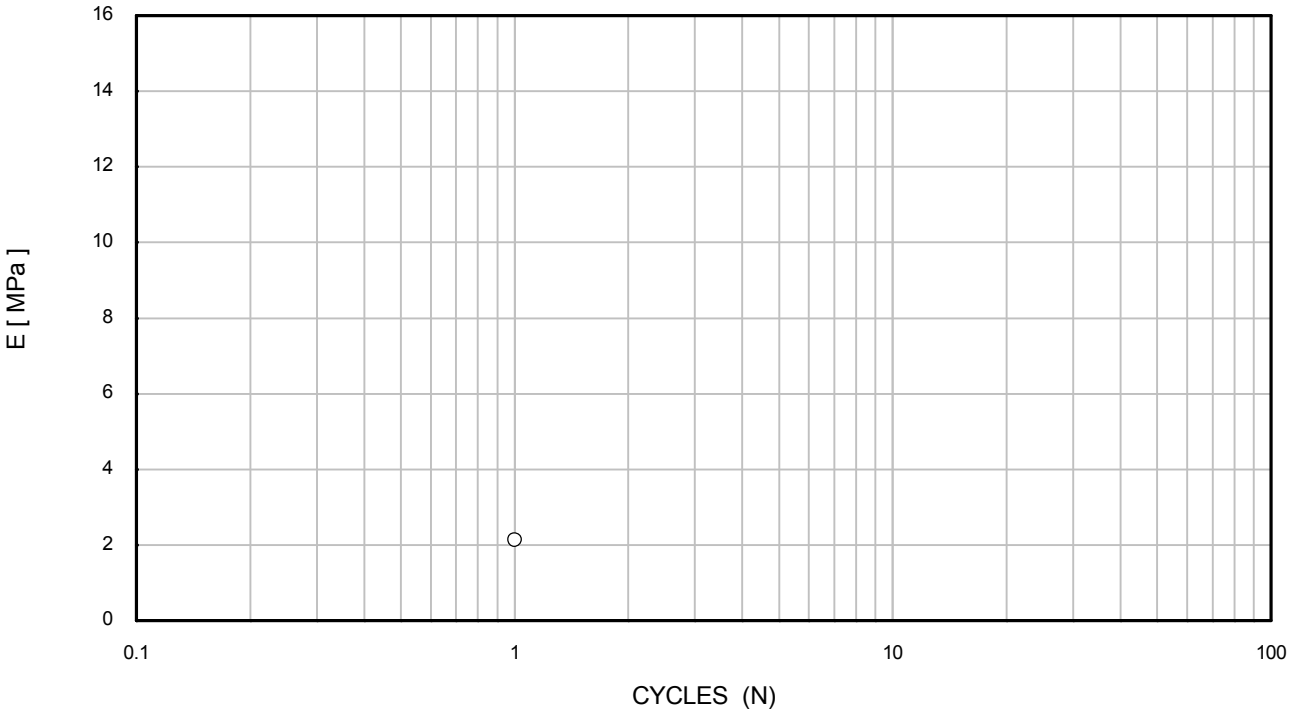


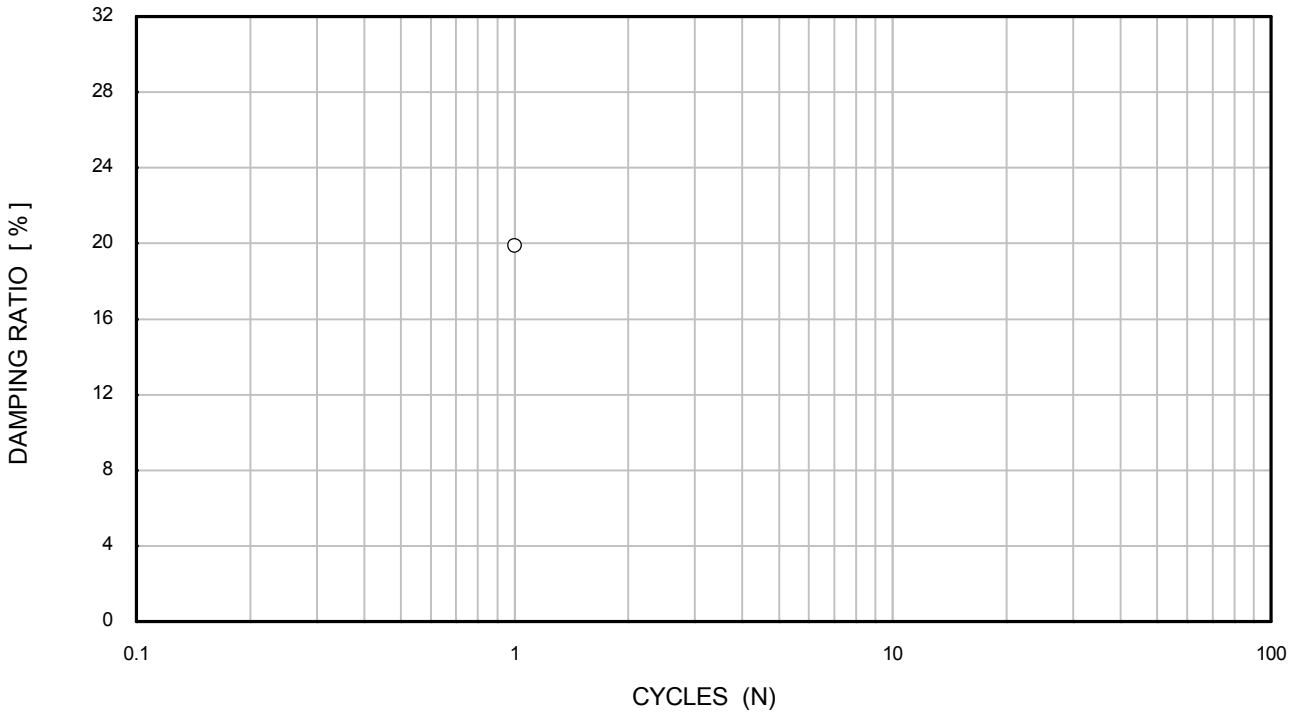


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	53 kPa	Depth [m]	:	-
q_{cy}	:	176 kPa	Test No.	:	CTXL9
Frequency	:	0.16 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	53 kPa	Depth [m]	:	-
q_{cy}	:	176 kPa	Test No.	:	CTXL9
Frequency	:	0.16 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Olive grey silty fine SAND

GENERAL	
Date test started	31/07/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.0
Length	[mm]	144.0
Moisture content	[%]	9.3
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.634
Degree of saturation	[%]	39
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Tongeren_CTXL10
Processed by	LC
Date	13/08/2015
Checked by	LJ
Date	13/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL10

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1400
Base PWP	[kPa]	1352
Mid height PWP	[kPa]	-
B value achieved	[-]	0.98

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1400
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	400
Effective axial pressure	[kPa]	400
Deviator stress	[kPa]	0
Volumetric strain	[%]	2.12
External axial strain	[%]	0.52
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	22.6
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.599
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL10

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	400
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	118
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	4
External ε_{av} at N_f	[%]	-8.59
External ε_{cy} at N_f	[%]	12.36
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	296
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	22.6
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.599
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	-0.06	0.15	80	-	17.99	-
2	-0.15	0.17	69	-	19.06	-
3	-1.91	1.91	6	-	26.28	-
4	-8.59	12.36	1	-	19.52	-
5	-4.08	16.15	1	-	14.69	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL10

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	31
Initial effective axial pressure	[kPa]	22
Rate of strain	[%/hour]	1.06
At peak deviator stress		
Corrected deviator stress	[kPa]	108
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	25.83
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	339
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	61
Effective axial pressure	[kPa]	170
Principal effective stress ratio	[-]	2.77
ε_{50}	[%]	15.26
Secant modulus (E_{50}) at ε_{50}	[kPa]	141
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	103
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	24.49
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	343
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	57
Effective axial pressure	[kPa]	160
Principal effective stress ratio	[-]	2.80
At 10% axial strain		
Corrected deviator stress	[kPa]	23
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	381
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	19
Effective axial pressure	[kPa]	42
Principal effective stress ratio	[-]	2.21

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL10

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

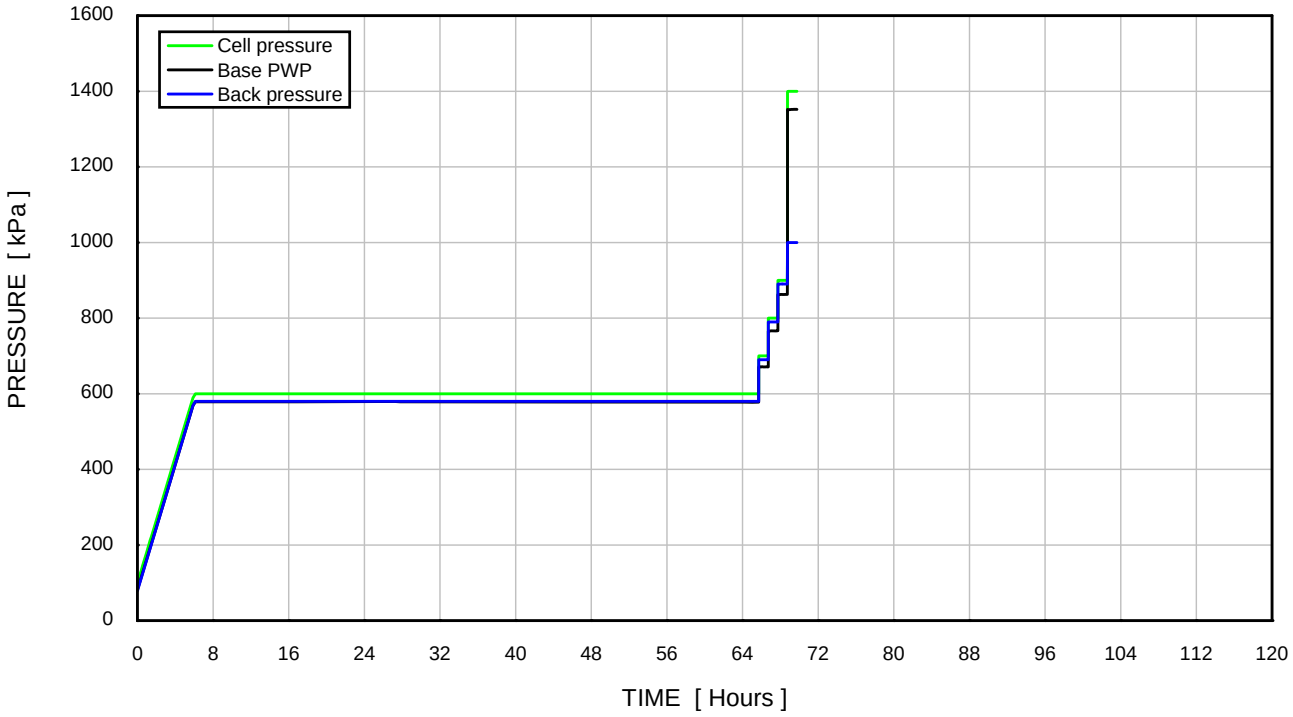
SPECIMEN PHOTOGRAPHS

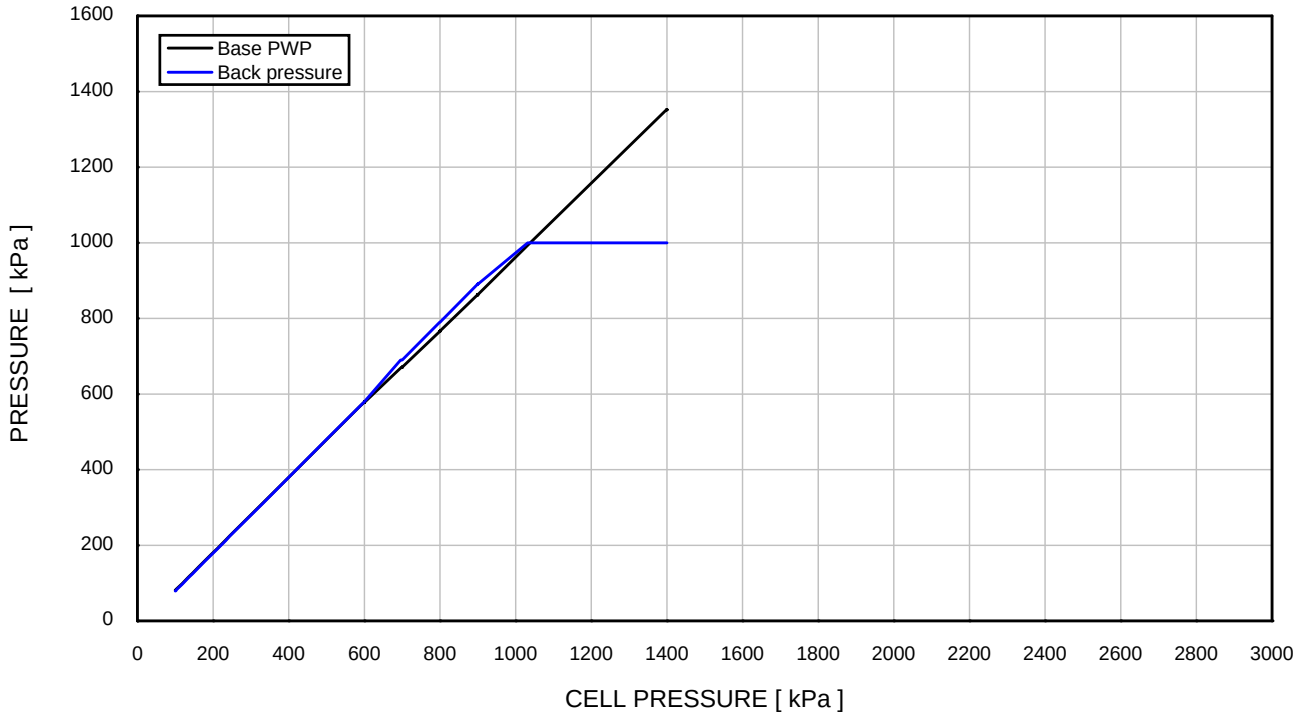
FINAL CONDITIONS		
Moisture content	[%]	22.6
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.66

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL10

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

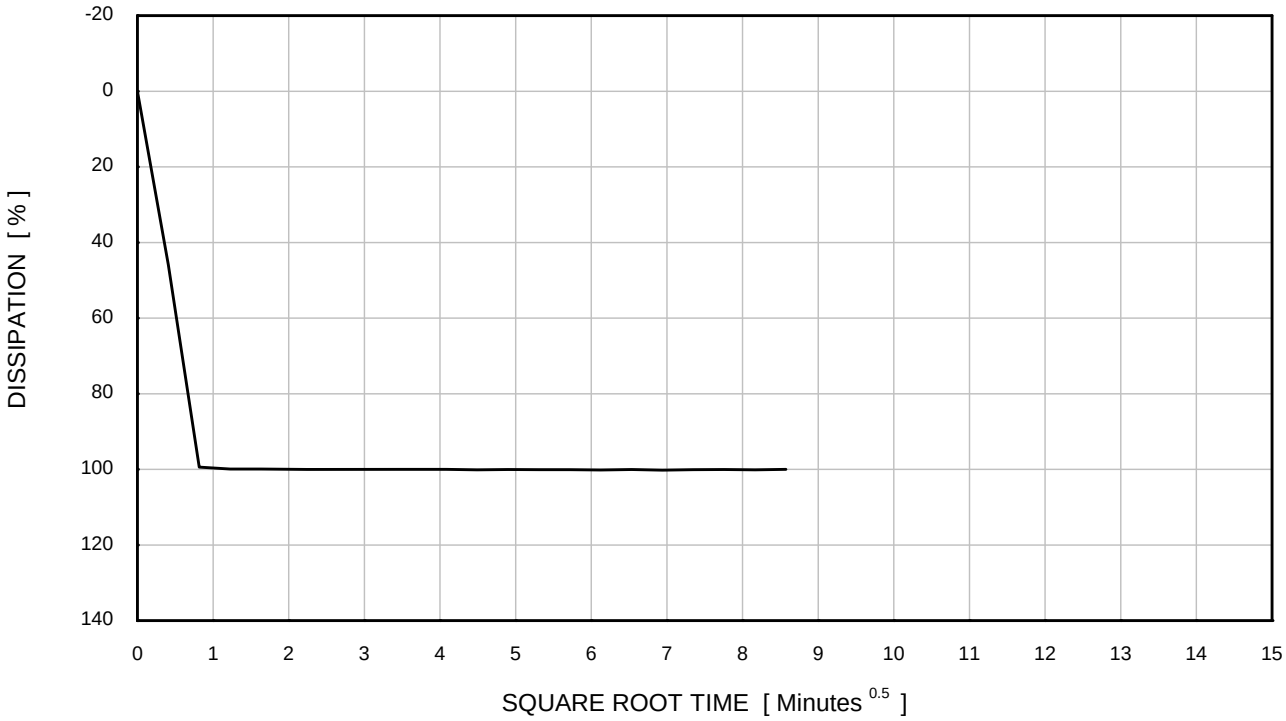


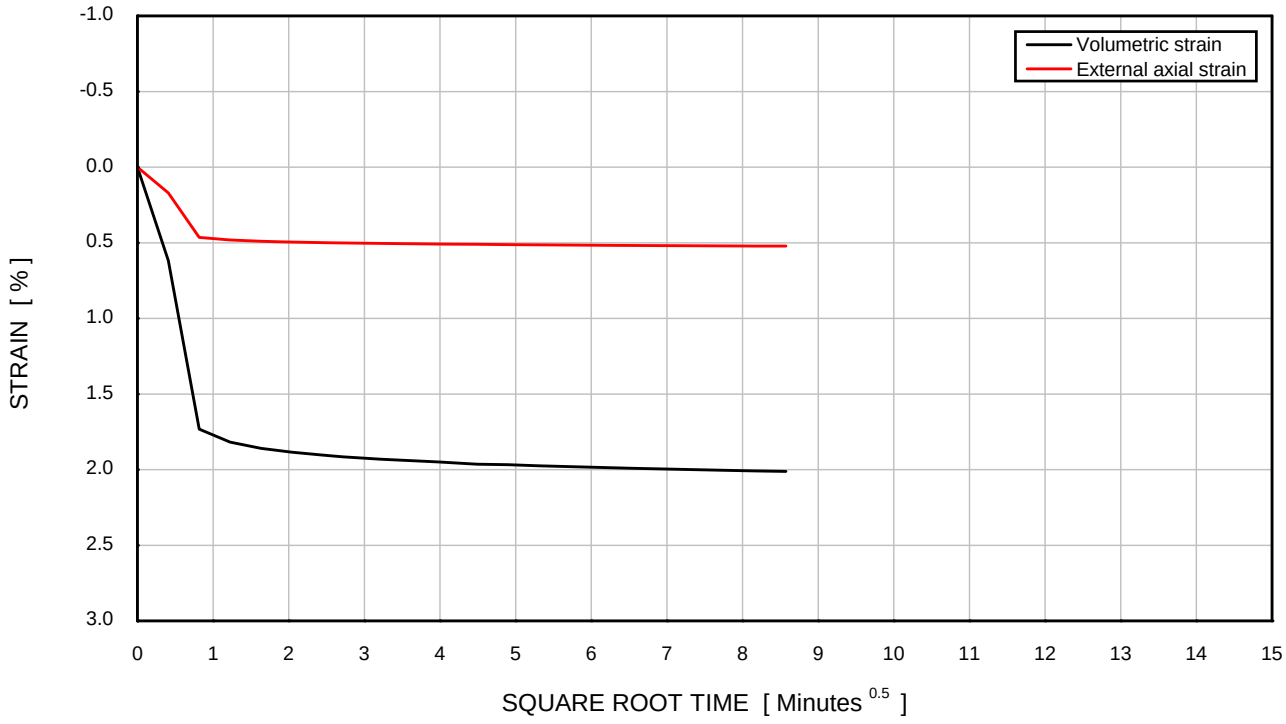


B value	:	0.98			
Initial σ'_r	:	19	kPa	Borehole	: Batch
Initial σ'_a	:	19	kPa	Sample	: Tongeren
Final σ'_r	:	48	kPa	Depth [m]	: -
Final σ'_a	:	48	kPa	Test No.	: CTXL10

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

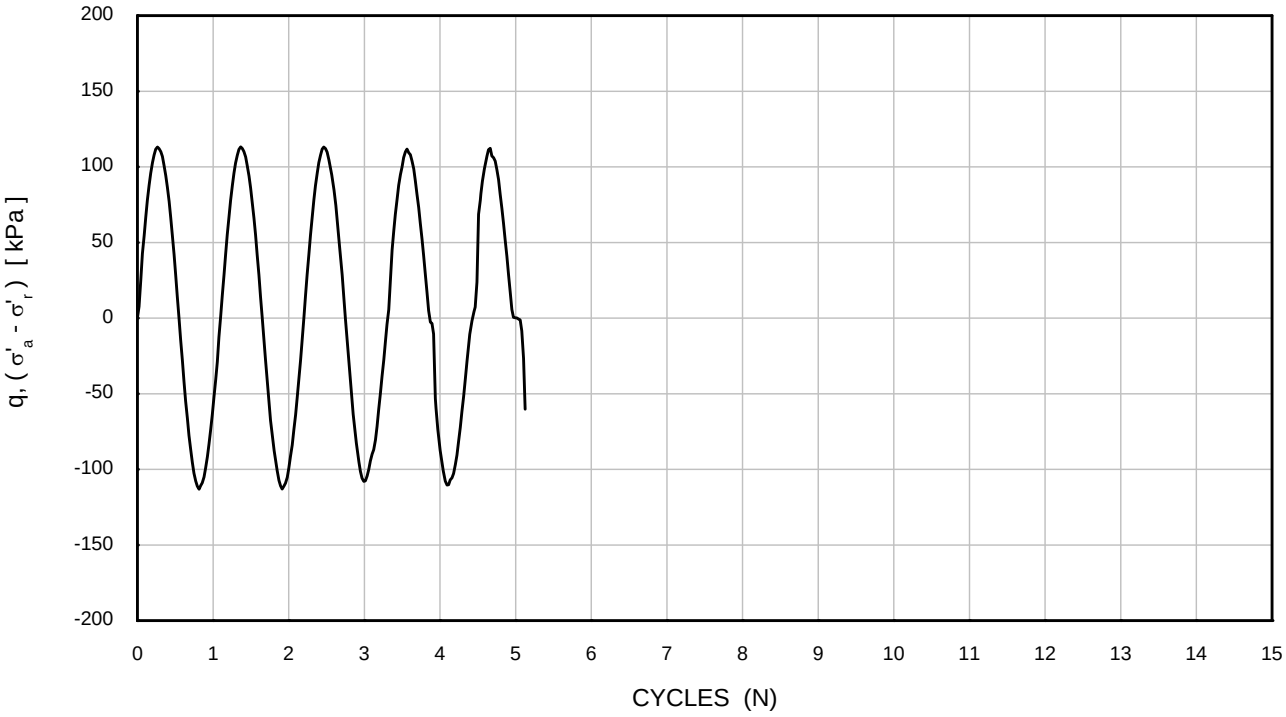


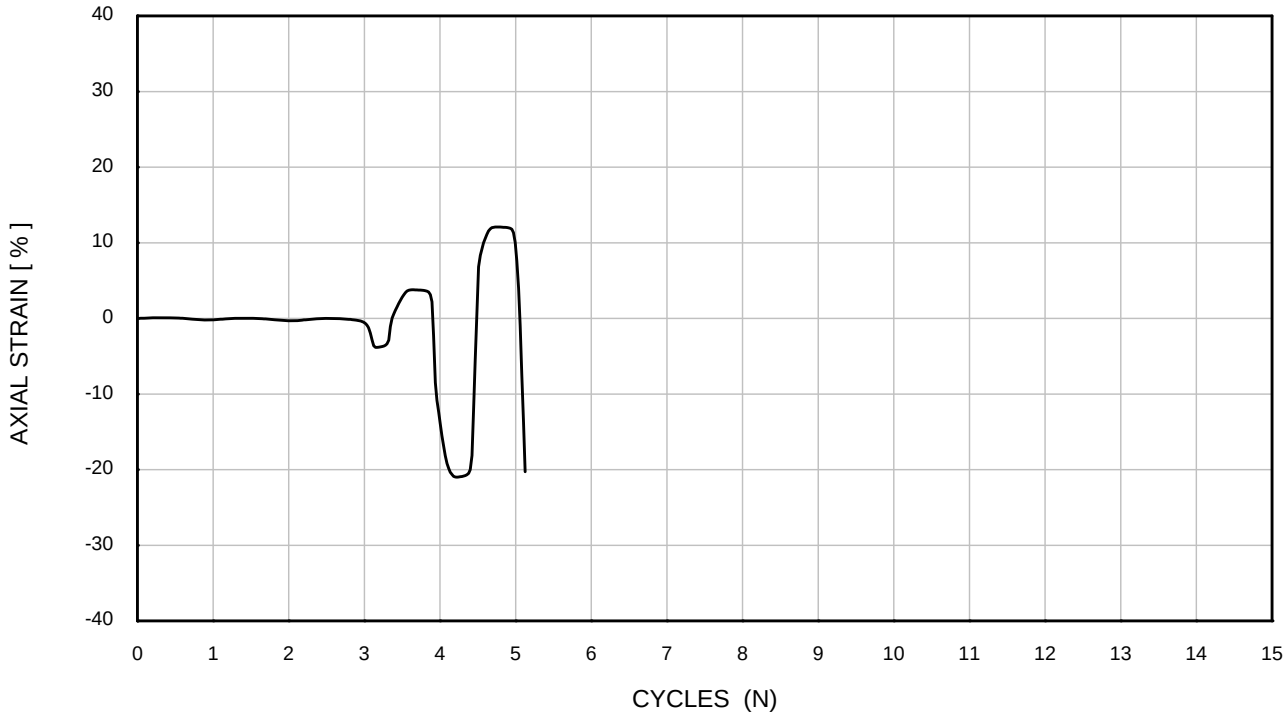


σ'_{rc}	: 400 kPa	Borehole	: Batch
σ'_{ac}	: 400 kPa	Sample	: Tongeren
		Depth [m]	: -
		Test No.	: CTXL10

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

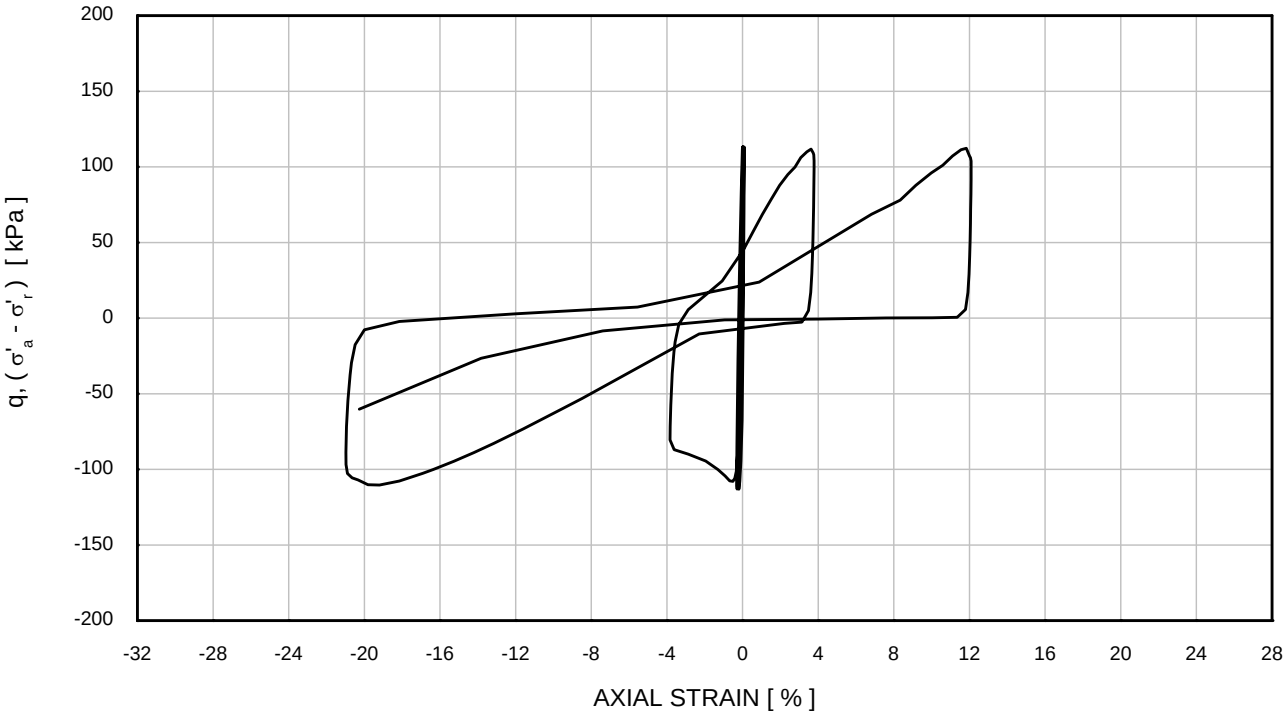


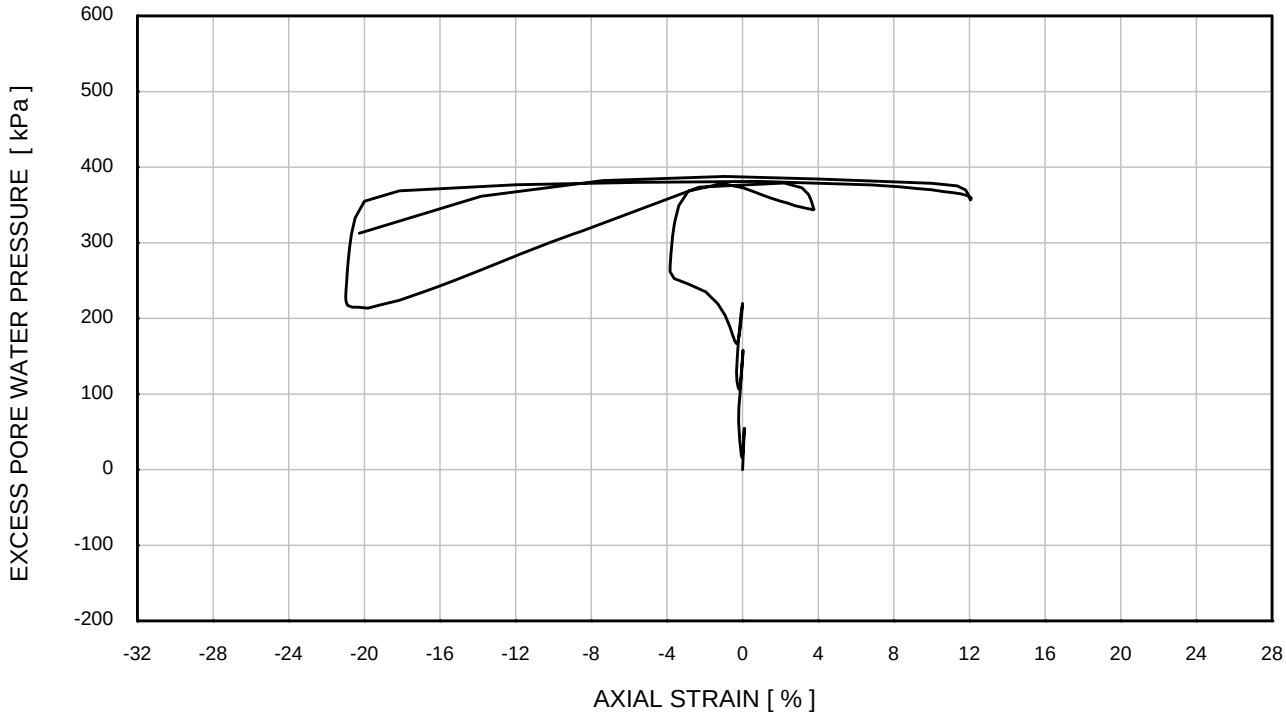


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

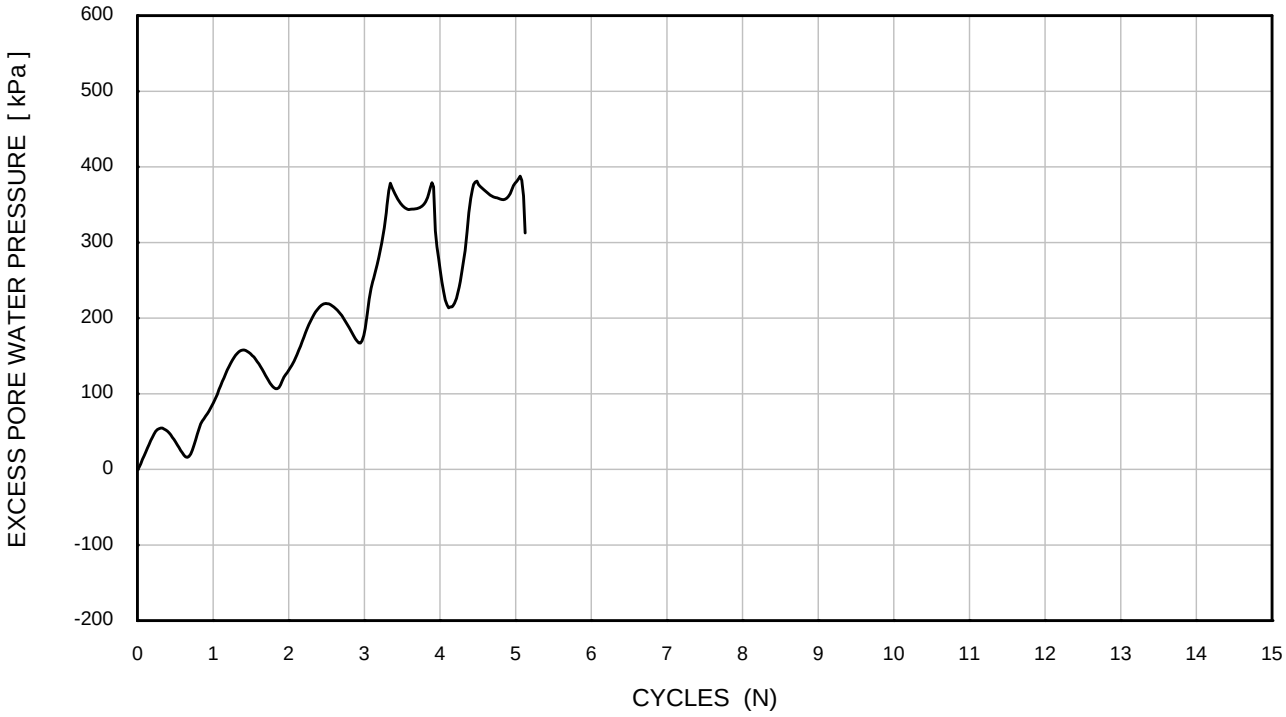


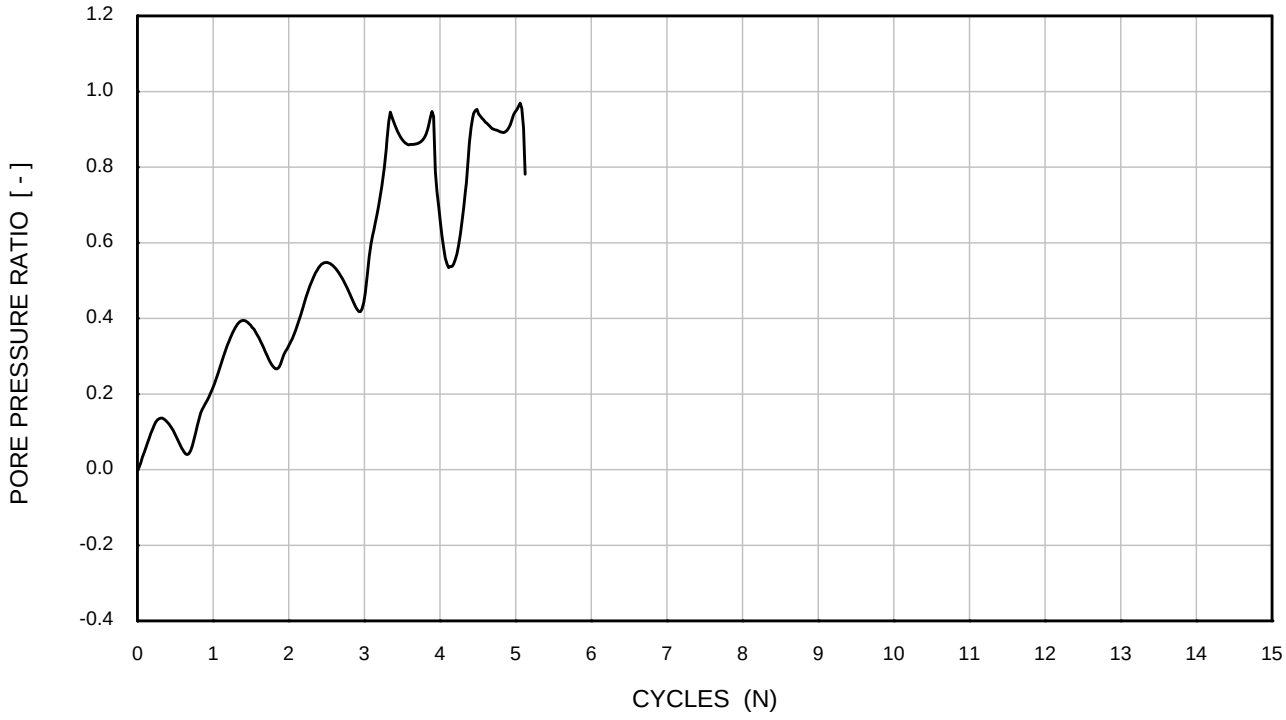


Initial σ'_r	:	400	kPa	Borehole	: Batch
Initial σ'_a	:	400	kPa	Sample	: Tongeren
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	118	kPa	Test No.	: CTXL10
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

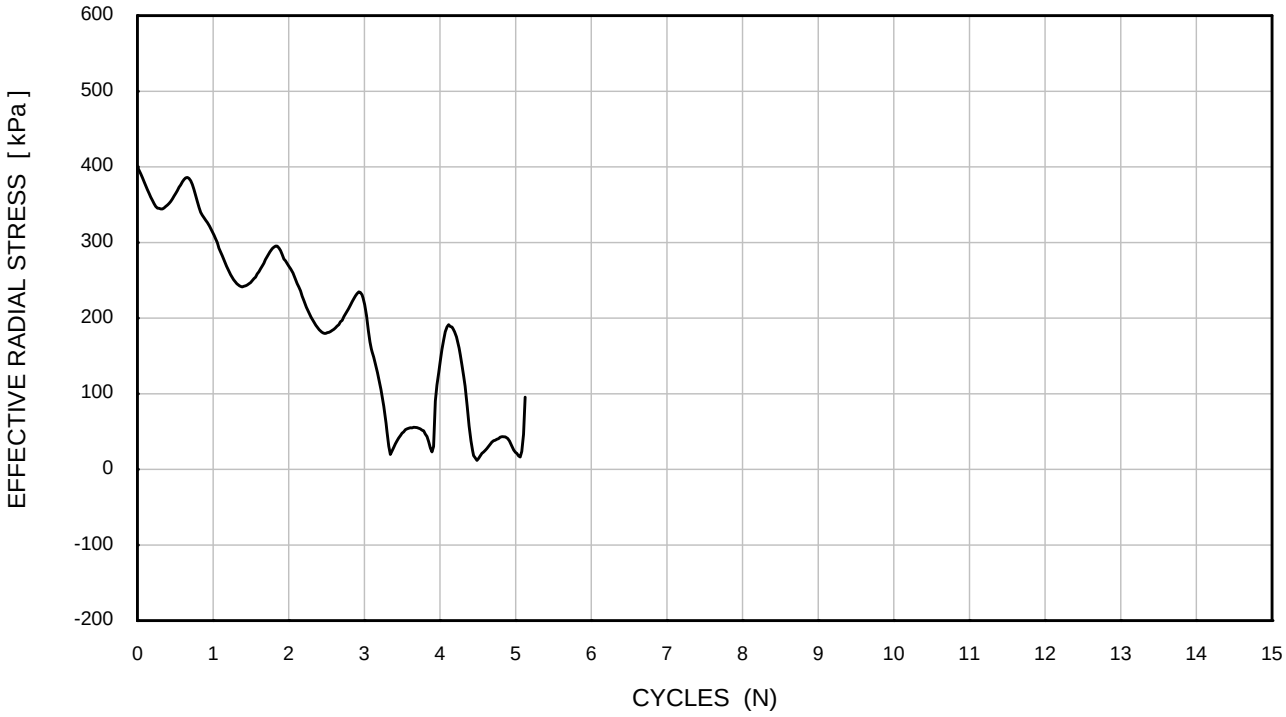


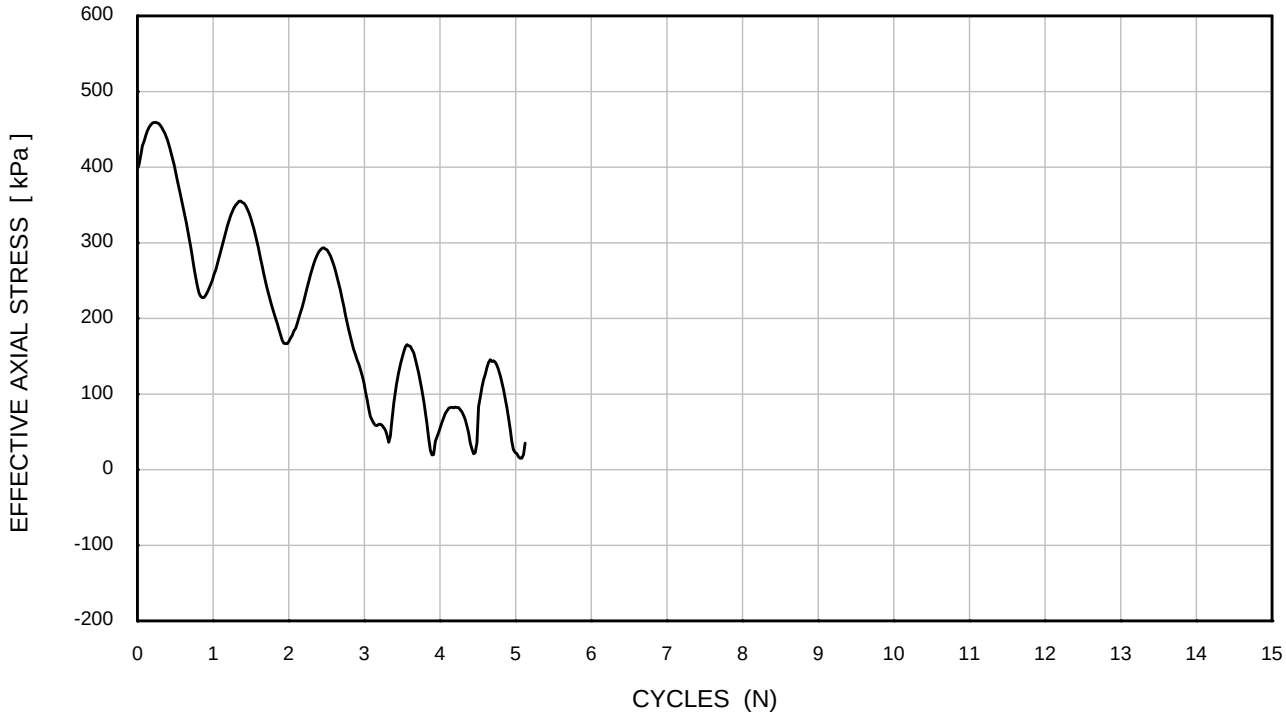


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

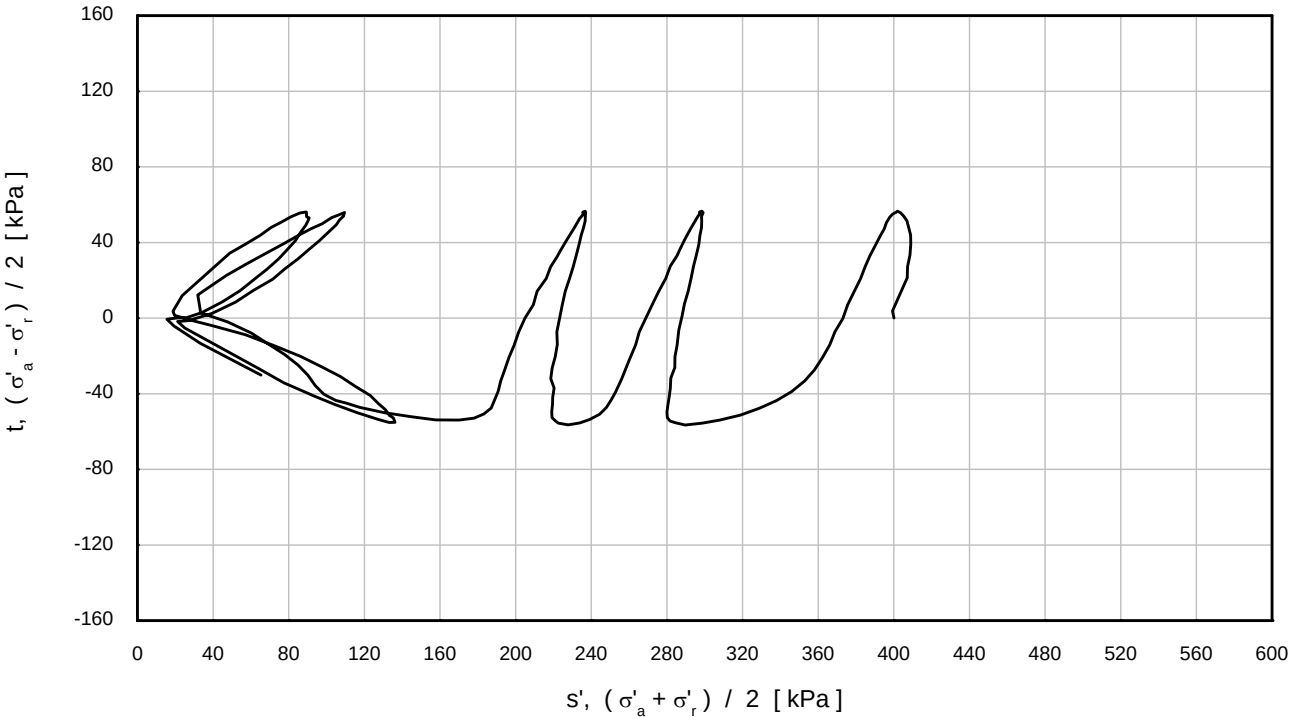


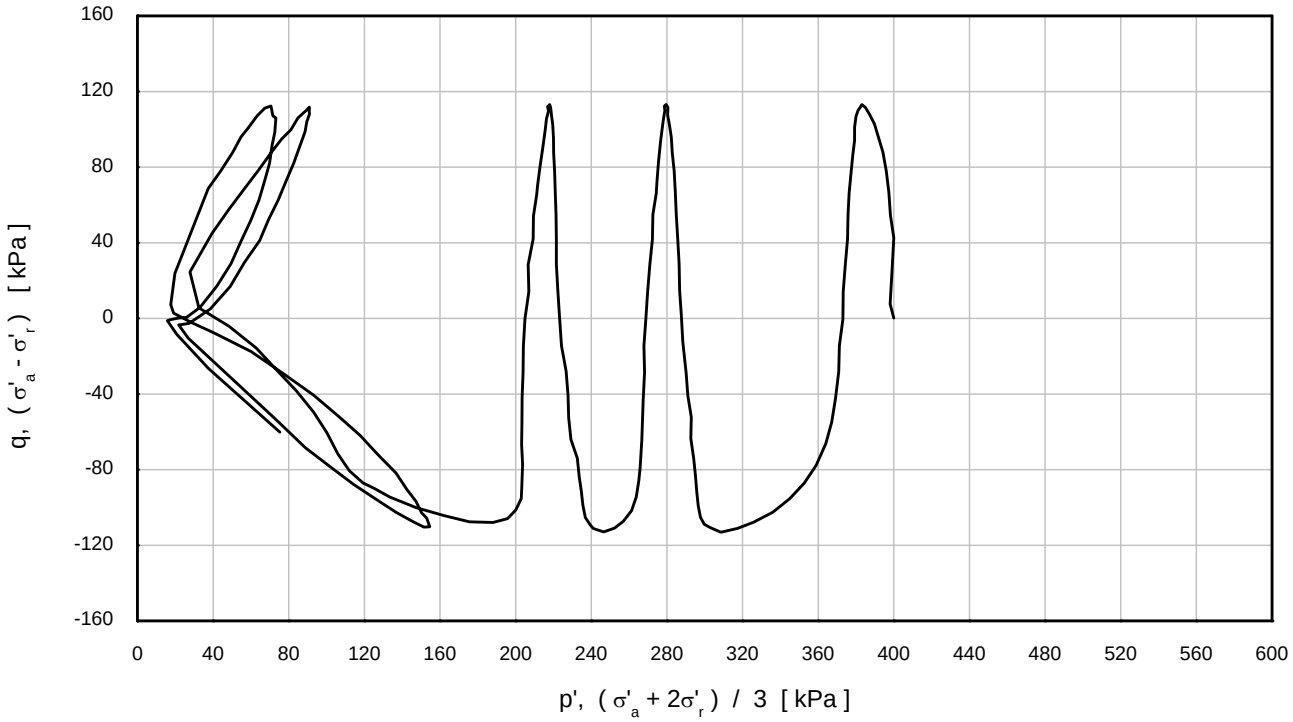


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





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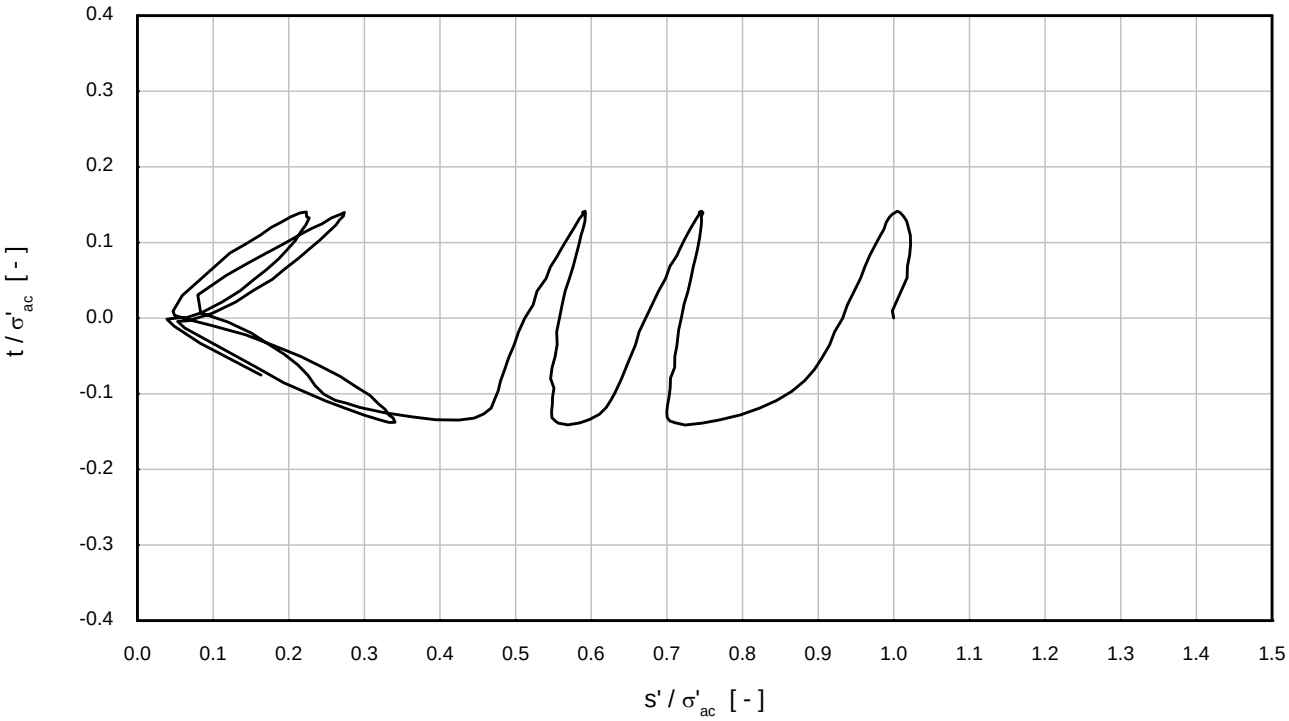
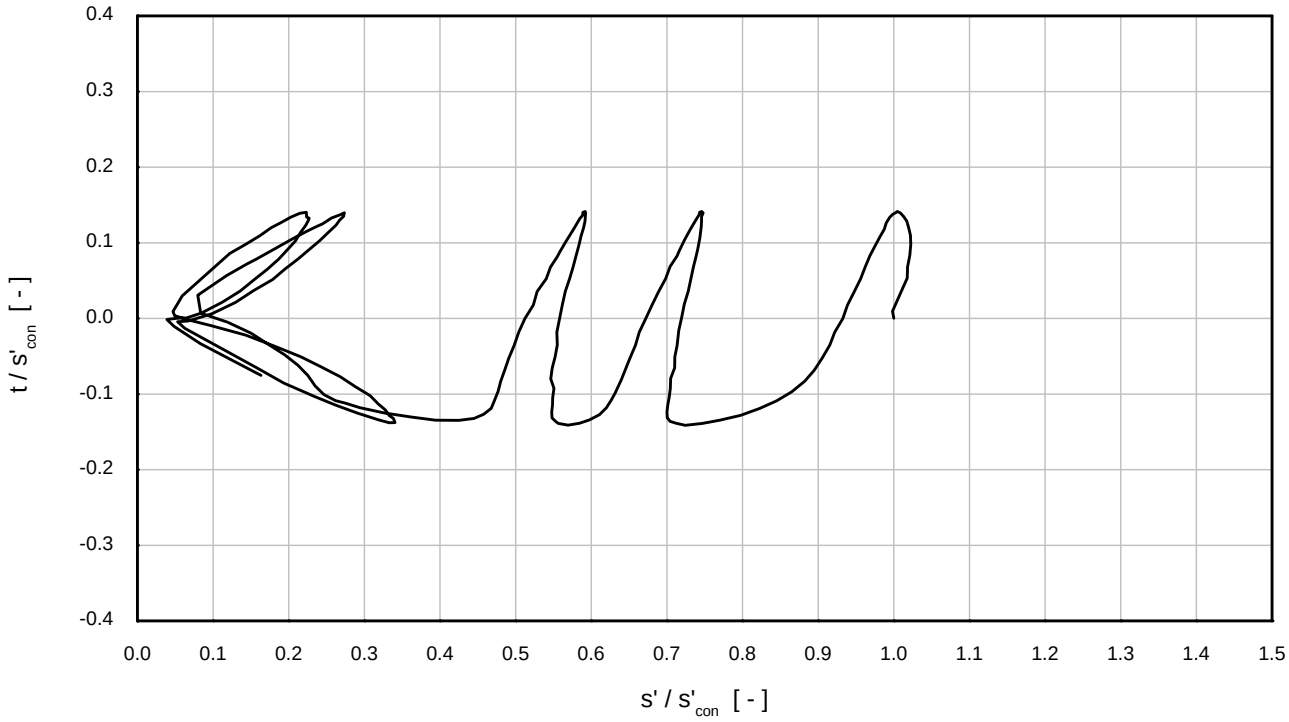
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

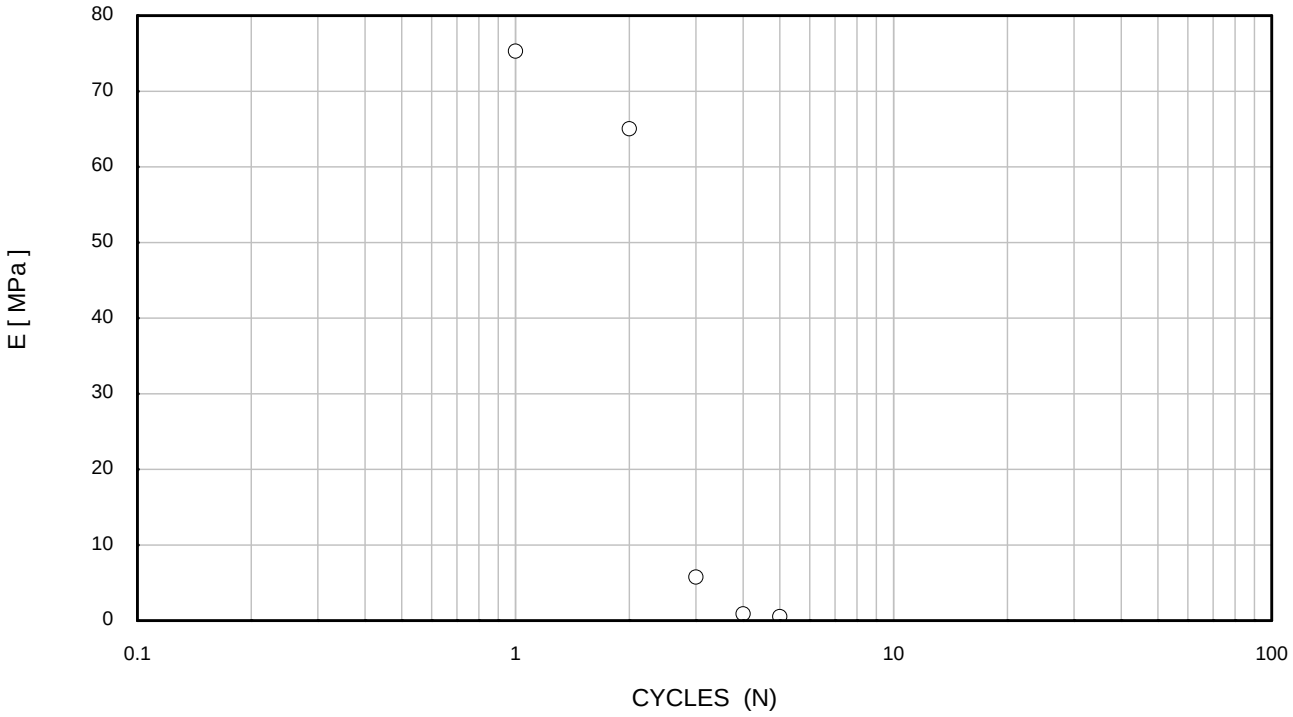


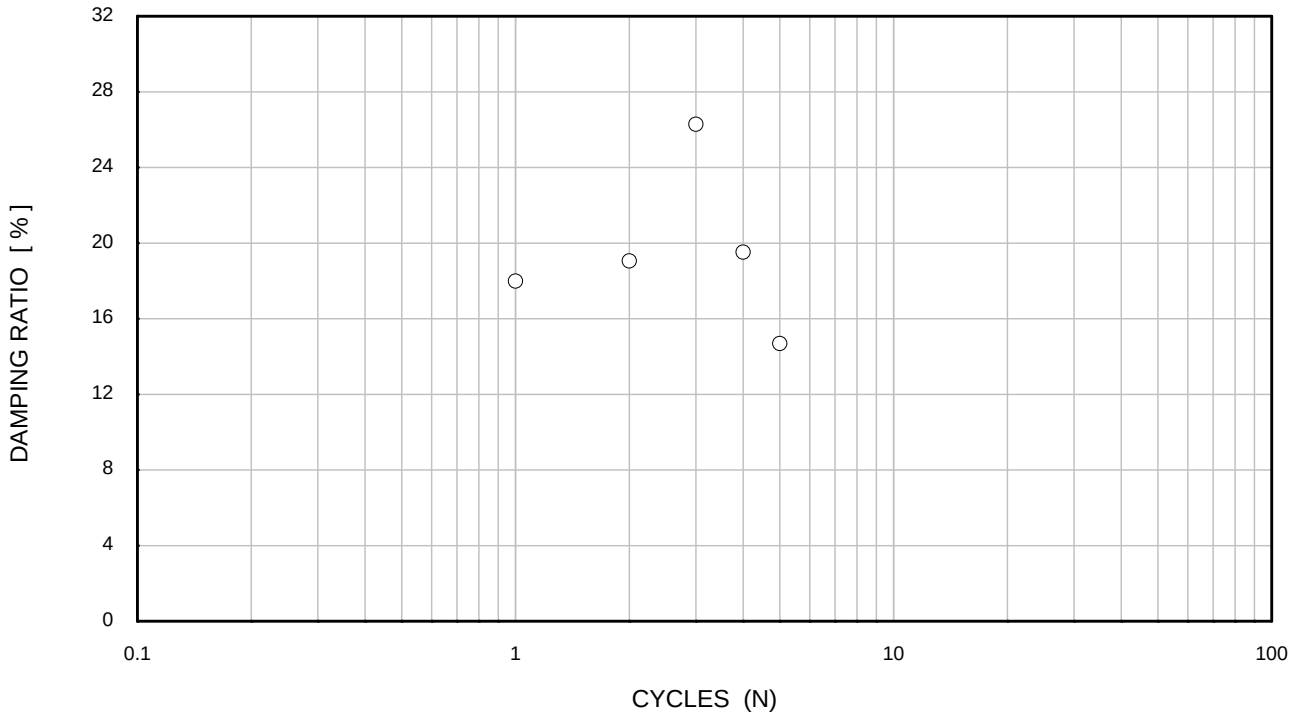


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

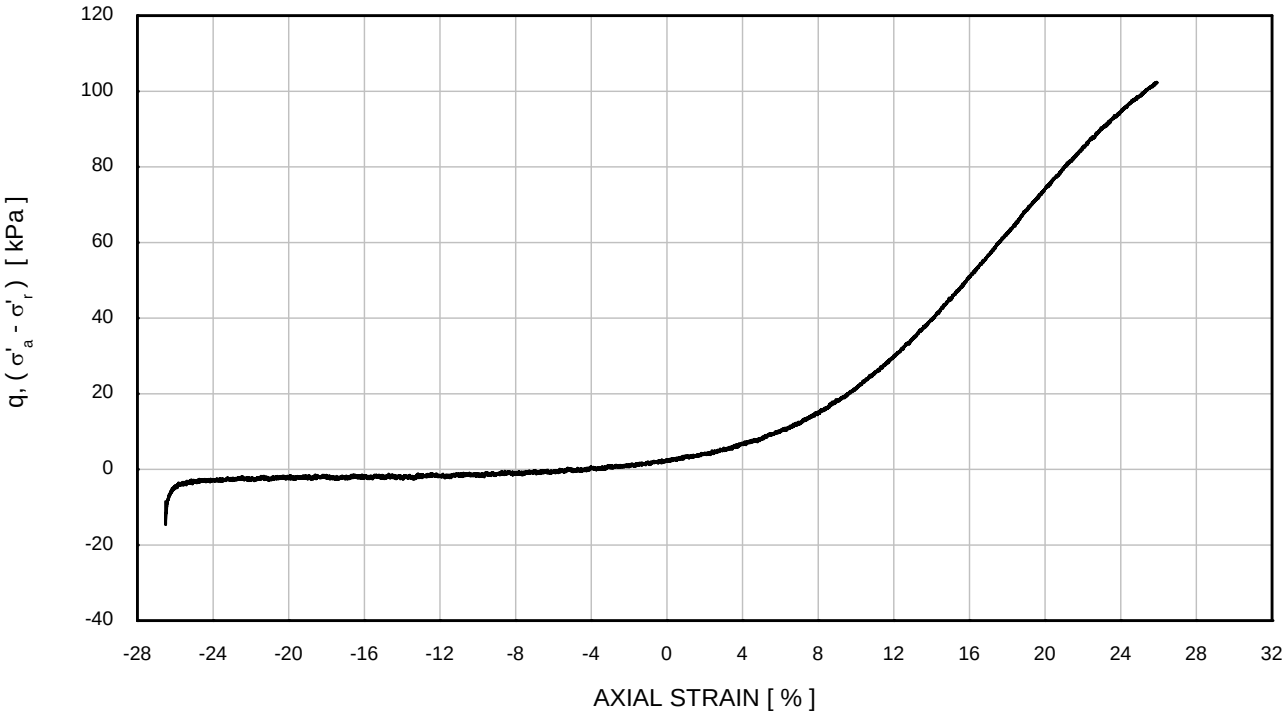


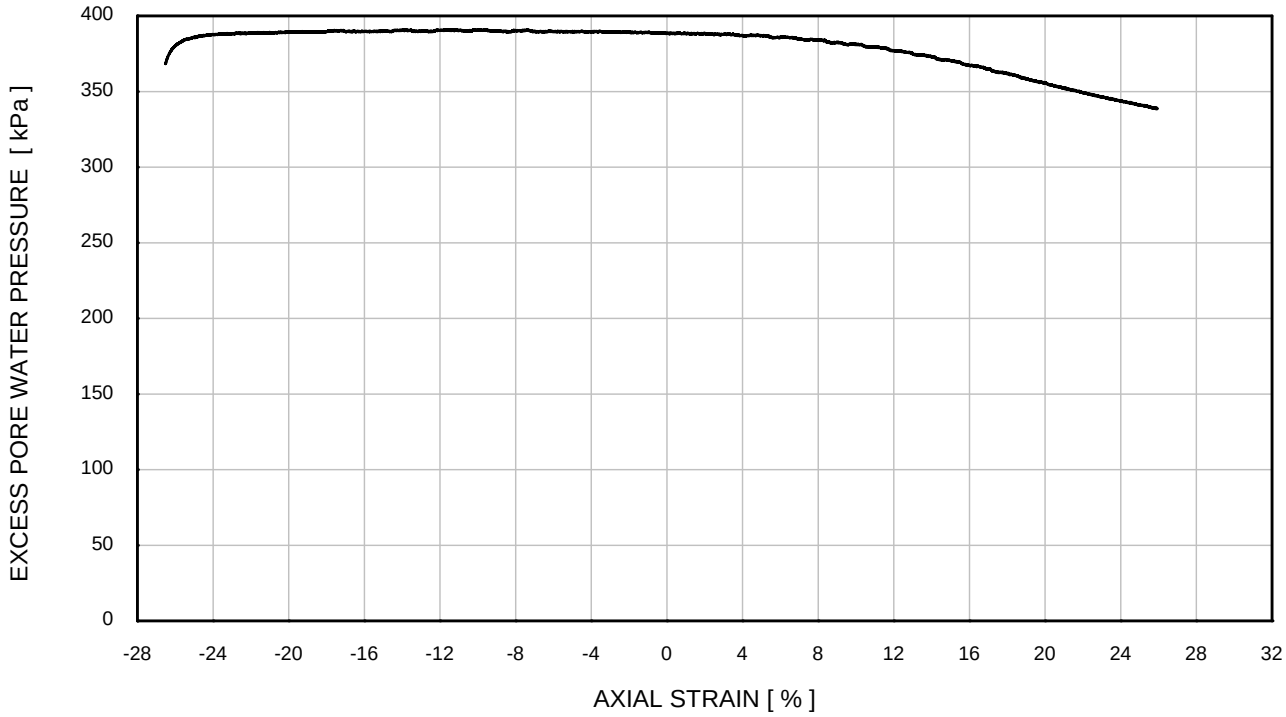


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	118 kPa	Test No.	:	CTXL10
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

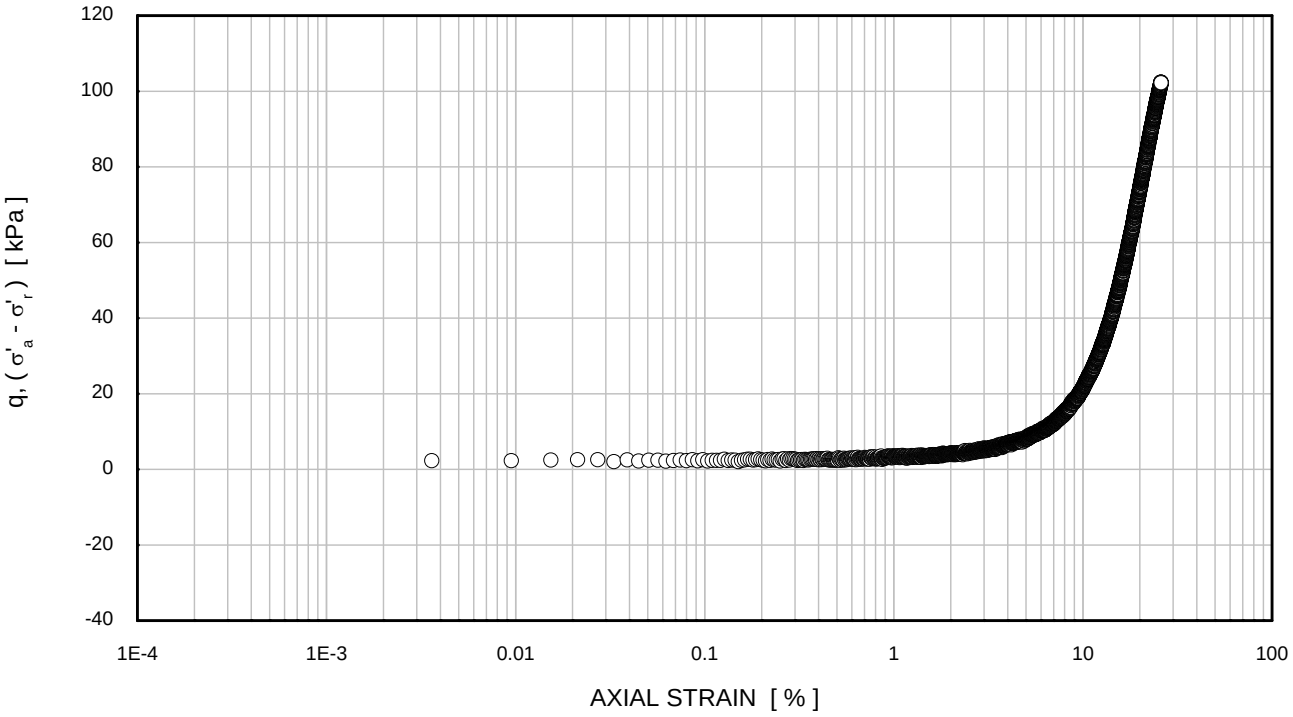


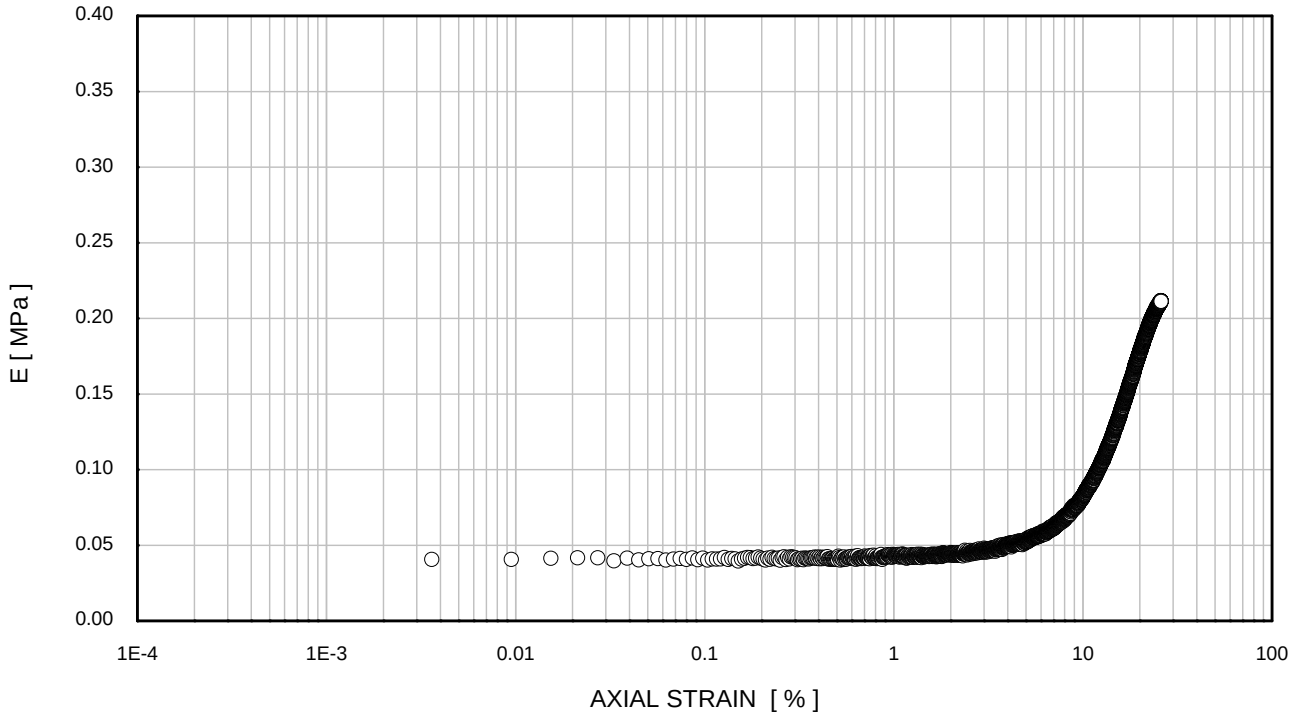


Initial σ'_r	:	31	kPa	Borehole	: Batch
Initial σ'_a	:	23	kPa	Sample	: Tongeren
q_{peak}	:	102	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	25.9	%	Test No.	: CTXL10
Rate of strain	:	1.06	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

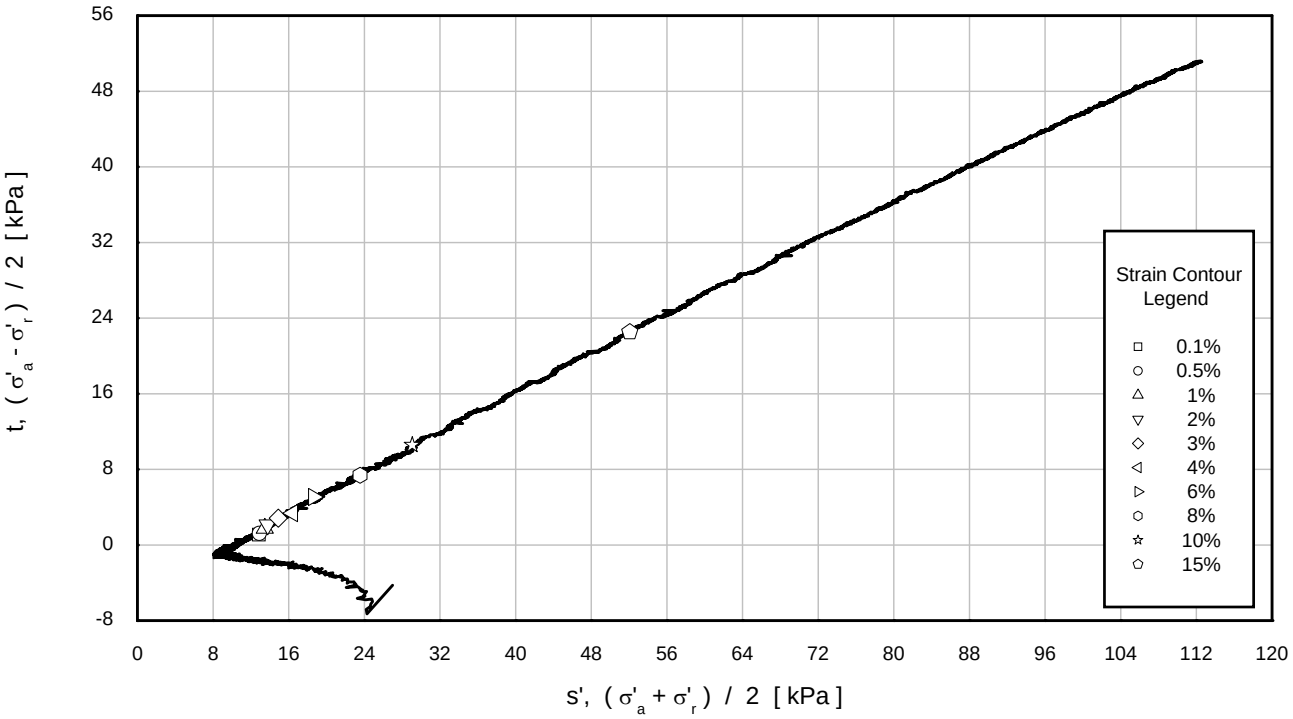


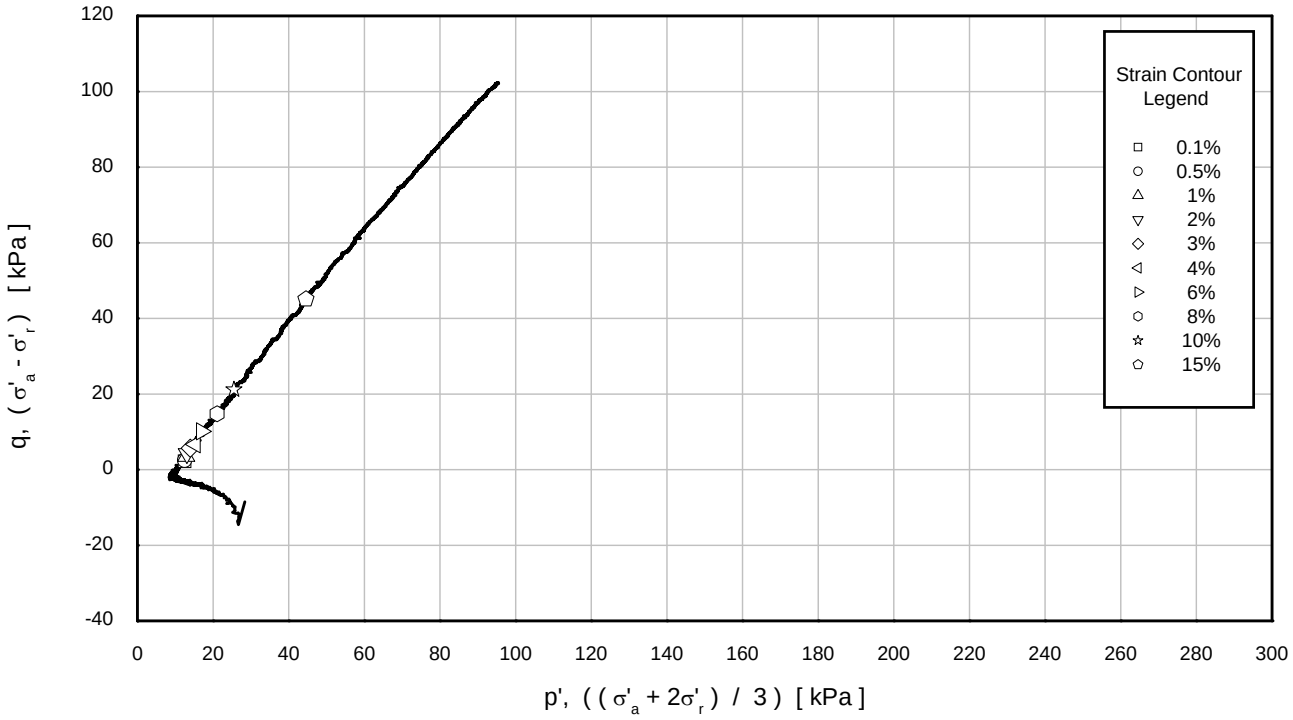


Initial σ'_r	:	31	kPa	Borehole	: Batch
Initial σ'_a	:	23	kPa	Sample	: Tongeren
q_{peak}	:	102	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	25.9	%	Test No.	: CTXL10
Rate of strain	:	1.06	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	31	kPa	Borehole	: Batch
Initial σ'_a	:	23	kPa	Sample	: Tongeren
q_{peak}	:	102	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	25.9	%	Test No.	: CTXL10
Rate of strain	:	1.06	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Olive grey silty fine SAND

GENERAL	
Date test started	08/05/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	72.1
Length	[mm]	144.0
Moisture content	[%]	9.5
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.62
Void ratio	[-]	0.637
Degree of saturation	[%]	40
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Tongeren_CTXL11
Processed by	LJ
Date	13/08/2015
Checked by	PH
Date	15/08/2015
Approved by	PH
Date	15/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL11

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	20
Cell pressure	[kPa]	1400
Base PWP	[kPa]	1364
Mid height PWP	[kPa]	-
B value achieved	[-]	0.98

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1400
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	400
Effective axial pressure	[kPa]	400
Deviator stress	[kPa]	0
Volumetric strain	[%]	2.74
External axial strain	[%]	0.44
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	22.3
Bulk density	[Mg/m³]	2.04
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.592
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL11

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	400
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	40
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
External ε_{av} at N_f	[%]	-0.01
External ε_{cy} at N_f	[%]	0.02
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	92
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	22.3
Bulk density	[Mg/m³]	2.04
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.592
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.00	0.02	209	-	3.69	-
2	0.00	0.02	217	-	2.13	-
5	0.00	0.02	219	-	1.12	-
10	-0.01	0.02	220	-	0.67	-
20	-0.01	0.02	217	-	0.22	-
30	-0.01	0.02	216	-	0.09	-
40	-0.01	0.02	215	-	0.08	-
50	-0.01	0.02	214	-	0.19	-
100	-0.01	0.02	211	-	0.44	-
500	-0.01	0.02	203	-	1.00	-
1000	-0.01	0.02	200	-	1.33	-
1500	-0.01	0.02	199	-	1.38	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL11

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SHEARING STAGE		
Initial effective radial pressure	[kPa]	308
Initial effective axial pressure	[kPa]	307
Rate of strain	[%/hour]	1.00
At peak deviator stress		
Corrected deviator stress	[kPa]	219
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	0.79
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	257
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	143
Effective axial pressure	[kPa]	362
Principal effective stress ratio	[-]	2.53
ε_{50}	[%]	0.06
Secant modulus (E_{50}) at ε_{50}	[kPa]	158284
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	194
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.37
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	320
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	274
Principal effective stress ratio	[-]	3.44
At 10% axial strain		
Corrected deviator stress	[kPa]	193
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	9.70
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	319
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	80
Effective axial pressure	[kPa]	274
Principal effective stress ratio	[-]	3.40

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL11

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

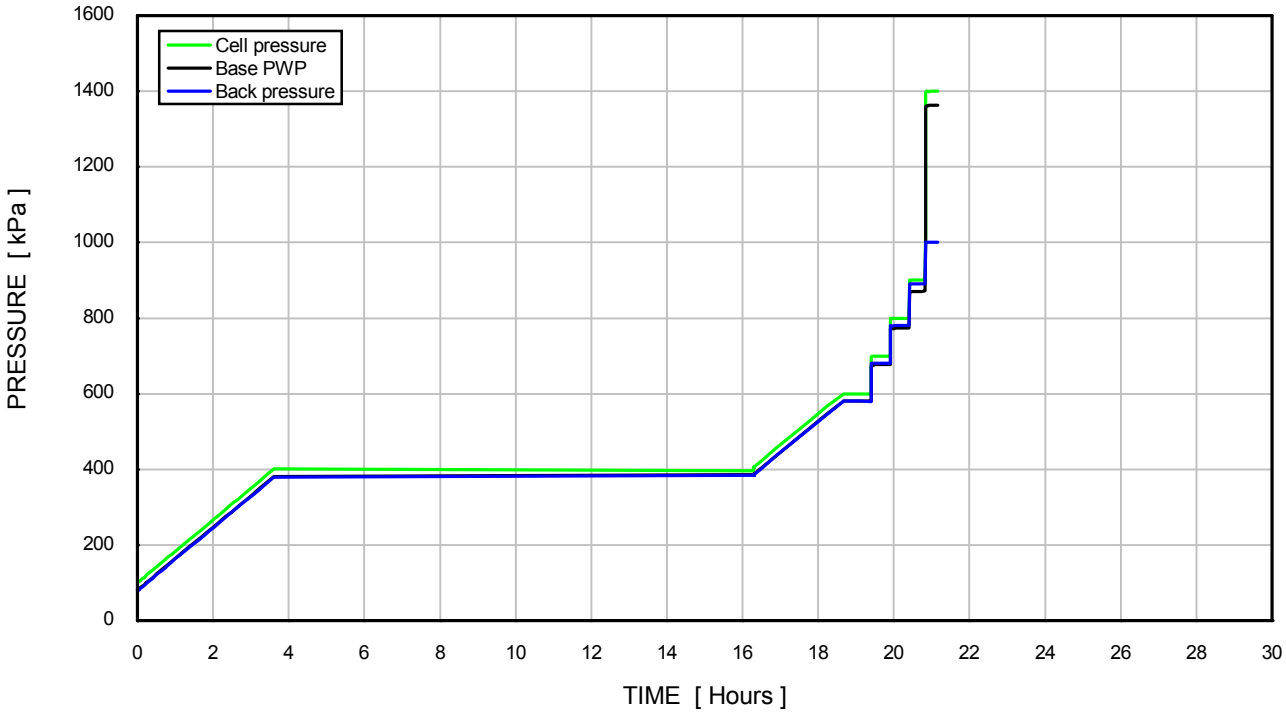
SPECIMEN PHOTOGRAPHS

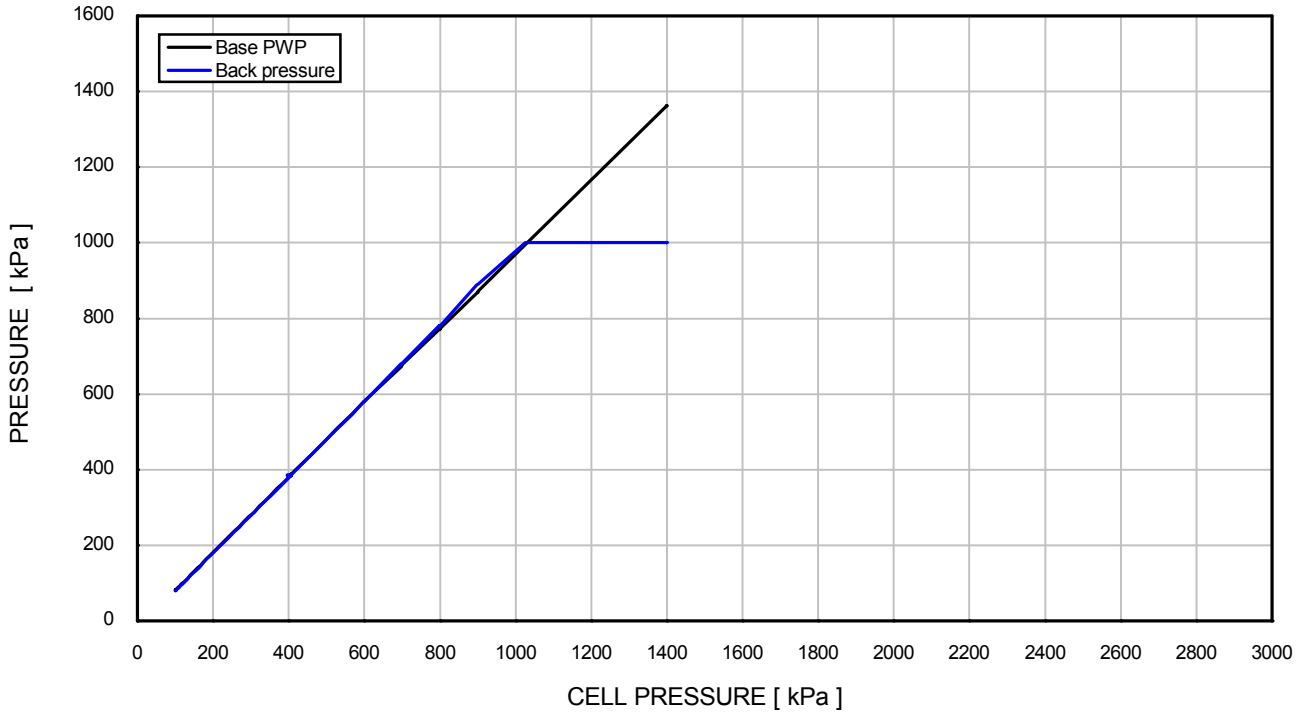
FINAL CONDITIONS		
Moisture content	[%]	22.3
Bulk density	[Mg/m³]	2.04
Dry density	[Mg/m³]	1.66

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL11

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

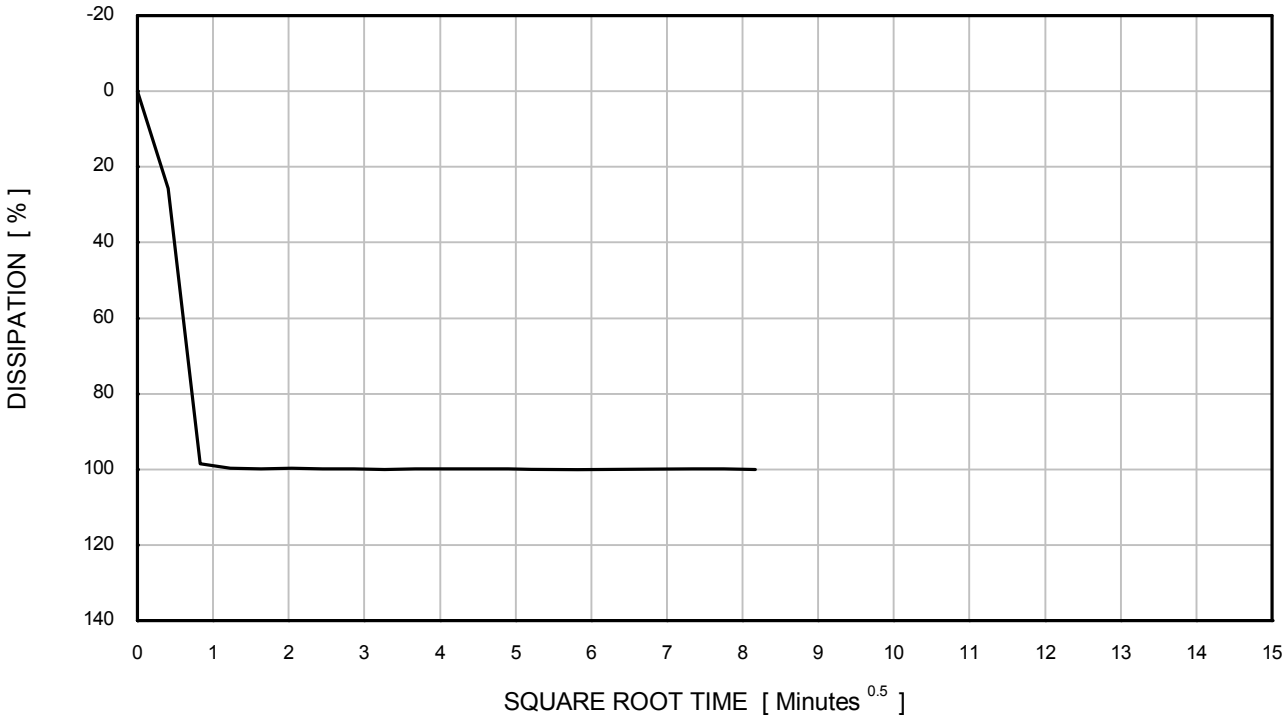


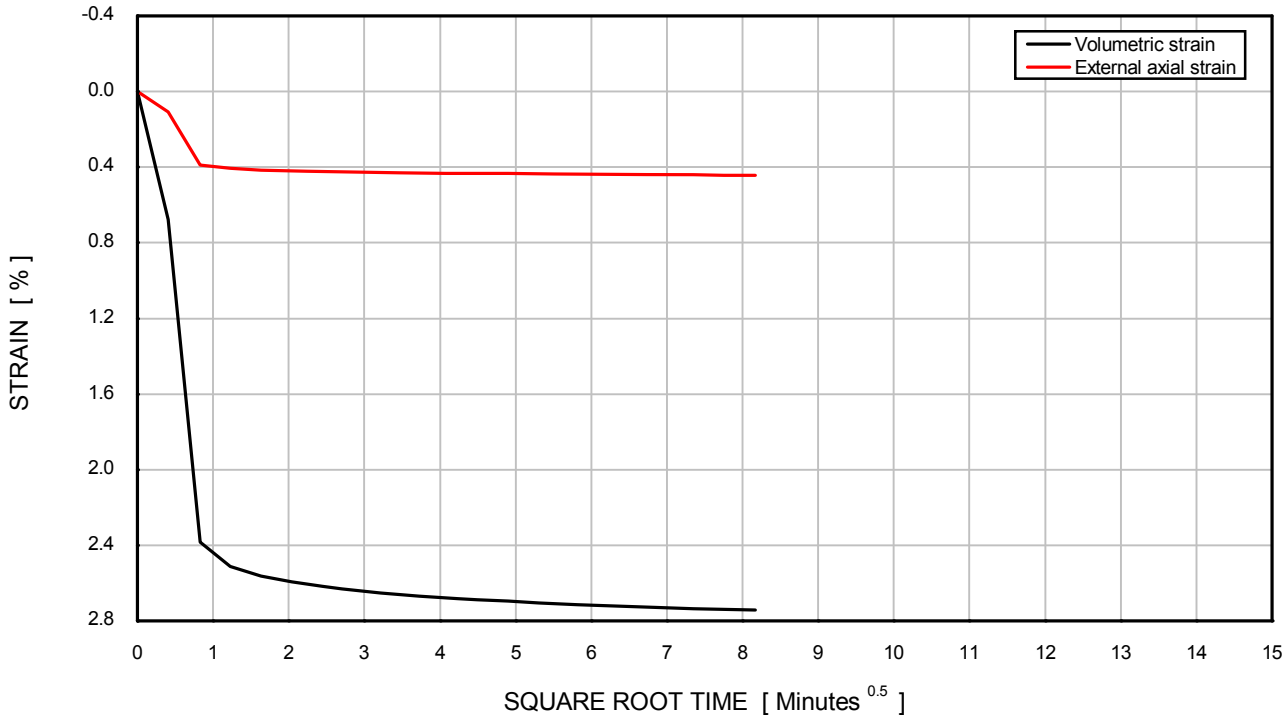


B value	:	0.98			
Initial σ'_r	:	18	kPa	Borehole	: Batch
Initial σ'_a	:	18	kPa	Sample	: Tongeren
Final σ'_r	:	36	kPa	Depth [m]	: -
Final σ'_a	:	36	kPa	Test No.	: CTXL11

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

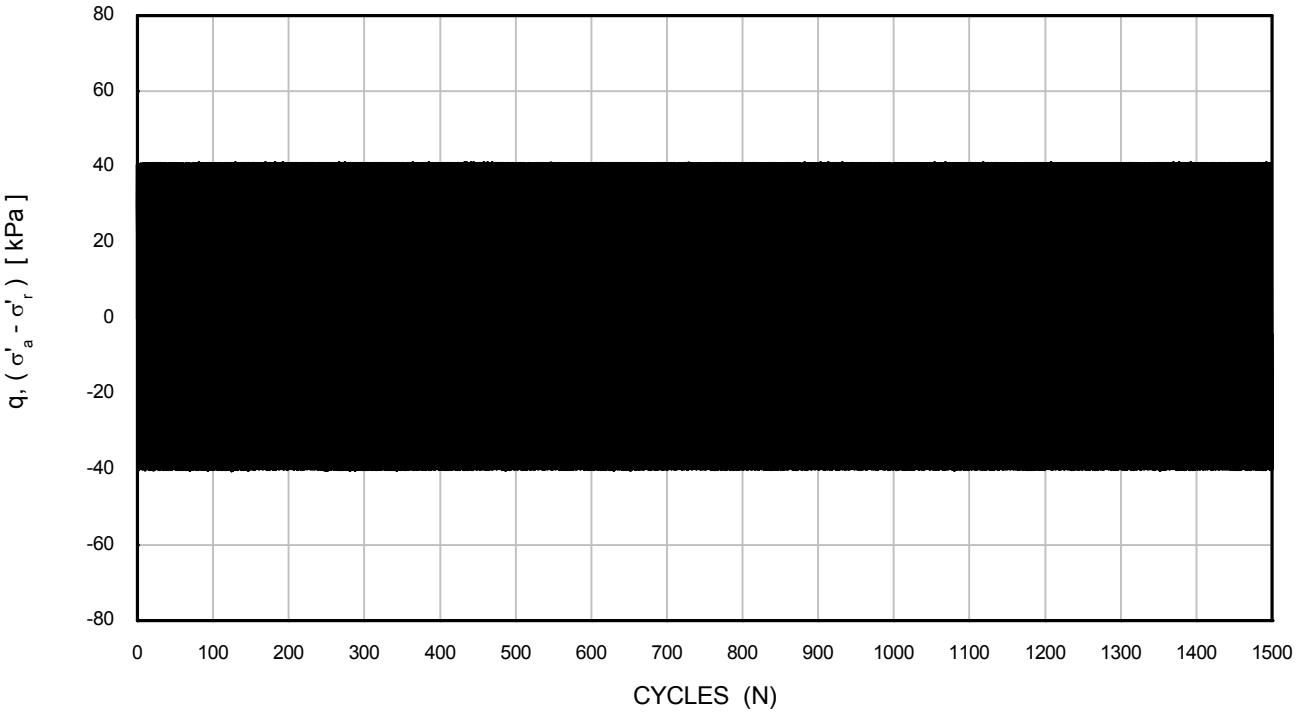


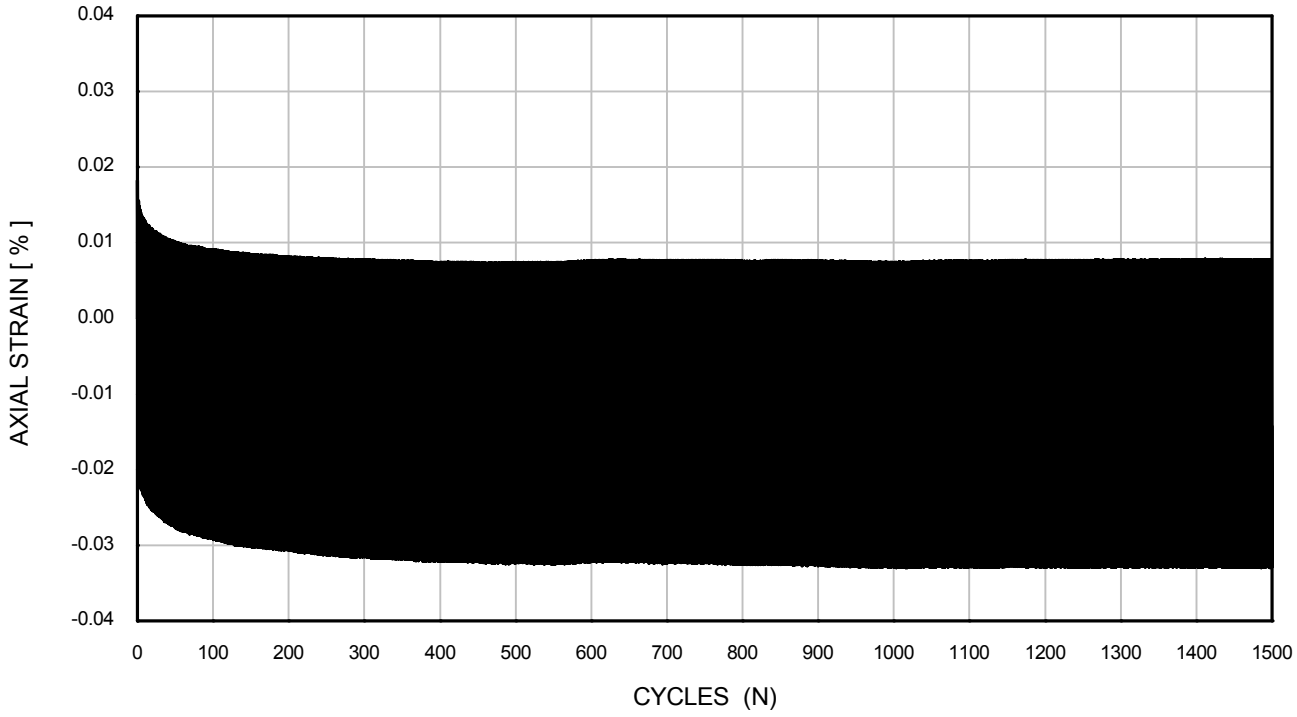


σ'_{rc}	: 400 kPa	Borehole	: Batch
σ'_{ac}	: 400 kPa	Sample	: Tongeren
		Depth [m]	: -
		Test No.	: CTXL11

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

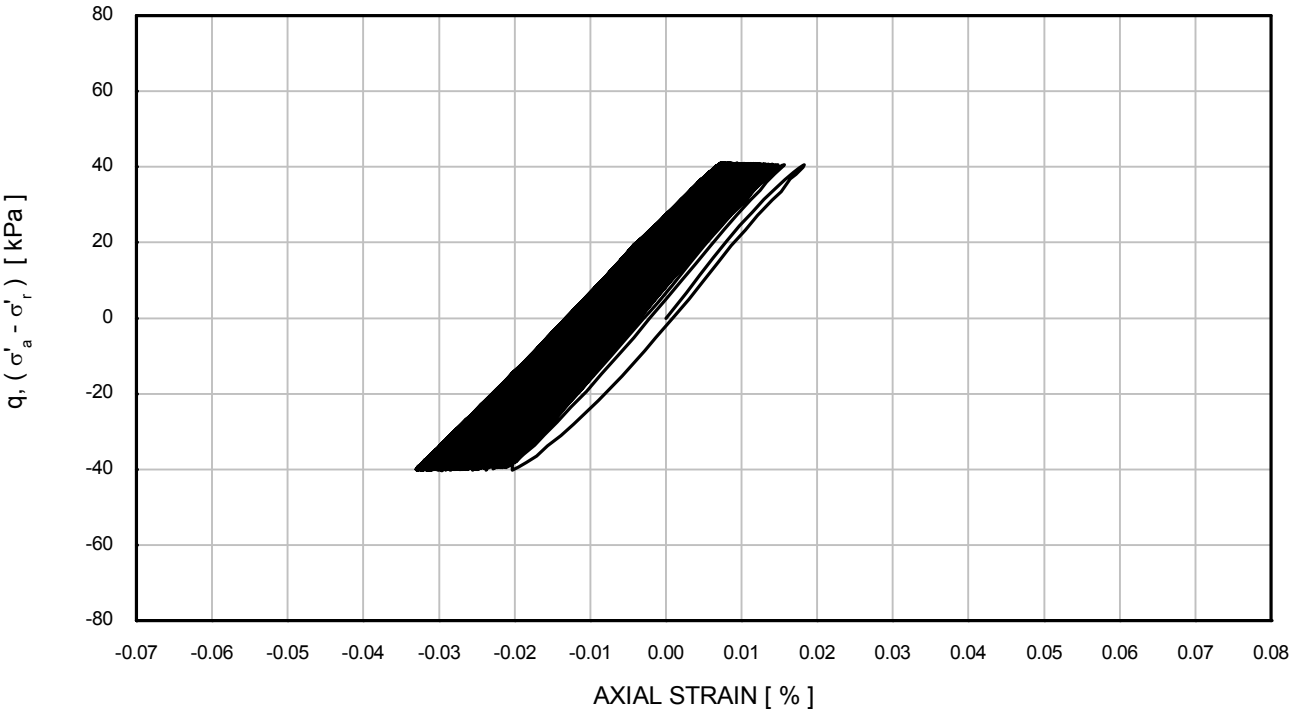


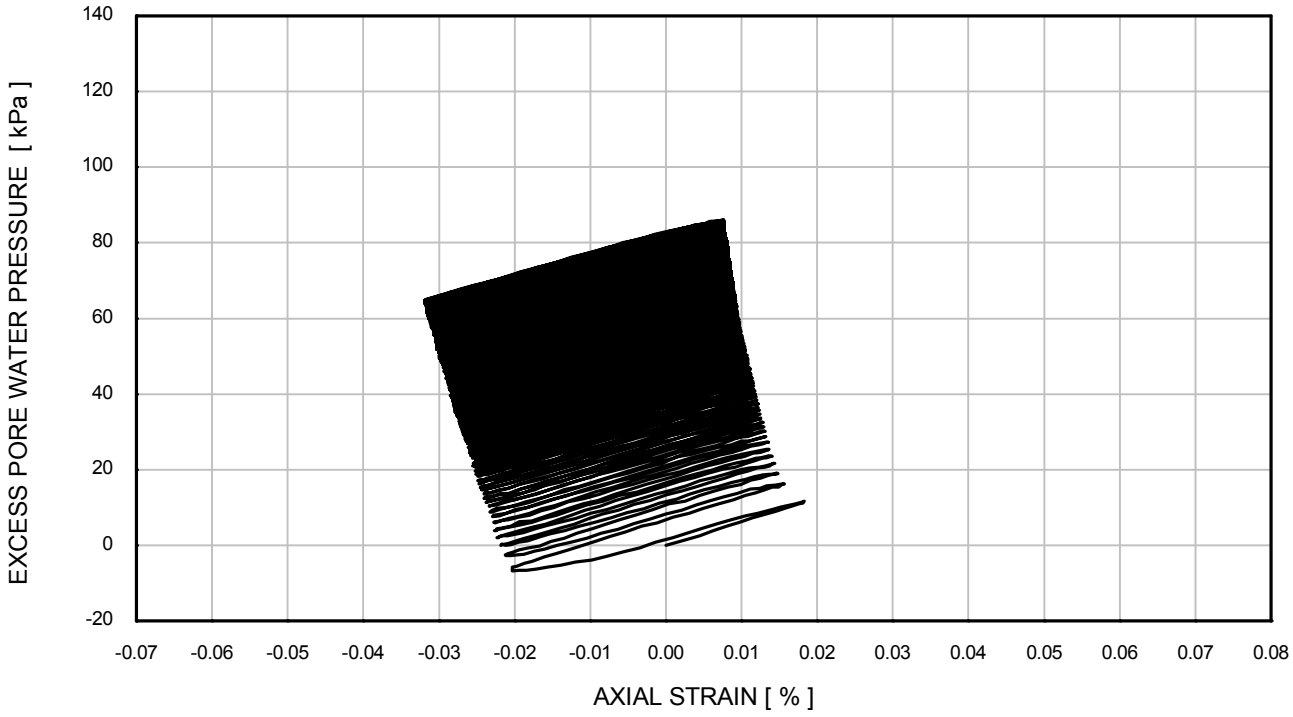


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

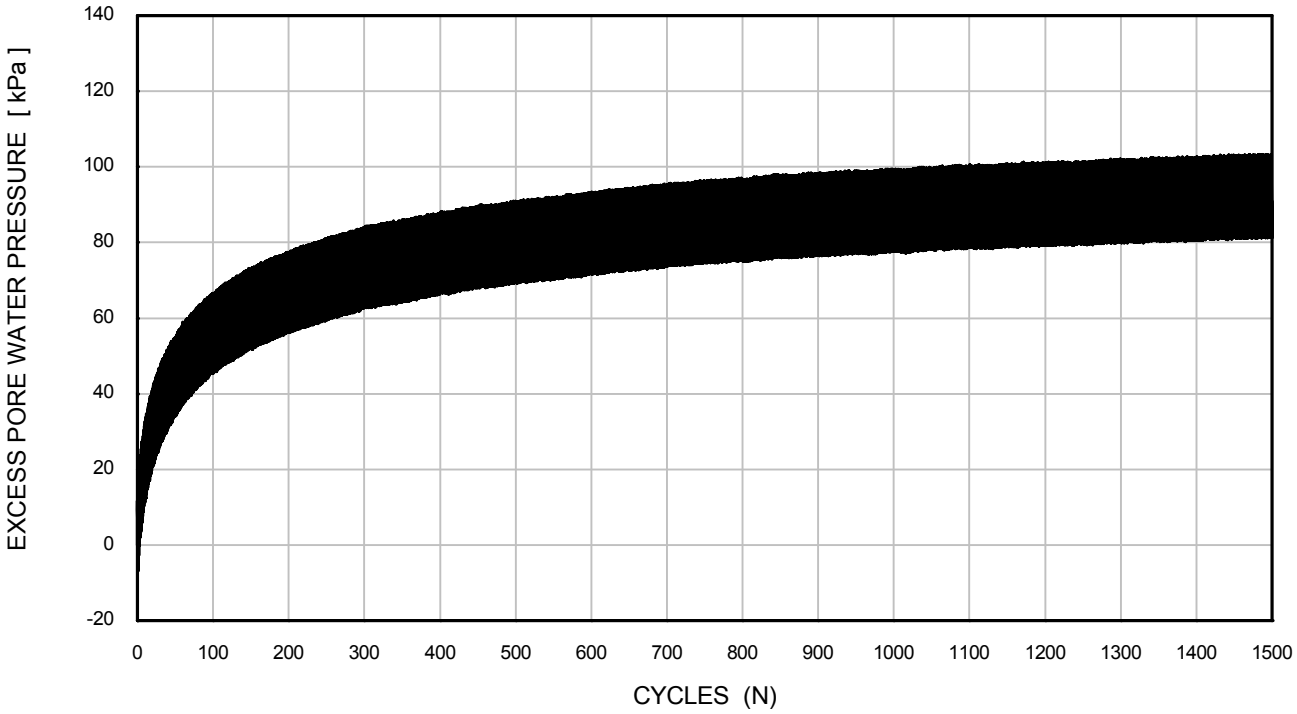


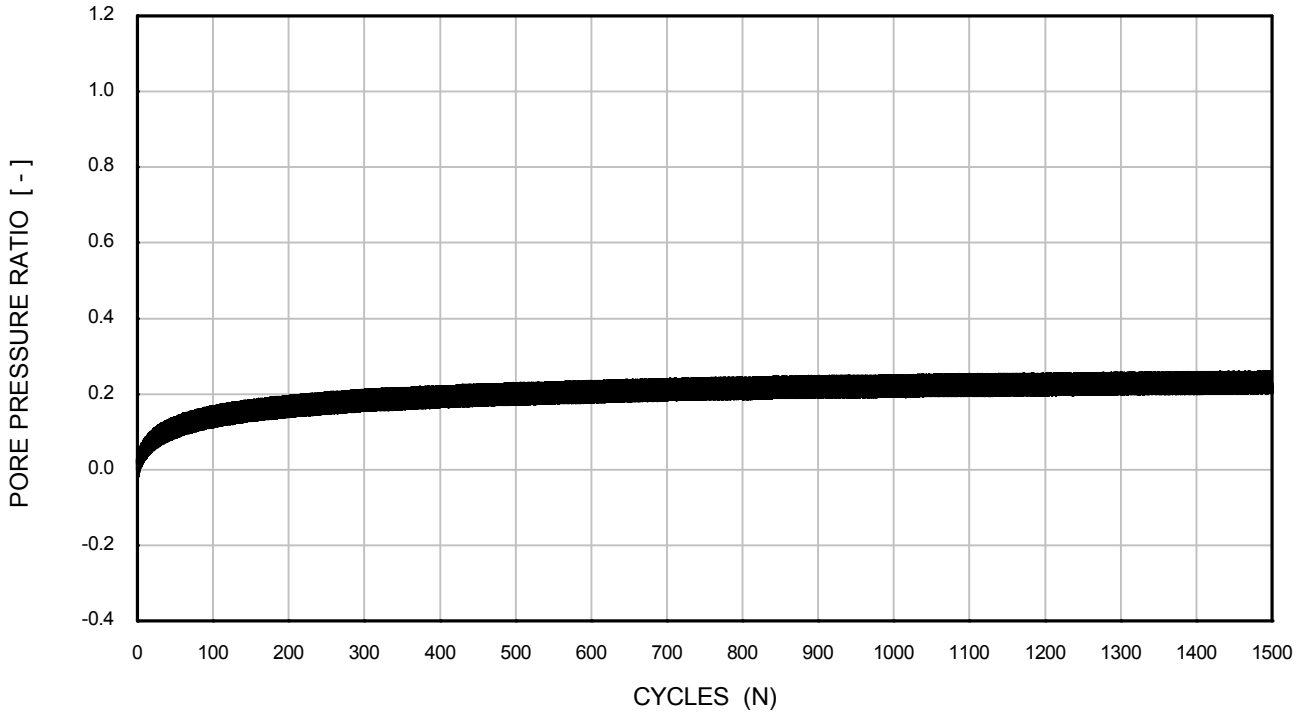


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

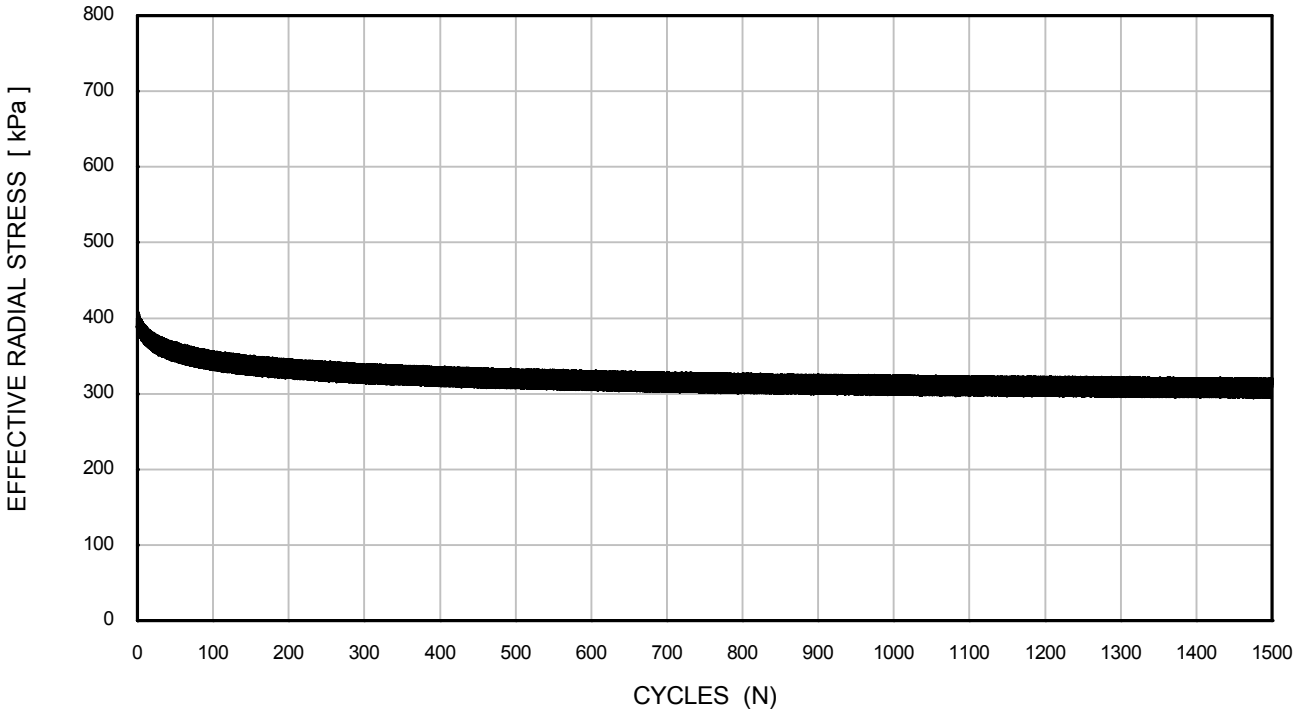


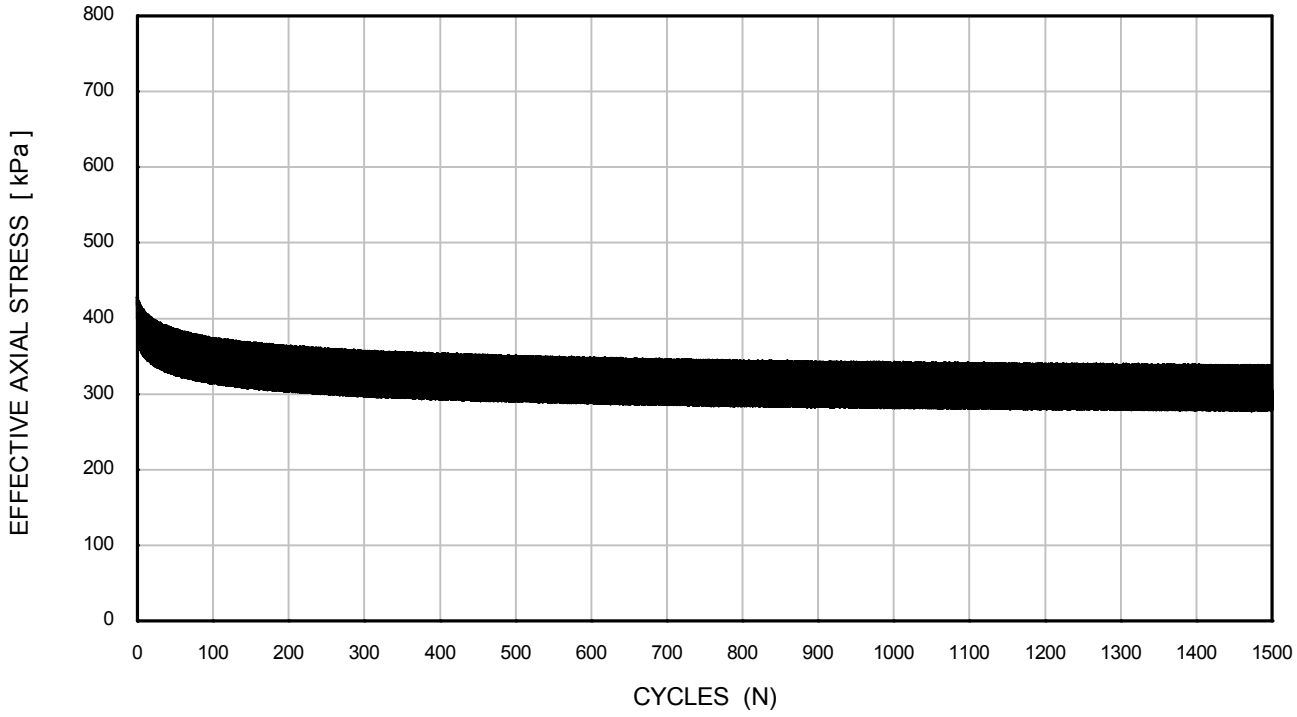


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

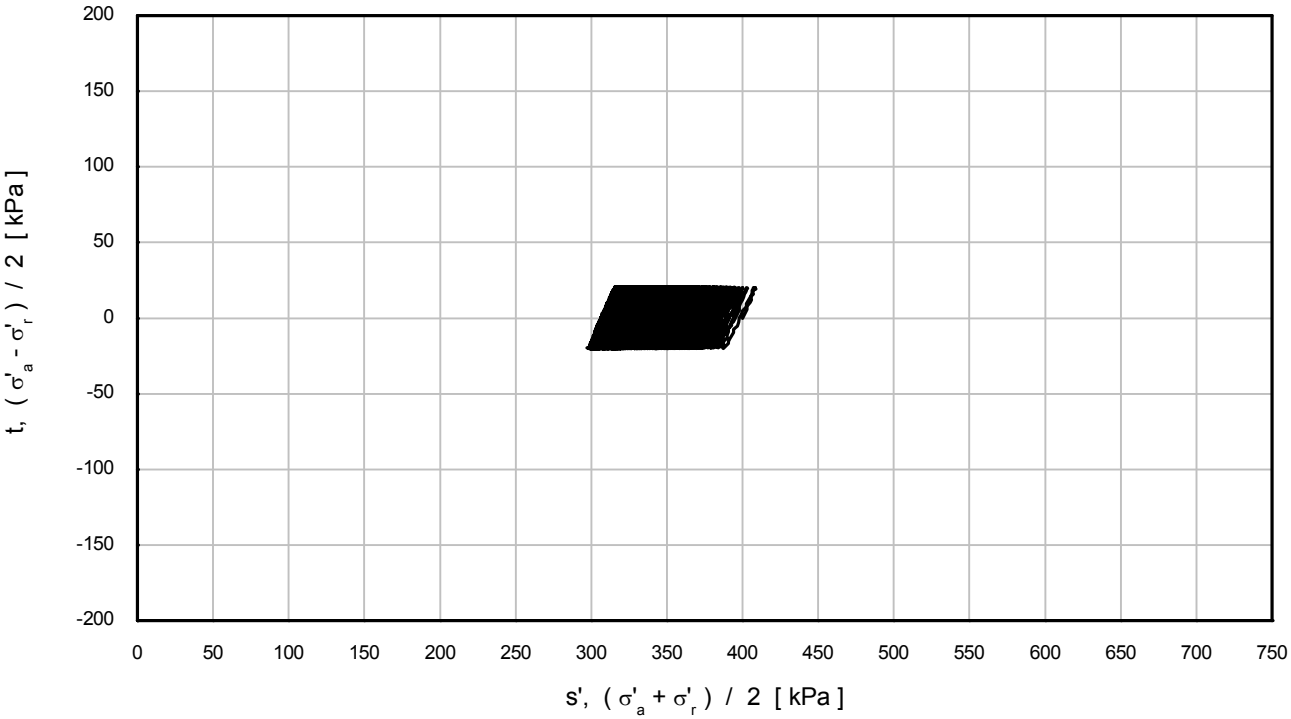


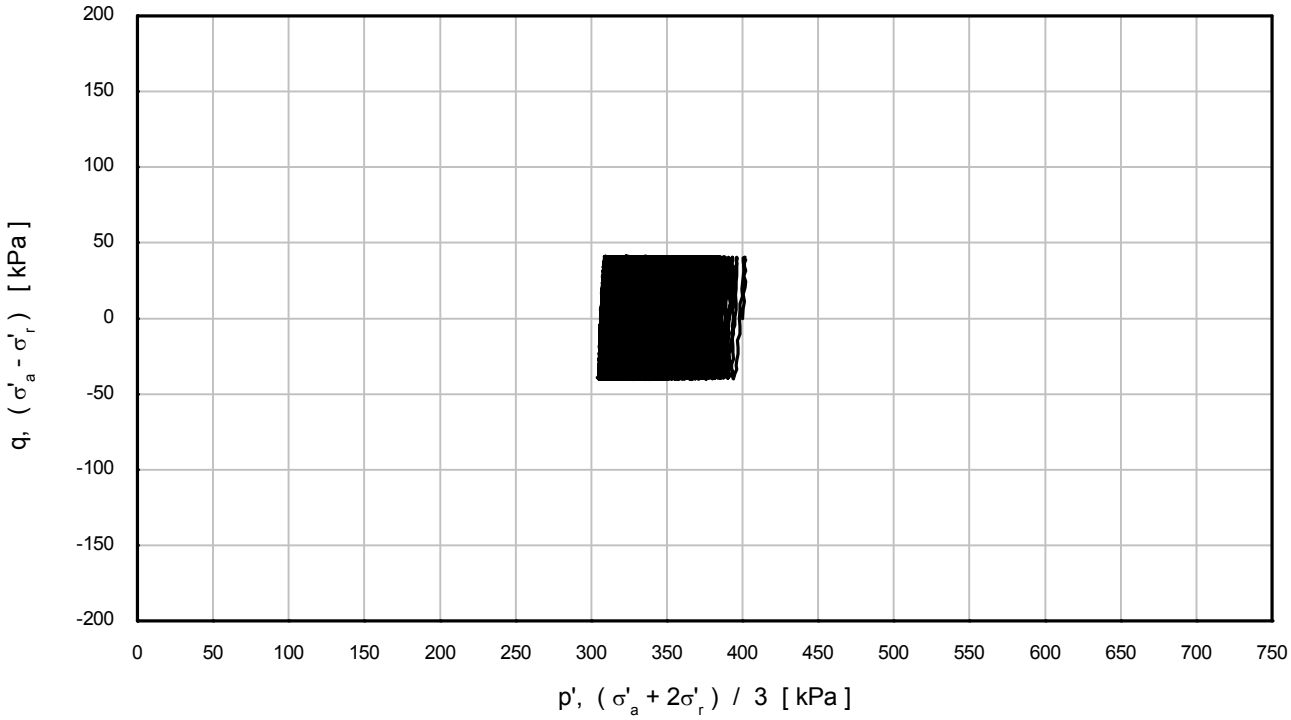


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

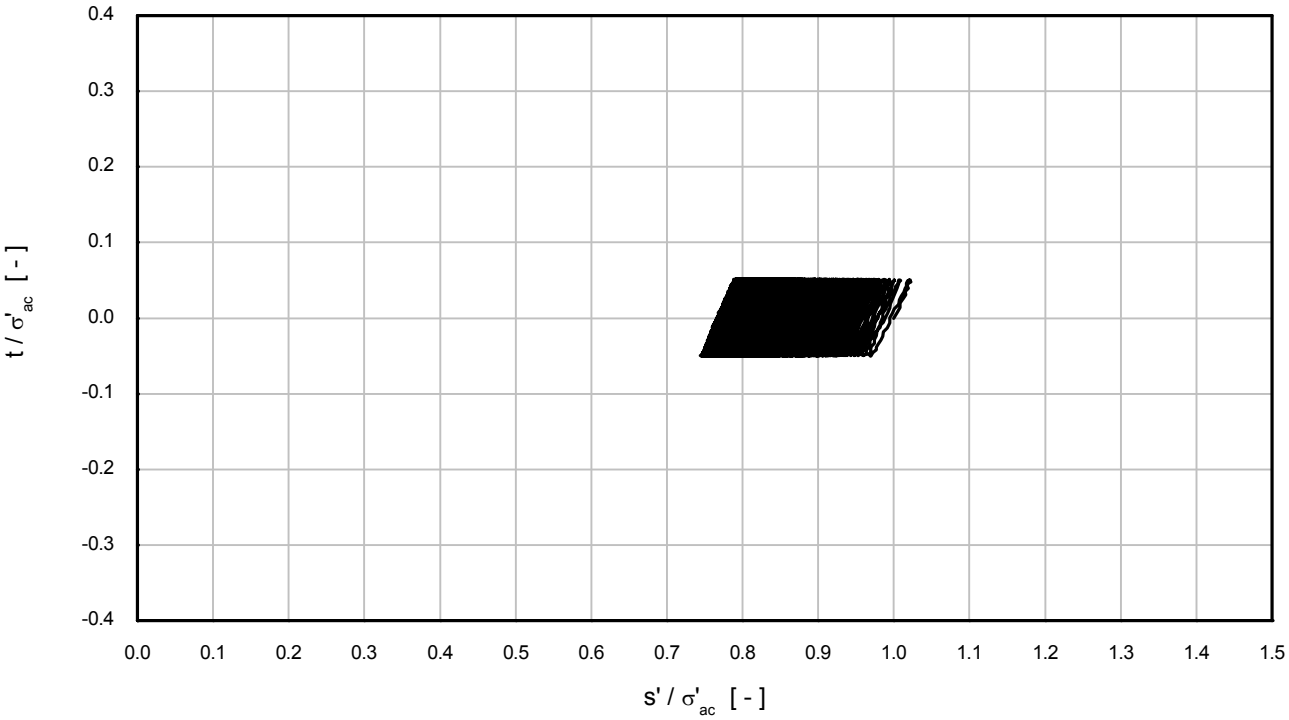


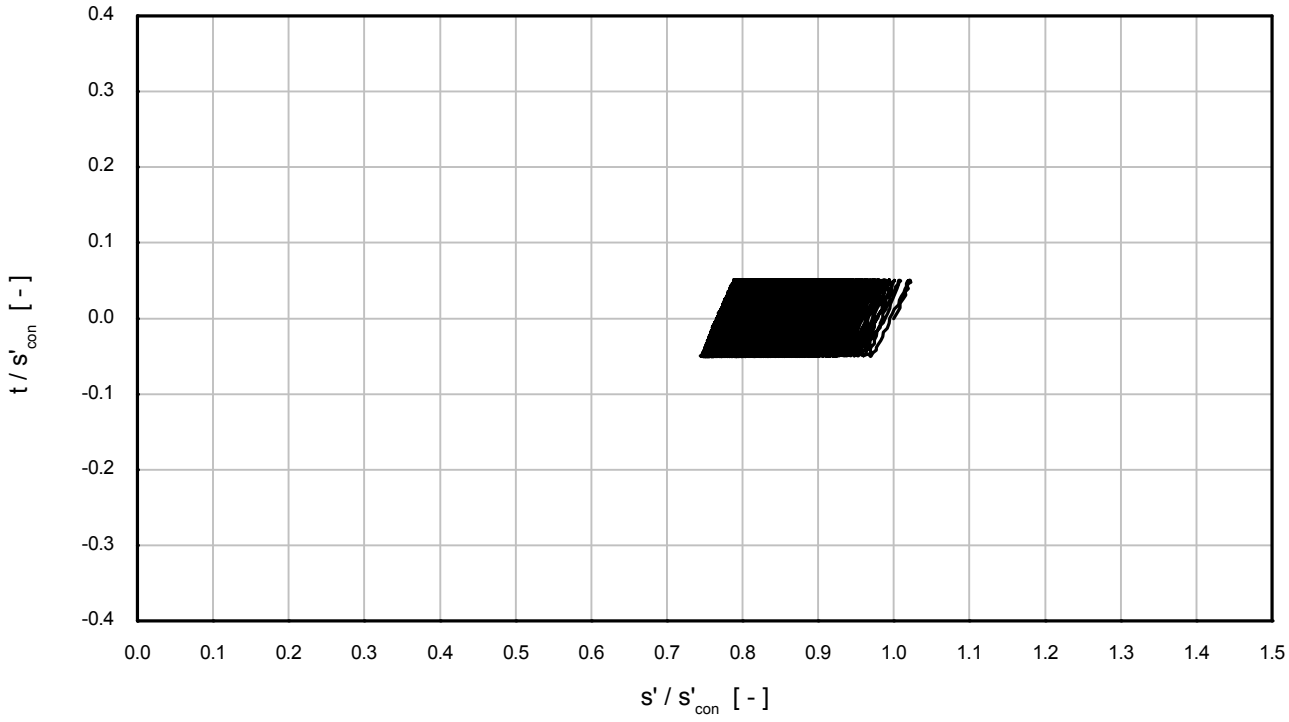


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

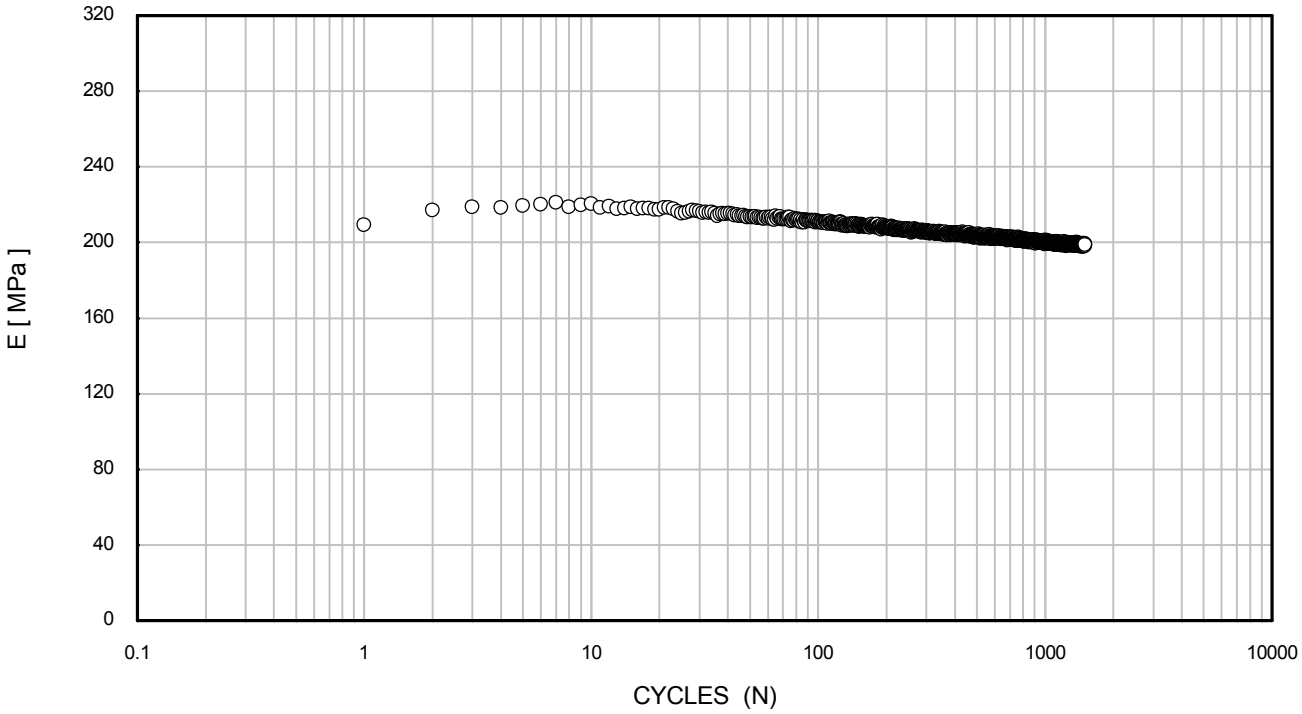


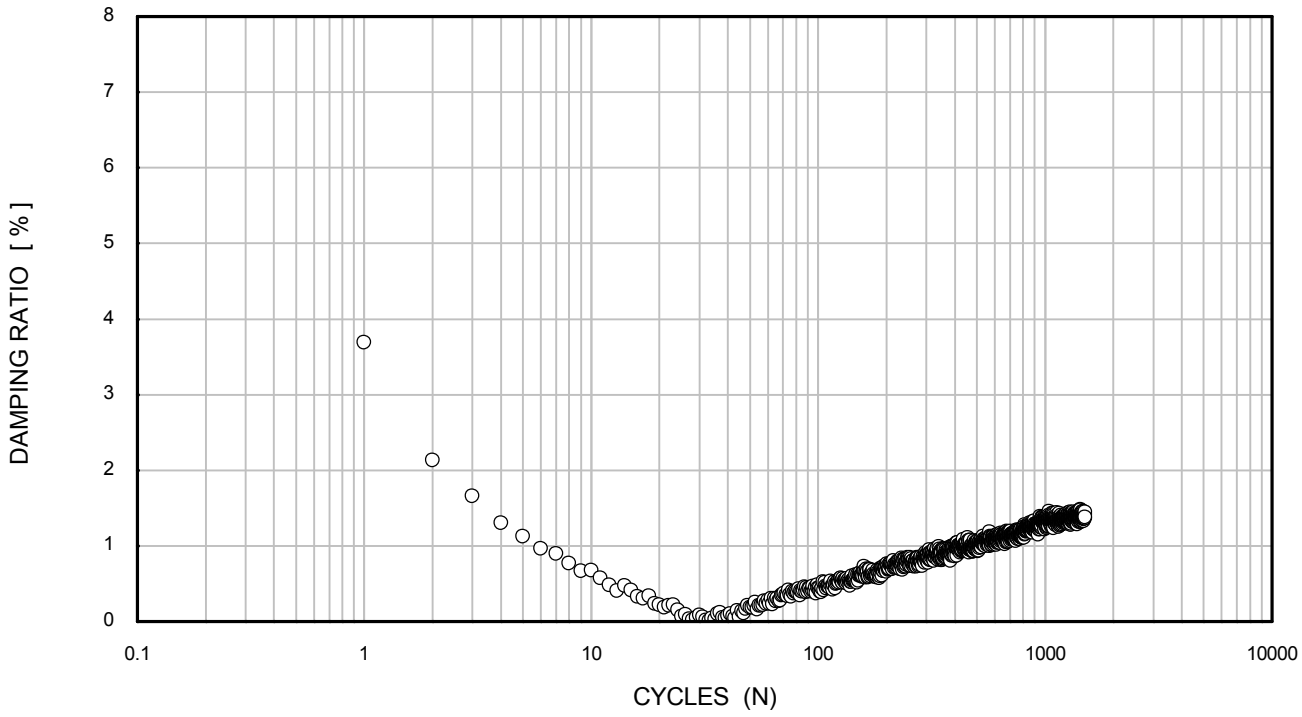


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

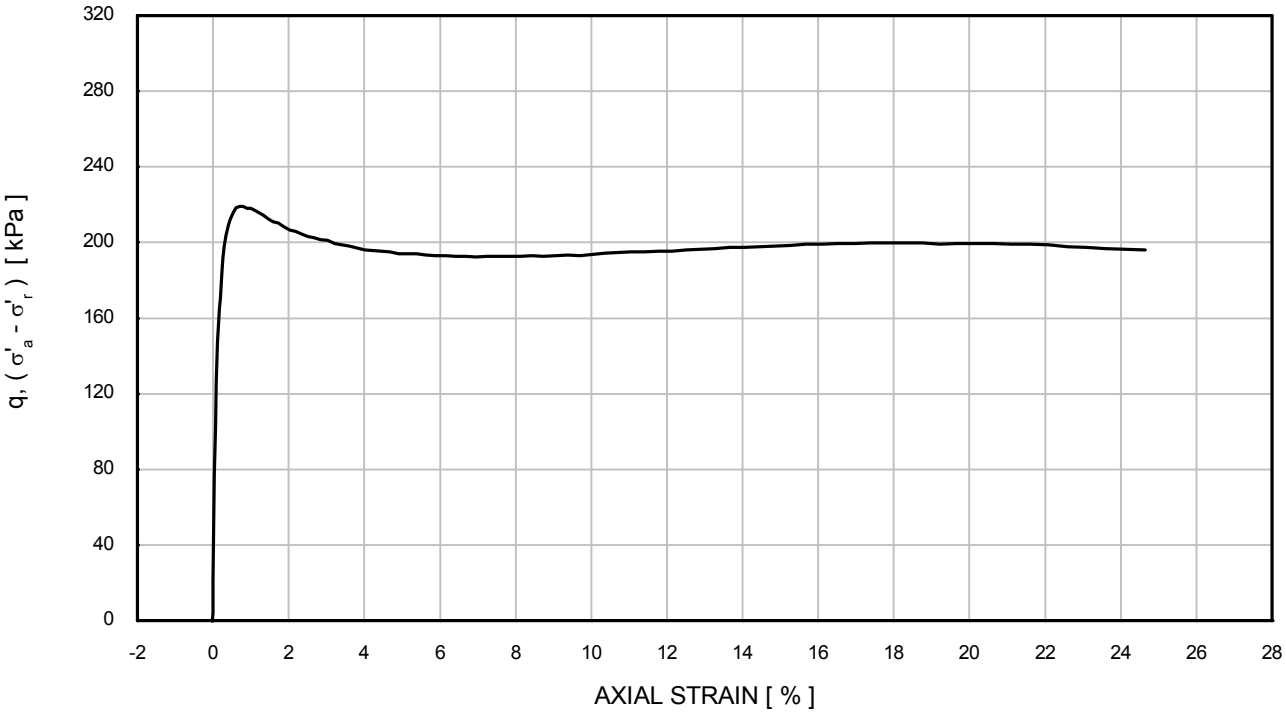


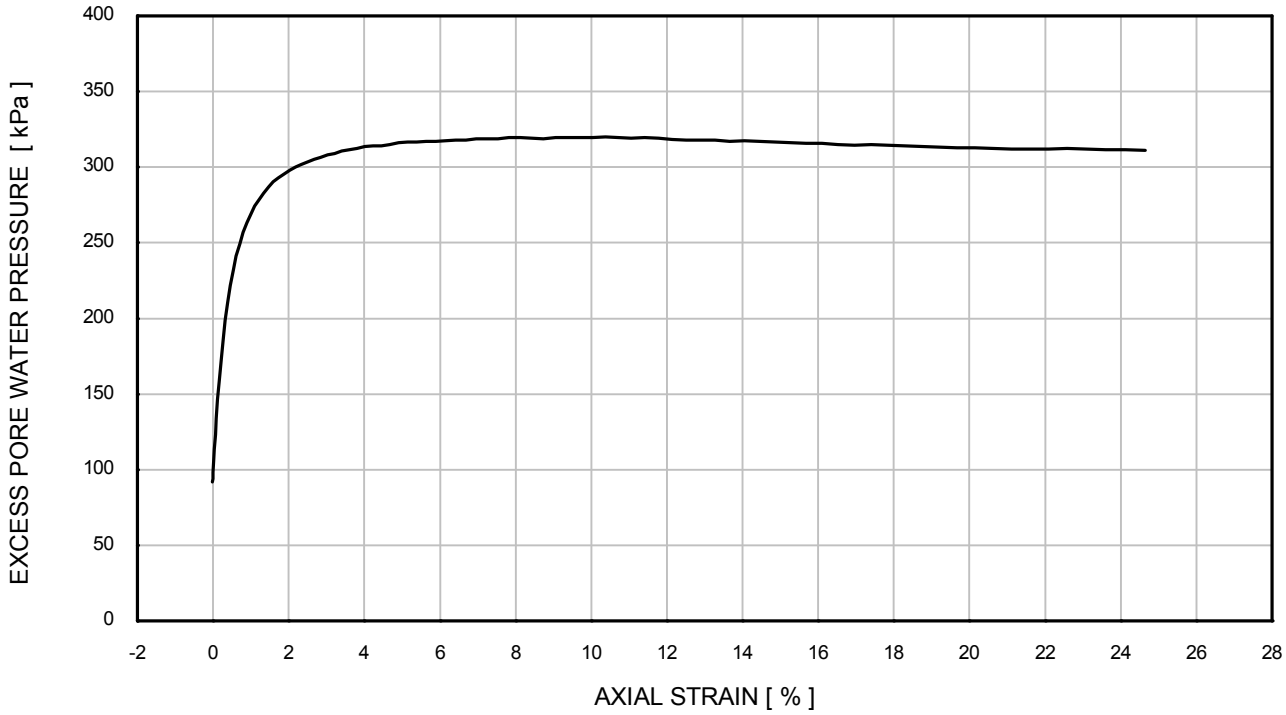


Initial σ'_r	:	400 kPa	Borehole	:	Batch
Initial σ'_a	:	400 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	40 kPa	Test No.	:	CTXL11
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

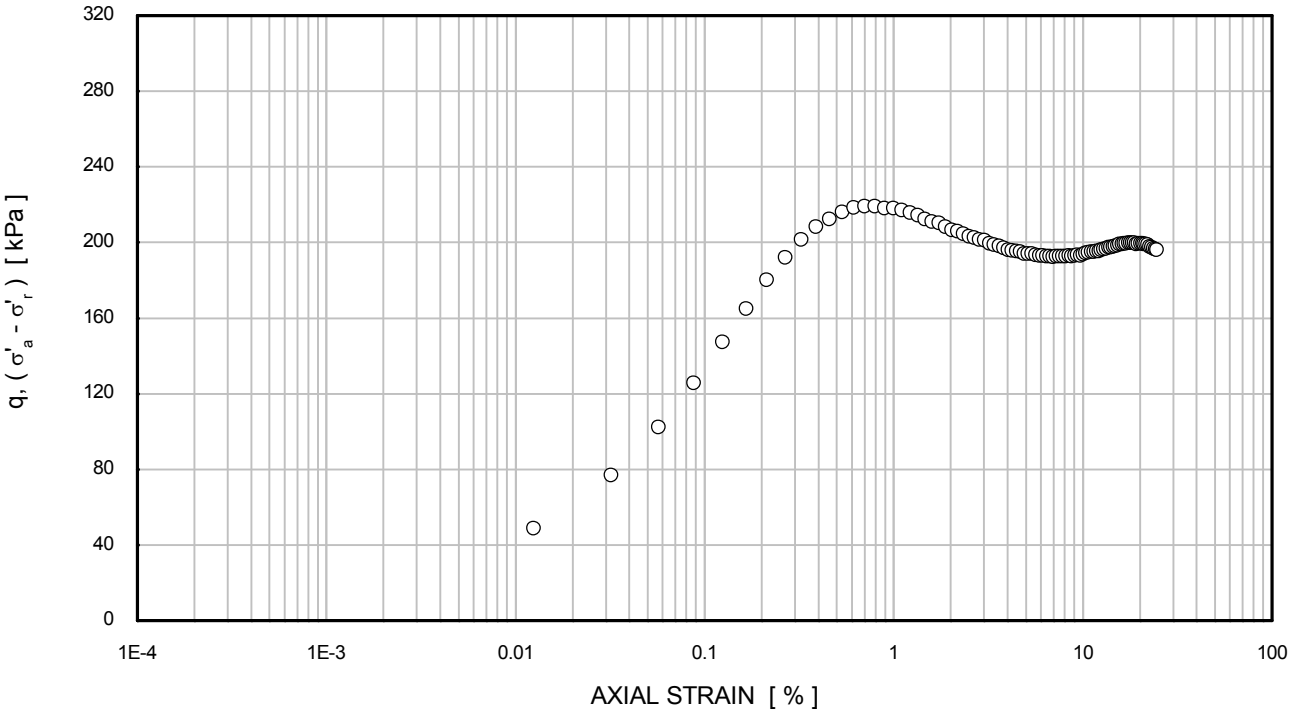


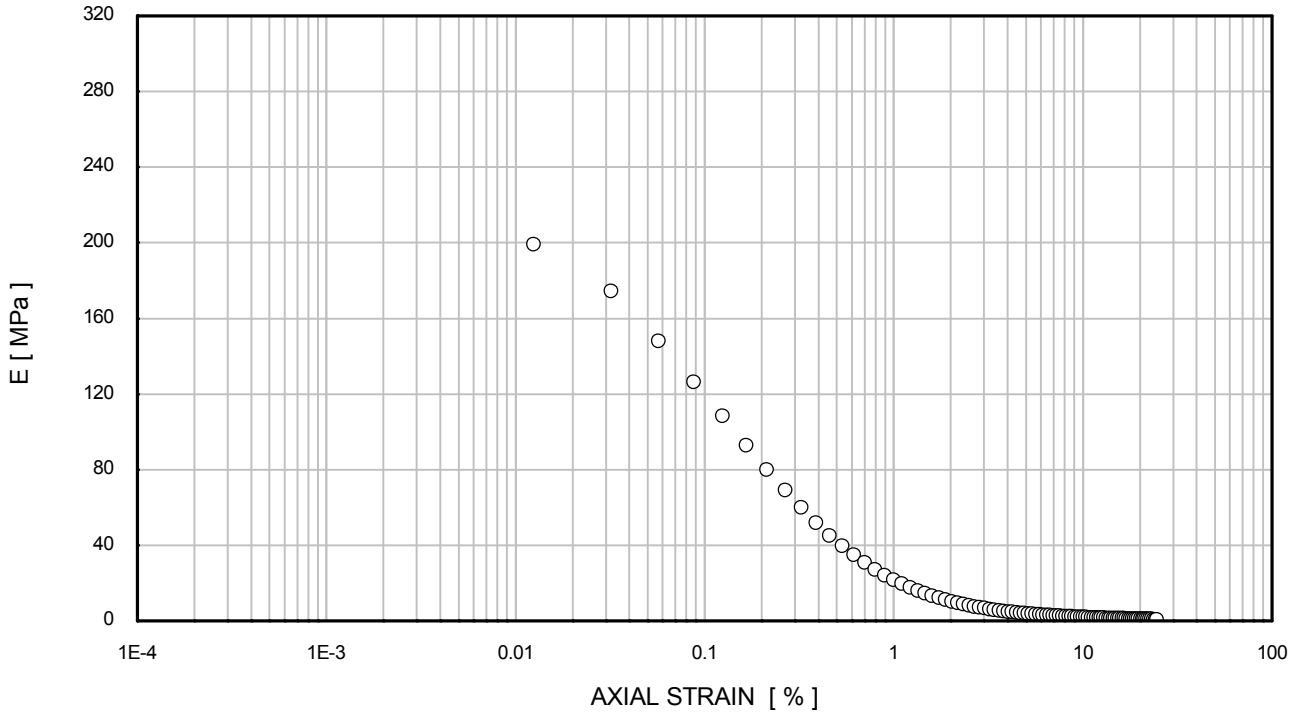


Initial σ'_r	:	308	kPa	Borehole	: Batch
Initial σ'_a	:	307	kPa	Sample	: Tongeren
q_{peak}	:	219	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	0.8	%	Test No.	: CTXL11
Rate of strain	:	1.00	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

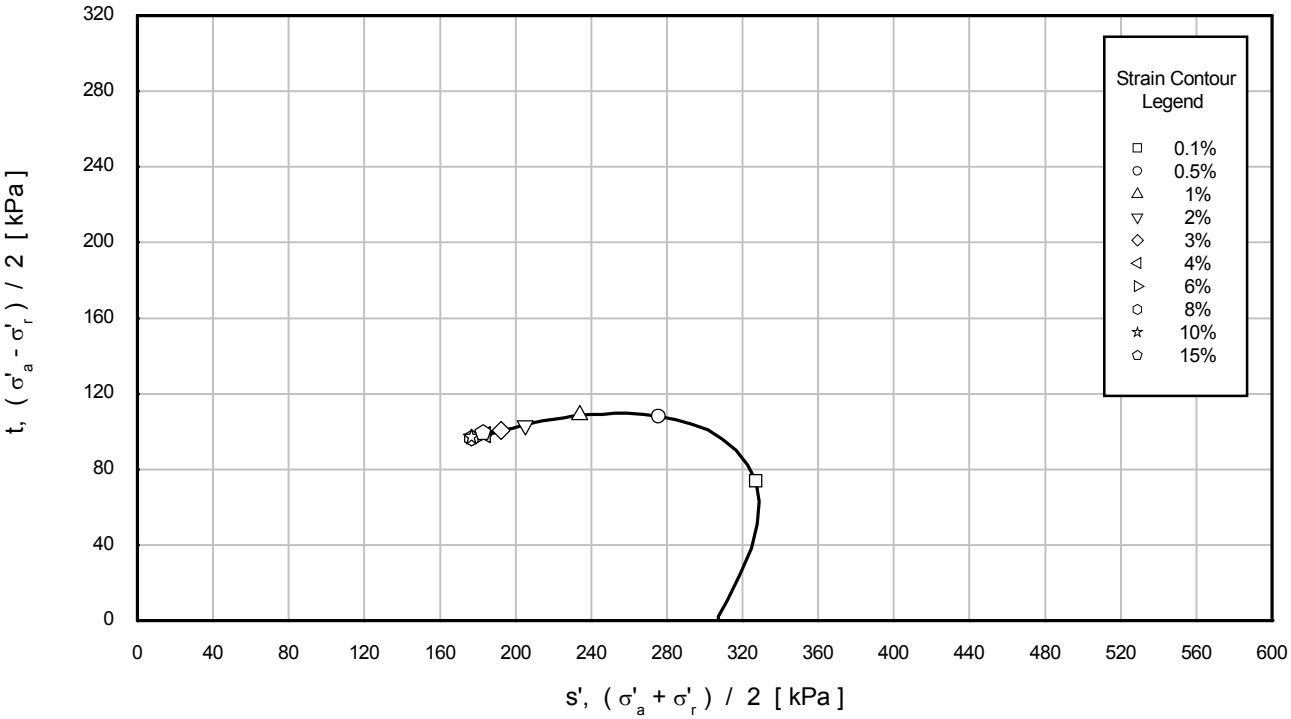


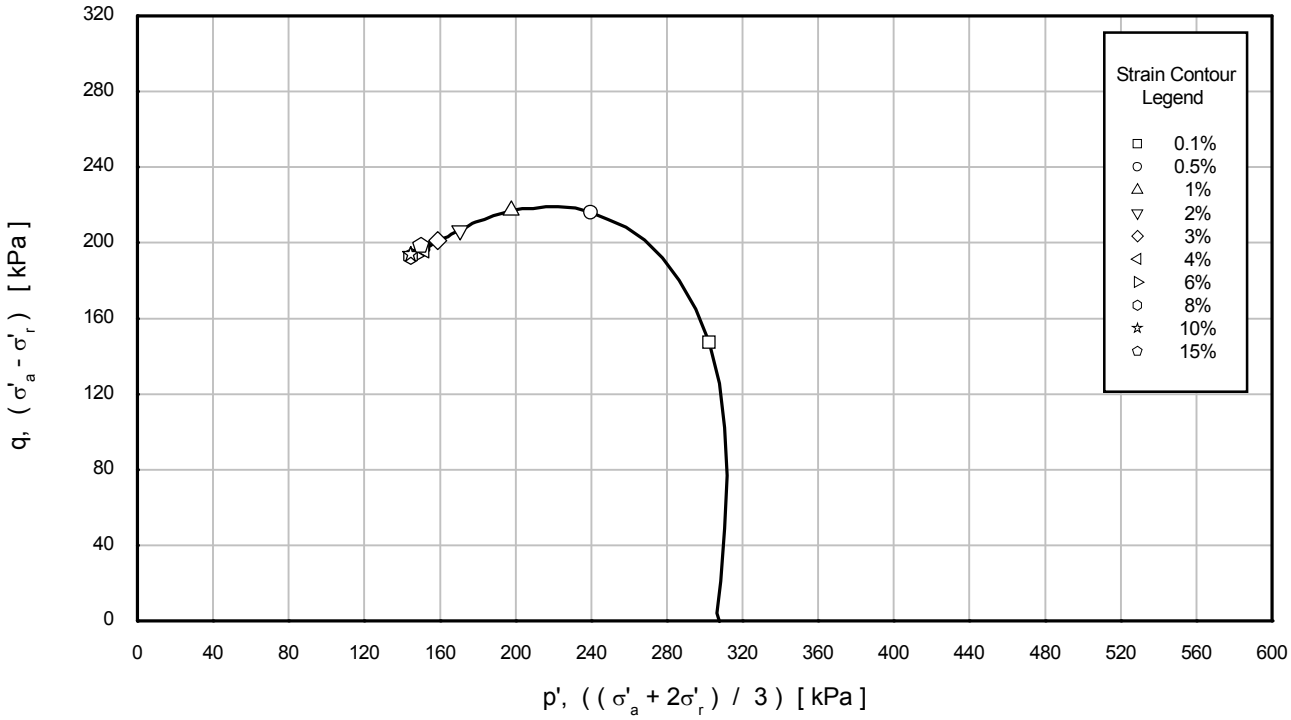


Initial σ'_r	:	308	kPa	Borehole	: Batch
Initial σ'_a	:	307	kPa	Sample	: Tongeren
q_{peak}	:	219	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	0.8	%	Test No.	: CTXL11
Rate of strain	:	1.00	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	308 kPa	Borehole	:	Batch
Initial σ'_a	:	307 kPa	Sample	:	Tongeren
q_{peak}	:	219 kPa	Depth [m]	:	-
Ext. ε at q_{peak}	:	0.8 %	Test No.	:	CTXL11
Rate of strain	:	1.00 %/hour			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Olive grey silty fine SAND

GENERAL	
Date test started	18/08/2015
Type of sample	Re-compacted
Type of drains fitted	One end only

INITIAL		
Diameter	[mm]	71.1
Length	[mm]	144.0
Moisture content	[%]	9.7
Bulk density	[Mg/m³]	1.77
Dry density	[Mg/m³]	1.61
Void ratio	[-]	0.642
Degree of saturation	[%]	40
Assumed particle density	[Mg/m³]	2.65
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-

TESTING PROCEDURES USED	
Specimen Set-up	Fugro in house procedure
Saturation	Fugro in house procedure
Consolidation - Isotropic	Fugro in house procedure
Consolidation - Anisotropic	N/A
Shearing	Fugro in house procedure
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Template Issue	1.0
Filename	J11286 \ Batch_Tongeren_CTXL12
Processed by	LC
Date	19/08/2015
Checked by	LJ
Date	20/08/2015
Approved by	PH
Date	20/08/2015

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL12

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SATURATION		
Pressure increments applied	[kPa]	Drained ramp, with subsequent 100 kPa increments
Differential pressure used	[kPa]	10
Cell pressure	[kPa]	1400
Base PWP	[kPa]	1395
Mid height PWP	[kPa]	-
B value achieved	[-]	1.00

CONSOLIDATION: ISOTROPIC		
Cell pressure	[kPa]	1400
Back pressure	[kPa]	1000
Base PWP	[kPa]	1000
Mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	400
Effective axial pressure	[kPa]	400
Deviator stress	[kPa]	0
Volumetric strain	[%]	5.22
External axial strain	[%]	2.60
Local axial strain	[%]	-
Local radial strain	[%]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.556
Degree of saturation	[%]	100

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL12

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

STRESS-CONTROLLED CYCLIC LOADING STAGE		
Reference stress	[kPa]	400
Mean q_{av}	[kPa]	0
Mean q_{cy}	[kPa]	72
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	58
External ε_{av} at N_f	[%]	-2.96
External ε_{cy} at N_f	[%]	15.72
Local ε_{av} at N_f	[%]	-
Local ε_{cy} at N_f	[%]	-
Δ base PWP at N_f	[kPa]	347
Δ mid height PWP at N_f	[kPa]	-
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70
Void ratio	[-]	0.556
Degree of saturation	[%]	100

Cycle (N)	ε_{av} [%]	ε_{cy} [%]	E_{ext} [MPa]	E_{loc} [MPa]	λ_{ext} [%]	λ_{loc} [%]
1	0.01	0.05	149	-	13.40	-
2	0.01	0.05	155	-	10.48	-
5	0.01	0.05	151	-	8.44	-
10	0.02	0.05	144	-	7.73	-
20	0.02	0.06	129	-	7.74	-
30	0.02	0.06	115	-	8.47	-
40	0.03	0.07	97	-	10.11	-
50	0.02	0.11	66	-	14.75	-
58	-2.96	15.72	0	-	11.59	-

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL12

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

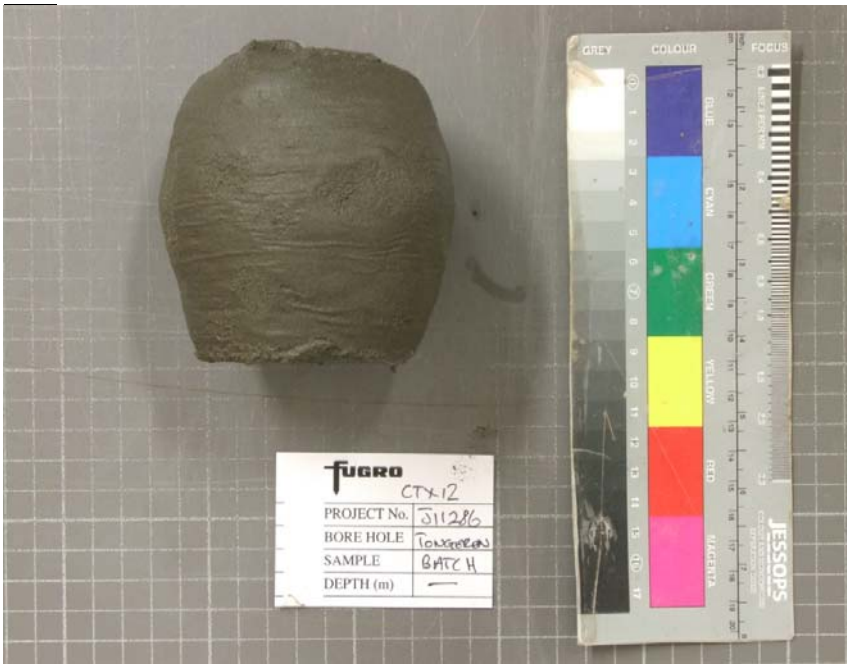
SHEARING STAGE		
Initial effective radial pressure	[kPa]	1
Initial effective axial pressure	[kPa]	2
Rate of strain	[%/hour]	0.87
At peak deviator stress		
Corrected deviator stress	[kPa]	140
Membrane correction applied	[kPa]	2
Drain correction applied	[kPa]	0
External axial strain	[%]	19.43
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	351
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	49
Effective axial pressure	[kPa]	189
Principal effective stress ratio	[-]	3.86
ε_{50}	[%]	14.40
Secant modulus (E_{50}) at ε_{50}	[kPa]	471
At peak principal effective stress ratio		
Corrected deviator stress	[kPa]	3
Membrane correction applied	[kPa]	0
Drain correction applied	[kPa]	0
External axial strain	[%]	1.70
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	399
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	0
Effective axial pressure	[kPa]	3
Principal effective stress ratio	[-]	14.19
At 10% axial strain		
Corrected deviator stress	[kPa]	26
Membrane correction applied	[kPa]	1
Drain correction applied	[kPa]	0
External axial strain	[%]	10.00
Local axial strain	[%]	-
Local radial strain	[%]	-
Excess base PWP	[kPa]	391
Excess mid height PWP	[kPa]	-
Effective radial pressure	[kPa]	9
Effective axial pressure	[kPa]	35
Principal effective stress ratio	[-]	4.09

TEST IDENTIFICATION	
Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL12

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SPECIMEN PHOTOGRAPHS



FINAL CONDITIONS

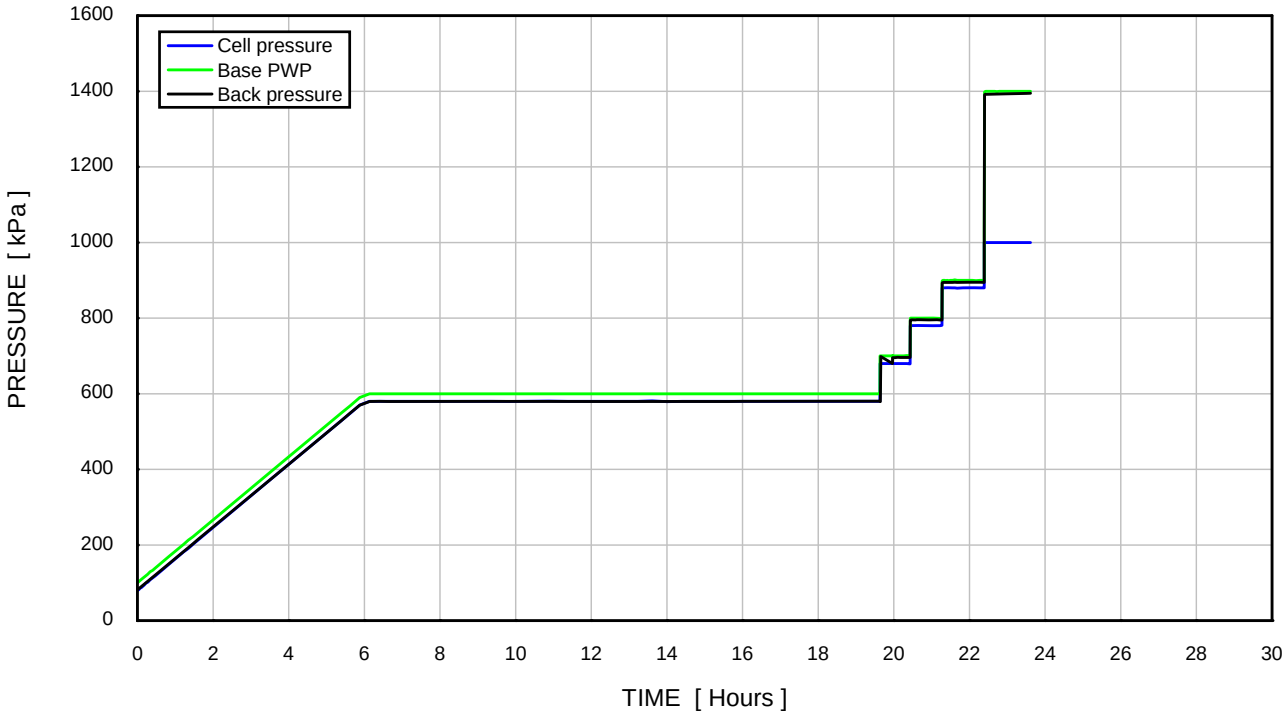
Moisture content	[%]	21.0
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.70

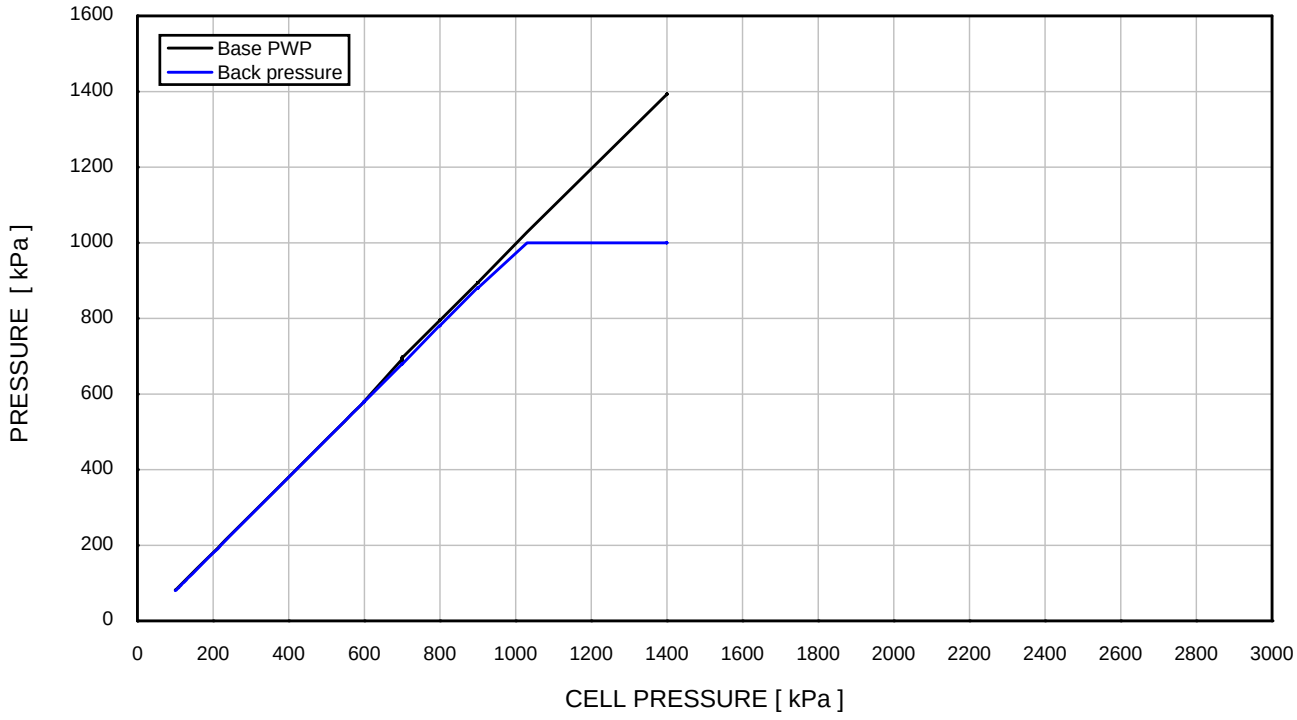
TEST IDENTIFICATION

Borehole	Batch
Sample	Tongeren
Depth [m]	-
Test number	CTXL12

SUMMARY OF ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

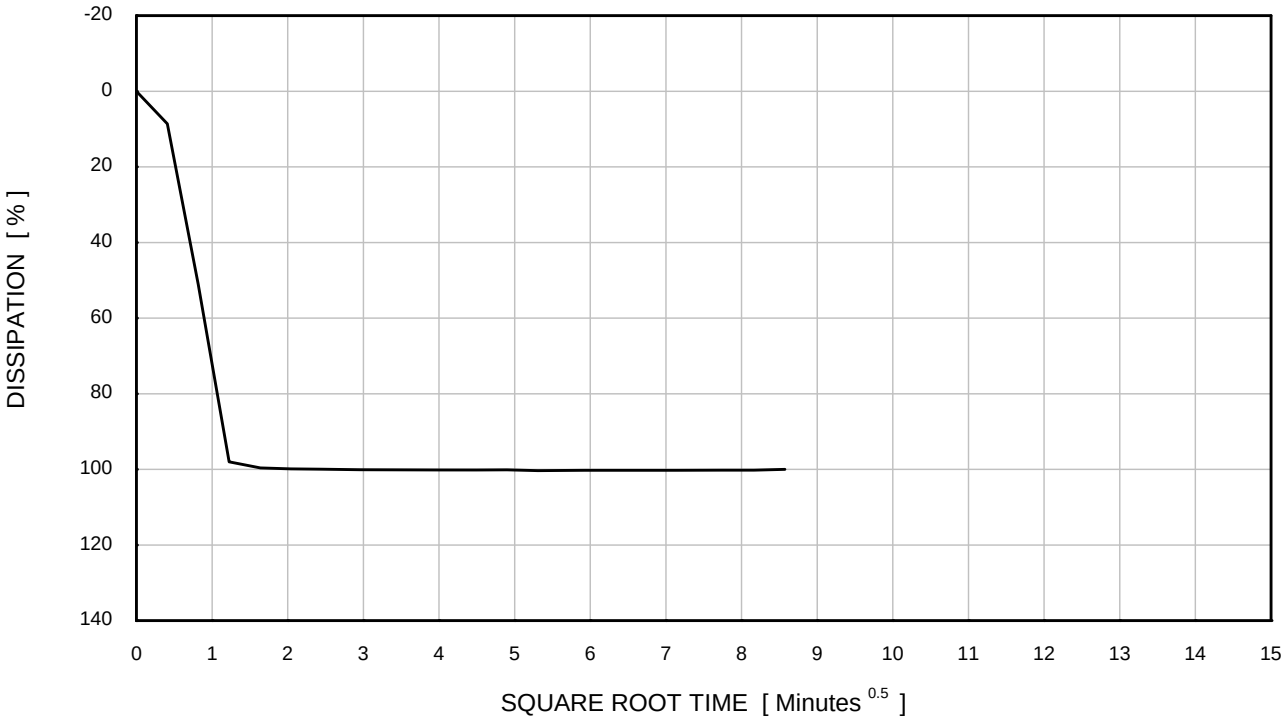


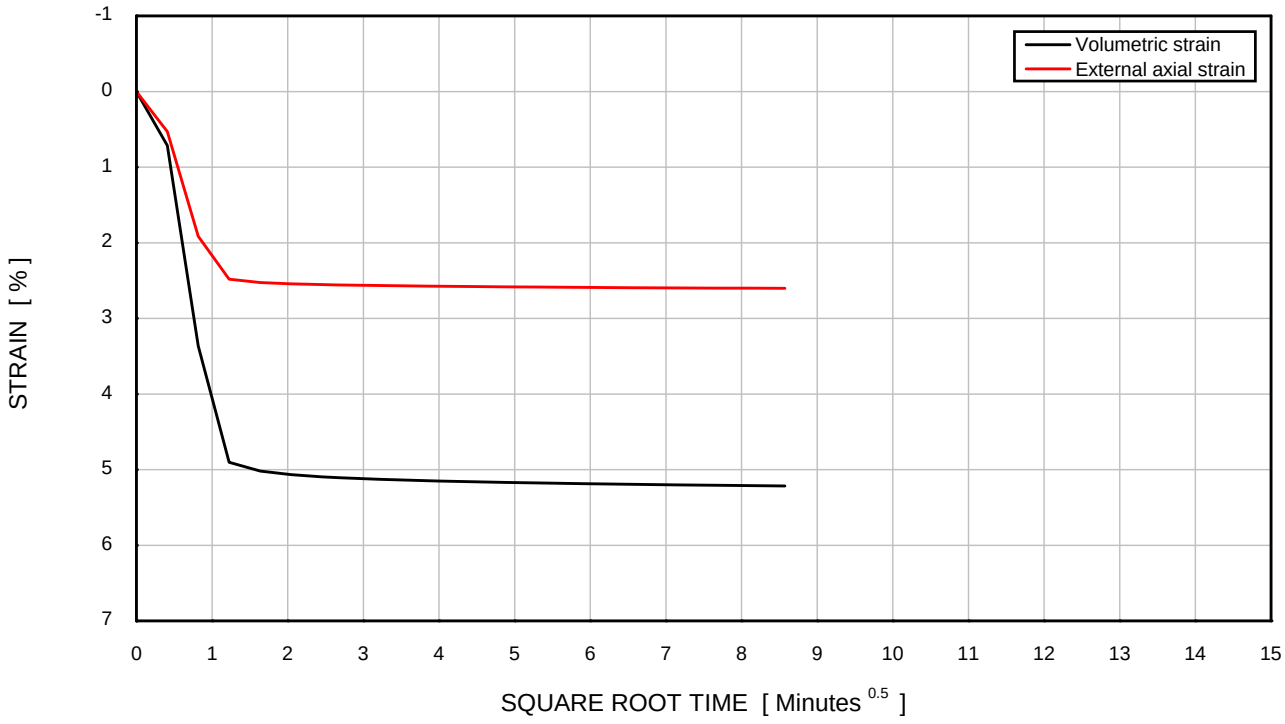


B value	:	1.00			
Initial σ'_r	:	18	kPa	Borehole	: Batch
Initial σ'_a	:	18	kPa	Sample	: Tongeren
Final σ'_r	:	5	kPa	Depth [m]	: -
Final σ'_a	:	5	kPa	Test No.	: CTXL12

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SATURATION STAGE - DRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

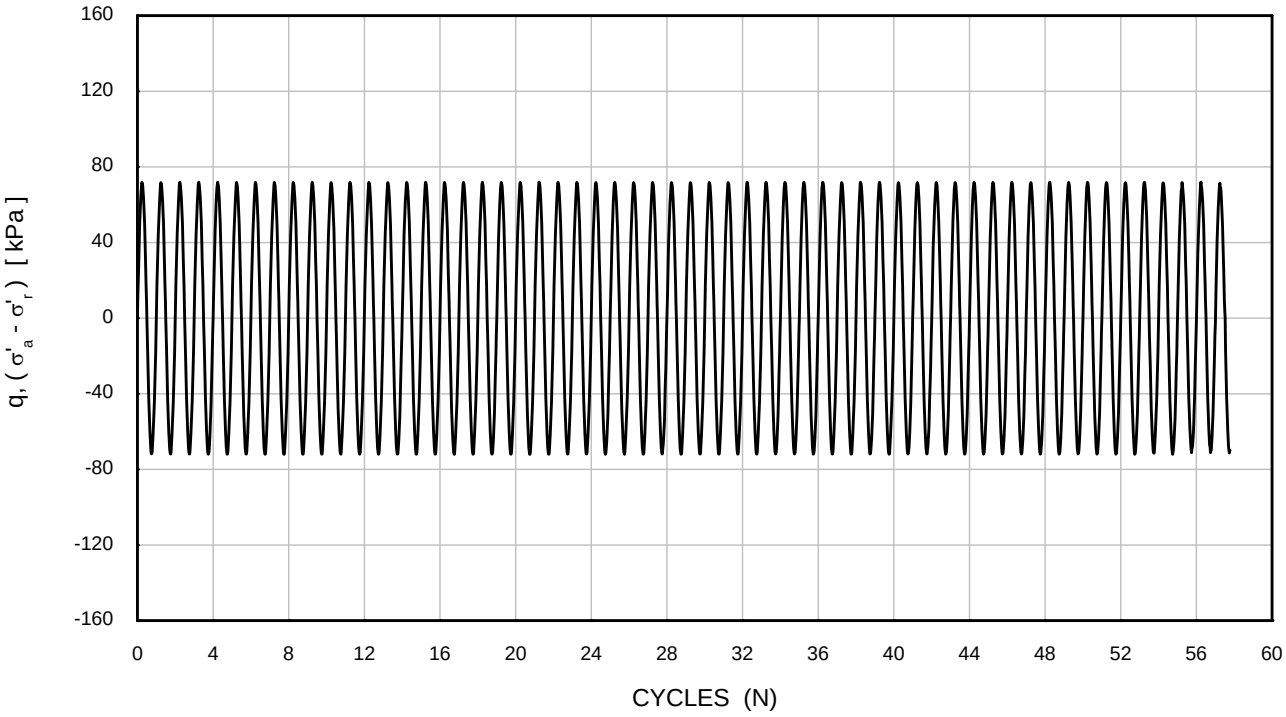


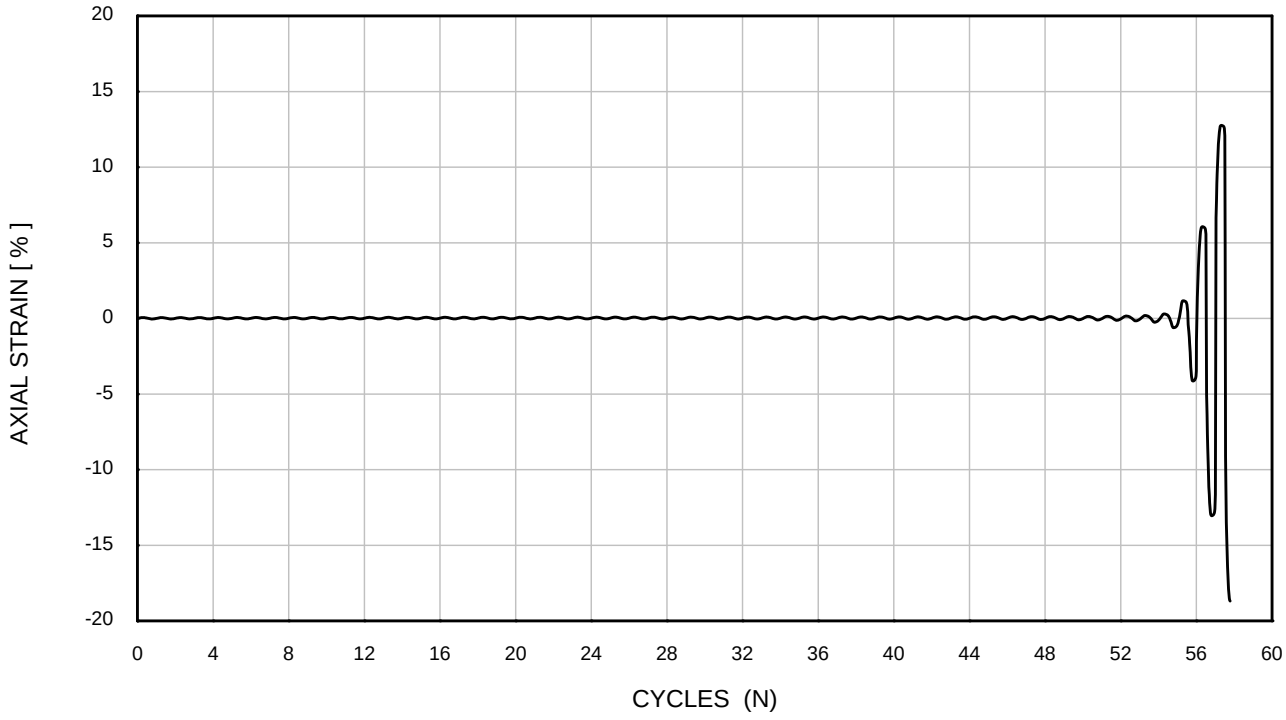


σ'_{rc}	: 400 kPa	Borehole	: Batch
σ'_{ac}	: 400 kPa	Sample	: Tongeren
		Depth [m]	: -
		Test No.	: CTXL12

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
ISOTROPIC CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

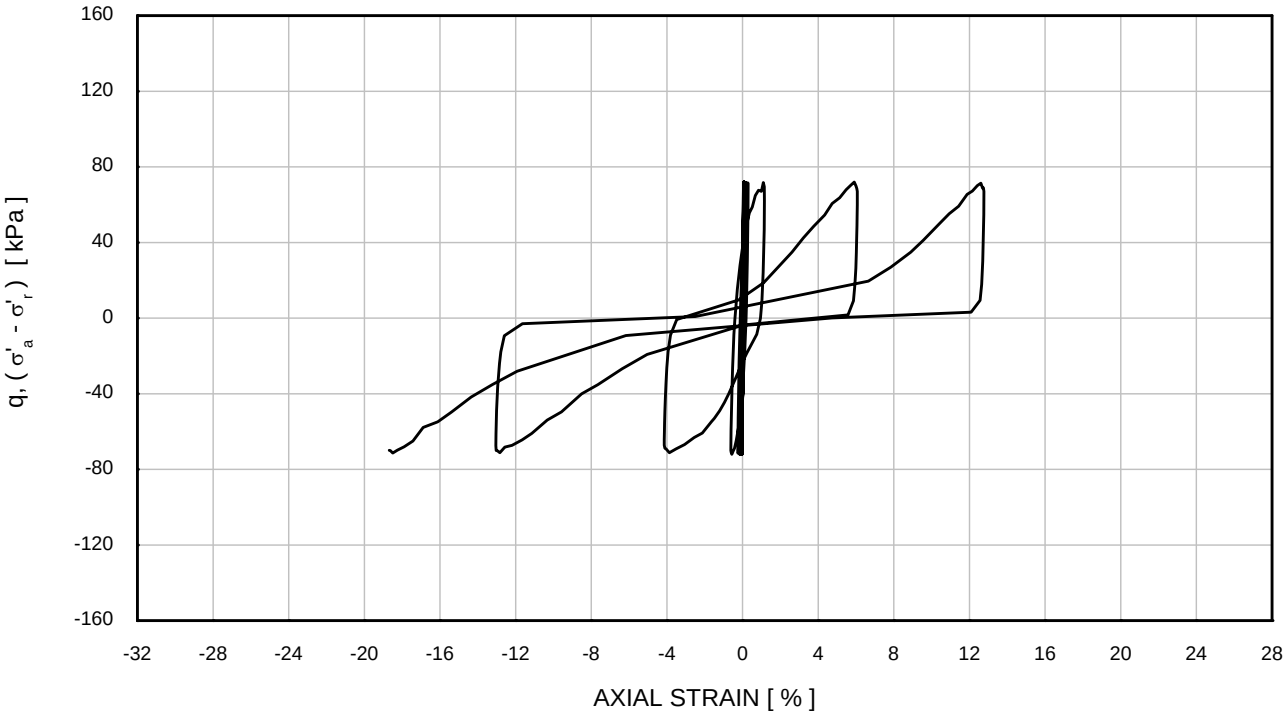


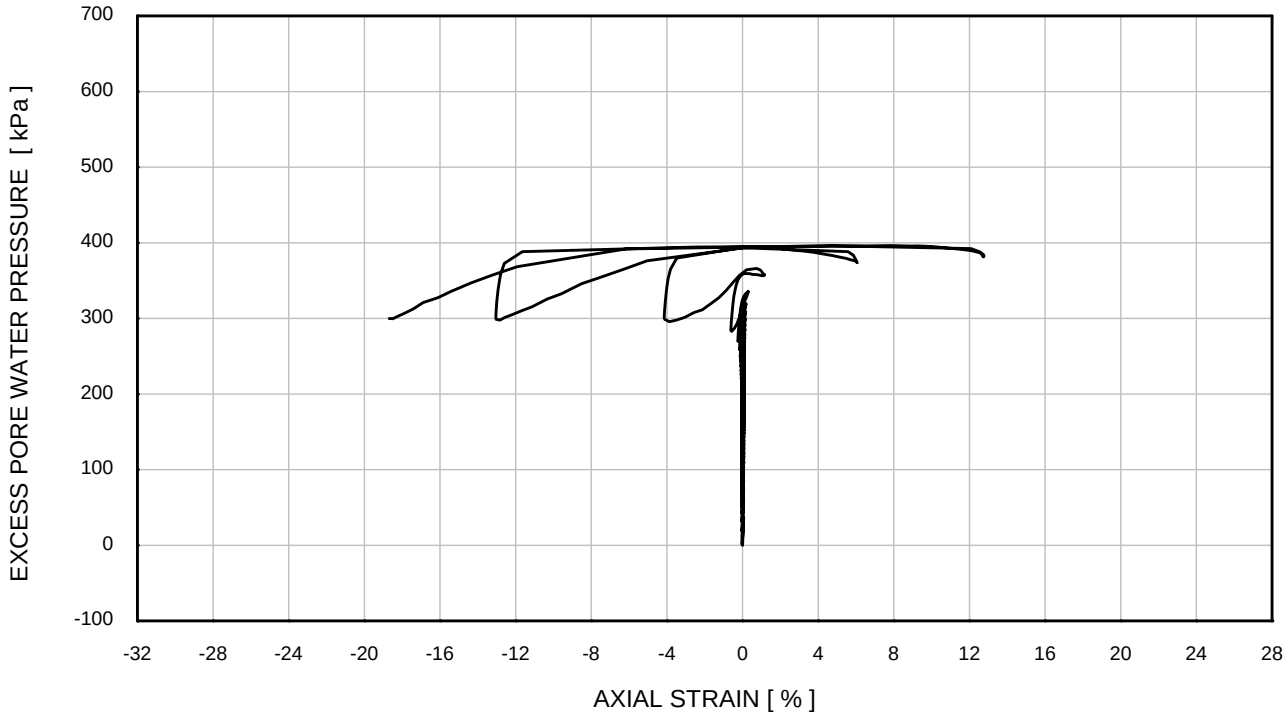


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

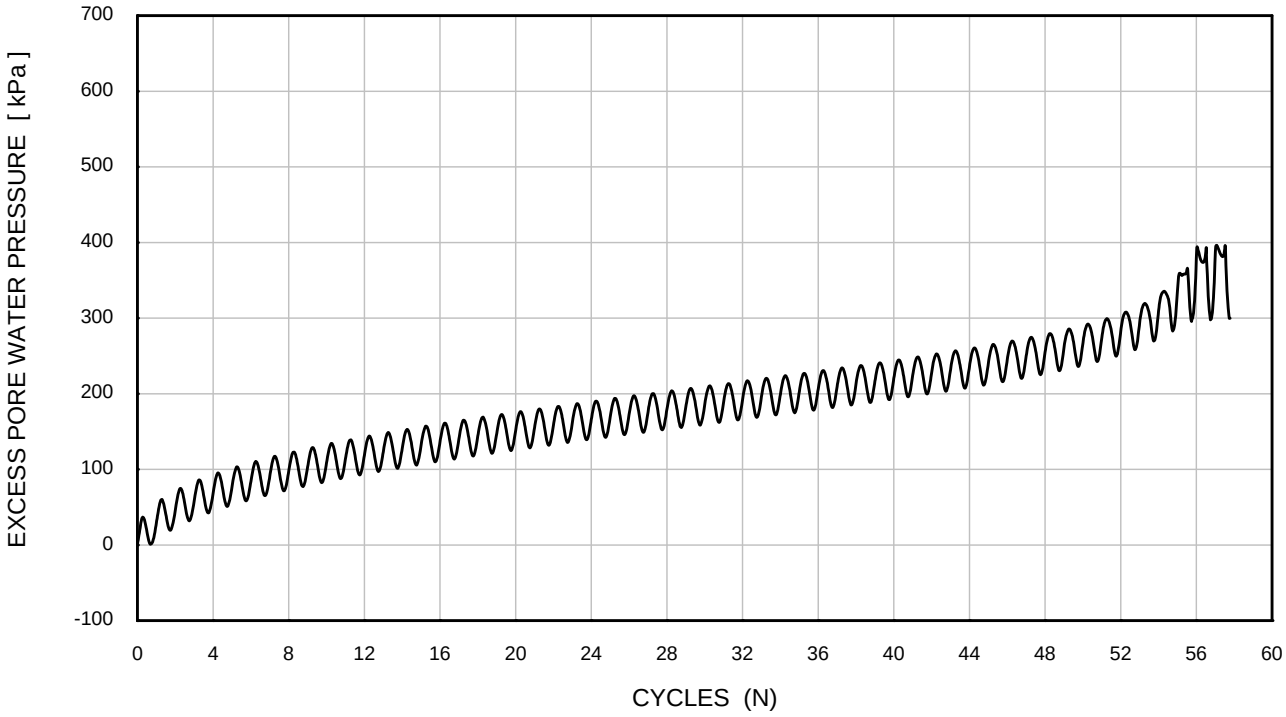


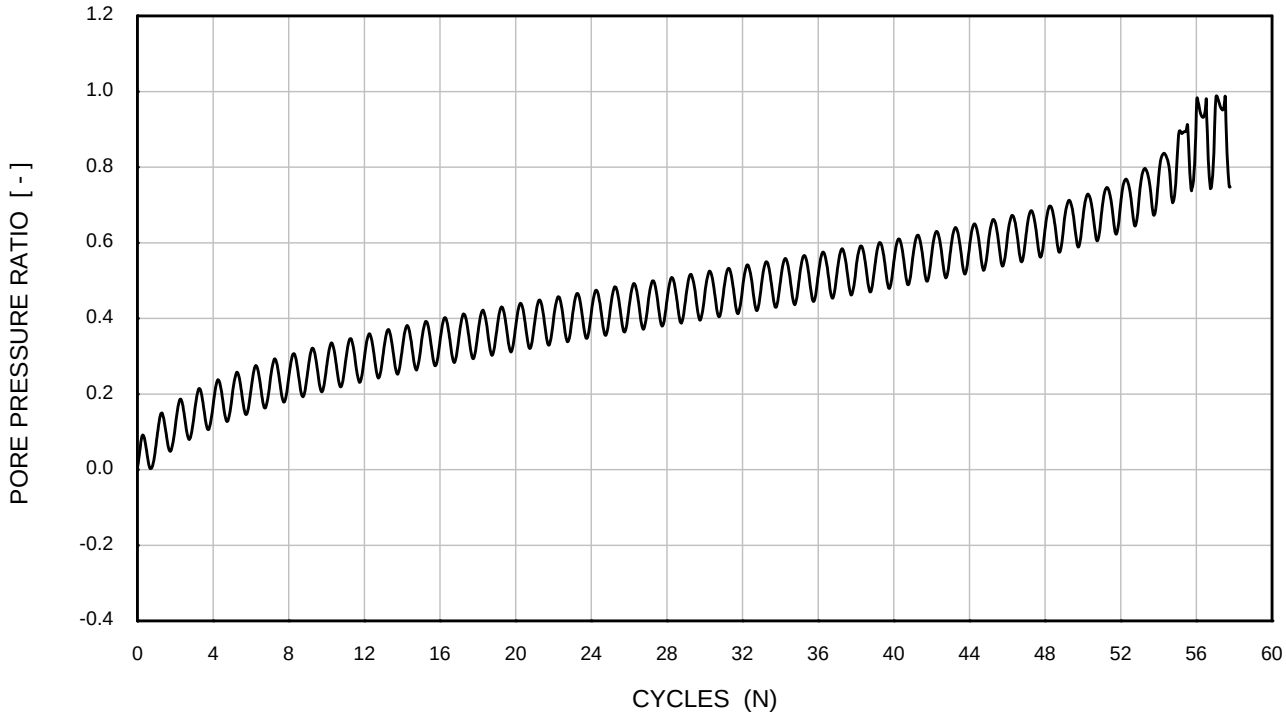


Initial σ'_r	:	401	kPa	Borehole	: Batch
Initial σ'_a	:	401	kPa	Sample	: Tongeren
q_{av}	:	0	kPa	Depth [m]	: -
q_{cy}	:	72	kPa	Test No.	: CTXL12
Frequency	:	0.10	Hz		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

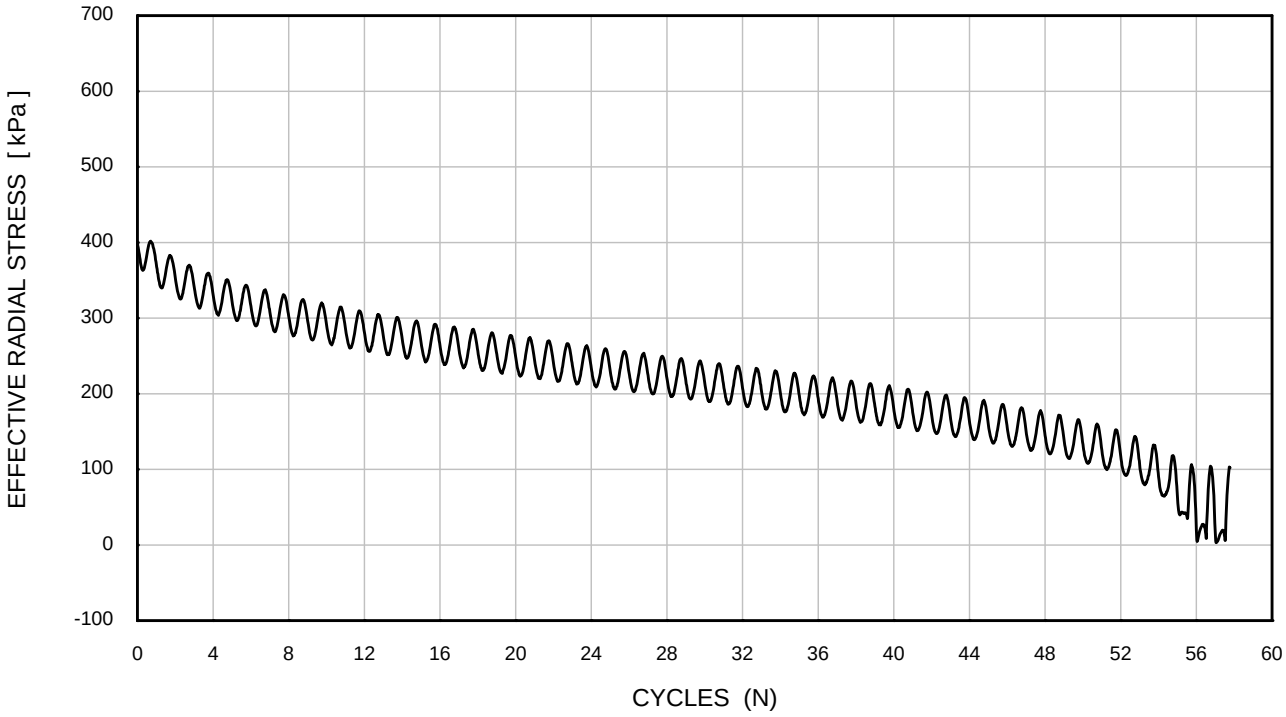


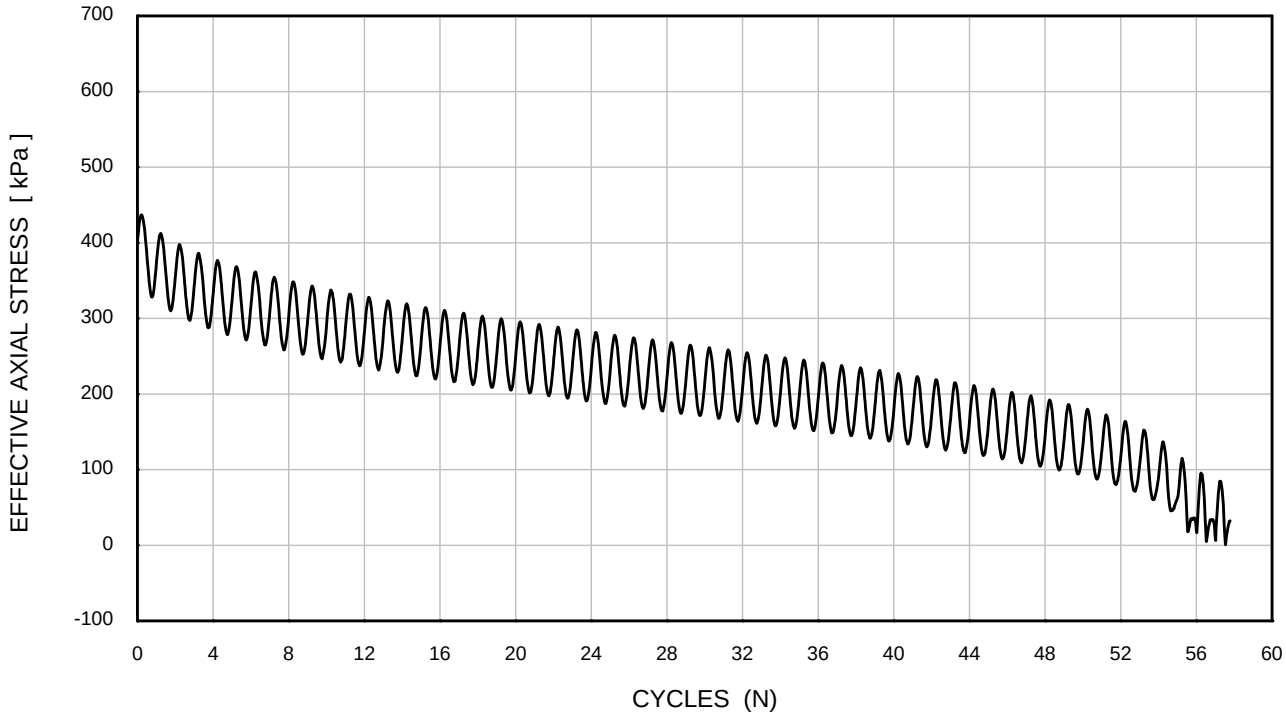


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

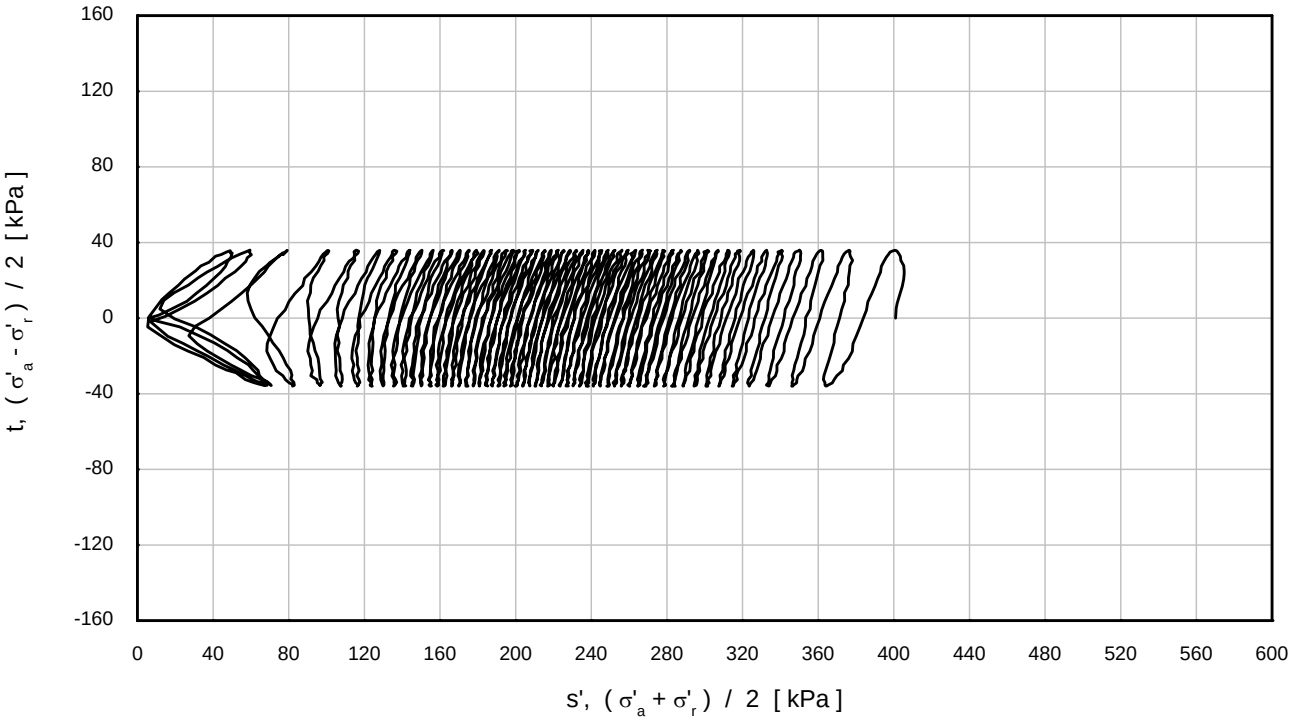


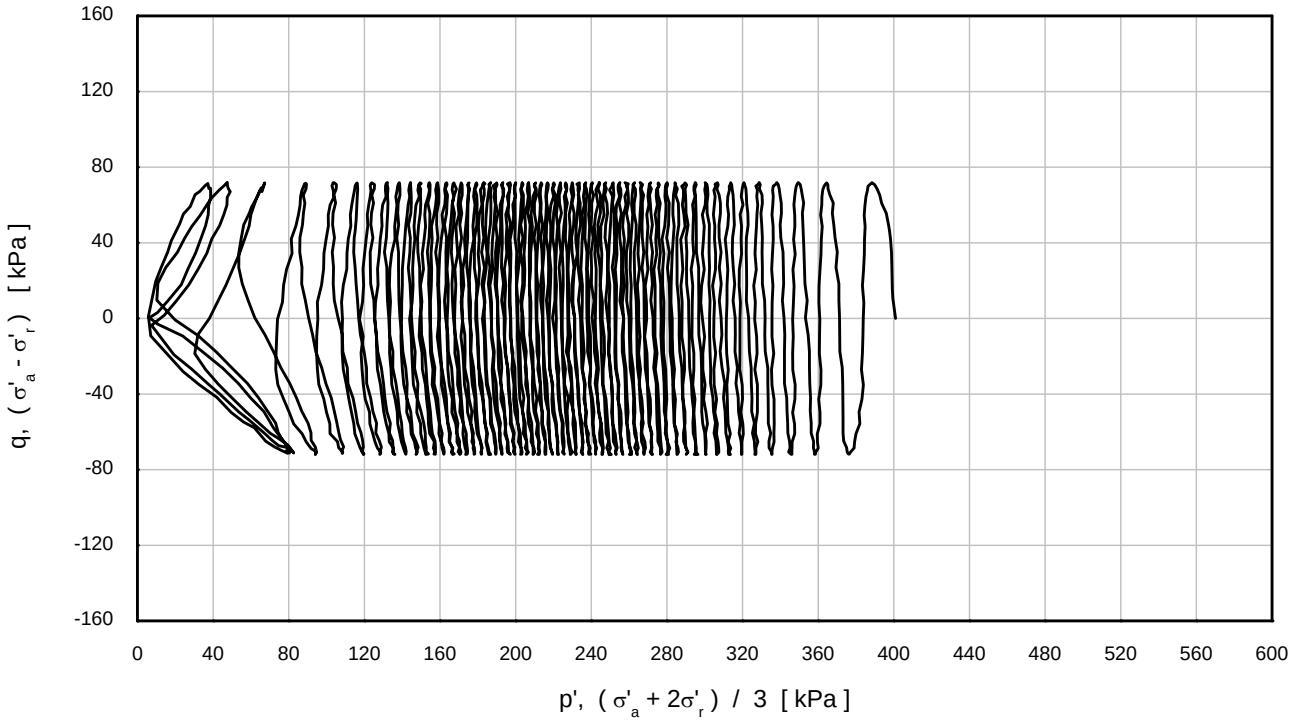


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

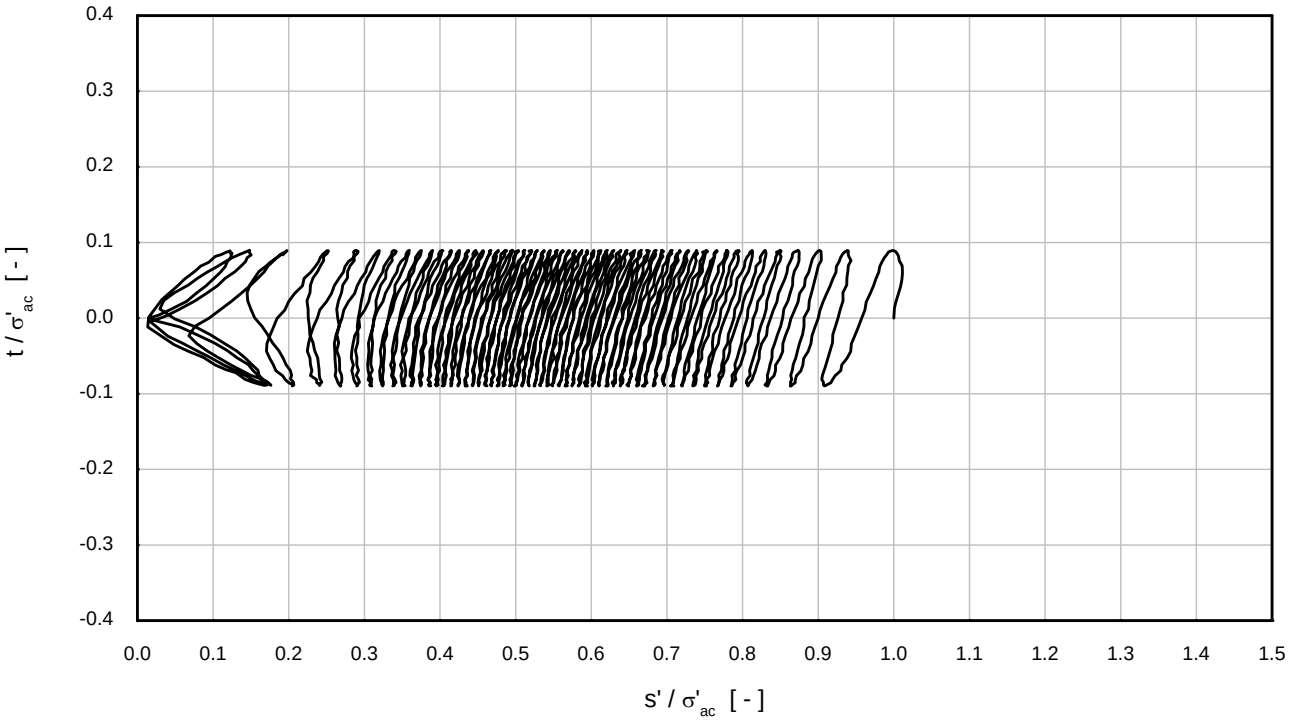


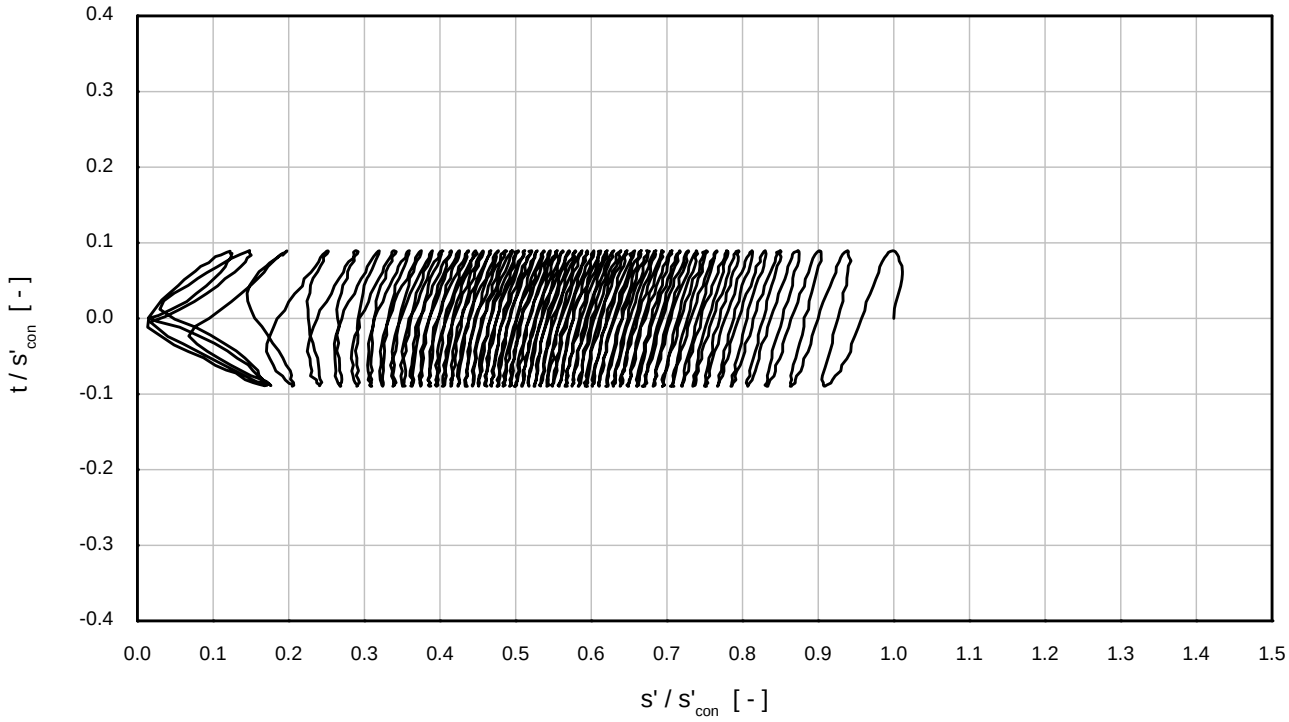


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

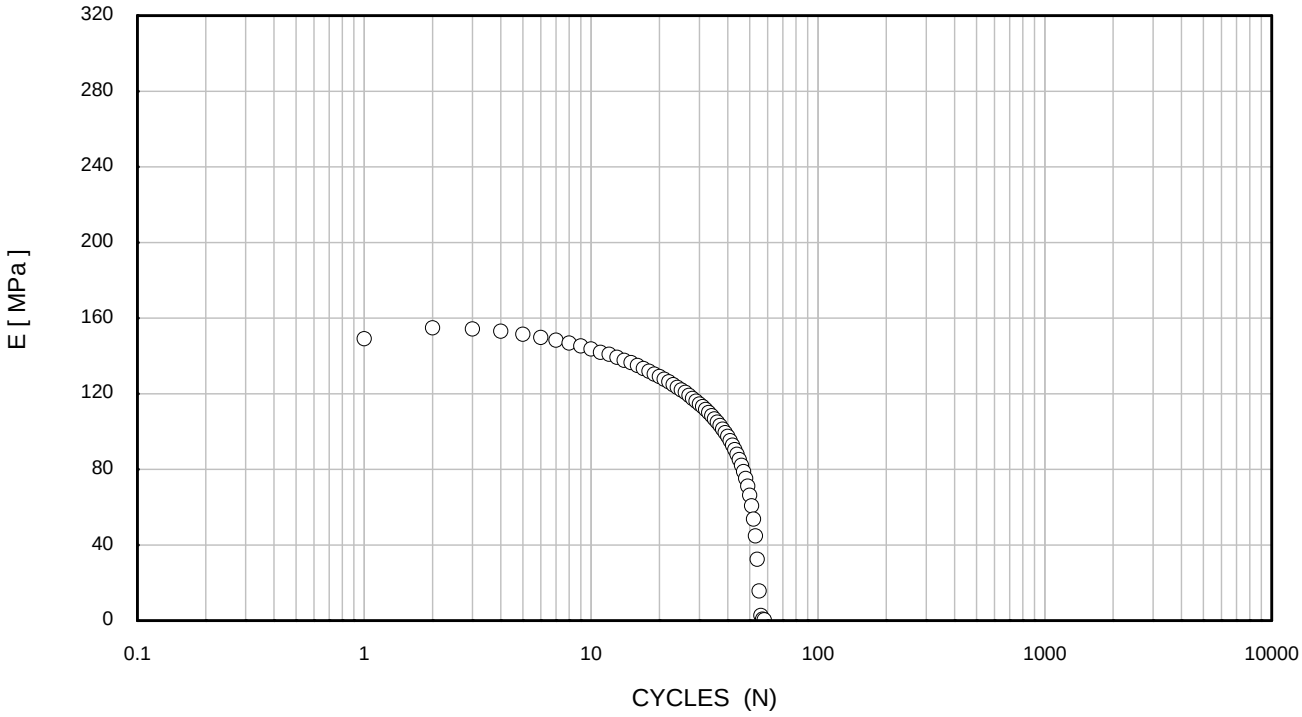


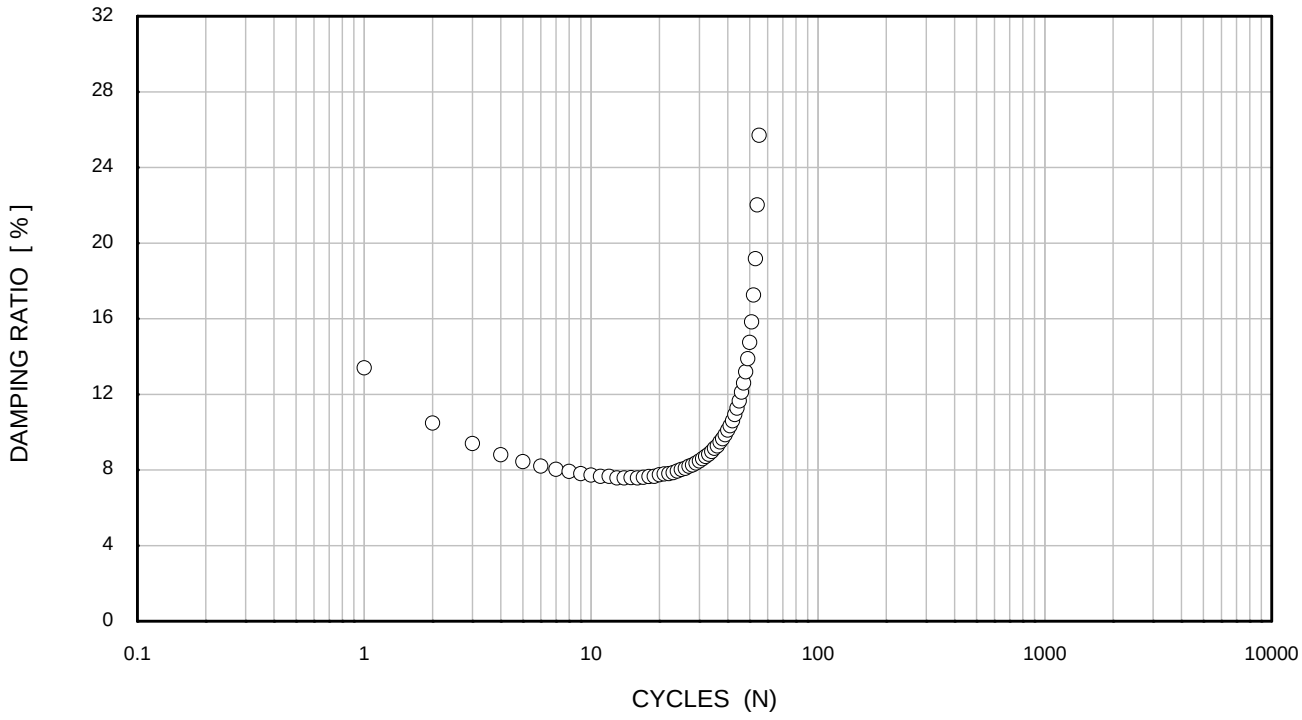


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

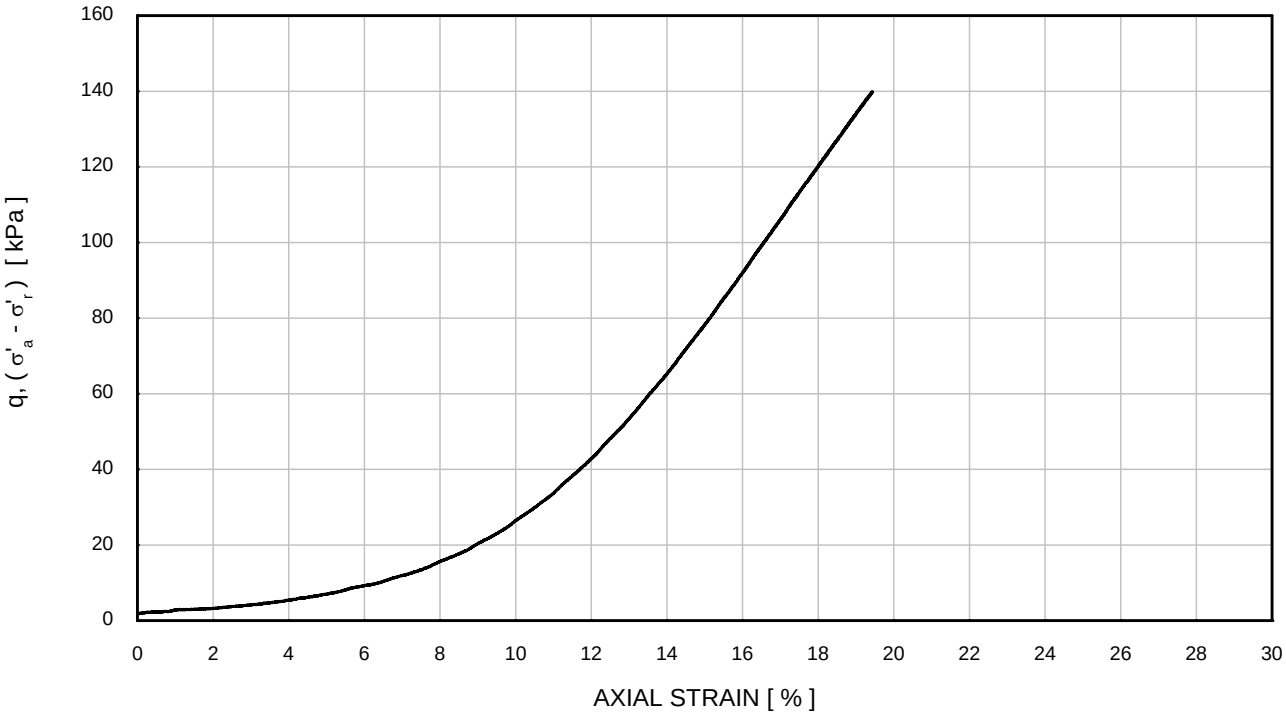


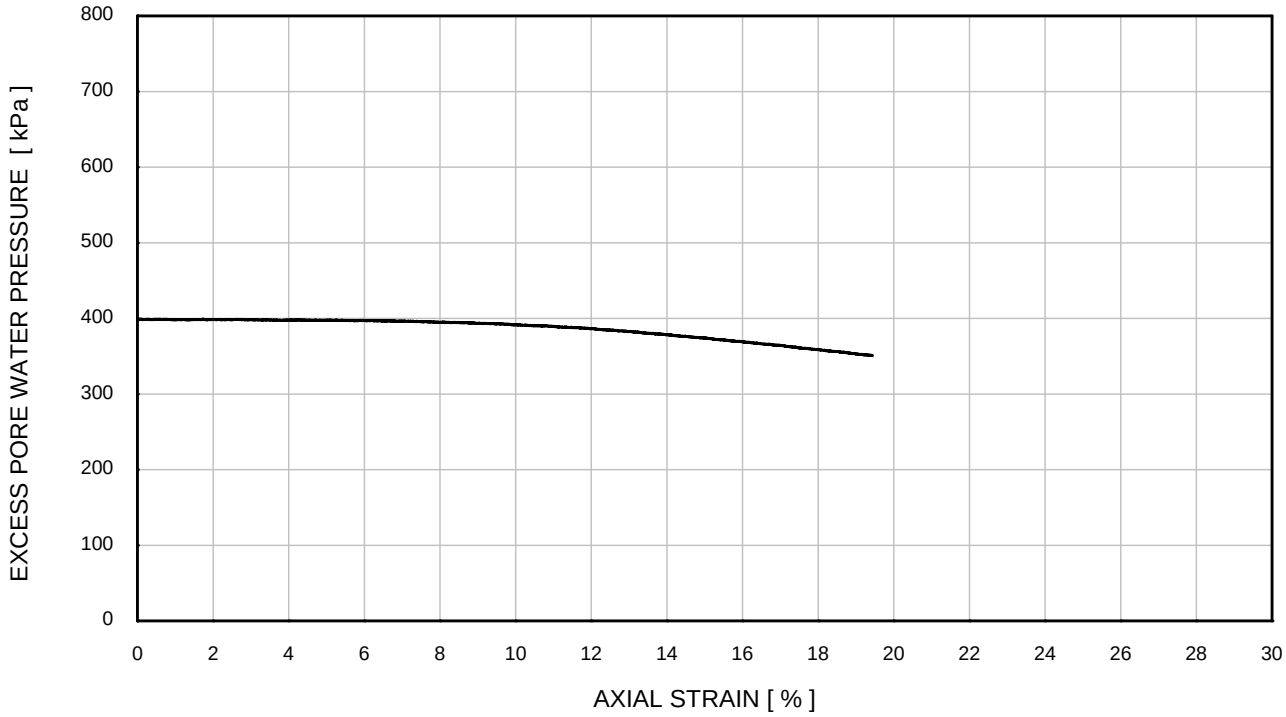


Initial σ'_r	:	401 kPa	Borehole	:	Batch
Initial σ'_a	:	401 kPa	Sample	:	Tongeren
q_{av}	:	0 kPa	Depth [m]	:	-
q_{cy}	:	72 kPa	Test No.	:	CTXL12
Frequency	:	0.10 Hz			

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
CYCLIC LOADING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

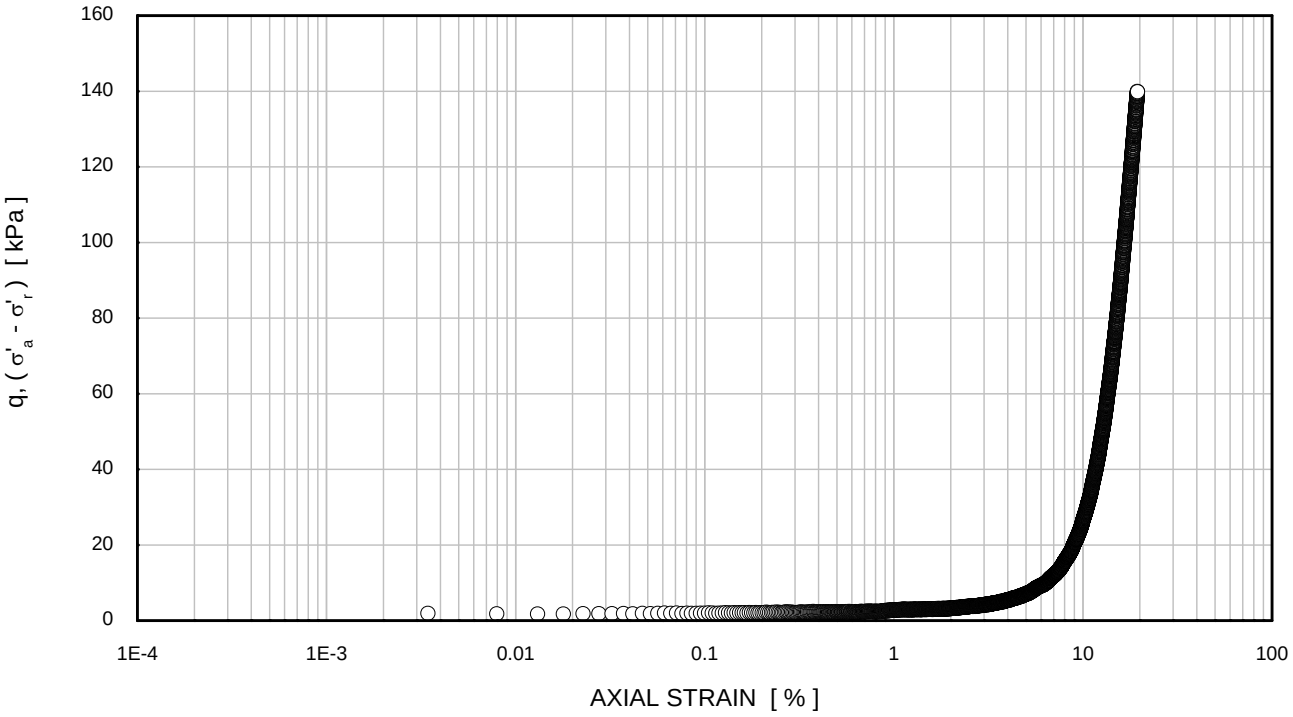


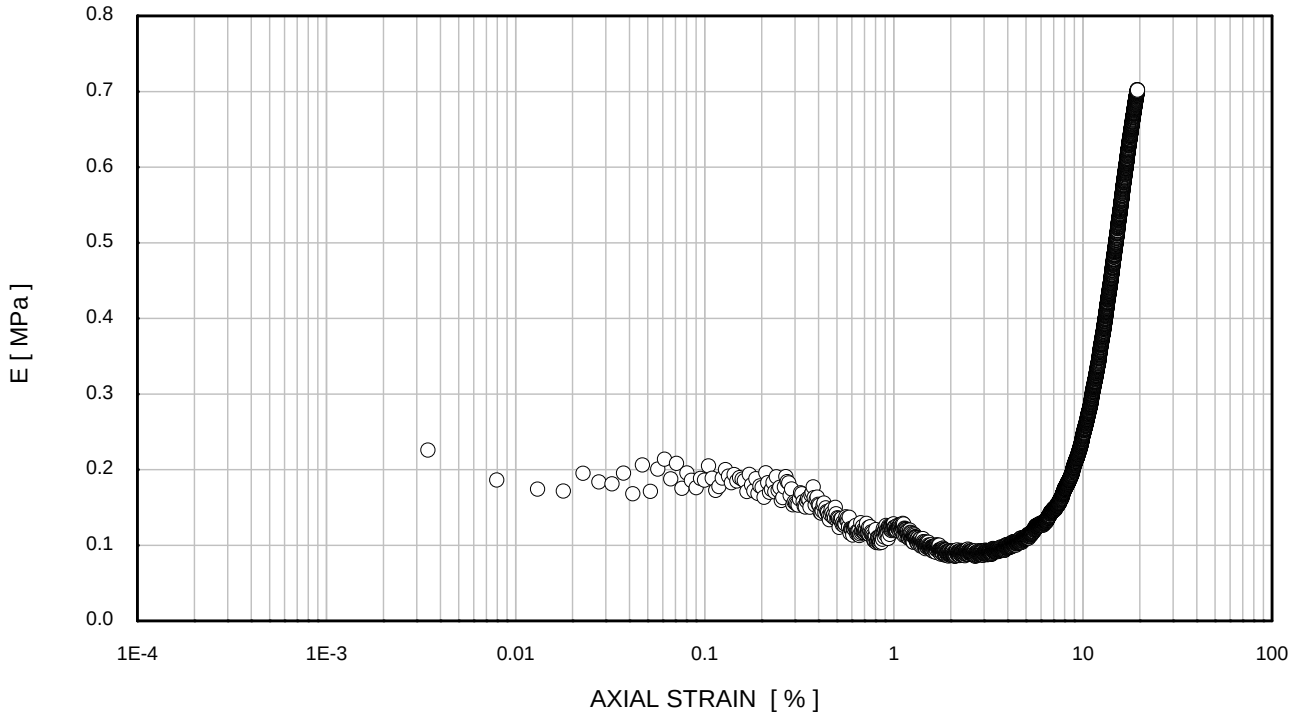


Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Tongeren
q_{peak}	:	140	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	19.4	%	Test No.	: CTXL12
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

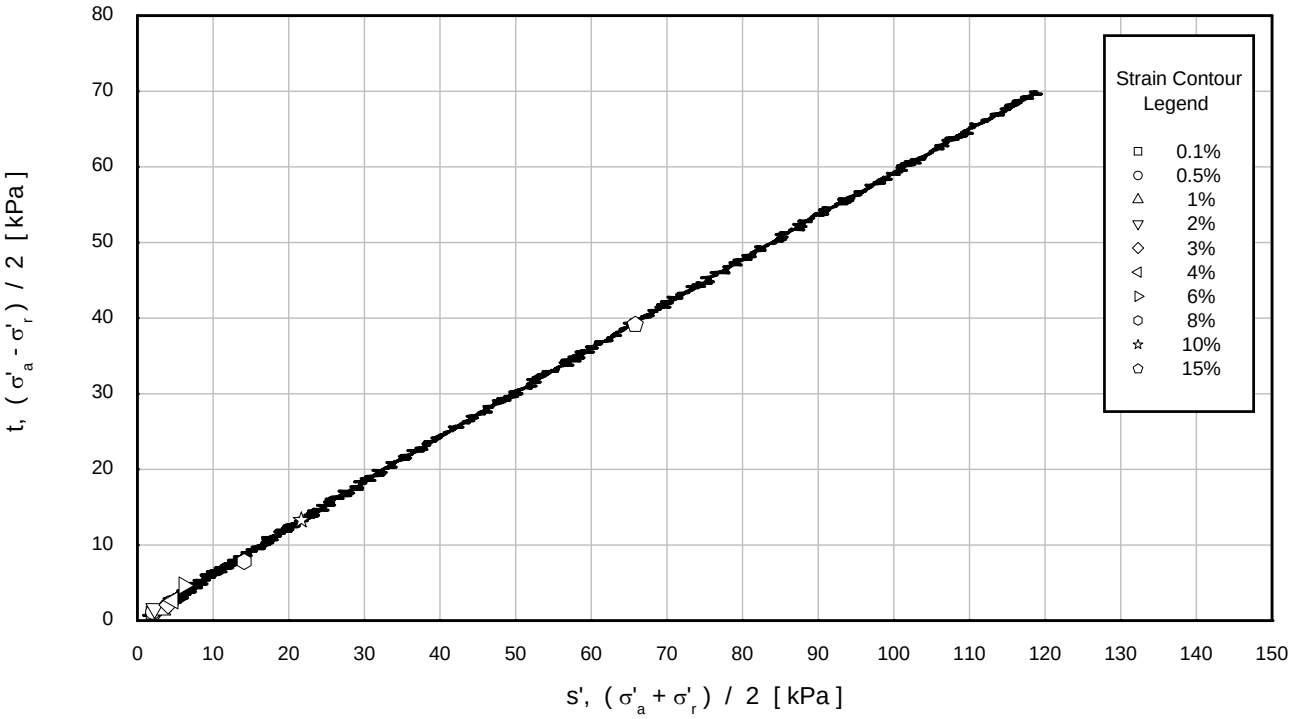


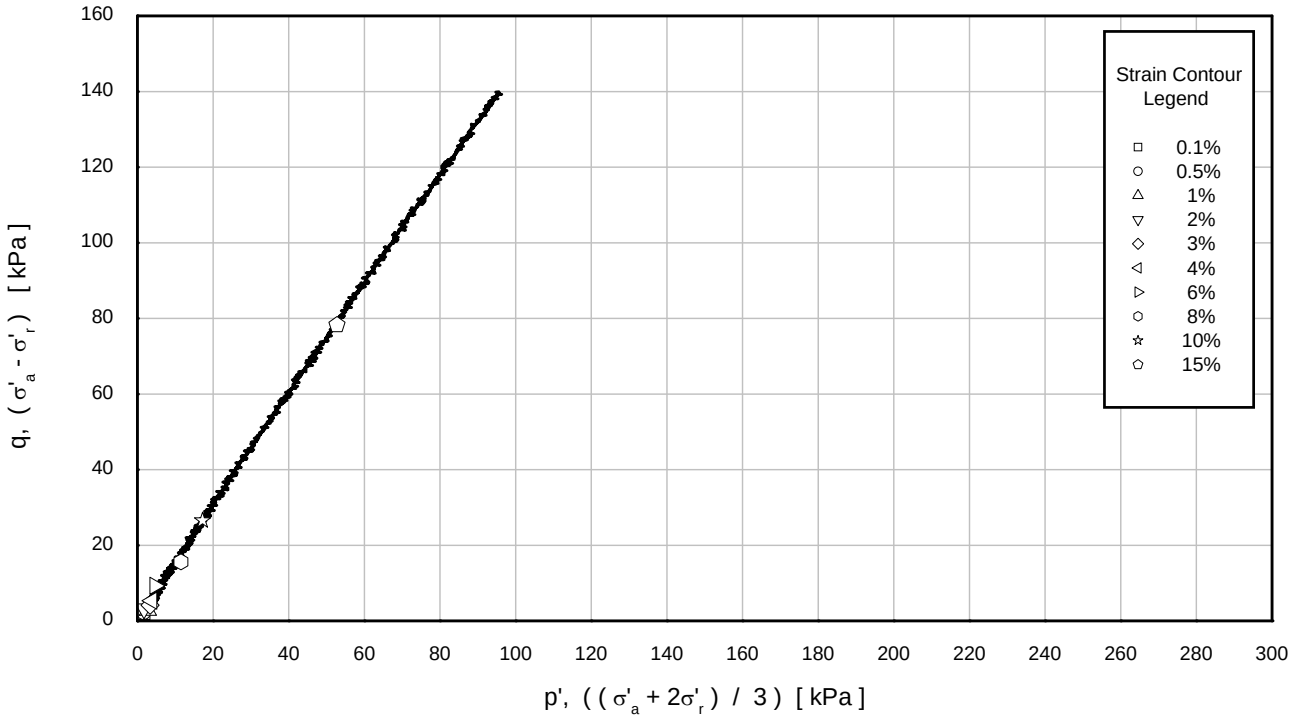


Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Tongeren
q_{peak}	:	140	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	19.4	%	Test No.	: CTXL12
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





Initial σ'_r	:	1	kPa	Borehole	: Batch
Initial σ'_a	:	2	kPa	Sample	: Tongeren
q_{peak}	:	140	kPa	Depth [m]	: -
Ext. ε at q_{peak}	:	19.4	%	Test No.	: CTXL12
Rate of strain	:	0.87	%/hour		

ISOTROPICALLY CONSOLIDATED CYCLIC TRIAXIAL TEST
SHEARING STAGE - UNDRAINED

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SECTION A7: CYCLIC SIMPLE SHEAR TESTS

LIST OF PLATES IN SECTION A7: Plate

VISUAL DESCRIPTION
Very high strength brown slightly sandy CLAY

GENERAL	
Date test started	16/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.8
Length	[mm]	30.0
Moisture content	[%]	20.5
Bulk density	[Mg/m³]	2.05
Dry density	[Mg/m³]	1.71
Void ratio	[-]	0.584
Degree of saturation	[%]	95
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	113
Pocket penetrometer	[kPa]	300
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 1-4_17C_CSS01
Template issue	1.2
Processed by	HB
Date	20/07/2015
Checked by	PH
Date	04/08/2015
Approved by	PH
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.00
Test number	CSS01

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	350
Vertical strain	[%]	2.89
Bulk density	[Mg/m^3]	2.09
Dry density	[Mg/m^3]	1.76
Void ratio	[-]	0.538
Moisture content	[%]	18.8

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	316
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	116
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	-0.20
γ_{cy} at N_f	[%]	3.56
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	263
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	211
Shear strain	[%]	20.76
Shear induced $\Delta\sigma'_v$	[kPa]	89
Vertical stress	[kPa]	261
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	2.57
At 15 % shear strain		
Shear stress	[kPa]	206
Shear induced -$\Delta\sigma'_v$	[kPa]	101
Vertical stress	[kPa]	249
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.00
Test number	CSS01

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

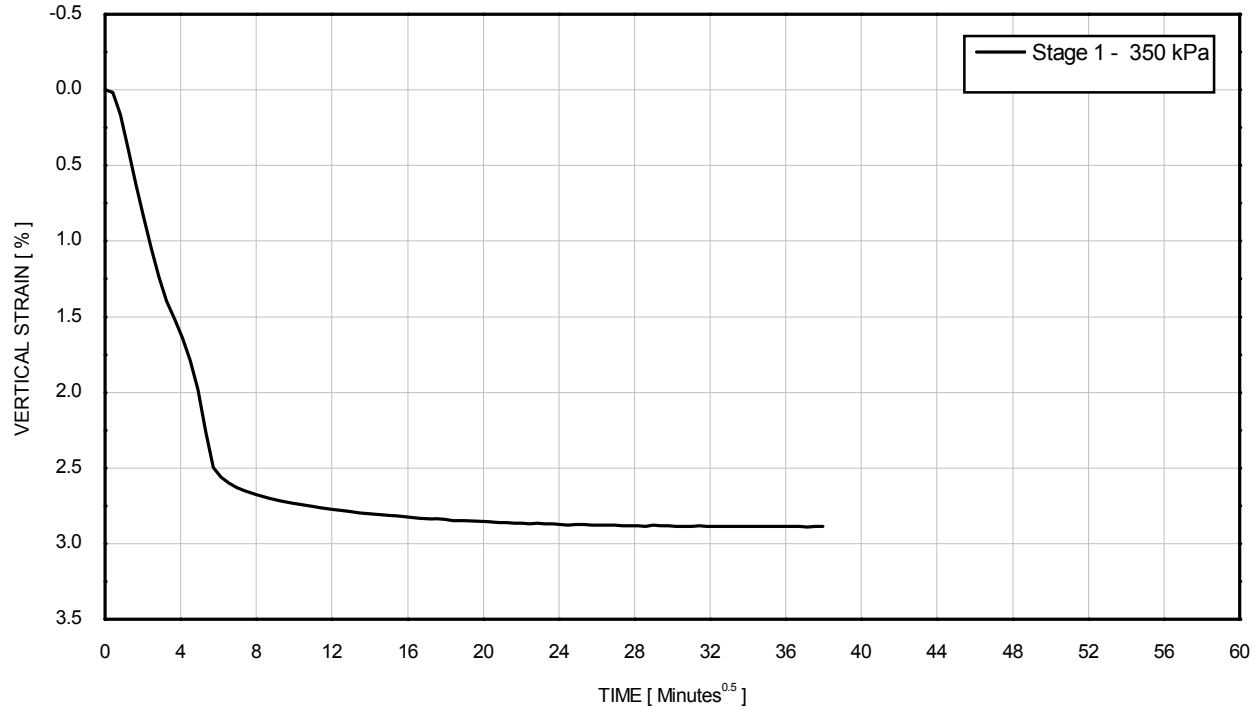
SPECIMEN PHOTOGRAPH

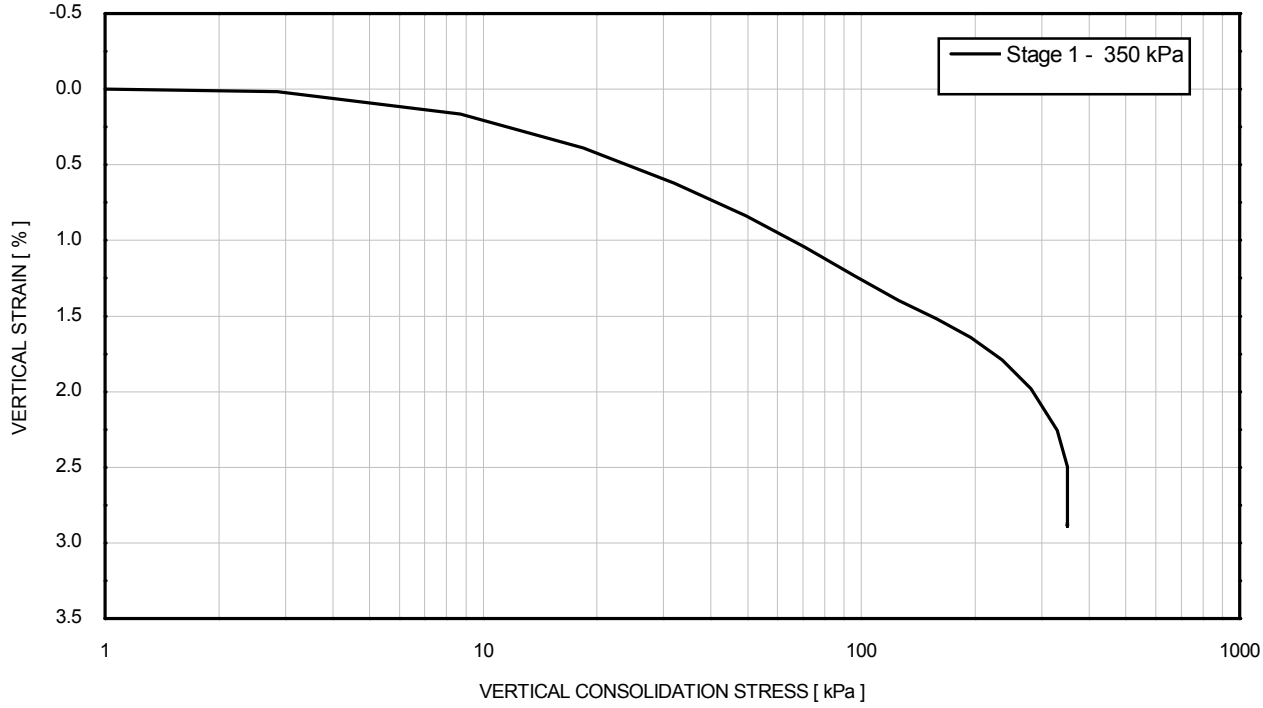
Photograph unavailable

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.00
Test number	CSS01

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

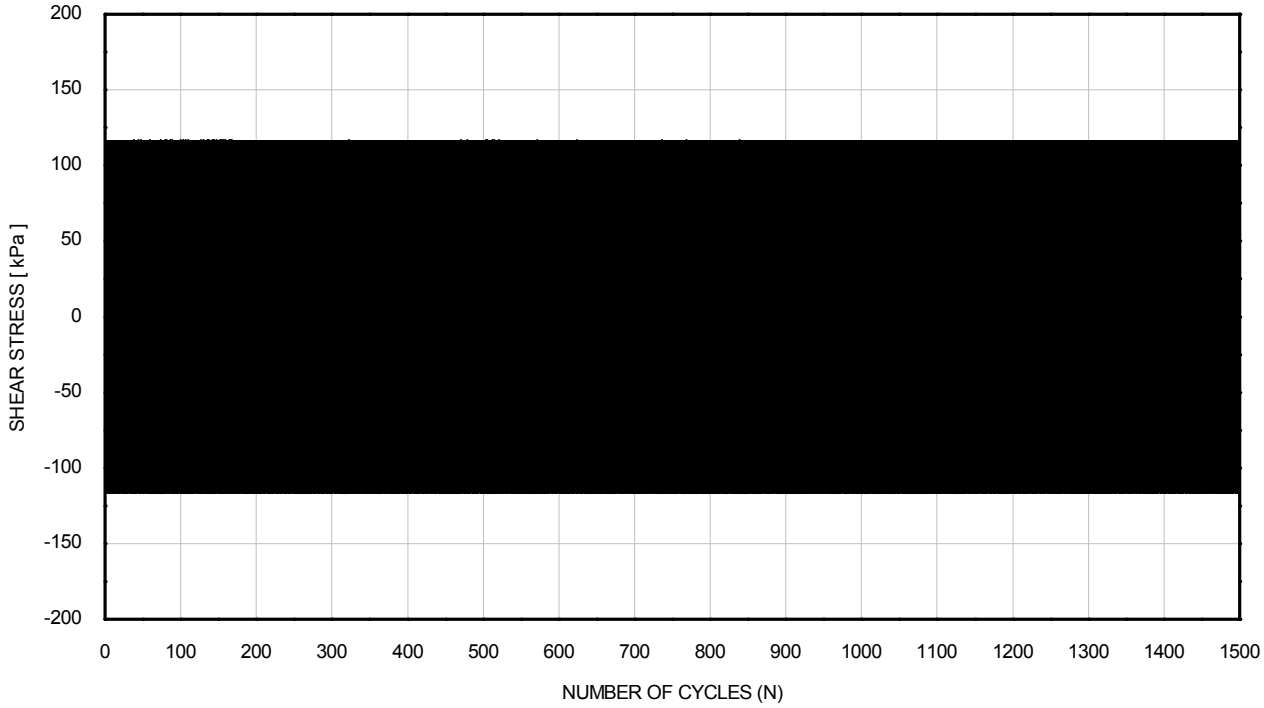


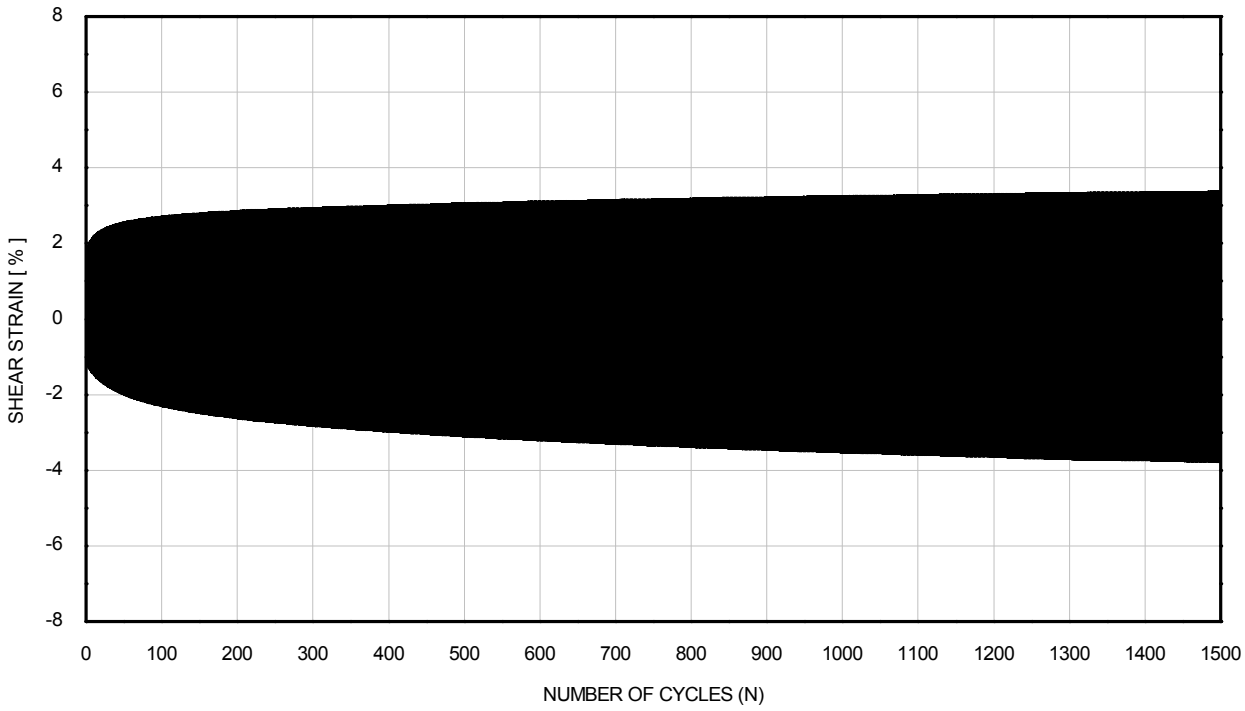


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
		Sample	: 17WAXC
		Depth [m]	: 35.00
		Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

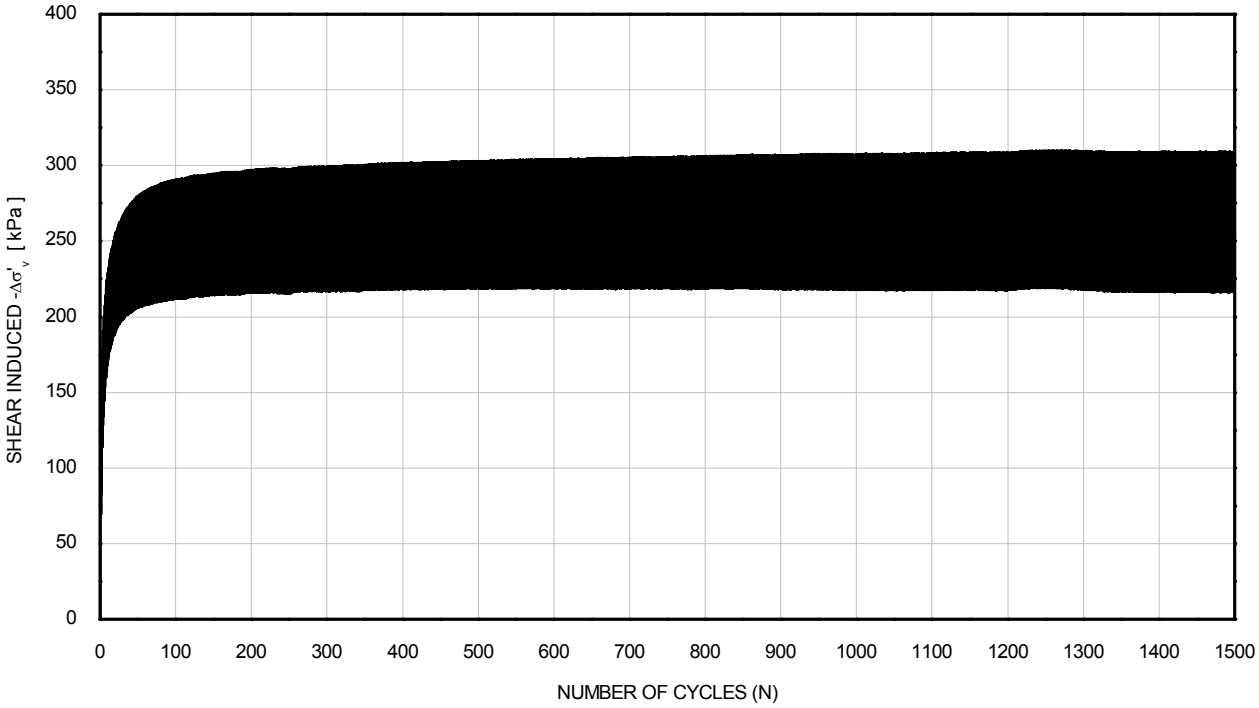


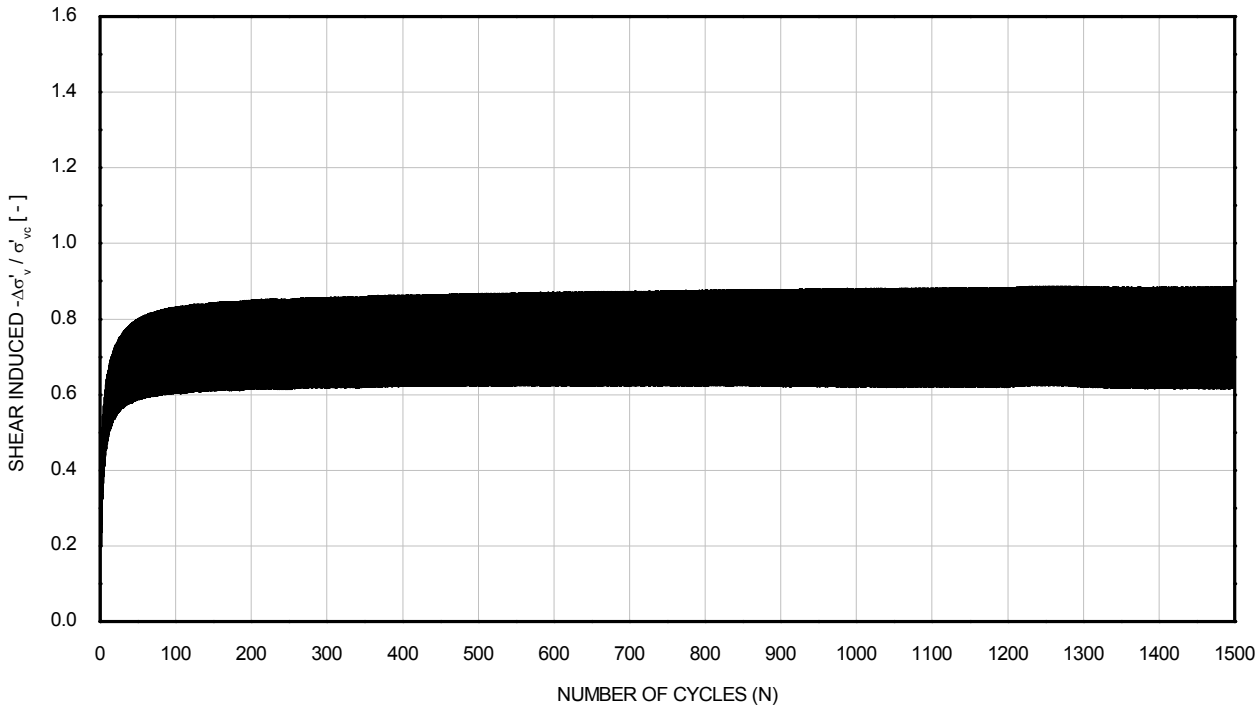


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	116 kPa	Depth [m]	:	35.00
Frequency	:	0.10 Hz	Test No.	:	CSS01

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

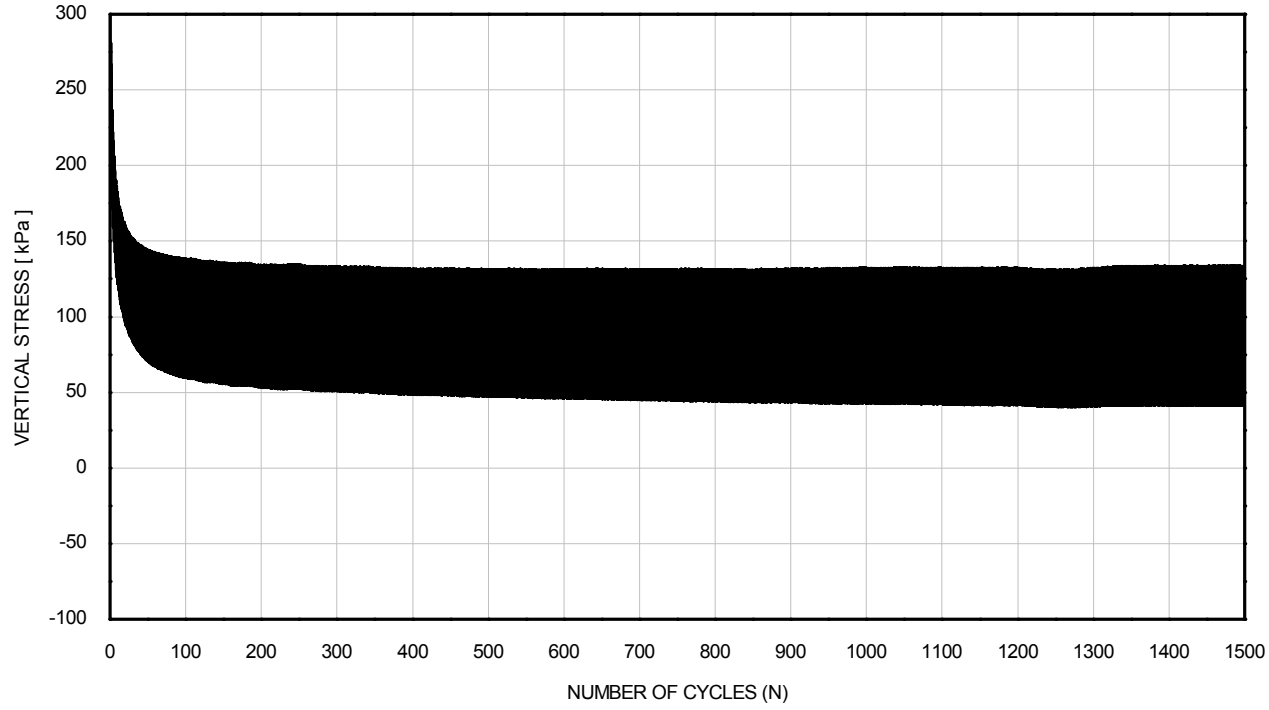


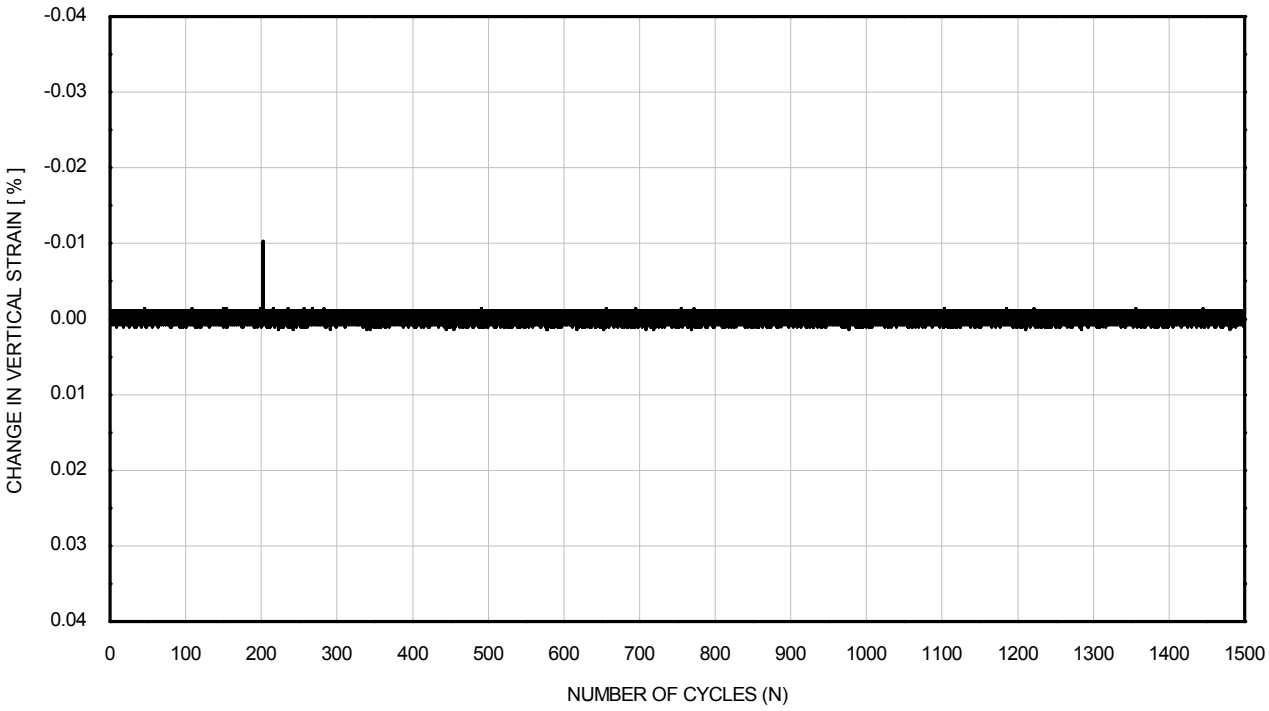


σ'_{vc}	:	350 kPa	Borehole	: BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	: 17WAXC
Mean τ_{cy}	:	116 kPa	Depth [m]	: 35.00
Frequency	:	0.10 Hz	Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

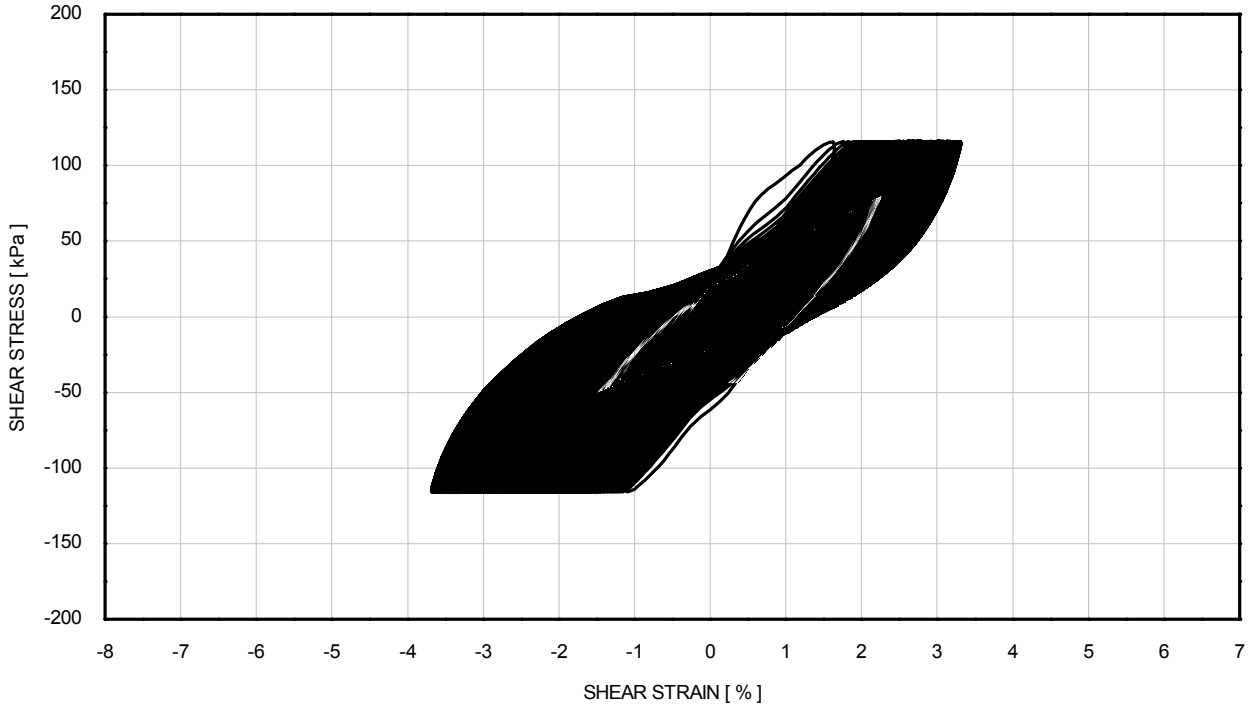


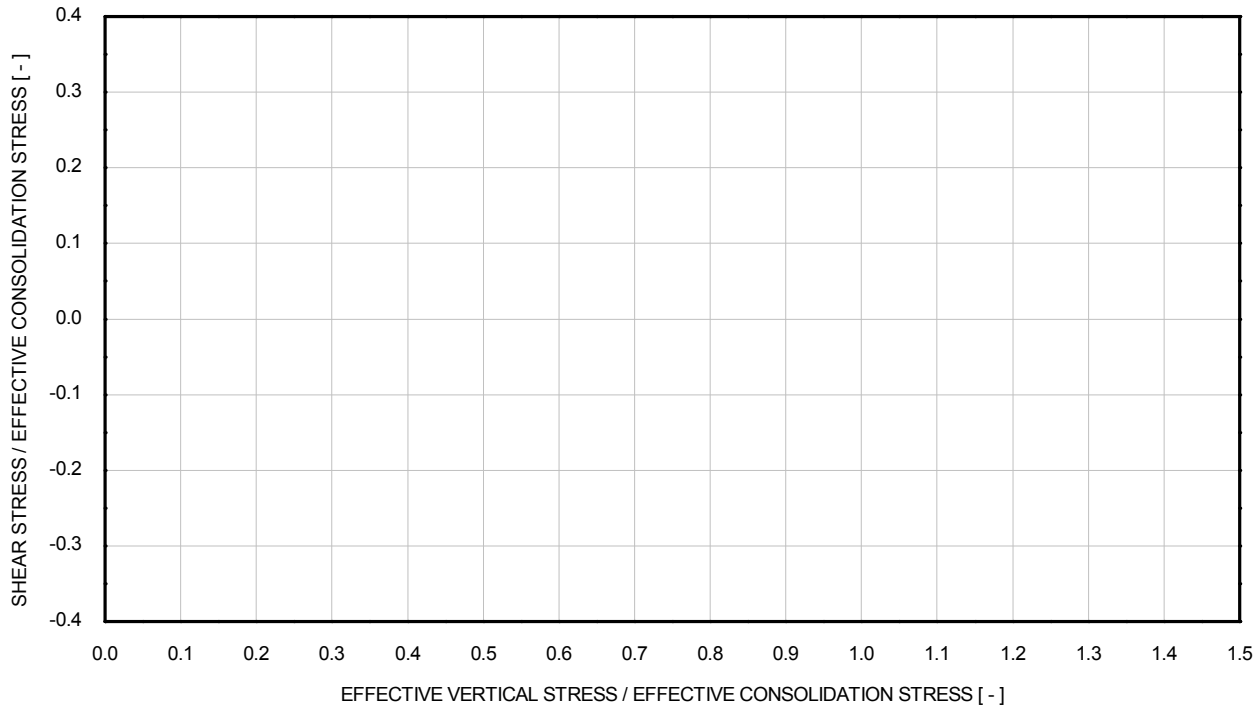


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	116 kPa	Depth [m]	:	35.00
Frequency	:	0.10 Hz	Test No.	:	CSS01

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

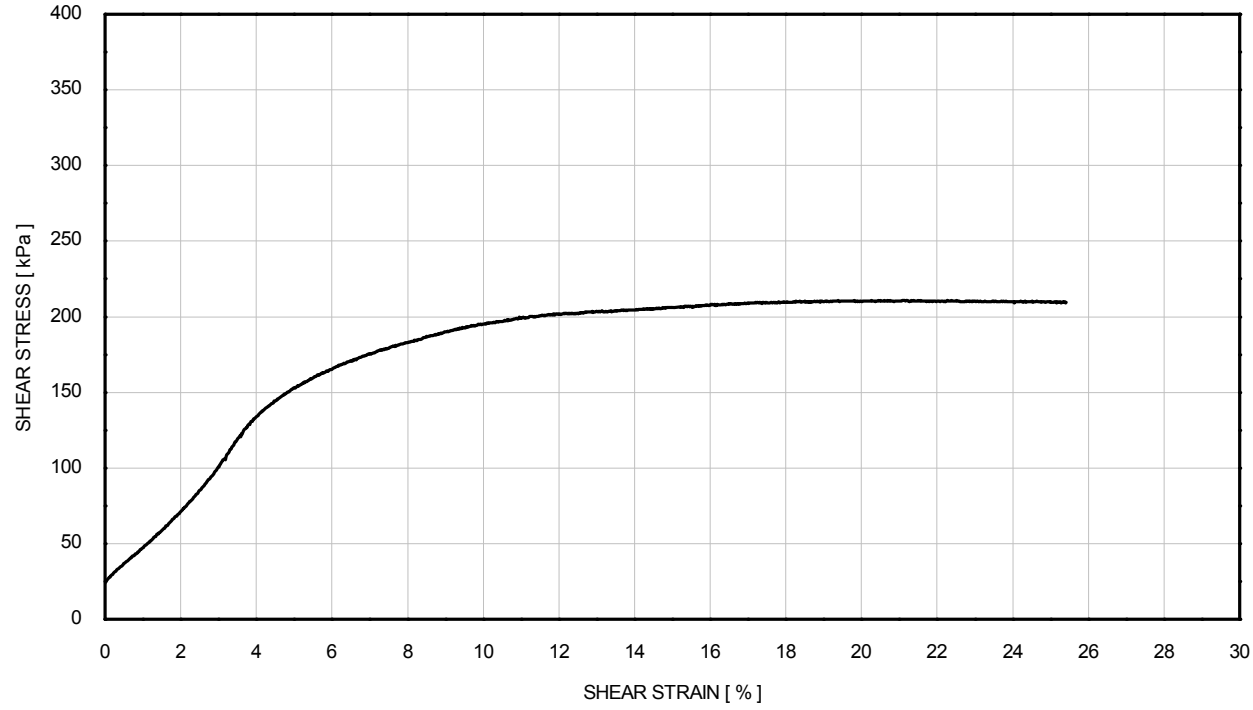


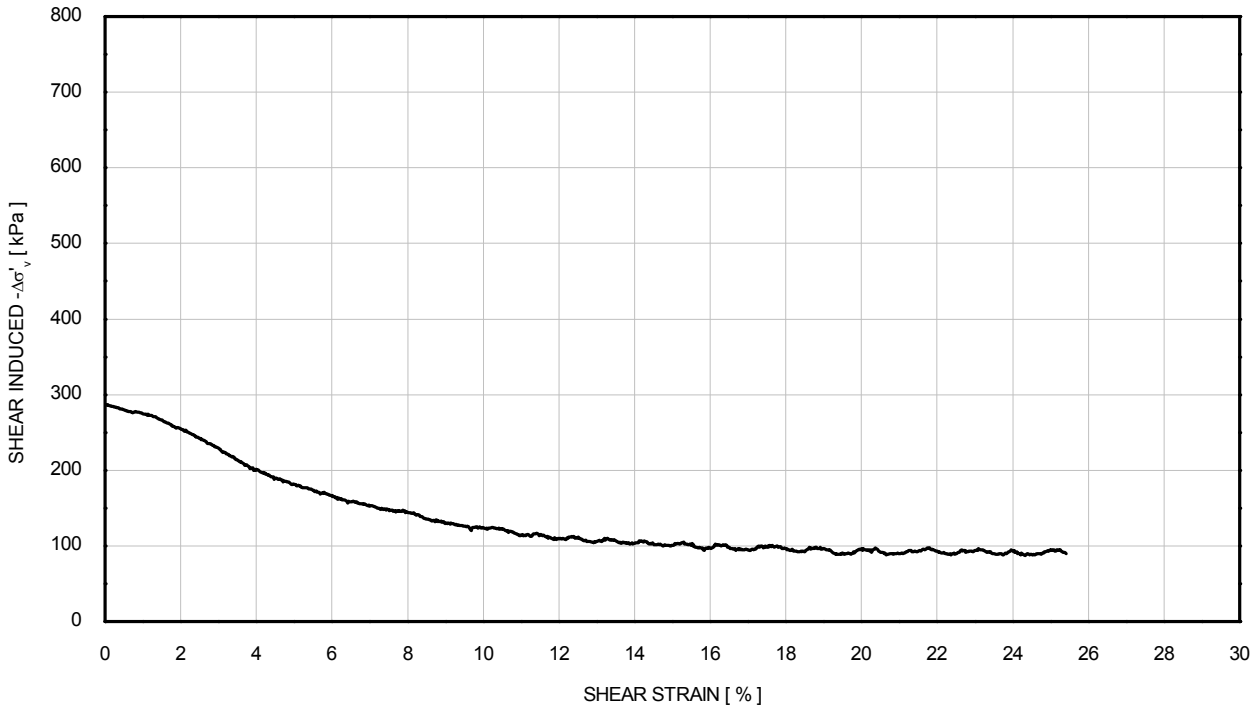


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	116 kPa	Depth [m]	:	35.00
Frequency	:	0.10 Hz	Test No.	:	CSS01

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

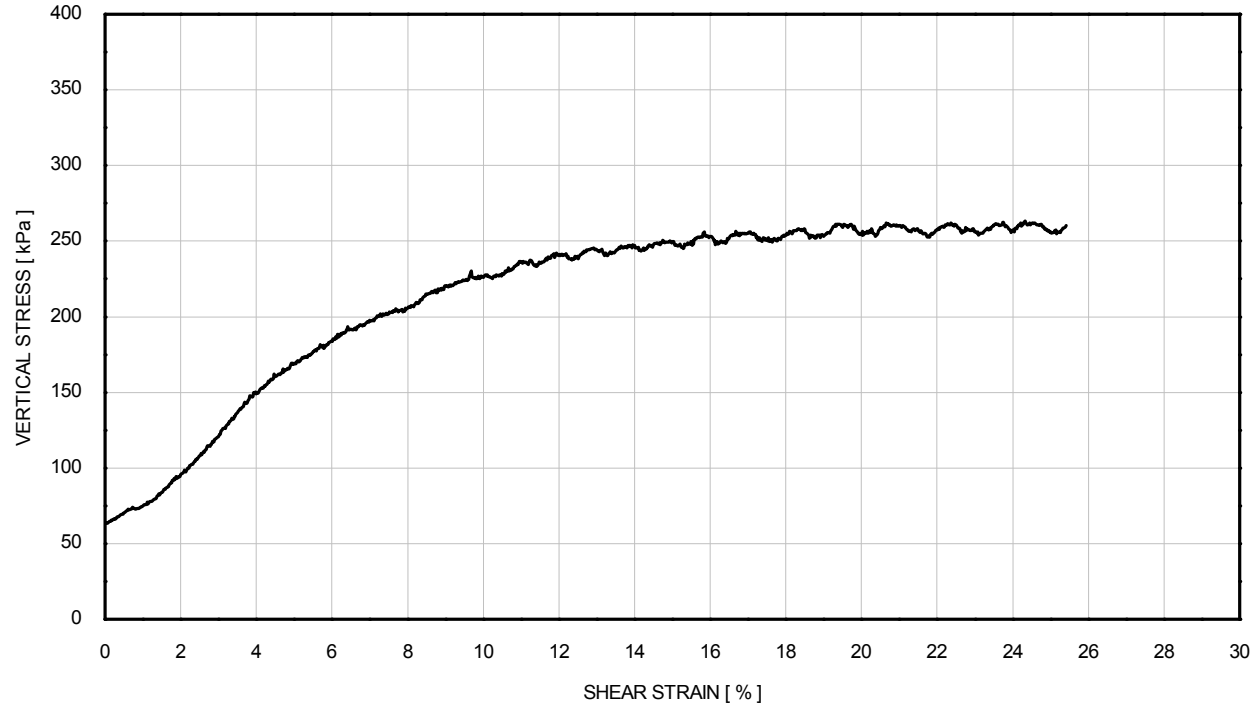


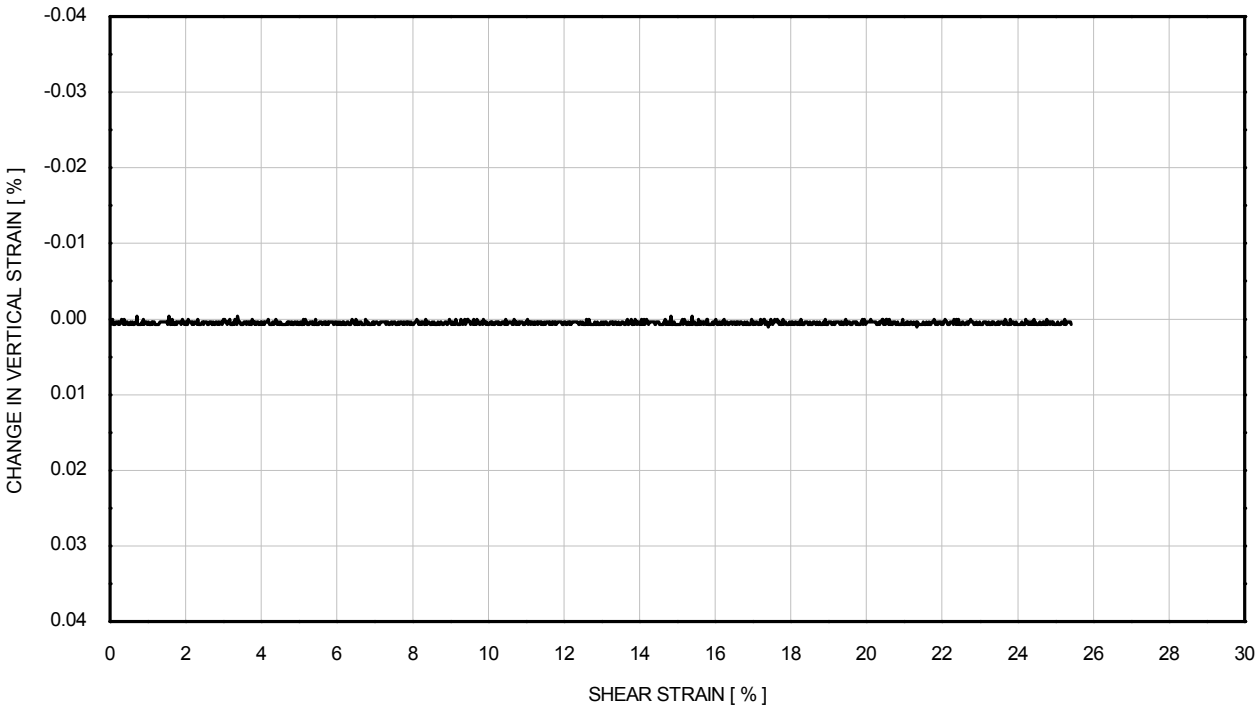


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 211 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 20.76 %	Depth [m]	: 35.00
Rate of strain	: 2.57 %/hour	Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

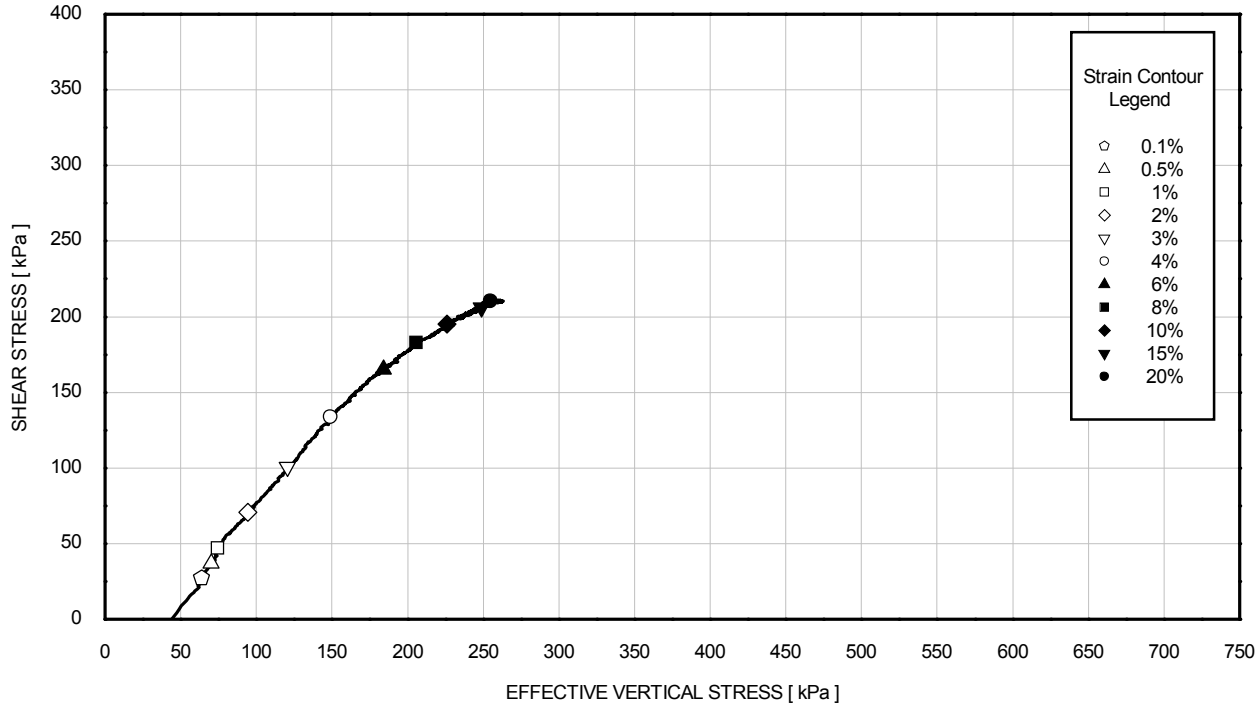


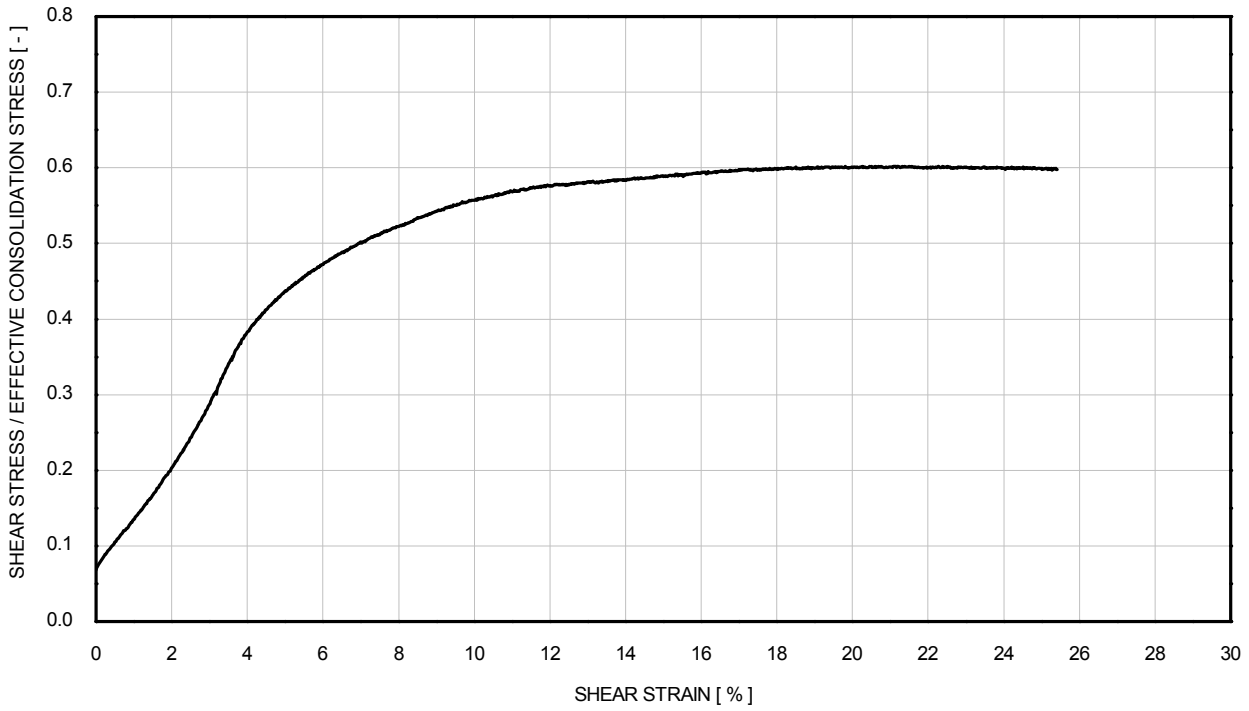


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 211 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 20.76 %	Depth [m]	: 35.00
Rate of strain	: 2.57 %/hour	Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

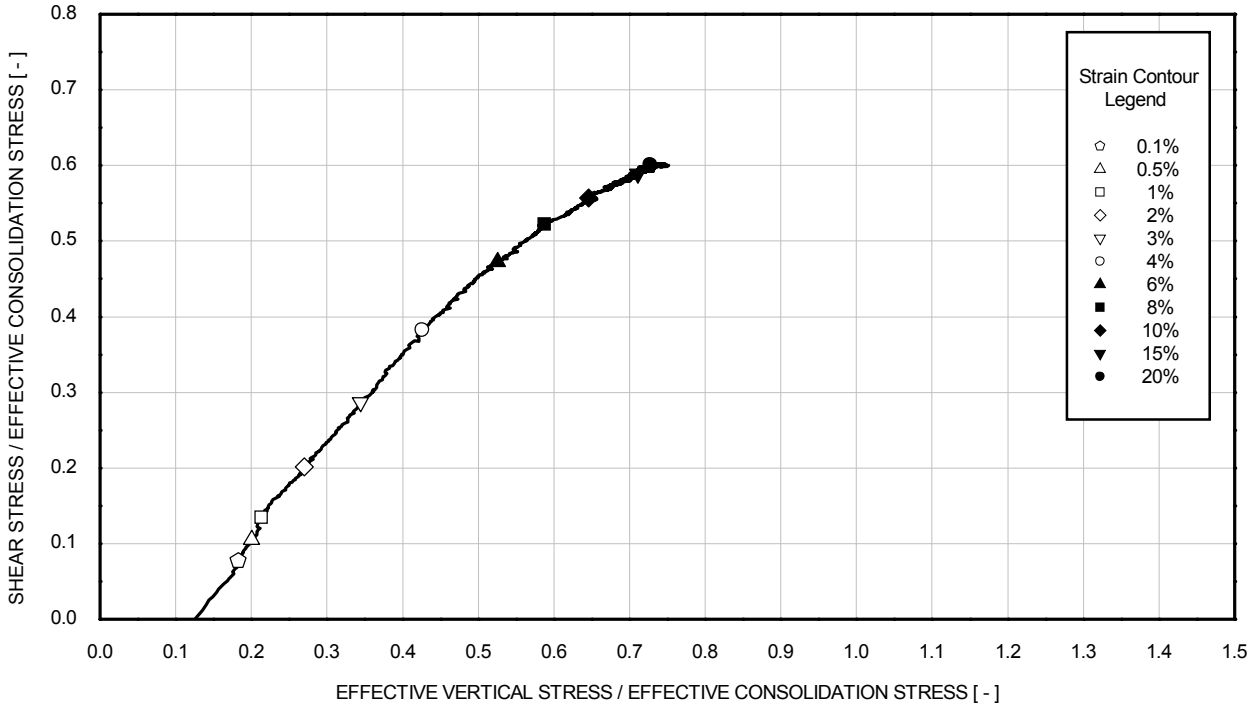


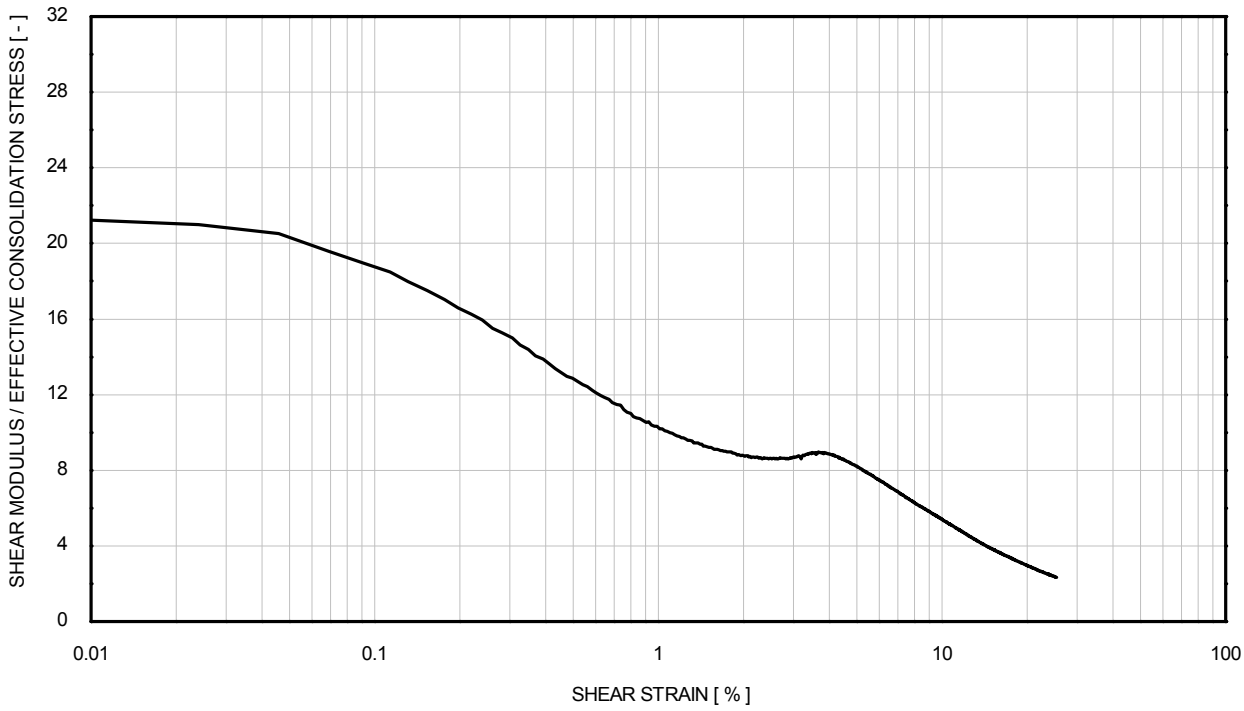


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 211 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 20.76 %	Depth [m]	: 35.00
Rate of strain	: 2.57 %/hour	Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 211 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 20.76 %	Depth [m]	: 35.00
Rate of strain	: 2.57 %/hour	Test No.	: CSS01

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength brown slightly sandy CLAY

GENERAL	
Date test started	16/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.0
Moisture content	[%]	21.1
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.68
Void ratio	[-]	0.610
Degree of saturation	[%]	94
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	113
Pocket penetrometer	[kPa]	150
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 1-4_17C_CSS02
Template issue	1.2
Processed by	HB
Date	20/07/2015
Checked by	PH
Date	04/08/2015
Approved by	PH
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.04
Test number	CSS02

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	350
Vertical strain	[%]	1.27
Bulk density	[Mg/m^3]	2.04
Dry density	[Mg/m^3]	1.70
Void ratio	[-]	0.589
Moisture content	[%]	20.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	316
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	165
Frequency	[Hz]	0.09
Number of cycles at failure (N_f)	[-]	103
γ_{av} at N_f	[%]	1.84
γ_{cy} at N_f	[%]	14.44
Shear induced $-\Delta\sigma'_v$ at N_f	[kPa]	164
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	159
Shear strain	[%]	27.28
Shear induced $\Delta\sigma'_v$	[kPa]	98
Vertical stress	[kPa]	253
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.07
At 15 % shear strain		
Shear stress	[kPa]	125
Shear induced $-\Delta\sigma'_v$	[kPa]	157
Vertical stress	[kPa]	193
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.04
Test number	CSS02

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

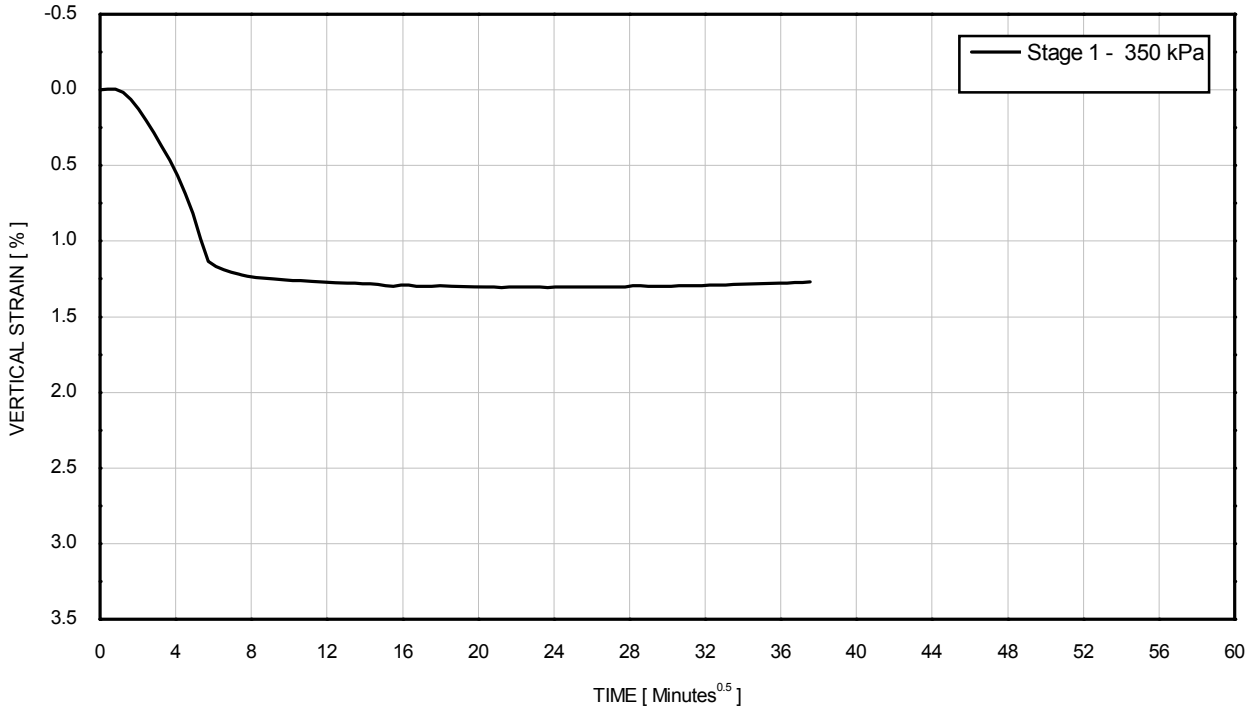
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

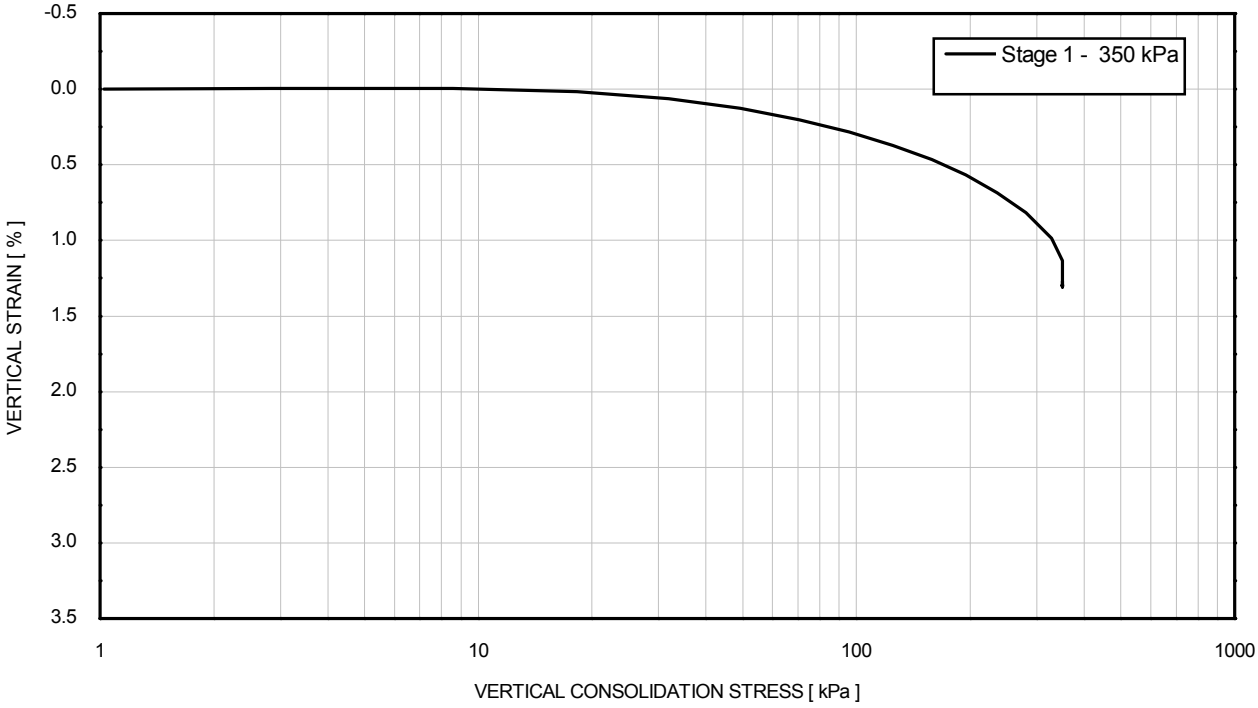
SPECIMEN PHOTOGRAPH
Photograph unavailable

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.04
Test number	CSS02

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

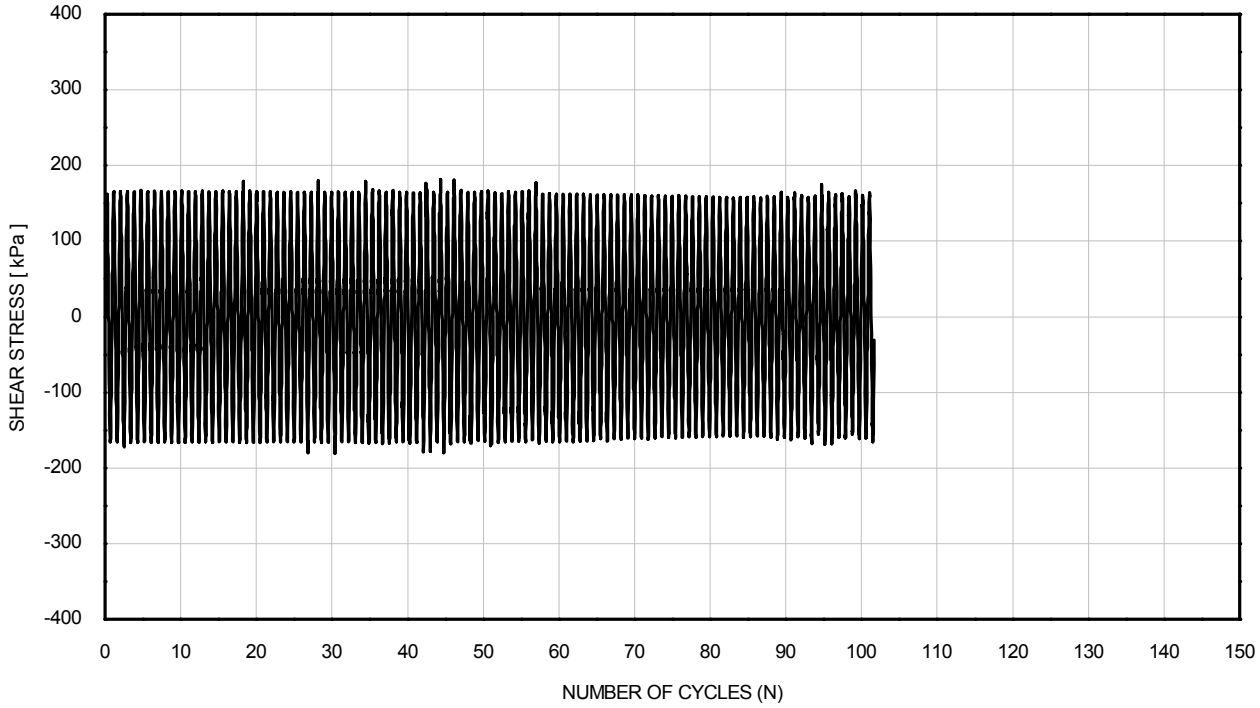


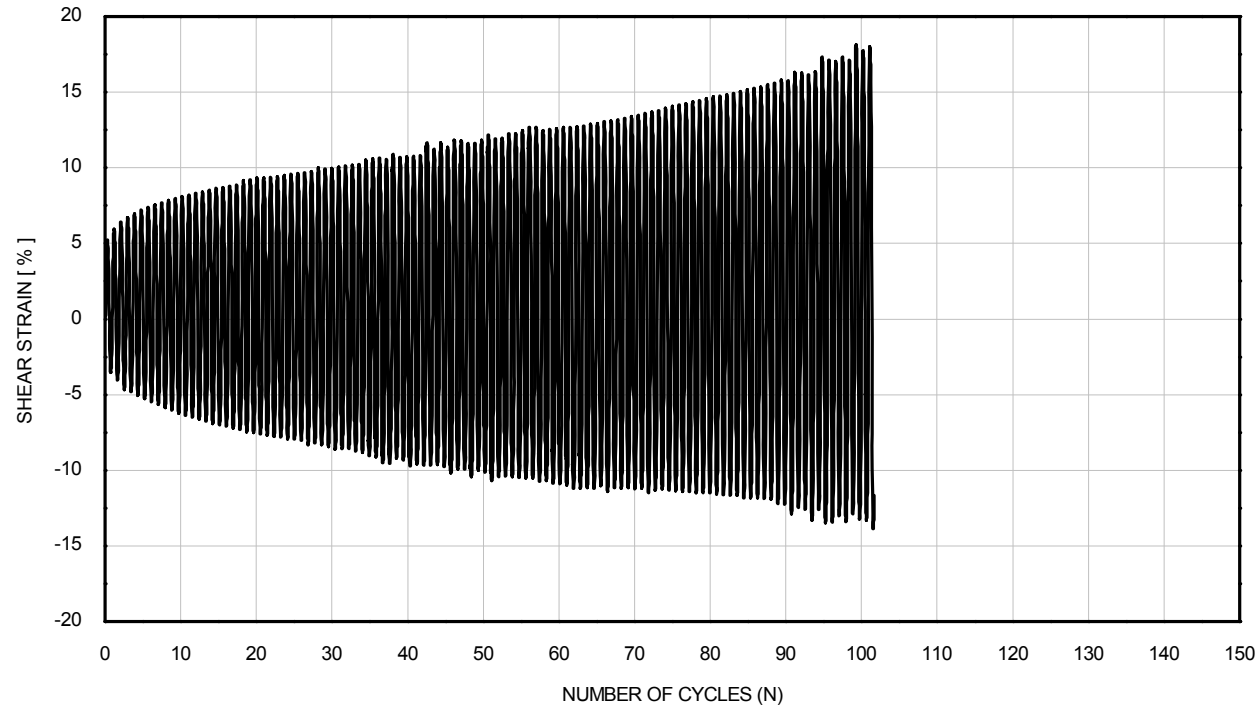


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
		Sample	: 17WAXC
		Depth [m]	: 35.04
		Test No.	: CSS02

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

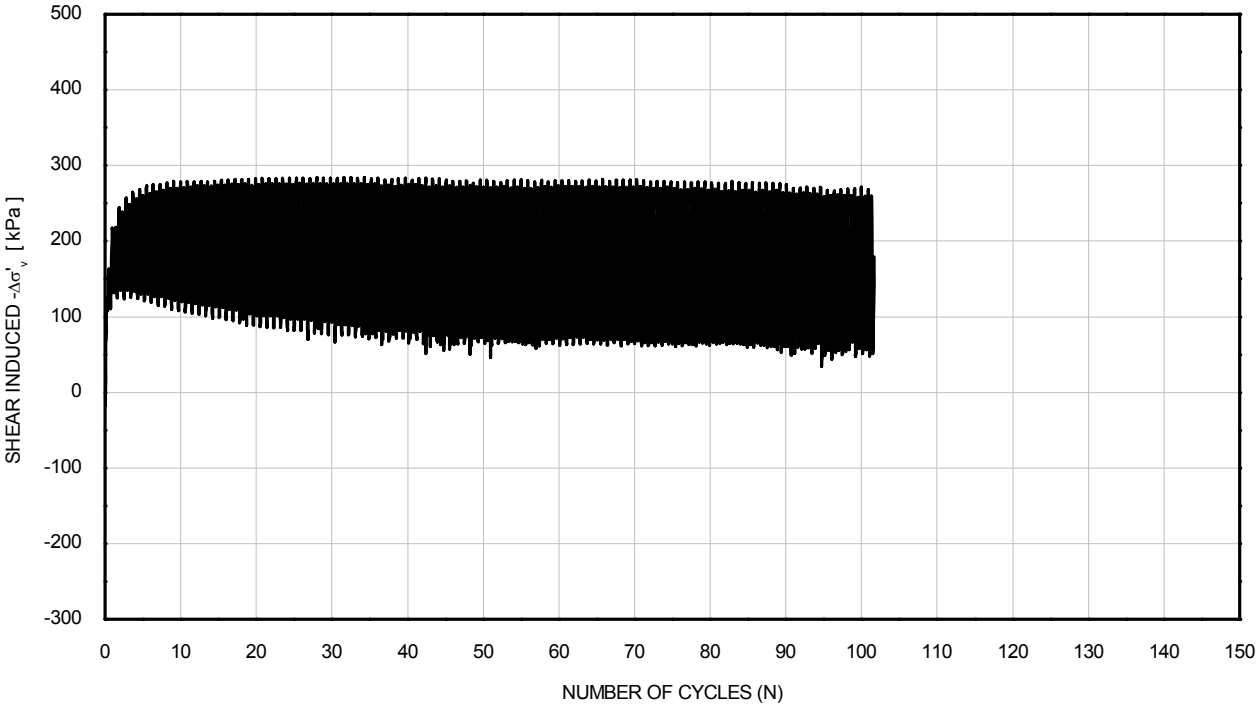


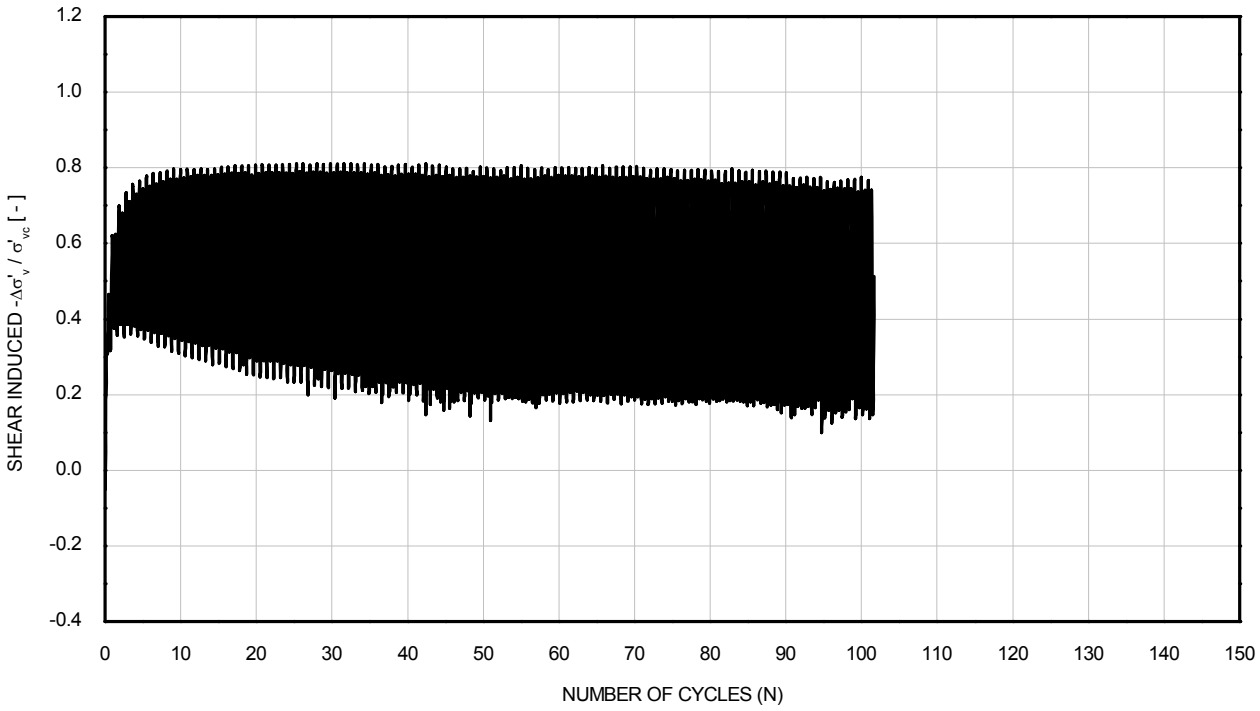


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	165 kPa	Depth [m]	:	35.04
Frequency	:	0.09 Hz	Test No.	:	CSS02

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

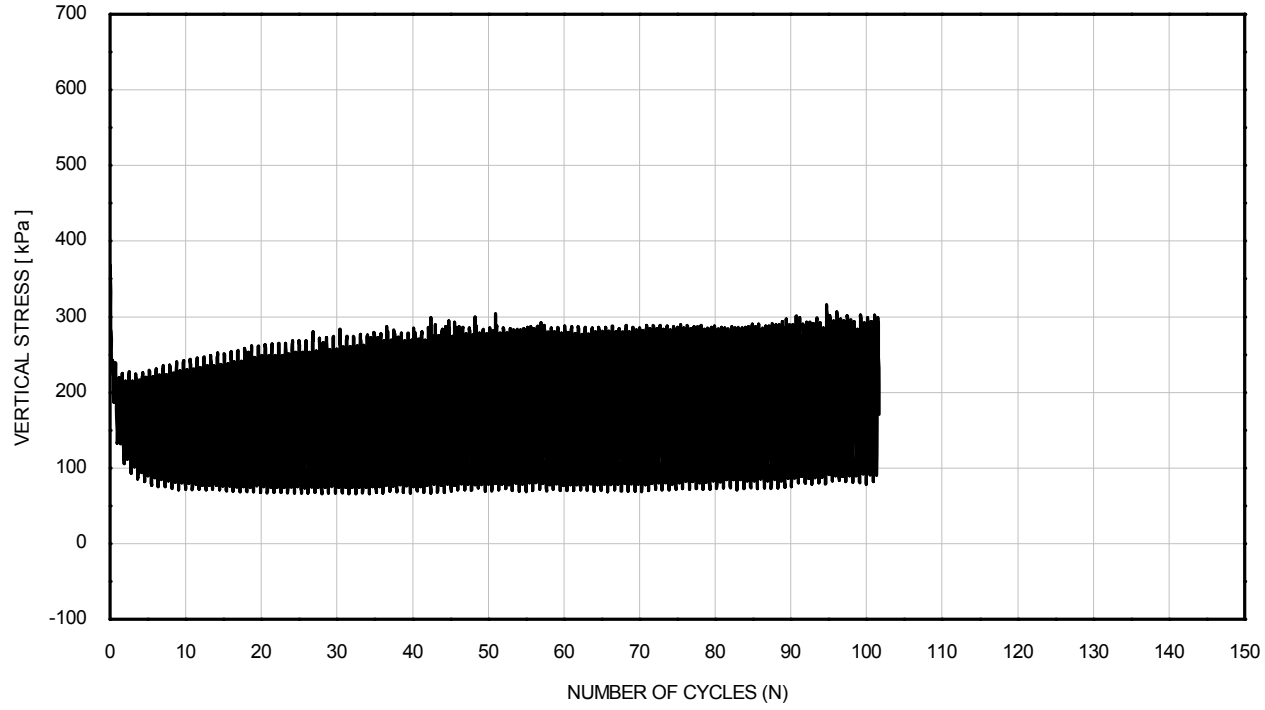


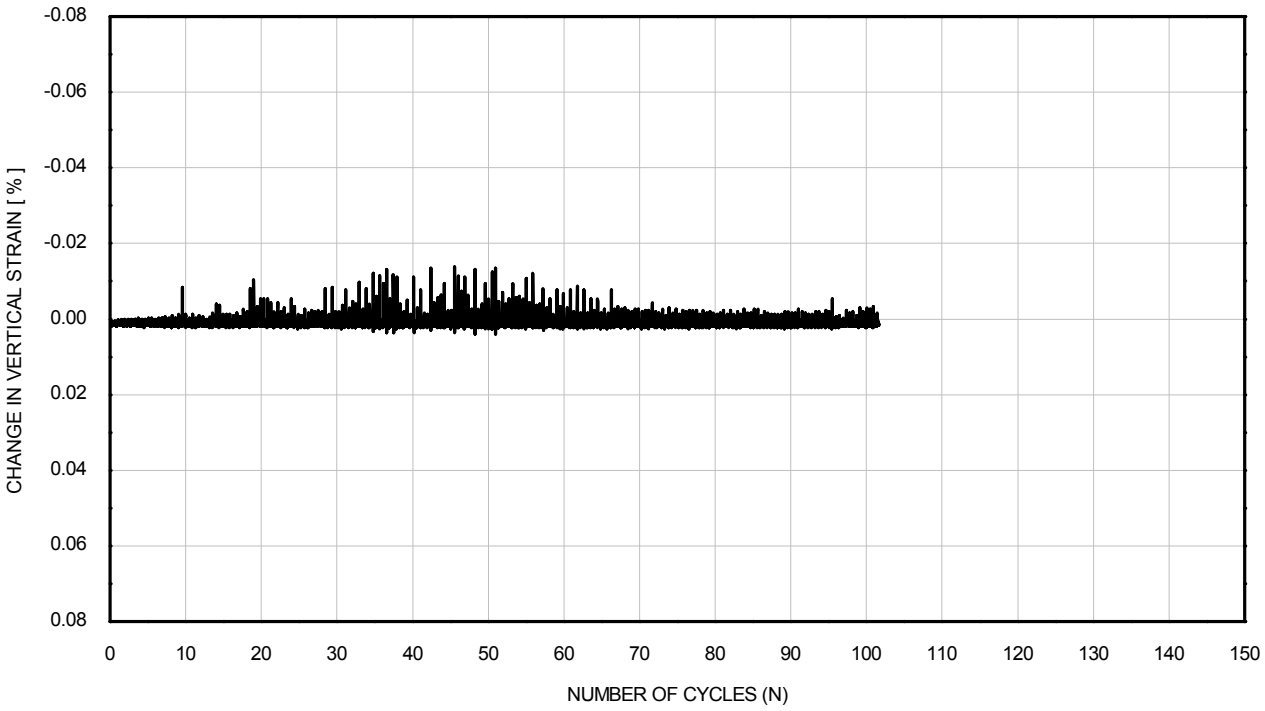


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	165 kPa	Depth [m]	:	35.04
Frequency	:	0.09 Hz	Test No.	:	CSS02

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

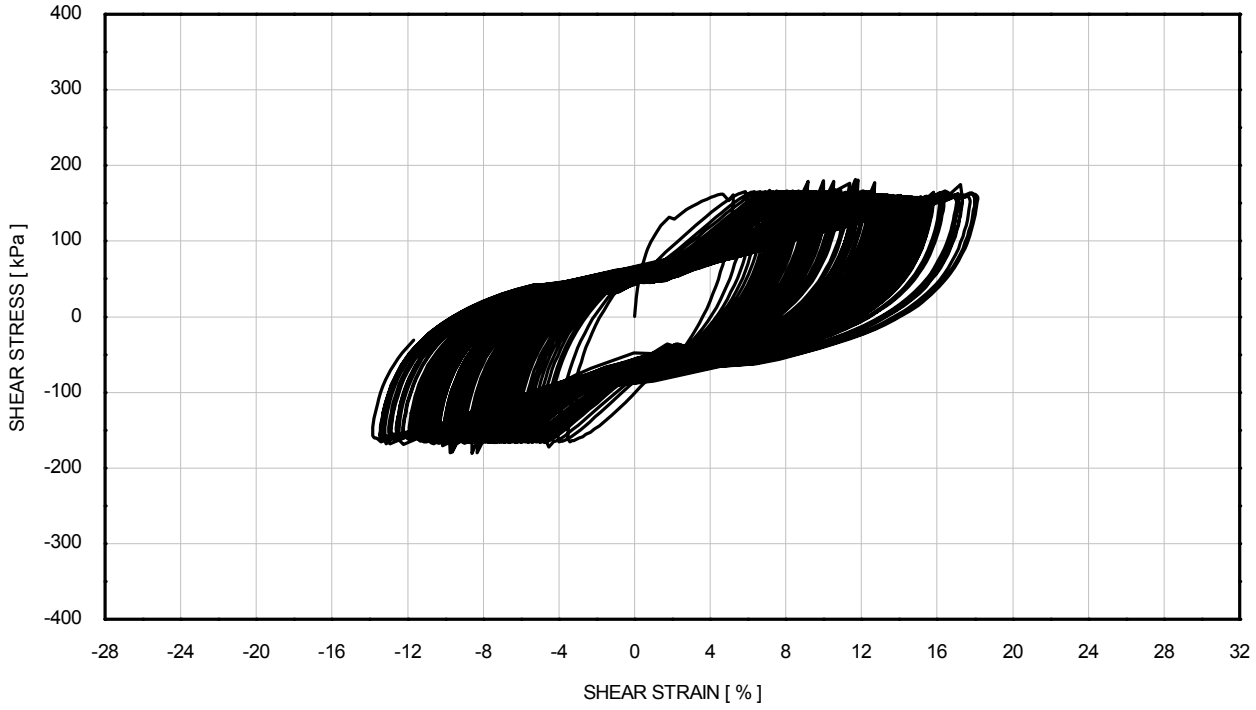




σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	165 kPa	Depth [m]	:	35.04
Frequency	:	0.09 Hz	Test No.	:	CSS02

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

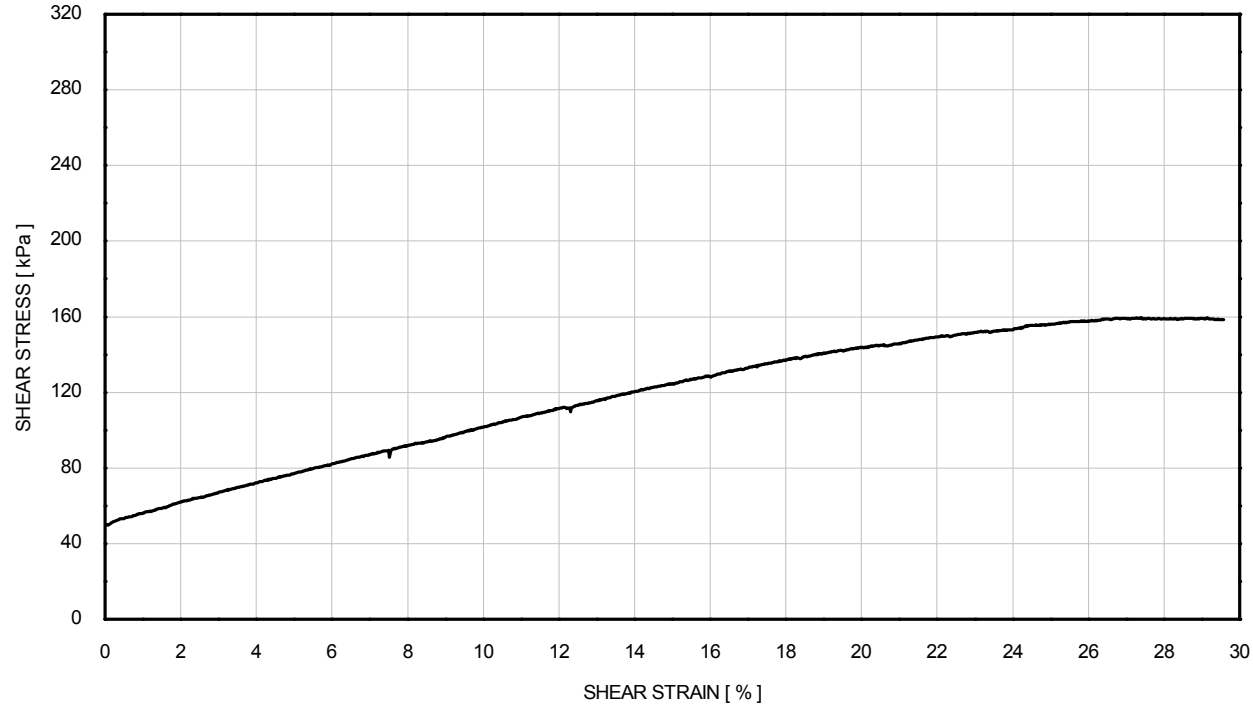
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

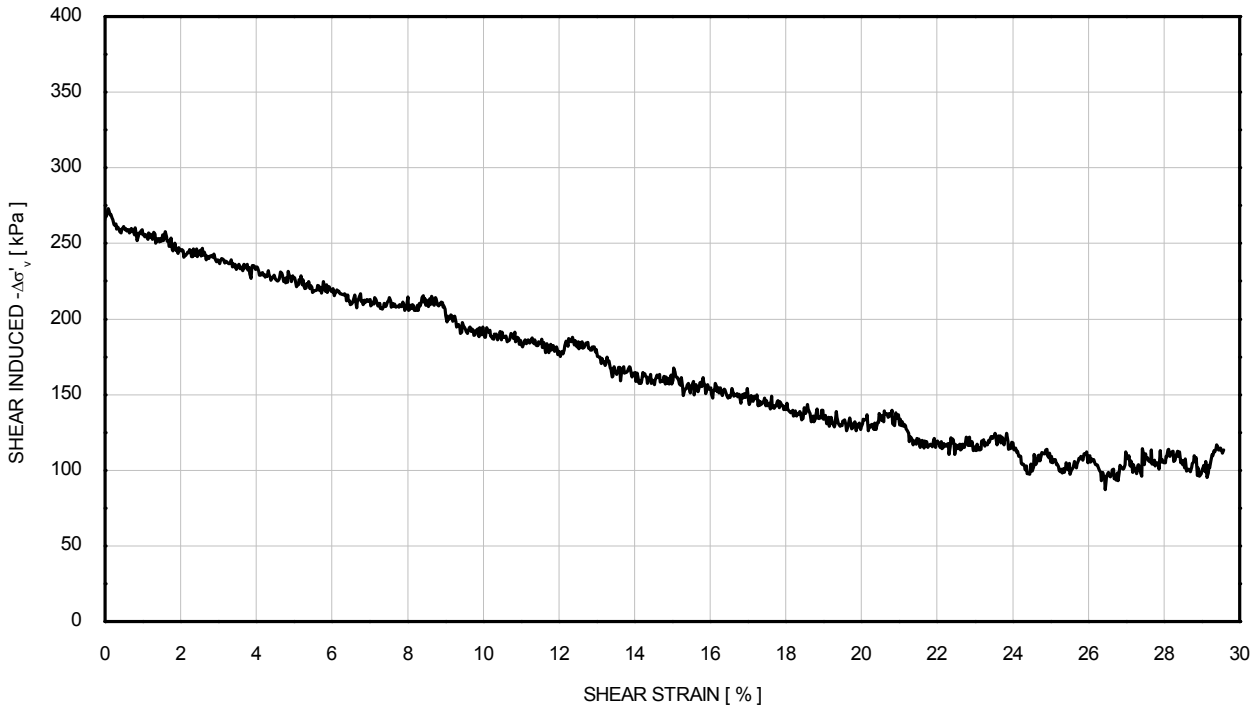


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	165 kPa	Depth [m]	:	35.04
Frequency	:	0.09 Hz	Test No.	:	CSS02

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

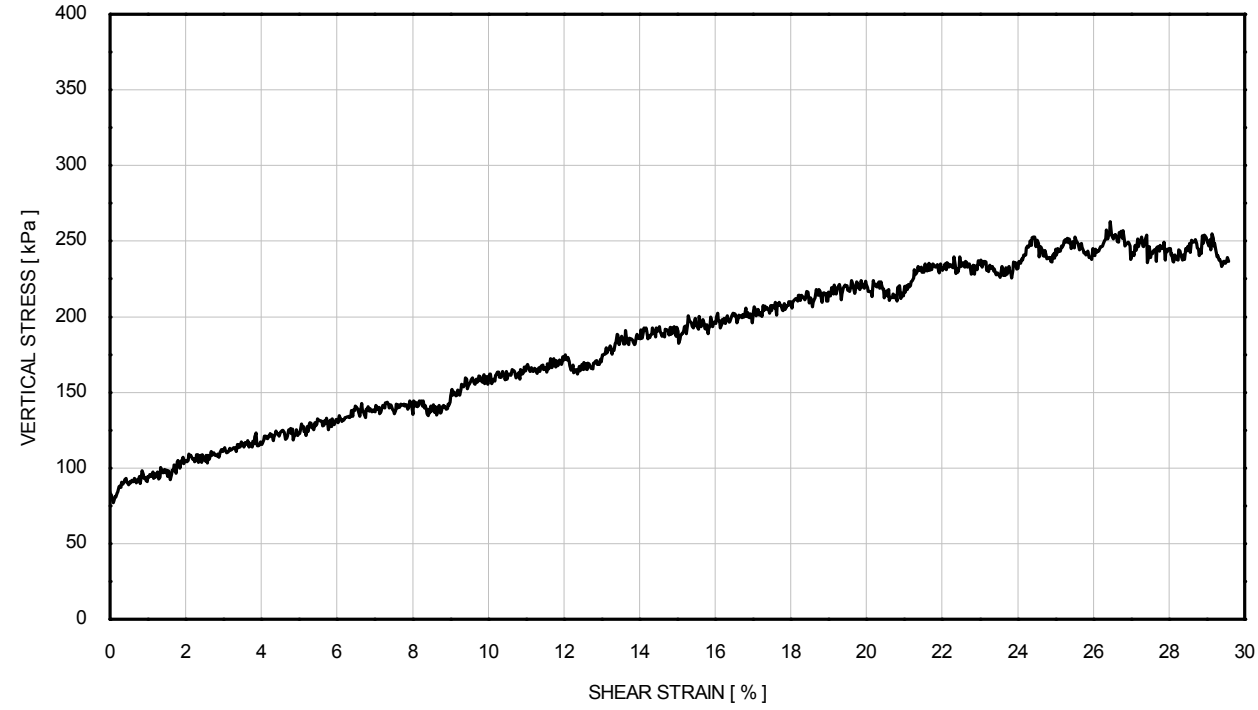


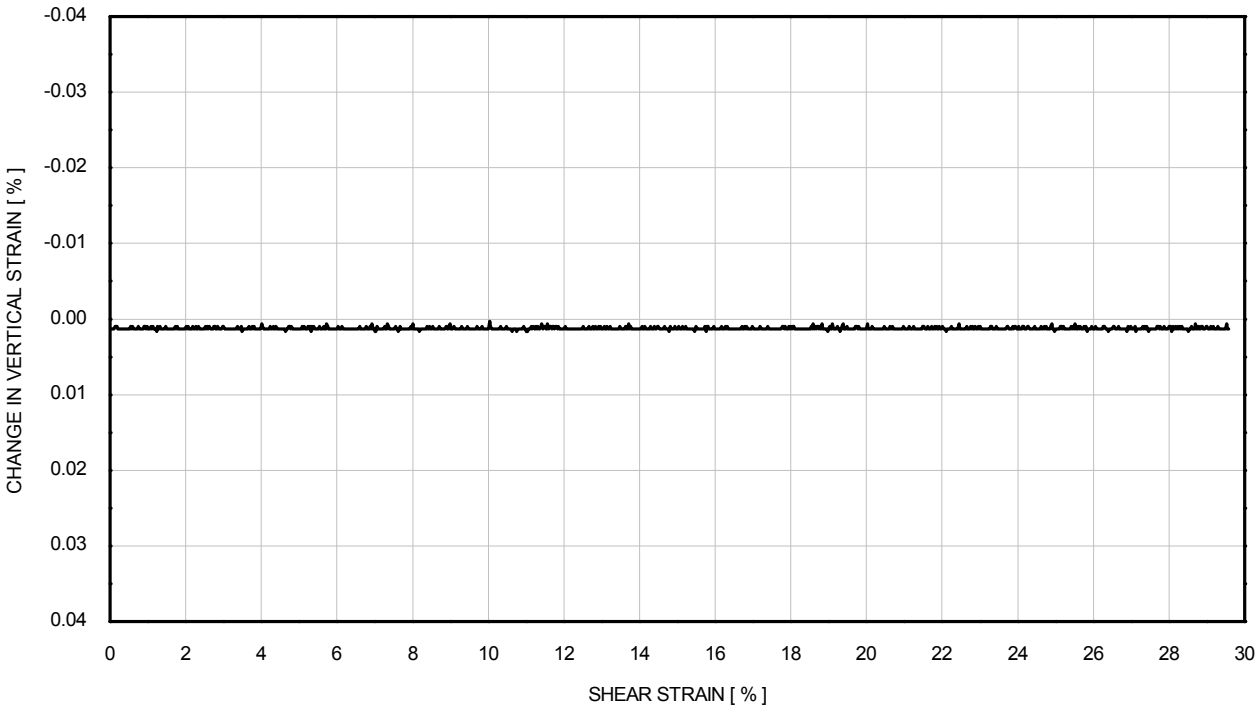


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 159 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.28 %	Depth [m]	: 35.04
Rate of strain	: 3.07 %/hour	Test No.	: CSS02

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

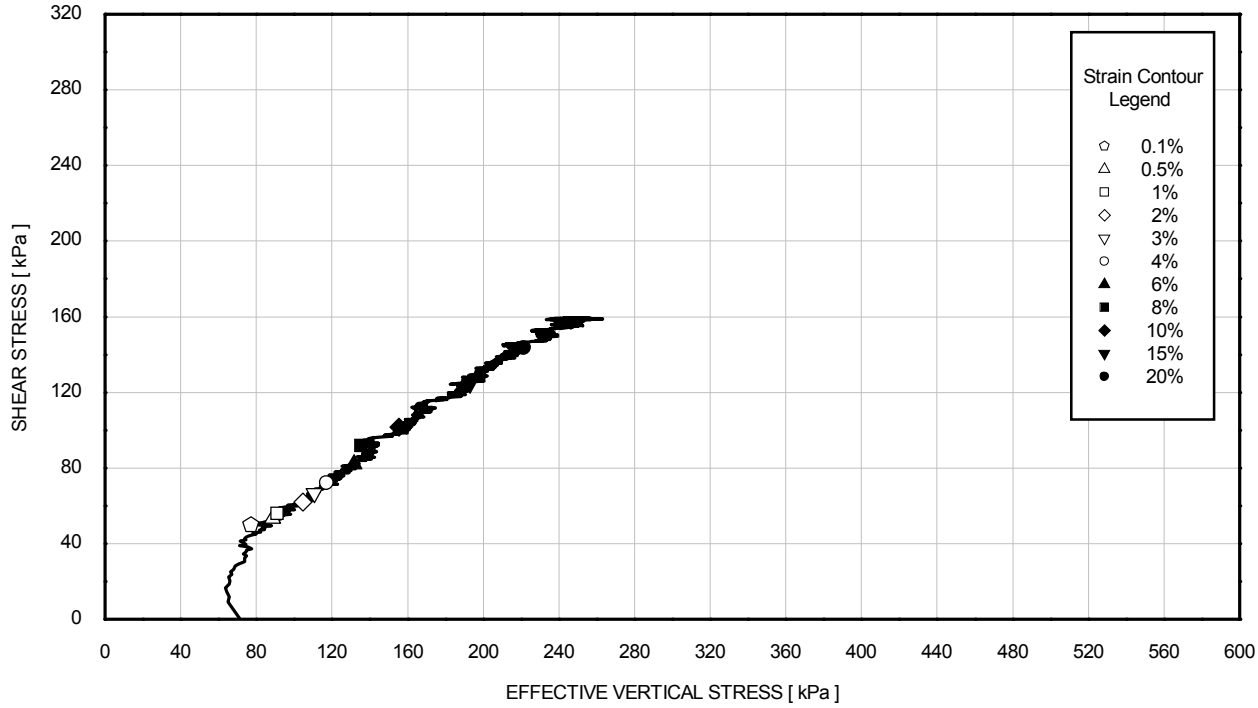


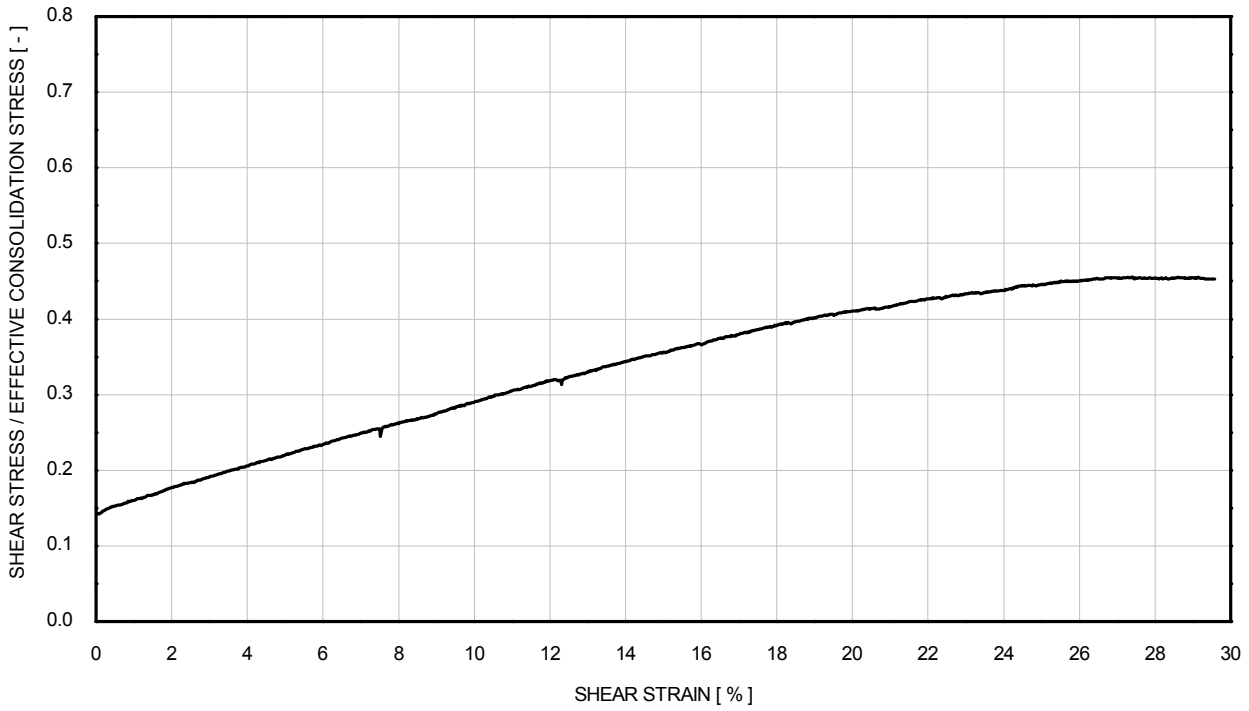


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 159 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.28 %	Depth [m]	: 35.04
Rate of strain	: 3.07 %/hour	Test No.	: CSS02

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

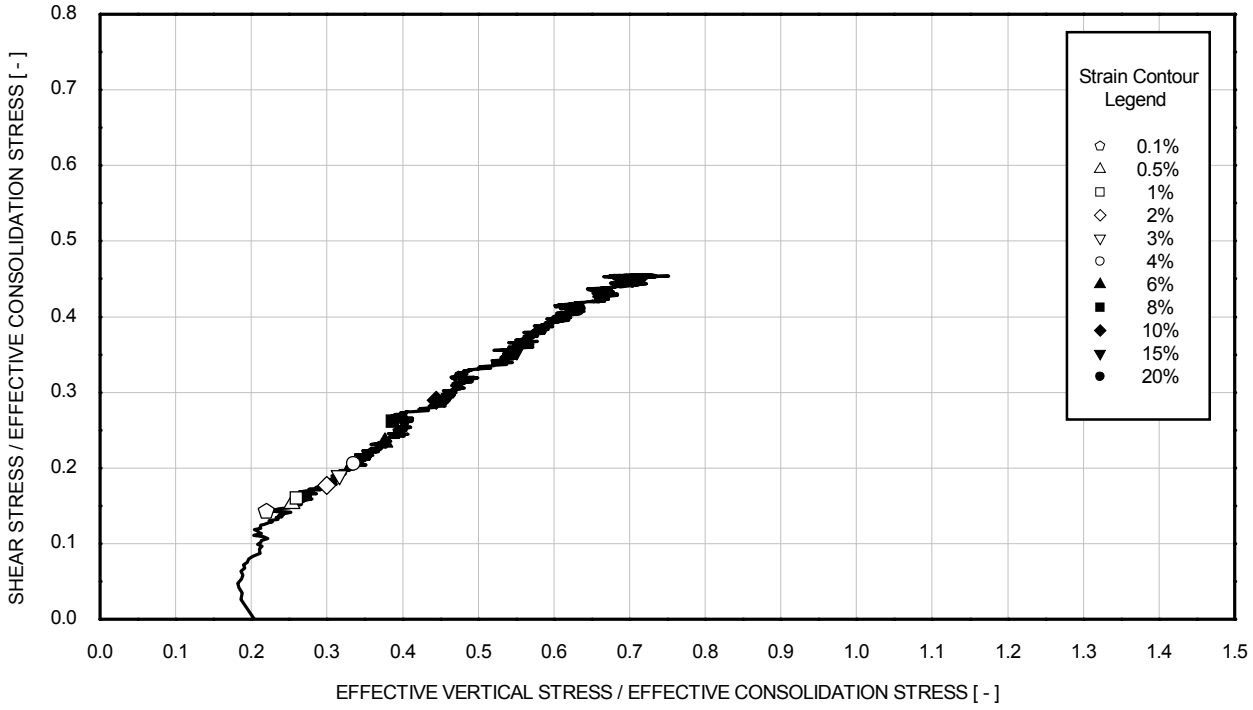


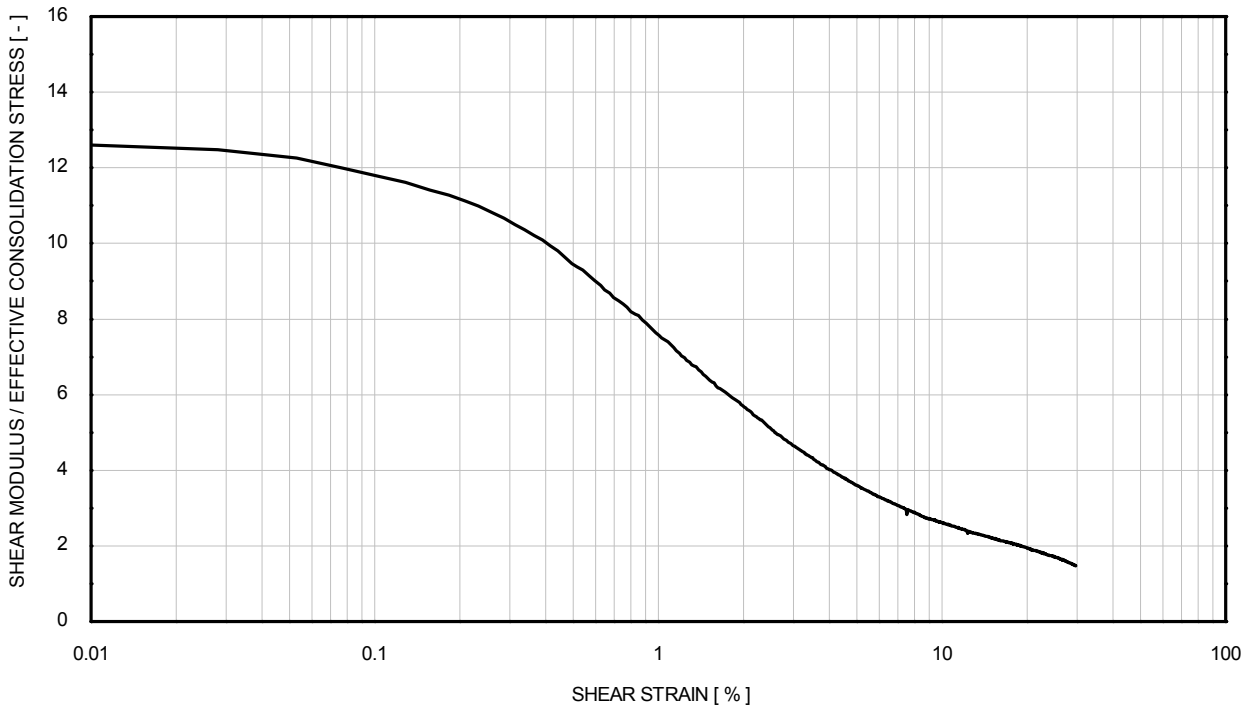


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 159 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.28 %	Depth [m]	: 35.04
Rate of strain	: 3.07 %/hour	Test No.	: CSS02

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 159 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 27.28 %	Depth [m]	: 35.04
Rate of strain	: 3.07 %/hour	Test No.	: CSS02

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark brown CLAY with medium pyritic gravel

GENERAL	
Date test started	28/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.0
Moisture content	[%]	22.5
Bulk density	[Mg/m³]	2.04
Dry density	[Mg/m³]	1.66
Void ratio	[-]	0.625
Degree of saturation	[%]	97
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	417
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 1-4_17D_CSS03
Template issue	1.2
Processed by	HB
Date	10/08/2015
Checked by	PH
Date	11/08/2015
Approved by	PH
Date	12/08/2015

TEST IDENTIFICATION	
Borehole	BH WFS 1-4
Sample	17WAXD
Depth [m]	35.05
Test number	CSS03

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	350
Vertical strain	[%]	1.86
Bulk density	[Mg/m^3]	2.06
Dry density	[Mg/m^3]	1.69
Void ratio	[-]	0.594
Moisture content	[%]	21.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	316
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	135
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	-0.11
γ_{cy} at N_f	[%]	1.96
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	204
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	325
Shear strain	[%]	29.92
Shear induced $\Delta\sigma'_v$	[kPa]	-50
Vertical stress	[kPa]	400
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.02
At 15 % shear strain		
Shear stress	[kPa]	254
Shear induced -$\Delta\sigma'_v$	[kPa]	57
Vertical stress	[kPa]	294
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH WFS 1-4
Sample	17WAXD
Depth [m]	35.05
Test number	CSS03

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

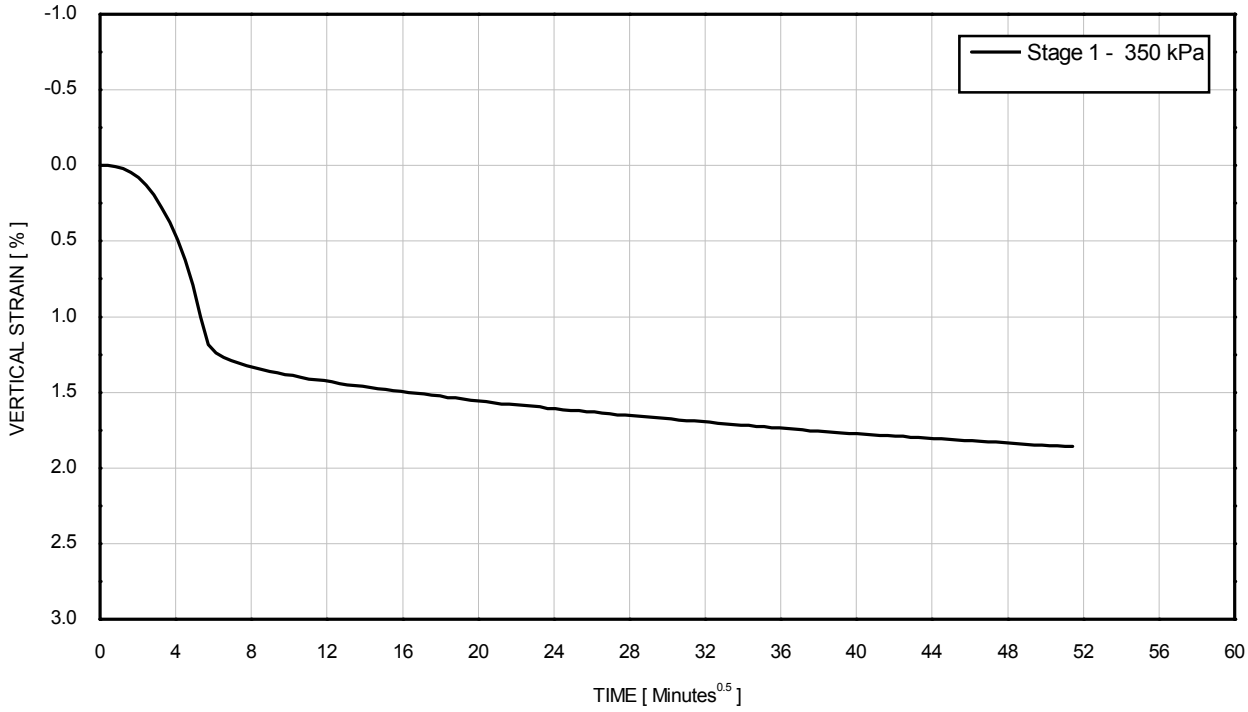
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

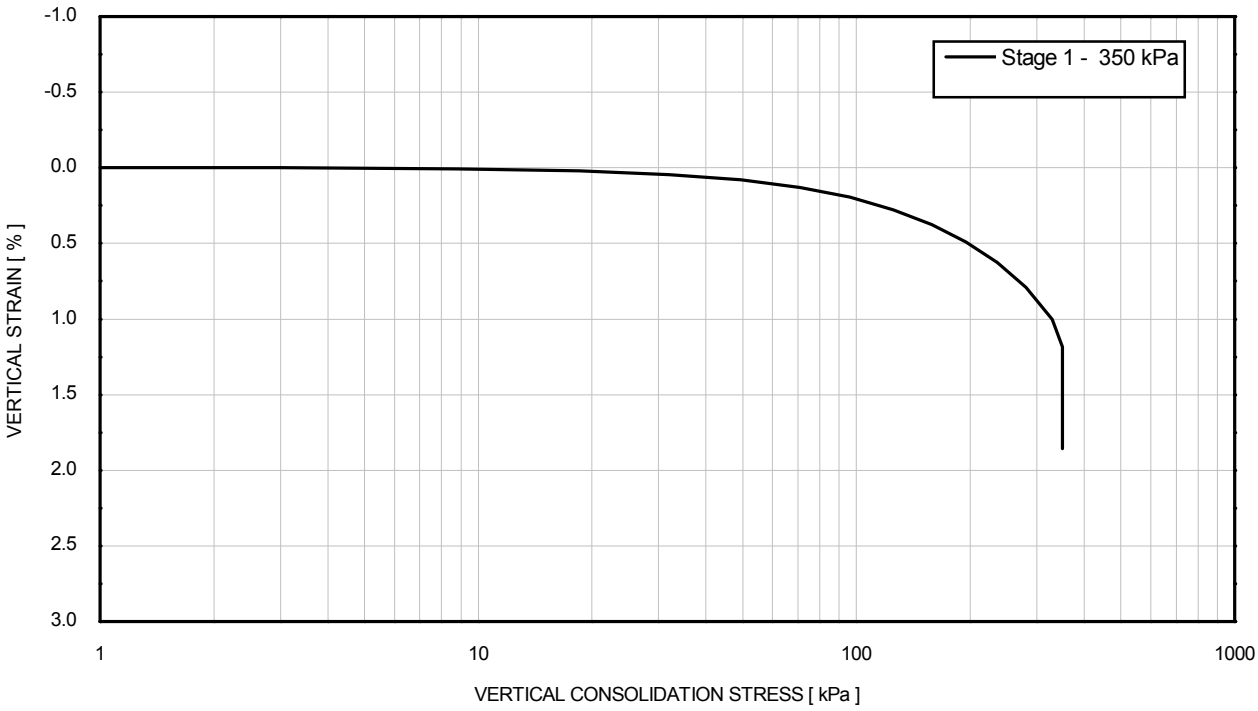
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH WFS 1-4
Sample	17WAXD
Depth [m]	35.05
Test number	CSS03

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

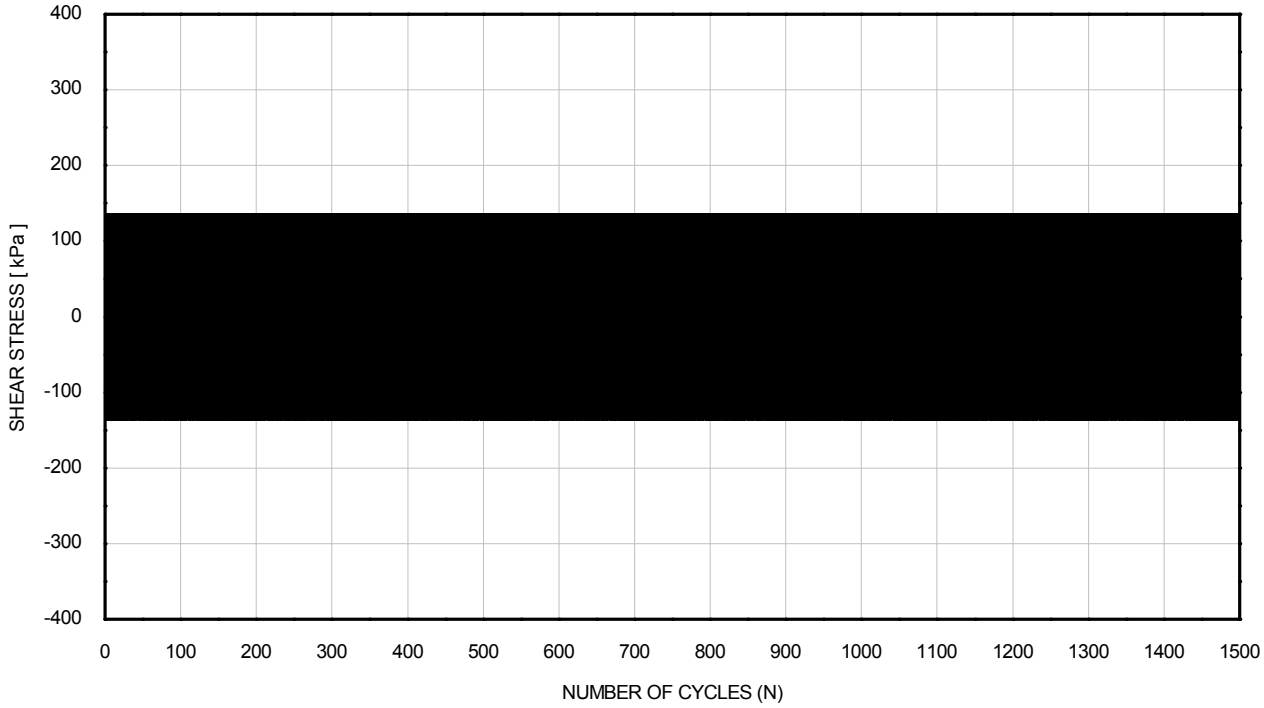


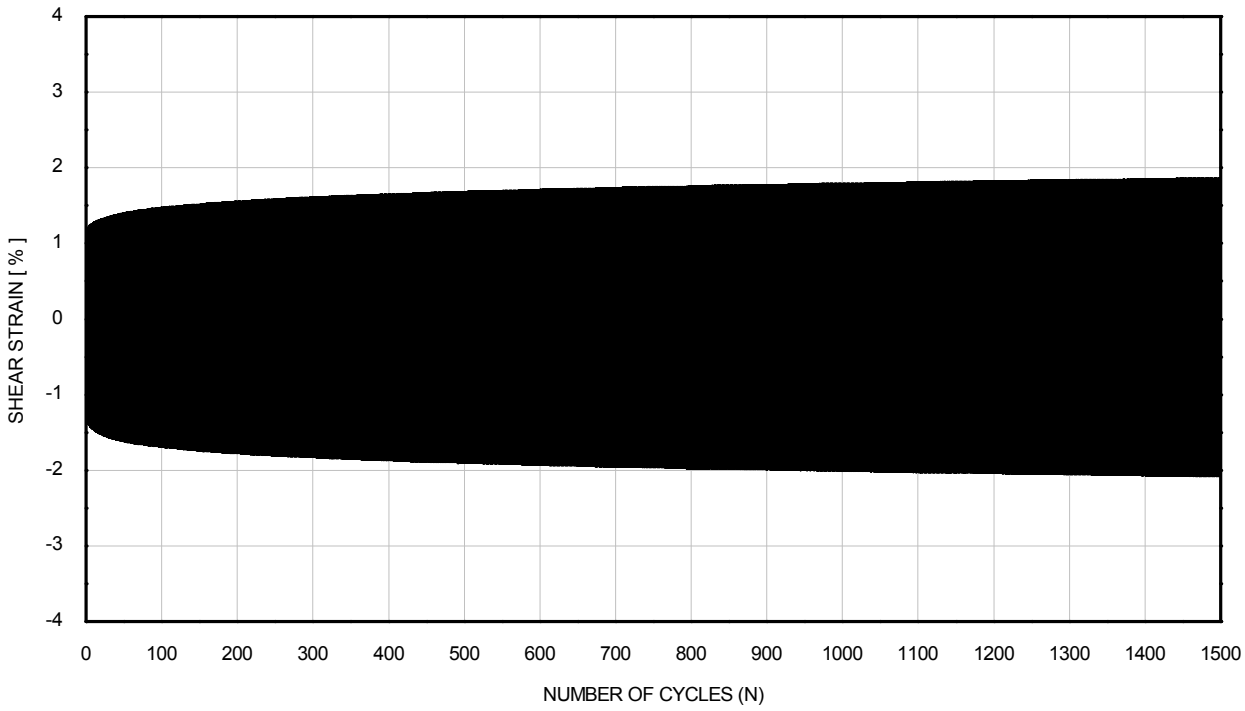


σ'_{vc}	: 350 kPa	Borehole	: BH WFS 1-4
		Sample	: 17WAXD
		Depth [m]	: 35.05
		Test No.	: CSS03

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

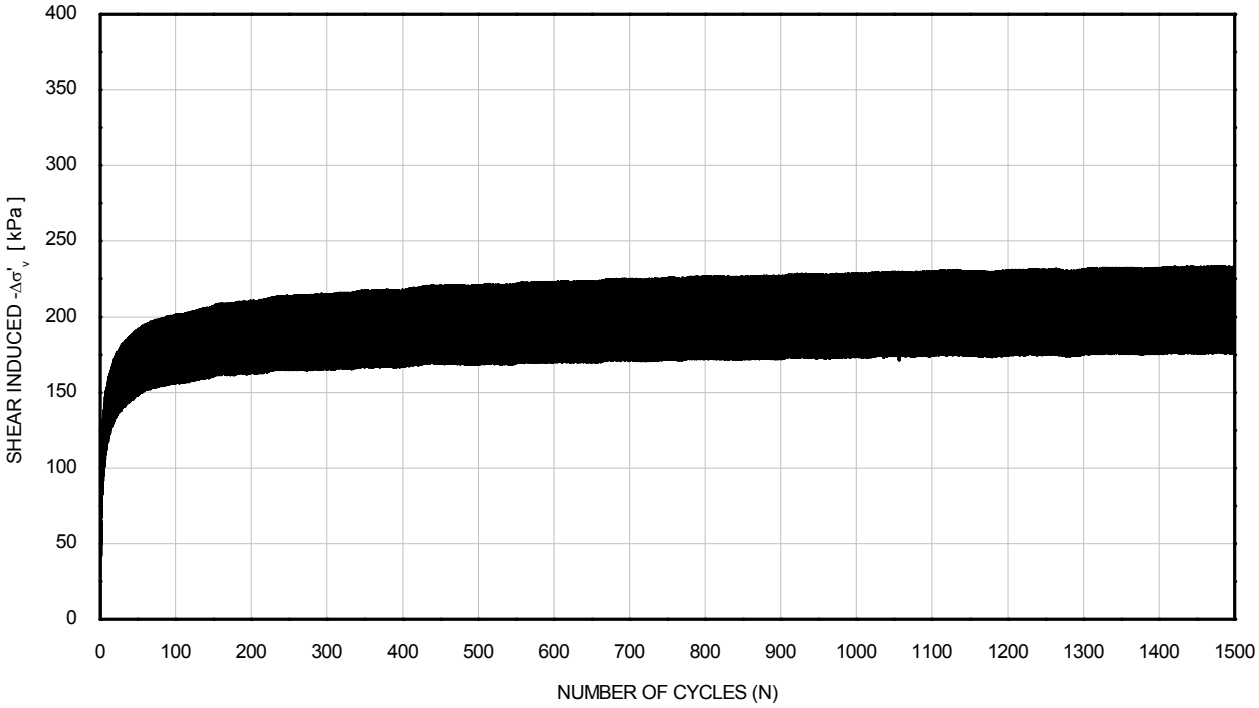


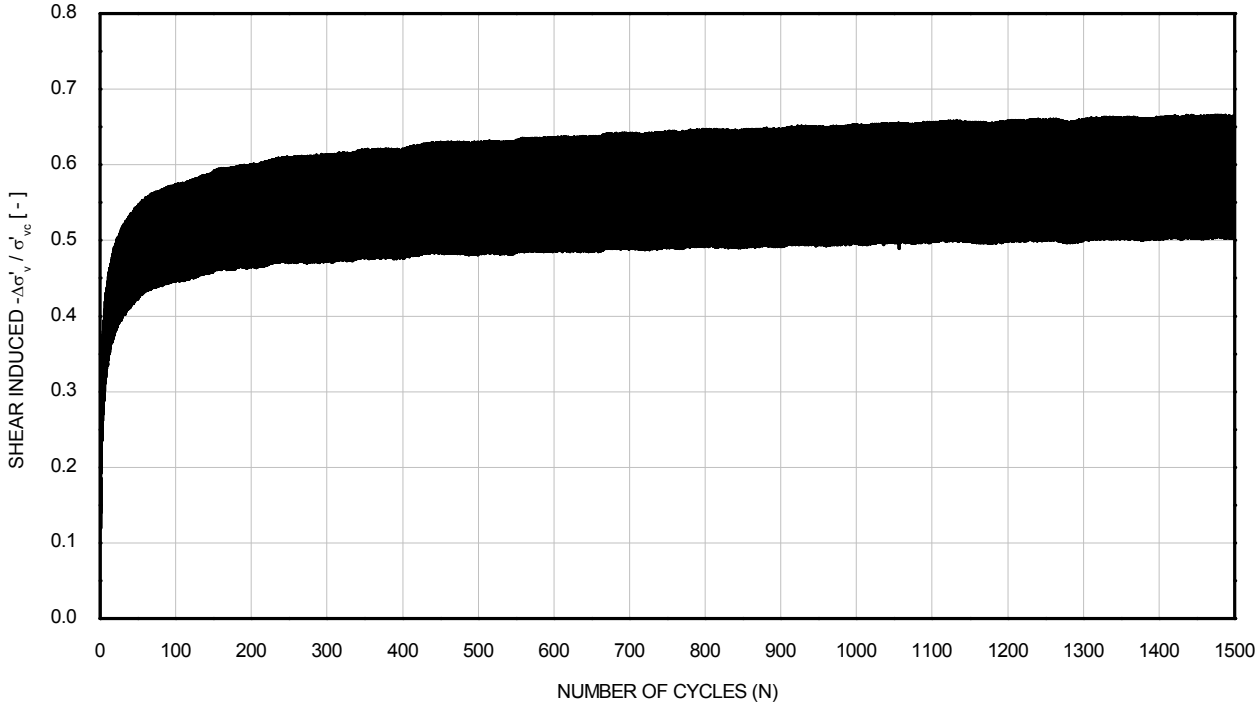


σ'_{vc}	:	350 kPa	Borehole	:	BH WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	135 kPa	Depth [m]	:	35.05
Frequency	:	0.10 Hz	Test No.	:	CSS03

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

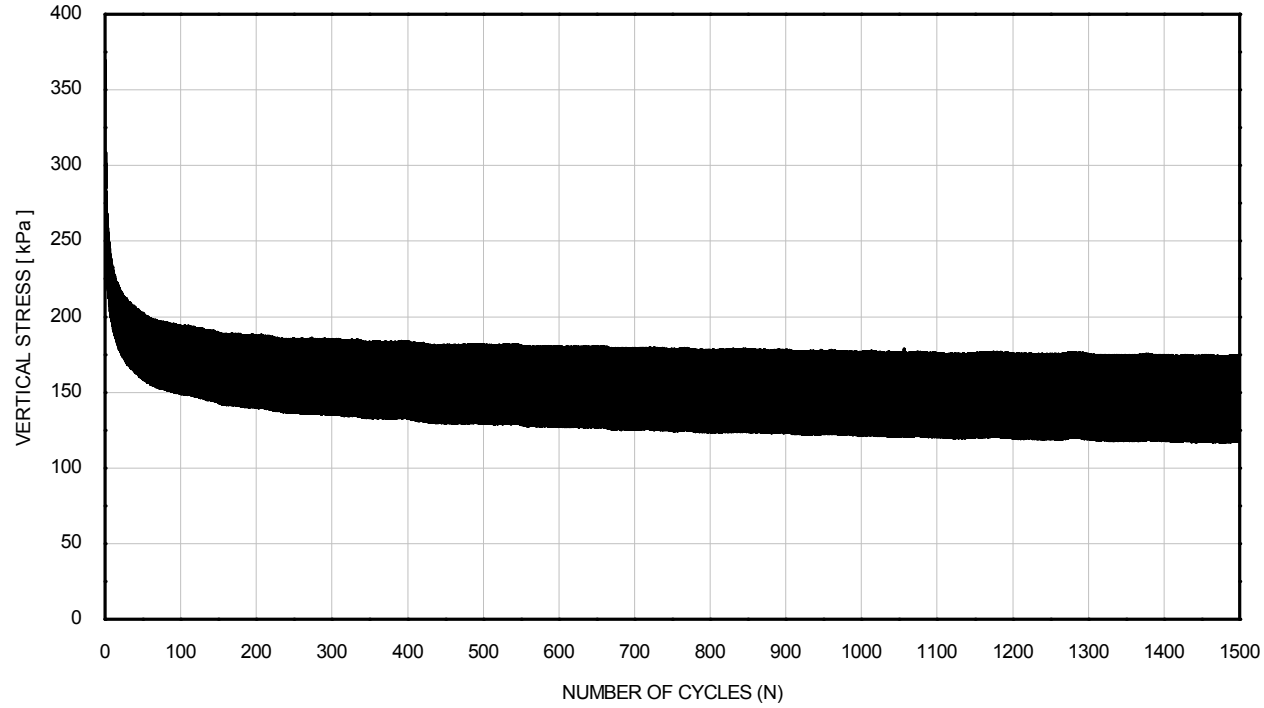


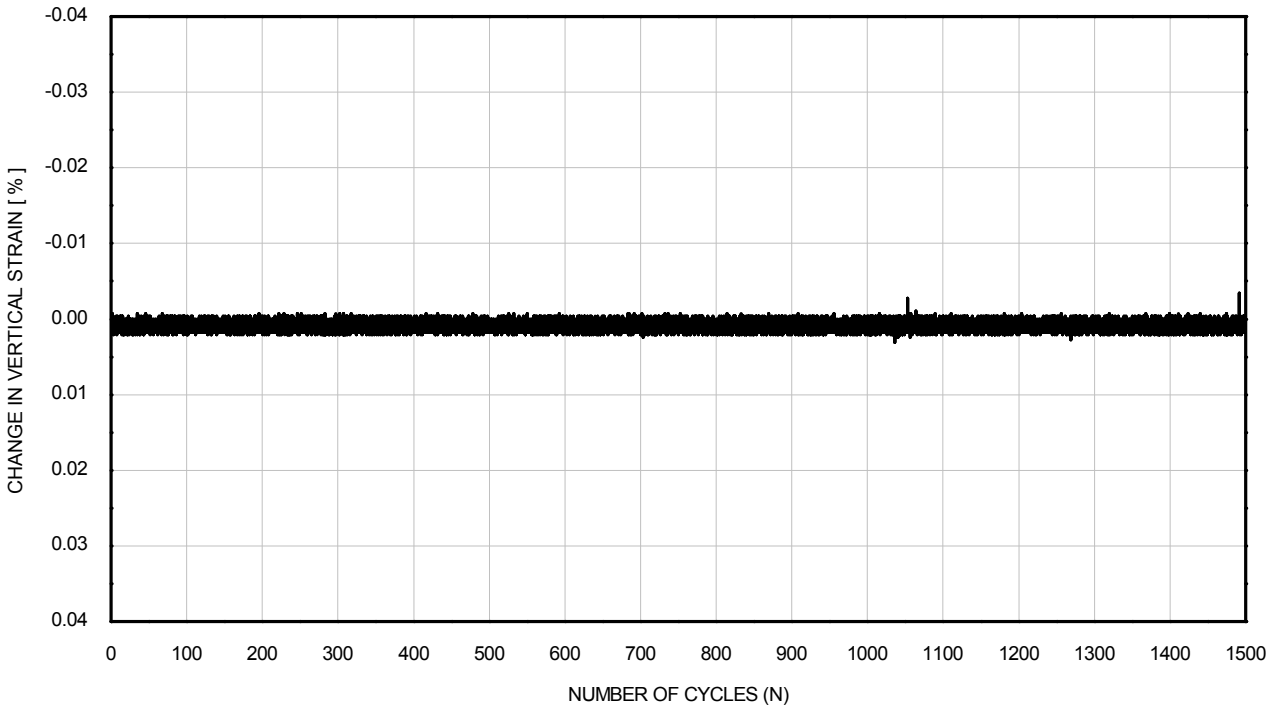


σ'_{vc}	:	350 kPa	Borehole	:	BH WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	135 kPa	Depth [m]	:	35.05
Frequency	:	0.10 Hz	Test No.	:	CSS03

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

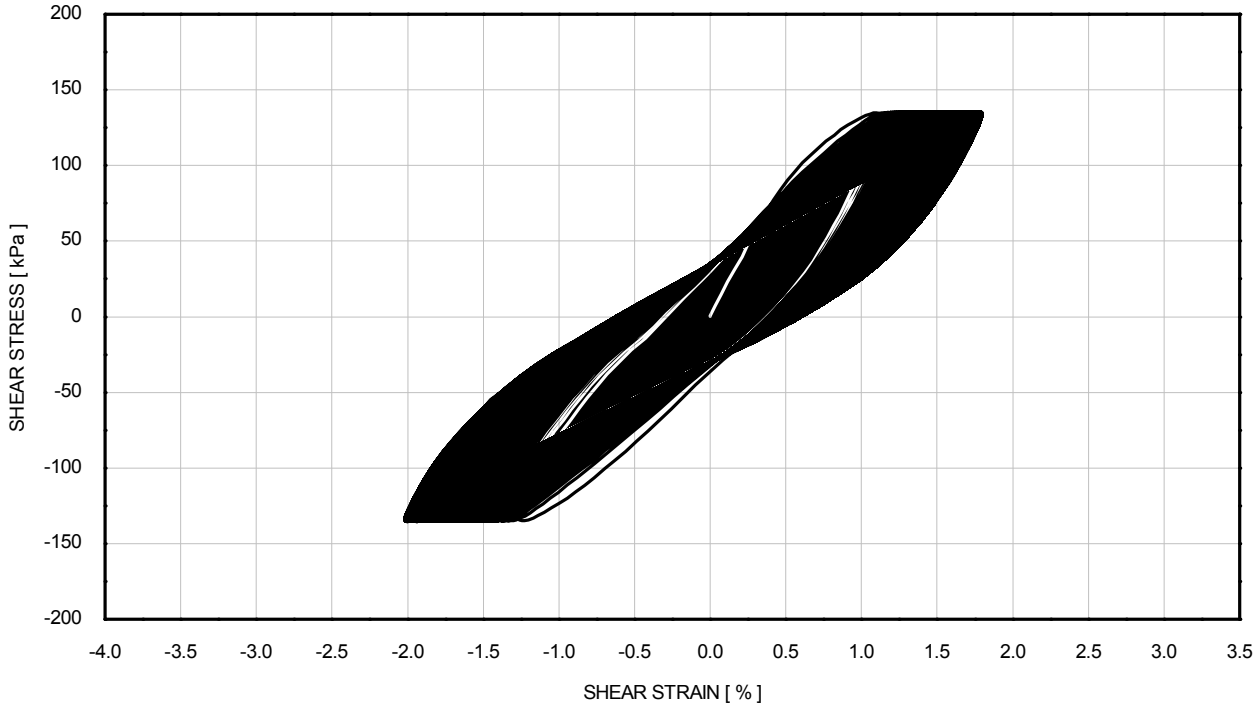


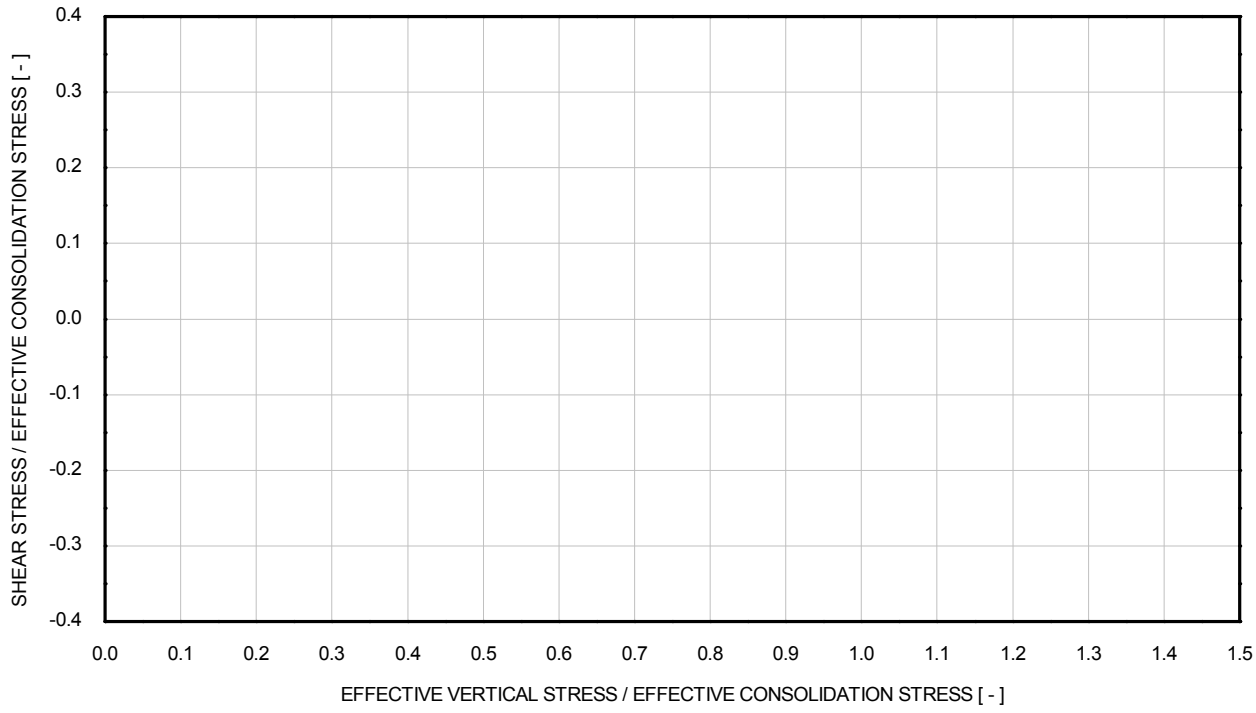


σ'_{vc}	:	350 kPa	Borehole	:	BH WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	135 kPa	Depth [m]	:	35.05
Frequency	:	0.10 Hz	Test No.	:	CSS03

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

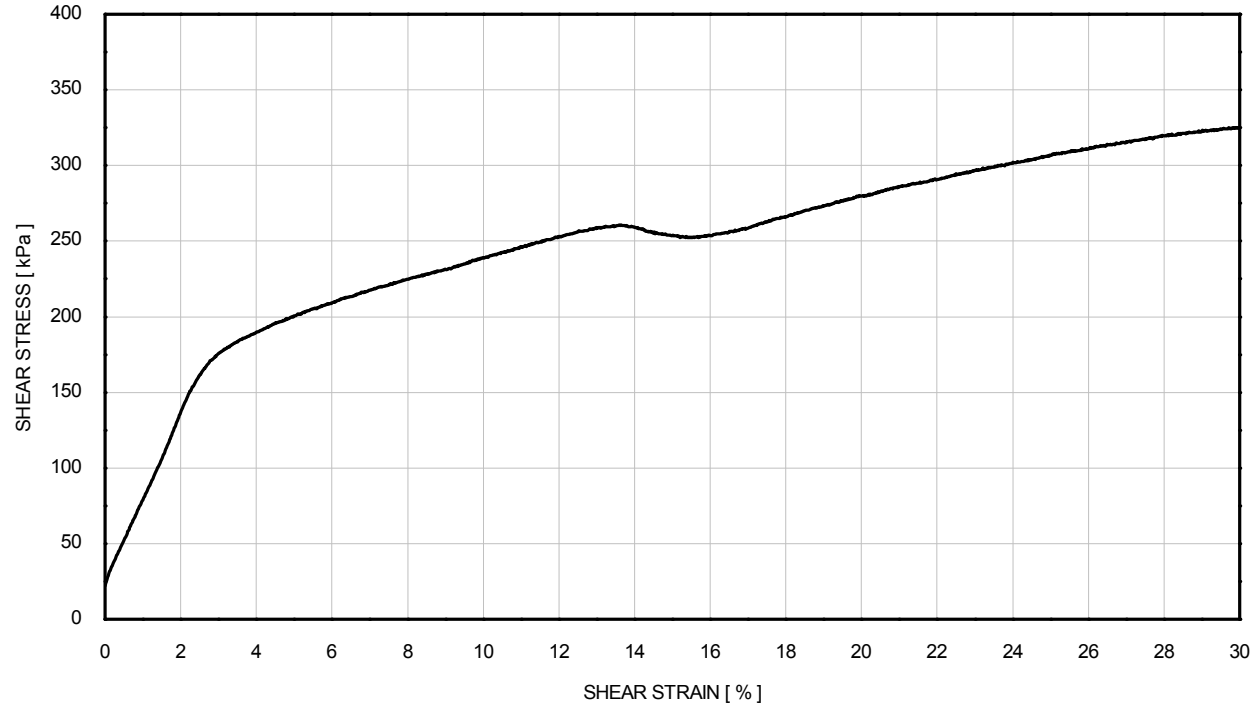


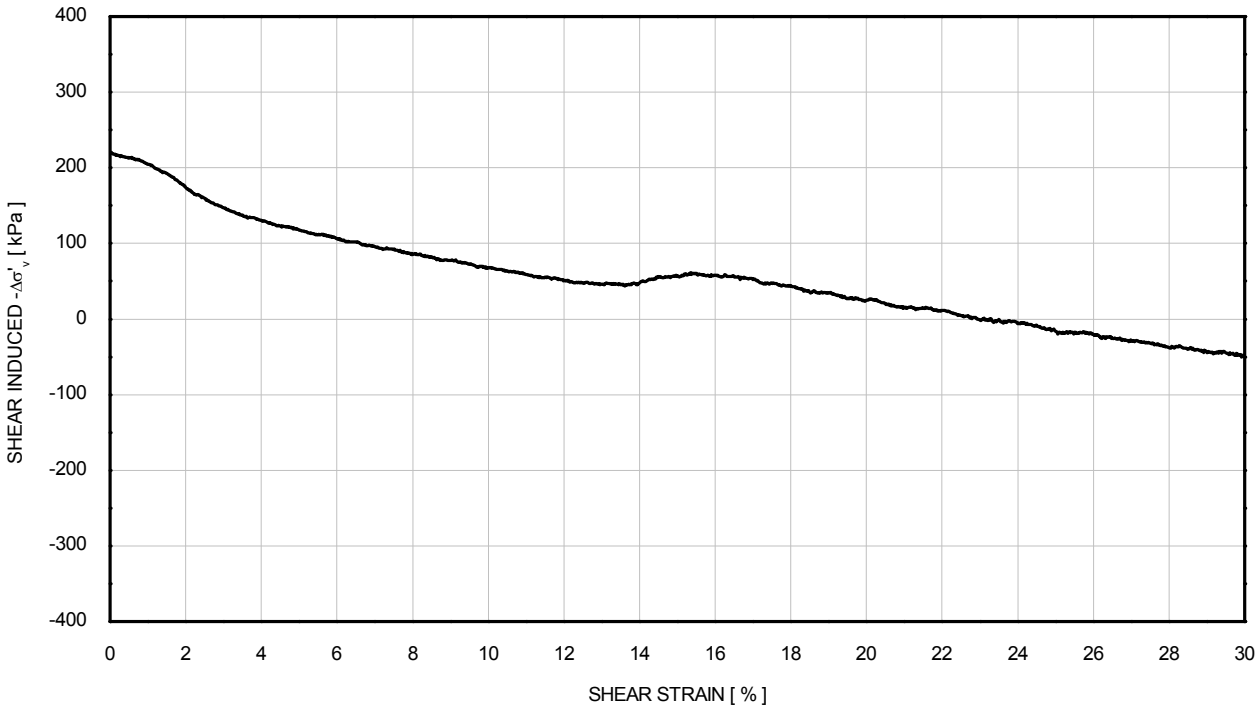


σ'_{vc}	:	350 kPa	Borehole	:	BH WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	135 kPa	Depth [m]	:	35.05
Frequency	:	0.10 Hz	Test No.	:	CSS03

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

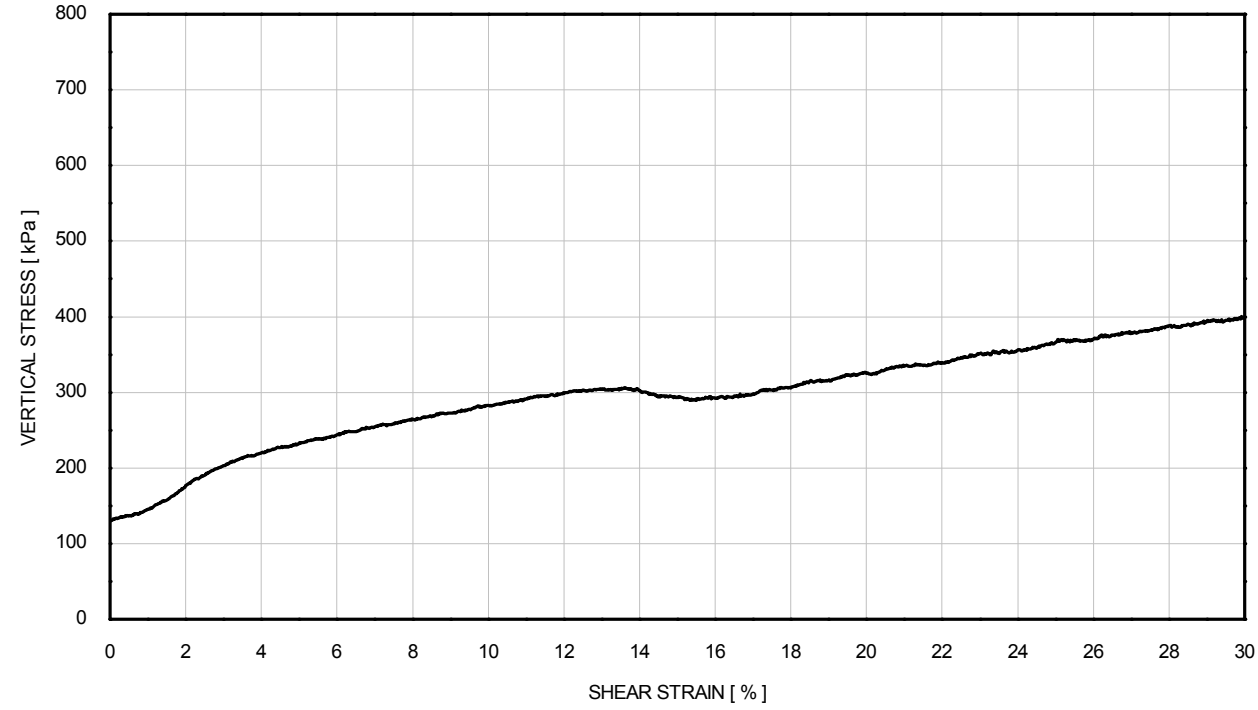


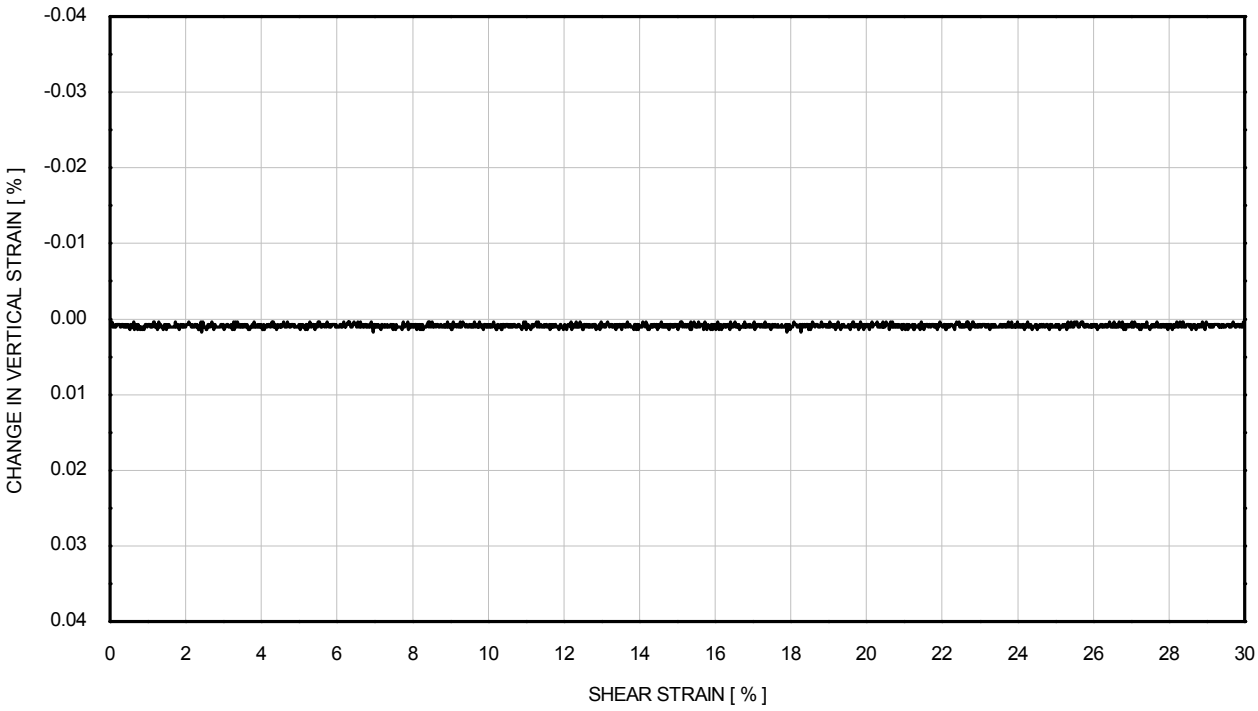


σ'_{vc}	: 350 kPa	Borehole	: BH WFS 1-4
τ_{peak}	: 325 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.92 %	Depth [m]	: 35.05
Rate of strain	: 3.02 %/hour	Test No.	: CSS03

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

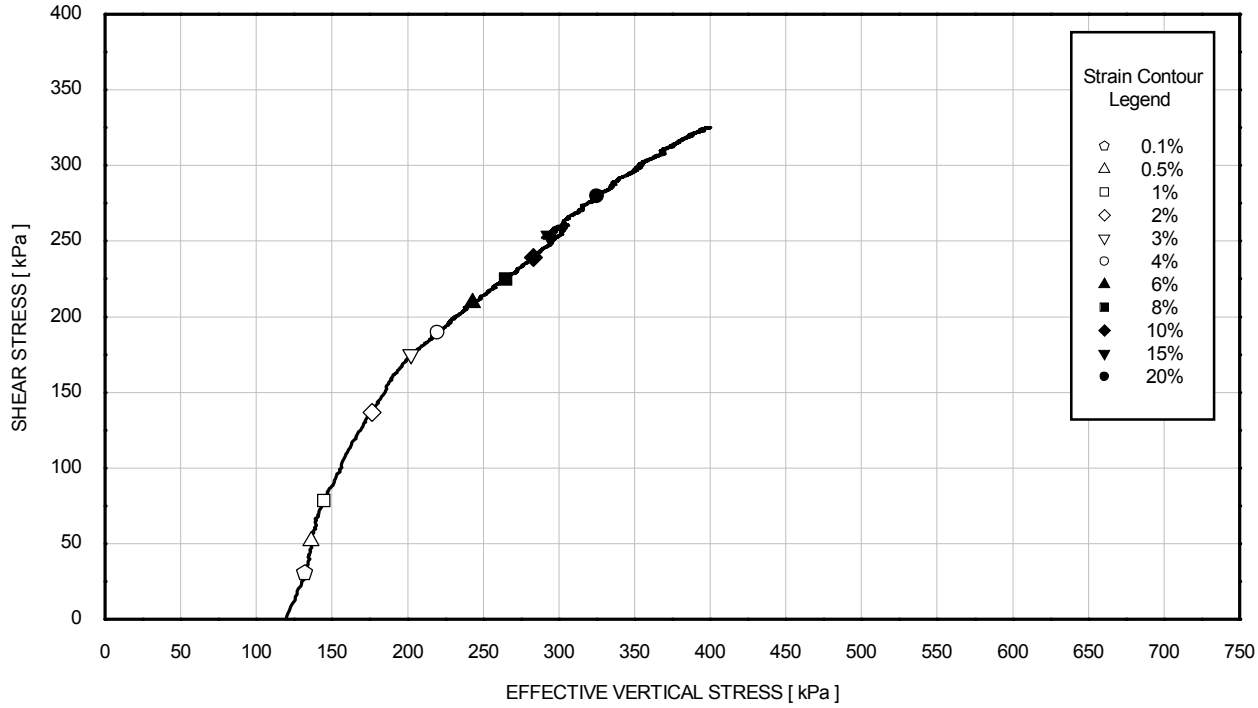


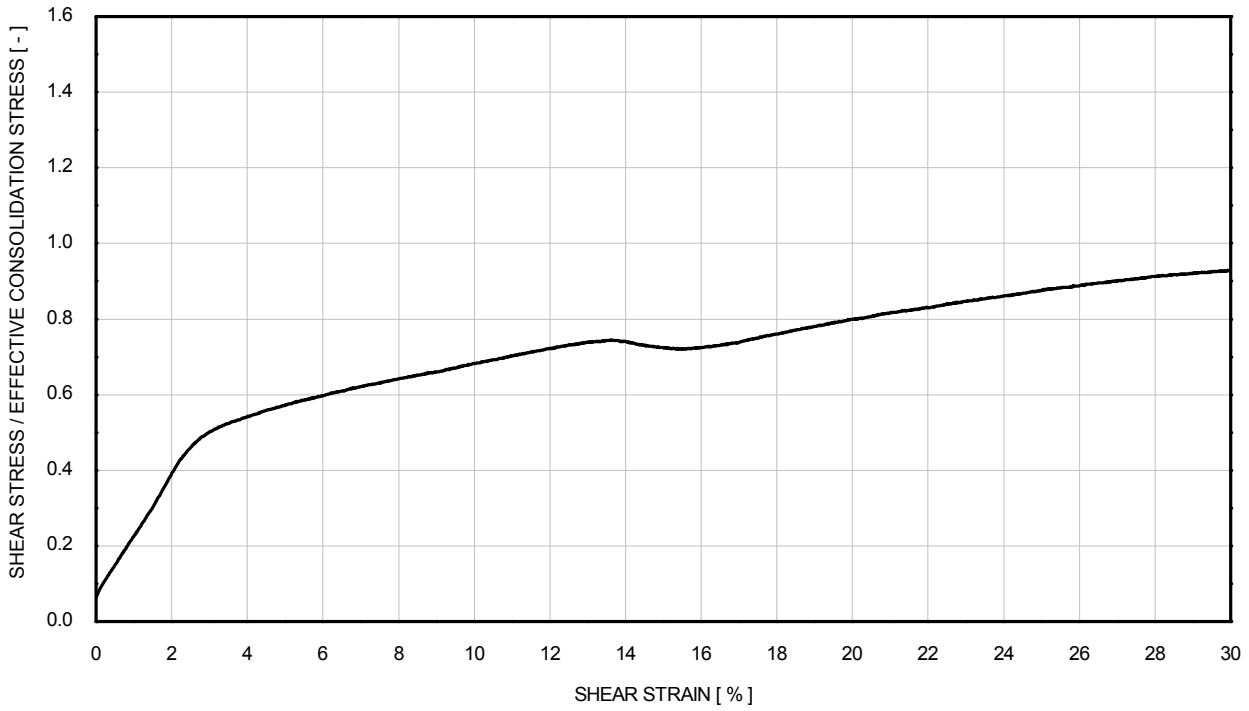


σ'_{vc}	: 350 kPa	Borehole	: BH WFS 1-4
τ_{peak}	: 325 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.92 %	Depth [m]	: 35.05
Rate of strain	: 3.02 %/hour	Test No.	: CSS03

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

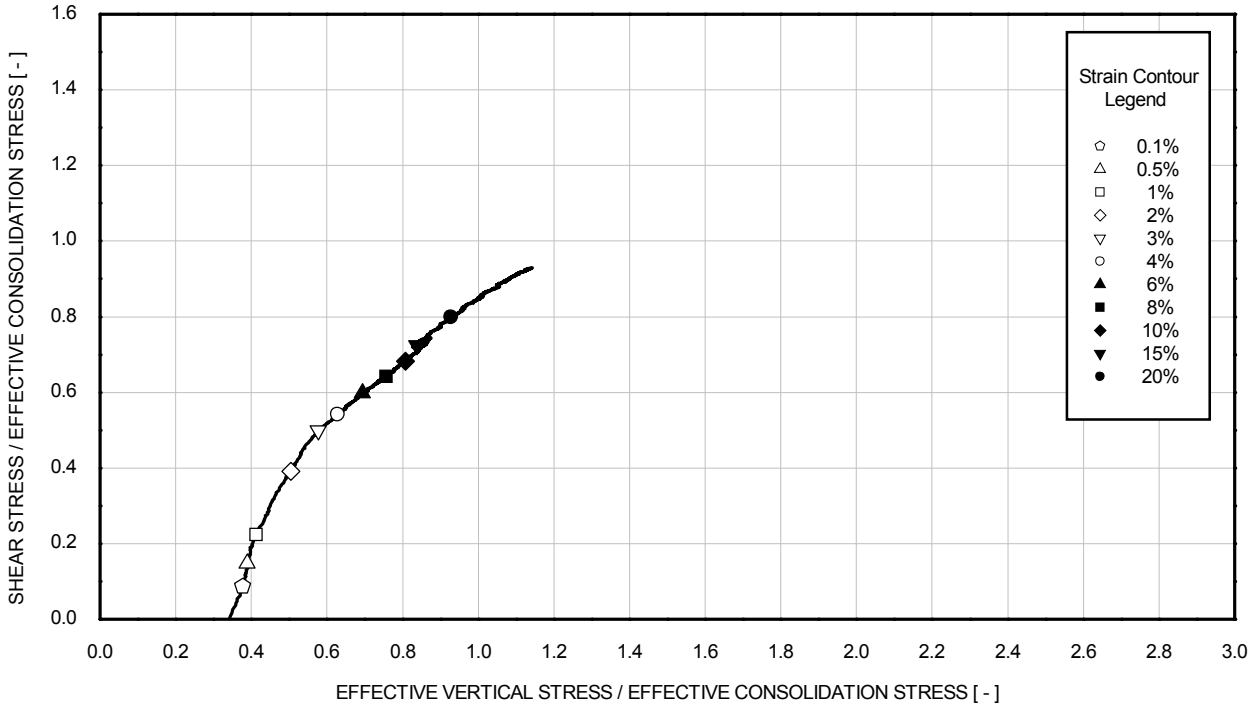


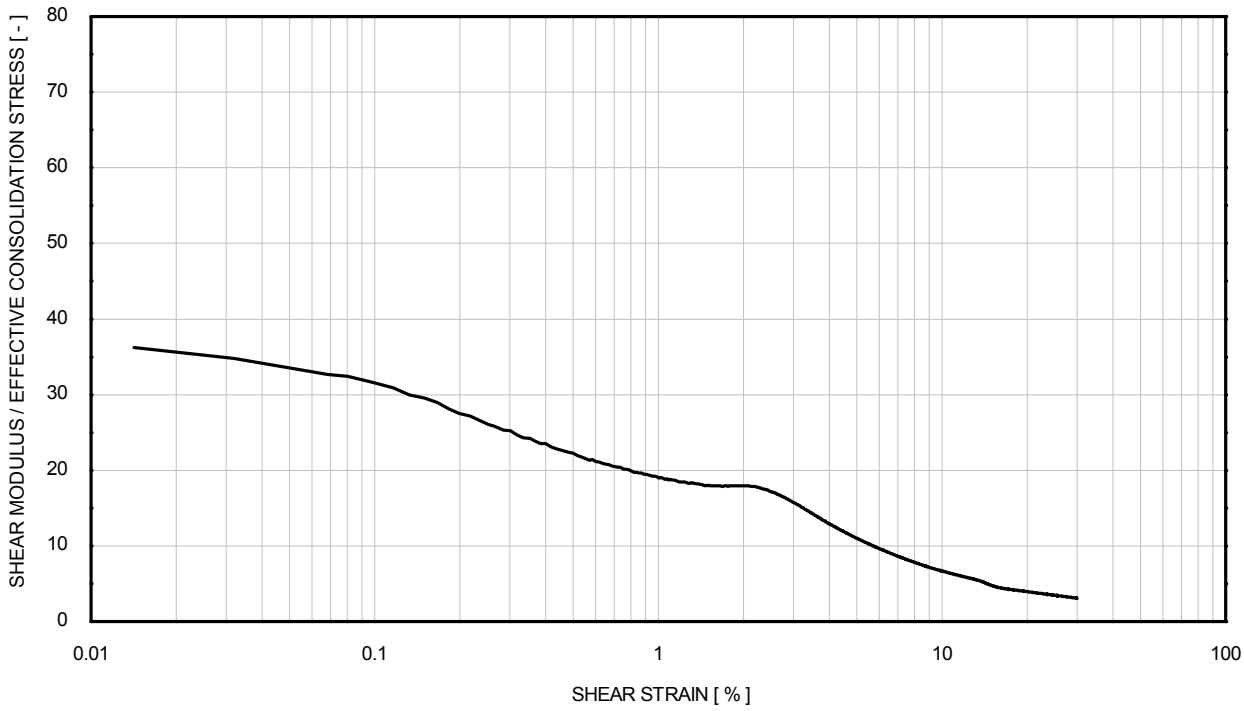


σ'_{vc}	: 350 kPa	Borehole	: BH WFS 1-4
τ_{peak}	: 325 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.92 %	Depth [m]	: 35.05
Rate of strain	: 3.02 %/hour	Test No.	: CSS03

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 350 kPa	Borehole	: BH WFS 1-4
τ_{peak}	: 325 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.92 %	Depth [m]	: 35.05
Rate of strain	: 3.02 %/hour	Test No.	: CSS03

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark brown CLAY with medium pyritic gravel

GENERAL	
Date test started	28/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.8
Length	[mm]	30.1
Moisture content	[%]	22.5
Bulk density	[Mg/m³]	2.06
Dry density	[Mg/m³]	1.68
Void ratio	[-]	0.604
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	417
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 1-4_17D_CSS04
Template issue	1.2
Processed by	HB
Date	10/08/2015
Checked by	PH
Date	18/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXD
Depth [m]	35.00
Test number	CSS04

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	351
Vertical strain	[%]	1.85
Bulk density	[Mg/m^3]	2.08
Dry density	[Mg/m^3]	1.72
Void ratio	[-]	0.574
Moisture content	[%]	21.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	316
Mean τ_{av}	[kPa]	-1
Mean τ_{cy}	[kPa]	184
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	464
γ_{av} at N_f	[%]	-2.50
γ_{cy} at N_f	[%]	15.06
Shear induced $-\Delta\sigma'_v$ at N_f	[kPa]	203
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	233
Shear strain	[%]	29.99
Shear induced $\Delta\sigma'_v$	[kPa]	8
Vertical stress	[kPa]	342
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.09
At 15 % shear strain		
Shear stress	[kPa]	202
Shear induced $-\Delta\sigma'_v$	[kPa]	69
Vertical stress	[kPa]	281
Vertical strain	[%]	0.00

* Please note that specimen failure was observed to occur along or close to the loading platen interface.

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXD
Depth [m]	35.00
Test number	CSS04

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

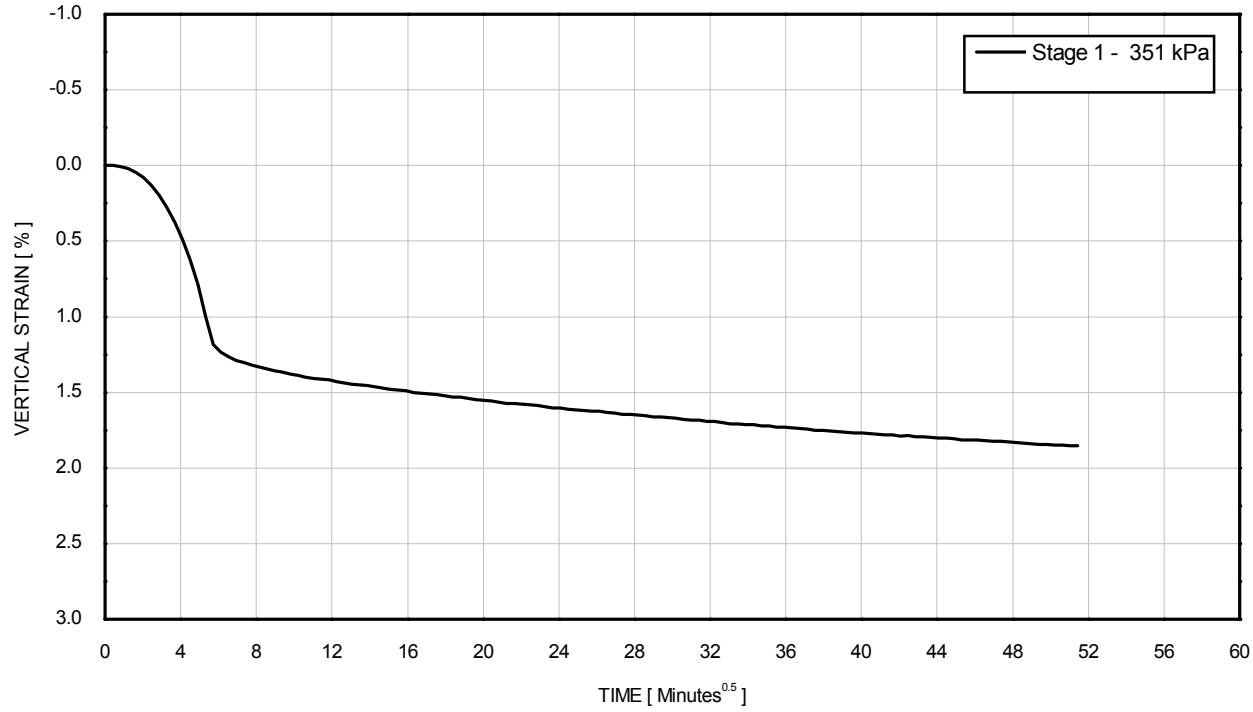
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

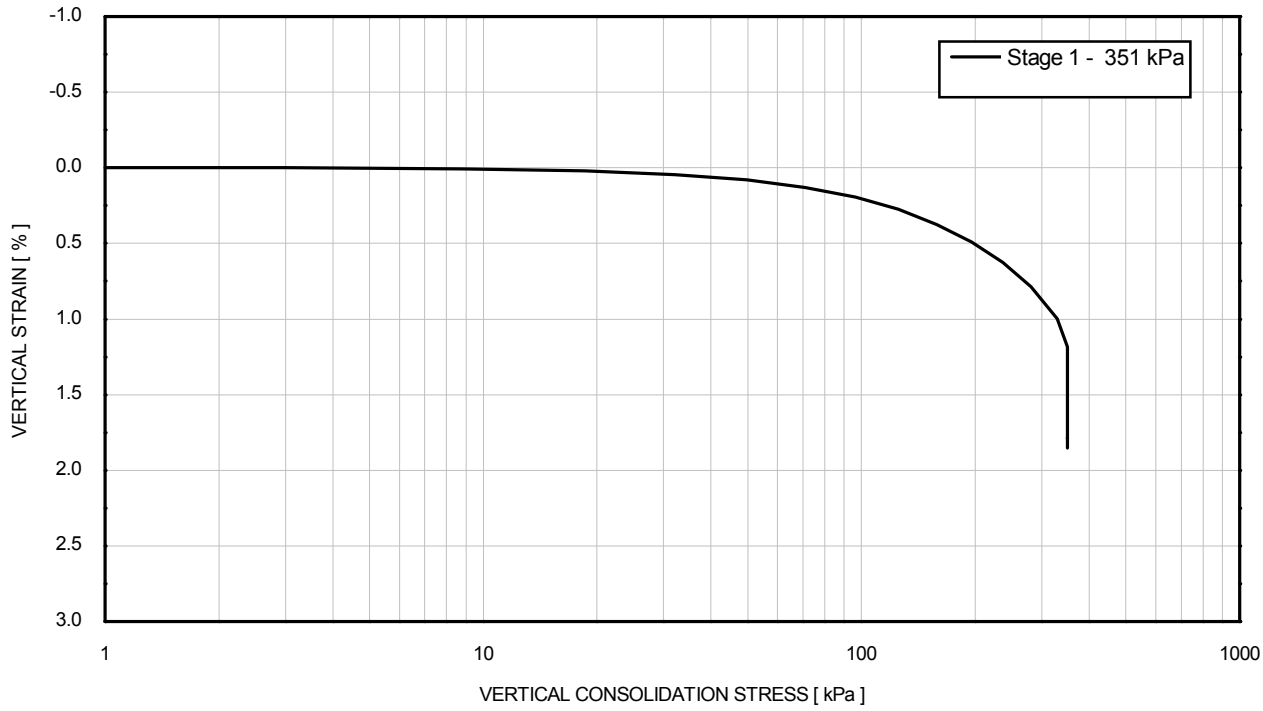
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXD
Depth [m]	35.00
Test number	CSS04

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

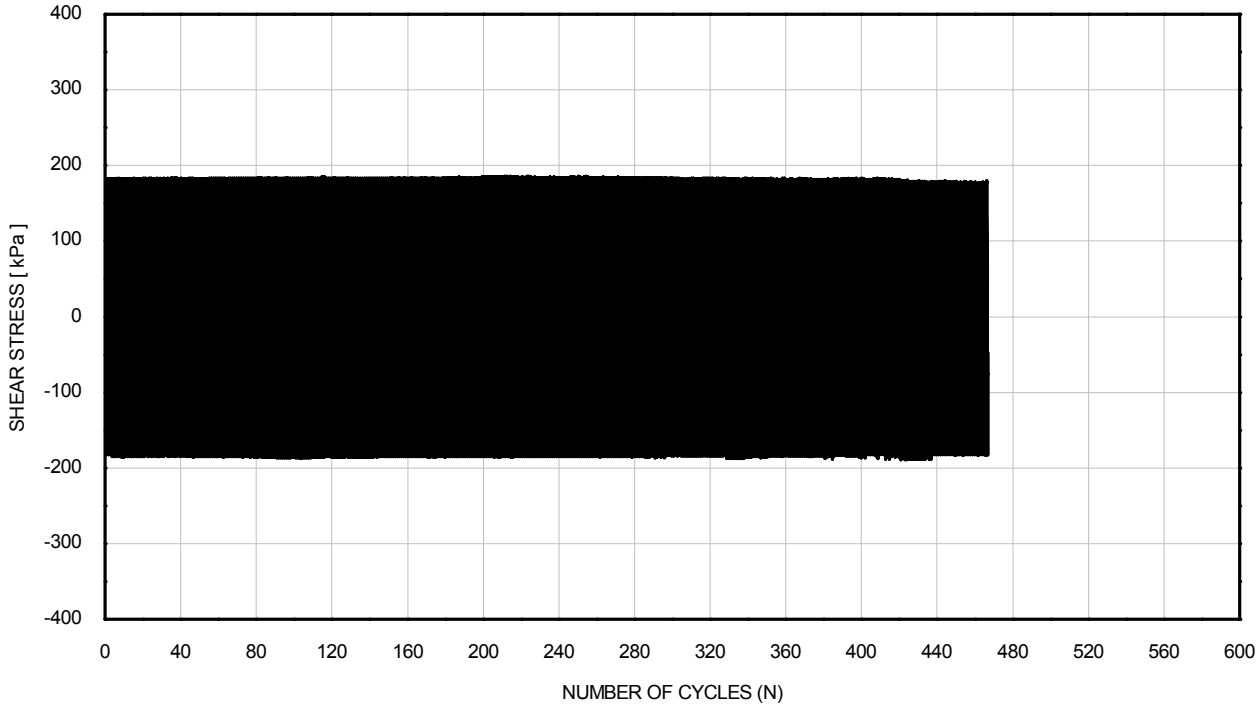


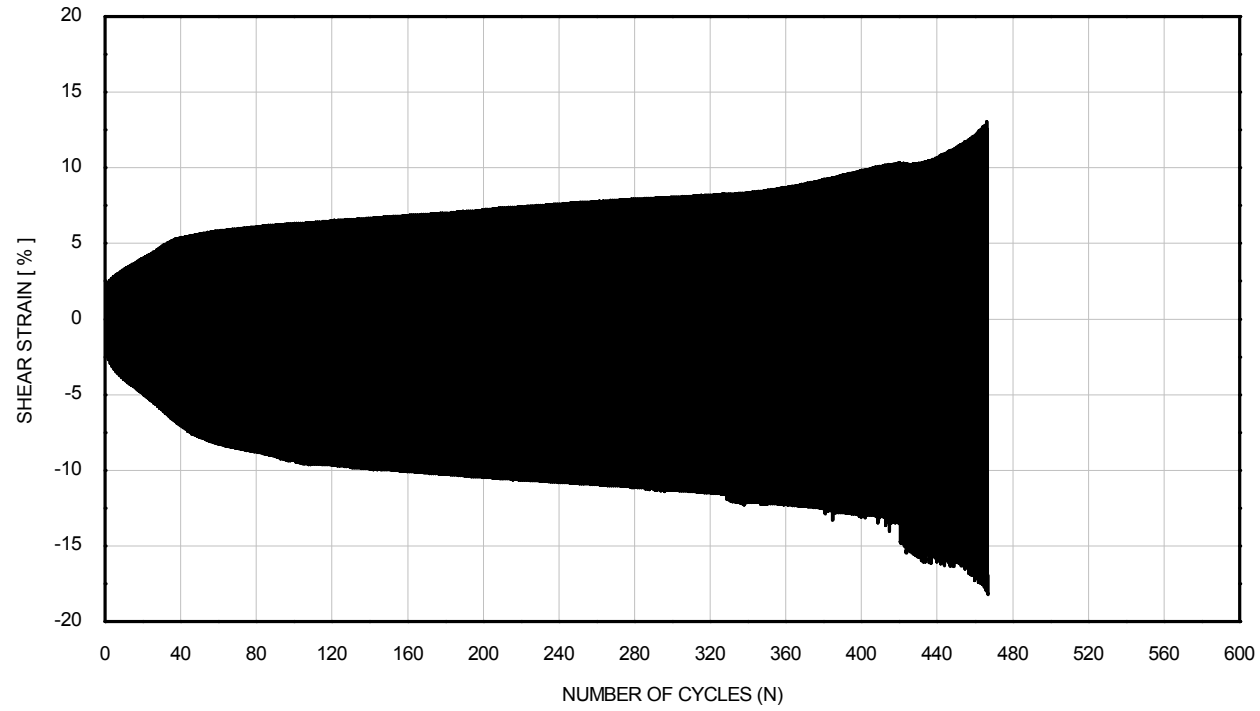


σ'_{vc}	: 351 kPa	Borehole	: BH-WFS 1-4
		Sample	: 17WAXD
		Depth [m]	: 35.00
		Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

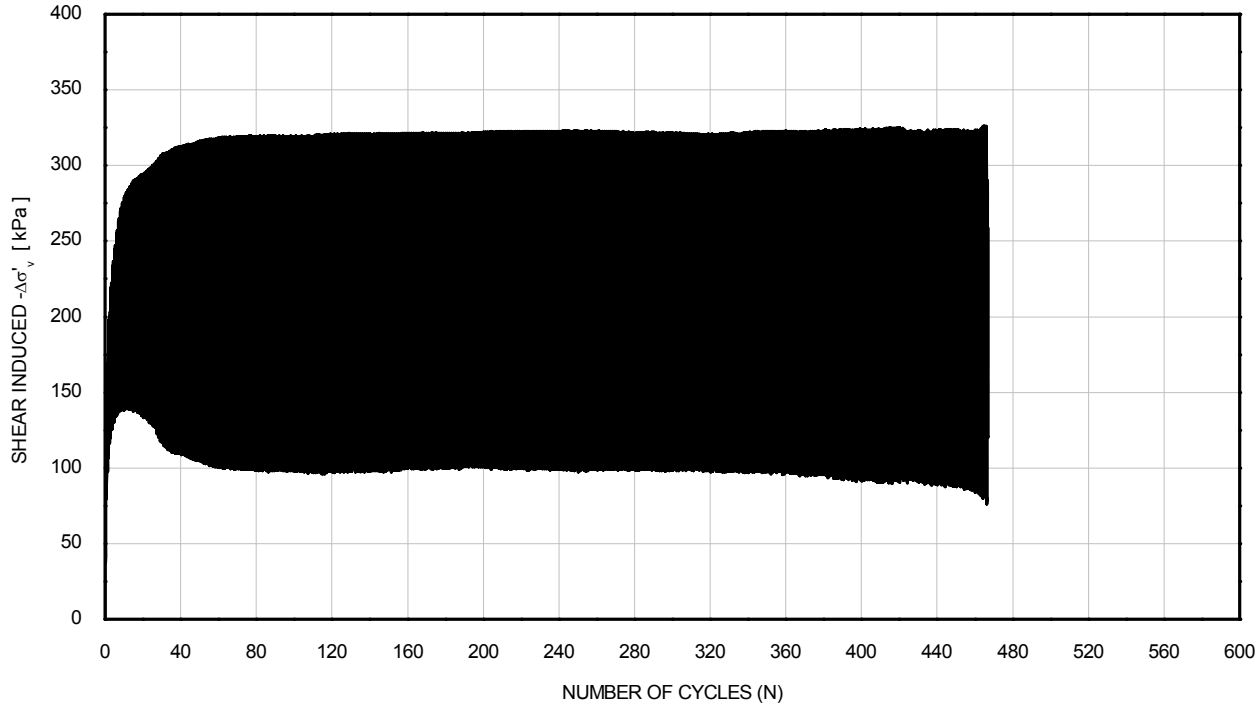


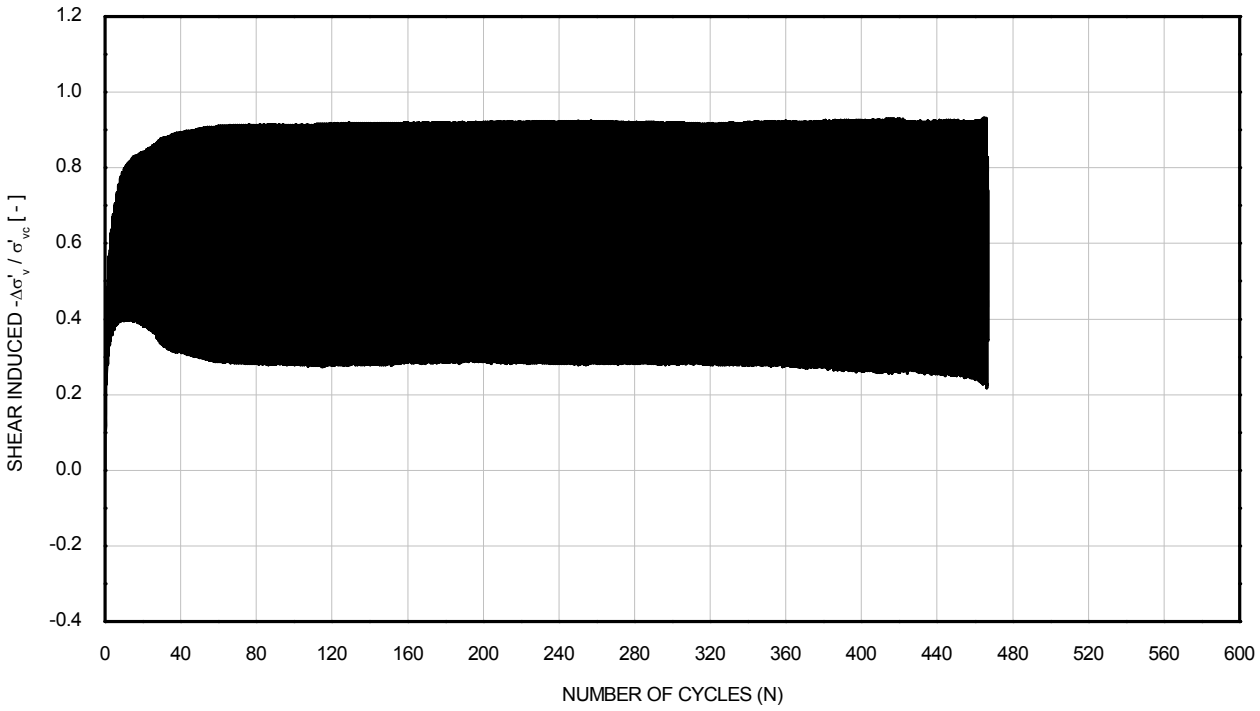


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	-1 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	184 kPa	Depth [m]	:	35.00
Frequency	:	0.10 Hz	Test No.	:	CSS04

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

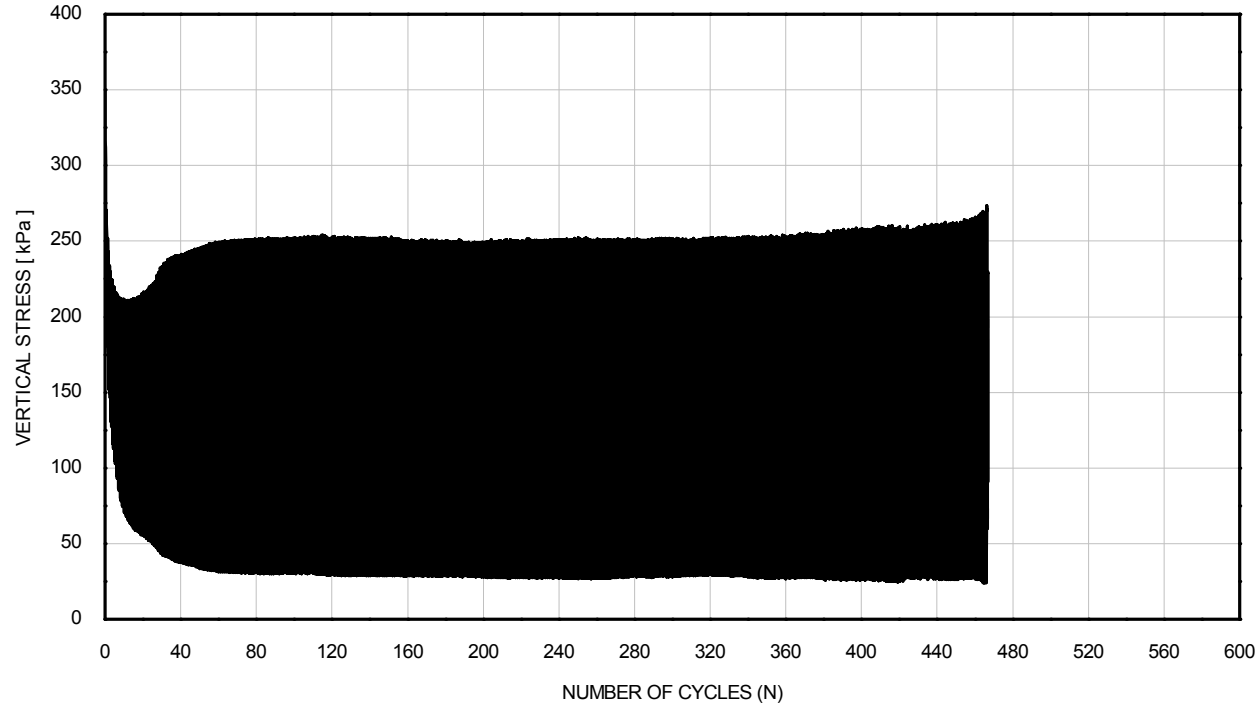


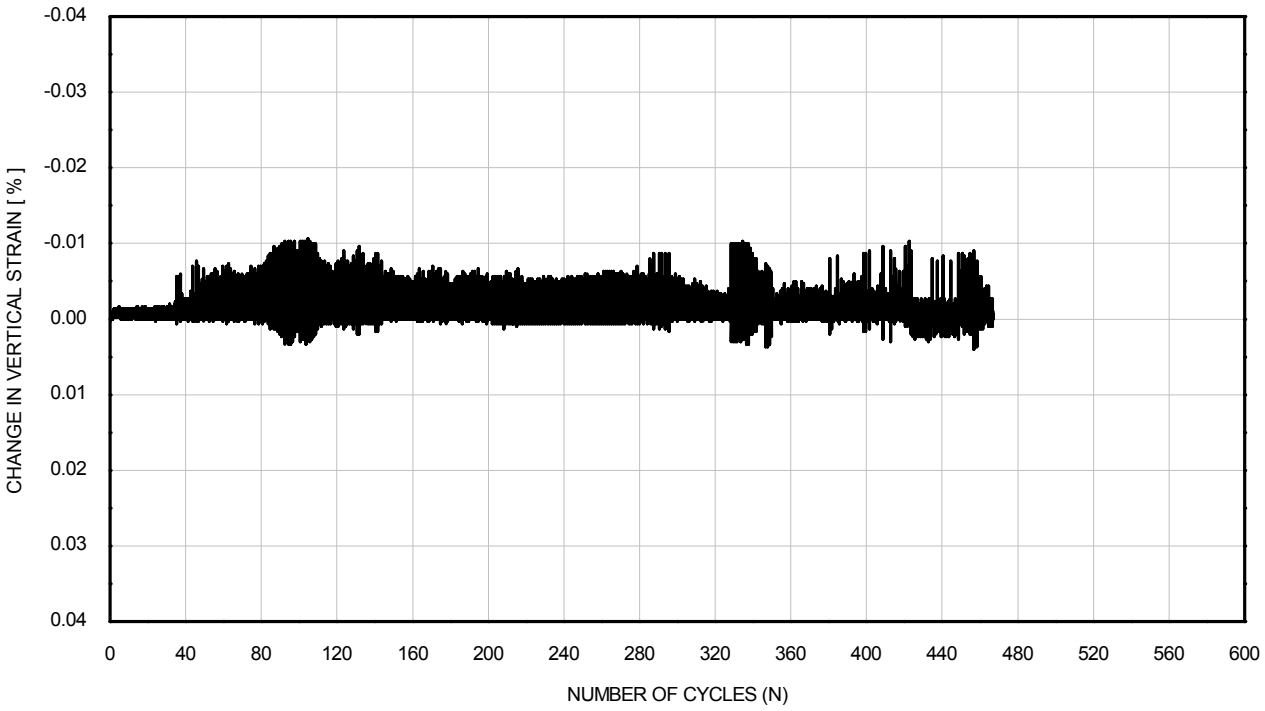


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
Mean τ_{av}	: -1 kPa	Sample	: 17WAXD
Mean τ_{cy}	: 184 kPa	Depth [m]	: 35.00
Frequency	: 0.10 Hz	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

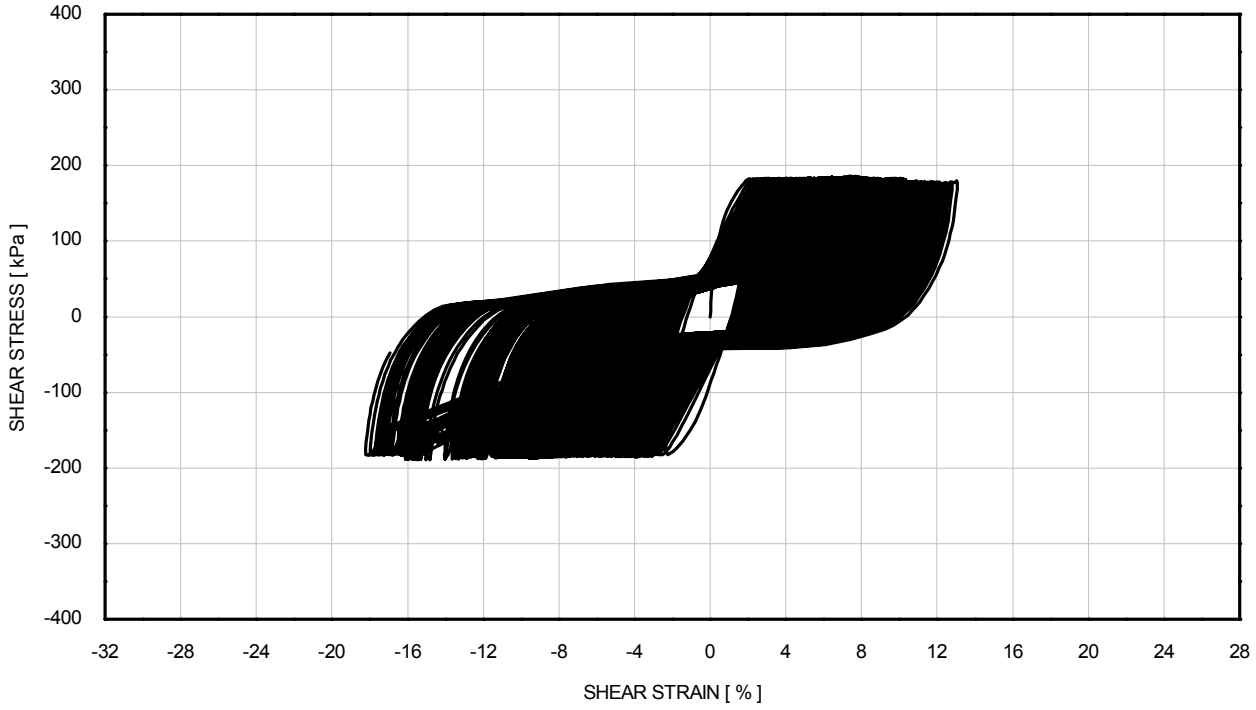


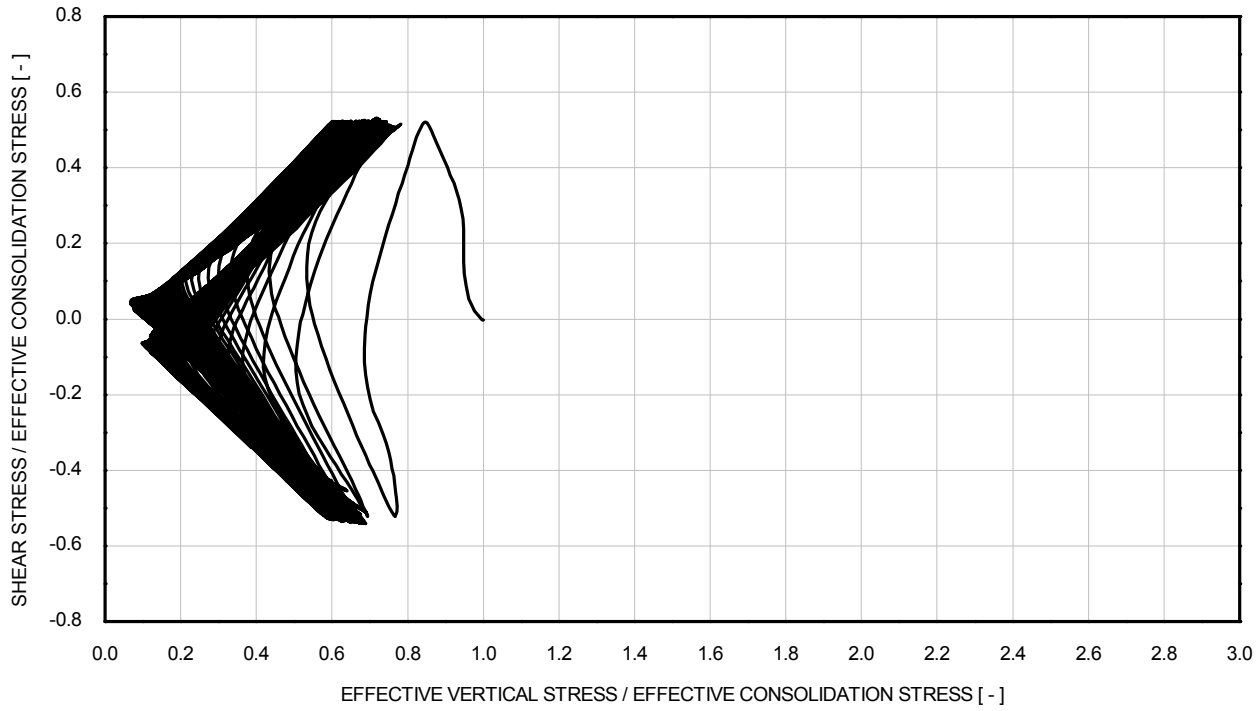


σ'_{vc}	:	350 kPa	Borehole	: BH-WFS 1-4
Mean τ_{av}	:	-1 kPa	Sample	: 17WAXD
Mean τ_{cy}	:	184 kPa	Depth [m]	: 35.00
Frequency	:	0.10 Hz	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

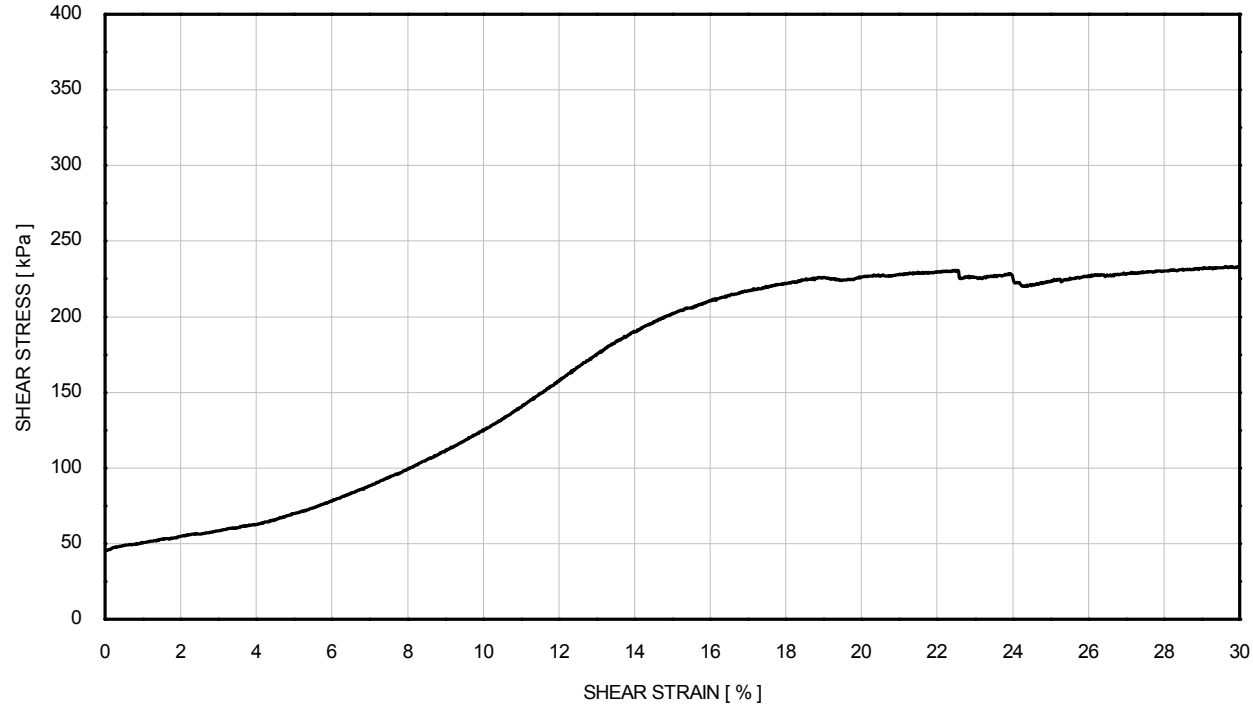


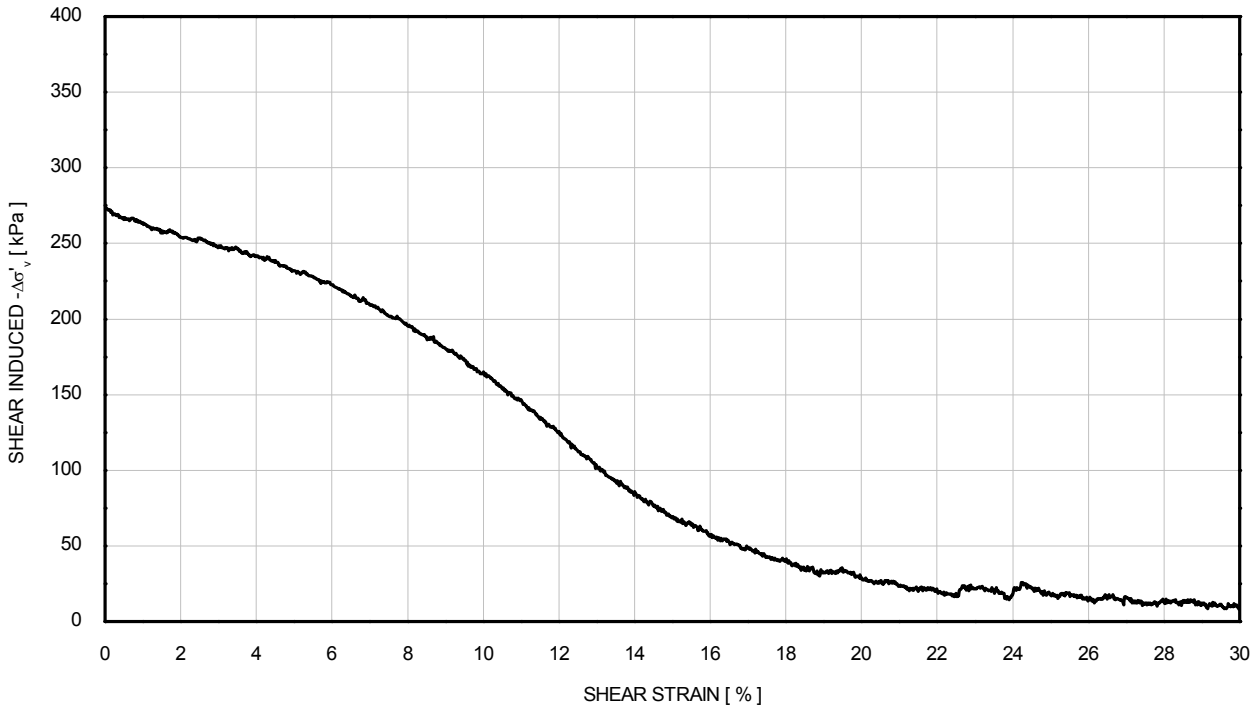


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	-1 kPa	Sample	:	17WAXD
Mean τ_{cy}	:	184 kPa	Depth [m]	:	35.00
Frequency	:	0.10 Hz	Test No.	:	CSS04

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

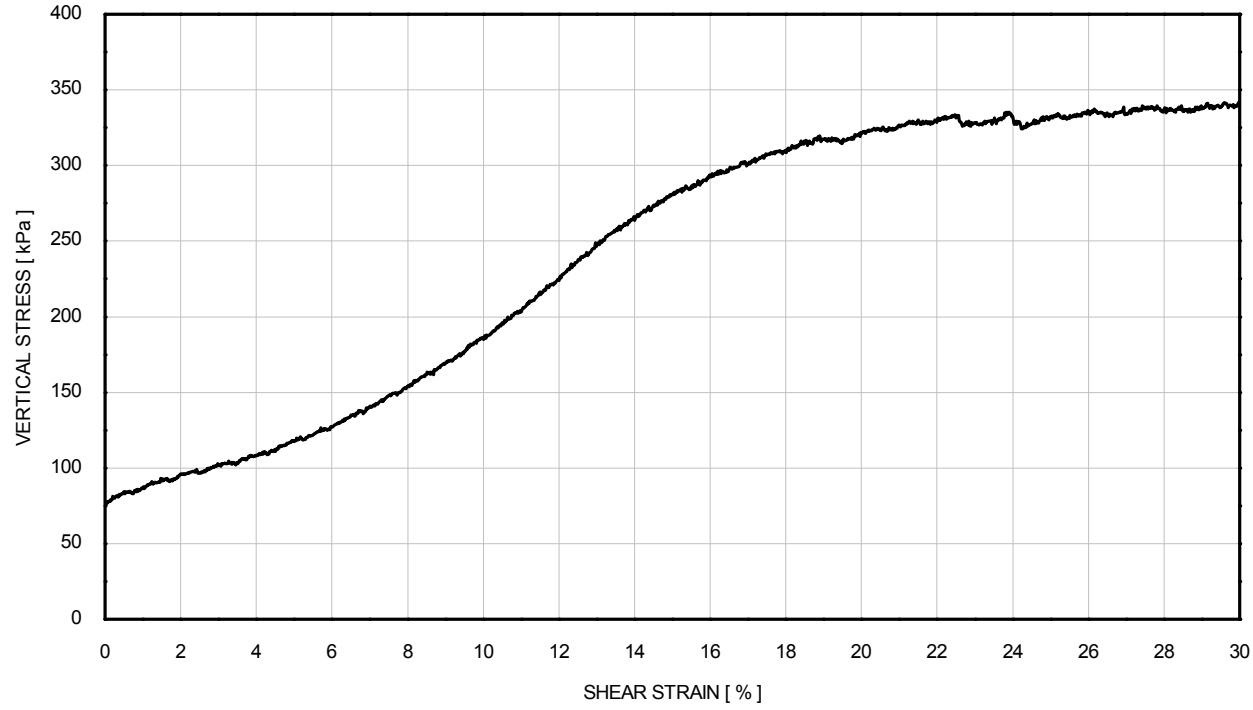


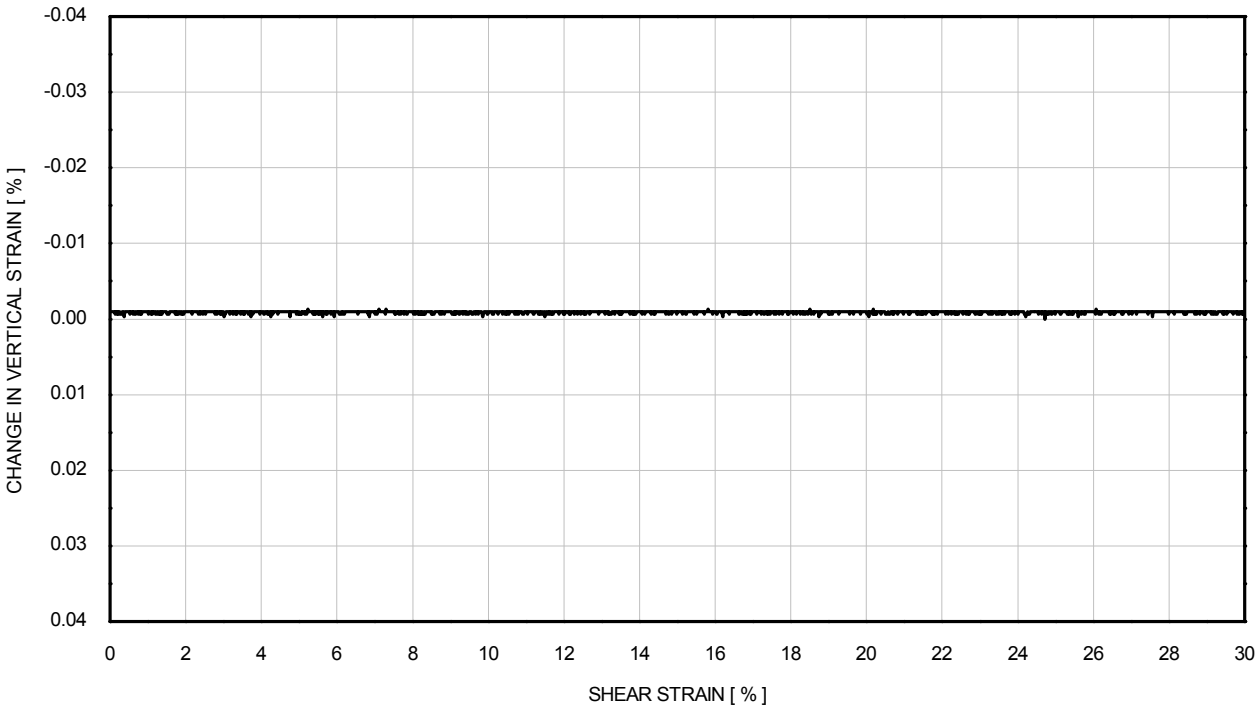


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 233 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.99 %	Depth [m]	: 35.00
Rate of strain	: 3.09 %/hour	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

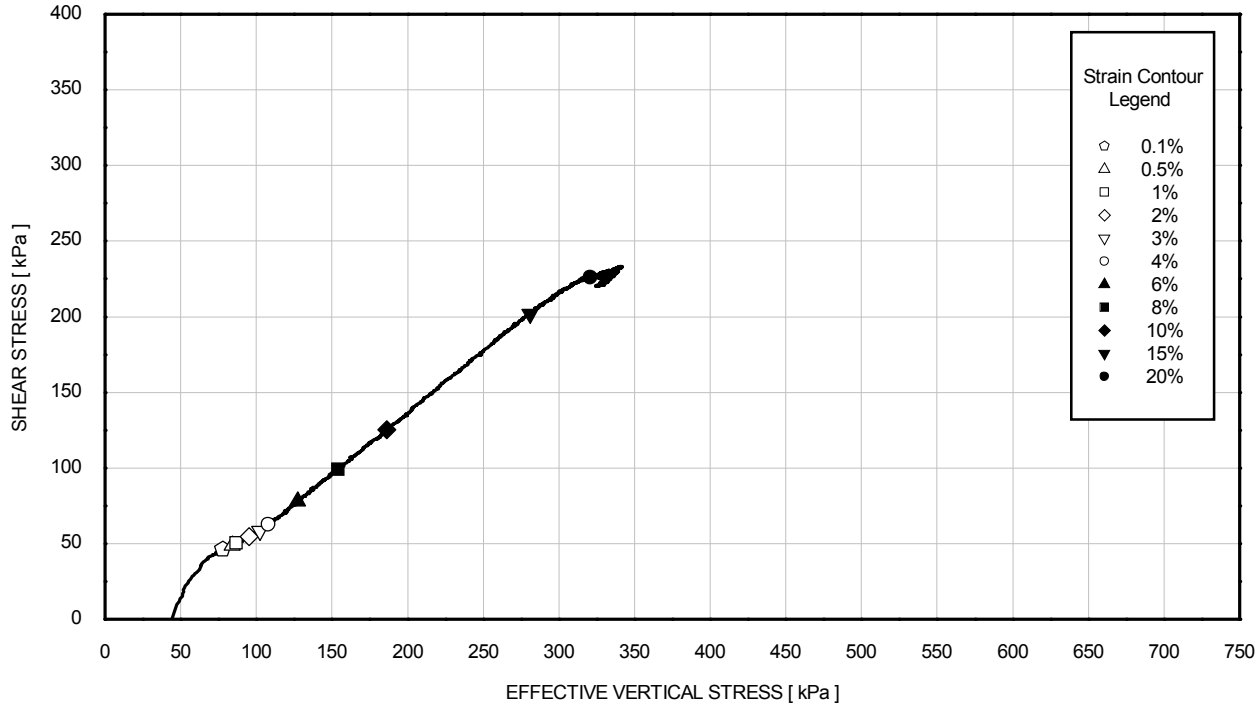


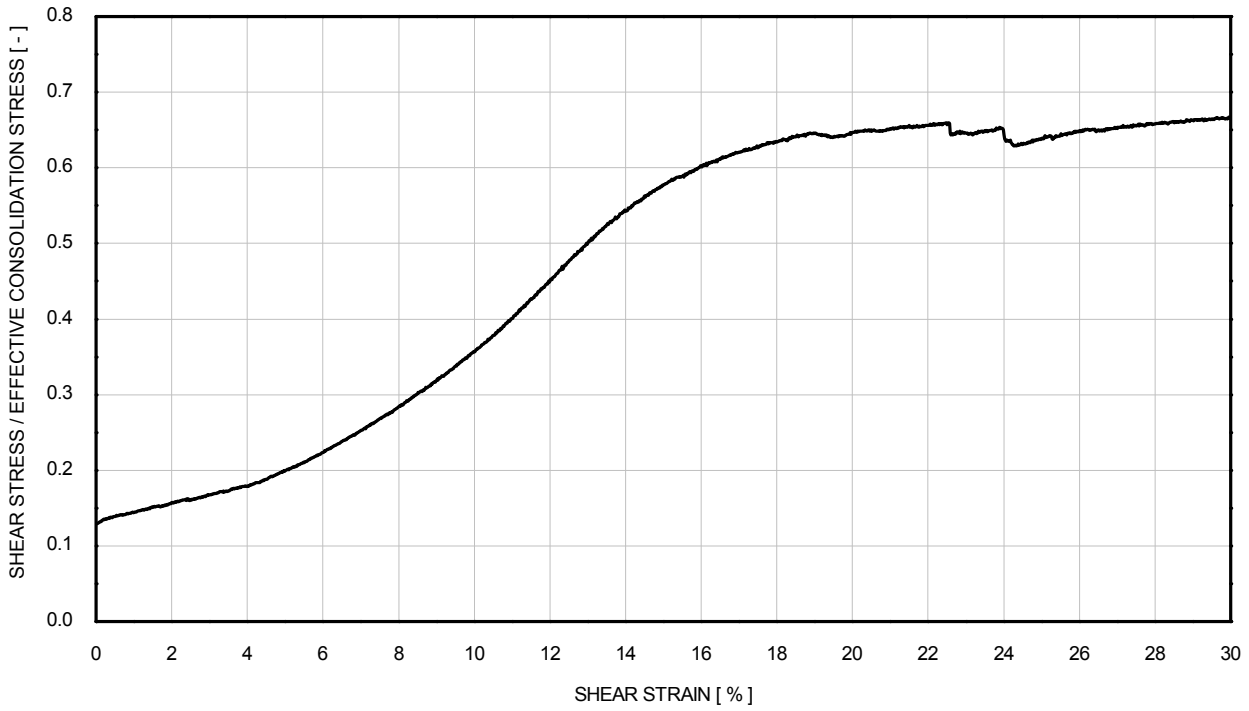


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 233 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.99 %	Depth [m]	: 35.00
Rate of strain	: 3.09 %/hour	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

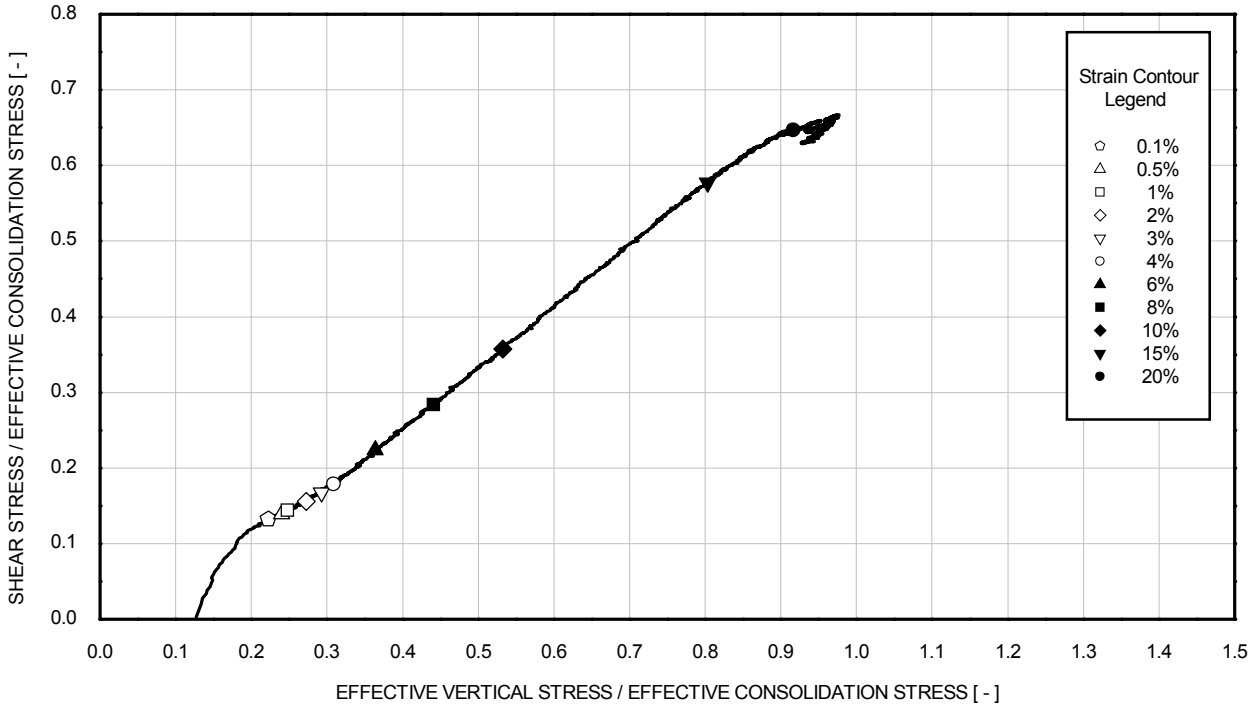


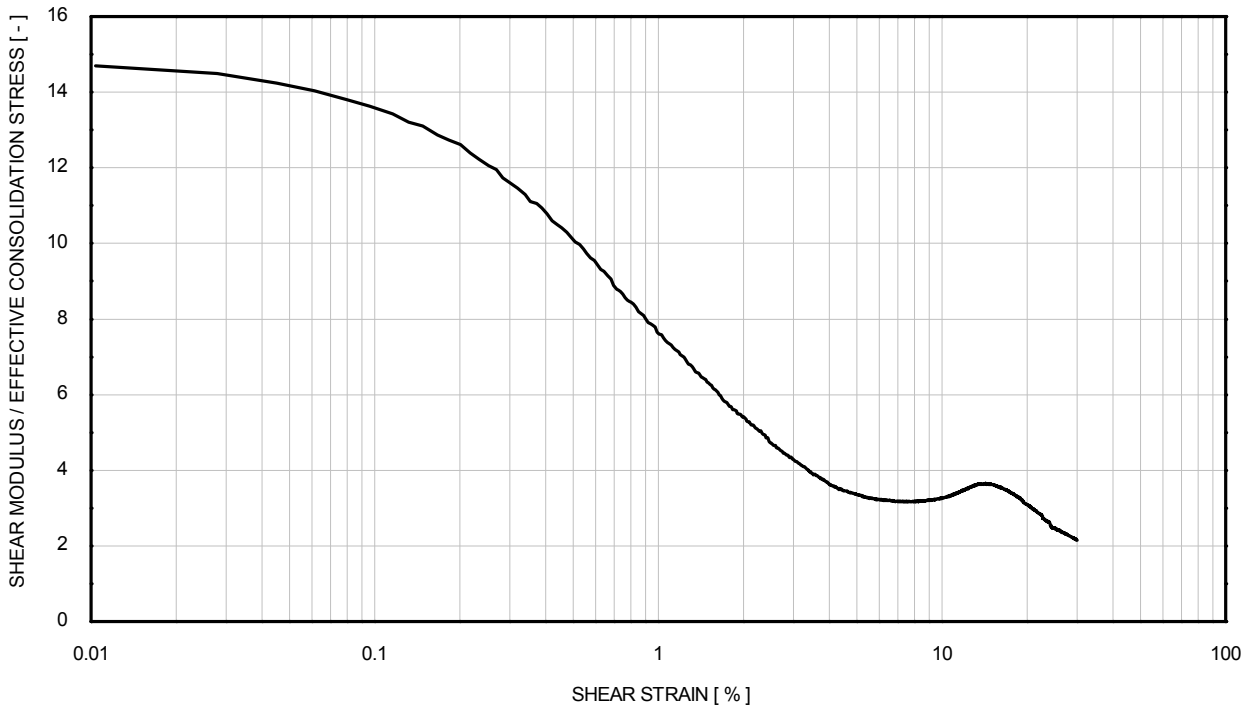


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 233 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.99 %	Depth [m]	: 35.00
Rate of strain	: 3.09 %/hour	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 233 kPa	Sample	: 17WAXD
γ at τ_{peak}	: 29.99 %	Depth [m]	: 35.00
Rate of strain	: 3.09 %/hour	Test No.	: CSS04

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Brown slightly sandy CLAY.

GENERAL	
Date test started	12/08/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.0
Moisture content	[%]	21.6
Bulk density	[Mg/m³]	2.03
Dry density	[Mg/m³]	1.67
Void ratio	[-]	0.614
Degree of saturation	[%]	95
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 1-4_17C_CSS05
Template issue	1.2
Processed by Date	ER 17/08/2015
Checked by Date	PH 18/08/2015
Approved by Date	PH 18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.07
Test number	CSS05

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	350
Vertical strain	[%]	1.98
Bulk density	[Mg/m^3]	2.05
Dry density	[Mg/m^3]	1.71
Void ratio	[-]	0.582
Moisture content	[%]	20.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	316
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	217
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	46
γ_{av} at N_f	[%]	0.07
γ_{cy} at N_f	[%]	15.33
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	187
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	285
Shear strain	[%]	29.88
Shear induced $\Delta\sigma'_v$	[kPa]	-4
Vertical stress	[kPa]	354
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.05
At 15 % shear strain		
Shear stress	[kPa]	213
Shear induced -$\Delta\sigma'_v$	[kPa]	101
Vertical stress	[kPa]	249
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.07
Test number	CSS05

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

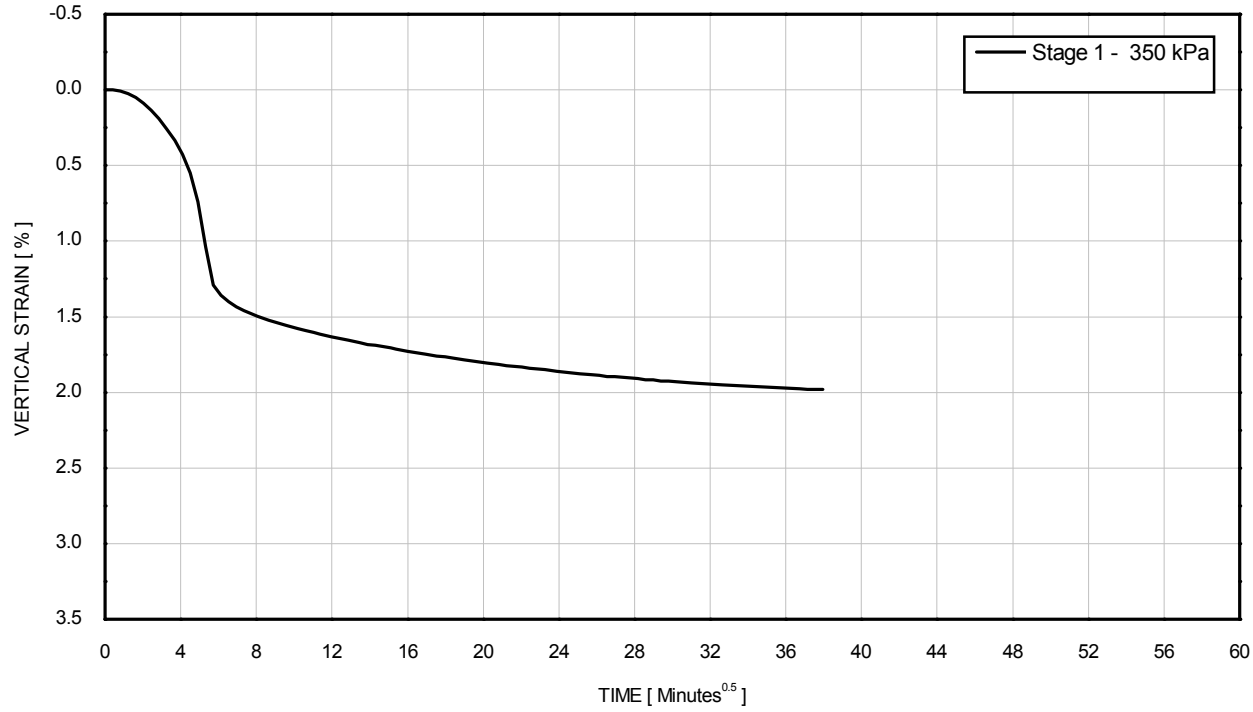
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

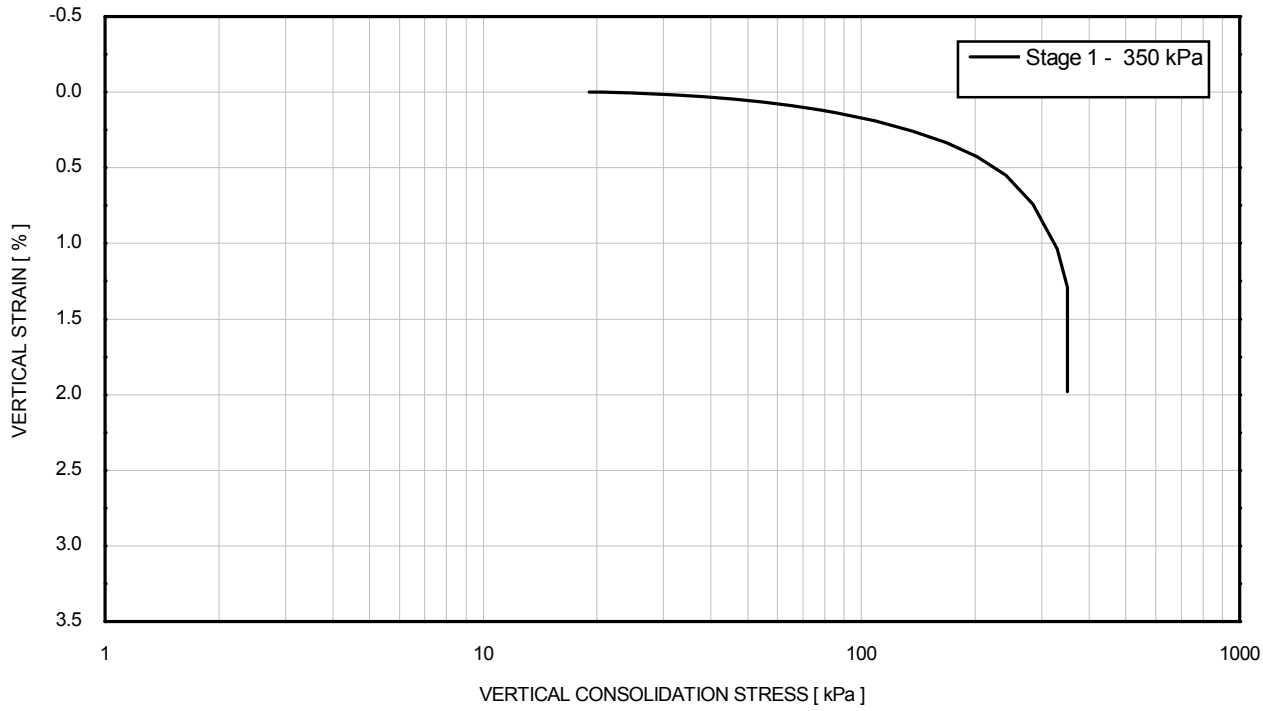
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 1-4
Sample	17WAXC
Depth [m]	35.07
Test number	CSS05

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

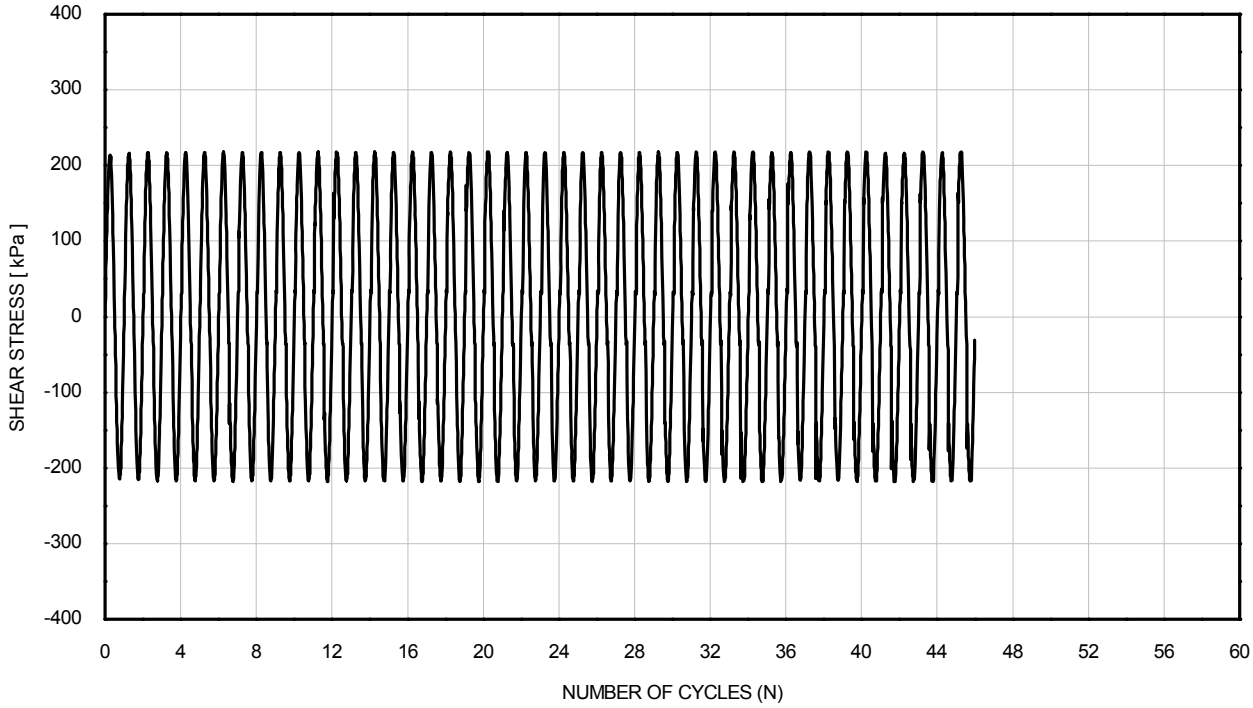


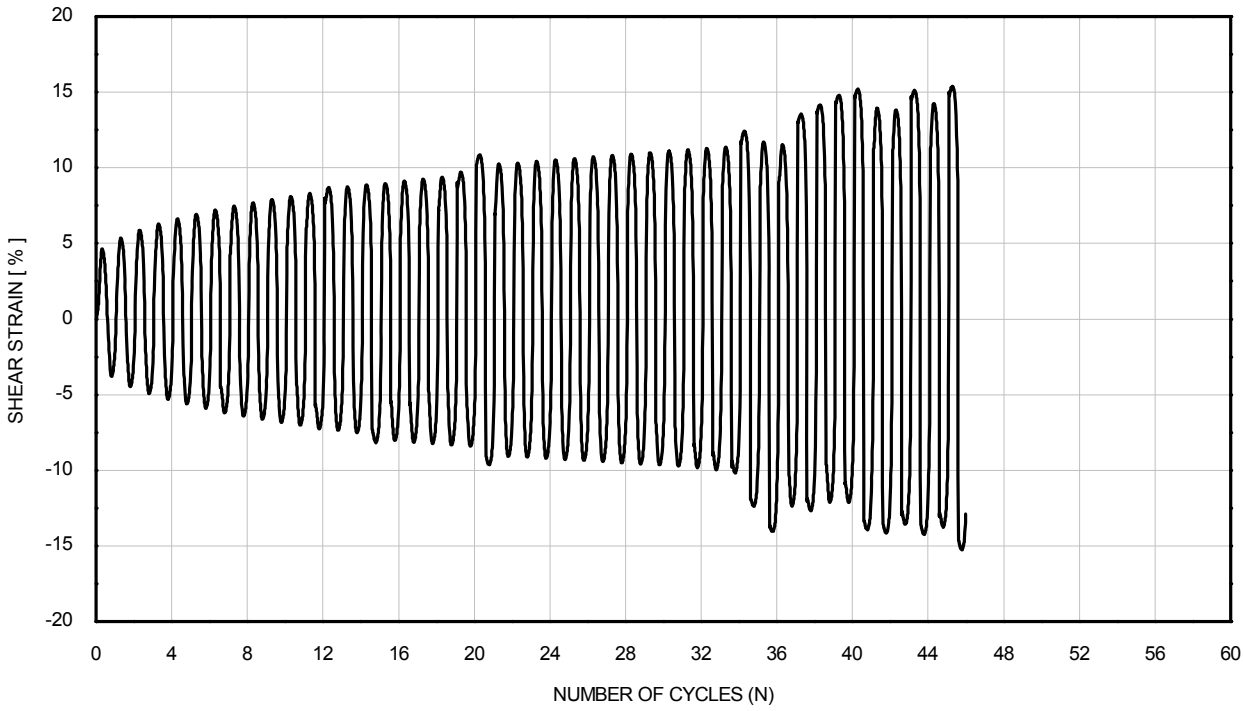


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
		Sample	: 17WAXC
		Depth [m]	: 35.07
		Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

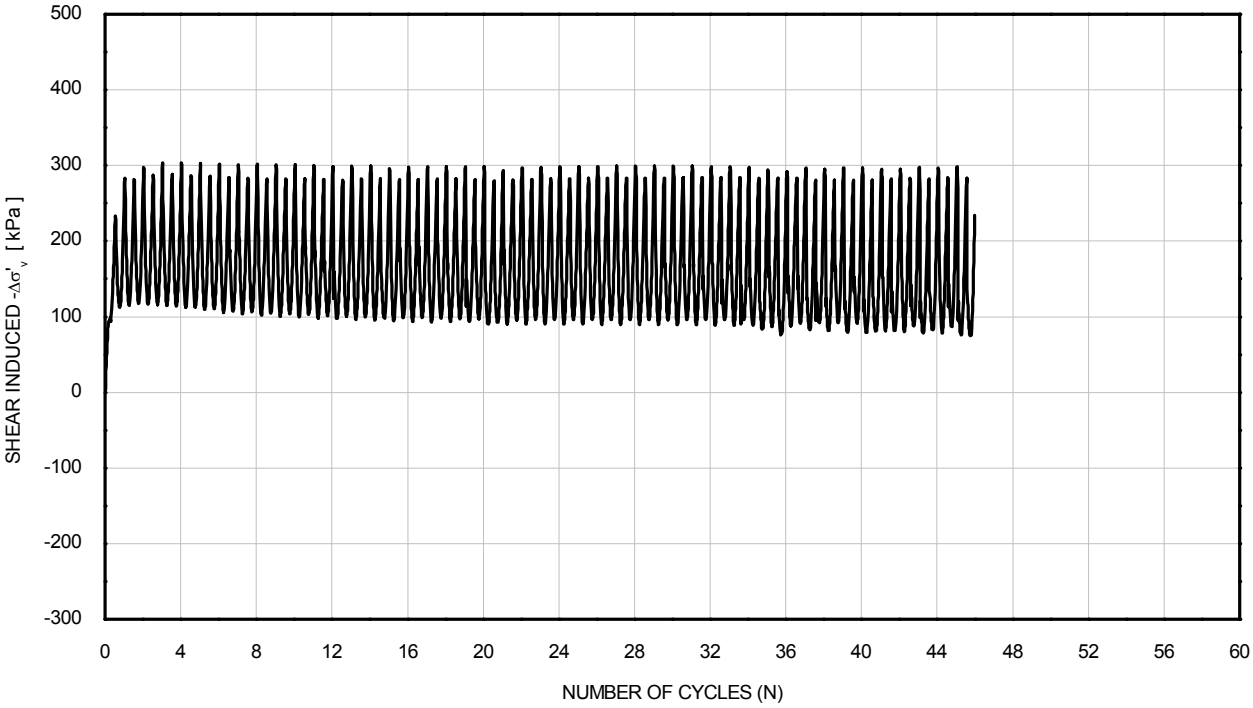


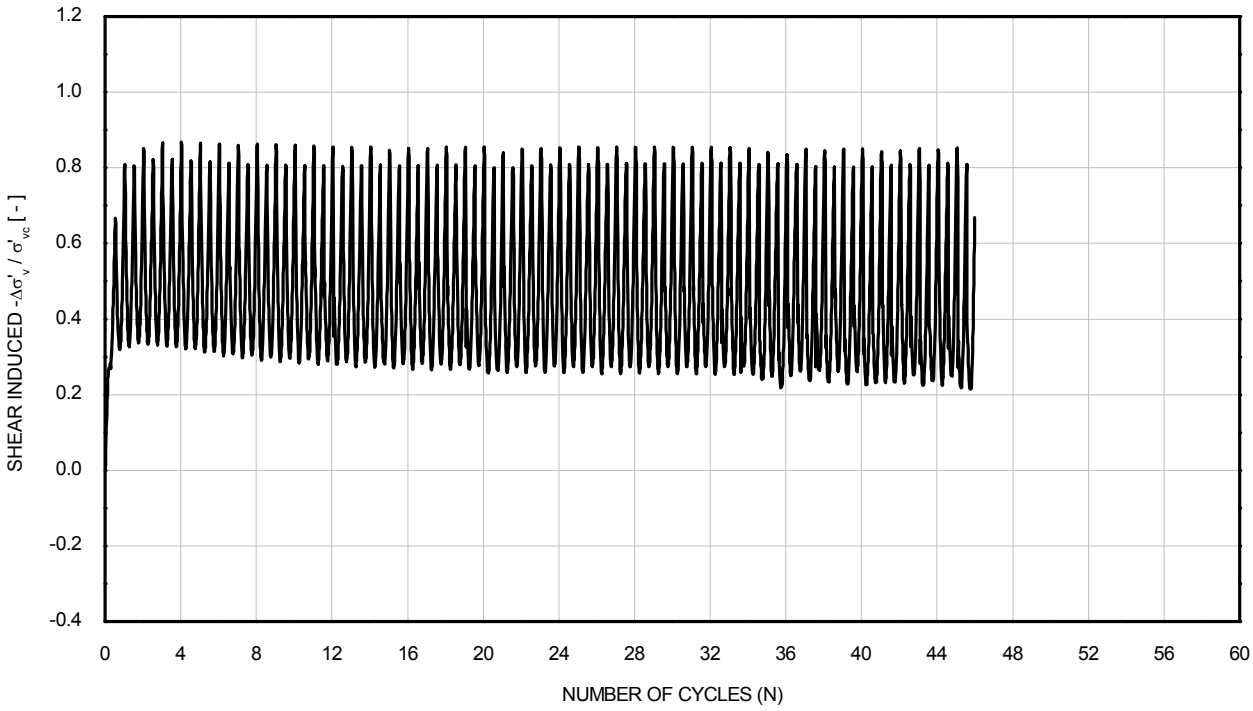


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	217 kPa	Depth [m]	:	35.07
Frequency	:	0.10 Hz	Test No.	:	CSS05

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

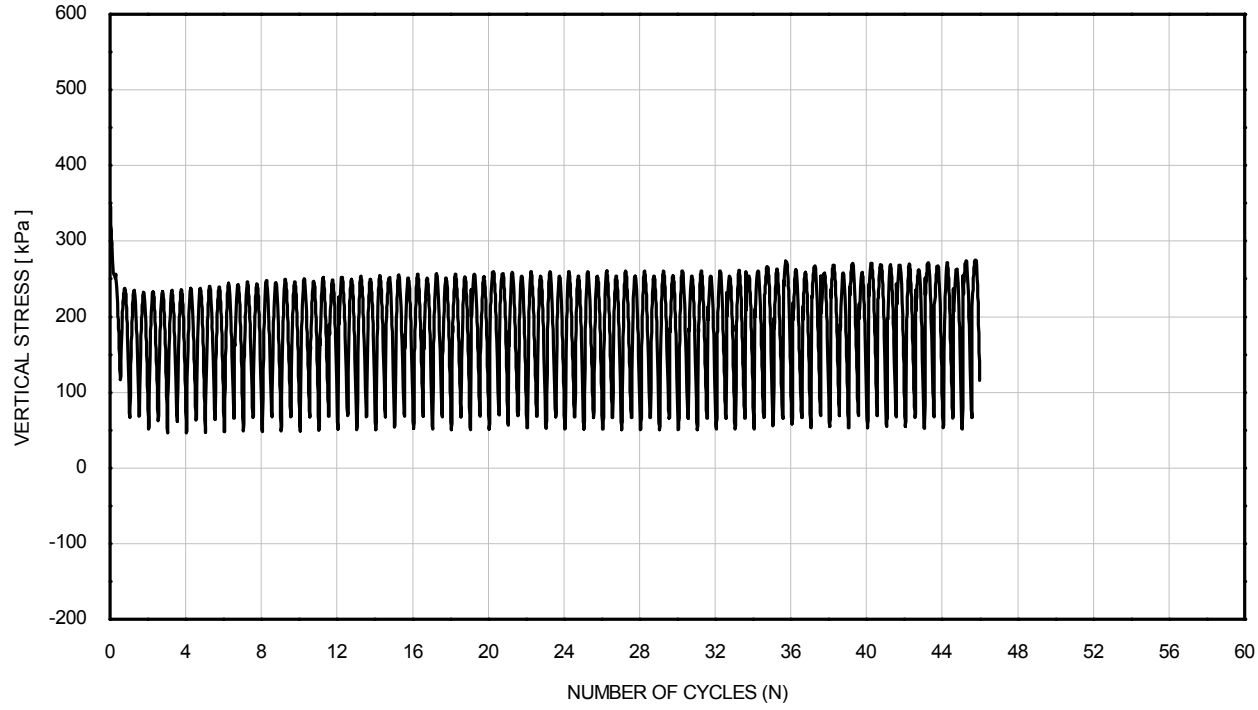


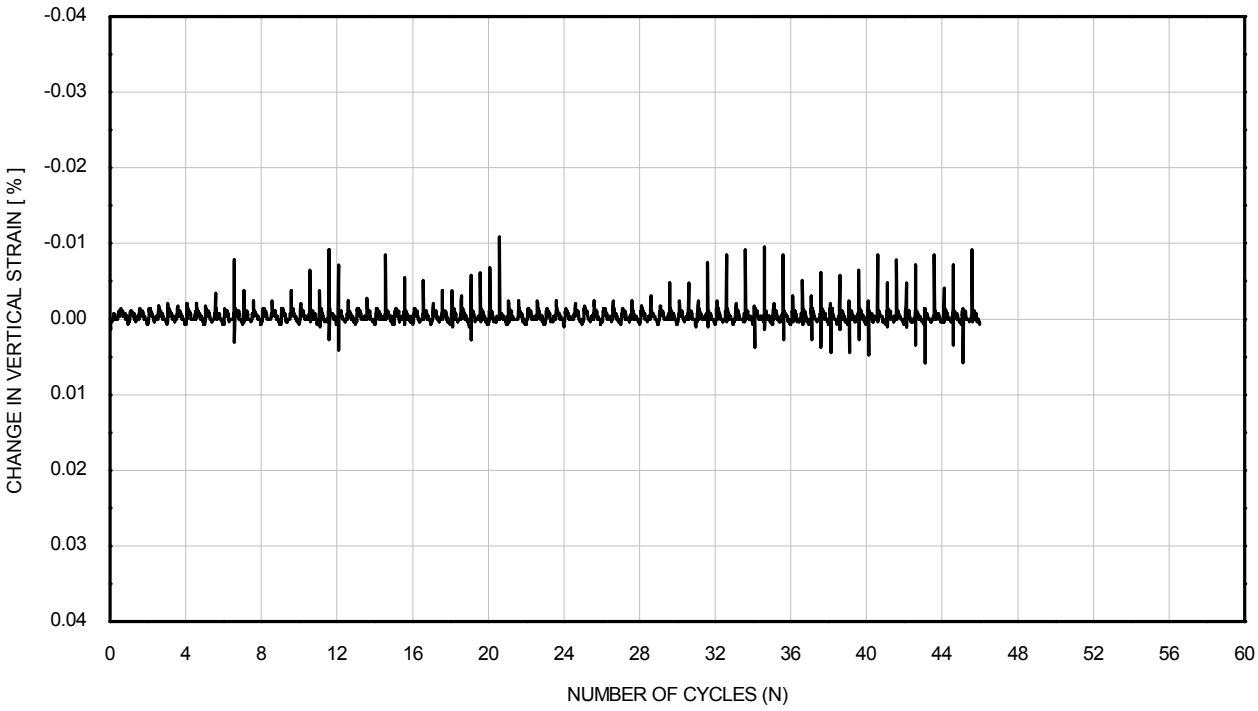


σ'_{vc}	:	350 kPa	Borehole	: BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	: 17WAXC
Mean τ_{cy}	:	217 kPa	Depth [m]	: 35.07
Frequency	:	0.10 Hz	Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

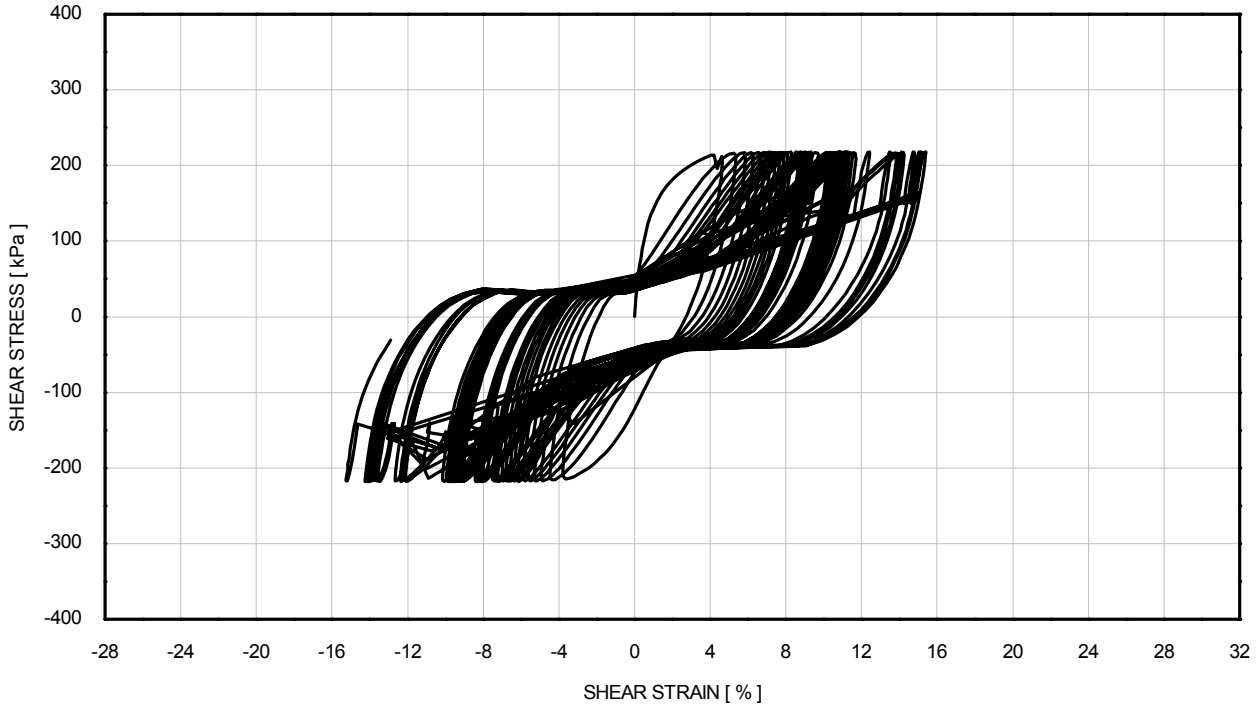




σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	217 kPa	Depth [m]	:	35.07
Frequency	:	0.10 Hz	Test No.	:	CSS05

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

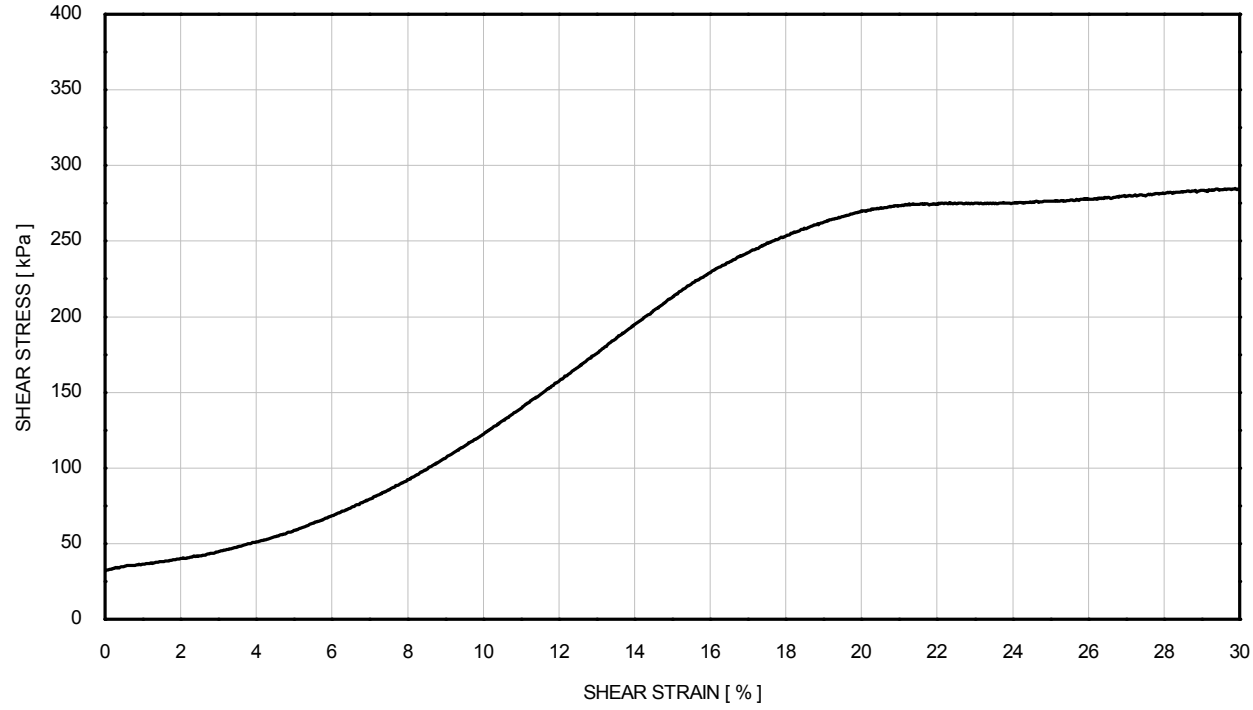
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

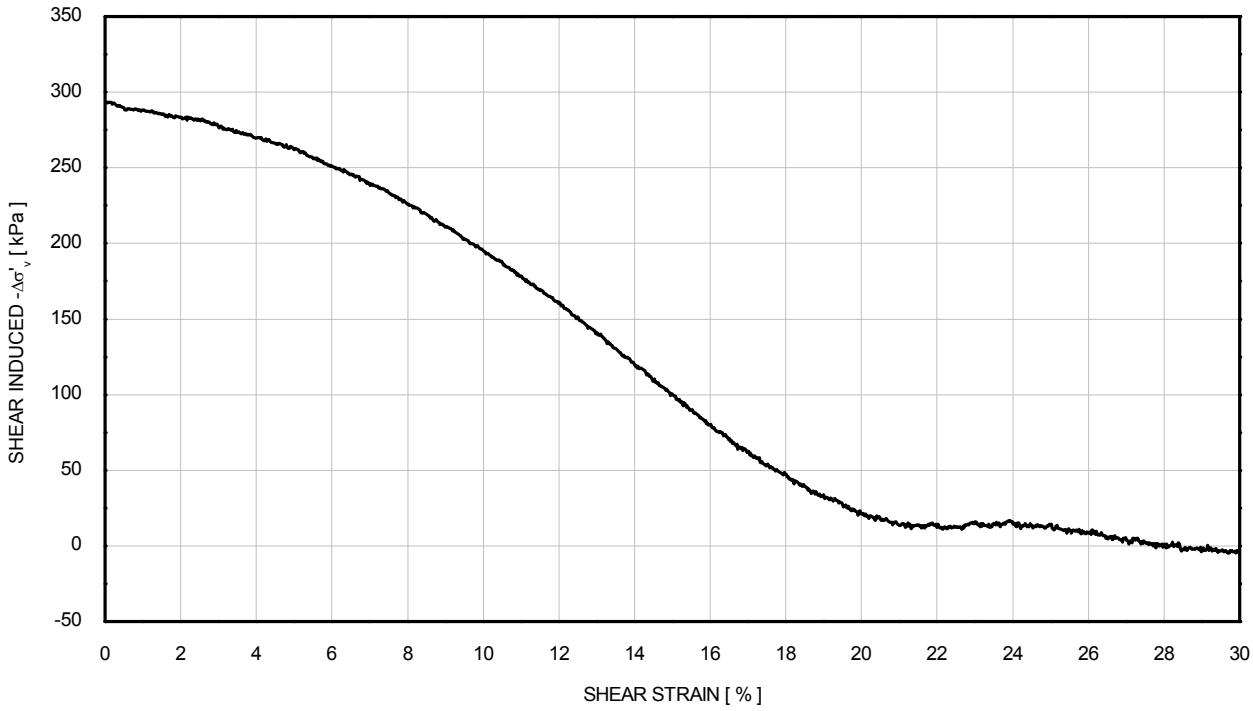


σ'_{vc}	:	350 kPa	Borehole	:	BH-WFS 1-4
Mean τ_{av}	:	0 kPa	Sample	:	17WAXC
Mean τ_{cy}	:	217 kPa	Depth [m]	:	35.07
Frequency	:	0.10 Hz	Test No.	:	CSS05

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

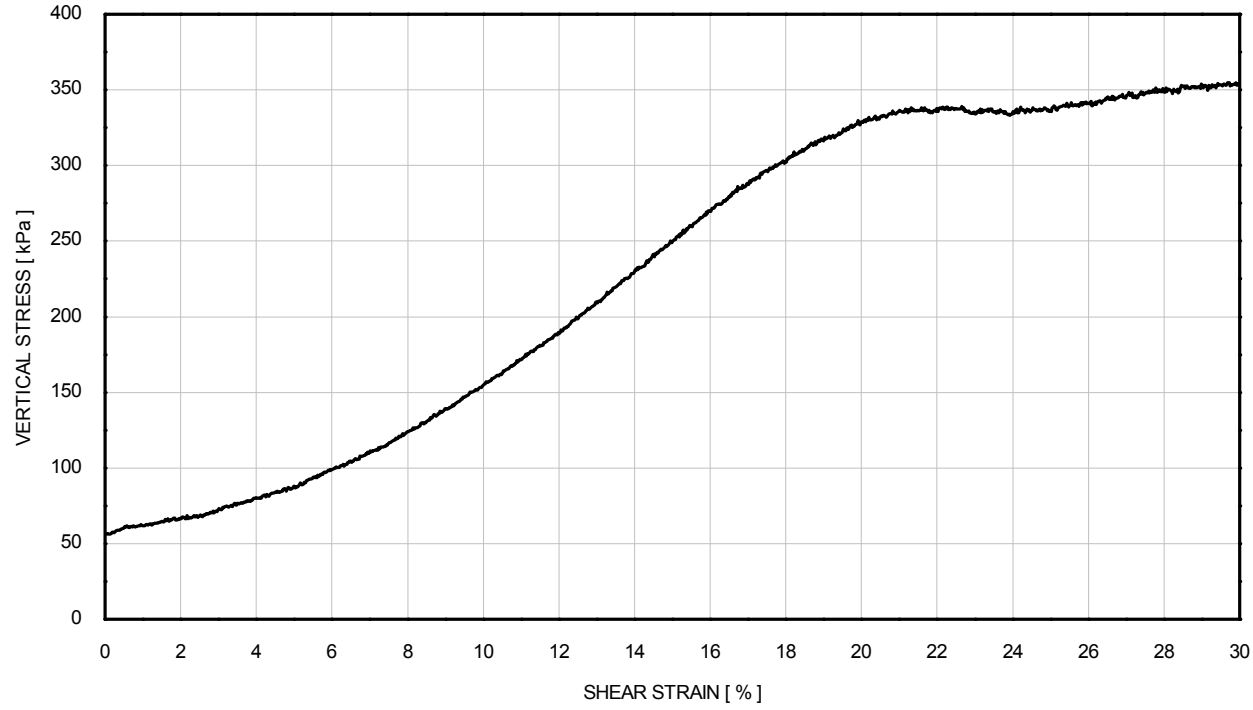


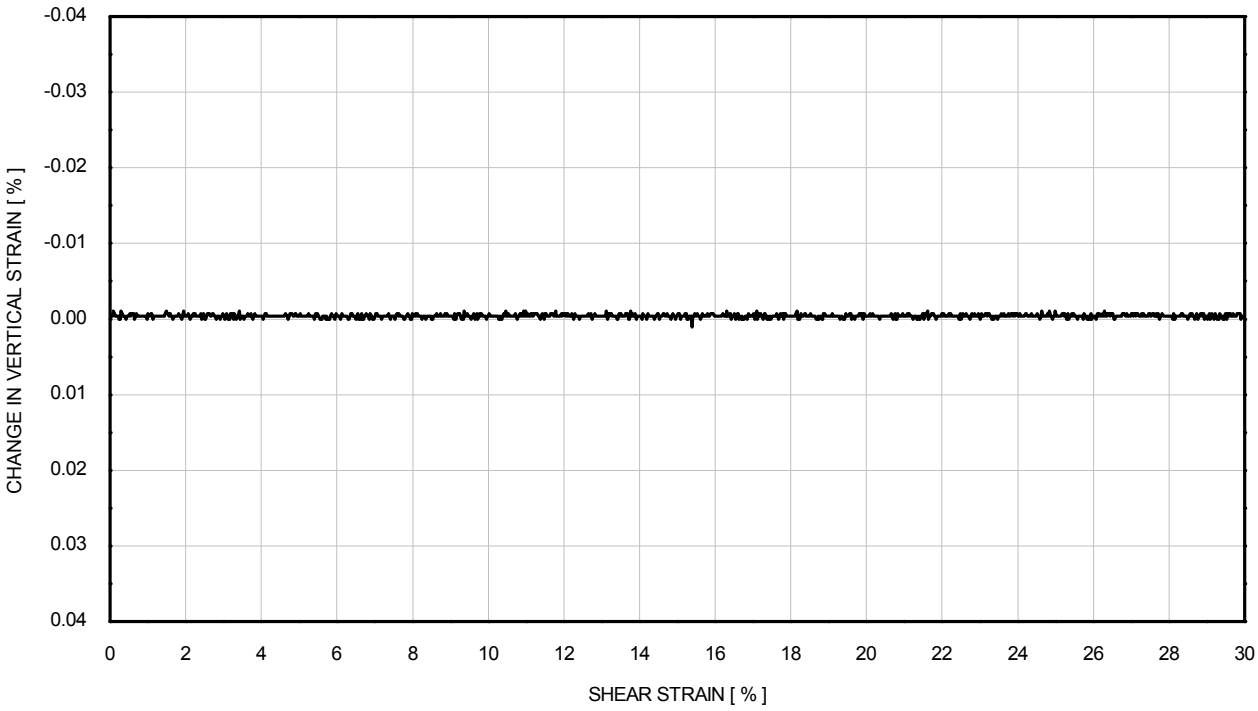


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 285 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 29.88 %	Depth [m]	: 35.07
Rate of strain	: 3.05 %/hour	Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

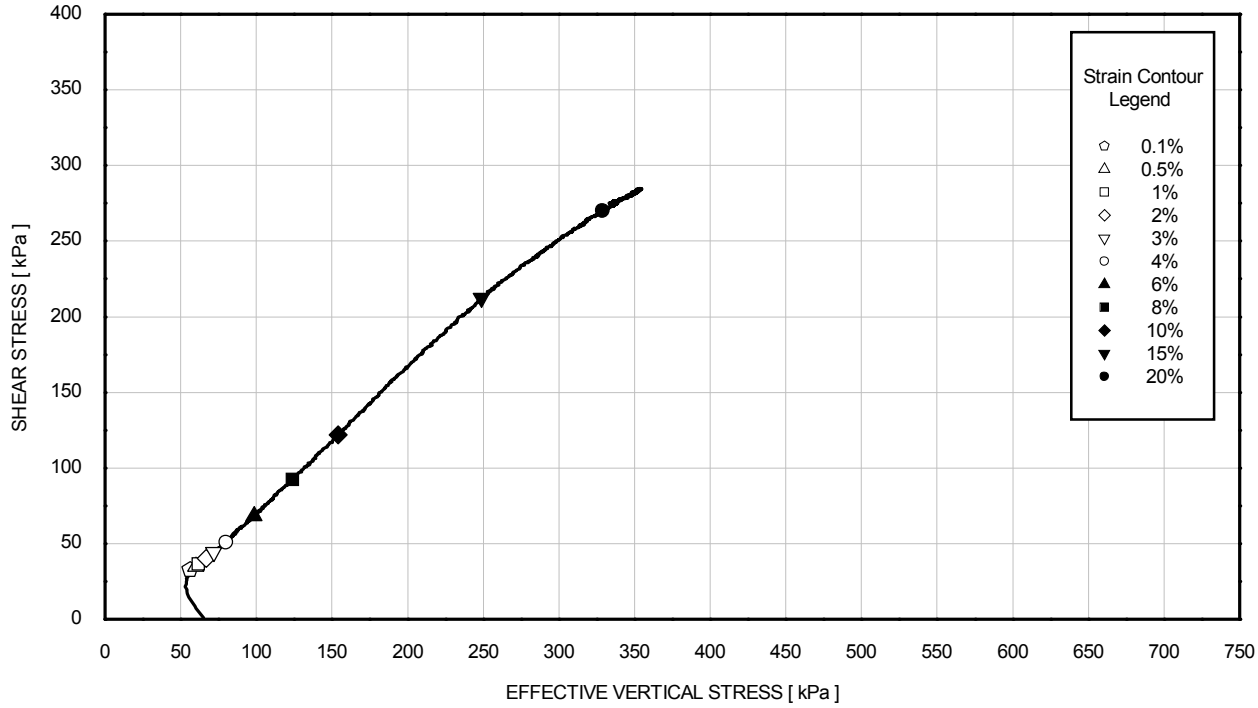


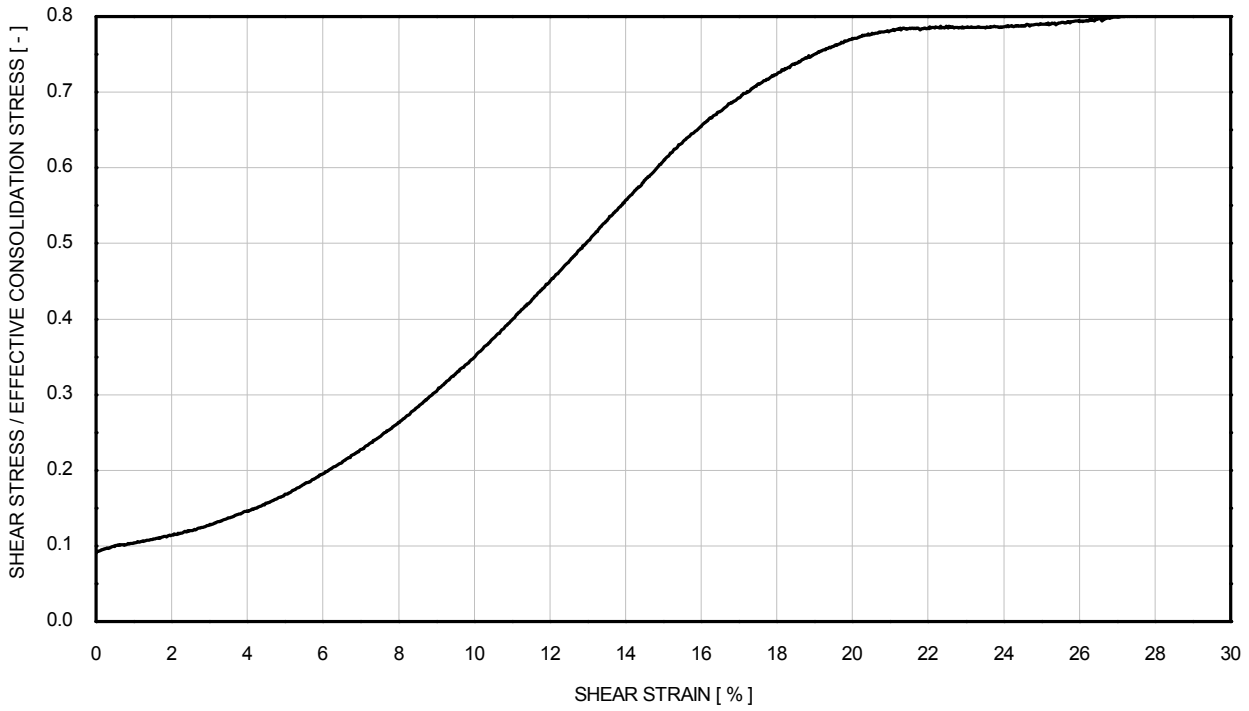


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 285 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 29.88 %	Depth [m]	: 35.07
Rate of strain	: 3.05 %/hour	Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

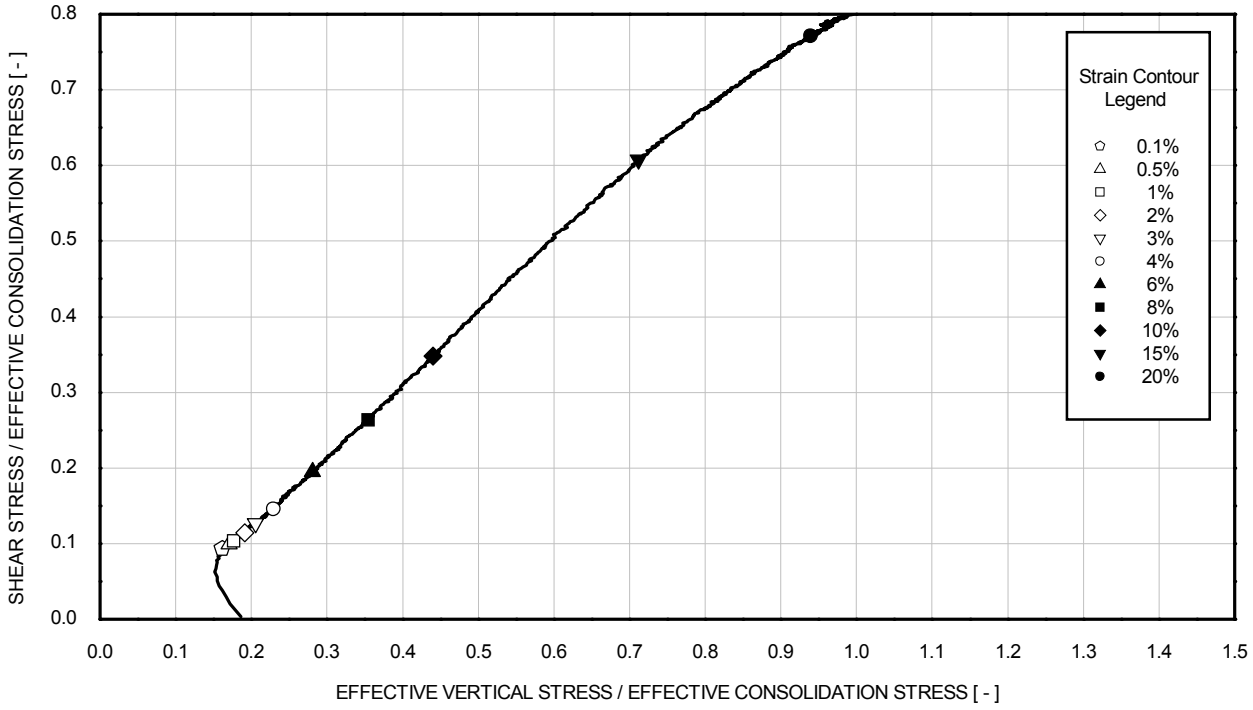


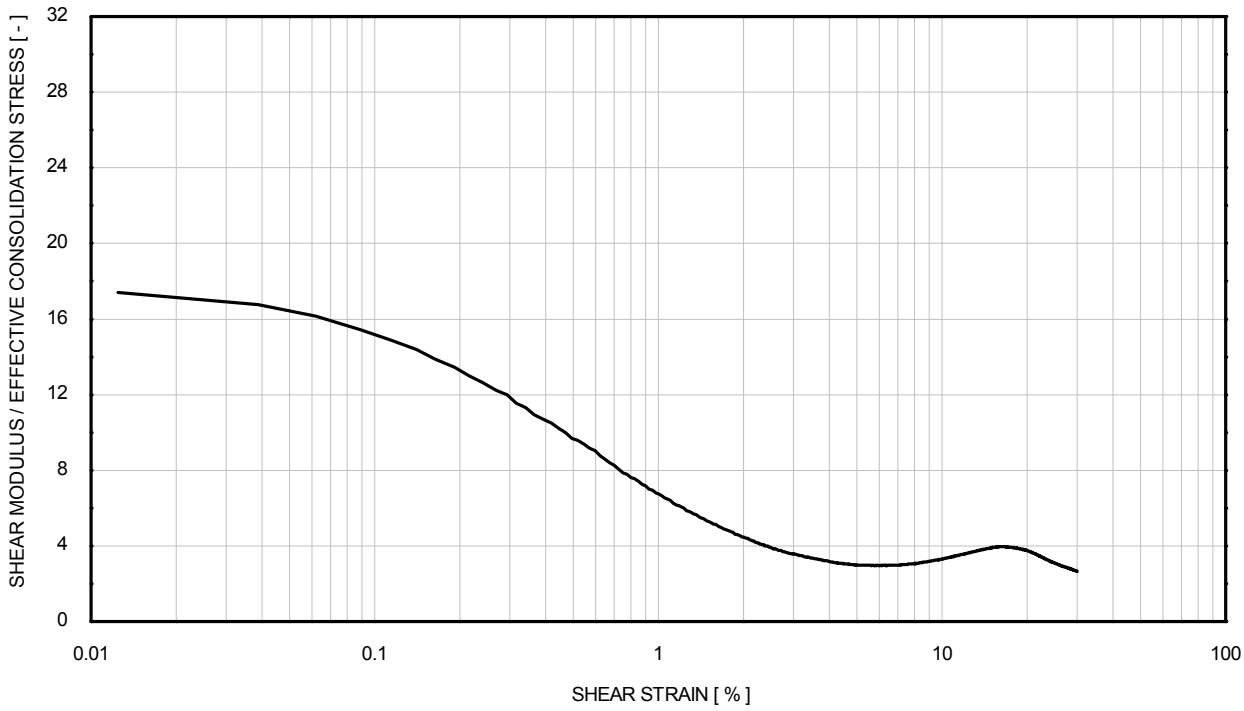


σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 285 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 29.88 %	Depth [m]	: 35.07
Rate of strain	: 3.05 %/hour	Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 350 kPa	Borehole	: BH-WFS 1-4
τ_{peak}	: 285 kPa	Sample	: 17WAXC
γ at τ_{peak}	: 29.88 %	Depth [m]	: 35.07
Rate of strain	: 3.05 %/hour	Test No.	: CSS05

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength dark greenish grey slightly sandy CLAY

GENERAL	
Date test started	17/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.7
Length	[mm]	30.0
Moisture content	[%]	38.9
Bulk density	[Mg/m³]	1.83
Dry density	[Mg/m³]	1.32
Void ratio	[-]	1.046
Degree of saturation	[%]	100
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	75
Pocket penetrometer	[kPa]	267
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_19C_CSS06
Template issue	1.2
Processed by	HB
Date	21/07/2015
Checked by	PH
Date	04/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS-2-7
Sample	19WAXC
Depth [m]	33.40
Test number	CSS06

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.15
Bulk density	[Mg/m^3]	1.84
Dry density	[Mg/m^3]	1.34
Void ratio	[-]	1.022
Moisture content	[%]	38.1

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	81
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	0.04
γ_{cy} at N_f	[%]	0.72
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	26
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	211
Shear strain	[%]	7.16
Shear induced $\Delta\sigma'_v$	[kPa]	-80
Vertical stress	[kPa]	390
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	2.52
At 15 % shear strain		
Shear stress	[kPa]	200
Shear induced -$\Delta\sigma'_v$	[kPa]	-163
Vertical stress	[kPa]	473
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS-2-7
Sample	19WAXC
Depth [m]	33.40
Test number	CSS06

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

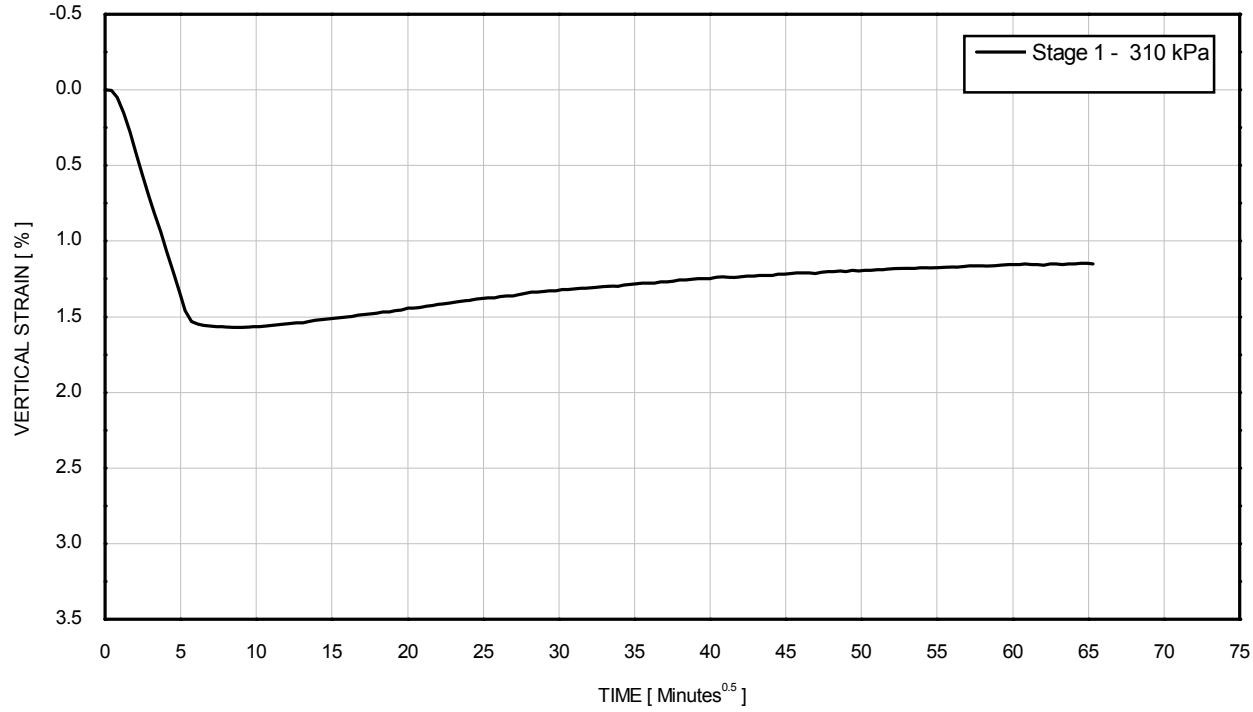
SPECIMEN PHOTOGRAPH

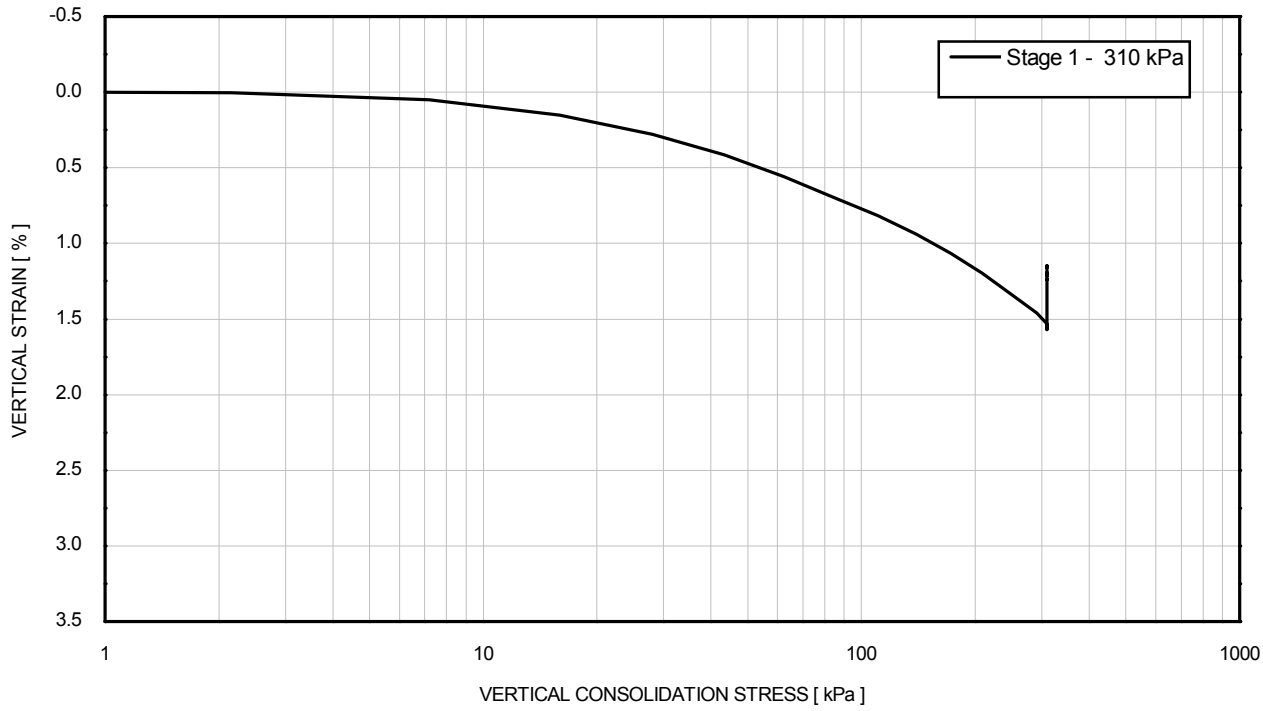
Photograph unavailable

TEST IDENTIFICATION	
Borehole	BH-WFS-2-7
Sample	19WAXC
Depth [m]	33.40
Test number	CSS06

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

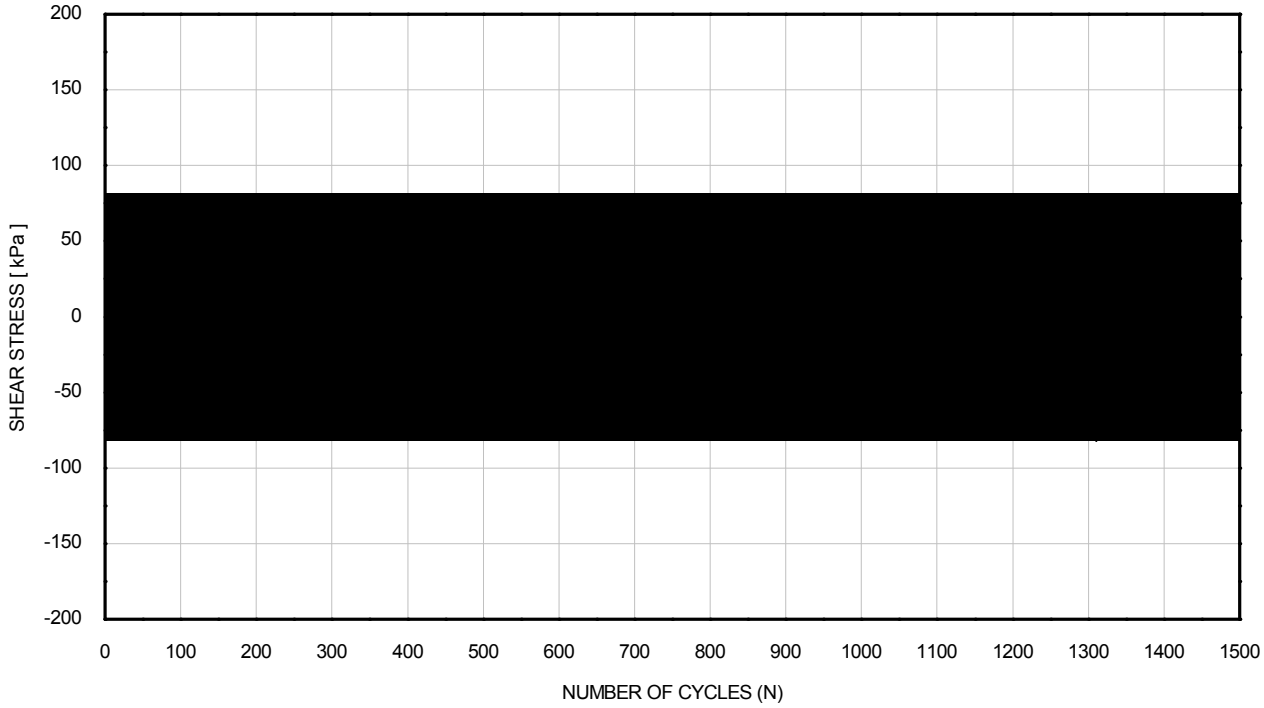


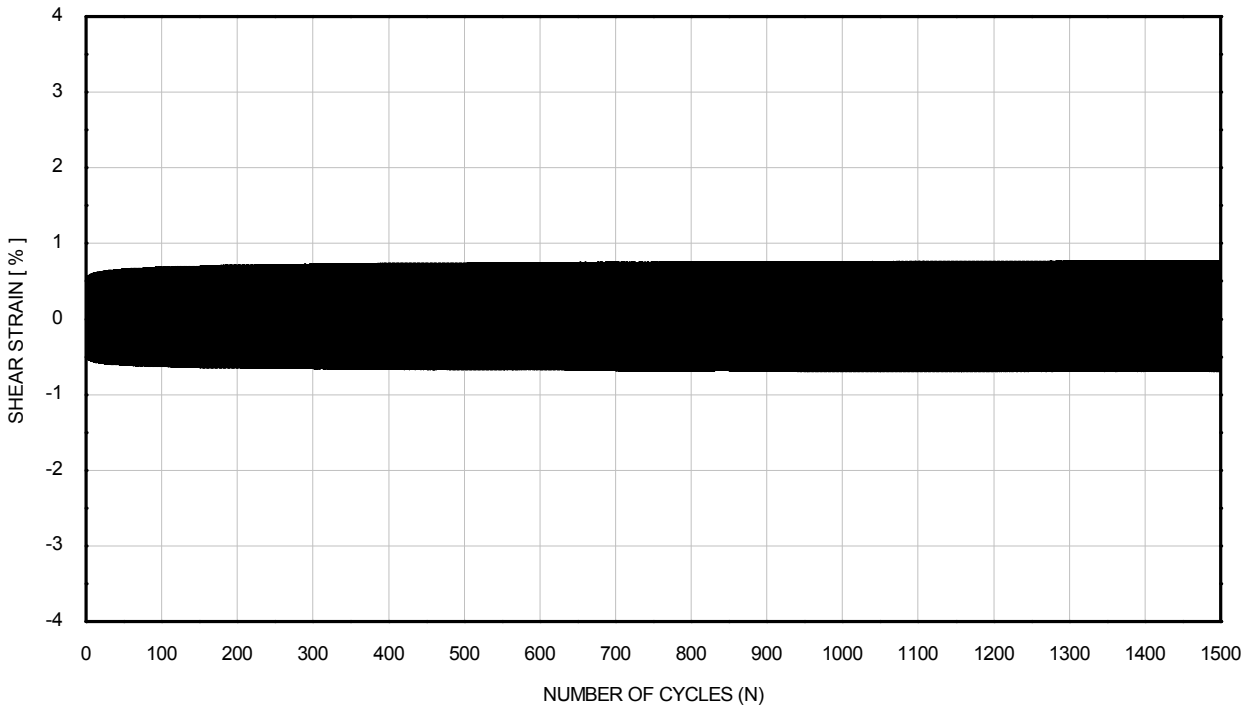


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS-2-7
		Sample	: 19WAXC
		Depth [m]	: 33.40
		Test No.	: CSS06

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

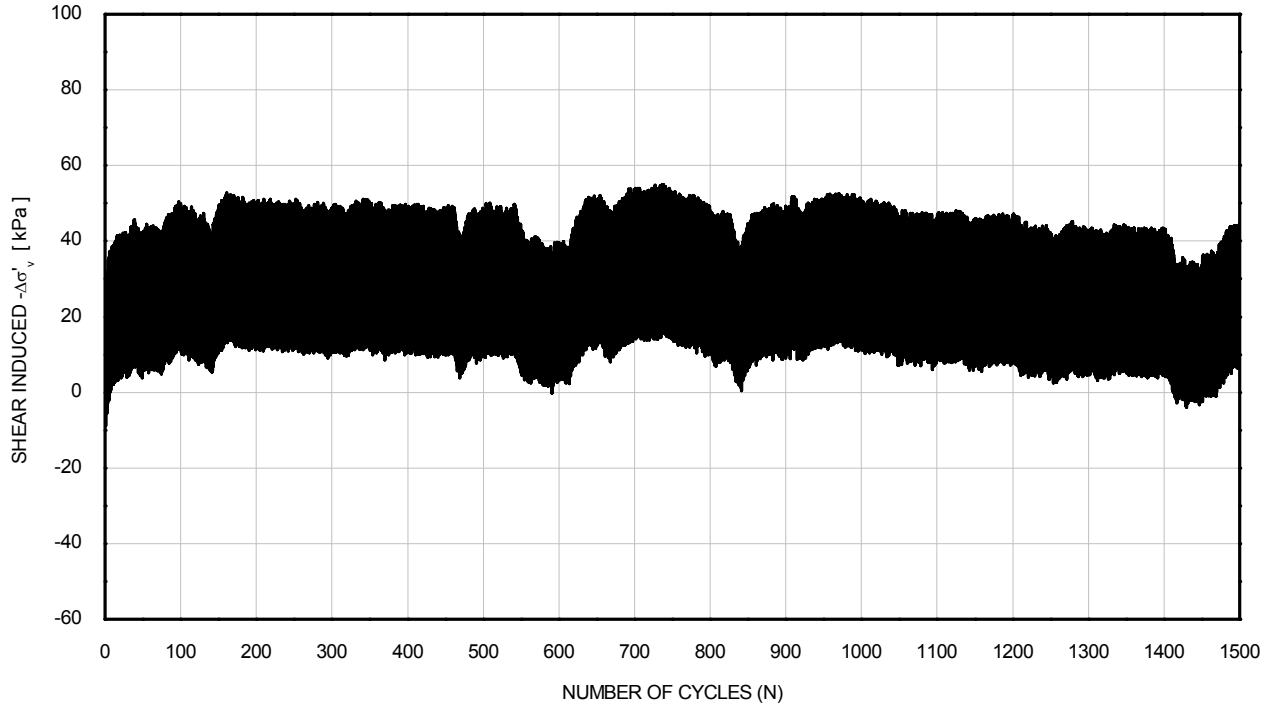


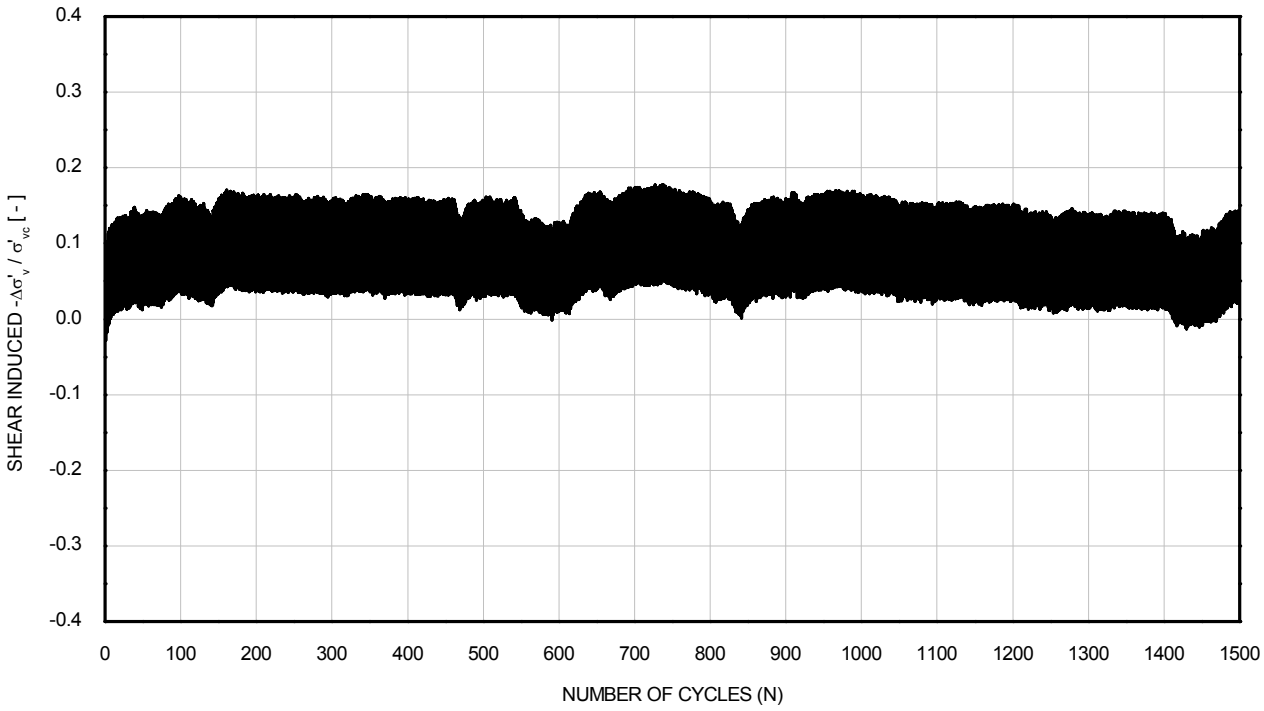


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS-2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	81 kPa	Depth [m]	:	33.40
Frequency	:	0.10 Hz	Test No.	:	CSS06

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

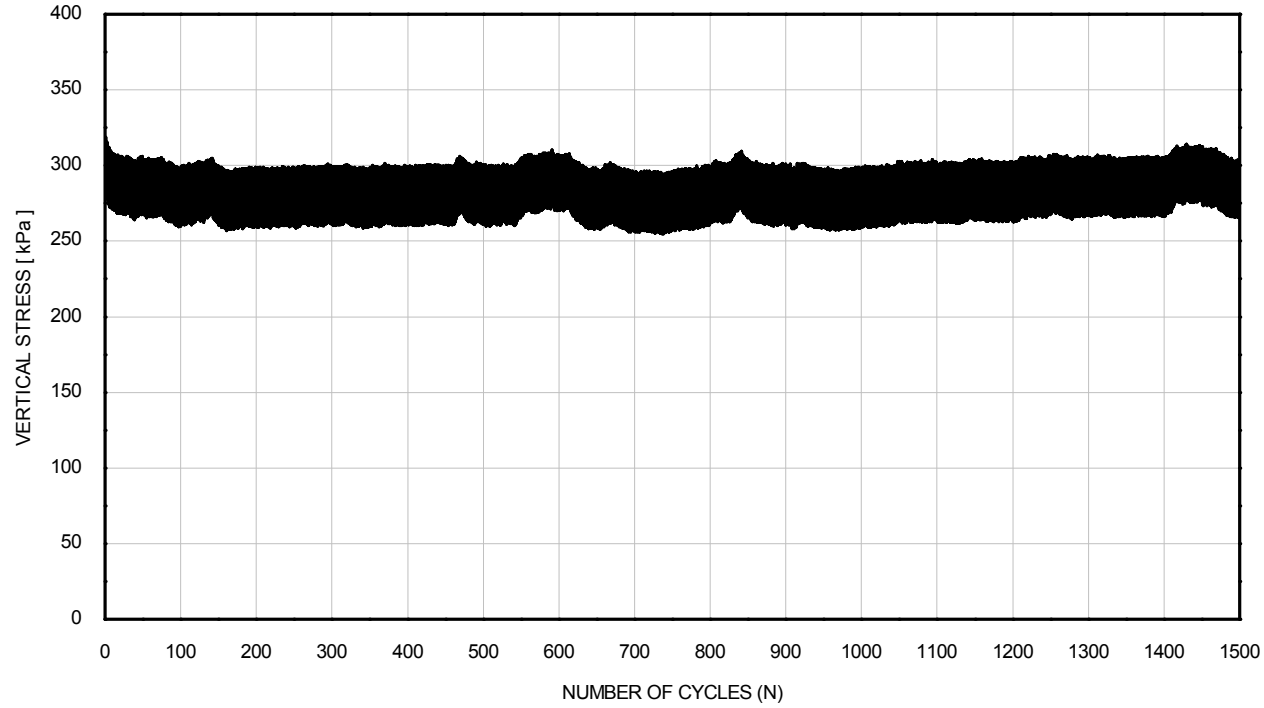


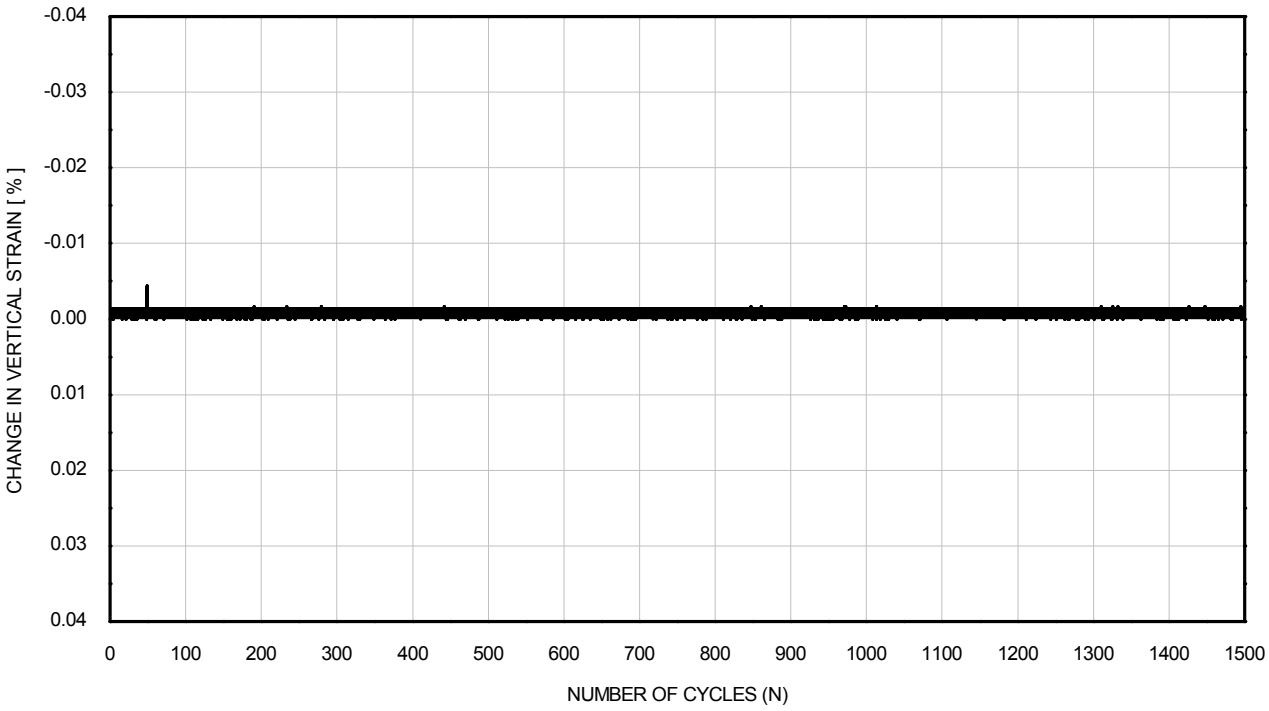


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS-2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	81 kPa	Depth [m]	:	33.40
Frequency	:	0.10 Hz	Test No.	:	CSS06

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

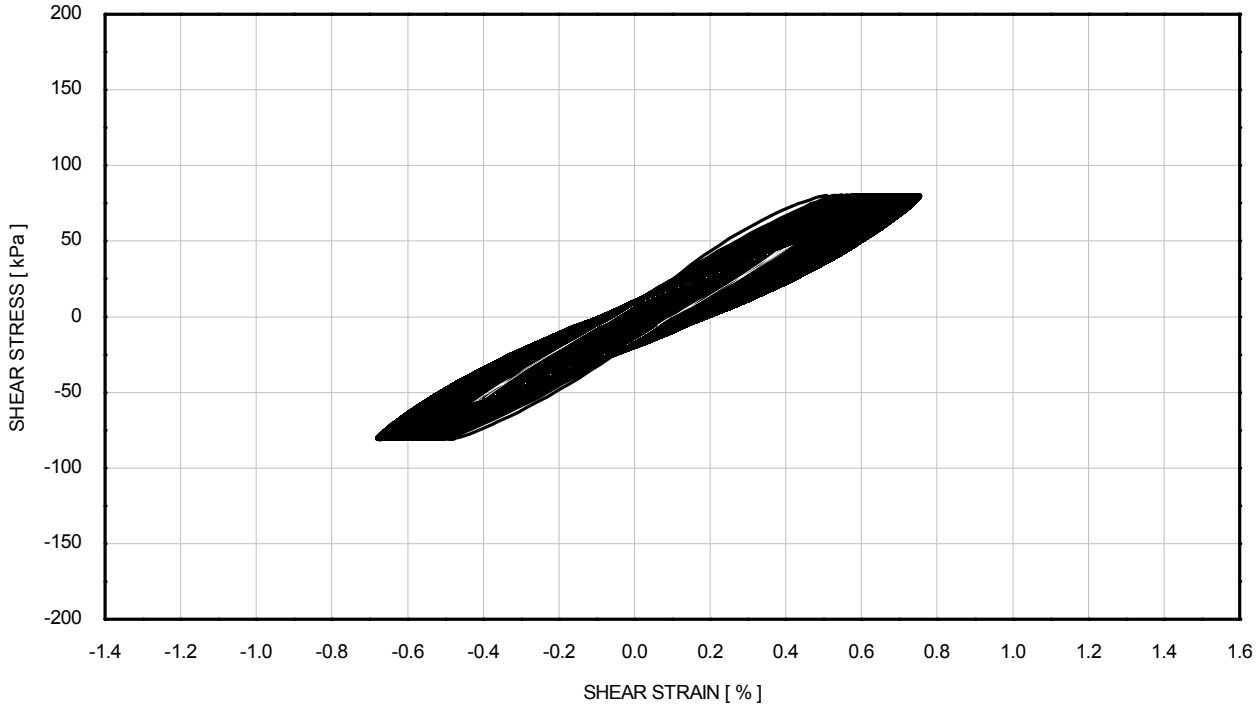


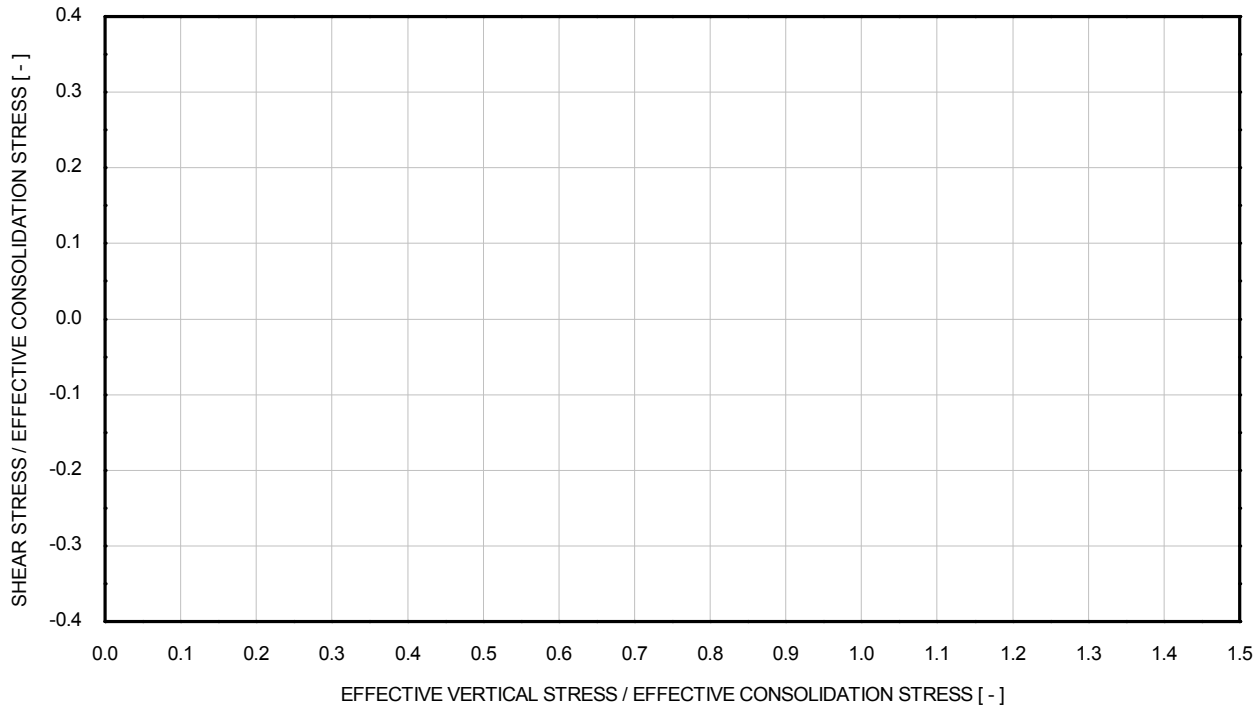


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS-2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	81 kPa	Depth [m]	:	33.40
Frequency	:	0.10 Hz	Test No.	:	CSS06

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

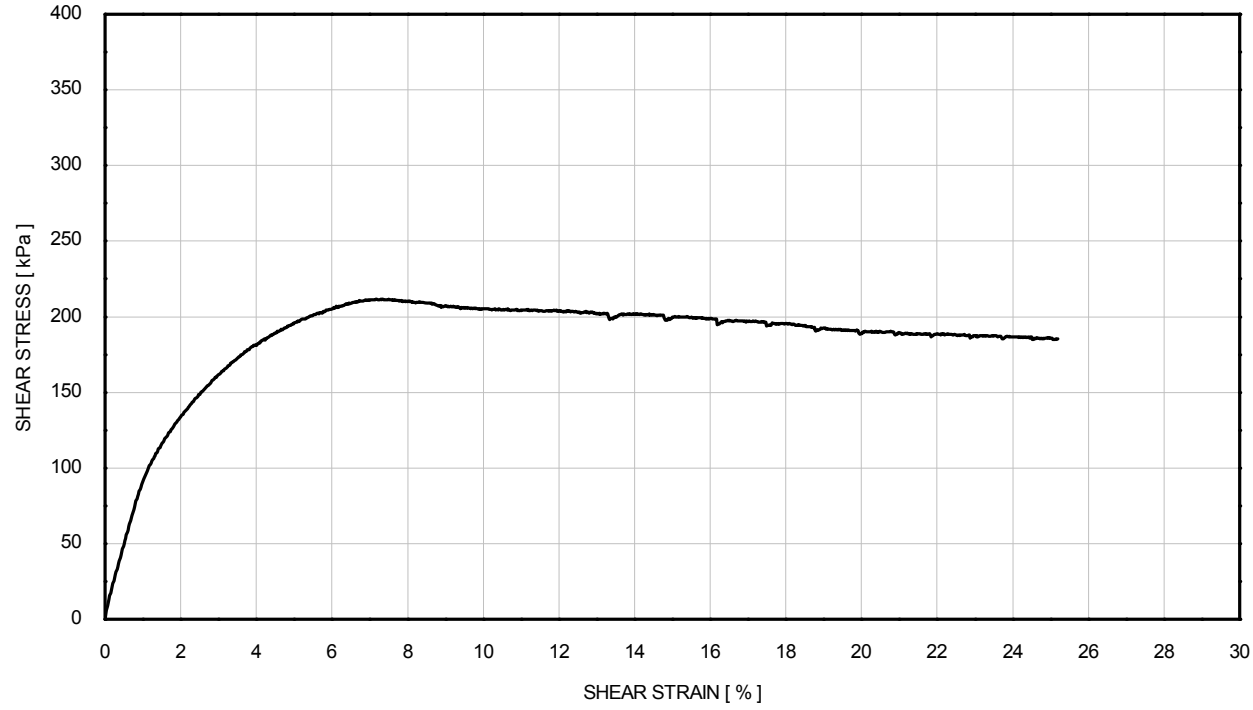


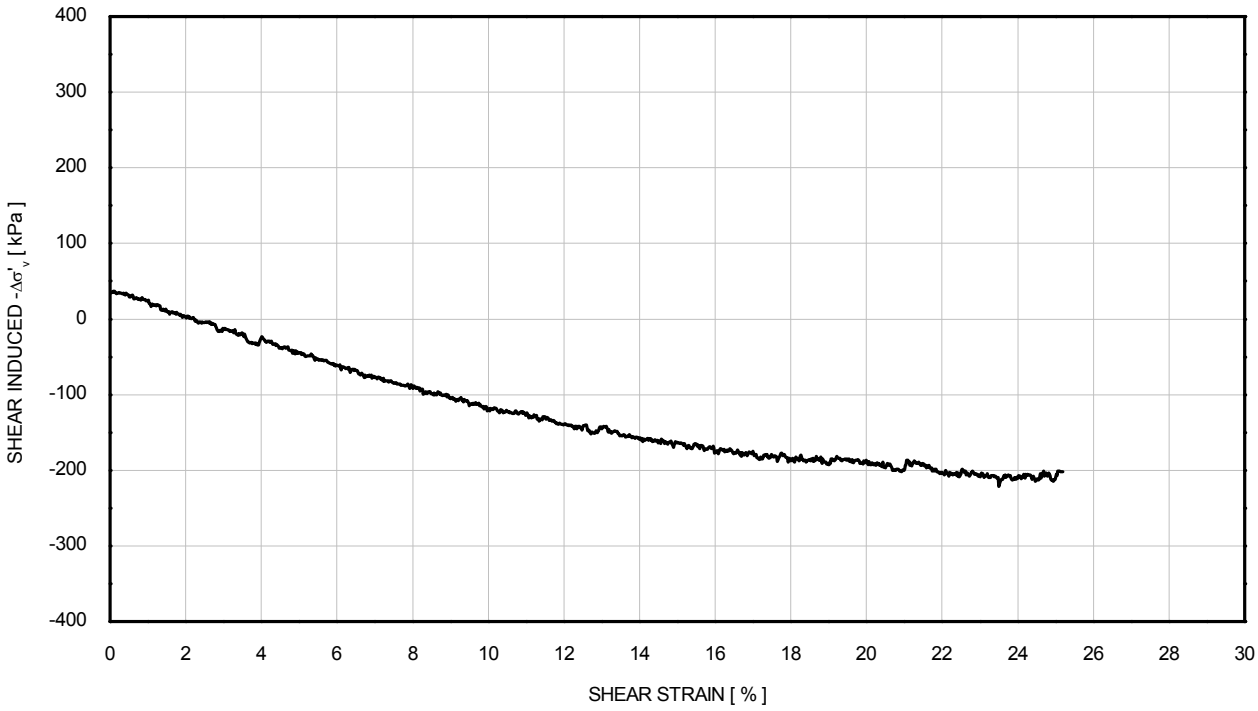


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS-2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	81 kPa	Depth [m]	:	33.40
Frequency	:	0.10 Hz	Test No.	:	CSS06

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

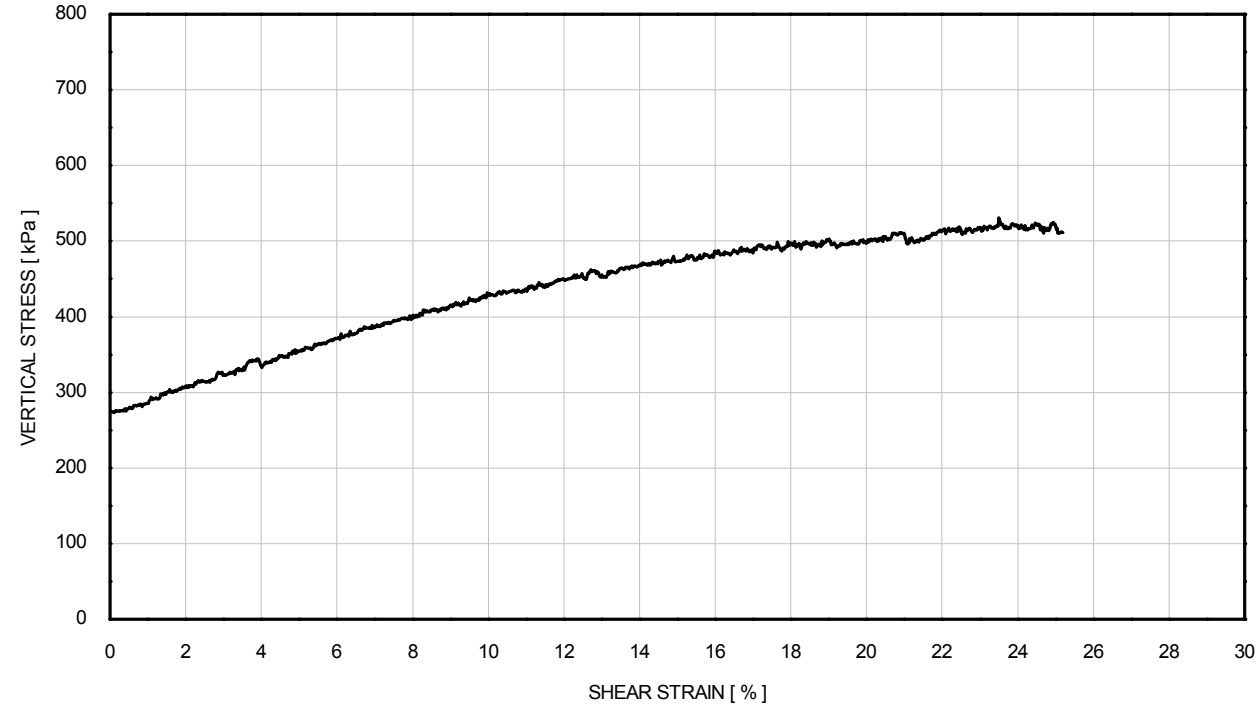


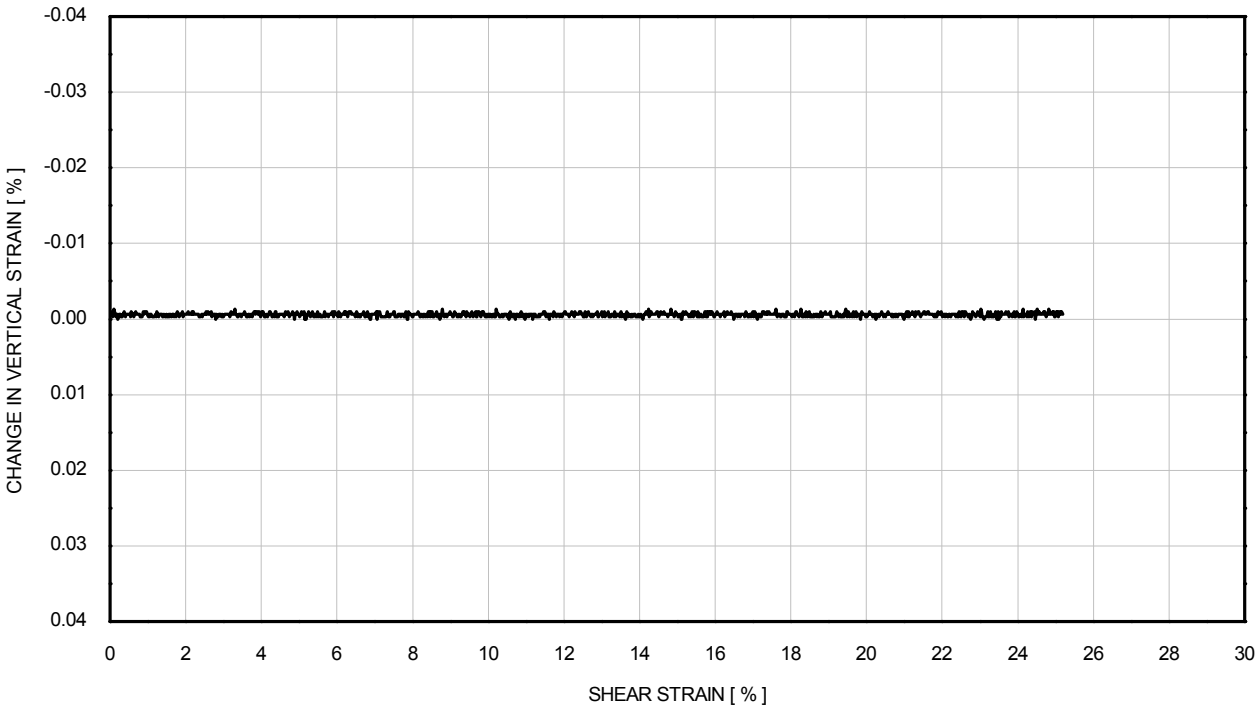


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS-2-7
τ_{peak}	:	211 kPa	Sample	:	19WAXC
γ at τ_{peak}	:	7.16 %	Depth [m]	:	33.40
Rate of strain	:	2.52 %/hour	Test No.	:	CSS06

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

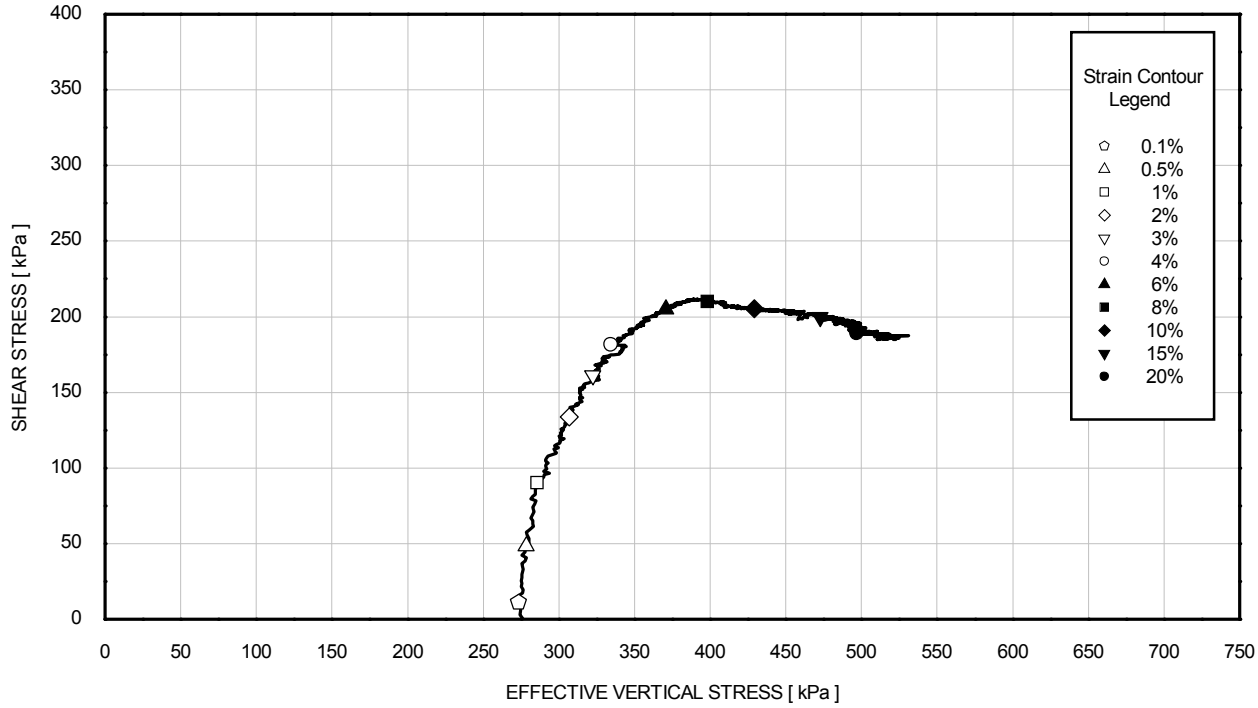


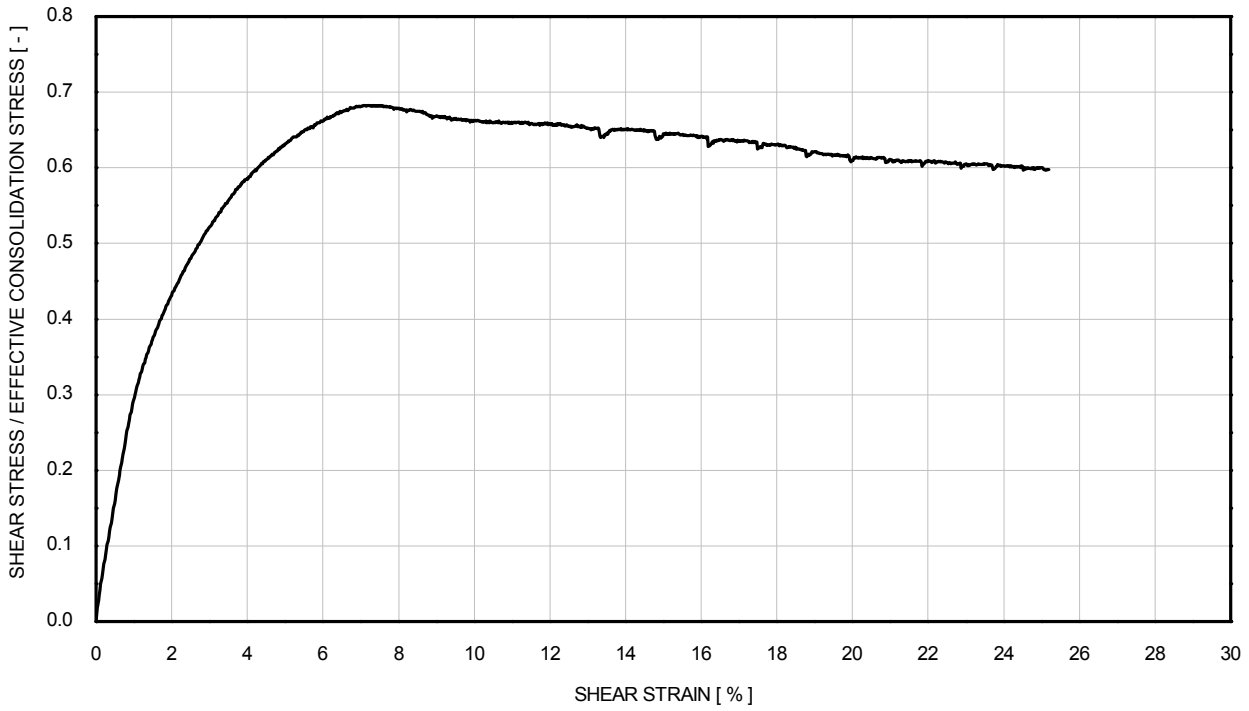


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS-2-7
τ_{peak}	: 211 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 7.16 %	Depth [m]	: 33.40
Rate of strain	: 2.52 %/hour	Test No.	: CSS06

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

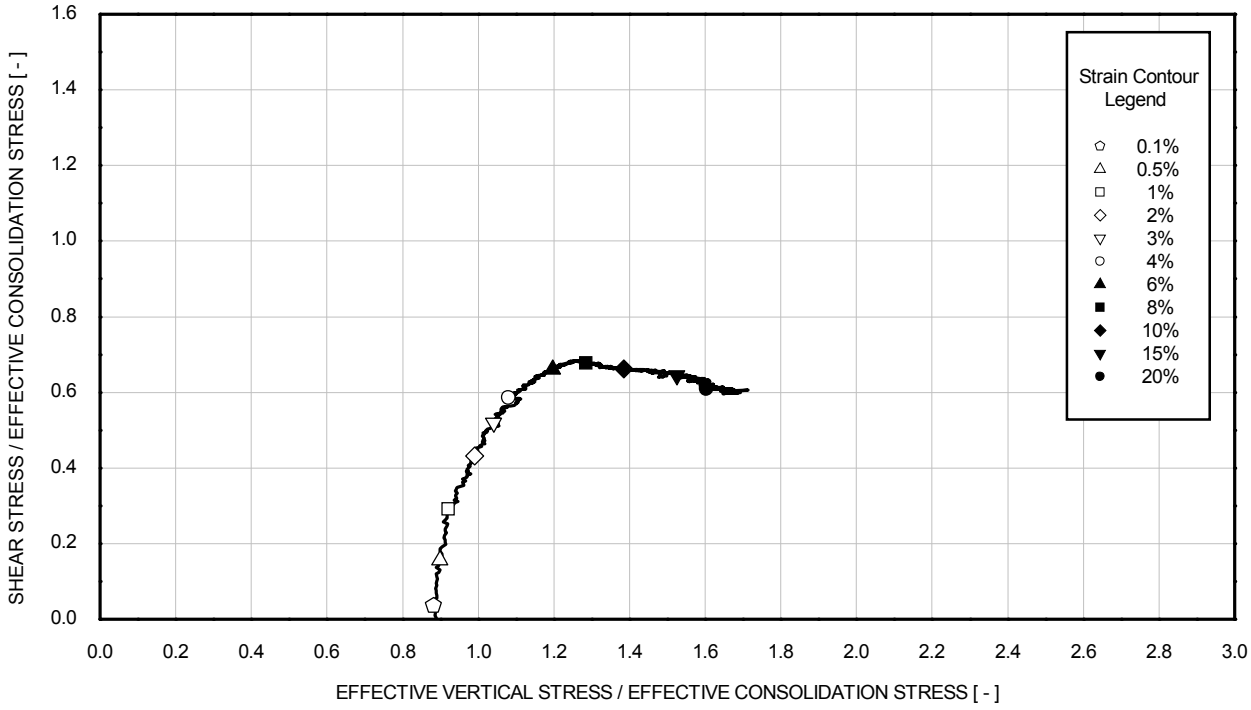


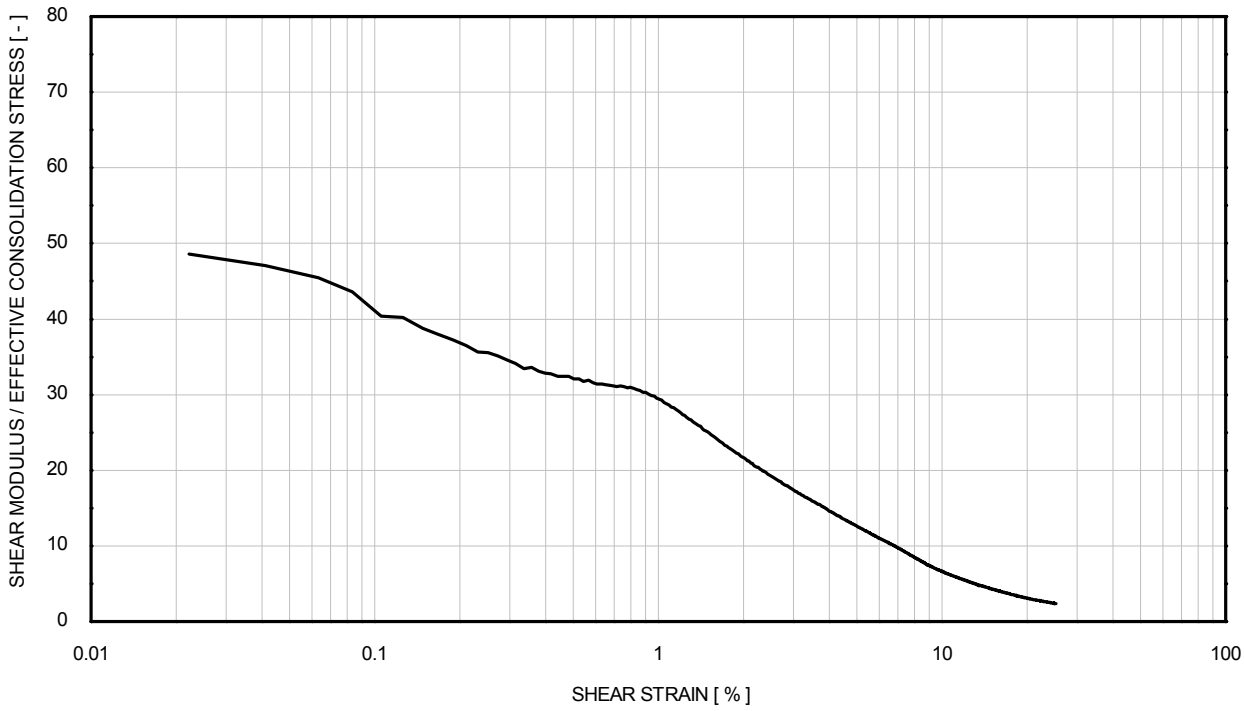


σ'_{vc}	:	310 kPa	Borehole	: BH-WFS-2-7
τ_{peak}	:	211 kPa	Sample	: 19WAXC
γ at τ_{peak}	:	7.16 %	Depth [m]	: 33.40
Rate of strain	:	2.52 %/hour	Test No.	: CSS06

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	:	310 kPa	Borehole	: BH-WFS-2-7
τ_{peak}	:	211 kPa	Sample	: 19WAXC
γ at τ_{peak}	:	7.16 %	Depth [m]	: 33.40
Rate of strain	:	2.52 %/hour	Test No.	: CSS06

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Very high strength dark greenish grey slightly sandy CLAY

GENERAL	
Date test started	20/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	29.9
Moisture content	[%]	39.2
Bulk density	[Mg/m³]	1.80
Dry density	[Mg/m³]	1.29
Void ratio	[-]	1.087
Degree of saturation	[%]	97
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_19C_CSS07
Template issue	1.2
Processed by	HB
Date	22/07/2015
Checked by	PH
Date	04/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXC
Depth [m]	33.45
Test number	CSS07

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.01
Bulk density	[Mg/m^3]	1.81
Dry density	[Mg/m^3]	1.31
Void ratio	[-]	1.065
Moisture content	[%]	38.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	121
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	-0.37
γ_{cy} at N_f	[%]	1.45
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	136
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	291
Shear strain	[%]	13.15
Shear induced $\Delta\sigma'_v$	[kPa]	-119
Vertical stress	[kPa]	429
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.02
At 15 % shear strain		
Shear stress	[kPa]	266
Shear induced -$\Delta\sigma'_v$	[kPa]	-83
Vertical stress	[kPa]	393
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXC
Depth [m]	33.45
Test number	CSS07

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

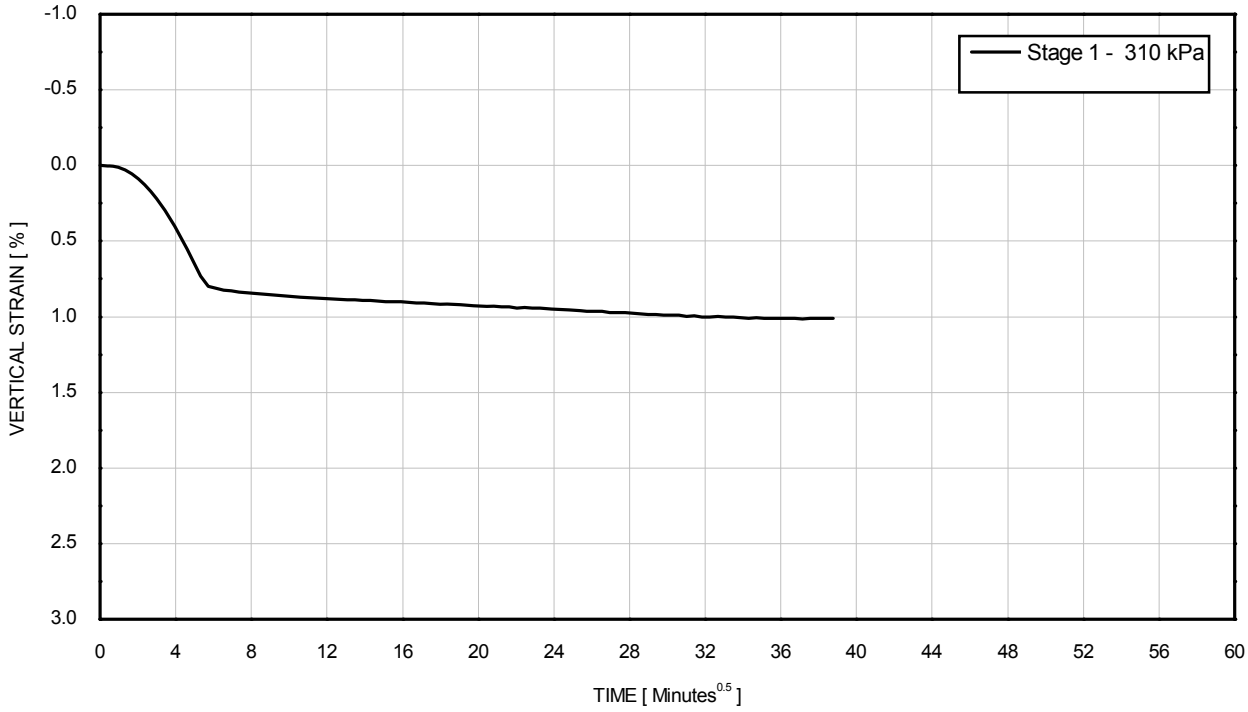
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

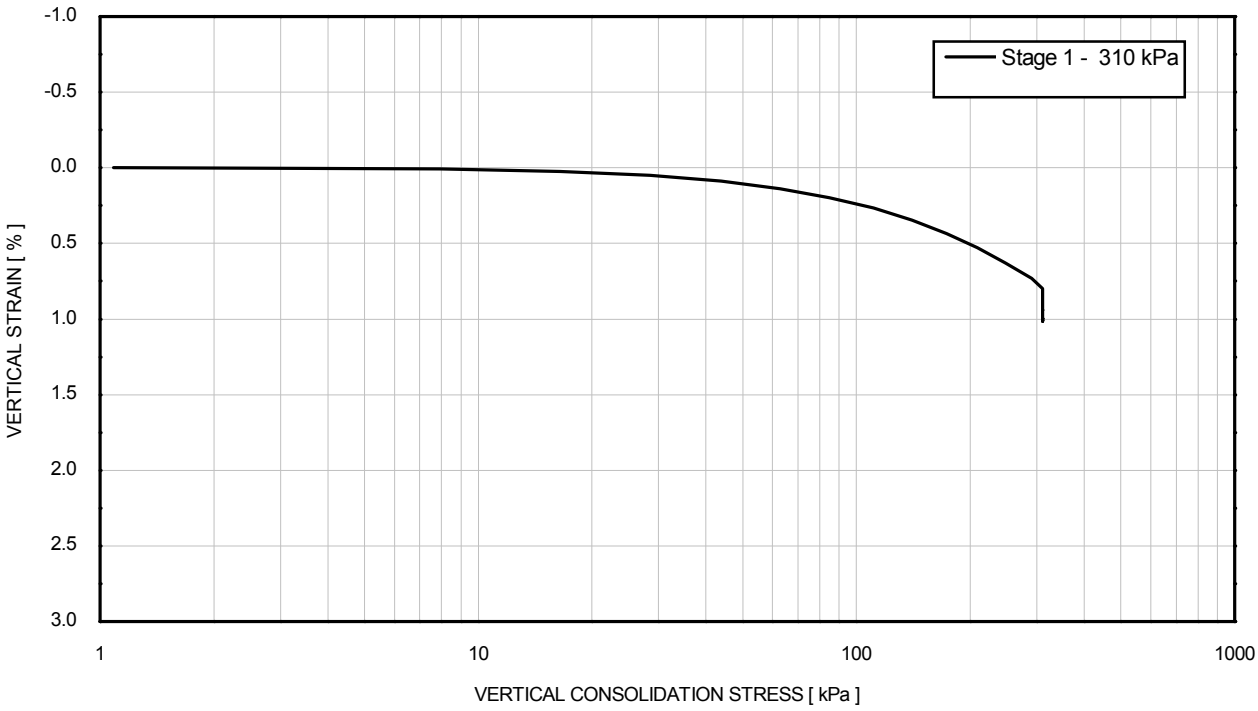
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXC
Depth [m]	33.45
Test number	CSS07

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

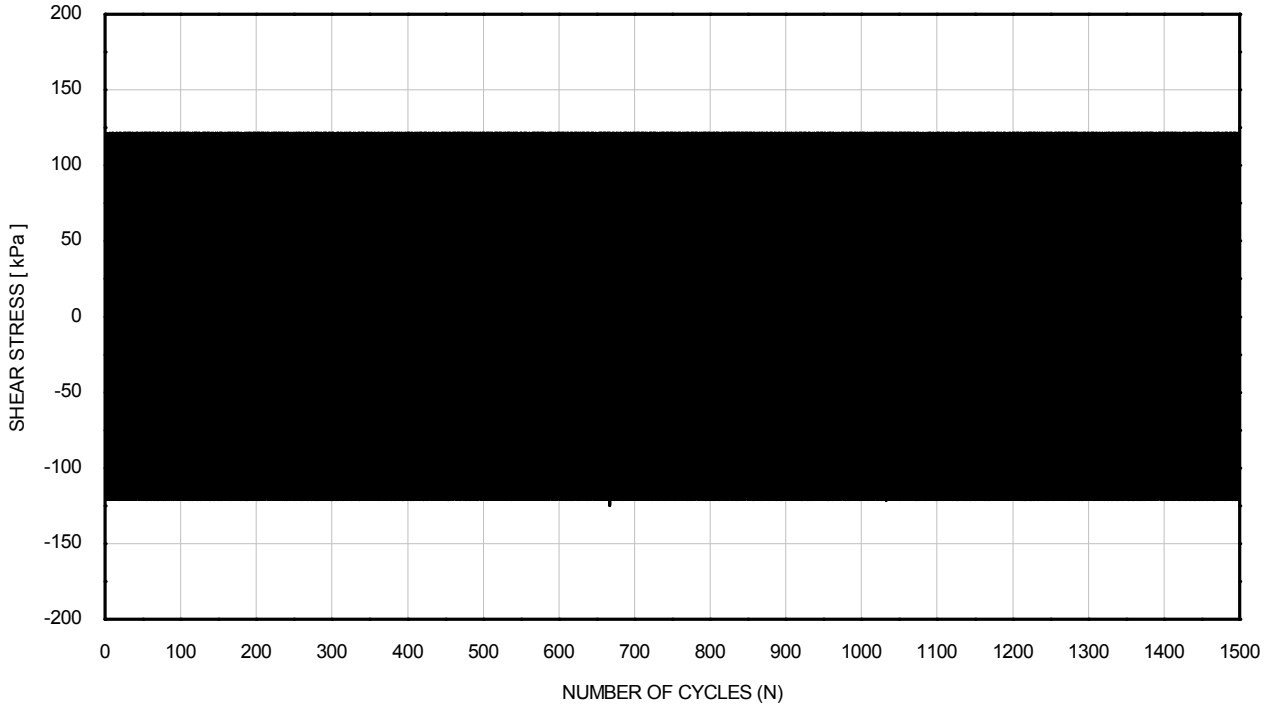


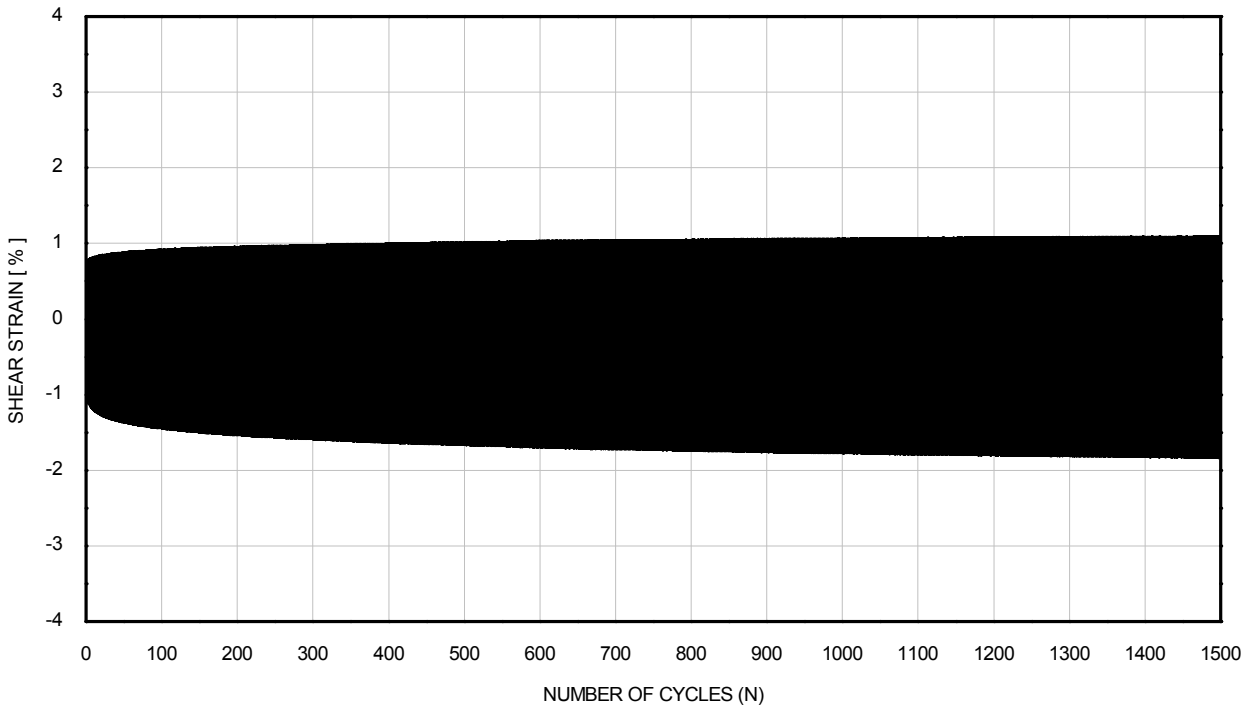


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
		Sample	: 19WAXC
		Depth [m]	: 33.45
		Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

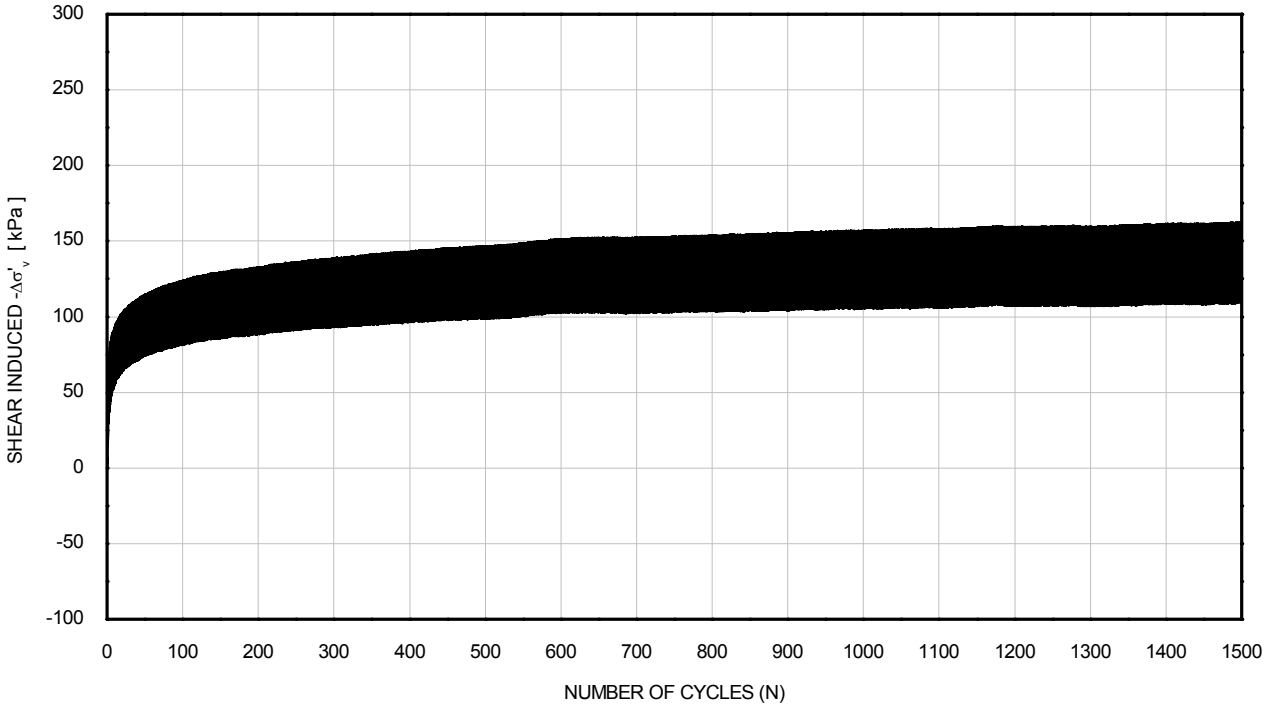


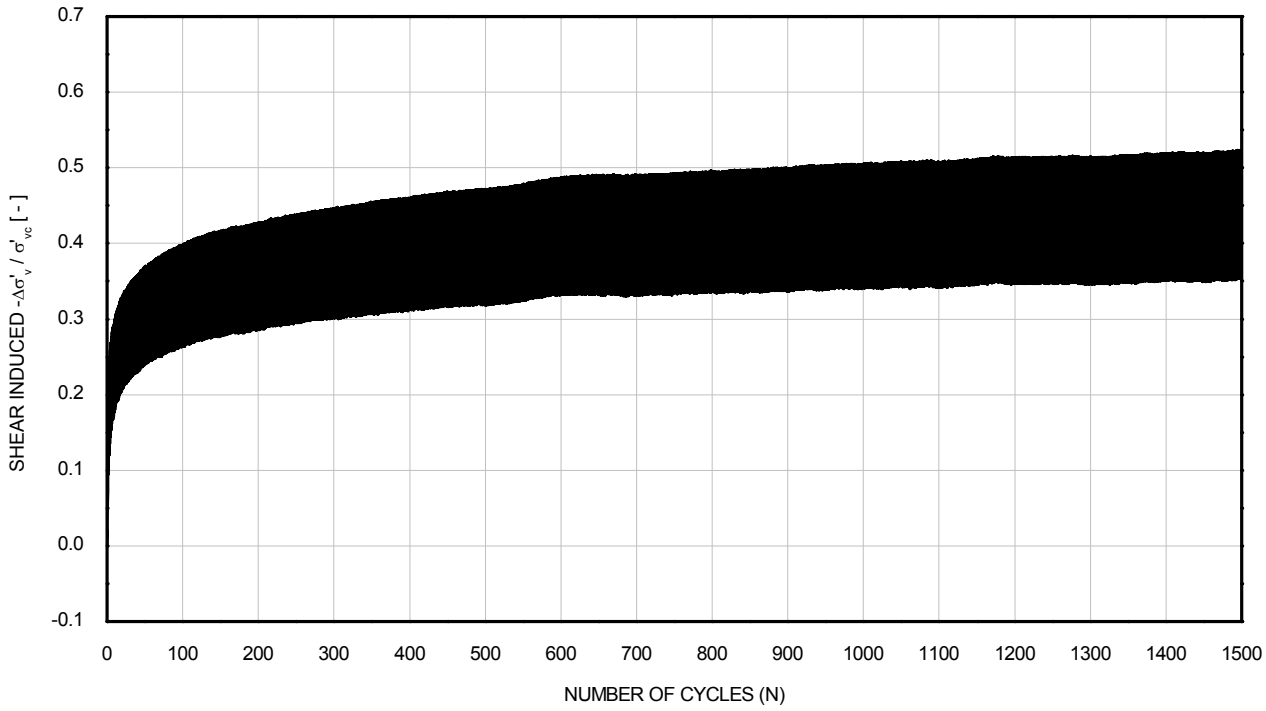


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	121 kPa	Depth [m]	:	33.45
Frequency	:	0.10 Hz	Test No.	:	CSS07

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

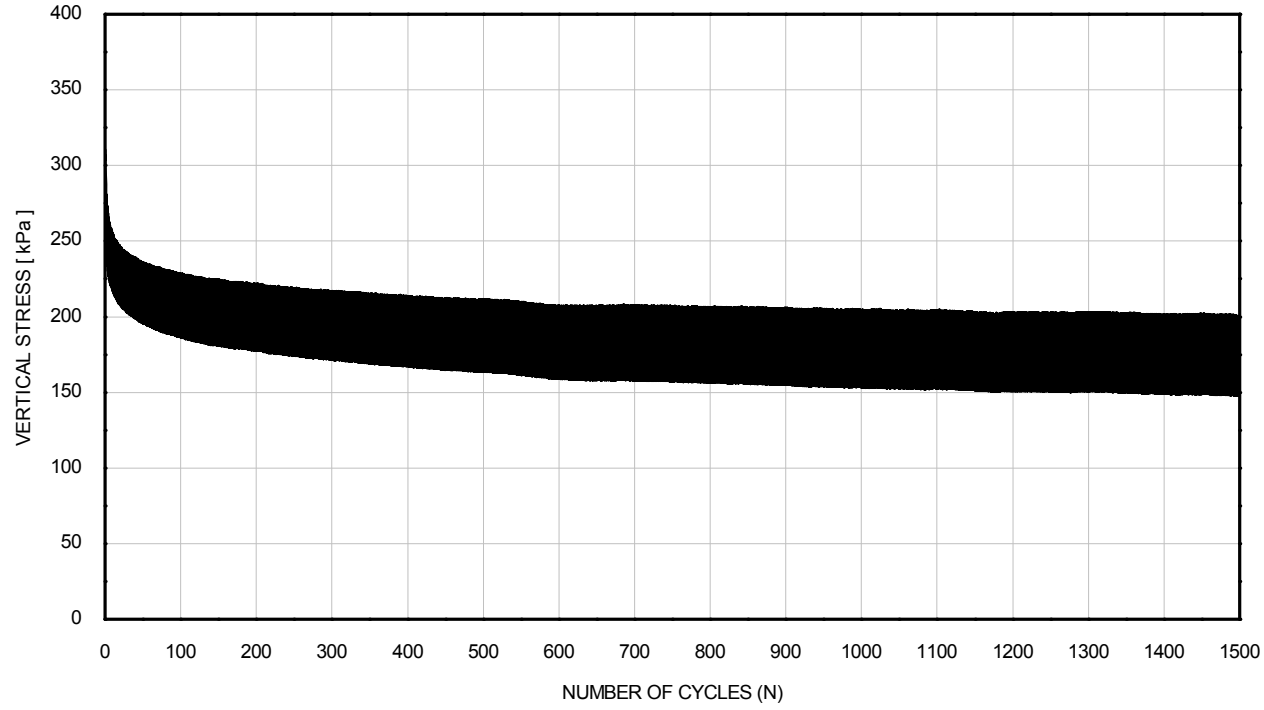


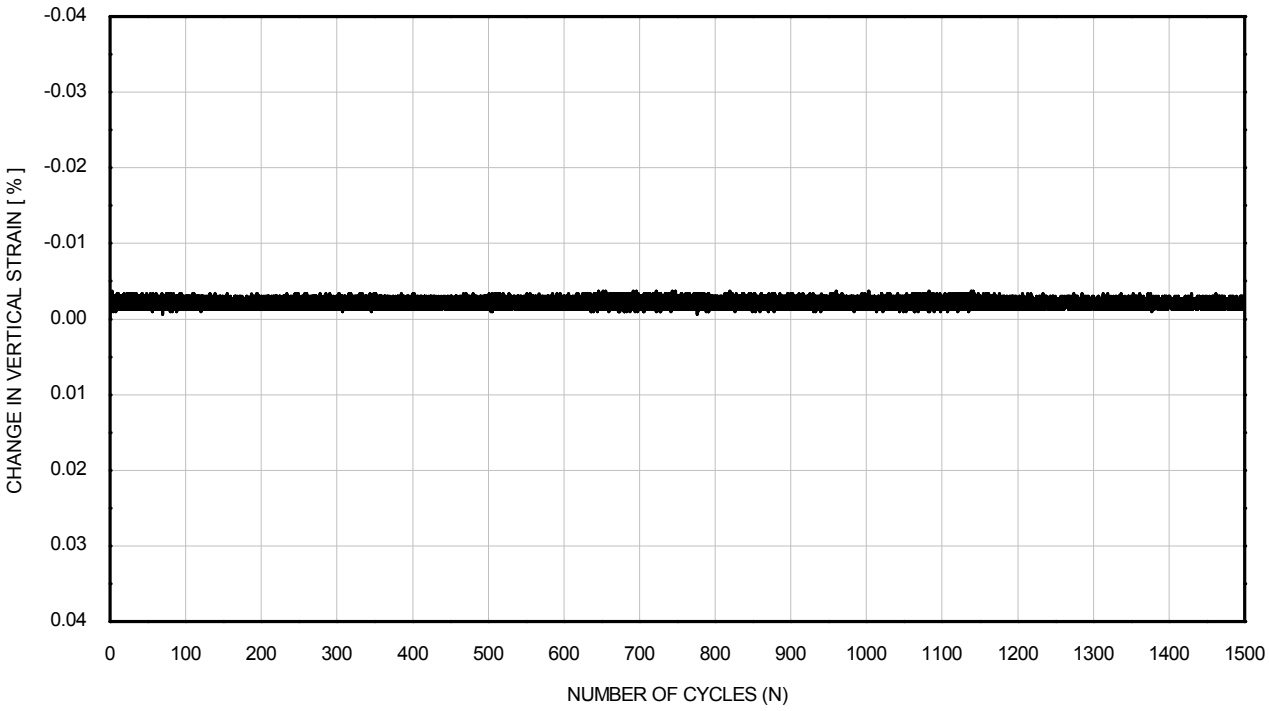


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	121 kPa	Depth [m]	:	33.45
Frequency	:	0.10 Hz	Test No.	:	CSS07

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

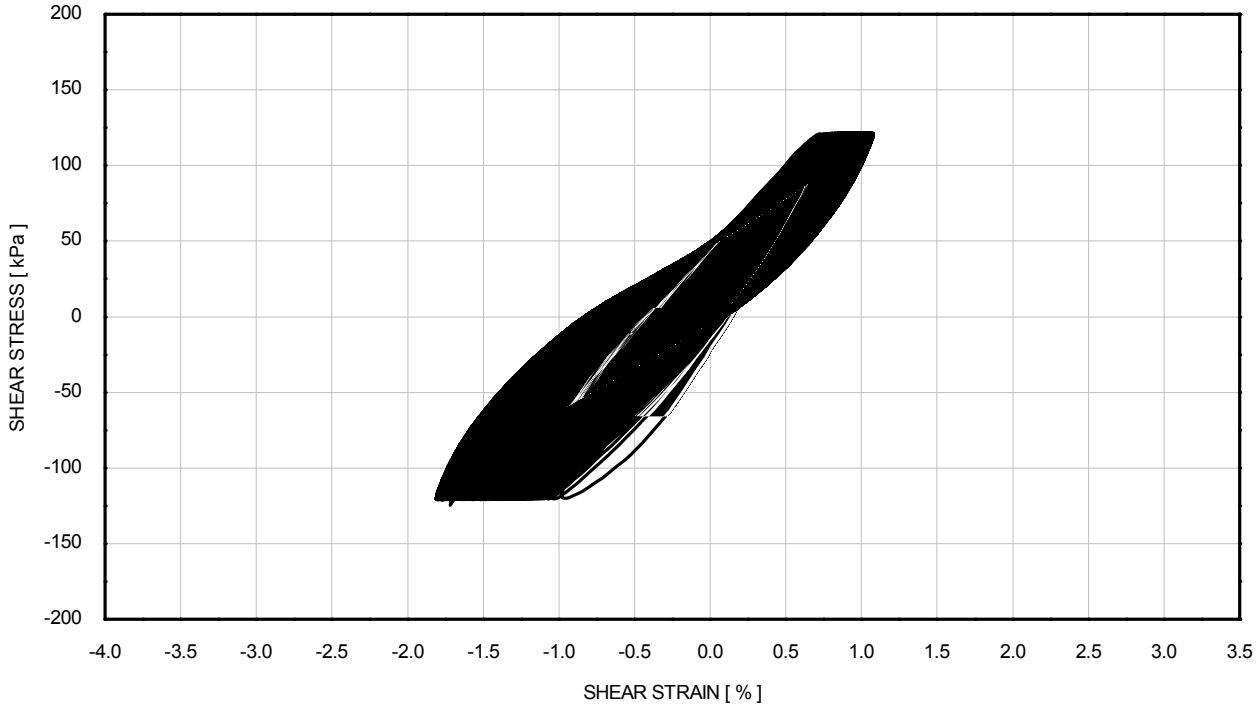


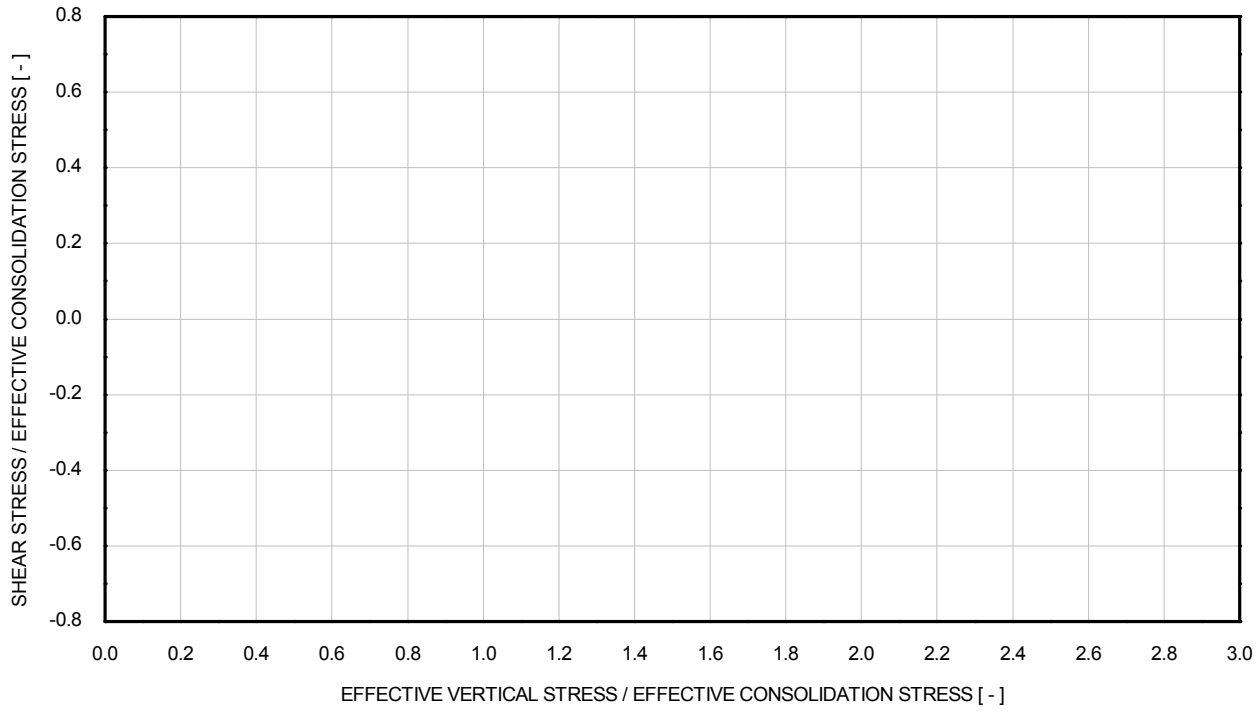


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXC
Mean τ_{cy}	:	121 kPa	Depth [m]	:	33.45
Frequency	:	0.10 Hz	Test No.	:	CSS07

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

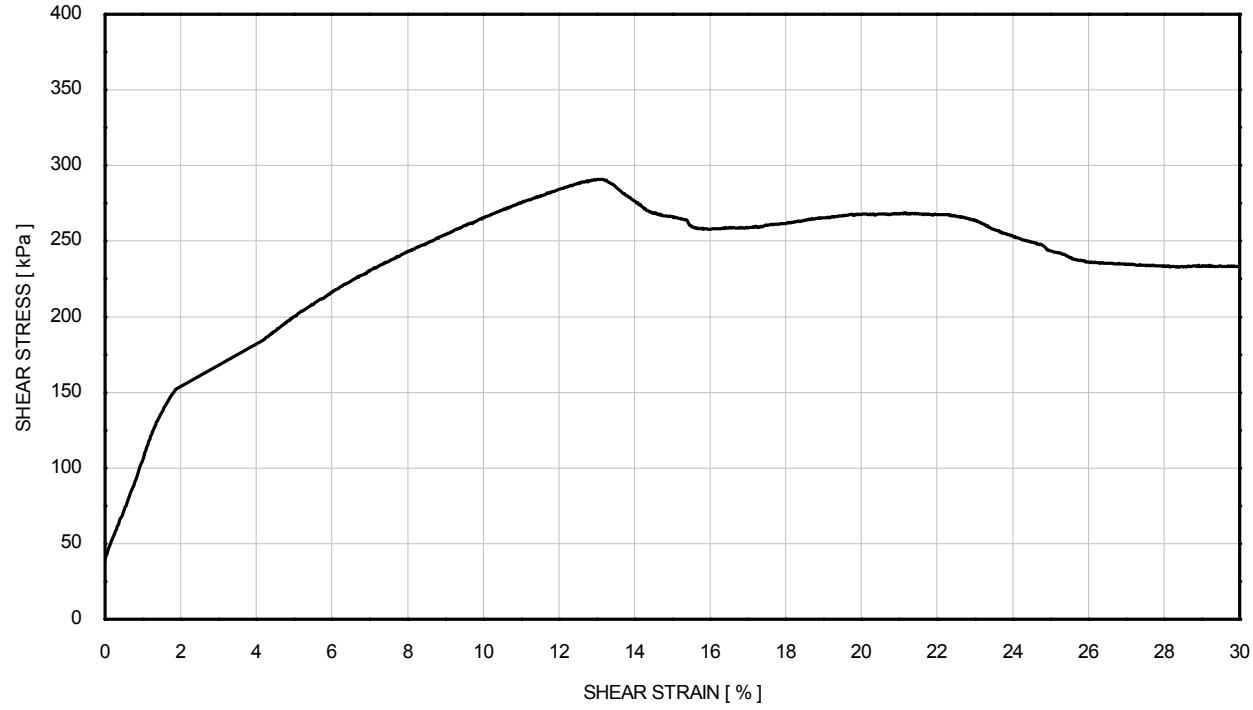


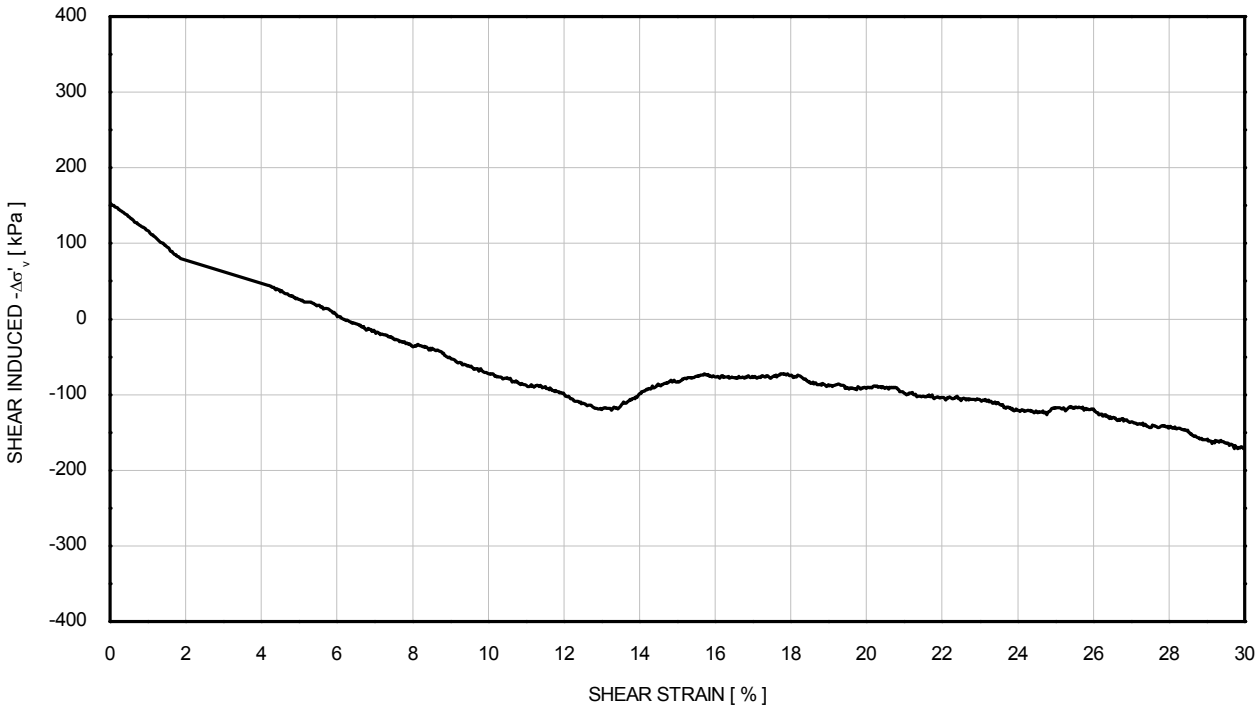


σ'_{vc}	:	310 kPa	Borehole	: BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	: 19WAXC
Mean τ_{cy}	:	121 kPa	Depth [m]	: 33.45
Frequency	:	0.10 Hz	Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

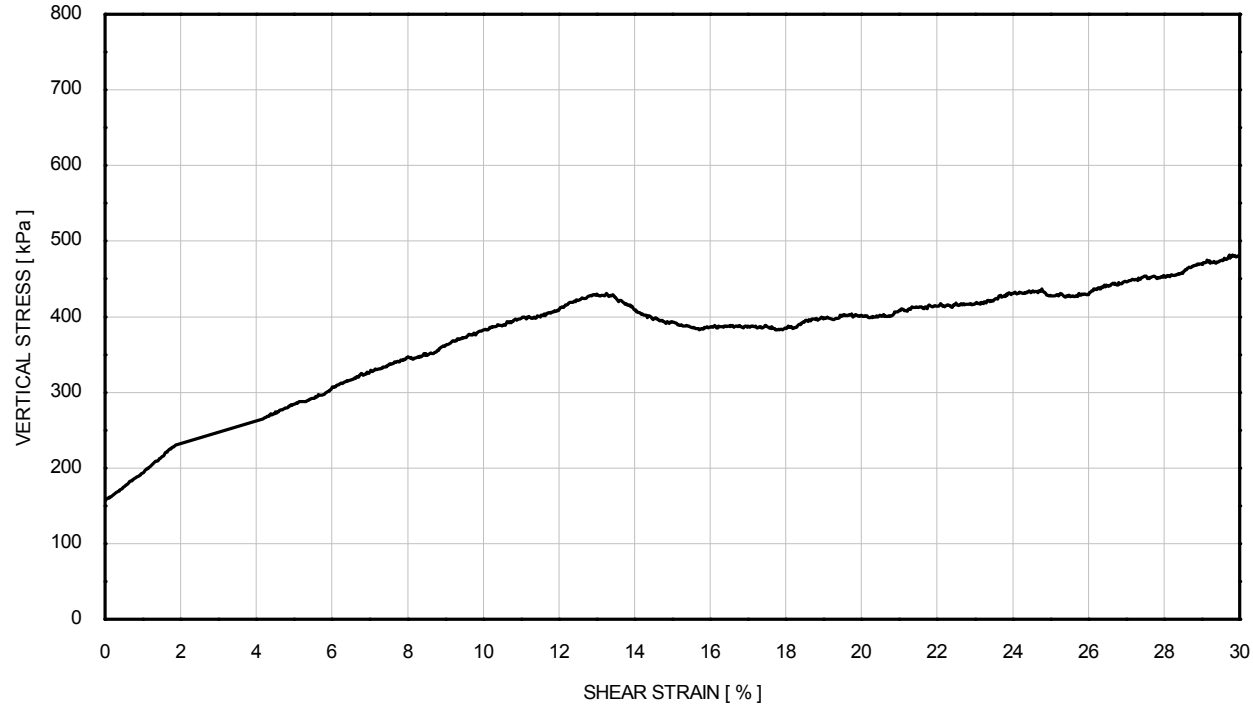


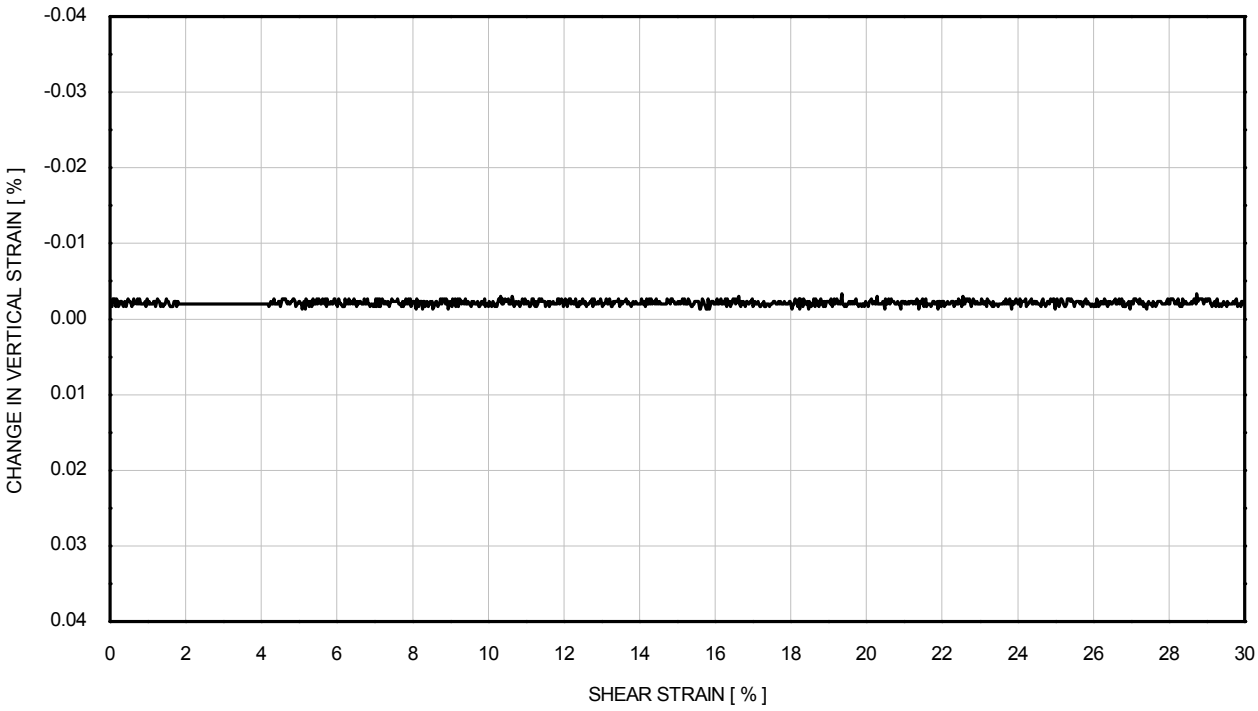


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 291 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 13.15 %	Depth [m]	: 33.45
Rate of strain	: 3.02 %/hour	Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

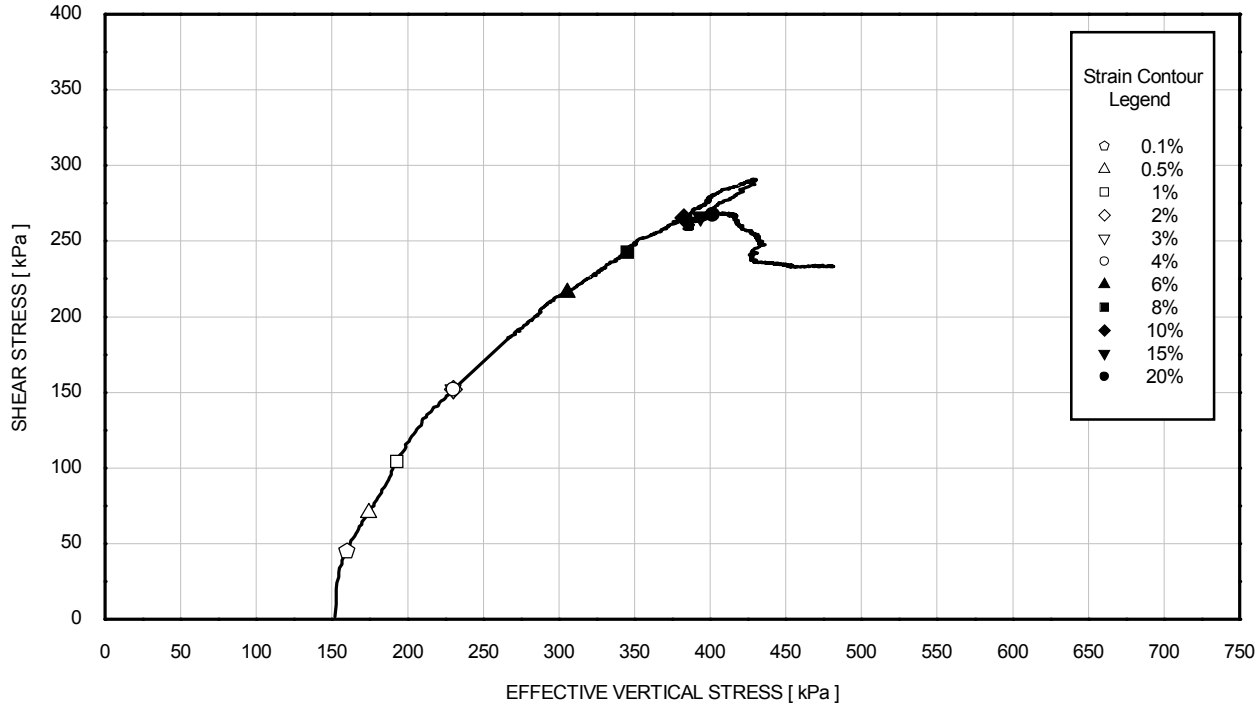


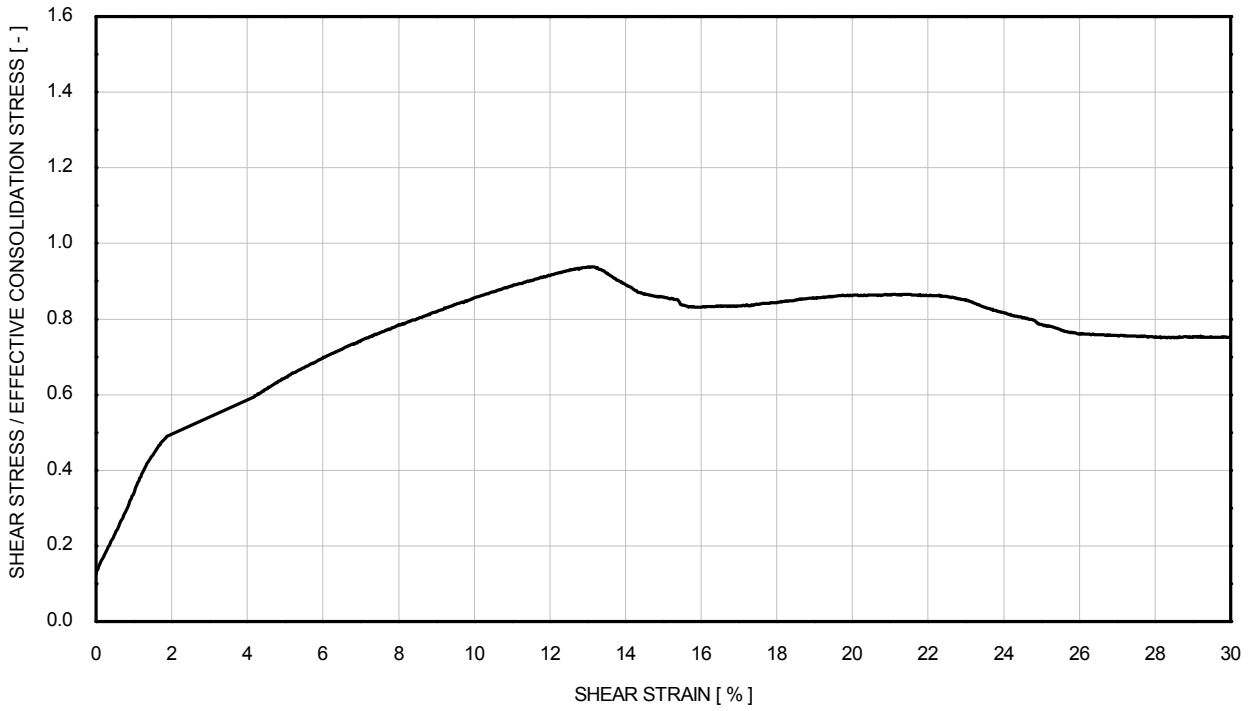


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 291 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 13.15 %	Depth [m]	: 33.45
Rate of strain	: 3.02 %/hour	Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

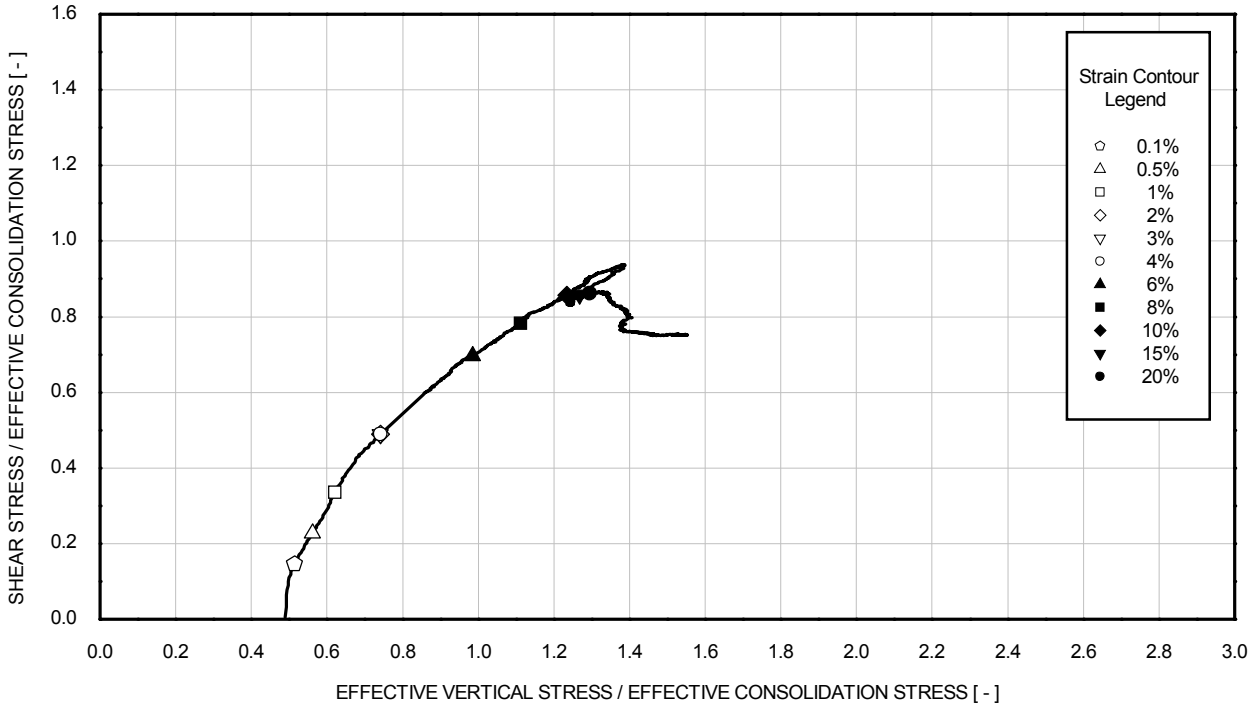


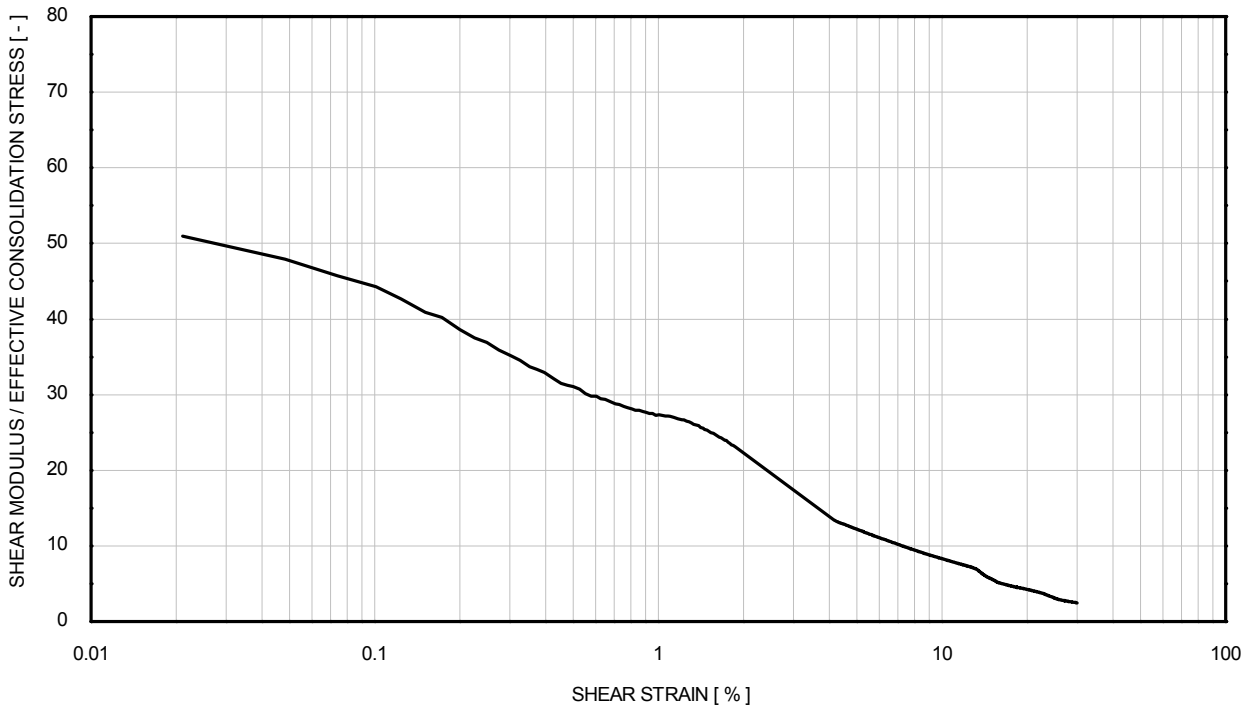


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 291 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 13.15 %	Depth [m]	: 33.45
Rate of strain	: 3.02 %/hour	Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 291 kPa	Sample	: 19WAXC
γ at τ_{peak}	: 13.15 %	Depth [m]	: 33.45
Rate of strain	: 3.02 %/hour	Test No.	: CSS07

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark greenish grey CLAY

GENERAL	
Date test started	28/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	66.0
Length	[mm]	29.9
Moisture content	[%]	40.6
Bulk density	[Mg/m³]	1.79
Dry density	[Mg/m³]	1.28
Void ratio	[-]	1.116
Degree of saturation	[%]	98
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	163
Pocket penetrometer	[kPa]	267
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_19D_CSS08
Template issue	1.2
Processed by	HB
Date	10/08/2015
Checked by	PH
Date	11/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.55
Test number	CSS08

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.91
Bulk density	[Mg/m^3]	1.81
Dry density	[Mg/m^3]	1.30
Void ratio	[-]	1.076
Moisture content	[%]	39.1

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	147
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	0.57
γ_{cy} at N_f	[%]	5.88
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	171
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	234
Shear strain	[%]	15.20
Shear induced $\Delta\sigma'_v$	[kPa]	-47
Vertical stress	[kPa]	357
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.05
At 15 % shear strain		
Shear stress	[kPa]	234
Shear induced -$\Delta\sigma'_v$	[kPa]	-42
Vertical stress	[kPa]	352
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.55
Test number	CSS08

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

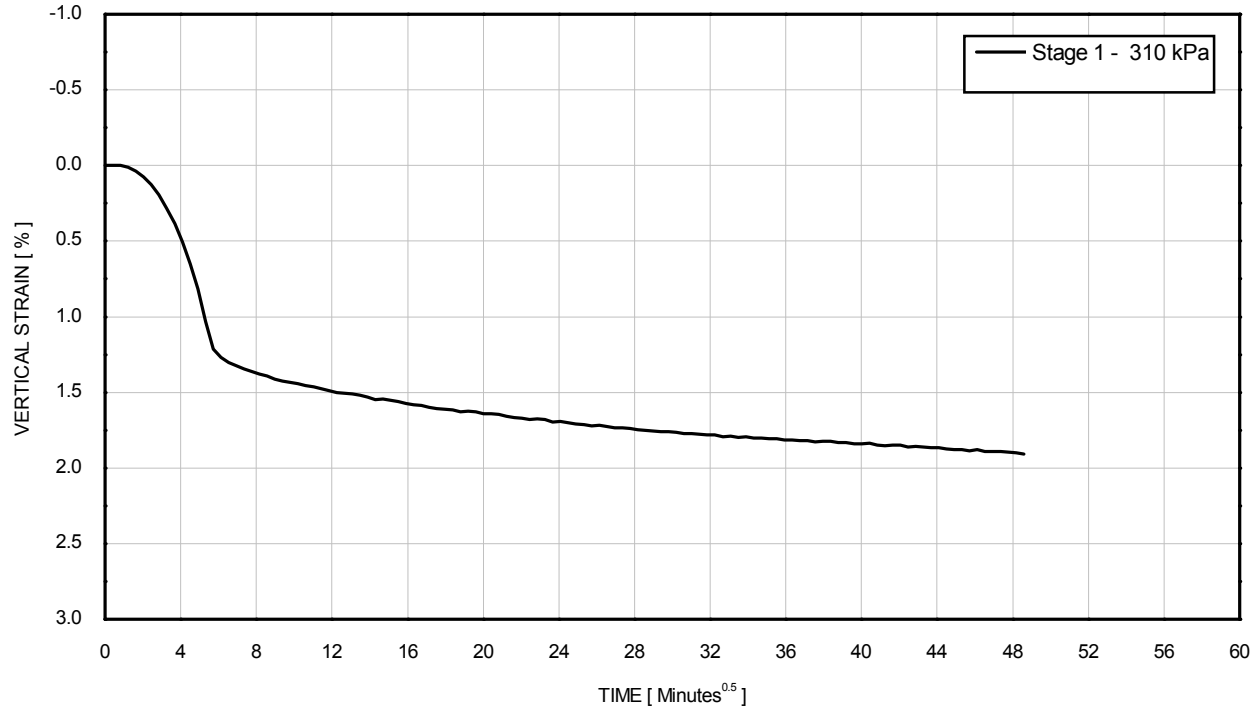
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

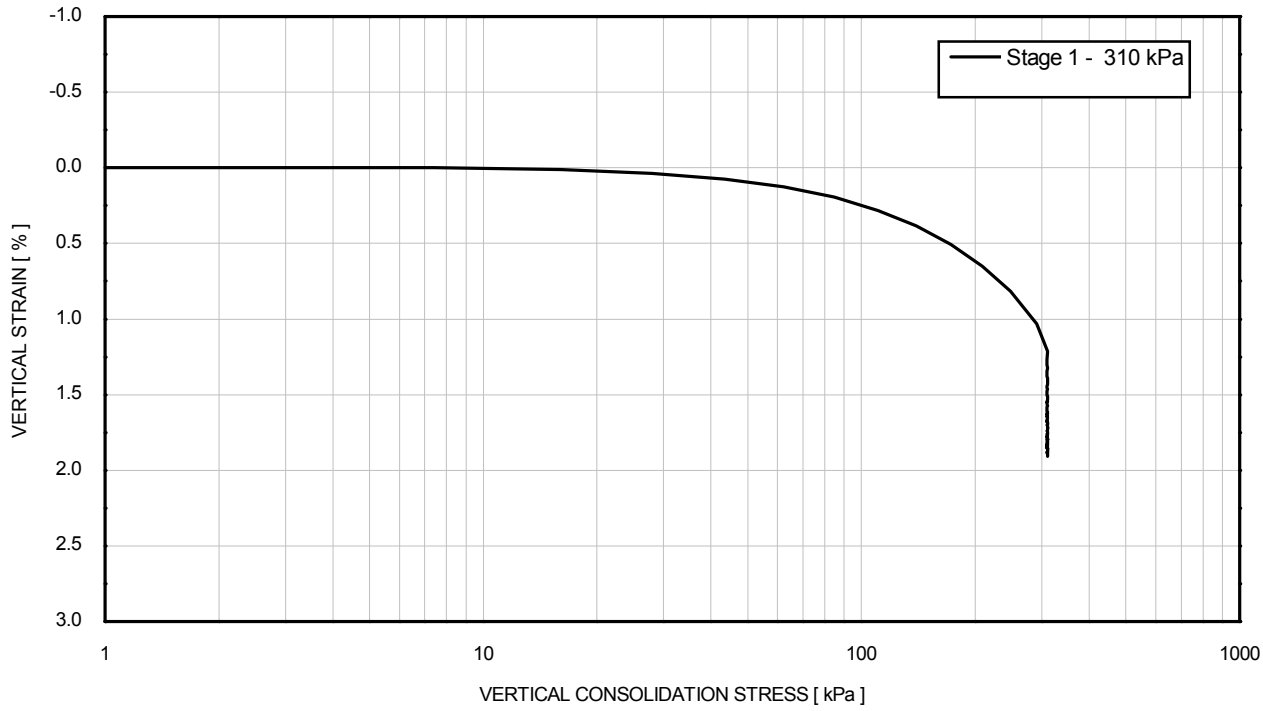
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.55
Test number	CSS08

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

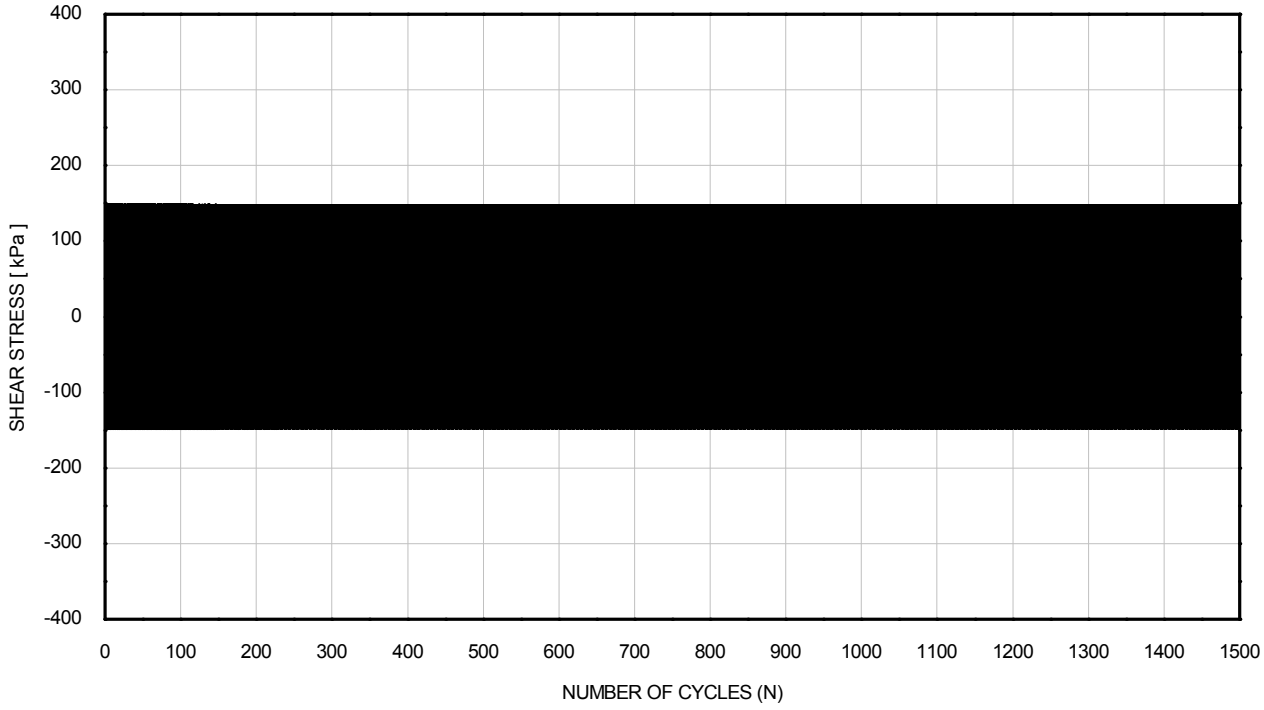


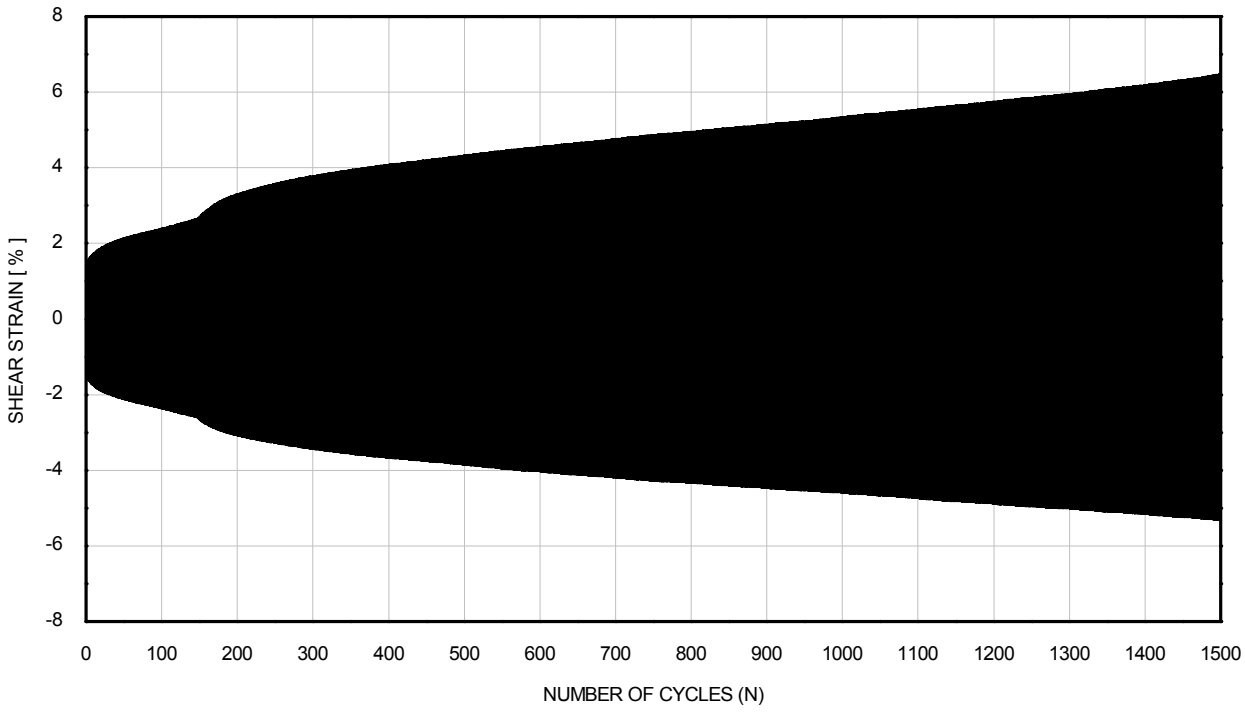


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
		Sample	: 19WAXD
		Depth [m]	: 33.55
		Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

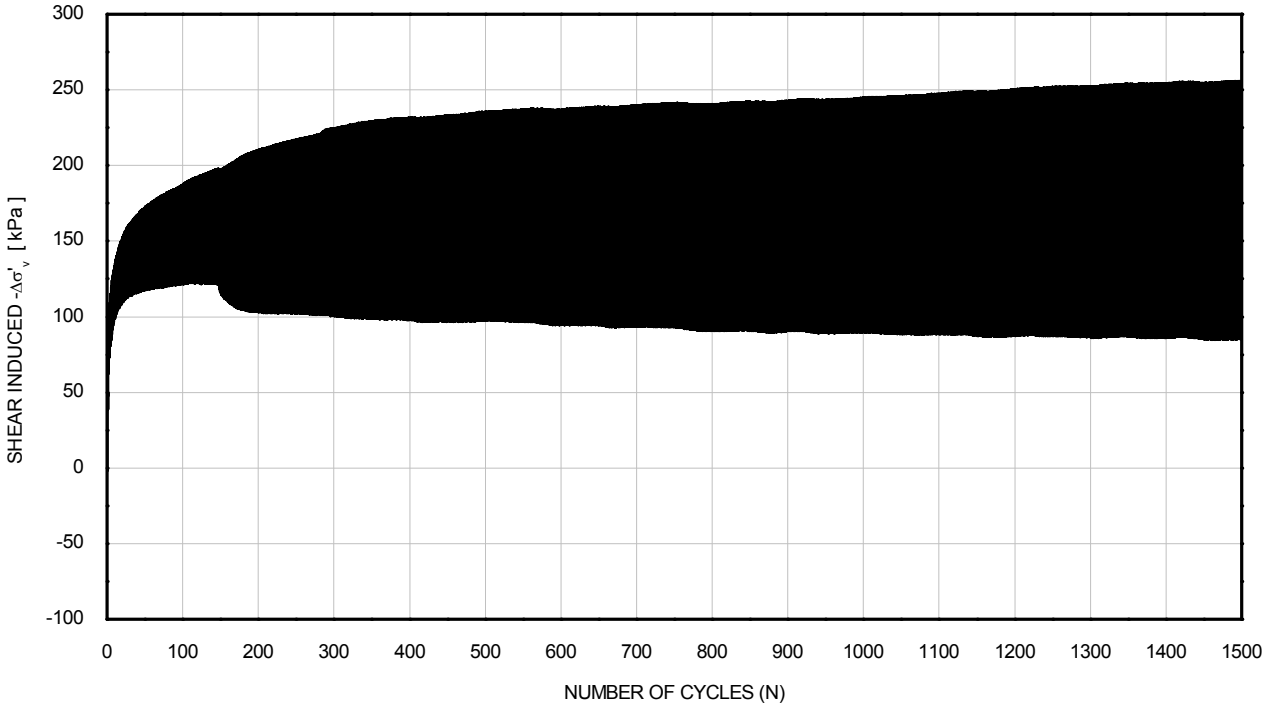


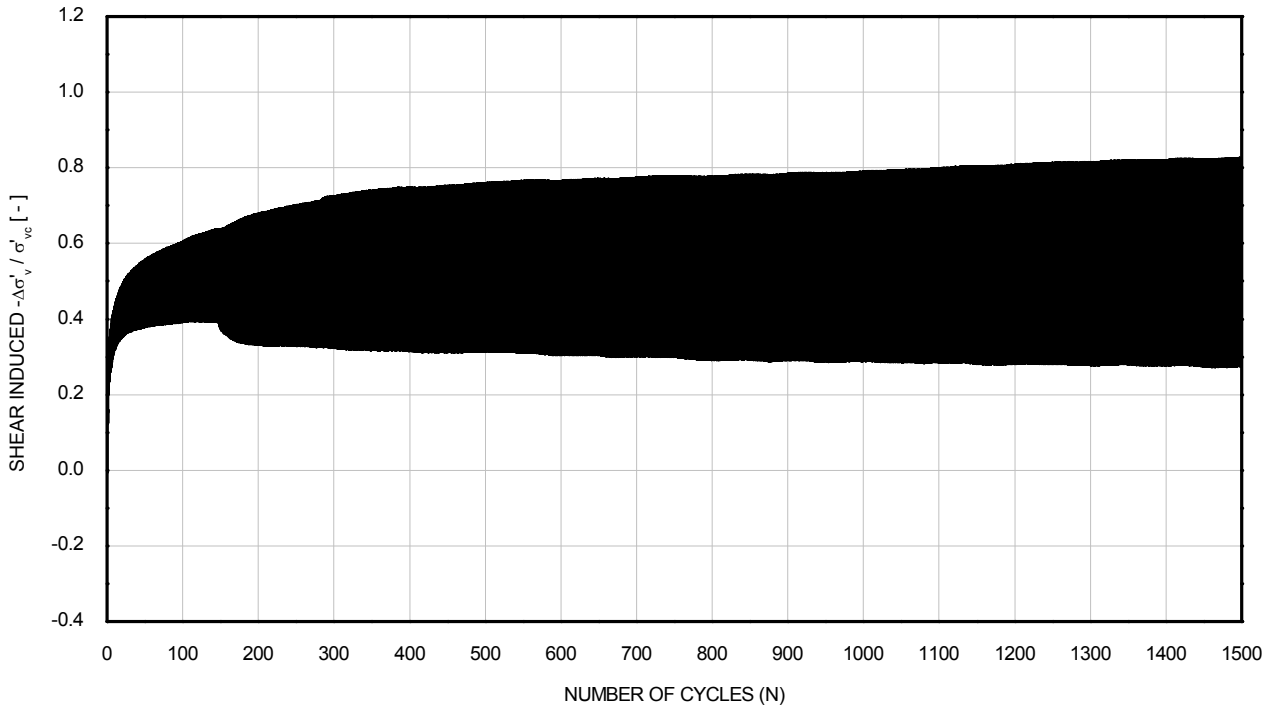


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	147 kPa	Depth [m]	:	33.55
Frequency	:	0.10 Hz	Test No.	:	CSS08

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

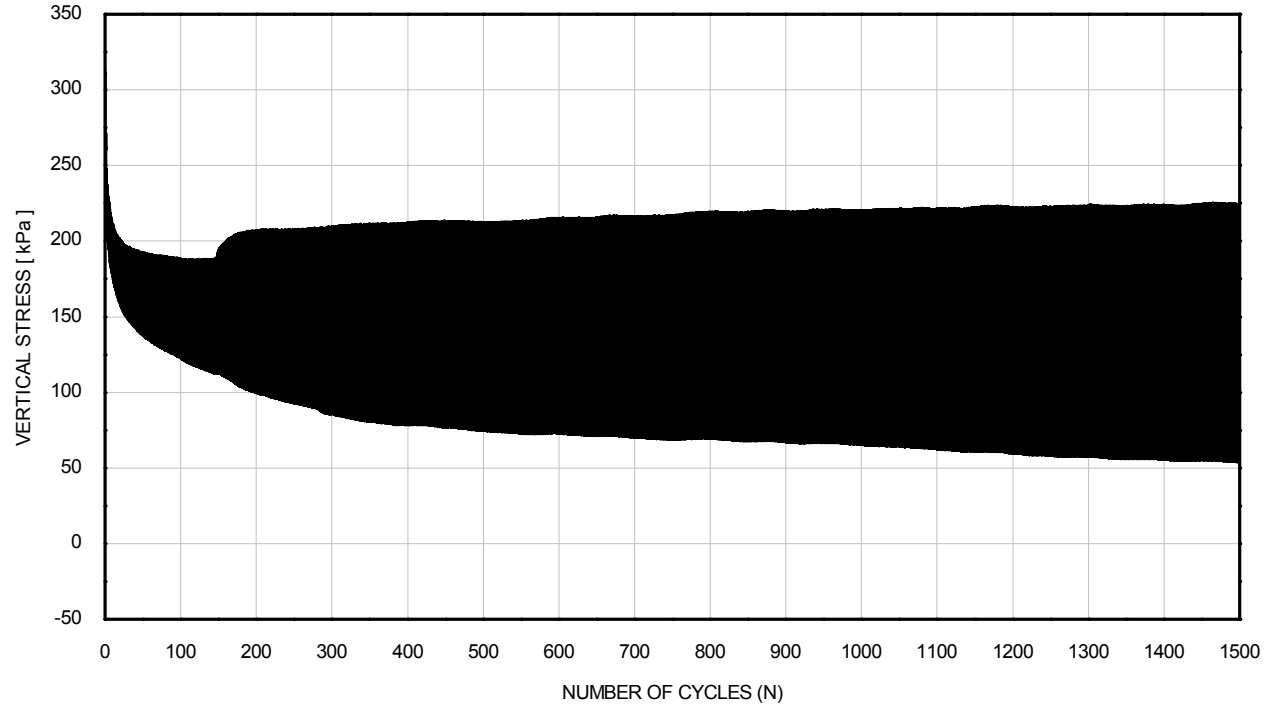


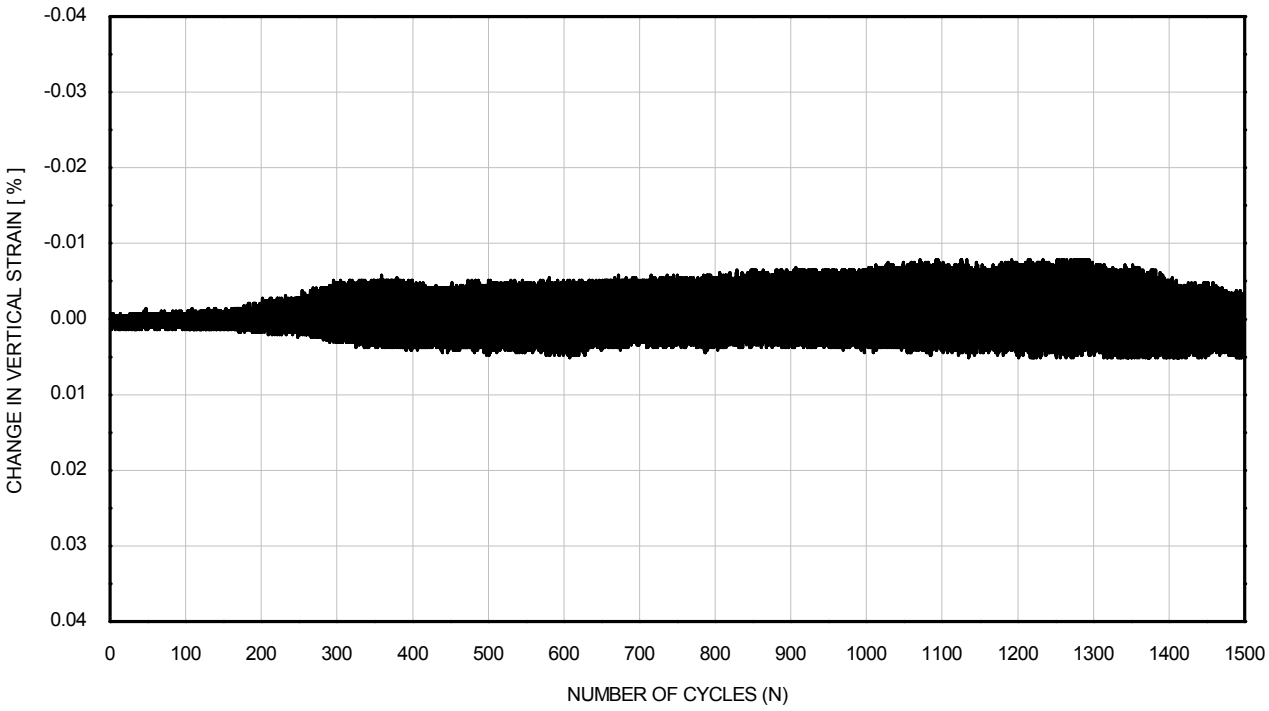


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	147 kPa	Depth [m]	:	33.55
Frequency	:	0.10 Hz	Test No.	:	CSS08

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

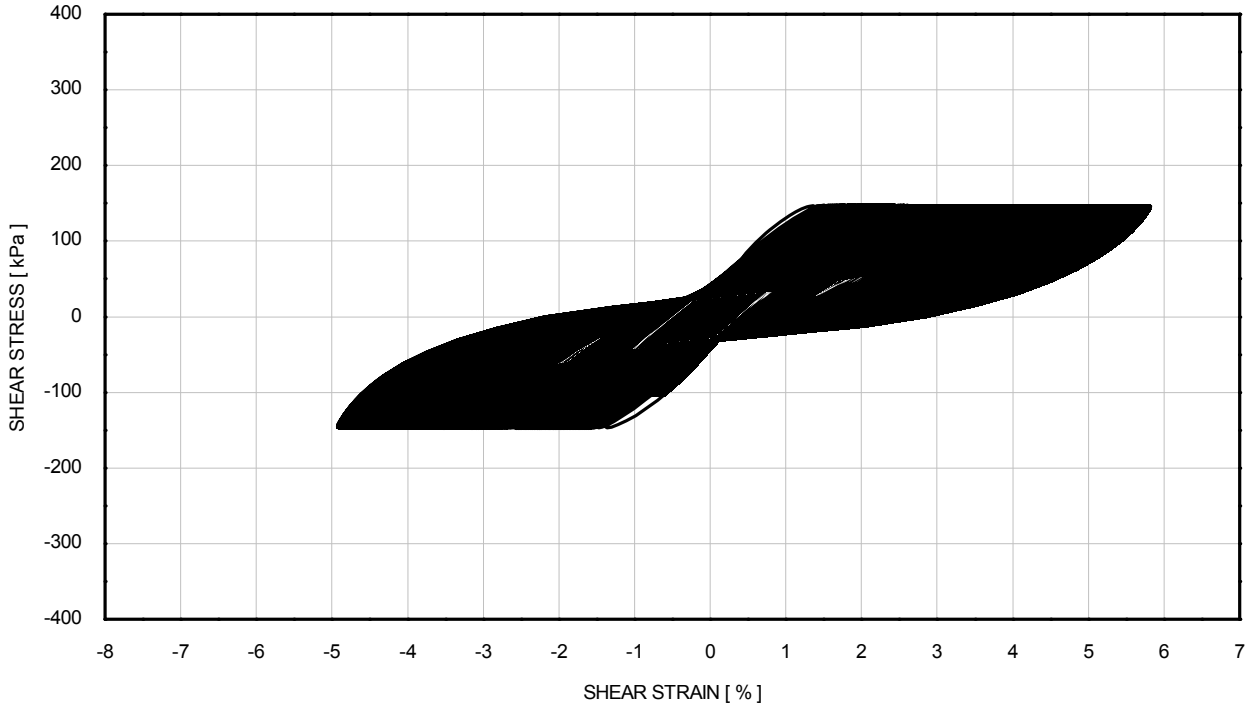


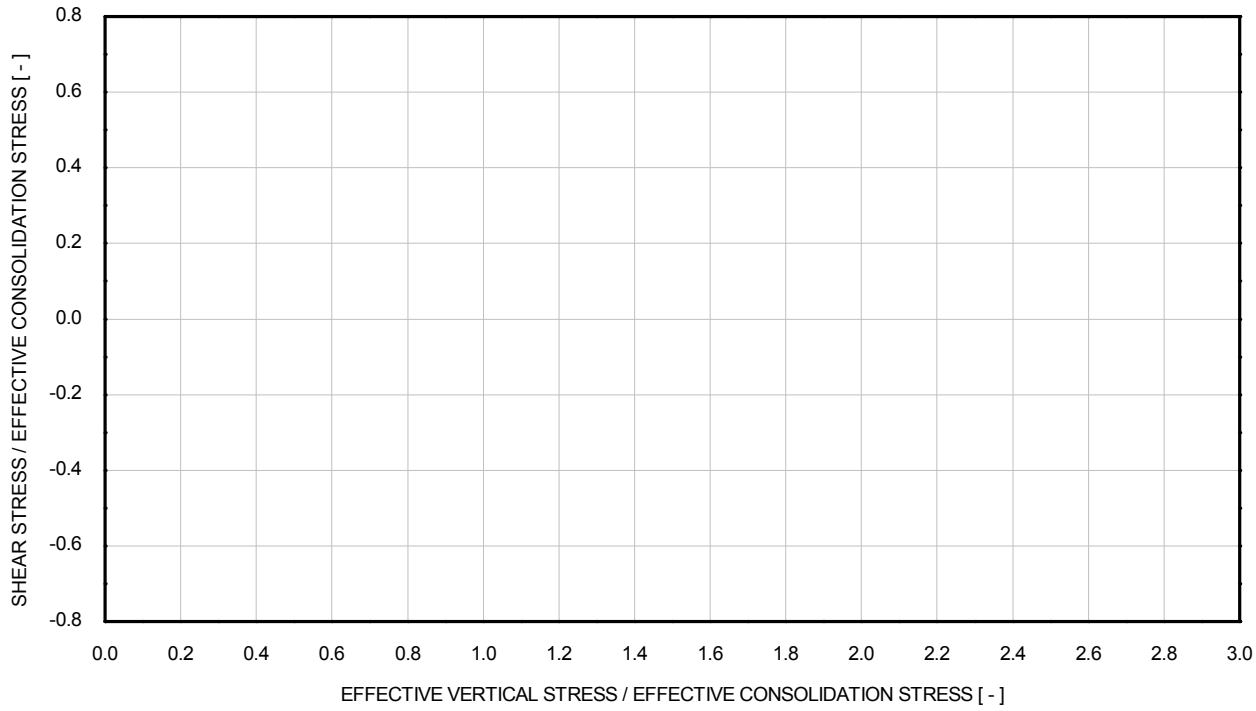


σ'_{vc}	:	310 kPa	Borehole	: BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	: 19WAXD
Mean τ_{cy}	:	147 kPa	Depth [m]	: 33.55
Frequency	:	0.10 Hz	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

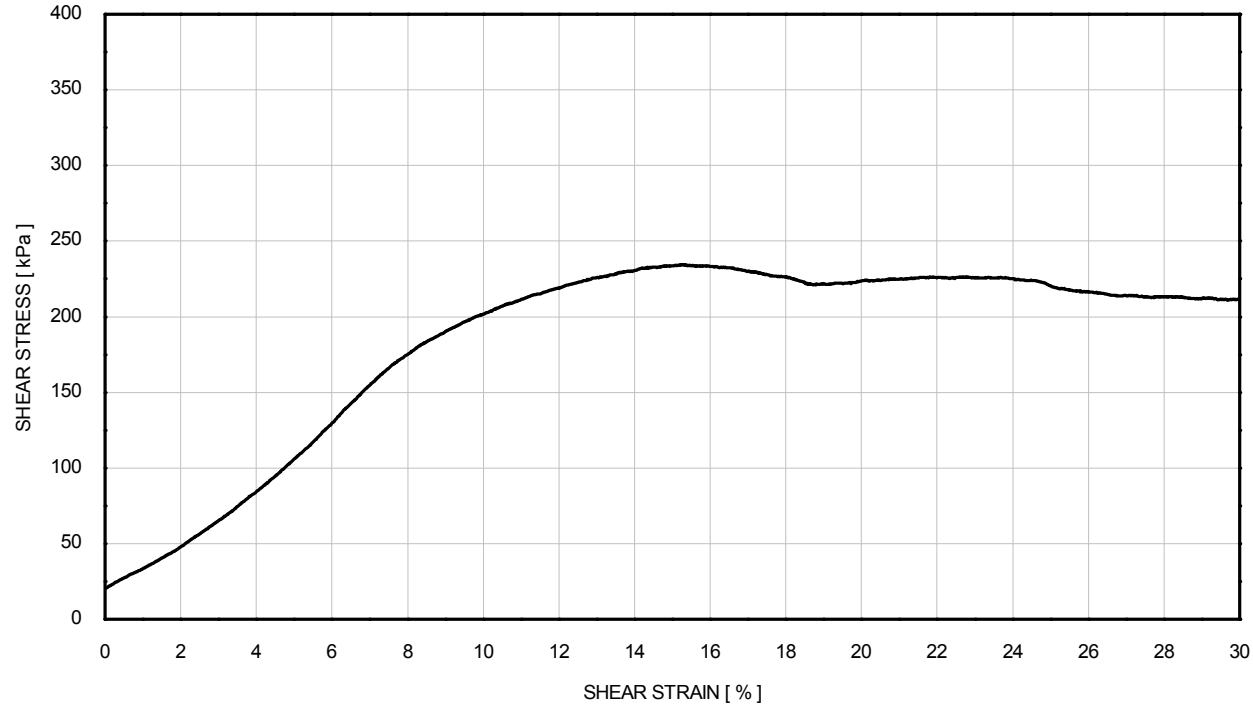


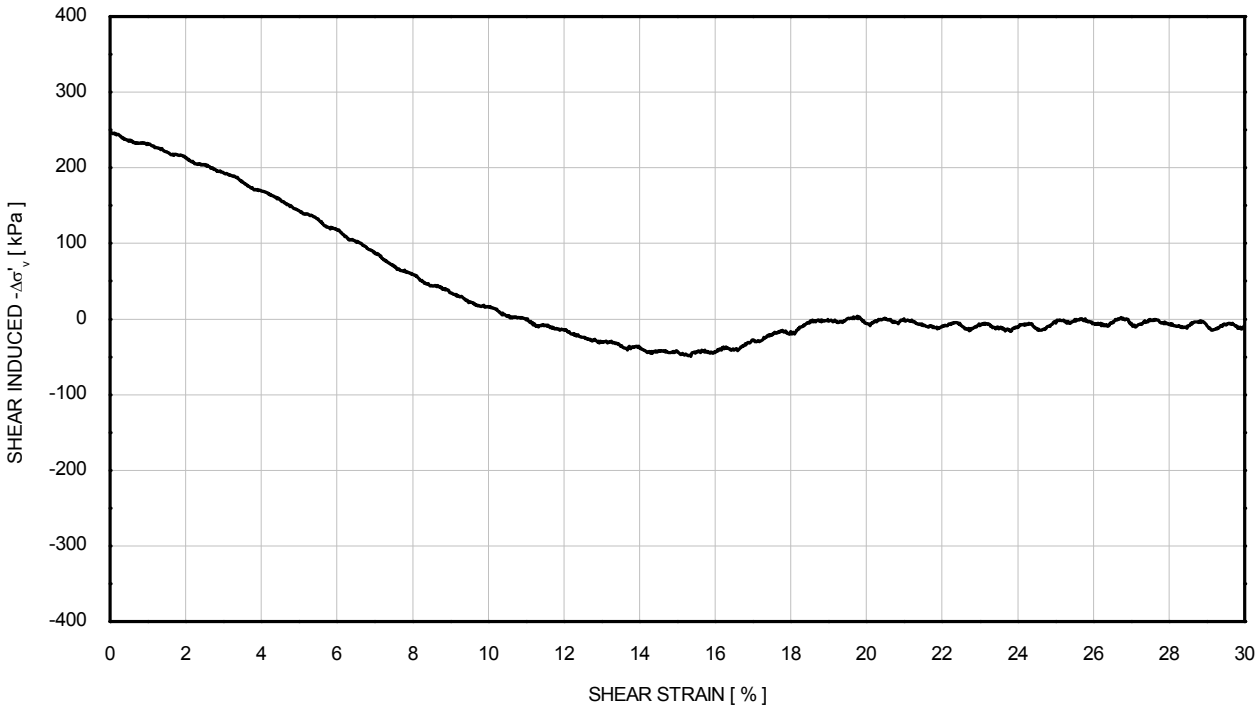


σ'_{vc}	:	310 kPa	Borehole	: BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	: 19WAXD
Mean τ_{cy}	:	147 kPa	Depth [m]	: 33.55
Frequency	:	0.10 Hz	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

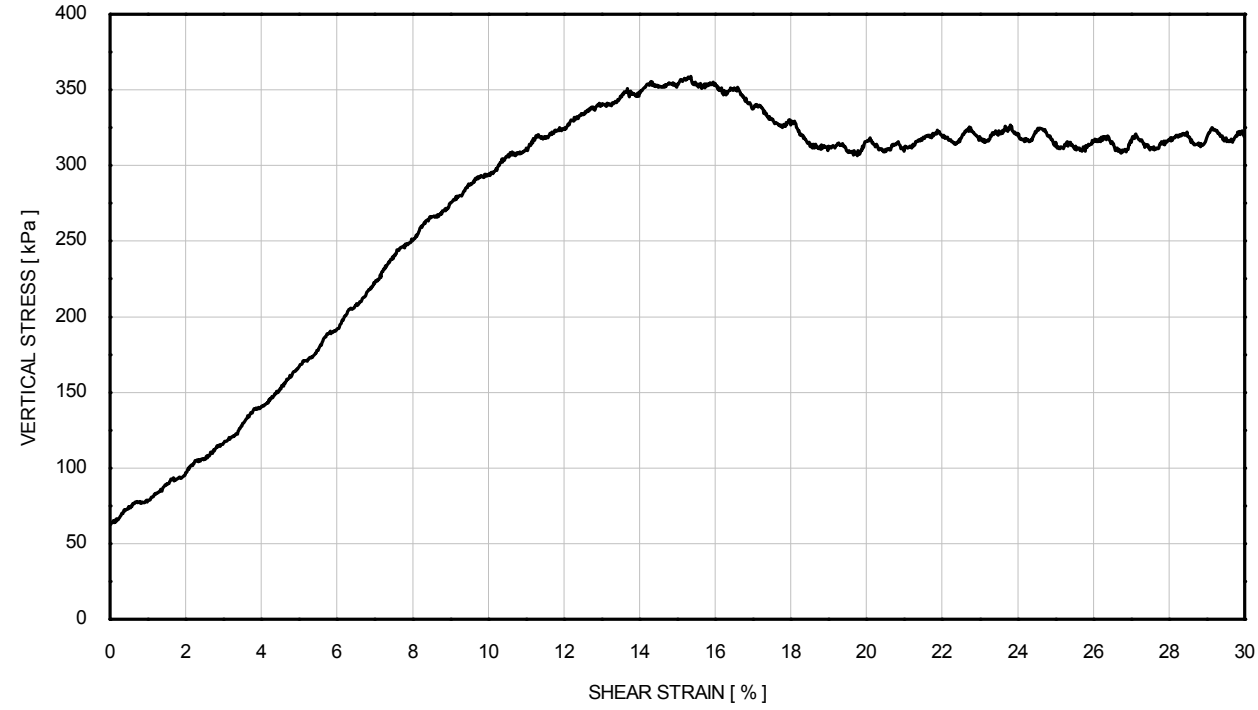


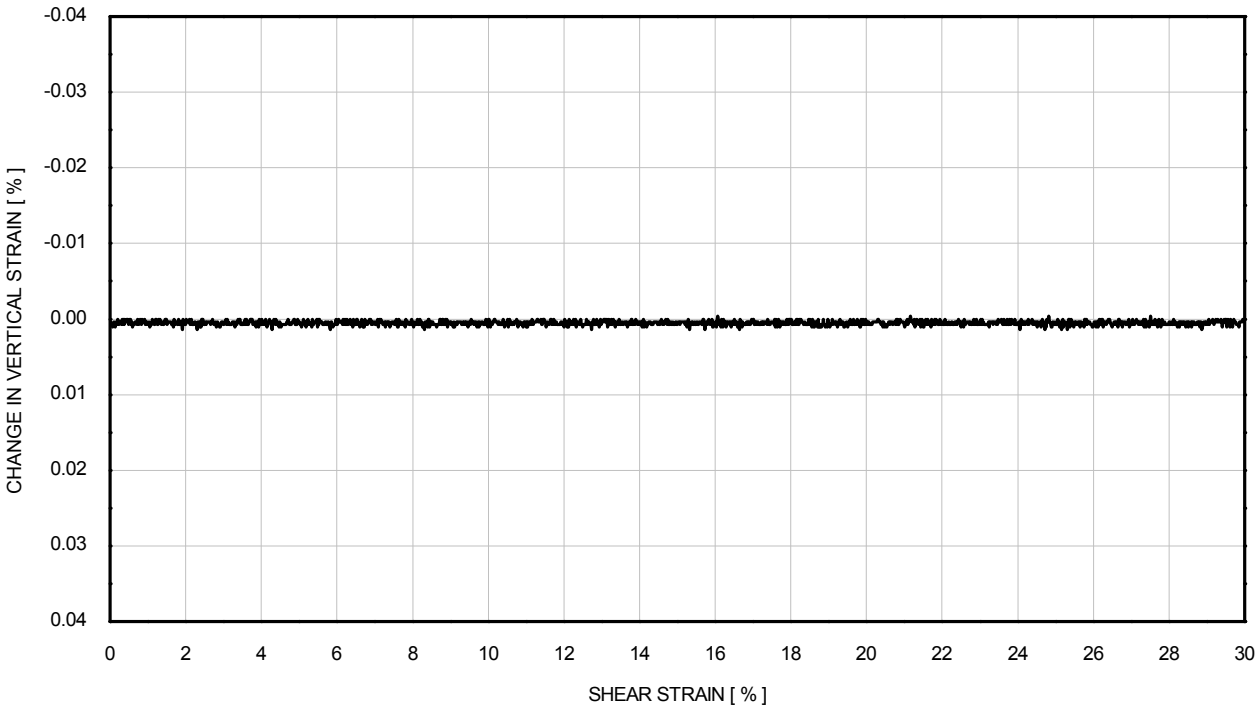


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 234 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 15.20 %	Depth [m]	: 33.55
Rate of strain	: 3.05 %/hour	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

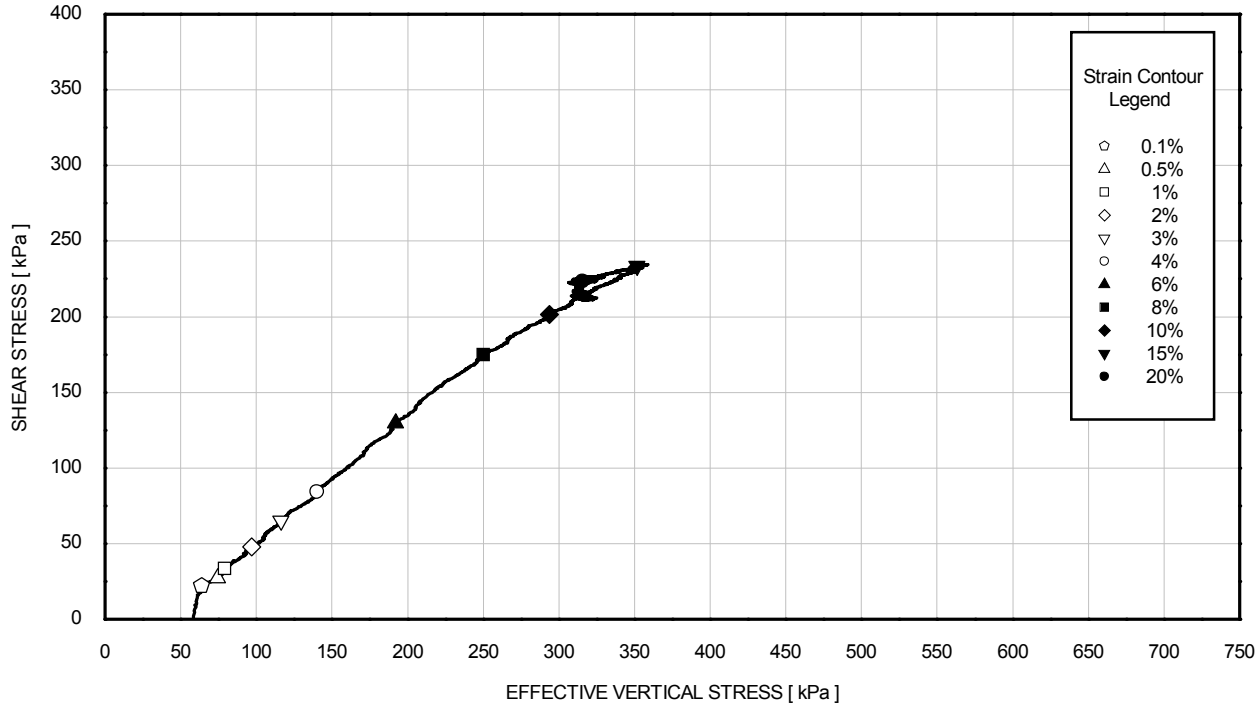


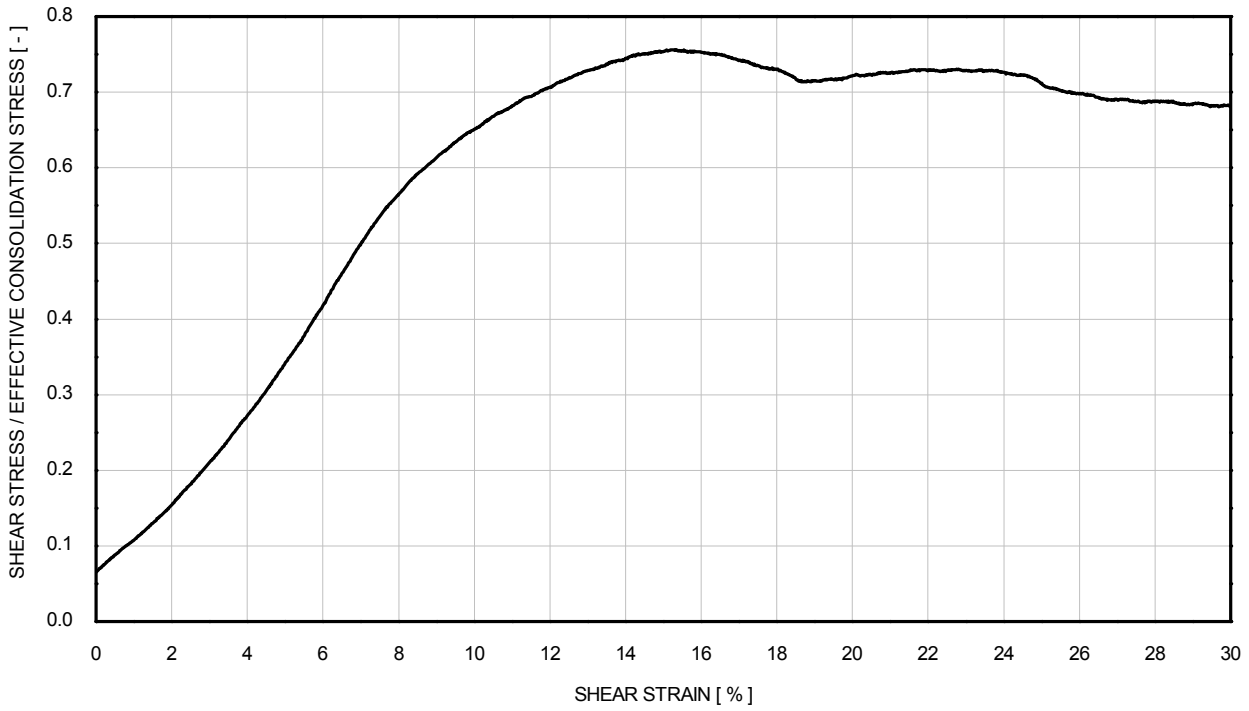


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 234 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 15.20 %	Depth [m]	: 33.55
Rate of strain	: 3.05 %/hour	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

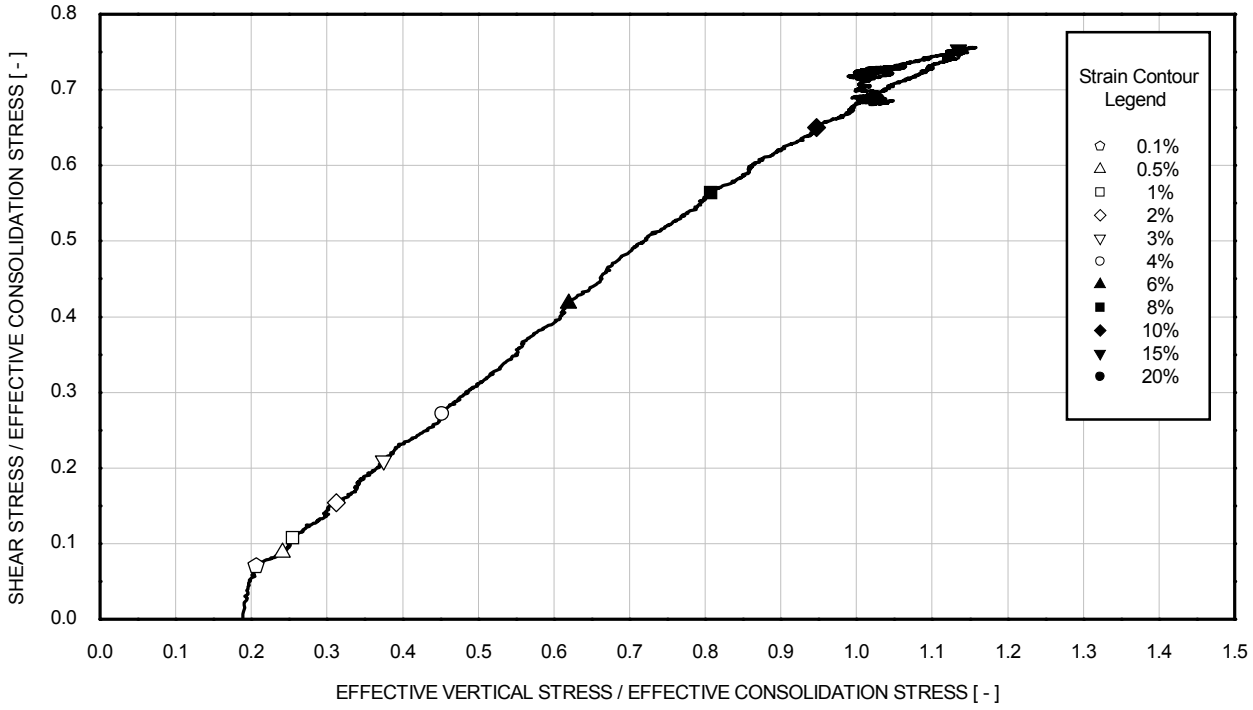


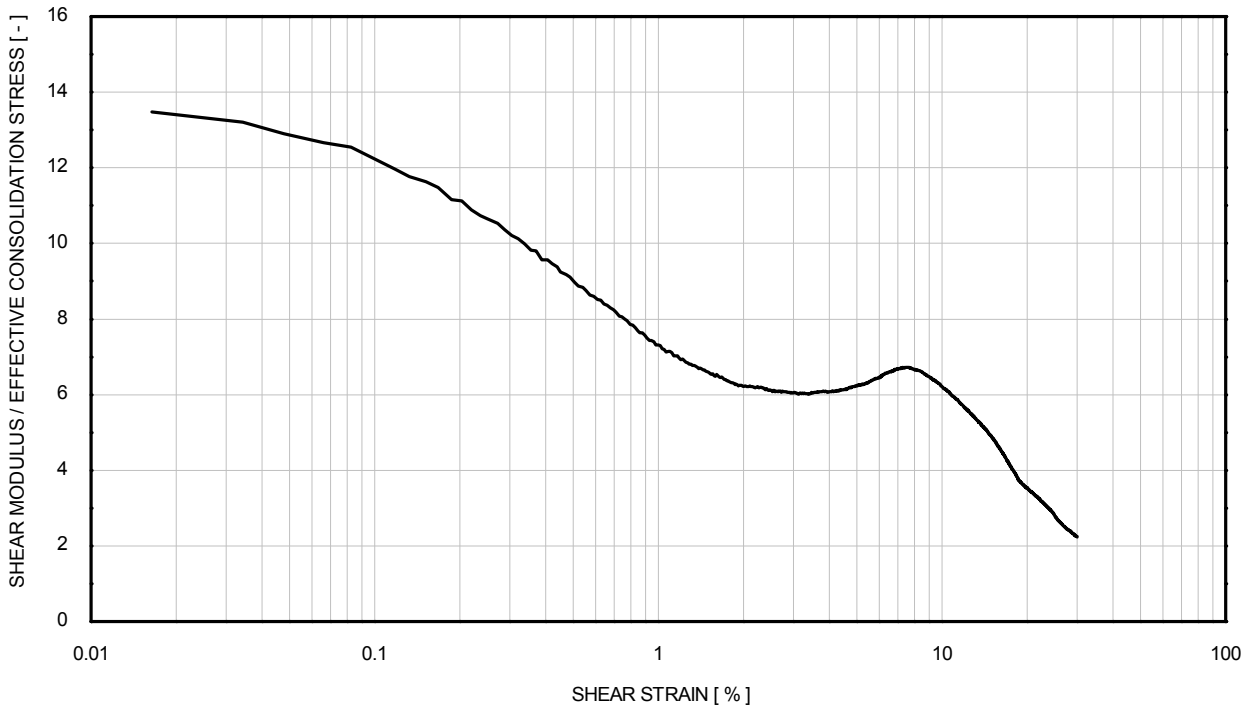


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 234 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 15.20 %	Depth [m]	: 33.55
Rate of strain	: 3.05 %/hour	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 234 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 15.20 %	Depth [m]	: 33.55
Rate of strain	: 3.05 %/hour	Test No.	: CSS08

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark greenish grey CLAY

GENERAL	
Date test started	27/07/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	66.0
Length	[mm]	30.0
Moisture content	[%]	40.6
Bulk density	[Mg/m³]	1.80
Dry density	[Mg/m³]	1.28
Void ratio	[-]	1.113
Degree of saturation	[%]	99
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	163
Pocket penetrometer	[kPa]	267
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_19D_CSS09
Template issue	1.2
Processed by	HB
Date	10/08/2015
Checked by	PH
Date	11/08/2015
Approved by	PH
Date	18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXD
Depth [m]	33.59
Test number	CSS09

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.58
Bulk density	[Mg/m^3]	1.81
Dry density	[Mg/m^3]	1.30
Void ratio	[-]	1.079
Moisture content	[%]	39.4

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	168
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	1500
γ_{av} at N_f	[%]	0.83
γ_{cy} at N_f	[%]	4.49
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	169
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	285
Shear strain	[%]	14.23
Shear induced $\Delta\sigma'_v$	[kPa]	-60
Vertical stress	[kPa]	370
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	2.86
At 15 % shear strain		
Shear stress	[kPa]	281
Shear induced -$\Delta\sigma'_v$	[kPa]	-46
Vertical stress	[kPa]	356
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXD
Depth [m]	33.59
Test number	CSS09

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

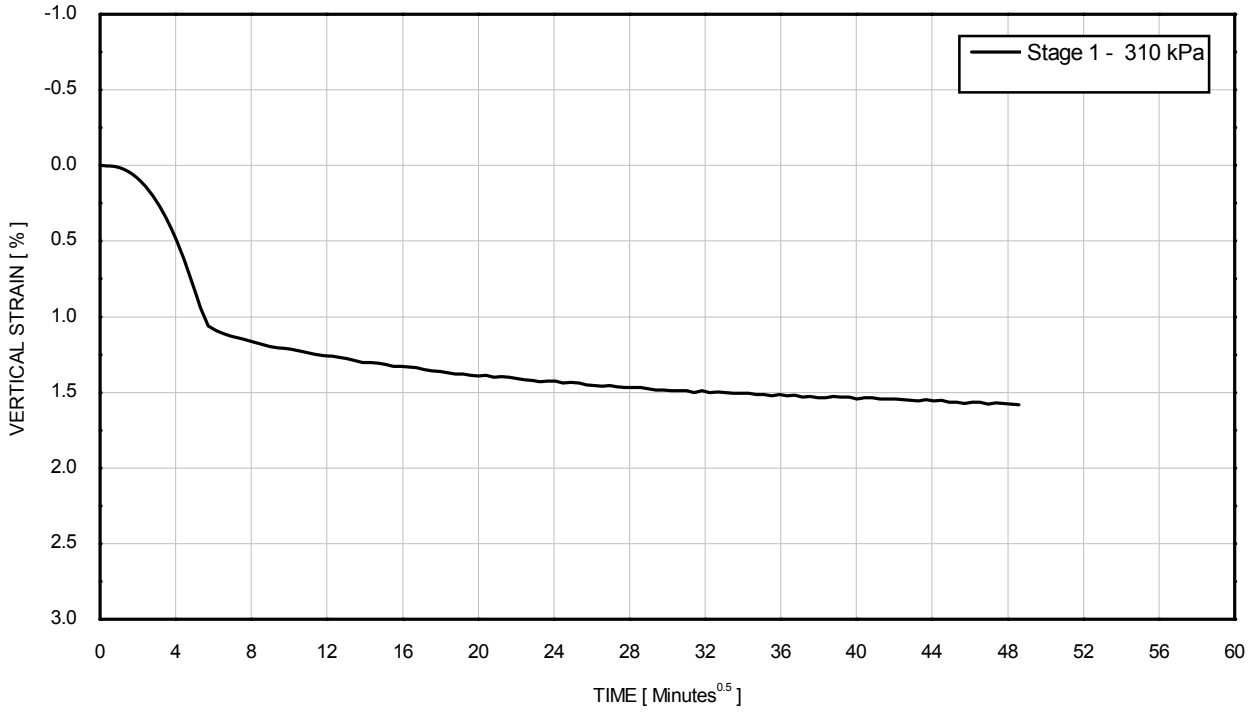
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

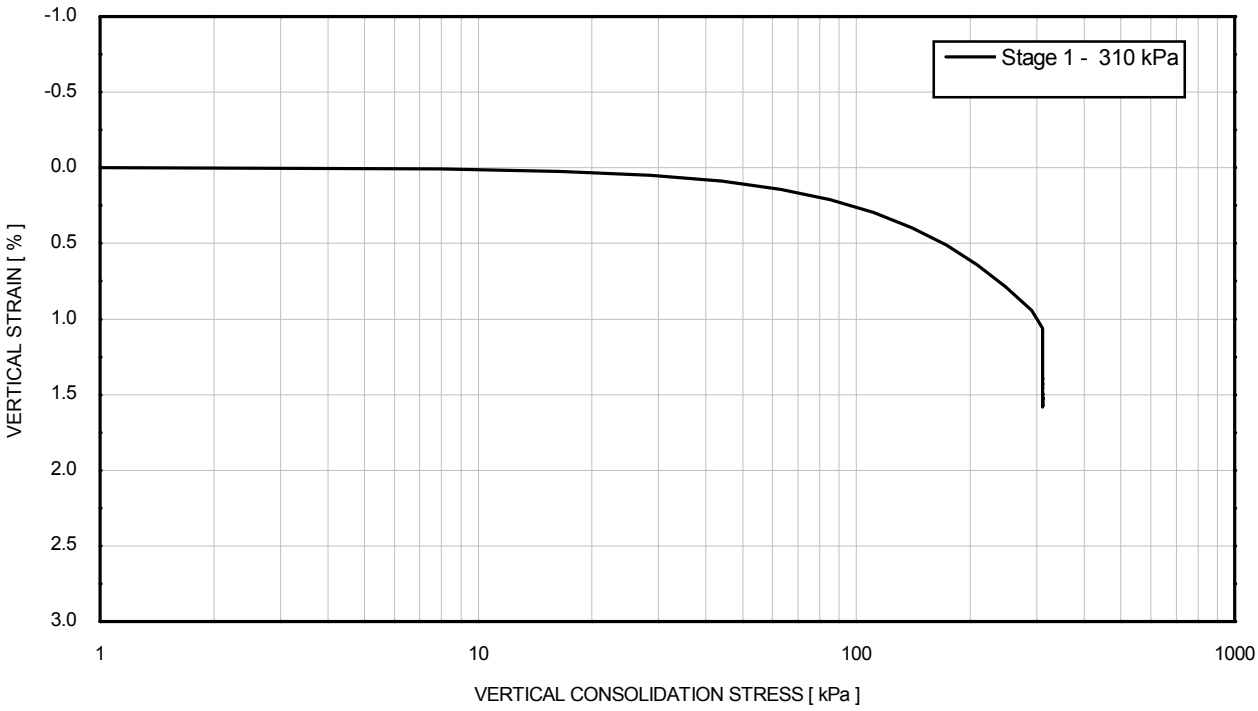
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS2-7
Sample	19WAXD
Depth [m]	33.59
Test number	CSS09

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

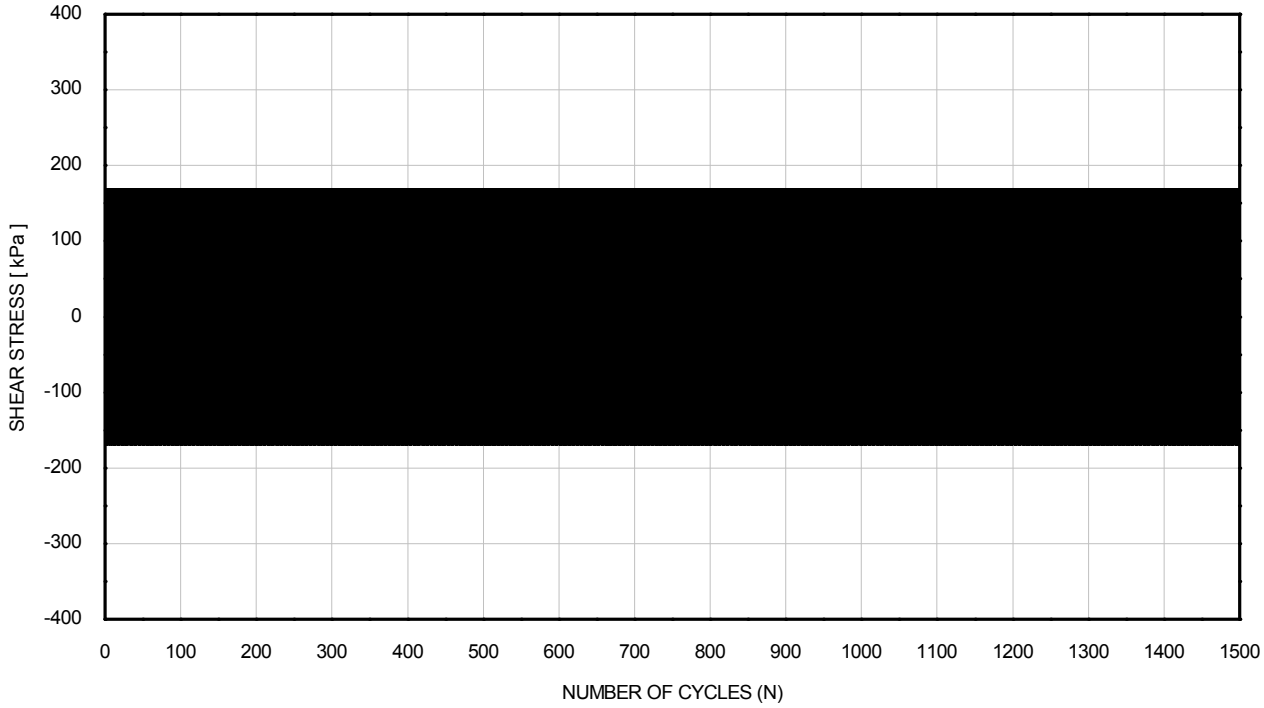


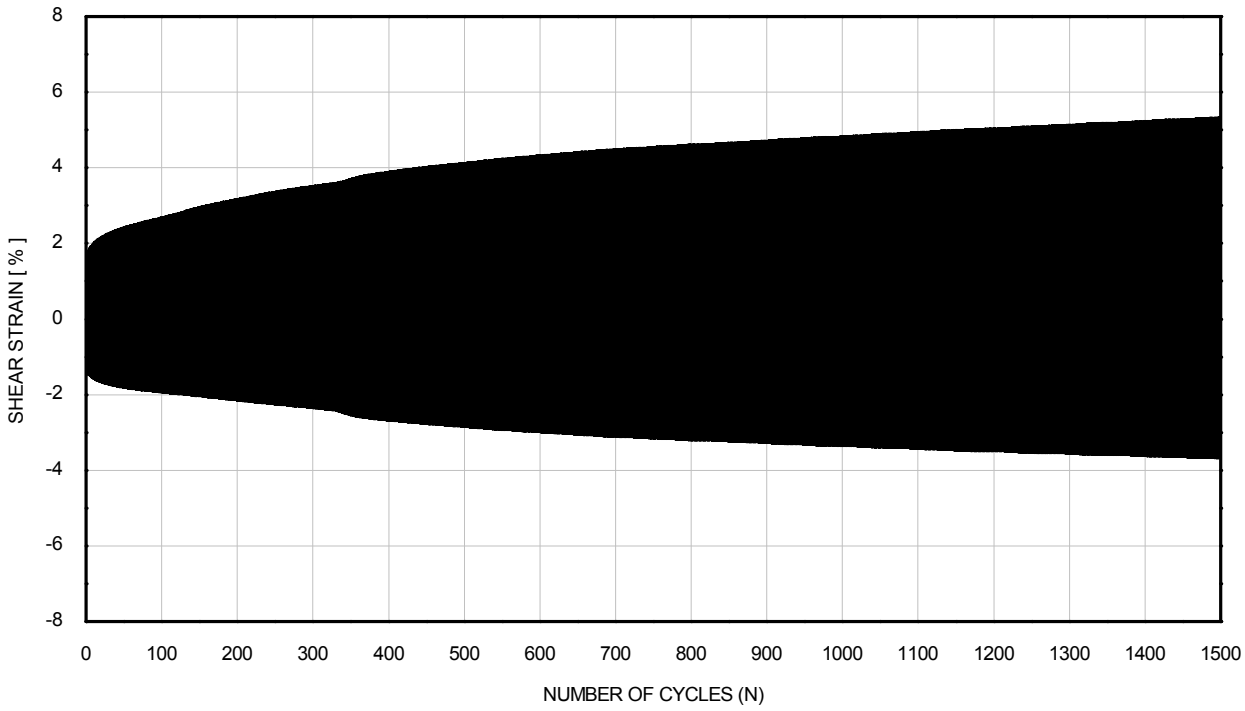


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
		Sample	: 19WAXD
		Depth [m]	: 33.59
		Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

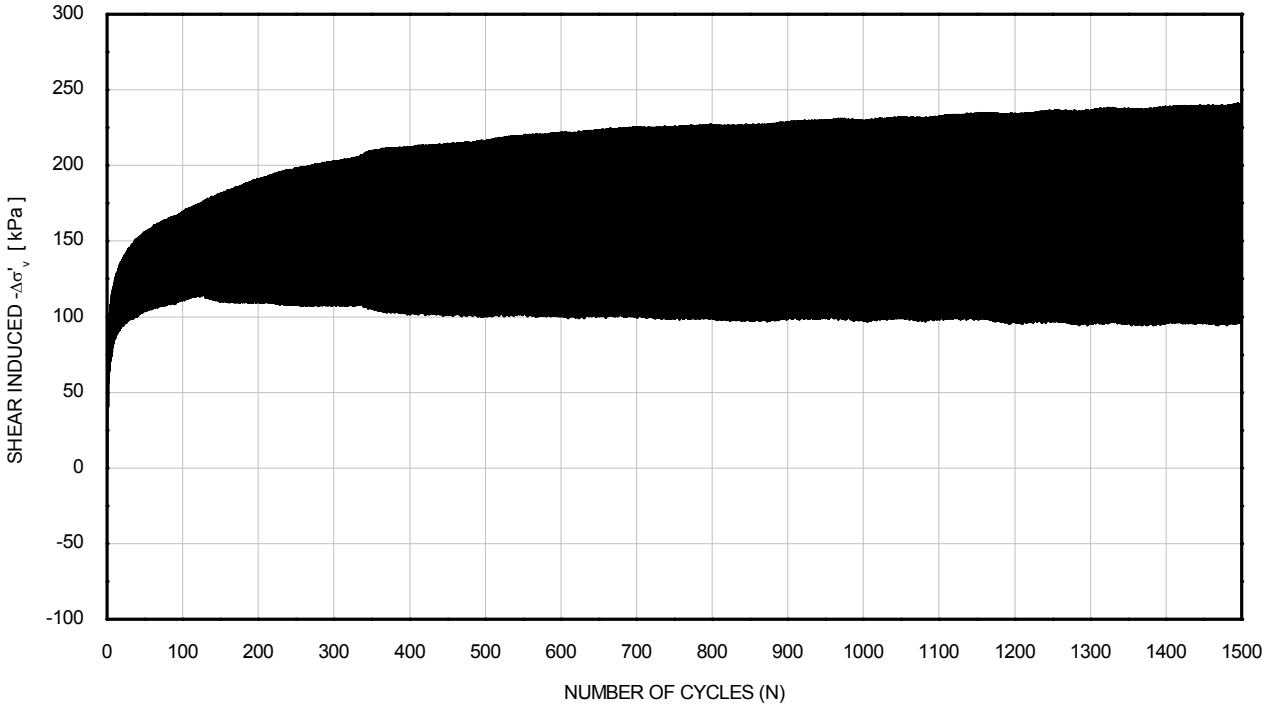


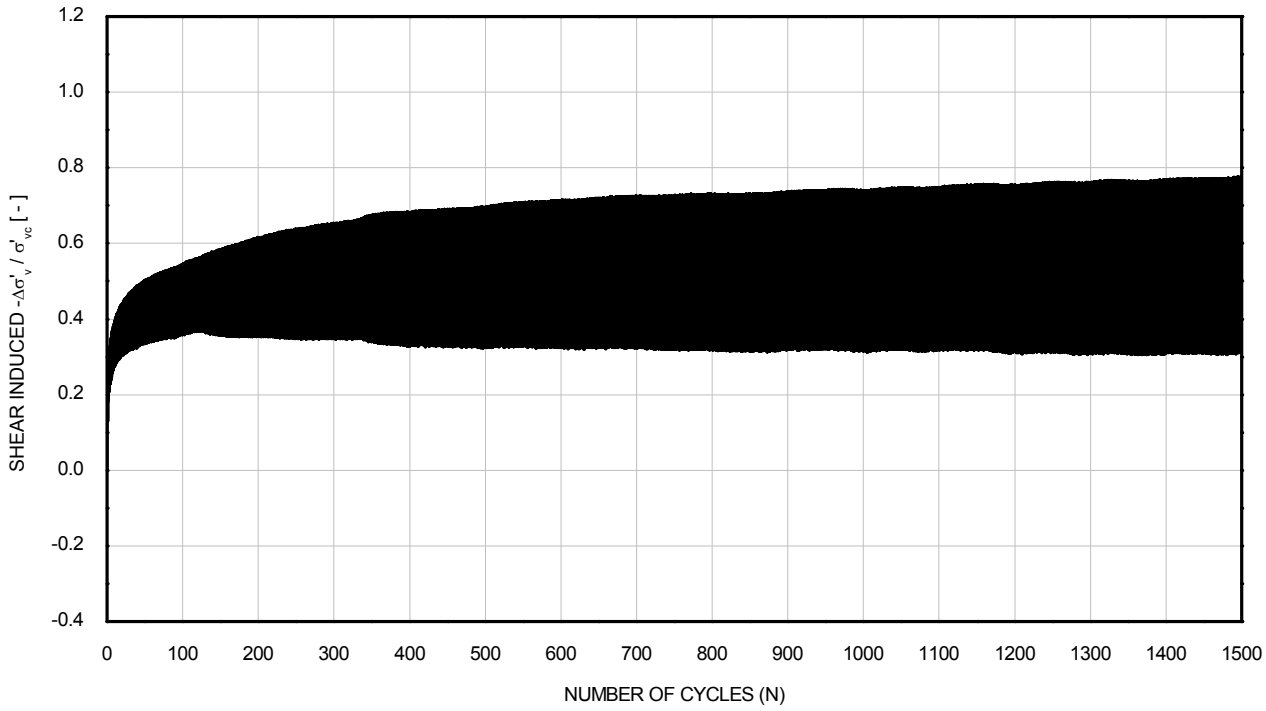


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	168 kPa	Depth [m]	:	33.59
Frequency	:	0.10 Hz	Test No.	:	CSS09

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

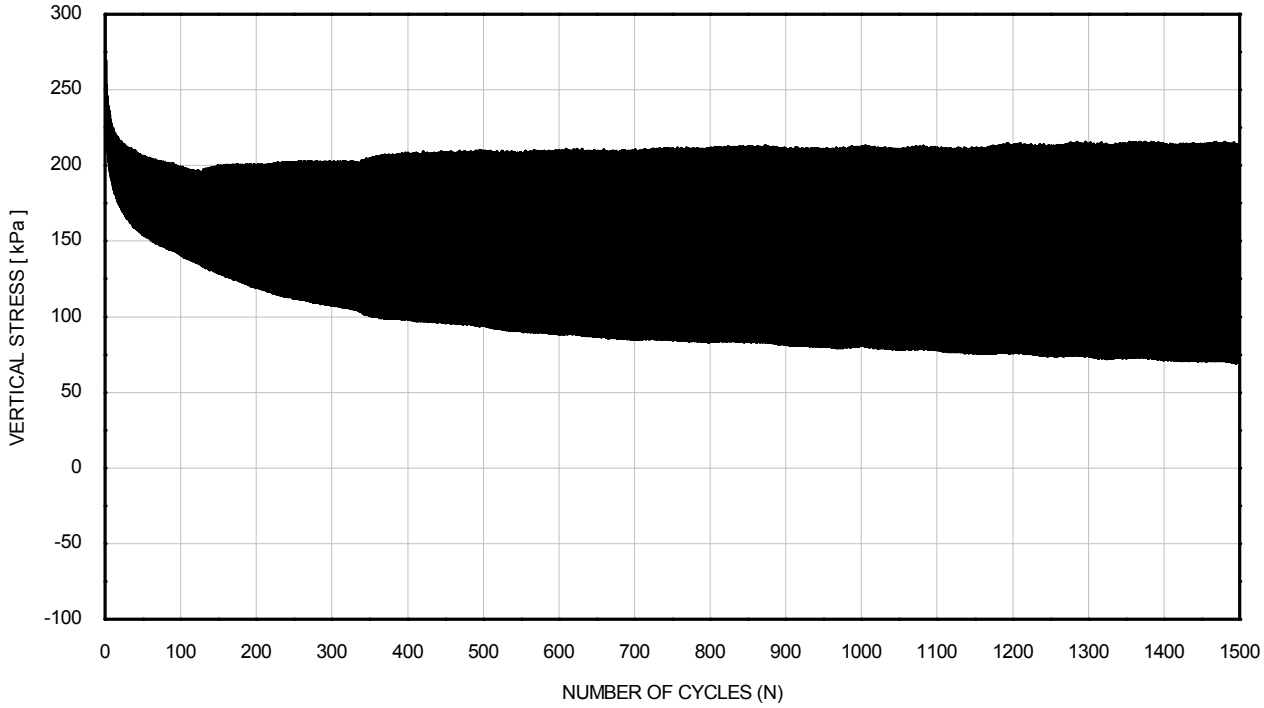


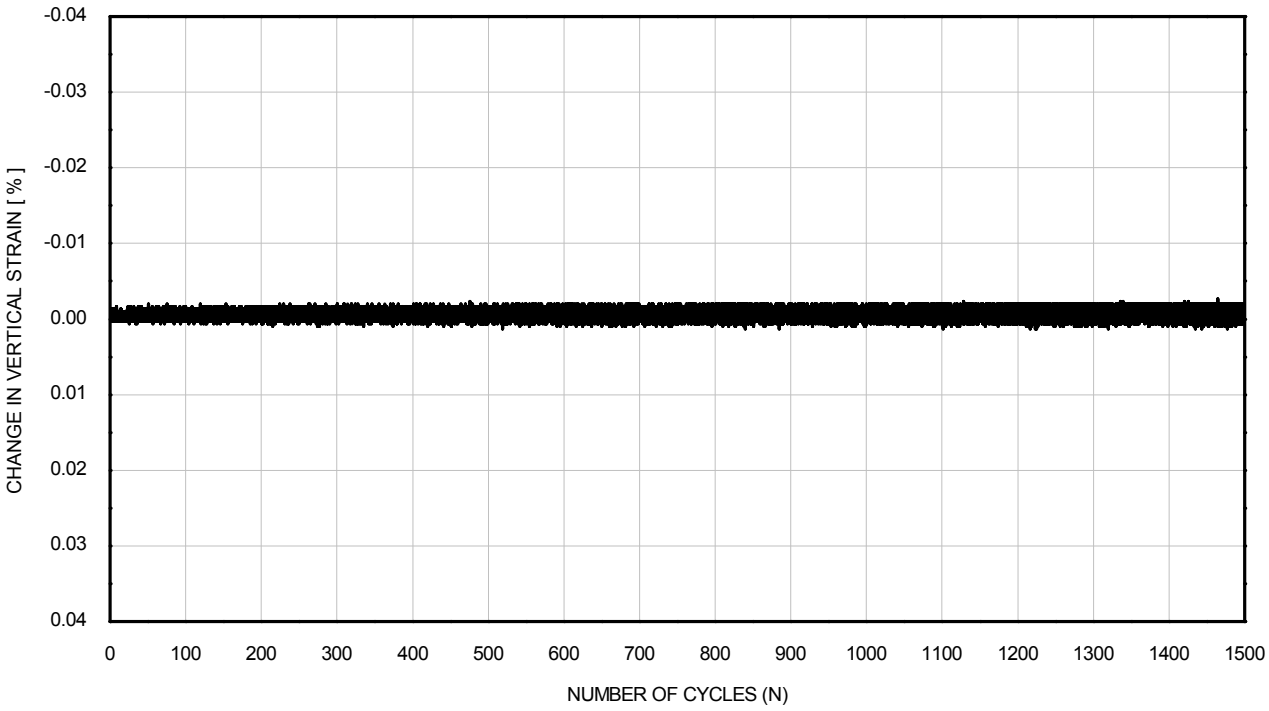


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	168 kPa	Depth [m]	:	33.59
Frequency	:	0.10 Hz	Test No.	:	CSS09

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

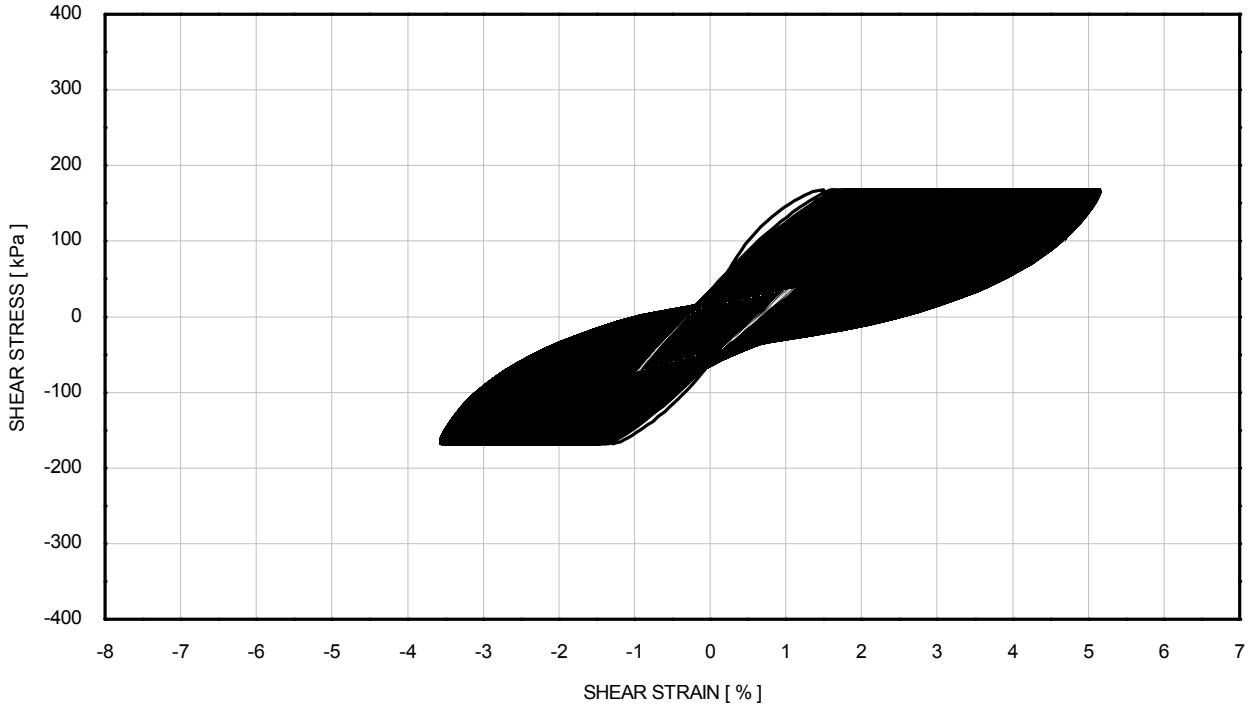


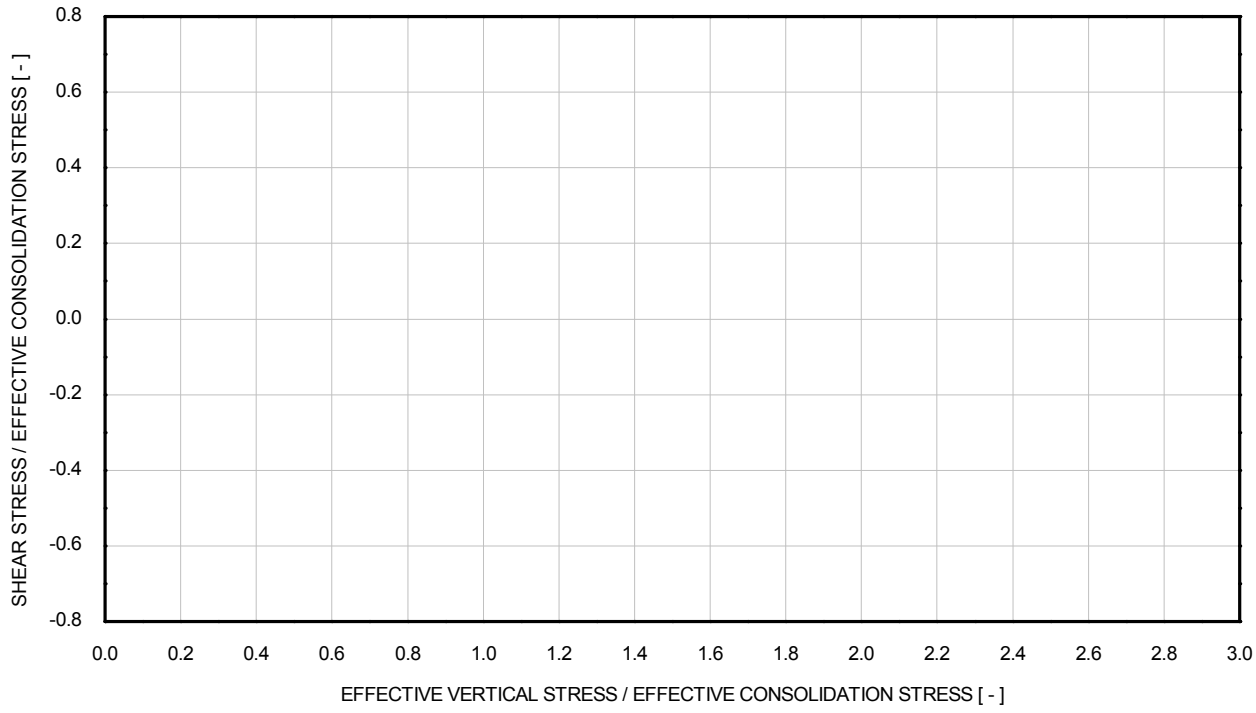


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	168 kPa	Depth [m]	:	33.59
Frequency	:	0.10 Hz	Test No.	:	CSS09

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

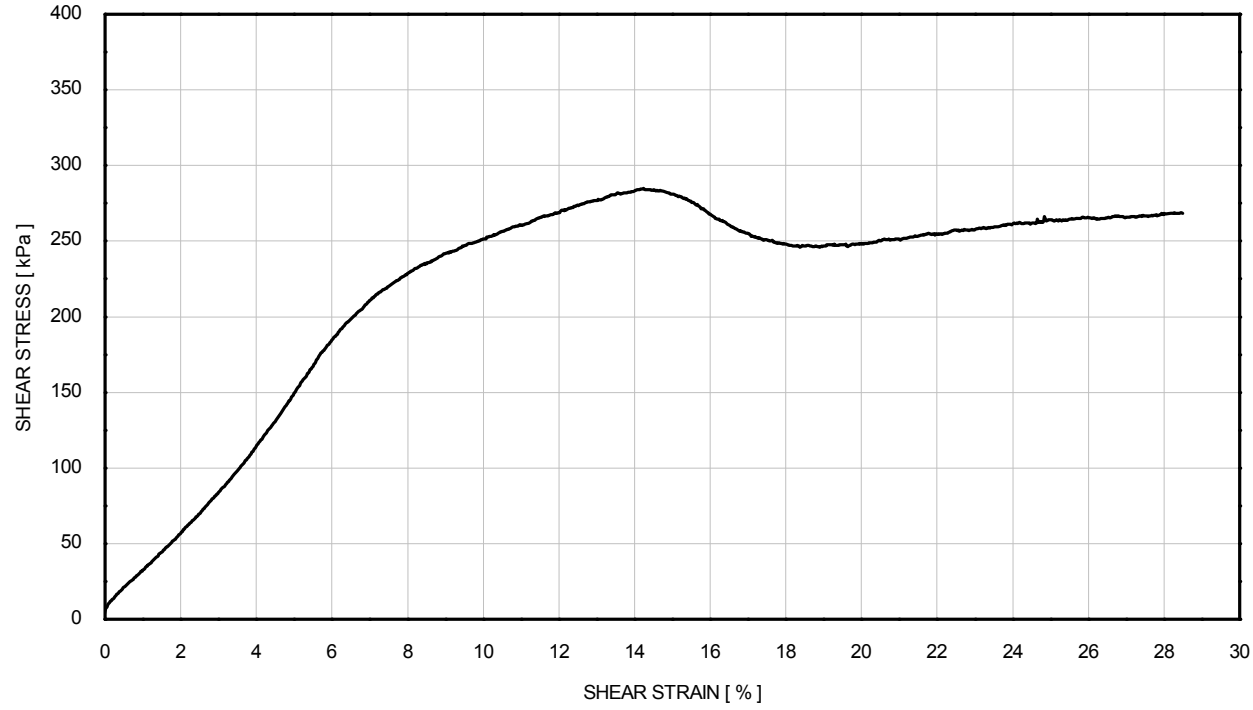


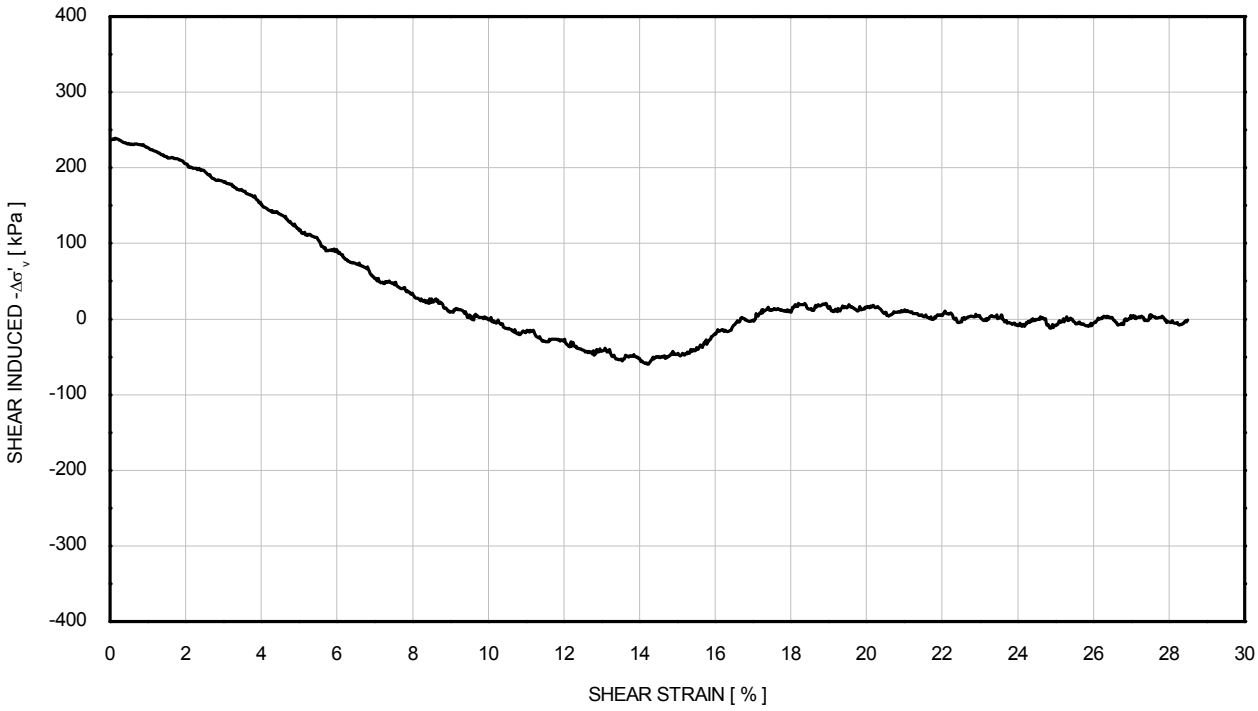


σ'_{vc}	:	310 kPa	Borehole	: BH-WFS2-7
Mean τ_{av}	:	0 kPa	Sample	: 19WAXD
Mean τ_{cy}	:	168 kPa	Depth [m]	: 33.59
Frequency	:	0.10 Hz	Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

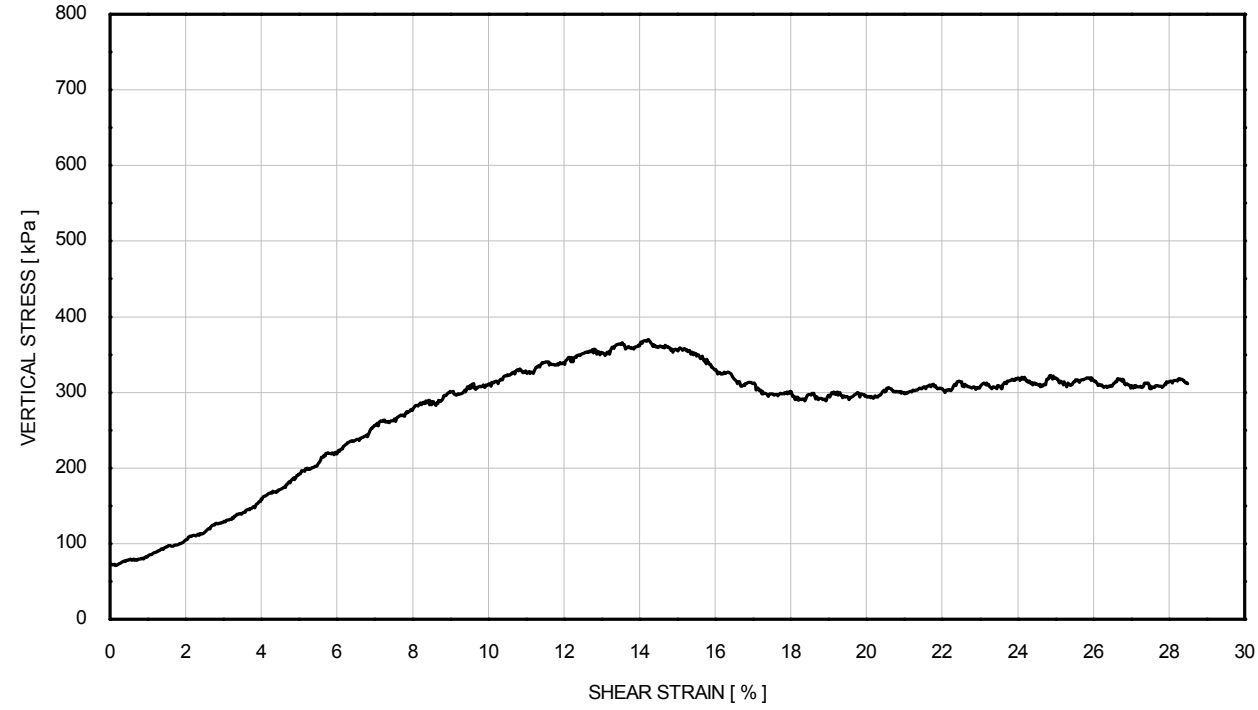


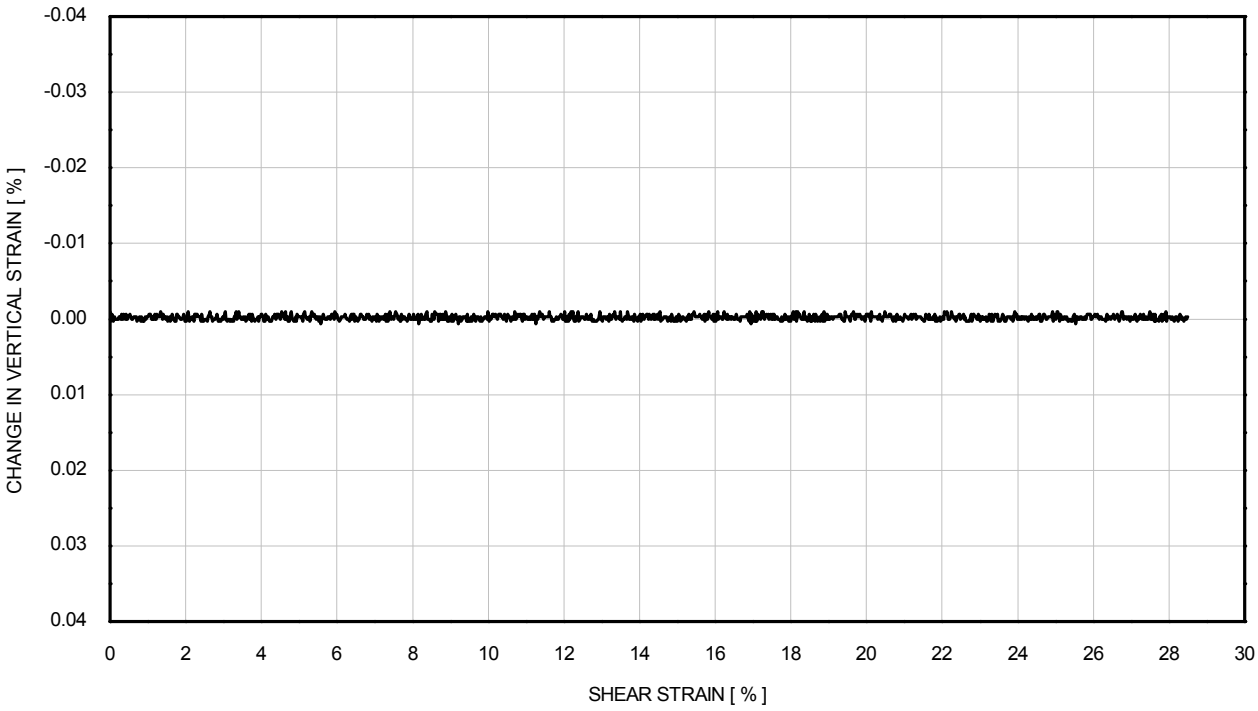


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 285 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 14.23 %	Depth [m]	: 33.59
Rate of strain	: 2.86 %/hour	Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

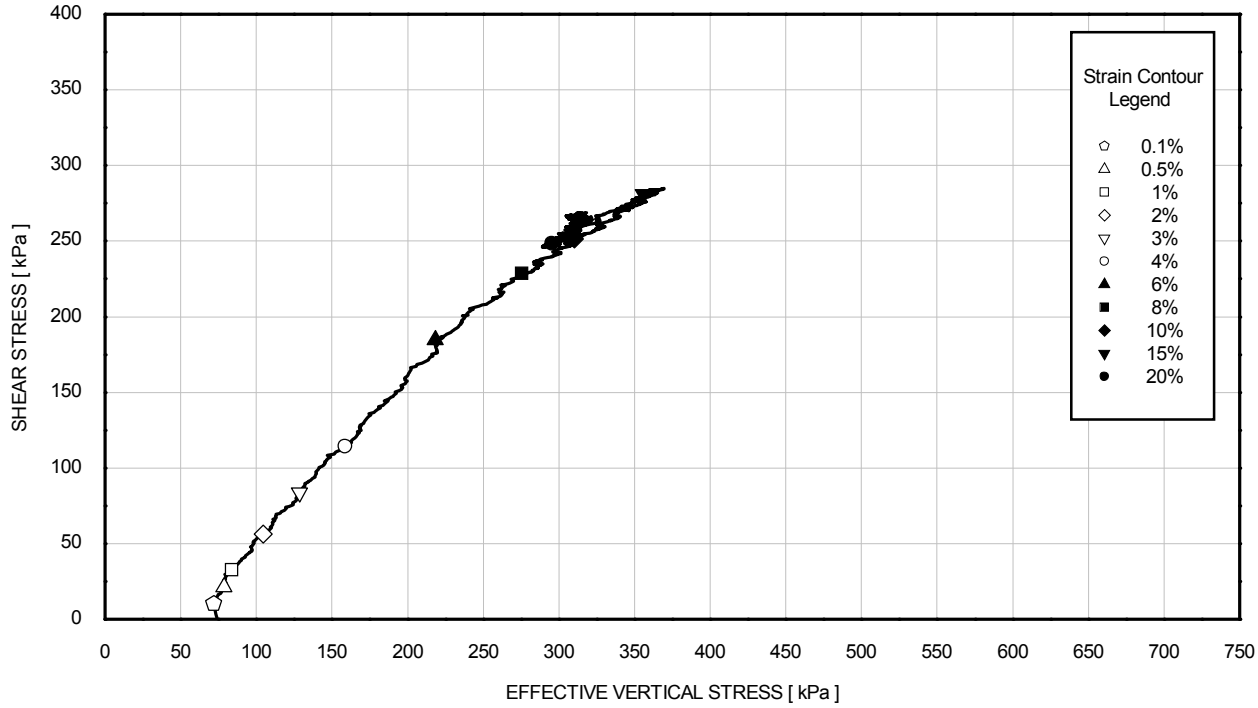


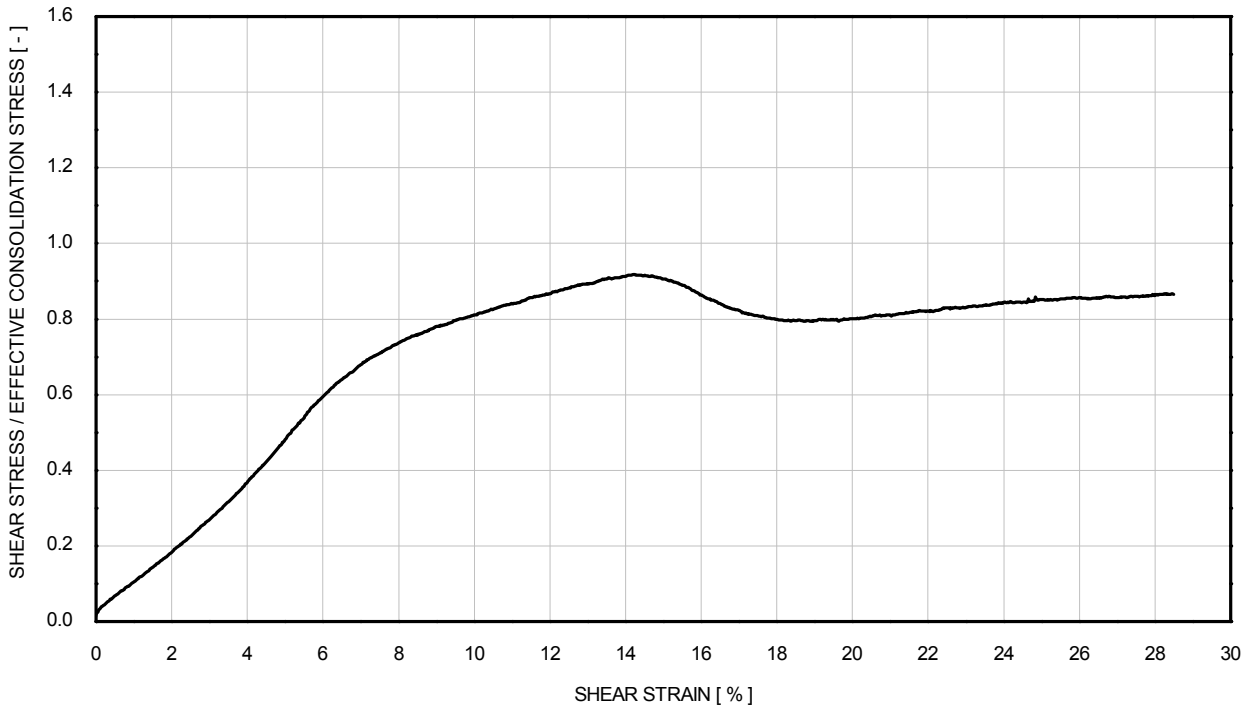


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 285 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 14.23 %	Depth [m]	: 33.59
Rate of strain	: 2.86 %/hour	Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

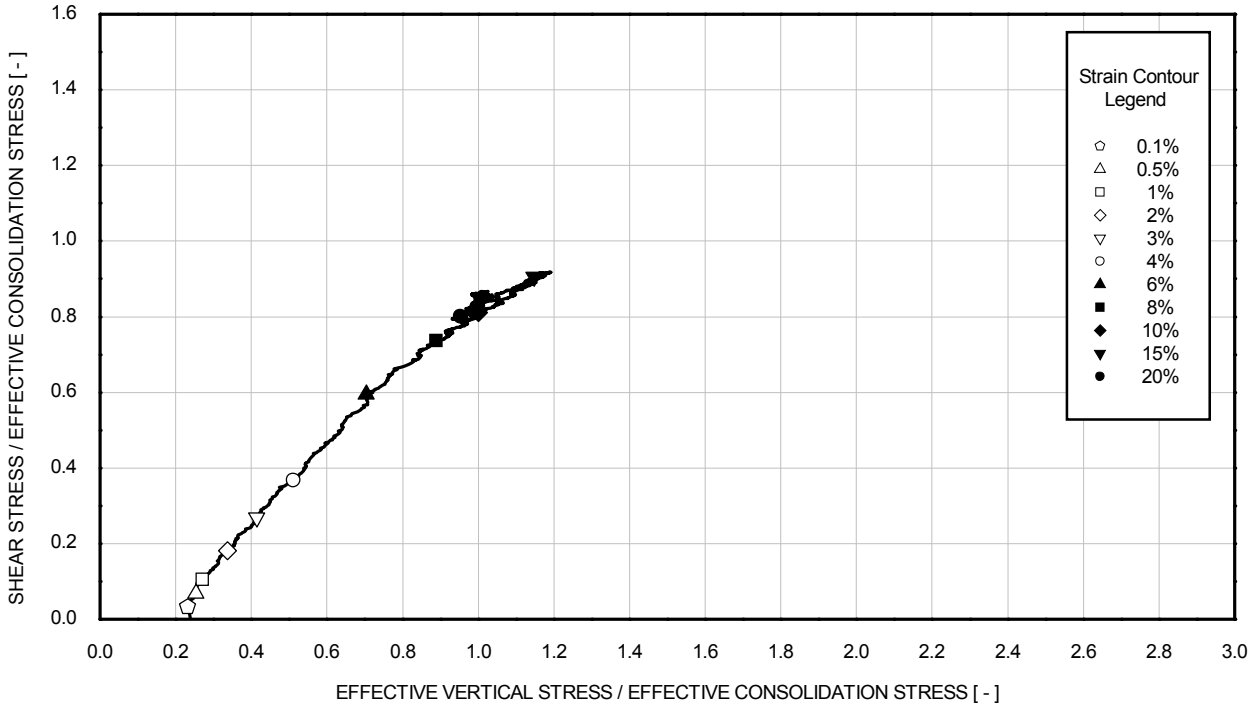


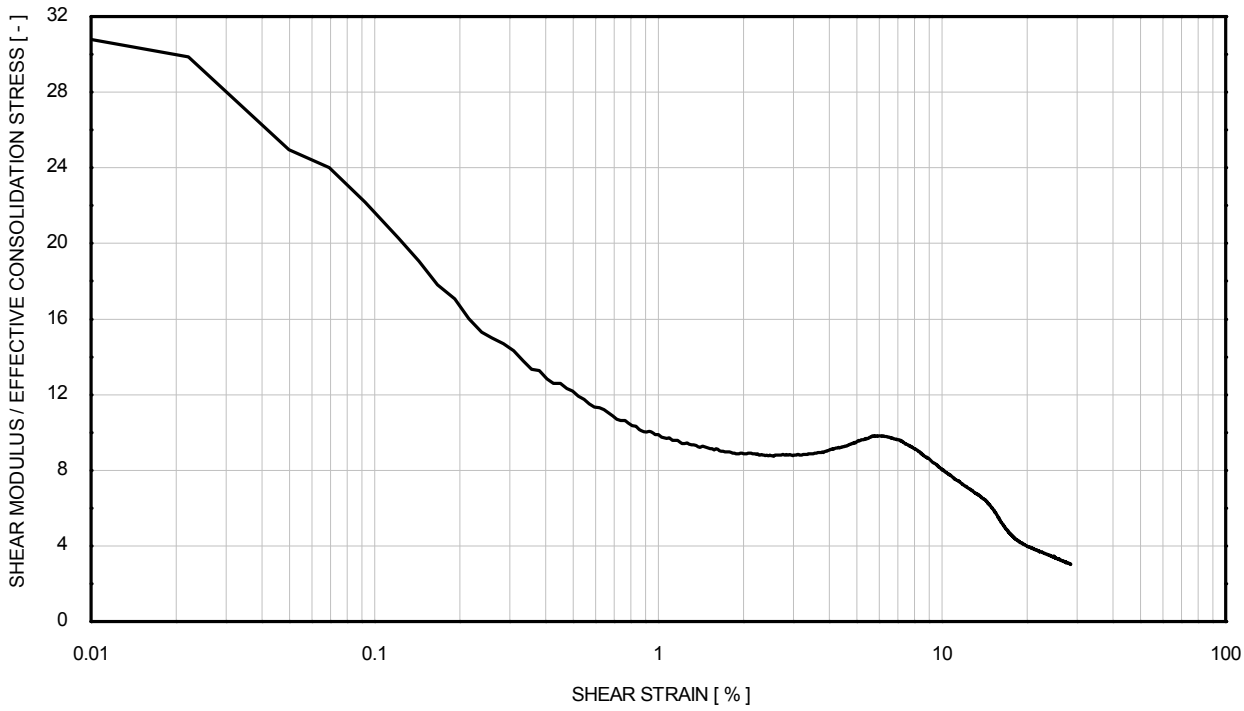


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 285 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 14.23 %	Depth [m]	: 33.59
Rate of strain	: 2.86 %/hour	Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 310 kPa	Borehole	: BH-WFS2-7
τ_{peak}	: 285 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 14.23 %	Depth [m]	: 33.59
Rate of strain	: 2.86 %/hour	Test No.	: CSS09

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark greenish grey CLAY

GENERAL	
Date test started	11/08/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	65.9
Length	[mm]	30.0
Moisture content	[%]	36.7
Bulk density	[Mg/m³]	1.81
Dry density	[Mg/m³]	1.32
Void ratio	[-]	1.044
Degree of saturation	[%]	95
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	188
Pocket penetrometer	[kPa]	267
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_19D_CSS10
Template issue	1.2
Processed by Date	ER 13/08/2015
Checked by Date	PH 18/08/2015
Approved by Date	PH 18/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.61
Test number	CSS10

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	310
Vertical strain	[%]	1.49
Bulk density	[Mg/m^3]	1.82
Dry density	[Mg/m^3]	1.34
Void ratio	[-]	1.014
Moisture content	[%]	35.5

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	195
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	182
γ_{av} at N_f	[%]	-2.14
γ_{cy} at N_f	[%]	15.08
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	132
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	210
Shear strain	[%]	28.91
Shear induced $\Delta\sigma'_v$	[kPa]	-88
Vertical stress	[kPa]	398
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.11
At 15 % shear strain		
Shear stress	[kPa]	189
Shear induced -$\Delta\sigma'_v$	[kPa]	18
Vertical stress	[kPa]	291
Vertical strain	[%]	0.00

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.61
Test number	CSS10

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

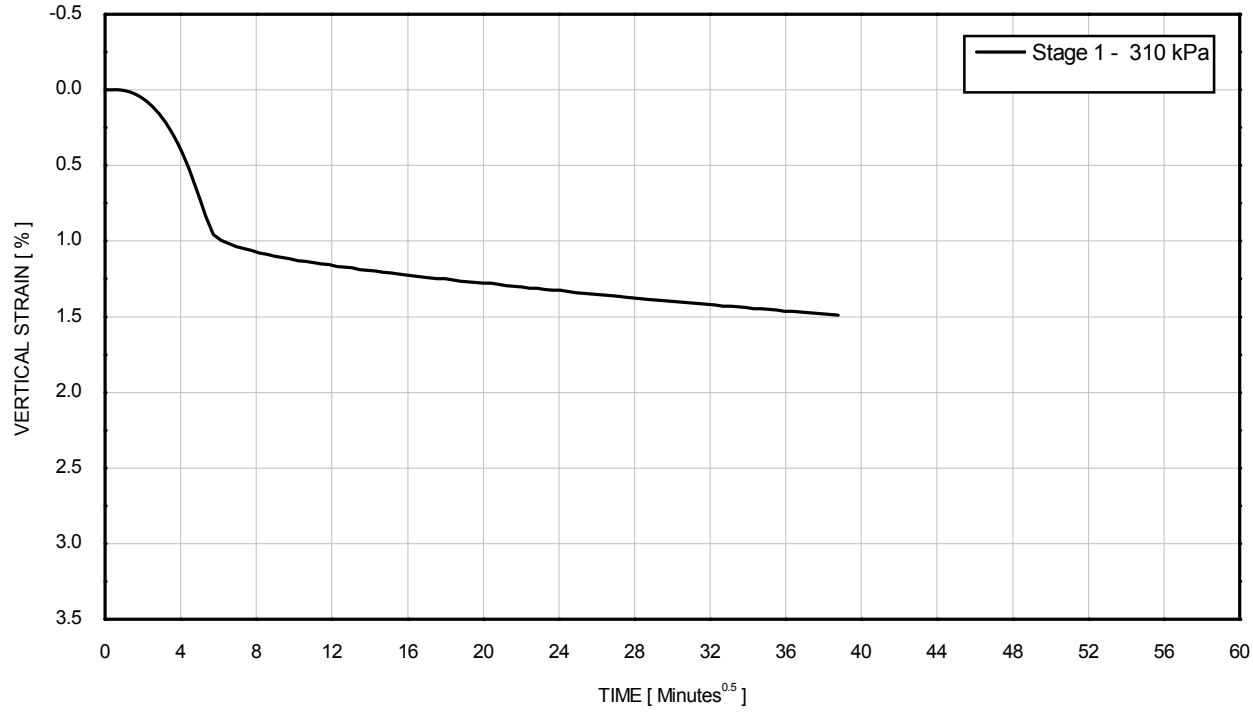
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

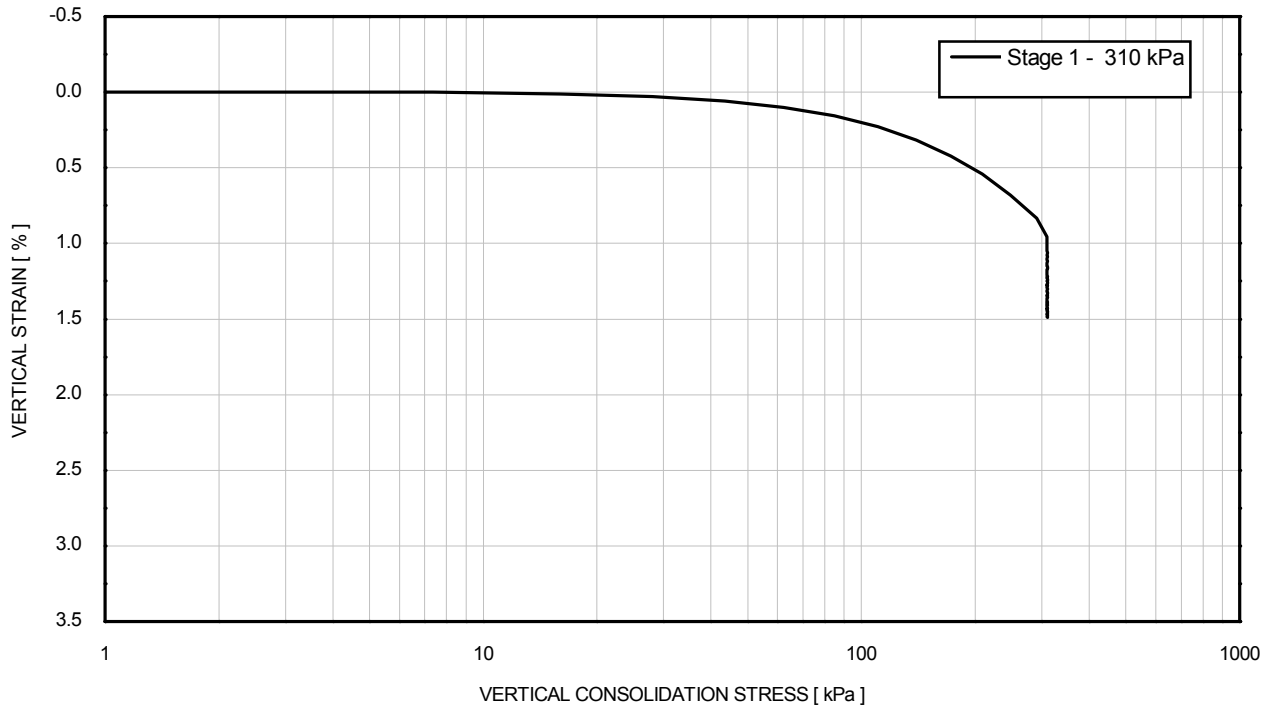
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	19WAXD
Depth [m]	33.61
Test number	CSS10

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

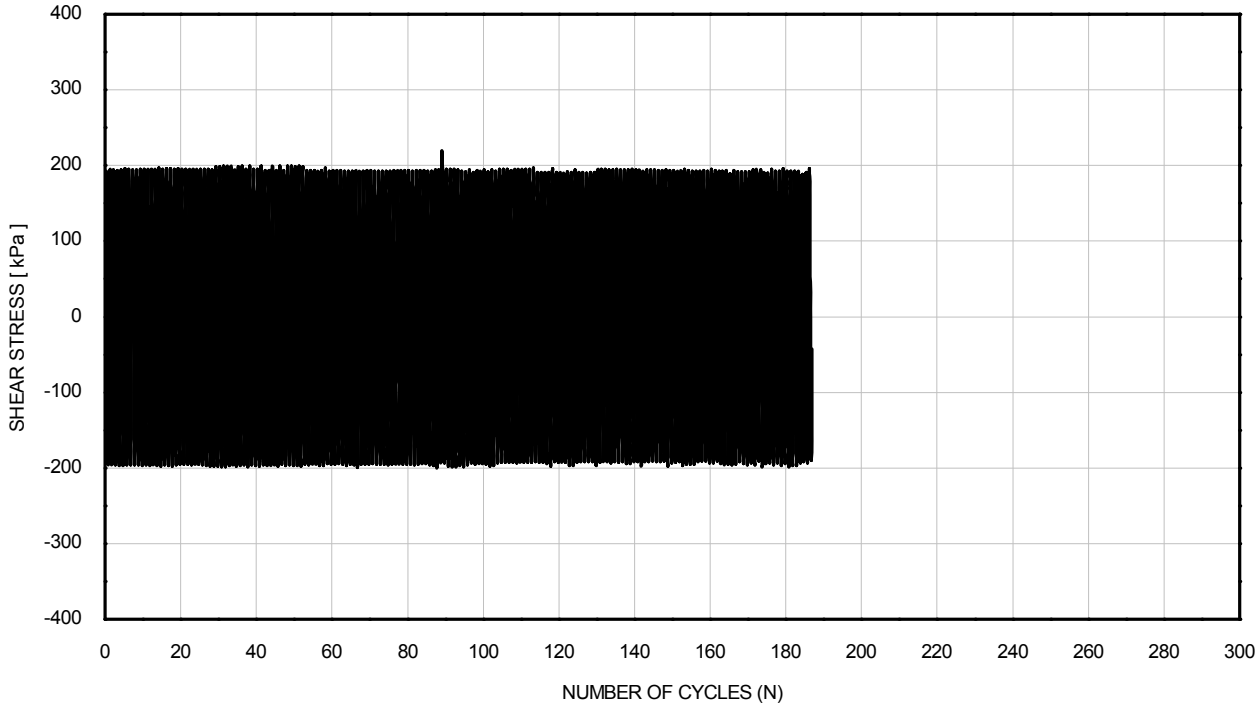


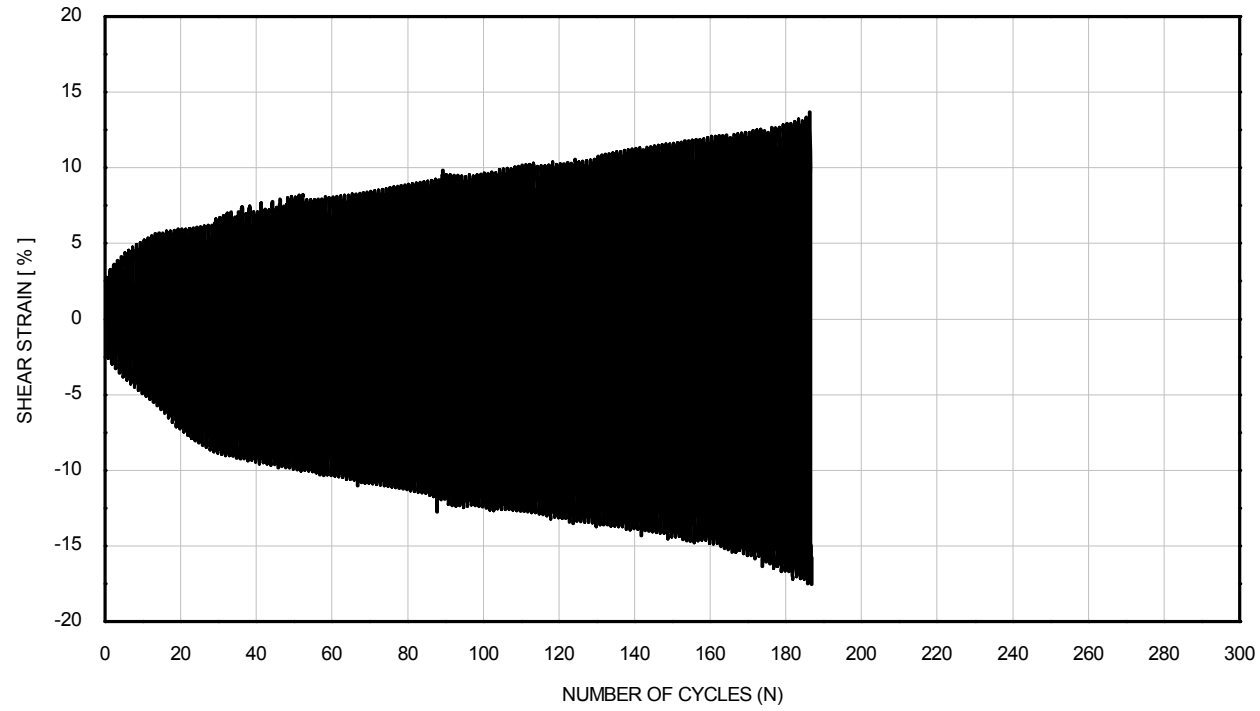


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
		Sample	: 19WAXD
		Depth [m]	: 33.61
		Test No.	: CSS10

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

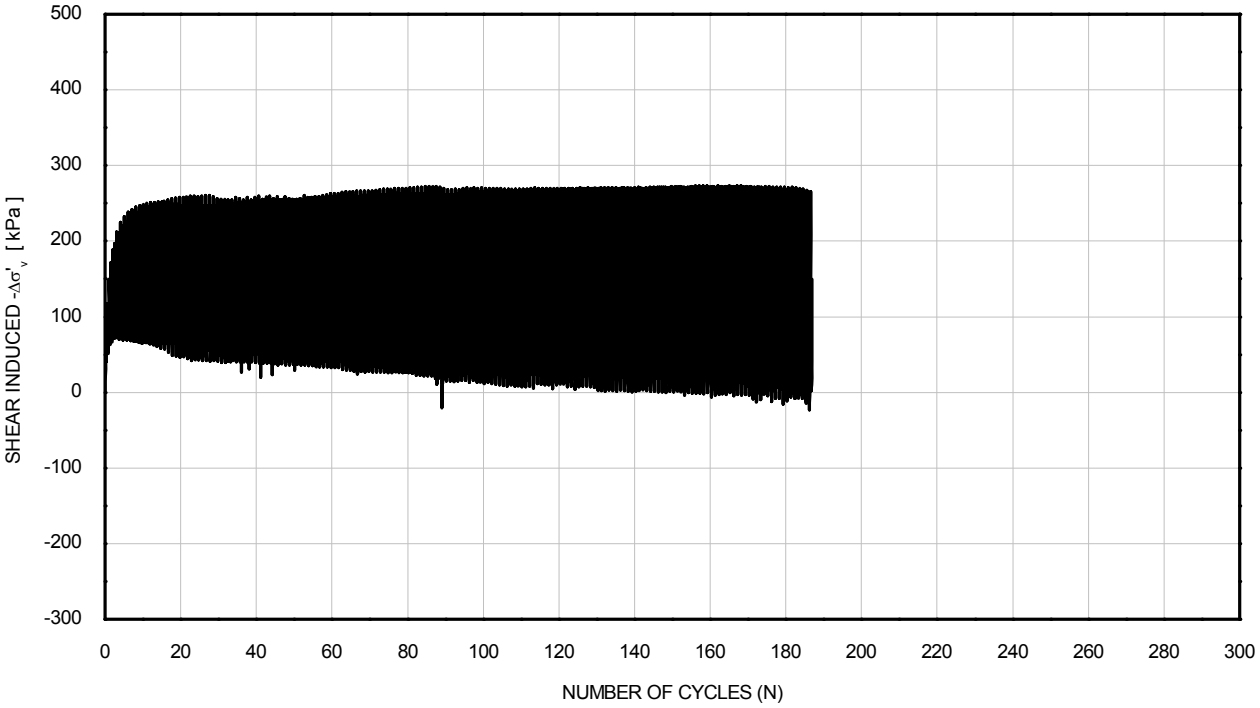


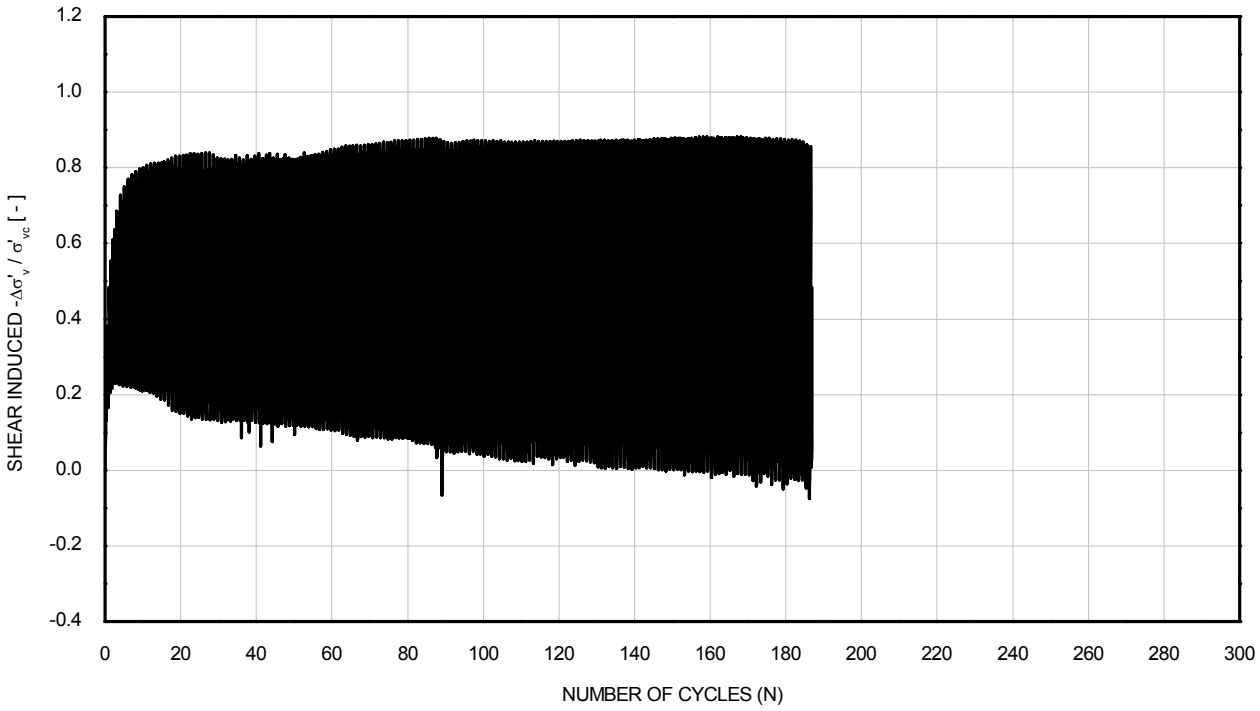


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	195 kPa	Depth [m]	:	33.61
Frequency	:	0.10 Hz	Test No.	:	CSS10

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

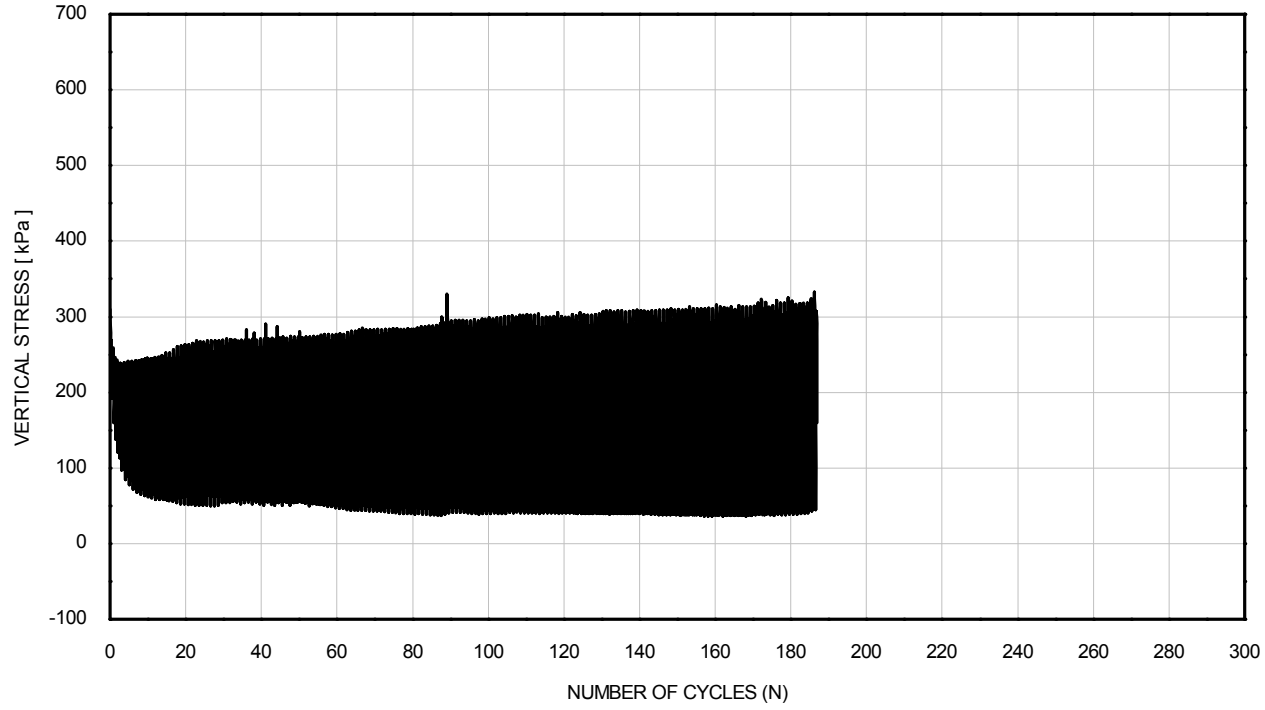


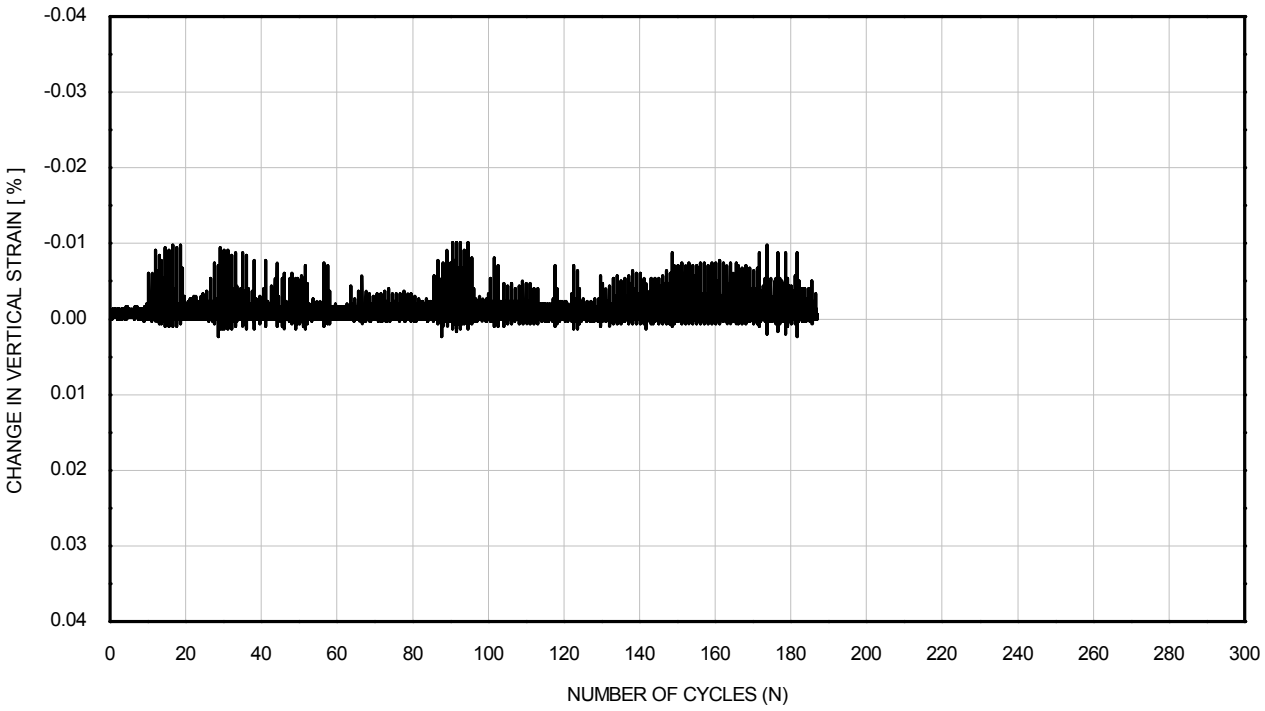


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	195 kPa	Depth [m]	:	33.61
Frequency	:	0.10 Hz	Test No.	:	CSS10

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

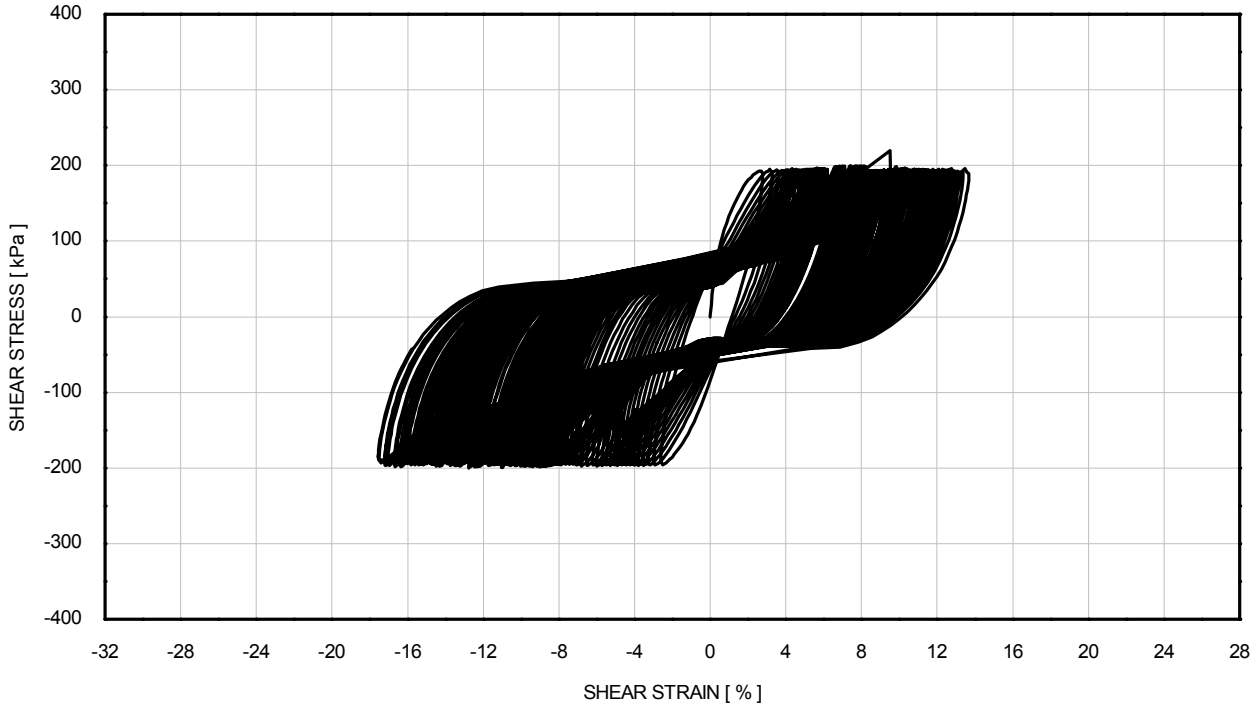


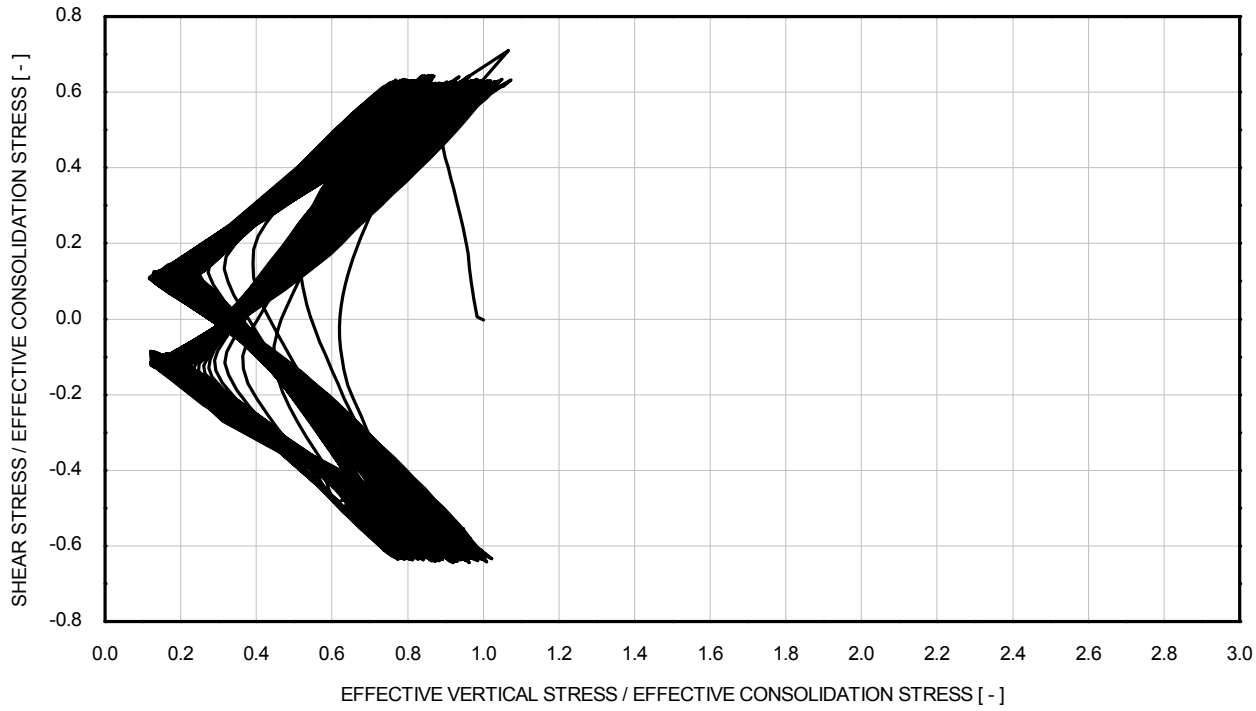


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	195 kPa	Depth [m]	:	33.61
Frequency	:	0.10 Hz	Test No.	:	CSS10

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

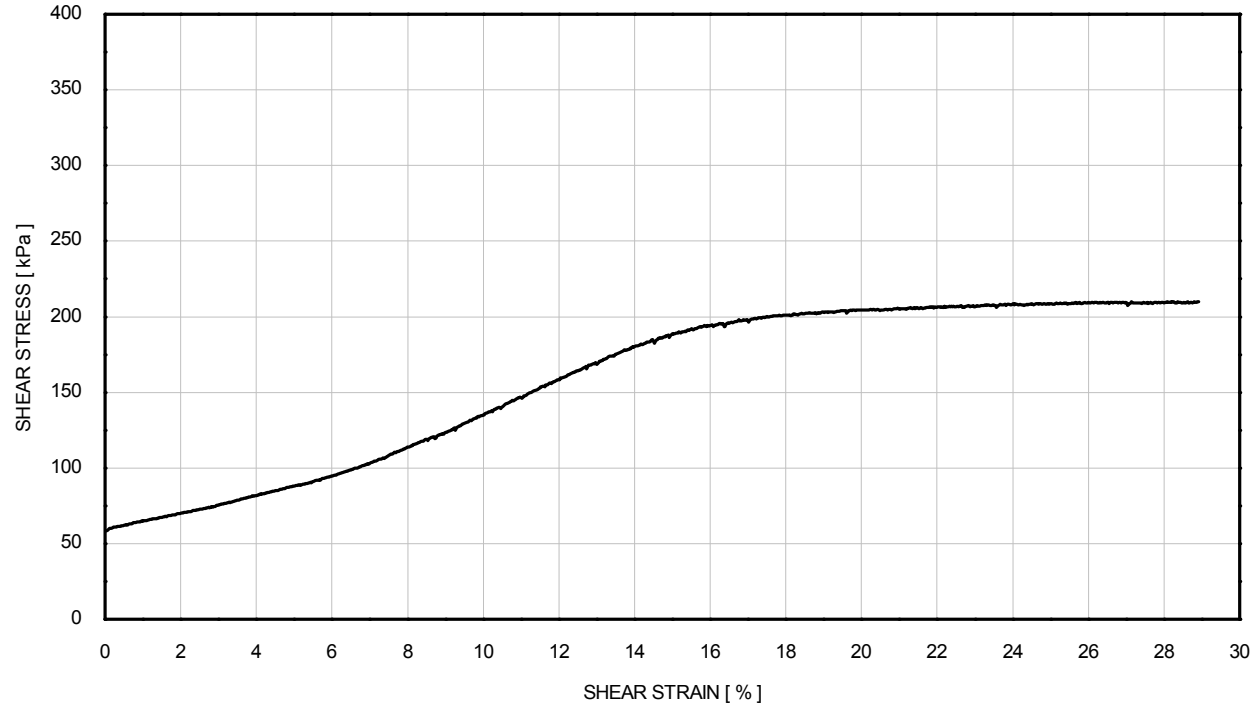


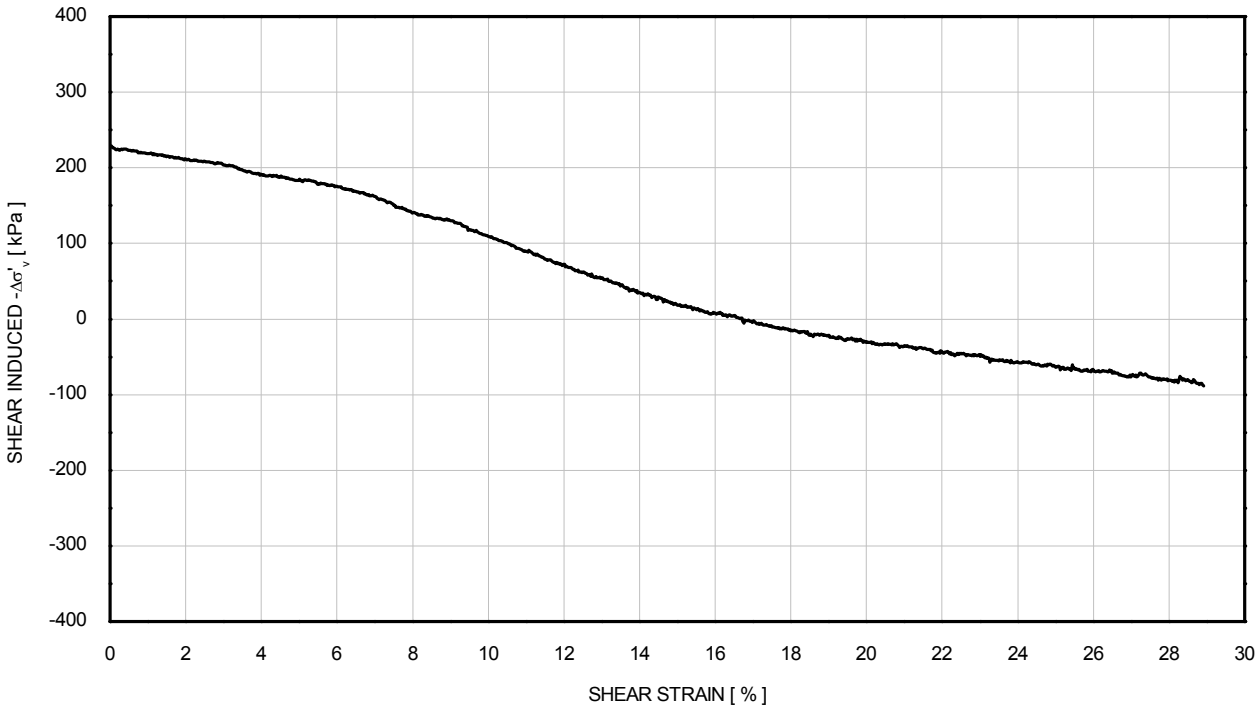


σ'_{vc}	:	310 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	19WAXD
Mean τ_{cy}	:	195 kPa	Depth [m]	:	33.61
Frequency	:	0.10 Hz	Test No.	:	CSS10

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

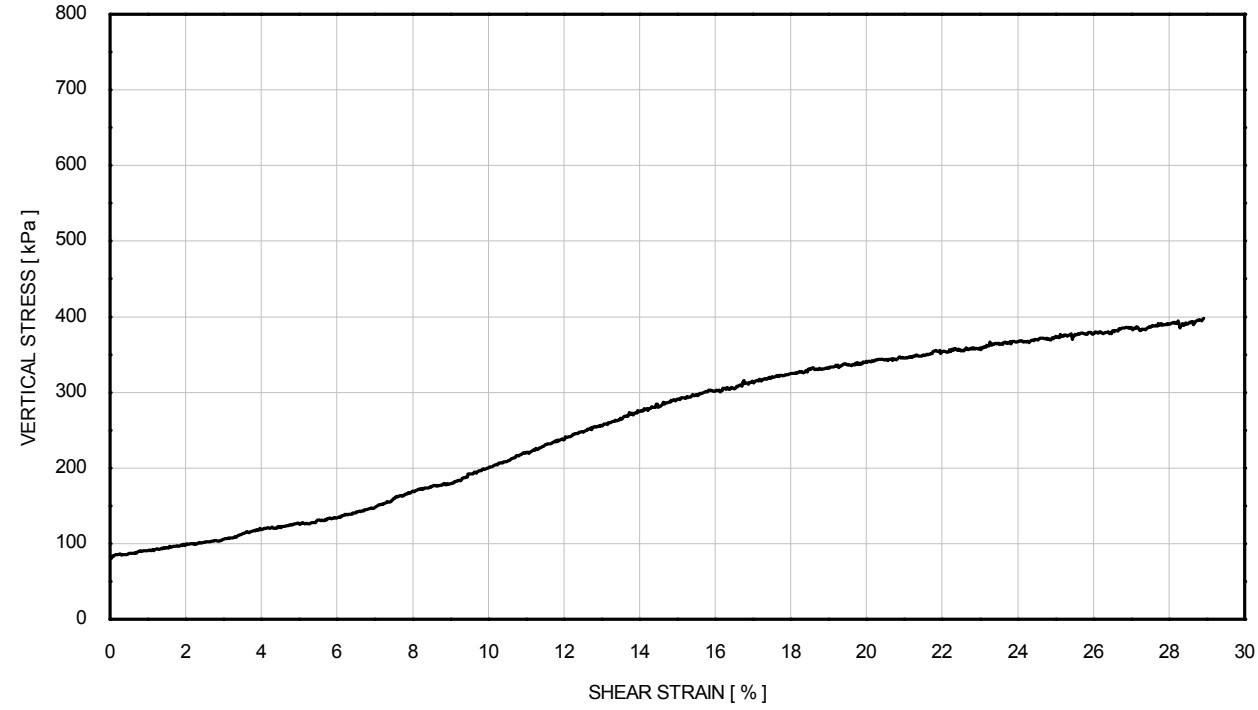


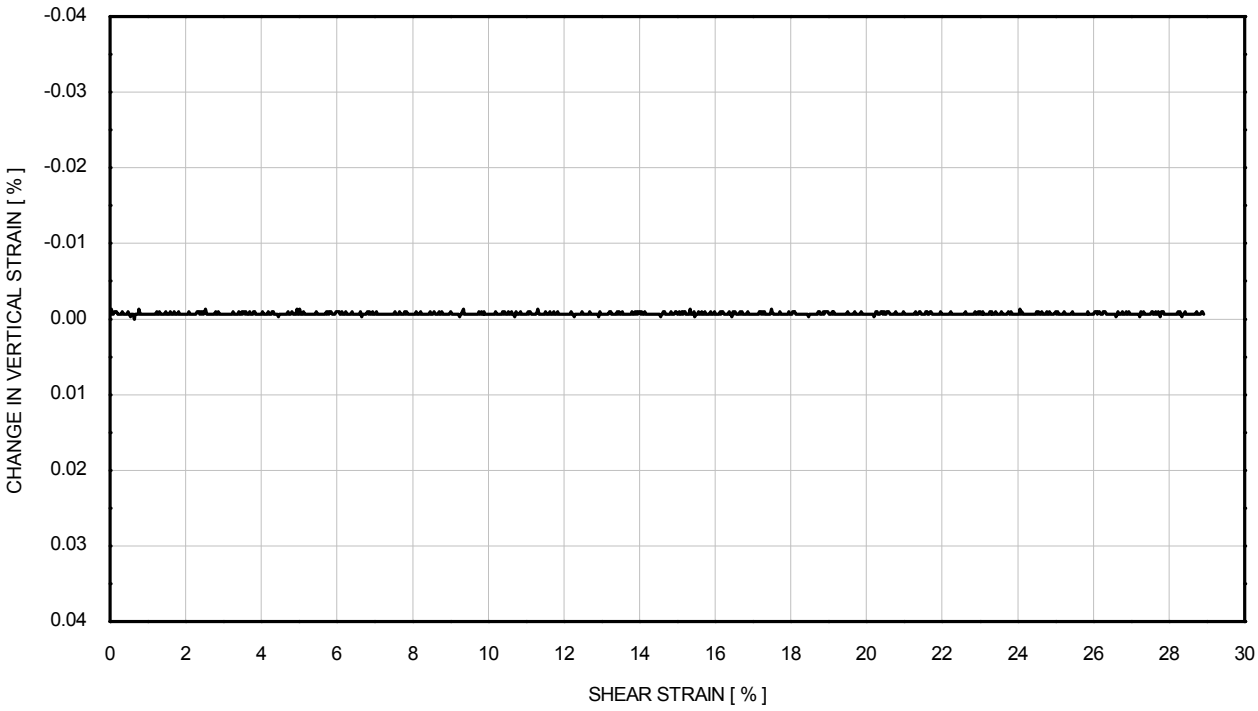


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 28.91 %	Depth [m]	: 33.61
Rate of strain	: 3.11 %/hour	Test No.	: CSS10

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

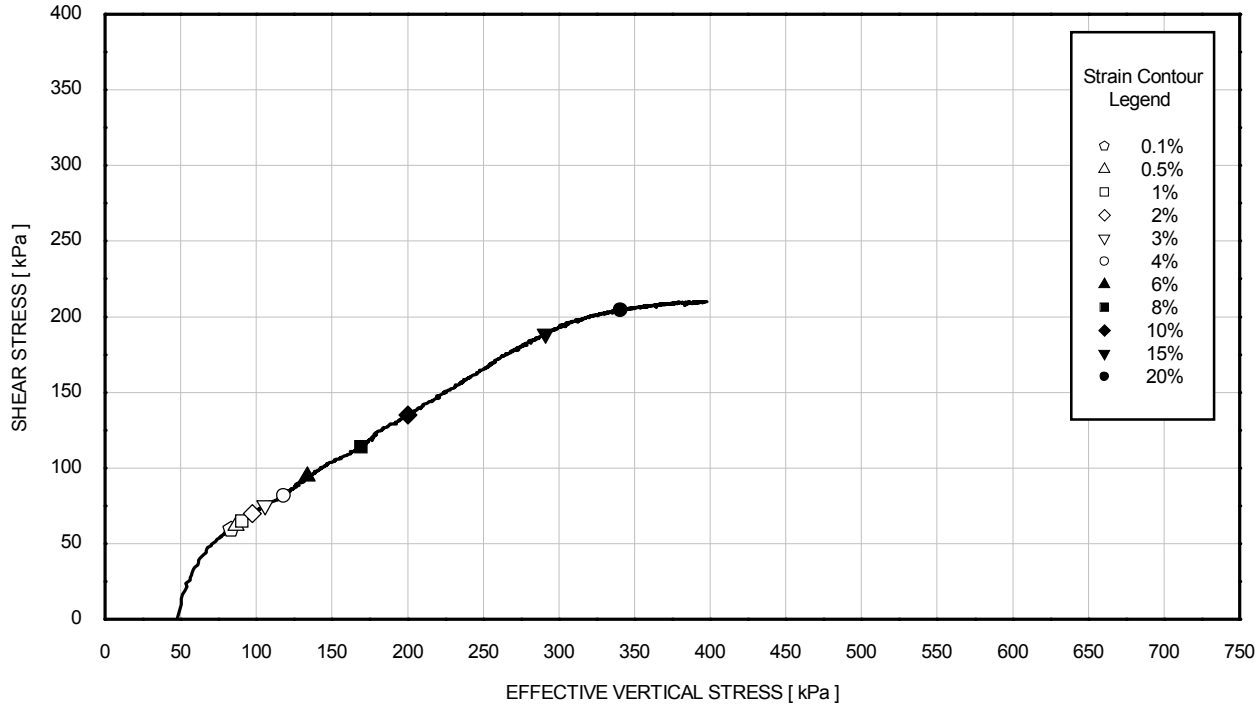


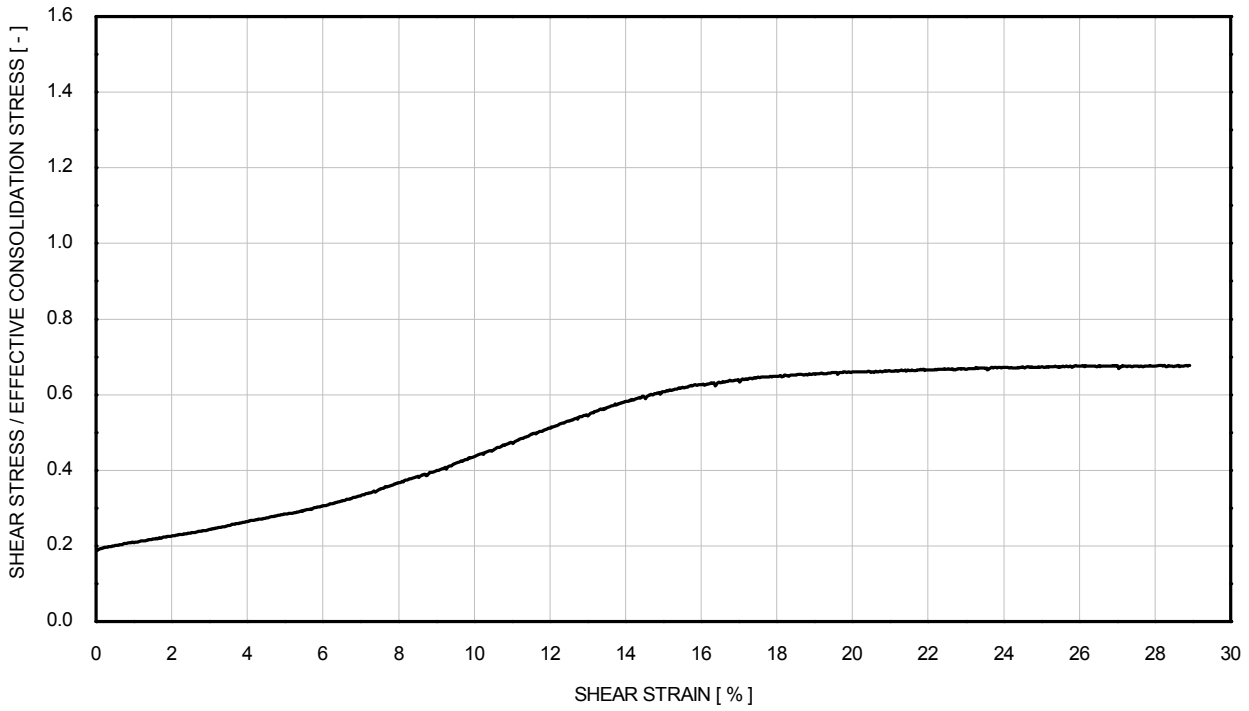


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 28.91 %	Depth [m]	: 33.61
Rate of strain	: 3.11 %/hour	Test No.	: CSS10

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

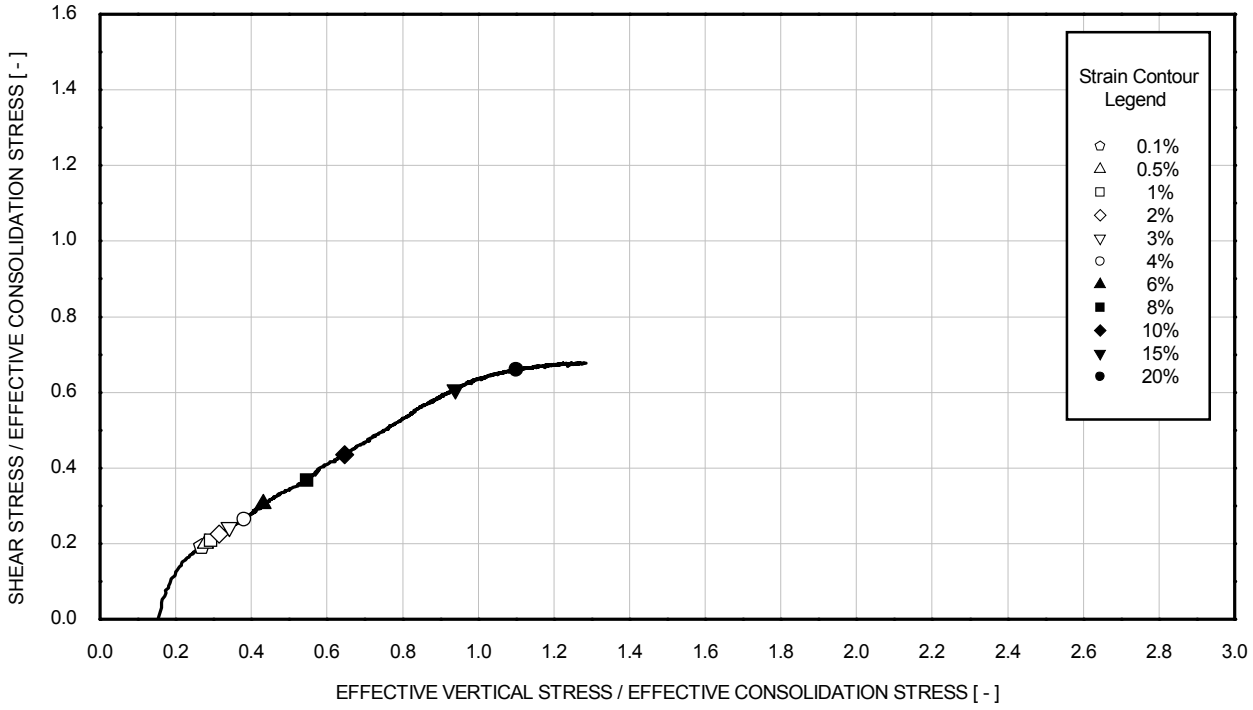


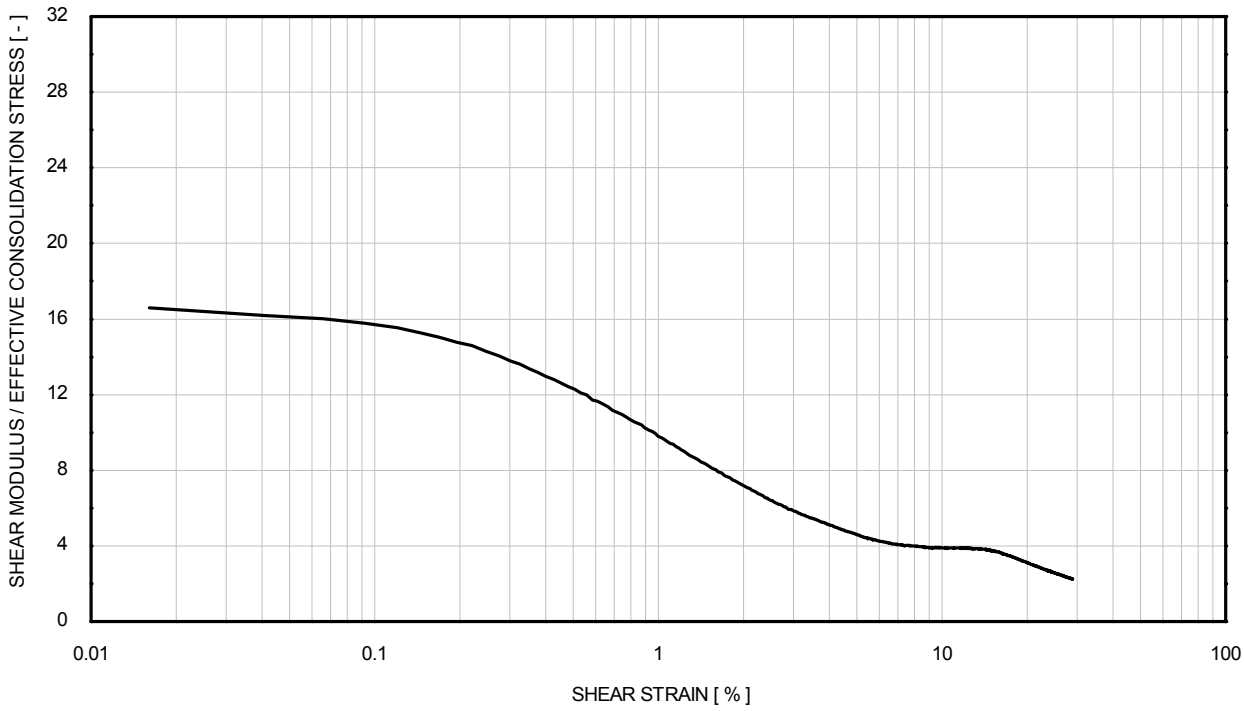


σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 28.91 %	Depth [m]	: 33.61
Rate of strain	: 3.11 %/hour	Test No.	: CSS10

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 310 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 19WAXD
γ at τ_{peak}	: 28.91 %	Depth [m]	: 33.61
Rate of strain	: 3.11 %/hour	Test No.	: CSS10

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

VISUAL DESCRIPTION
Dark greenish grey slightly sandy CLAY

GENERAL	
Date test started	18/08/2015
Type of sample	Undisturbed
Specimen orientation	Vertical

INITIAL		
Diameter	[mm]	66.0
Length	[mm]	30.0
Moisture content	[%]	42.1
Bulk density	[Mg/m³]	1.78
Dry density	[Mg/m³]	1.25
Void ratio	[-]	1.156
Degree of saturation	[%]	98
Assumed particle density	[Mg/m³]	2.70
Torvane	[kPa]	-
Pocket penetrometer	[kPa]	-
Torvane 90°	[kPa]	-
Pocket penetrometer 90°	[kPa]	-

TESTING PROCEDURES USED	
Specimen set-up	Fugro in house procedure based on ASTM D6528-07
Consolidation	Fugro in house procedure based on ASTM D6528-07
Shearing	Fugro in house procedure based on ASTM D6528-07
Note: Fugro testing procedures are available upon request	

QUALITY ASSURANCE	
Filename	J11286 \ BH-WFS 2-7_20C_CSS11r
Template issue	1.2
Processed by Date	RN 20/08/2015
Checked by Date	PH 20/08/2015
Approved by Date	PH 20/08/2015

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	20WAXC
Depth [m]	34.39
Test number	CSS11

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

CONSOLIDATION		
σ'_{vc}	[kPa]	316
Vertical strain	[%]	1.04
Bulk density	[Mg/m^3]	1.79
Dry density	[Mg/m^3]	1.27
Void ratio	[-]	1.134
Moisture content	[%]	41.2

STRESS-CONTROLLED CYCLIC LOADING – CONSTANT VOLUME		
Reference stress	[kPa]	253
Mean τ_{av}	[kPa]	0
Mean τ_{cy}	[kPa]	224
Frequency	[Hz]	0.10
Number of cycles at failure (N_f)	[-]	26
γ_{av} at N_f	[%]	-1.12
γ_{cy} at N_f	[%]	15.57
Shear induced -$\Delta\sigma'_v$ at N_f	[kPa]	7
Vertical strain	[%]	0.00

SHEARING – CONSTANT VOLUME		
At peak shear stress		
Shear stress	[kPa]	210
Shear strain	[%]	29.74
Shear induced $\Delta\sigma'_v$	[kPa]	-161
Vertical stress	[kPa]	478
Vertical strain	[%]	0.00
Rate of strain	[%/hour]	3.07
At 15 % shear strain		
Shear stress	[kPa]	157
Shear induced -$\Delta\sigma'_v$	[kPa]	19
Vertical stress	[kPa]	297
Vertical strain	[%]	0.00

* Please note that specimen failure was observed to occur along or close to the loading platen interface.

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	20WAXC
Depth [m]	34.39
Test number	CSS11

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

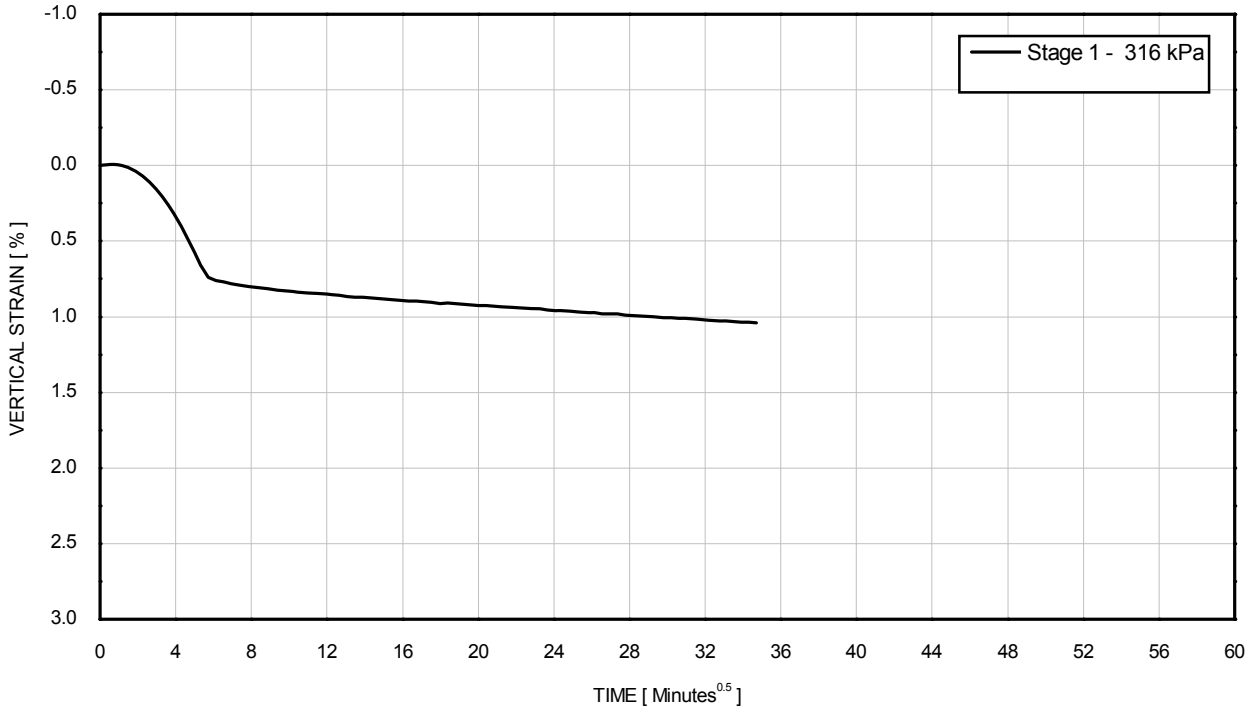
BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

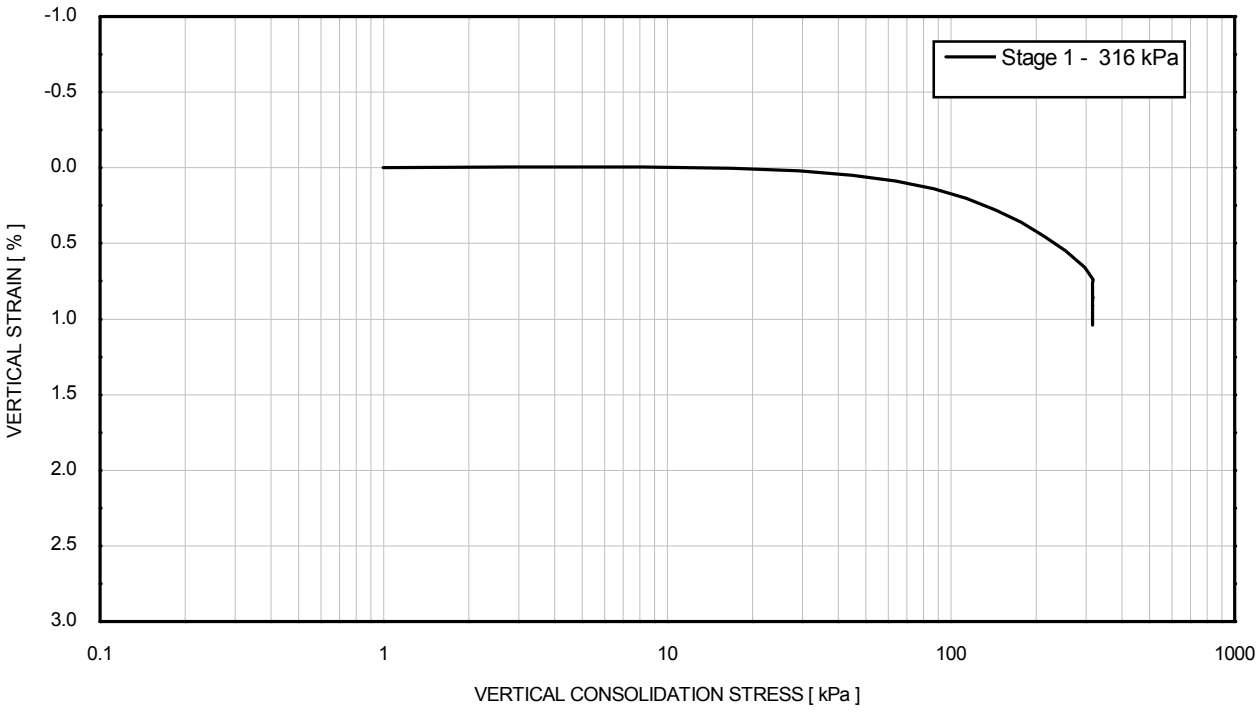
SPECIMEN PHOTOGRAPH

TEST IDENTIFICATION	
Borehole	BH-WFS 2-7
Sample	20WAXC
Depth [m]	34.39
Test number	CSS11

SUMMARY OF CONSOLIDATED CYCLIC DSS TEST

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

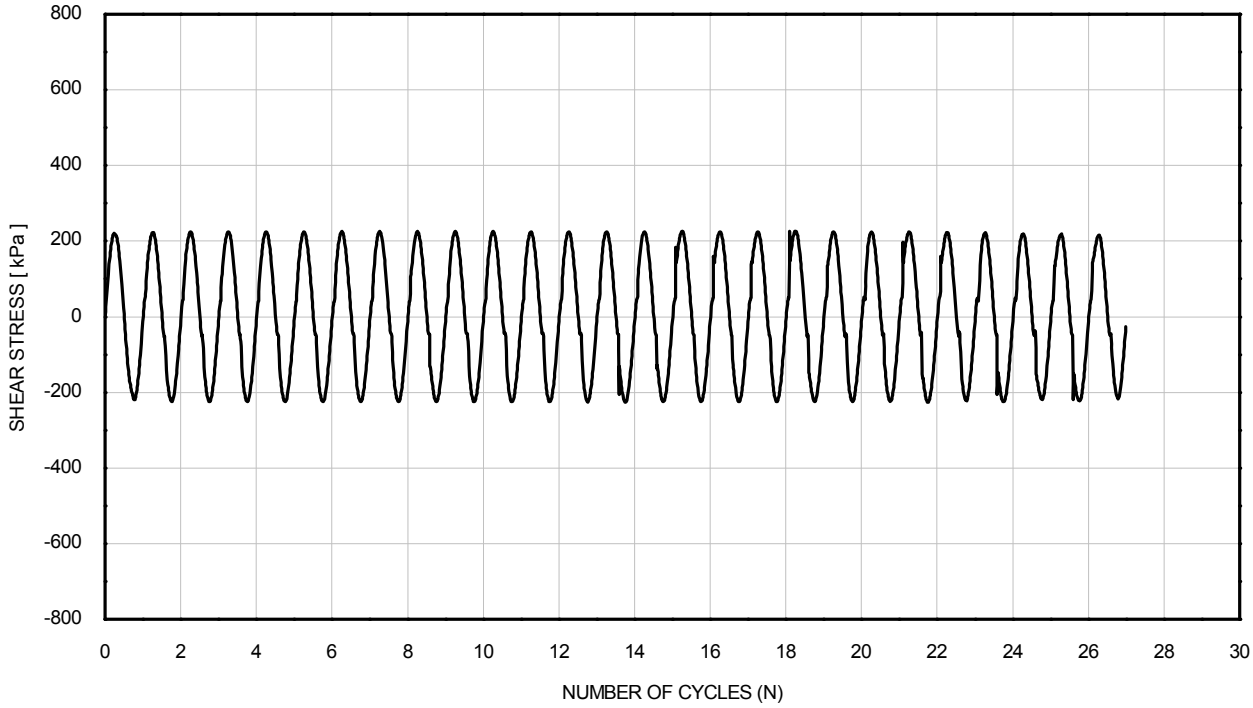


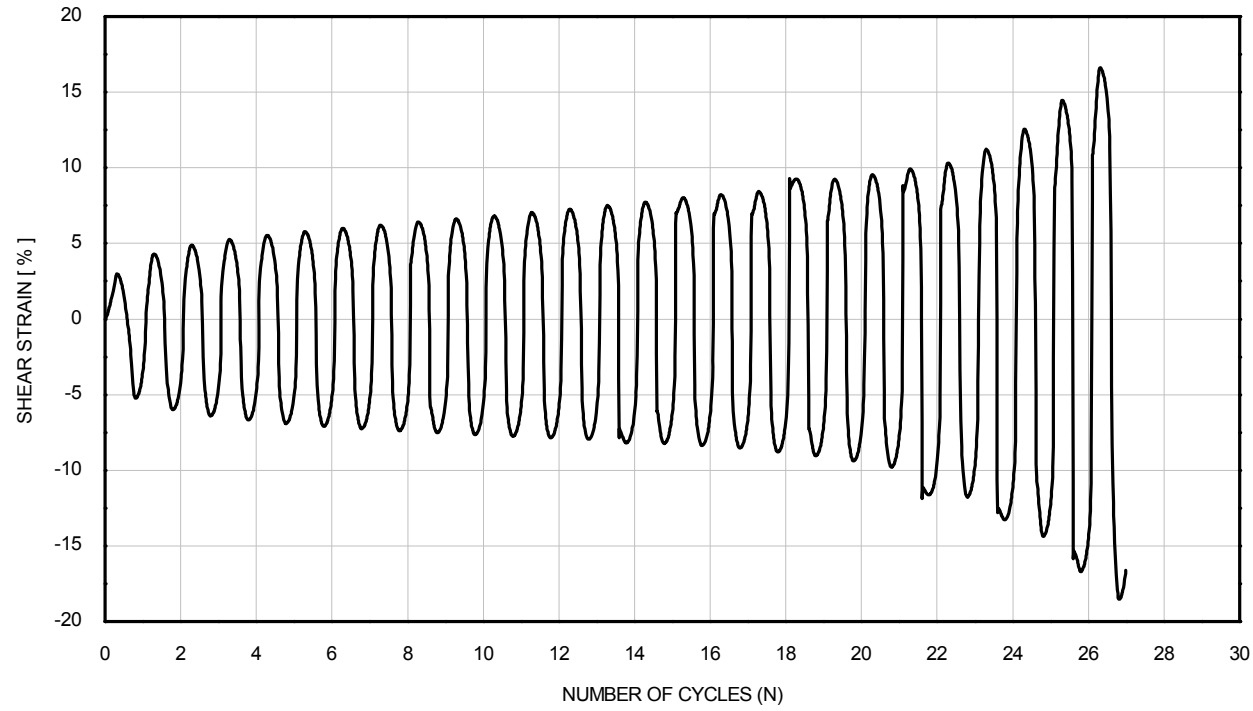


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS 2-7
		Sample	: 20WAXC
		Depth [m]	: 34.39
		Test No.	: CSS11

CONSOLIDATED CYCLIC DSS TEST
CONSOLIDATION STAGE

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

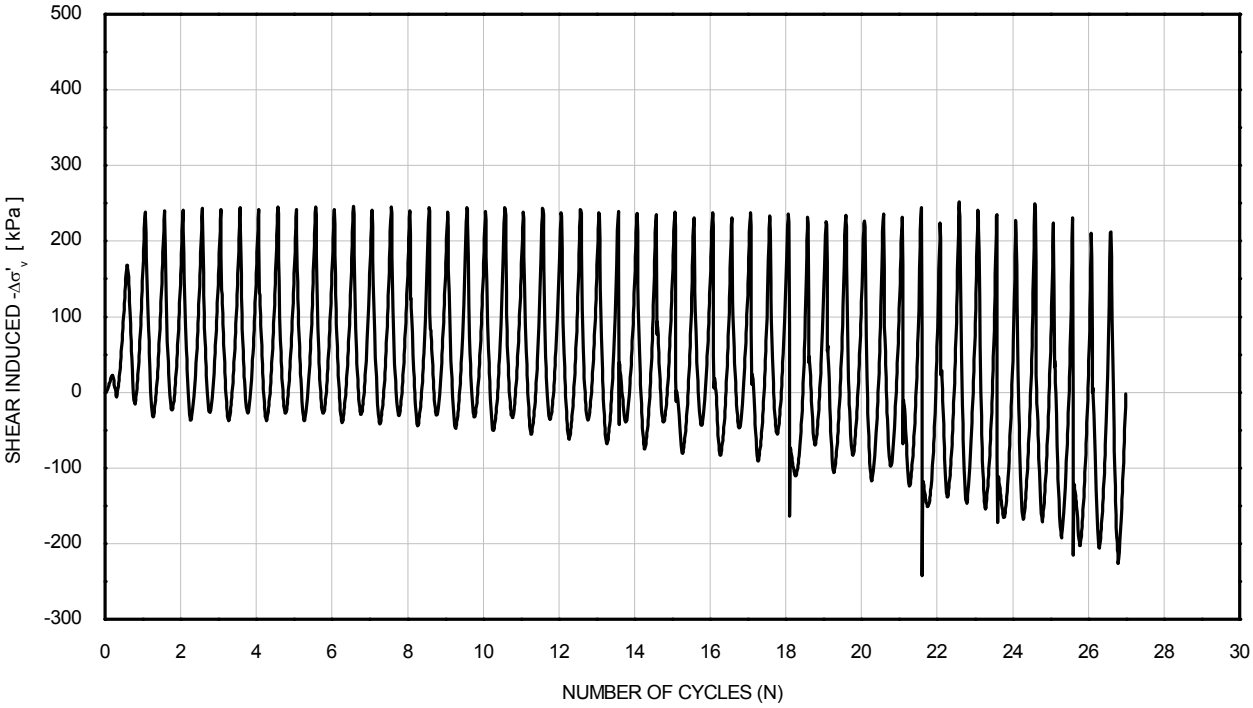


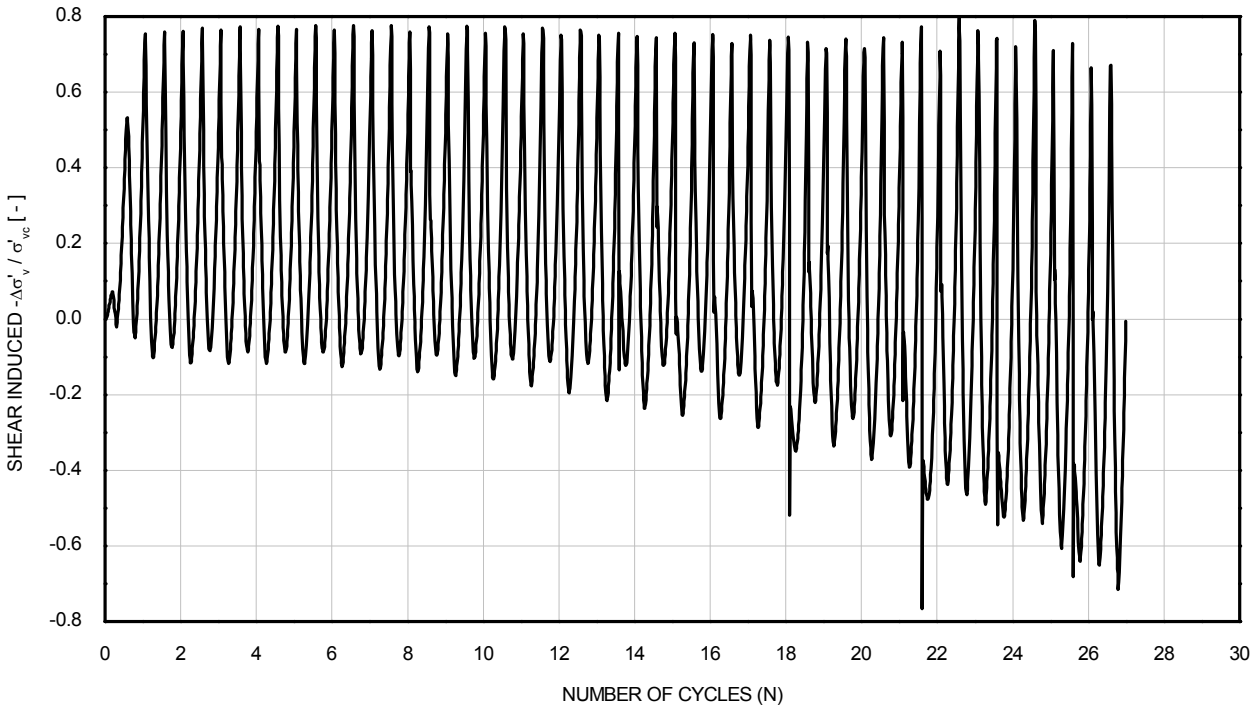


σ'_{vc}	:	316 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	20WAXC
Mean τ_{cy}	:	224 kPa	Depth [m]	:	34.39
Frequency	:	0.10 Hz	Test No.	:	CSS11

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

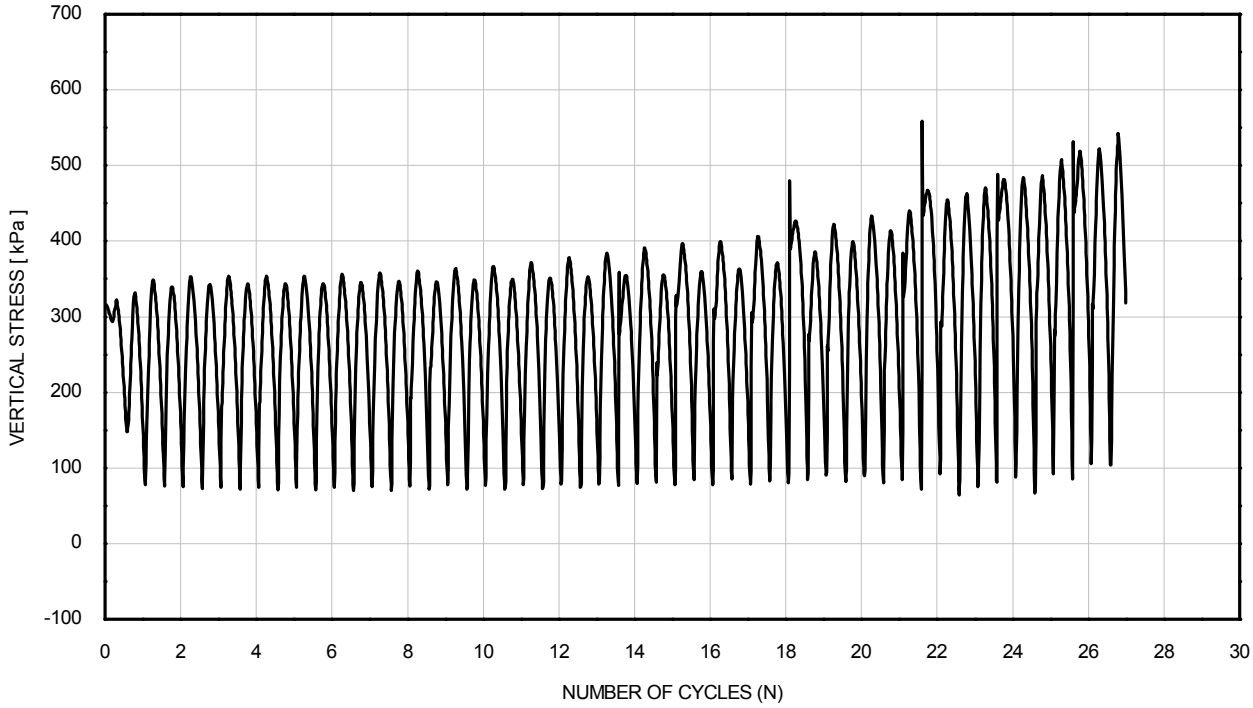


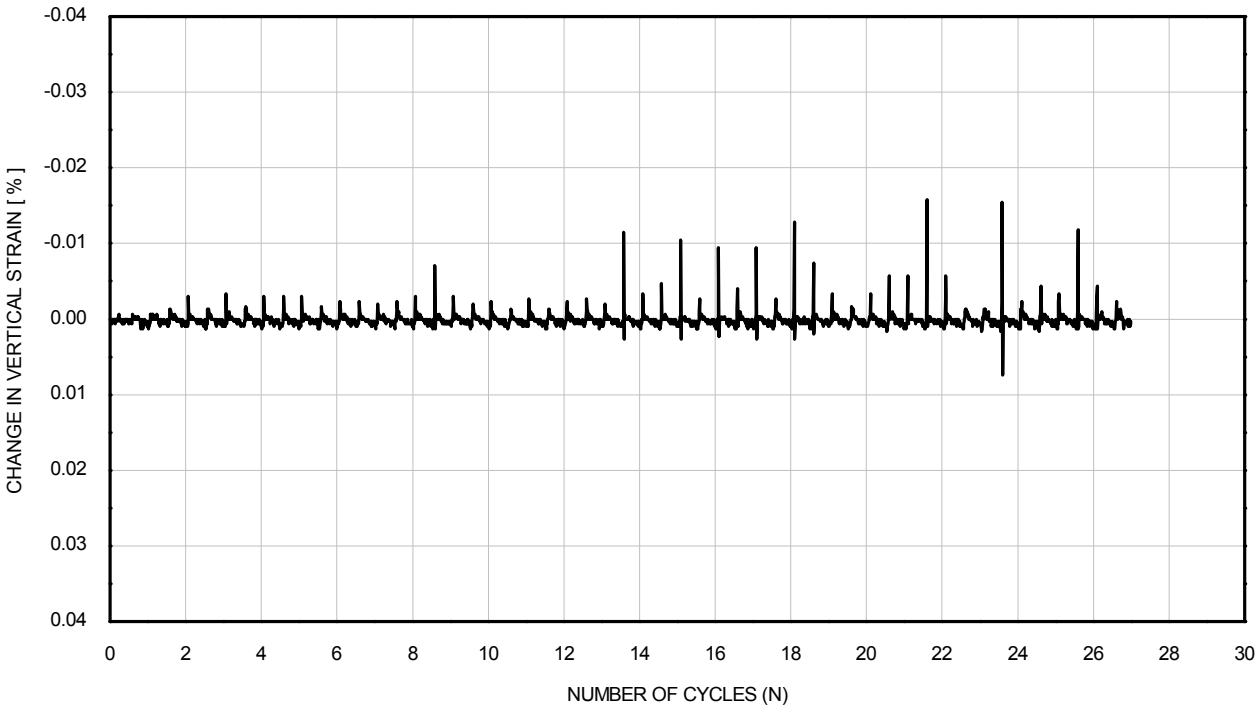


σ'_{vc}	:	316 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	20WAXC
Mean τ_{cy}	:	224 kPa	Depth [m]	:	34.39
Frequency	:	0.10 Hz	Test No.	:	CSS11

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

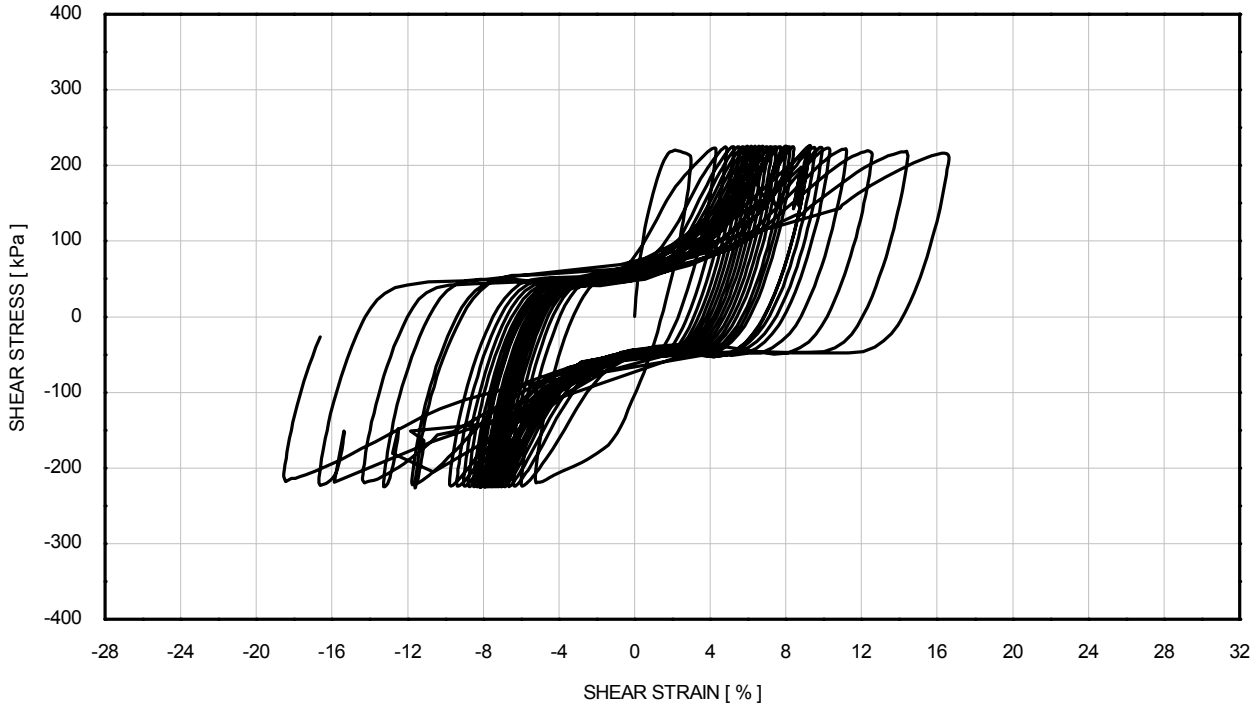


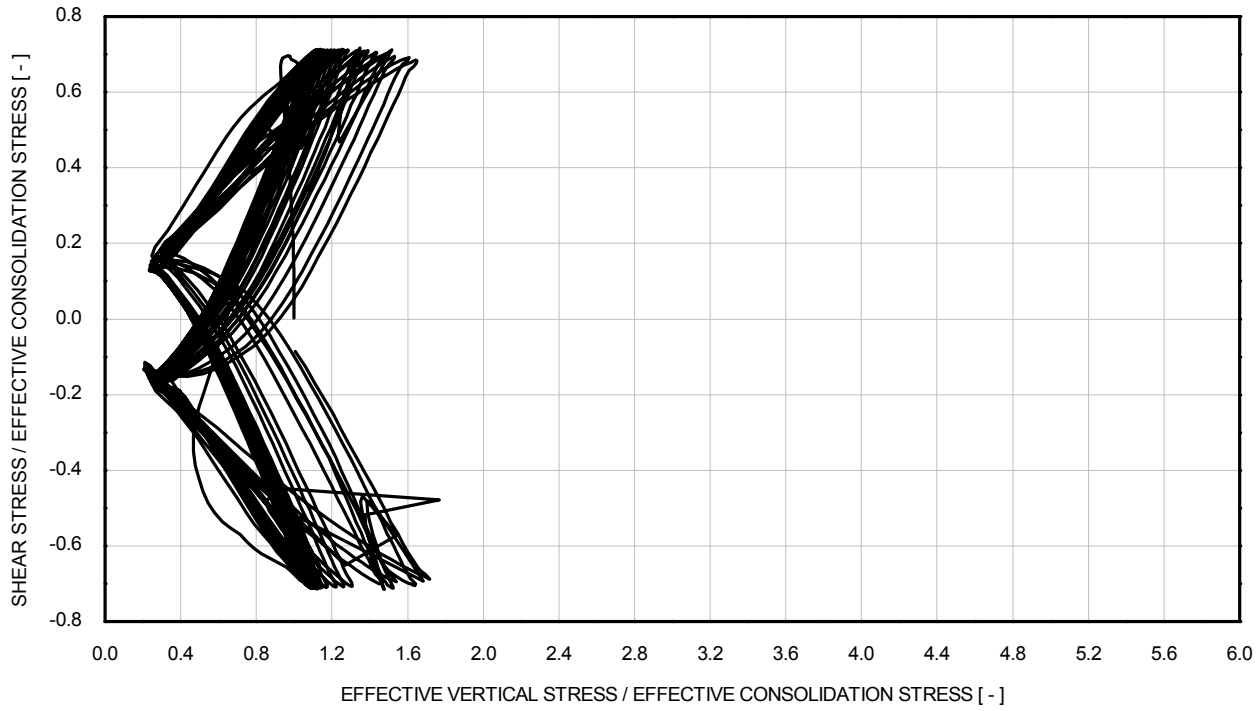


σ'_{vc}	:	316 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	20WAXC
Mean τ_{cy}	:	224 kPa	Depth [m]	:	34.39
Frequency	:	0.10 Hz	Test No.	:	CSS11

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

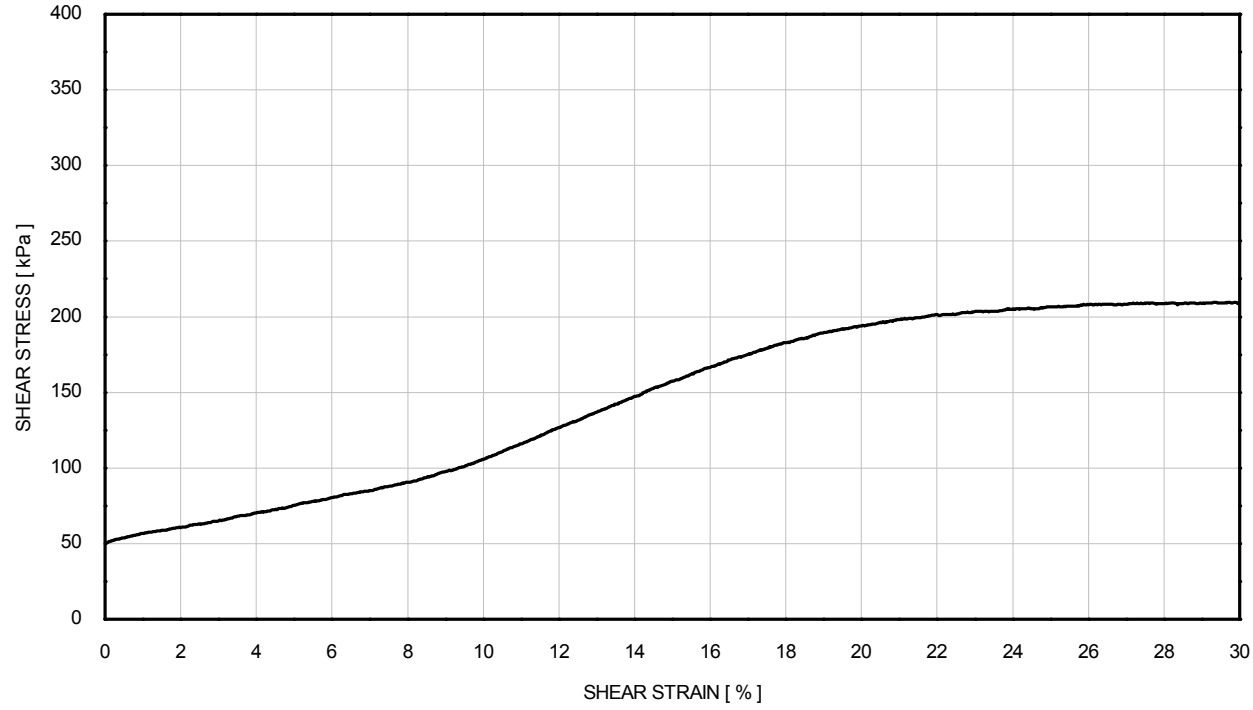


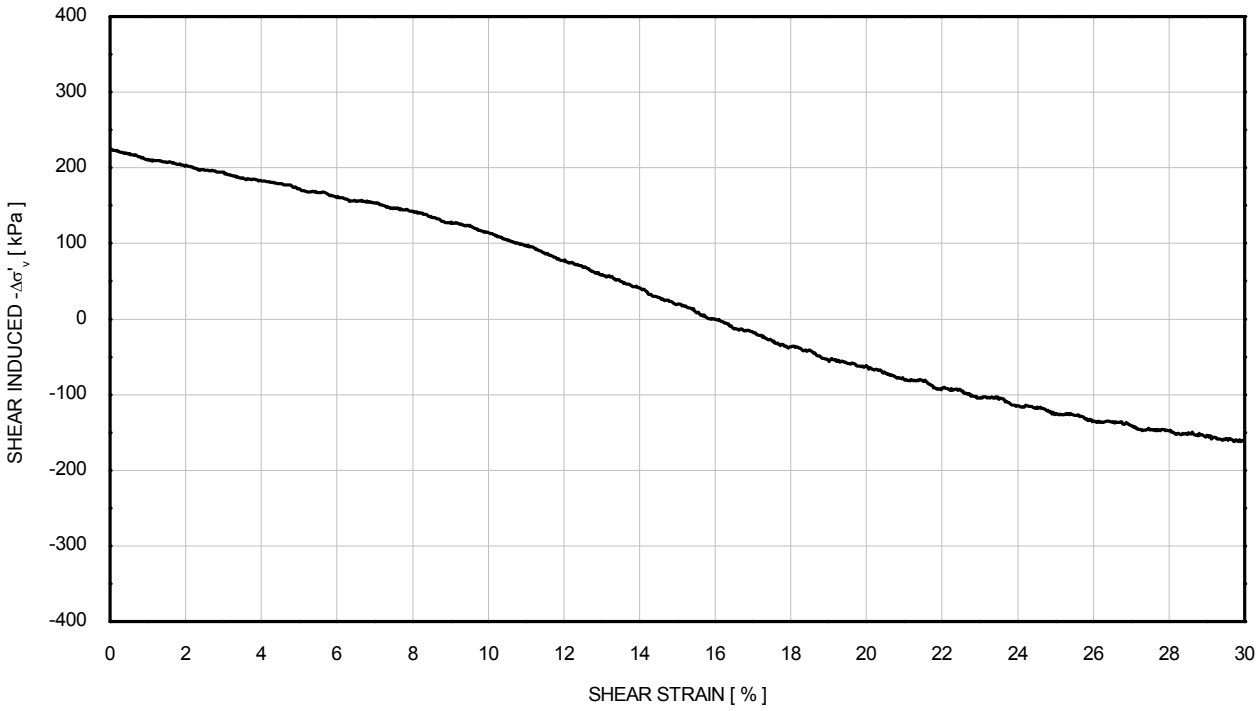


σ'_{vc}	:	316 kPa	Borehole	:	BH-WFS 2-7
Mean τ_{av}	:	0 kPa	Sample	:	20WAXC
Mean τ_{cy}	:	224 kPa	Depth [m]	:	34.39
Frequency	:	0.10 Hz	Test No.	:	CSS11

CONSOLIDATED CYCLIC DSS TEST
STRESS-CONTROLLED CYCLIC LOADING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

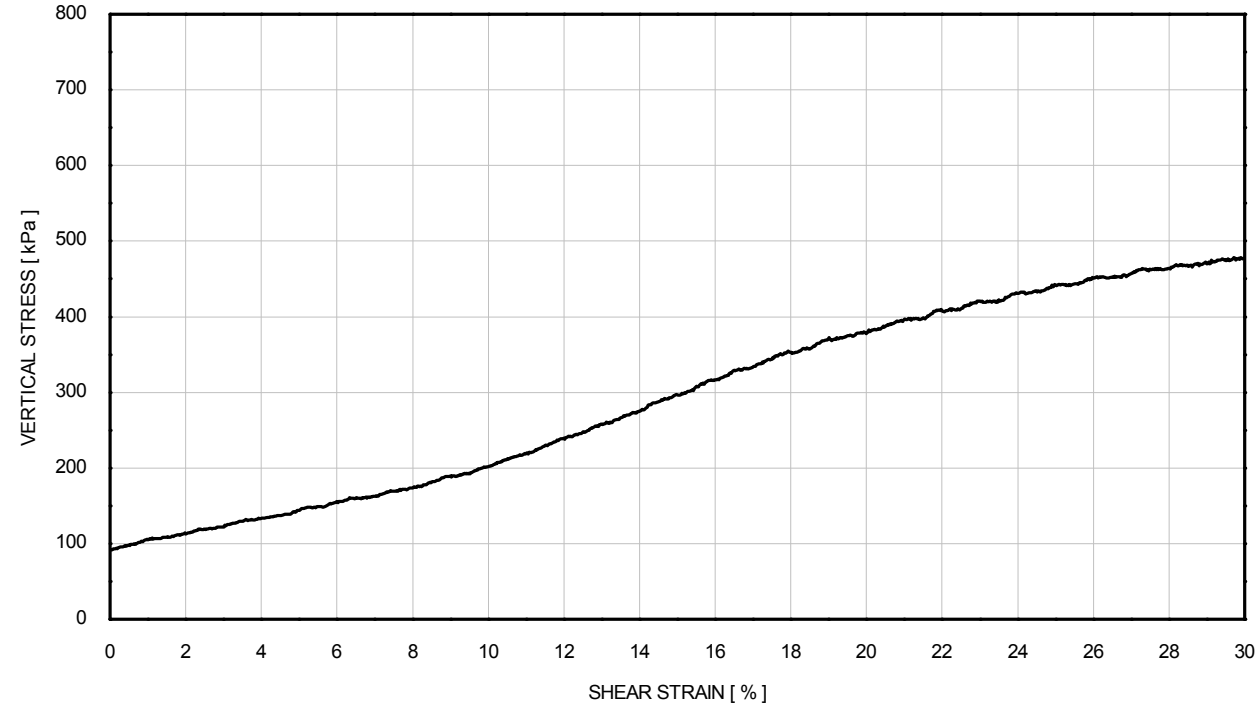


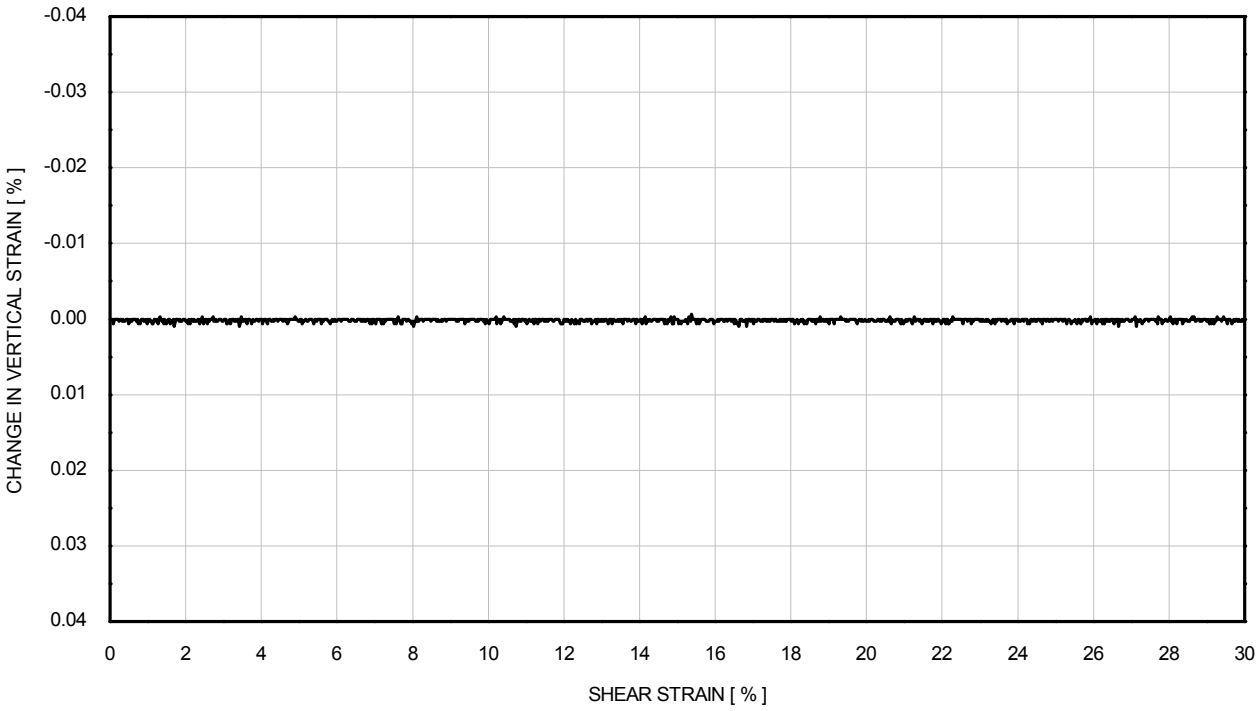


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 29.74 %	Depth [m]	: 34.39
Rate of strain	: 3.07 %/hour	Test No.	: CSS11

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

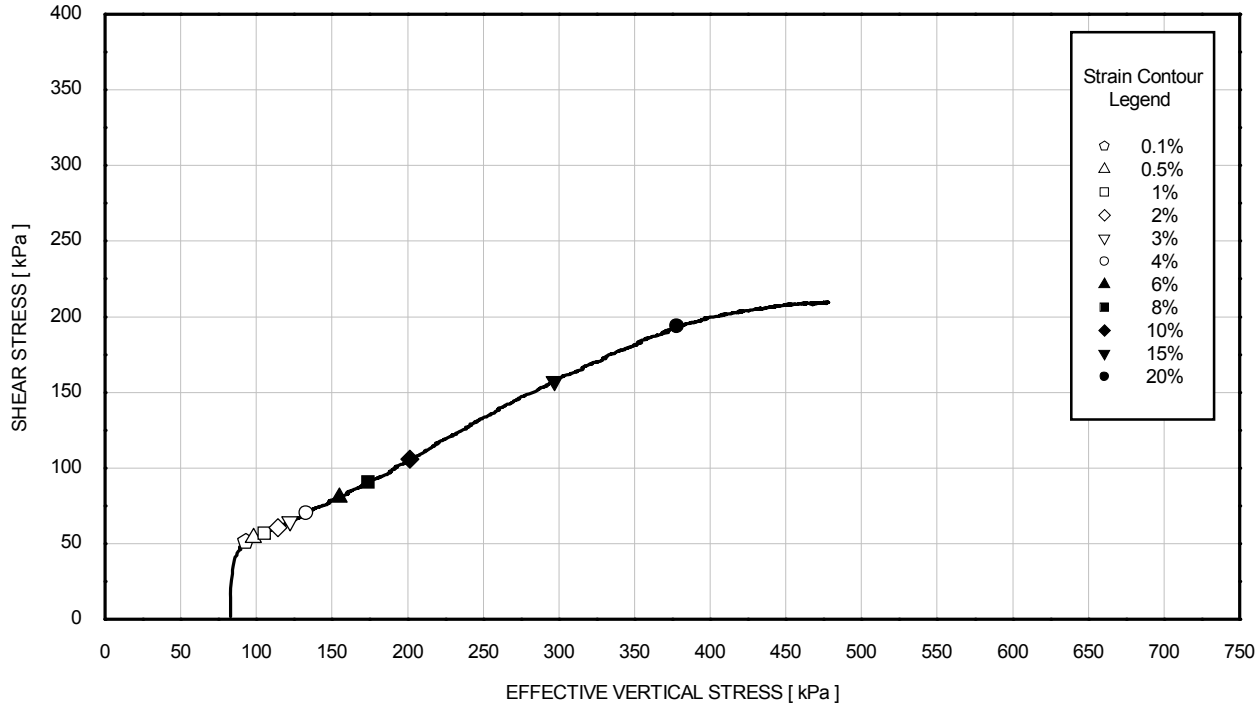


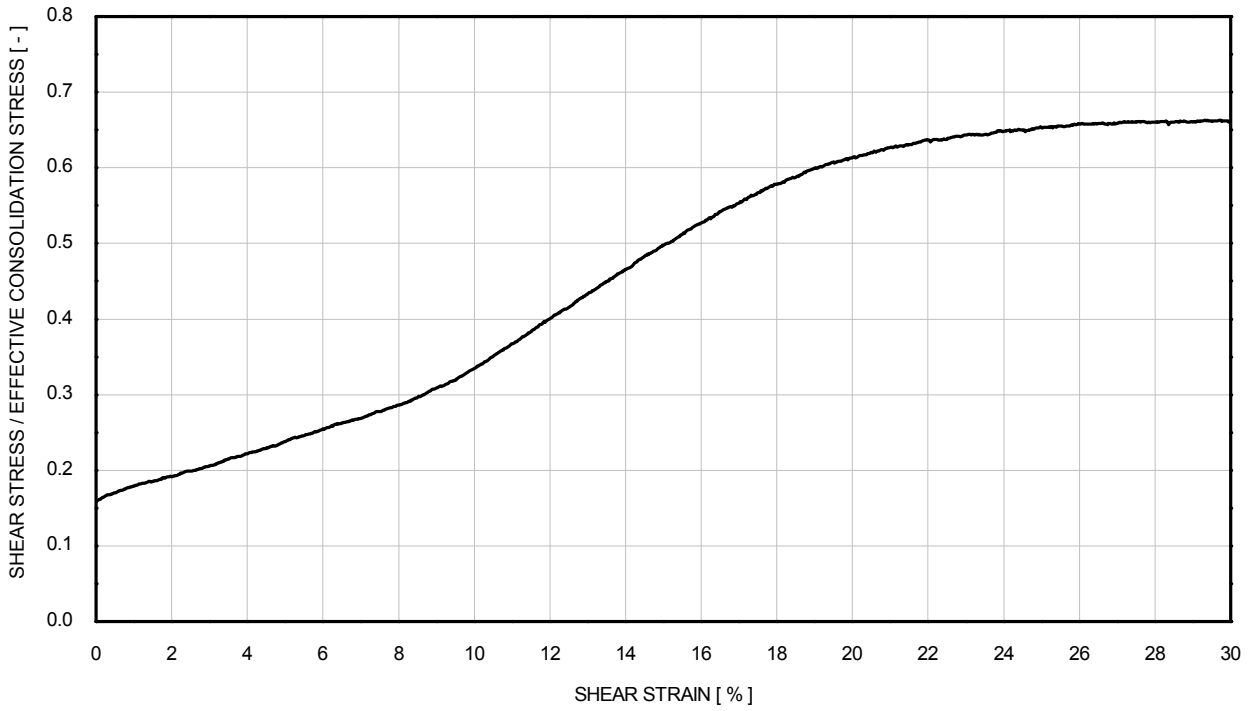


σ'_{vc}	: 316 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 29.74 %	Depth [m]	: 34.39
Rate of strain	: 3.07 %/hour	Test No.	: CSS11

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 316 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 29.74 %	Depth [m]	: 34.39
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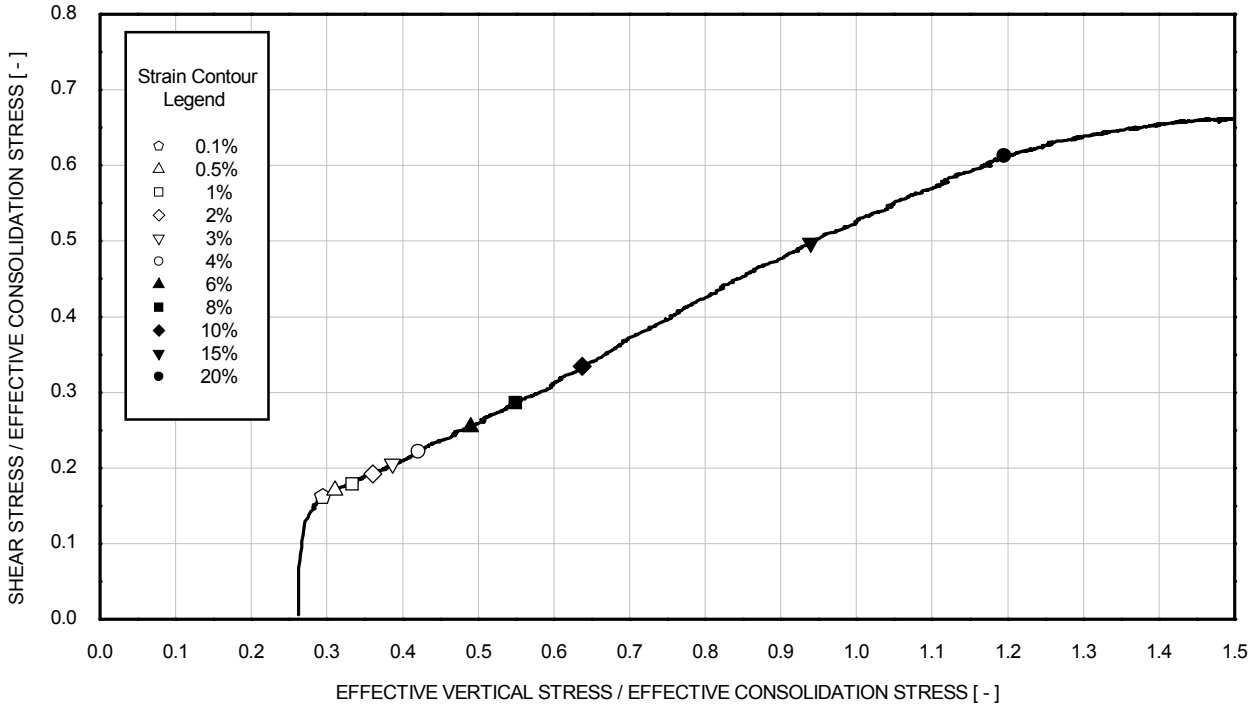
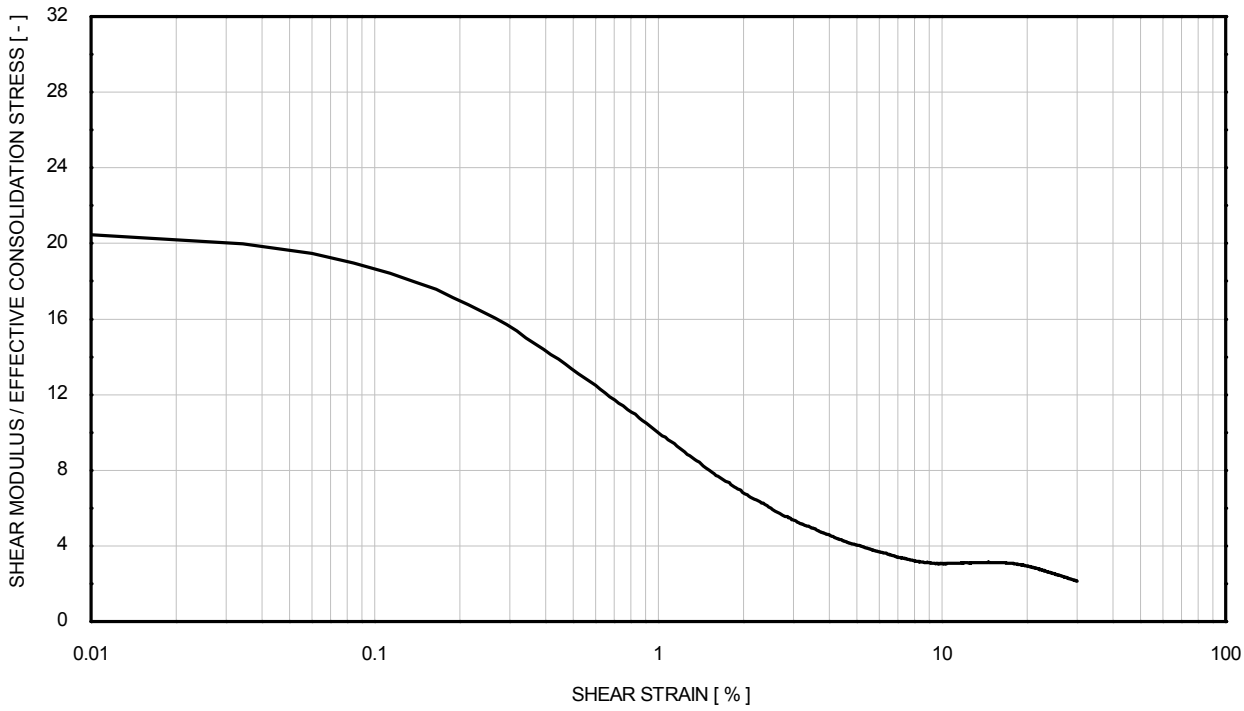
CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA





σ'_{vc}	: 316 kPa	Borehole	: BH-WFS 2-7
τ_{peak}	: 210 kPa	Sample	: 20WAXC
γ at τ_{peak}	: 29.74 %	Depth [m]	: 34.39
Rate of strain	: 3.07 %/hour	Test No.	: CSS11

CONSOLIDATED CYCLIC DSS TEST
SHEARING STAGE - CONSTANT VOLUME

BORSSELE WIND FARM SITE I&II - DUTCH SECTOR, NORTH SEA

SECTION B: GUIDELINES FOR USE OF REPORT

CONTENTS Reference

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 INVESTIGATIONS

Fugro follows ISO 9001 quality principles for project management. Project activities usually comprise part of specific phases of a construction project. The quality plan for the entire construction project must incorporate geotechnical input in every phase - from the feasibility planning stages to project completion. The parties involved must 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.

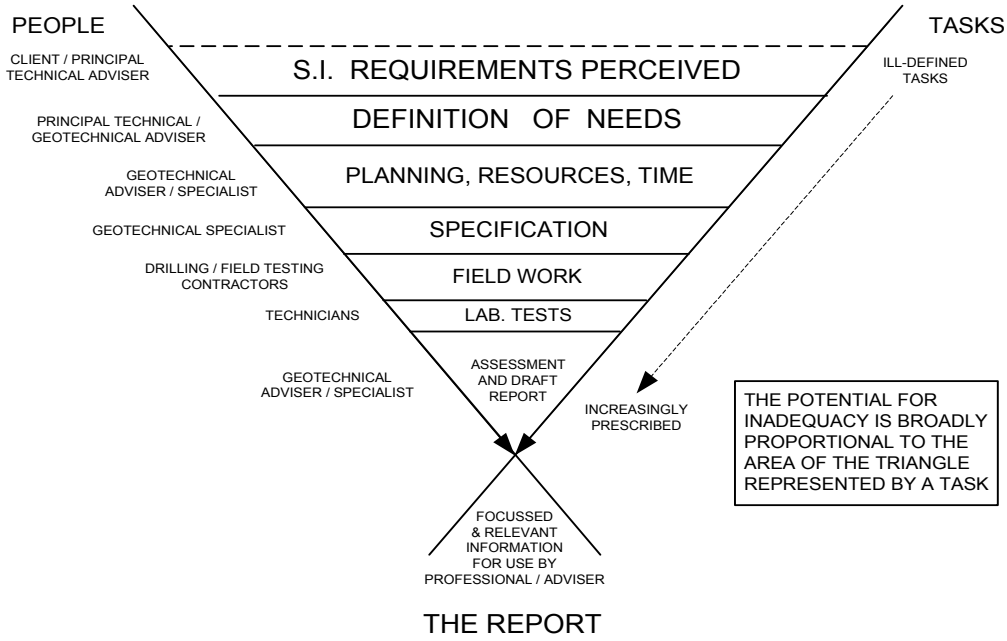
AUTHORITY, TIME AND RESOURCES NECESSARY FOR GEOTECHNICAL INVESTIGATIONS

To ensure compliance with these requirements, there must be adequate designation of authority and accountability for geotechnical aspects of construction projects. 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 in ensuring that adequate geotechnical information is gathered 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.

ISSUE 10

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 must 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 borehole 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.

1 Site Investigation Steering Group SISG (1993), “Site Investigation in Construction 2: Planning, Procurement and Quality Management”, Thomas Telford, London.

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 must 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.