REPORT

Norwegian GeoTest Sites (NGTS)

FIELD AND LABORATORY TEST RESULTS HALDEN

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Summary

Halden silt site is property of Halden municipality and it is known locally as Rødsparken. As part of the characterization of Halden silt site during NGTS project, two main reports are prepared: 1) a factual report (20160154-04-R) and 2) an interpretation report (20160154-05-R) (see figure in the next page). The present report (20160154-04-R) presents a factual summary of all laboratory and in situ testing carried out for the NGTS project between May 2015 and March 2019.

Site specific tests and methods are described in the present report. Standard methods for laboratory and in situ tests that apply for all NGTS sites are detailed in the general reports NGTS Report 02 (20160154-02-R) and NGTS Report 03 (20160154-03-R), respectively.

NGTS – Halden Research Site

VOLUME 1:

FIELD AND LABORATORY OPERATIONS, PROCEDURES AND RESULTS,

INCLUDING

MEASURED AND DERIVED GEOTECHNICAL AND GEOPHYSICAL PARAMETERS

NGTS REPORT NO.:

20160154-04-R

Executive Summary

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2. **Research site**: Geological setting. See associated Appendix and Tables for Log of Field Operations, Mapping and Coordinates.
3. **Field investigations**: Sub section for each In Situ Test. Contains Results (Measured and Derived). See corresponding Appendix and Tables for figures.
4. **Laboratory testing**: Sub section for each test. Contains Results (Measured and Derived). See corresponding Enclosure and Tables for figures
5. **Geotechnical Borehole Logs** with Soil Units, Summary of Geology, Soil Conditions and Soil Units.
6. **List of Symbols and Terms**
7. **References**

List of Appendix (figures and tables for field and laboratory test results)
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White background means current report.

VOLUME 2:

DATA INTERPRETATION

AND

EVALUATION OF

REPRESENTATIVE GEOTECHNICAL AND GEOPHYSICAL PARAMETERS

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20160154-05-R

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1 Introduction

This report describes the work carried out at Halden Silt Site between May 2015 and March 2019 as part of Research Council of Norway's (RCN) infrastructure project "Norwegian GeoTest Sites (NGTS)" (*Nasjonalt forsøksfelt*). NGTS projects has in total five sites. The report will be revised accordingly in the future to provide updates on new activities.

All onshore and offshore construction projects require geotechnical design parameters to evaluate and plan infrastructure developments. A lack of high quality samples and correctly interpreted geotechnical data may lead to oversized and costly infrastructure foundations, structure collapse or damage, geohazards and loss of human lives. Silty or intermediate soils include a group of natural deposits (e.g. sandy clays, silty clays, clayey silt, and silty sands) that often violate assumptions inherent to geotechnical engineering for the characterization of clays (e.g. undrained response) and sands (e.g. drained response). This is due to the fact that intermediate soils often exhibit “transitional” behaviour, i.e. neither “clay-like” nor “sand-like” but rather a complex combination of the two.

There is general agreement in the geotechnical community that there is a need for greater understanding of the behaviour of silts to give increased confidence in parameter selection, geotechnical design and mitigate risk. In order to achieve this current practice in geotechnical investigations, both laboratory and in situ, are tested at Halden. Novel test methods are introduced where possible by NGTS project team together with research work at the site. The results of which lead to improved understanding of silt at Halden.

1.1 Scope of work

During the first three years of the NGTS project (i.e. June 2016 to June 2019), resources are directed towards a full geotechnical characterization of the selected sites. This includes purchase of equipment and establishment of necessary site infrastructure for future use of the sites for in situ testing, including model testing, during the next 20 years. For example installation of permanent in situ equipment (e.g. piezometers, thermistor strings and pressure cells), electricity and water supply to the site.

2 Halden Research Site, Norway

The silt deposit at Halden was first investigated by NGI in 2011 after a landslide in the area (NGI, 2012). More recently, the deposit has been studied with the aim of developing a National GeoTest Site for silty soils as part of NGI's internal strategic project 8 (SP8) and NGTS.

The Halden Research Site is located in south-eastern Norway, approximately 120 km south of Oslo, See maps in Appendix A for further details. Here the marine silt deposit is up to 10-11 m thick and uniform in nature. Over the past two years a series of geophysical, geological and geotechnical investigations have been carried out in the field and in the laboratory to characterise the natural silt deposit. This information will provide a basis for understanding the main factors controlling the engineering properties and behaviour for this silt.

2.1 Topography of the site

The silt site at Halden is located at Rødsparken. It is 6150 m² and it has a nearly flat topography varying between +27 and +34 height levels from southwest to northeast. Towards the north and west, the site is limited by a ridge which ascends to +55 height level. Another ridge with height levels varying between +35 to +44 limits the site to the east. To the south, the terrains descends gradually along Bøkeveien, with a higher terrain inclination towards the southwest descending to a +5 height level.

2.2 Geological setting and source material

The location of the Halden research site in the regional geological setting is presented in Appendix A. In the quaternary maps of the Halden area (Figs. 1.3 and 2.3) the colours reflect the geological processes and general properties of the deposits:

- Shades of blue indicates that the soils have been transported by and deposited in a marine environment. These deposits dominate the Halden area.
- Shades of green indicate soils that were deposited by the ice.
- Pink shows exposed bedrock.

Halden lies within the Norwegian South-East basement area. The dominating rocks are gneiss in the North-East and granites in the Northwest and Southeast (Olsen and Sørensen, 1993). The glacial striations are generally North-South and Northeast-Southwest and topographical characteristics like small valleys and hills are typically oriented in that direction. The dominating geological feature in the area is the zone of marginal moraines called "*the Ra*". This end moraine was deposited about 10,700 years ago immediately in front of the glacier. It traverses the area from Northwest to Southeast and retains the water in the three lakes *Tvetervatn, Rokkevatnet* and *Korsevatnet*. Earlier the moraine also retained a larger lake *Femsjøen*. A second zone of marginal moraine, parallel to the Ra is located south of Halden, namely "*Ytterraet",* or the *Onsøy-Borge step*. Between and outside these two features are large veneers of clay deposits, interrupted in certain areas by silt and sand deposits e.g south of Halden. Areas Northeast of "*the Ra"* are dominated by exposed bedrock, with clay only in local depressions.

Since the deglaciation of the Oslofjord area in Southeastern Norway about 8,000-12,000 years ago the retreating ice masses were followed by increasing sea levels and significant marine sediment deposition with subsequent significant isostatic uplift following the deglaciation (Kenny, 1964).. Halden is situated in this region Today the area is rebounding at a rate of about 3 mm/year (Olsen and Sørensen, 1993). The marine limit (highest post-glacial sea level in the region) is about 185 m above its present sea level (Olsen and Sørensen, 1993). The research site has an elevation of approximately 28.5 m above present sea level, as such the depositional environment has therefore changed from rapid deposition of glacial marine silts and clays during deglaciation to more placid deposition in an estuarine environment during the early Holocene.

The source material was primarily produced by glacial erosion, with secondary fluvial transport. The Glomma River is Norway's longest and largest river and runs into the Oslofjord in Fredrikstad, about 25 km northwest of the site. East of Halden, a system of lakes and rivers called *Haldenvassdraget* flow into the fjord. This system is the second largest in Norway which runs into the *Iddefjord* at Halden through the *Tista River*. During higher sea levels, the test site was most likely highly influenced by both the Glomma River and *Haldenvassdraget* as Halden was inundated by the sea (Sørensen, 1979). The material deposited by river transportation is glacial rock flour which contains clay minerals (mostly illite and chlorite), quartz and feldspars. Following the onset of more ameliorated climatic conditions, the influence of biological productivity in the waters above the site on the sea floor at the site itself have become more prevalent. The source material will have changed to more local sources as the relative sea level in the region reduced. This is not expected to have changed the composition of the deposited material, as it has partly been derived from reworking of similar deposits and from eroded crystalline bedrock. The maps in Appendix A show that the site is located on a thick marine deposit (i.e. mostly marine fine-grained deposit, continuous cover, great thickness prevalent).

2.3 In situ testing and site investigations

Fieldwork was carried out in separate stages beginning in May 2015 to August 2018. Further details on test ID, date of testing, coordinates, cone factors, elevation, depth to end of test and depth to bedrock where identified can be found in the Coordinate Table in Appendix B.

Halden municipality have installed water and power at the site near the parking area. A sign will be placed at the site close to this location for information to the public about NGTS.

2.3.1 Ground water table

The water table was measured from in situ stand pipe to be 2.5 m below ground level in 2015. Later readings found the GWL to sit at 2.37 m depth below the surface. Monitoring of piezometers showed seasonal variations in the ground water levels. This difference is of about 15 kPa between March and October readings. Appendix E presents results from electrical piezometers at Halden.

2.3.2 Stratigraphy

The stratigraphy at the site is divided into four main units based on laboratory and in situ testing results. It consists of approximate (approx.) 4.5 m of silty sand (Unit I) above approx. 10-11 m of silt (Units IIA, IIB and III) and the final clay unit (Unit IV). Appendix R presents borehole logs with the described stratigraphy.

3 Field testing

3.1 General

At present, geotechnical site investigation comprises of the tests listed in Table 3.1. For a full description of the abbreviated terms used in Appendix B see Section 6.3.

Table 3.1 List of in situ tests at Halden

Abbreviation	Description	Number
BH54C	54 mm composite sample borehole (with liner)	2 boreholes with 15 and 12 samples, respectively
BH72	72 mm sample borehole (no liner)	1 borehole with 14 samples
BHGPS	Gel Push Static penetration	2 boreholes with 2 and 4 samples, respectively
BHSB	Sherbrooke block sample borehole	1 borehole with 16 samples of Ø250 mm and 3 samples of Ø160 mm samples
BHGUS	Gregory undisturbed Fixed Piston sampler	1 borehole with 6 samples of Ø63.5 mm
BHDM	Dames and Moore Fixed Piston sampler	1 borehole with 7 samples of Ø61.4 mm
CPTU	Cone penetration test with pore pressure measurements	7
CPTU-DIS	Cone penetration test with dissipation	7
ERT	Electrical resistivity tomography	6 lines
HYP	Hydraulic piezometer (Manual reading)	1
MASW	Multichannel Analysis of Surface Waves	2
Piezo	Piezometer (Electric reading)	4
RCPTU	Resistivity cone penetration test	1
RCPTU-DIS	Resistivity cone penetration test with dissipation	1
RPS	Rotary pressure sounding	5
SBP	Self boring pressuremeter test	1
SCPTU	Seismic cone penetration tests	3
SCPTU-DIS	Seismic cone penetration tests with dissipation	4
SDMT	Seismic dilatometer test	1
PS	Passive seismic test	3
StandP	Stand pipe	1
THS	Thermistor string	1
HSFT	Hydraulic fracture stress tests	2
FVT	Field vane tests	1
SPLT	Screw-Plate Load Tests	2

The investigations reached bedrock at depths ranging from 1.12 m and 23.71 m. Samples were recovered from BHs to a maximum depth of 18.96 m.

All samples analysed (geotechnical laboratory testing) at NGI's onshore laboratory in Oslo with the exception of one set of 54 mm diameter composite samples from borehole HALB02 which was analysed (geological descriptions) at NGU in Trondheim. Samples HALB07 and HALB08 are being analysed at University of Massachusetts (Amherst).

3.2 Electric Resistivity Tomography

A total of six profiles of ERT were performed between May 2015 and November 2016. Appendix A shows a location plan of ERT lines and Appendix C shows the ERT test results with the start and end point of each resistivity profile.

3.2.1 Results

Two parallel profiles were carried out in the North East - South West (NE-SW) direction, three parallel profiles were performed in North West - South East (NW-SE) direction and one profile were performed in the North-South direction, see Appendix A. All resistivity profiles are presented in Appendix C.

The electrode spacing is 1.0 m - 2.0 m and the profile lengths range between 72 m and 160 m. Further detail on spacing of electrodes is presented in the comments table in Appendix B. In order to obtain position of the ERT profile, electrode positions were measured with a Differential Global Positioning System (DGPS). The density of the DGPS measurements along the profiles varied, mostly based on the observed topography. The DGPS coordinates of start and end points of the resistivity profiles acquired during the 2015 and 2016 investigations are shown in Appendix B.

Resistivity profile HALER01 up to 125 m is affected by electrical noise from a buried electrical cable running parallel with the ERT line HALER01. ERT profiles HALER02, HALER03 and HALER05 contain noise due to a buried electrical power cable and a water supply pipe running along profile HALER01. The 2016 a new round of ERT lines were carried out to acquire better quality resistivity data from the site away from the buried cables and in areas where there was no existing data, these were profiles HALER04, HALER05 and HALER06.

On all profiles, the top few meters are marked by a resistive ($\rho > 300$ Ωm) dry crust layer. Profiles HALER02 and HALER03 shows high resistivity bedrock ($\rho > 600$ Ωm) outcropping to the SE, while HALER04 shows bedrock in the region of 10 mid way along the line reducing to 5 m to 7 m depth at the end of the ERT line in the NE direction. Due to smoothing effect of the inversion method it is difficult to pin point the bedrock depth without further information from a BH or CPT. The depth interval of interest based on BH and CPTU investigations has a resistivity in the order of 100 Ωm to 160 Ωm, see profiles HALER04 to HALER05.

3.3 Rotary Pressure Sounding

3.3.1 Results

Five rotary pressure soundings are performed at the Halden. Results are shown in Appendix D. Some problems appear with the recording system during one sounding (i.e. HALRP04) that the data was not logged.

3.4 Cone Penetration Tests

3.4.1 General

A total of 23 cone tests have been performed at Halden. They comprise of CPTU, SCPTU and RCPTU tests. Standard rates of 20 mm/s were used in most cases. Near 50% (11 of 23) of the tests include dissipation tests with variable rates of penetration varying between 2 mm/s and 320 mm/s (see Table 3.2). Different cones types were used at the site, the manufacturers include:

- Envi
- Geotech
- GeoMill
- Pagani
- A.P. van den Berg

The coordinate list in Appendix B documents the cone and a factor for each cone. See the comments for additional information on tests. Results from the cone tests are presented in Appendix G. Where variable rate is used the rate is presented in the figure and where standard rate is used no rate is presented in the figure. All cones have a projected area of 10 cm^2. Tests were terminated at the discretion of the operator performing the test or at refusal due to bedrock or stiff ground.

3.4.2 Resistivity Cone Penetration Tests

The results from the RCPT tests are presented in Appendix G. Resistivity is presented in combination with q_t where it is recorded.

3.4.3 Seismic Cone Penetration Tests

Six SCPTU tests were carried out at Halden and results are shown Appendix G following the figures containing q_t, f_s and u_2. All shear wave velocity (Vs) results are interpreted from dual element cones. Further information on the cones used is presented in 20160154-02-TN (NGI, 2018). Important comments on tests are presented in the coordinate table comment table in Appendix B. For details on processing of the SCPTU, see 20160154-02-TN (NGI, 2018). It should be noted that the Vs results from the van den Berg piezocone are smaller than the ones obtained with the other cones.

3.4.4 Dissipation Tests

Eleven cone tests carried out dissipation tests as part of the penetration phase of the test. A total of thirty seven dissipation tests were completed. The penetration rate was constant in most cases for minimum 1 m prior to the start of the dissipation test. In some cases the rate was constant for up to 1.5 m before the dissipation depth. A summary of the various rates and depth intervals where tests were performed is presented in Table 3.2. The rates presented in this table are approximate rates.

Table 3.2 Summary of depths for dissipation tests and penetration rates prior to the test

Depth [m]	Rate < 2 mm/s	Rate = 20 mm/s	Rate between 40-80 mm/s	Rate = 100 or 280 or 320 mm/s	Total
5.0	1	2			3
6.5	3	4	1	2	10
8.5	2	5	1	2	10
10-10.5	2	4	1	3	10
11.5		1			1
12.5		2	1		3

The mechanical operation for the Envi, Geotech and Pagani cone tests comprised of stopping penetration at the target depth and start logging by manual trigger from the operator for data logging.

In the Envi and Geotech set up the base clamps are then engaged and the top hydraulic clamps are disengaged to avoid possible movement of the hydraulic system with time and applying pressure on the cone.

In essence there can be a short time lapse of a couple of seconds between end of penetration and start of logging and some change in stress conditions due to movement of the clamps engaging and disengaging. However care and attention to these processes was made during testing to minimize possible effects on measurements.

Results from the dissipation tests are presented in Appendix H and a table of the test ID, depth interval, rate and cone used is also presented in Appendix H. The dominant response in these tests was dilation (i.e. u_i rises with time, reaches a peak value u_{max}, and then decreases with time towards u_o). Several of the tests with the Envi cone had a sudden drop in u_2 before a quick recovery. Results are grouped and presented by location ID.

3.5 Seismic Dilatometer testing

One SDMT was performed at Halden using a dual element device. The results from the test are presented in Appendix I.

3.6 Hydraulic fracturing stress tests

Two HFST were performed: one at 8 m and the other one at 13 m. The results from the tests are presented in Appendix K.

3.7 In Situ Pore Water Pressure (u_o)

Four piezometers were installed at Halden on 23rd September 2016 at depth intervals of 5, 10, 15 and 20 m. Readings are taken twice in a 24 hour interval. An overview of the data collected is from these piezometers is presented in Appendix E. The results show a slight change of about 5-15 kPa in the in situ u_0 profile over a year interval. The pore pressure distribution is slightly under hydrostatic down to 15 meters depth (9 kPa/m), and well under further down to 20 meters (5 kPa/m). The piezometer at 15 meters just above the clay and the one at 20 meters on the clay.

3.8 Sampling

A total of 8 boreholes are completed and 78 samples are collected at Halden. Table 3.3 presents a summary of samples recovered from the boreholes at Halden. A detailed list of samples and depth intervals for each borehole is presented in Appendix L. The initial attempt for a block sampling borehole (HALB04A) was abandoned due to collapse of the borehole over the initial 3 m.

Table 3.3 Summary of samples recovered from boreholes at Halden

LOCA_ID-HOLE_ID	ABBR	No. of samples	Depth to end of test (m)	DATE
HALB01	BH72	14	12.80	2015-05-18
HALB02	BH54C	15	16.50	2015-10-19
HALB03	BH54C	12	14.80	2016-06-06
HALB04	BHSB	19	15.20	2016-06-13
HALB04A	BHSB	0	3.00	2016-06-13
HALB05	BHGPS	2	23.67	2017-09-11
HALB06	BHGPS	4	13.40	2018-05-09
HALB07	BHGUS	6	18.81	2019-03-18
HALB08	BHDM	7	18.96	2019-03-19

3.9 Thermistor string

The thermistor string was located in the gel push sampling borehole (HALB05). After sampling was complete the BH was extended to bedrock and the thermistor string inserted.

Data is collected from the thermistor string via NGI's Vista database and presented online with the following site: http://vistadv01.ngi.no/vdv/index.html

- Username: NGTS
- Password: NGTS2017

Historical data, real time display and graphical output can be viewed under main functions on the top of the page for the selected site. Data can be downloaded under the information option. Results from the thermistor strings are presented in Appendix T.

3.10 MASW testing

The Multi-channel Analysis of Surface Waves (MASW) survey was conducted by NGI the 9rd of March 2018. The ground was covered with snow but there was only a thin frozen crust layer in the subsurface. The weather was optimal for seismic surveying with no rain and little wind. The acquisition parameters are summarized in Table 3.4. Two profiles were acquired, one (HALM01) near the piezometers and one 50 m to the NE (HALM02).

Table 3.4 MASW survey acquisition parameters

Recording system	Daqlink, 2*12 channels
Geophone type	Single geophone 4.5-Hz (vertical)
Receiver interval	1 m
Recording time	2 s
Sampling interval	1 ms
Recording filter	None
Polarity	SEG convention
File format	SEG2
Data storage type	Un-stacked
Source	Sledge hammer (5 kg) and rubber plate
Shot count/location	4 to 5 shots per location
Source positions	4 m both ends of the array

The 1-12 geophone cable was unfortunately inverted during the acquisition at HALM01 (left and right gather). The acquisition geometry was corrected using the ReflexW software.

The data was processed using the WinMASW software (Dal Moro et al., 2015). Once the acquisition geometry is properly defined and the data are vertically stacked for repeated shots-receiver combinations, the data quality is assessed in time domain. Traces numbers 10 and 13 are noisy and therefore excluded for further processing. The fundamental mode, 1st, 2nd, and 3rd modes are then picked in phase-velocity domain. These picks are used for the velocity inversion with WinMASW. The inversion of the dispersion curves provides a 1D Vs profile averaging the subsurface properties below the geophone array.

Data and results are presented in Appendix U.

3.11 Passive seismic testing

Microtremor array exploration is a method for inferring the subsurface structure by identifying the phase velocity of surface waves through array observations of microtremors (also referred to as ambient noise, microseisms, etc.). NEID has developed new methods in recent years for extracting surface wave characteristics from miniature arrays (Cho and Senna, 2016).

The passive seismic survey was conducted by NGI and NEID the 9th of March 2018. The ground was covered with snow but there was only a thin frozen crust layer in the subsurface. The weather was optimal with no rain and little wind. The acquisition parameters are summarized in Table 3.5. Three sites were acquired, one near the piezometers (HALPS01), one 50m to the NE (HALPS02), and one at the NE end of the park (HALPS03).

Table 3.5 Passive seismic survey acquisition parameters

Recording system	Datamark JU410 (HAKUSAN CORPORATION)
Geophone type	Accelerometers, 3 channels, JA-40GA-4G
Recording time	15 min
Sampling rate	200 Hz
Recording filter	None
Polarity	Z,E,N
File format	WIN format developed by ERI Univ. of Tokyo & ascii

The data was processed with the open source software Geopsy (e.g. Wathelet et al., 2008). The H/V spectral ratio of microtremor measurements is generally able to estimate the predominant frequency of a site (Nakamura, 1989). First, horizontal to vertical ratio are derived from each of the three sites. Only the first site, HALPS01, shows a clear peak at 3.2Hz. Assuming an average Vs velocity of 160 m/s, it provides a sediment thickness of 12.6 m (Depth=Vs/4F_0). It is suspected that the H/V spectral ratio for

HALPS02 and HALPS03 do not show any clear predominant frequency due to the valley shape of the substructure that does not follow the 1D assumption.

The phase-velocity dispersion curve for the individual modes (the fundamental mode of the Rayleigh waves and the higher modes) can also be calculated. As for the MASW method, those dispersion curves can be inverted to obtain the shallow velocity structure.

Results are presented in Appendix V.

3.12 Field vane tests

Field vane testing (FVT) was performed using a Geotech AB 130 × 65 mm vane with a tapered lower end in general accordance with the Norwegian guidelines (NGF, 1989). After pre-drilling down to about 4.5 m the vane was advanced to the target depth from the ground level encased in a protective housing. The vane was then pushed out of the housing and rotated using electric heads and the torque was measured on the drill rig. Both intact and remolded tests were conducted at a rate of shearing of about 0.1 °/s. Remolded tests were performed after 10 full revolutions of the vane. The intact and remolded FVT results are presented in Appendix X.

3.13 Screw-Plate Load Tests

Two SPLT were performed in august 2018 as part of the PhD work of Øyvind Blaker. Details about the tests and results will be later presented by Blaker in a publication.

4 Soil Descriptions and Geotechnical Boring Logs

4.1 General

The borehole logs for boreholes listed in Table 3.3 are presented in Appendix R. The closest CPTU at standard rate of penetration is presented in the log.

4.2 Borehole Logs

The borehole logs for the investigated locations are presented in Appendix R. The borehole logs are based on the laboratory test results presented in this report as well as the cone penetration test results as presented in Appendix G. An average total unit weight of 19 kN/m^3 has been used to establish the corrected cone resistance.

4.3 Soil Description

Table 4.1 presents a summary of the generalised soil conditions encountered at the test site locations. Depths below surface are based on location HALB01.

*Table 4.1 Summary of generalised soil stratigraphy at HALB01**

Unit	Depth below surface, m (to top of unit)	Soil description
I	0	SAND, clayey, silty, fine, loose to medium dense
IIa	4.5	SILT, sandy, clayey, low strength
IIb	7.5	SILT, clayey, low to medium strength
III	12.1	SILT, clayey, medium to high strength
IV	15.3	CLAY, low to medium strength
V	21.3	BEDROCK

*Strength descriptions in this table and in BH logs (Appendix R) are based on including the undrained shear strength from CPTU with a N_{kt} = 12-20. See Section 6.4 for more information about the strength classification.

5 Laboratory Results

5.1 Classification Tests

A number of classification tests have been performed in the laboratory in order to obtain basic soil characteristics of samples from all locations where samples were obtained.

Appendix M presents a summary table of classification tests performed in the laboratory.

Parameter	Value
Natural water content, w (%)	20.0 – 33.5
Total unit weight, γ (kN/m³)	18.6 – 20.3
Liquid Limit, w_p (%)	25.5 – 37.3
Plastic Limit, w_p (%)	19.8 – 25.5
Plasticity index, I_p (%)	5.0 – 12.8
Clay content (%)	6.8 – 11.0
Salinity (g NaCl/L)	1.1 – 4.6
Fall cone strength (kPa)	24 – 113
Sensitivity (-)	3 – 23
Unit weight of solid particles, γ_s (kN/m^3)	26.26 – 26.50
Total Carbon, TC (%)	0.14 – 0.54
Total Organic Carbon, TOC (%)	0.11 – 0.52

5.1.1 Natural Water Content

Water contents measured on all sample are presented on the borehole logs in Appendix R and the classification test summary table in Appendix M.

5.1.2 Total Unit Weight

The measured results are presented on the borehole logs in Appendix R and the classification test summary table in Appendix M.

Total unit weight as measured on all advanced tests as well as the values based on water content measurements are presented in the borehole logs, assuming a unit weight of solid particles of 26.4 kN/m^3 based on the onshore laboratory results and 100 % saturation. Interpretation of unit weight from multisensor core loggings is also shown for some of the boreholes.

5.1.3 Atterberg Limits

The liquid limit, w_L, and the plastic limit, w_p, have been determined on selected samples. The measured w_L and w_p are presented with the plasticity index, $I_p = w_L - w_p$ on the borehole logs in Appendix R and in the classification test summary table in Appendix M.

5.1.4 Grain Size Distribution

As a standard, the grain size distributions are found using the falling drop (FD) method (Moum, 1965) for the clay and silt fractions, and by wet sieving for the coarser fractions. A combination of wet sieving and hydrometer testing (Hyd) were performed on some selected samples.

The FD method droplets from a given depth in the sedimentation tube are sampled with a calibrated micropipette after certain time intervals and then ejected into a glass column containing an organic liquid. The time required for each droplet to fall a given distance in the organic liquid is measured. In the hydrometer test, the hydrometer is inserted in a 1000 mL glass cylinder with suspension at certain time intervals. The device is graduated to read in either specific gravity or grams per litre of suspension. Both methods are based on Stoke's law.

At the Halden site the clay content in the silty soil units ranges from about 7% to 11%.

Numerical values for the clay, silt and sand fractions are listed in the classification test summary table in Appendix M. The detailed grain size distribution curves are also presented herein.

5.1.5 Salinity

In order to aid the understanding of the geology of the Halden area the salinity of the pore water in 9 selected samples has been analysed by means of ISO 11265.

All results indicate a salinity of less than 5 g NaCl/L. Individual test results are presented in the salinity test summary table in Appendix M.

5.1.6 Fall cone strength and Sensitivity

Index strength tests were carried out in the laboratory using the fall cone apparatus.

The sensitivity is taken as $S_t = s_u/s_{ur}$ where s_u and s_{ur} are the undrained shear strengths found by fall cone tests for the intact and the remoulded samples, respectively. It should be noted that the test apparatus and correlations between cone penetration and the undrained shear strength of the soil are developed for clays.

The results are presented on the borehole logs in Appendix R and the classification test summary table in Appendix M.

5.1.7 Unit weight of solid particles

The unit weight of solid particles, γ_s, was determined on selected samples. The individual results are presented in the classification test summary table in Appendix M.

The average value of γ_s in the Halden silt units is 26.4 kN/m^3.

5.1.8 Scanning Electron Microscopy

High-resolution imaging of the soil specimens from borehole HALB01 has been performed using Scanning Electron Microscopy (SEM) at the University of Oslo.

Appendix M presents a selection of images resulting from these analyses.

5.1.9 Mineralogy

Mineralogical analyses by X-ray Diffraction (XRD) were performed by Norwegian Geotechnical Society (NGU) on 3 soil specimens. The individual results and equipment details are presented in Appendix S. Note that the location naming convention has changed since the NGU report was written. Table 5.1 lists the correct borehole names, depth of the test specimens and the corresponding XRD results.

Table 5.1 Summary of NGU XRD results on Halden specimens.

NGU Sample ID	NGTS borehole	Depth	qtz	K-fsp	Plag	ill/musc	Chl	amph
(-)	(-)	(m)	(%)	(%)	(%)	(%)	(%)	(%)
SP8-4-50	HALB02	4.50	41	12	30	8	3	6
SP8-8-19	HALB02	8.19	40	13	29	8	4	6
SP8-13-44	HALB02	13.44	44	12	30	7	2	5
qtz = quartz, K-fsp = alkali-feldspar, plag = plagioclase, ill/musc = illite/muscovite, chl = chlorite								

5.1.10 Total Carbon and Total Organic Carbon

Total carbon (TC) and Total organic carbon (TOC) tests were performed by Norwegian Geotechnical Society (NGU) on selected soil samples.

The individual results and equipment details are presented in Appendix S. Note that the location naming convention has changed since the NGU report was written and Sample IDs SP8-1-20 to SP8-15-45 all represent NGTS borehole HALB02.

5.1.11 Multisensor Core Logging and X-Ray Imaging

X-ray inspection and Multisensor core logging (MSCL) was performed at the Geological Survey of Norway (NGU) from 27-10-2015 to 03-11-2015. A total of 15 sediment cores with a total core length of 12 m was logged (54 mm samples from borehole HALB02 with plastic liner). X-ray images of whole cores were taken with the Geotek MSCL-XCT. Whole core Gamma density, i.e. wet bulk density (WBD) and magnetic susceptibility (MS) were measured using the Standard MSCL-S core logger (GeoTek Ltd., UK) at 0.5 cm resolution with 5 sec exposure/measurement time. After lengthwise core opening and surface cleaning colour images were taken. Core surface images were taken with the GeoScan colour line-scan camera.

The individual results and equipment details are presented in Appendix S.

5.1.12 Age dating

Two samples from borehole HALB02 were dated using the accelerator mass spectrometry (AMS) ^{14}C method at the National Laboratory for Age Determination at the Norwegian University of Science and Technology (NTNU). Results are presented in Table 5.2 below.

Table 5.2 Age dating results.

Borehole	Sample No.	Depth (m)	Reservoir corrected 14C age BP (BP=1950)
HALB02	HALB02-4-066	6.36	6455 ± 25
HALB02	HALB02-13-064	16.31	11820 ± 25

5.2 Oedometer Tests

5.2.1 General

The general purpose of the oedometer test is to obtain consolidation and settlement parameters and an estimate of the preconsolidation stress, p_c' in clays. Oedometer test results can also be used to assess sample quality in low OCR marine clays.

This section summarises the results of oedometer tests performed as either Constant Rate of Strain Consolidation (CRSC) or Incremental Loading (IL) tests. The program consisted of:

Borehole	HALB03	HALB01	HALB04/A	HALB04/A	HALB05	HALB06
Sample type	Ø54 mm	Ø72 mm	Ø250 mm	Ø160 mm	Gel push Ø83 mm	Gel push Ø83 mm
CRSC	5	1	5	-	2	1
IL	-	1	3	-	-	1

The CRSC and IL test specimens had a cross-sectional area of either 35 cm^2 or 20 cm^2. All tests were performed with either one or two unloading-reloading loops.

5.2.2 Constant Rate of Strain Tests

Specimens subjected to one unloading and reloading loop were first loaded to a stress level corresponding to approximately 4% axial strain, where the stress was kept constant until the excess pore pressure dissipated and a constant head permeability (hydraulic conductivity) test was performed . Loading was then resumed and continued to a stress level corresponding to approximately 7% axial strain, where the stress was kept constant for about 24 hours before unloading to p_0'. Finally, the samples were then reloaded to approximately 14% axial strain, where again the stress was kept constant for about 24 hours.

The specimens subjected to unloading and reloading loop were generally performed according to the procedure described above, but unloaded to p_0' from the stress levels corresponding to approximately 4% and 7% axial strain.

The rate of strain was about 5% per hour.

Permeability was continuously computed based on the pore pressure measurements at the base, and the rate of strain. In addition, the permeability was measured directly on the specimen, by constant head permeability (hydraulic conductivity) tests at the stress levels corresponding to 4%, 7% and 14% axial strain. The reported k-value in the oedometer summary table is at zero strain (see Appendix N).

The coefficient of consolidation, c_v is calculated on the basis of the deformation modulus, M, and the straight line interpretation of permeability based on the permeability computations (Sandbækken et al., 1986).

5.2.3 Incremental Load Tests

The specimens were loaded in increments up to about 4 times the estimated preconsolidation stress (p'_c), where the stress was kept constant until the excess pore pressure dissipated and a constant head permeability (hydraulic conductivity) test was performed (in some of the tests). Loading was then resumed and continued to about 8 times the estimated preconsolidation stress, where the stress was kept constant for about 16 hours. A second permeability test was conducted before unloading to p'_0. Finally, the specimen was reloaded and the load increments were increased to a final stress between 3 and 5 MPa where the stress was kept constant for about 16 hours and a third permeability test was conducted.

A standard load increment duration (reference time) of 30 minutes was applied.

5.2.4 Consolidation Test Results

Results of each individual test are presented in Appendix N on both semi-logarithmic and linear plots. The pore pressure normalised by the total applied stress is also presented for the CRSC tests. The variation of the deformation modulus, M, with stress is included in the linear format figures together with the coefficient of consolidation, c_v.

The key results are tabulated in the oedometer summary table in Appendix N. The table presents values of constrained modulus, M, and coefficient of vertical consolidation, c_v, at various stress levels during the tests. M_0 and c_{v0} represent values at the in situ effective vertical stress, p_0', during the initial loading. M_1 and c_{v1} represent average values during the first reloading. M_2 and c_{v2} represent average values during the second reloading.

The modulus number, m, and the reference stress, p_r', given in oedometer summary table represents the deformation characteristics of the soil in the stress range above the preconsolidation stress, p_c', when the following relationship is used:

$$M = m \cdot (p_v' - p_r')$$

Due to the nature of the material interpretation of preconsolidation stress, p_c', using the procedures proposed by Casagrande (1936), by Becker (1987) and by Janbu (1963), has proven very challenging and values are not reported.

5.2.5 Sample quality

For clays, the current state of the art method to assess and identify sample quality are based on change in void ratio relative to initial void ratio (i.e. $\Delta e/e_0$) upon specimen recompression to in-situ stress levels during odometer or consolidated triaxial tests (Lunne et al., 1998). However, these criteria are strictly valid for marine clays of low overconsolidation ratio (OCR=1-4).

Silts and intermediate soils (silty sand, sandy silt, clayey silt, silty clay etc.) may be sampled drained, partially drained or undrained depending on sampling rate, soil composition, type of sampler etc. Volume changes during sampling may or may not occur and alterations of the soil structure may be challenging to identify. Currently there is no quantitative framework to assess the quality of silt or silty soil samples.

5.3 Direct Simple Shear Tests

5.3.1 General

The general purpose of the direct simple shear (DSS) tests is to provide horizontal shear strength parameters for engineering design of various foundations and consequently anisotropy ratios in clay. This section summarises the results from the DSS tests performed on the Halden silt. The program consisted of:

Borehole	HALB03	HALB01	HALB01	HALB04
Sample type	Ø54 mm	Ø72 mm	Reconstituted	Ø250 mm
DSS	2	2	1	6

Except for the test on the reconstituted specimen, all DSS tests were performed on "intact" material, i.e., specimens were trimmed directly from the material extruded from the tube or cut from the block sample. The reconstituted specimen was prepared by moist tamping.

The DSS specimens had a cross sectional area of 35 cm^2 or 20 cm^2 and a height of 16 mm. All DSS tests were performed as consolidated constant volume tests (CCV).

5.3.2 DSS Results

Consolidation

The effective vertical in situ stress ($p'_0 = \sigma'_{v0}$) was estimated from the total unit weight of the soil and the in situ pore water pressure measured in four piezometers on site (5 m, 10 m, 15 m, and 20m below ground level).

"Intact" silt specimens (i.e., specimen trimmed directly from the material extruded from the tube or cut from the block sample) were consolidated to the best estimate p'_0 before shearing.

The applied consolidation stresses are based on the best estimate at the time of testing.

Details from the consolidation stage are presented in the DSS summary table in Appendix O.

Monotonic DSS Tests

In total 11 CCV DSS tests were performed on silt material. Due to the dilative nature of the material the undrained shear strength, s_{uD}, (i.e. τ_f) is taken at peak pore pressure.

Static DSS results are presented as plots of horizontal shear stress (τ_h) and pore pressure (u) versus shear strain (γ), and horizontal shear stress versus vertical effective stress (σ'_a). Appendix O presents all plots and key parameters for each test are summarised in the DSS summary table.

The rate of shearing was approximately 5 % shear strain/hour.

G_{max} by bender elements were performed measured on selected DSS tests, as described in Section 5.6.

5.3.3 Sample quality

For clays, the current state of the art method to assess and identify sample quality are based on change in void ratio relative to initial void ratio (i.e. $\Delta e/e_0$) upon specimen recompression to in-situ stress levels during odometer or consolidated triaxial tests (Lunne et al., 1998). In DSS tests these evaluations may only be made when the specimen is consolidated to p'_0. The Lunne et al. (1998) sample quality criteria are strictly valid for marine clays of low overconsolidation ratio (OCR=1-4) only.

Silts and intermediate soils (silty sand, sandy silt, clayey silt, silty clay etc.) may be sampled drained, partially drained or undrained depending on sampling rate, soil composition, type of sampler etc. Volume changes during sampling may or may not occur and alterations of the soil structure may be challenging to identify. Currently there is no quantitative framework to assess the quality of silt or silty soil samples.

5.4 Consolidated Triaxial Tests

5.4.1 General

The general purpose of the consolidated triaxial test is to provide shear strength parameters for engineering design of various foundations. This part summarises the results from the triaxial tests performed on the Halden silt. The program consisted of:

Borehole	HALB03	HALB01	HALB01	HALB04	HALB05	HALB06
Sample type	Ø54 mm	Ø72 mm	Reconstituted	Ø250 mm	Gel push Ø83 mm	Gel push Ø83 mm
CAUC	3	4	1	5	2	2
CK_0UC				1		
CADC				1	1	2
CAUE						1

Except for the test on the reconstituted specimen from HALB01 all triaxial tests were performed on "intact" material, i.e., specimens were trimmed directly from the material extruded from the tube or cut from the block sample. The reconstituted specimen was prepared by moist tamping using undercompaction (Ladd, 1978).

All triaxial compression tests were run by increasing the vertical total stress ($\Delta\sigma_a>0$), keeping the horizontal total stress constant ($\Delta\sigma_h=0$).

G_{max} by bender elements, constant head permeability (hydraulic conductivity) and resistivity tests were performed on selected triaxial test specimens, as described in Section 5.5, Section 5.6 and Section 5.7.

5.4.2 Triaxial Test Results

Consolidation
The silt specimens were consolidated to the best estimate of the in situ stress conditions. The effective vertical in situ stress (p'_0) was derived from the measured total unit weights and the pore pressure measured by four piezometers on site (5 m, 10 m, 15 m, and 20m below ground level).

Generally, the horizontal effective stresses at the end of consolidation were applied using $K_0 = 0.5$, i.e. $\sigma'_{rc} = 0.5 \times \sigma'_{ac}$.

In the CK_0UC test the applied horizontal effective stress during consolidation equal the stress that prevented radial deformation of the test specimen.

Details of the consolidation of the specimens are given in the summary table in Appendix P.

Anisotropically Consolidated Undrained (CAU) tests
In total 15 static CAUC tests were performed on silt material. Due to the dilative nature of the material the undrained shear strength (s_{uC}) is defined as the shear stress at peak pore pressure (u_{max}). Results of the static undrained triaxial tests in compression are presented as shear stress (τ) and pore pressure (u) versus axial strain (ε_a), and as shear stress versus mean effective stress (p').

Appendix P presents all individual test plots. Key parameters are summarised in the Triaxial test summary table.

K_0 Consolidated Undrained (CK_0U) tests
One static CK_0UC test was performed on silt material. K_0 at the end of consolidation to the estimated in situ vertical effective stress was about K_0=0.56. The result of the static undrained triaxial test in compression are presented as shear stress (τ) and pore pressure (u) versus axial strain (ε_a), and as shear stress versus mean effective stress (p').

Appendix P presents all individual test plots. Key parameters are summarised in the Triaxial test summary table.

Anisotropically consolidated drained (CAD) tests
In total 2 static CADC were performed on silt material. Results of the static drained triaxial tests in compression are presented as shear stress (τ) and volumetric strain (ε_{vol}) versus axial strain (ε_a), and shear stress versus mean effective stress (p').

Appendix P presents all individual test plots. Key parameters are summarised in the Triaxial test summary table.

5.4.3 Sample quality

For clays, the current state of the art method to assess and identify sample quality are based on change in void ratio relative to initial void ratio (i.e. $\Delta e/e_0$) upon specimen recompression to in-situ stress levels during odometer or consolidated triaxial tests (Lunne et al., 1998). However, these criteria are strictly valid for marine clays of low overconsolidation ratio (OCR=1-4).

Silts and intermediate soils (silty sand, sandy silt, clayey silt, silty clay etc.) may be sampled drained, partially drained or undrained depending on sampling rate, soil composition, type of sampler etc. Volume changes during sampling may or may not occur and alterations of the soil structure may be challenging to identify. Currently there is no quantitative framework to assess the quality of silt or silty soil samples.

5.5 Permeability tests

In total 12 and 17 permeability (hydraulic conductivity) tests were performed in the triaxial cell and the oedometer cell, respectively.

The hydraulic conductivity was measured by hydrologic flow through the specimens using constant head. The permeability coefficient is determined through Darcy's equation:

$$v = k \cdot i$$

where:

- v = velocity of water flow. Volume of water (Q) flowing through the cross-sectional area (A) of the specimen during the time, t, i.e. $v=Q/(A \cdot t)$,
- i = water pressure gradient, $i=\Delta h/\Delta l$,
- k = permeability coefficient

In the consolidated triaxial tests the permeability was measured at the estimated in situ vertical stress, $\sigma'_{ac} = p'_0$.

In the oedometer tests measurements were made at several stress levels throughout the test, and the results were back-extrapolated to estimate the permeability at zero vertical strain (Sandbækken et al., 1986).

Results are presented in the Oedometer and Triaxial test summary tables in Appendix N and Appendix P, respectively.

5.6 Resistivity Tests

A total of 4 resistivity measurements were performed in connection with the consolidated triaxial compression tests.

The resistance was measured using a setup modelled after Wang et al. (2009), using the top cap and pedestal as electrodes. An input voltage, V_{in} (ω), generated by a sinusoidal function at the function generator, was passed through a reference resistor (with known resistance, R_{ref}), and the potential difference across the specimen, V_{out} (ω) was measured by a Picoscope.

The resistivity is computed by:

$$R = V(\omega)/I,$$

and,

$$\rho = R \times (A/L)$$

where,

R	= resistance (Ω),	
V	= voltage (V)	
I	= electrical current (A)	
ρ	= the resistivity of the specimen (Ωm)	
A	= area of specimen (m^2),	
L	= height of specimen (m)	
ω	= angular frequency (Hz)	

Based on previous experience a measurement band for the triaxial cell from about 10 Hz to 2 kHz were used.

Results of the resistivity tests are summarized in the Triaxial test summary table in Appendix P. The resistivity values presented in the table are determined at a frequency of 100 Hz. Individual plots of resistance, phase shift (between the input voltage and the output voltage associated with the specimen) and resistivity with frequency are presented with the triaxial test results in Appendix P.

5.7 Bender Element Tests

5.7.1 General

The shear wave velocity, V_s, and small strain shear modulus, G_{max}, was determined by piezoceramic bender elements (BE) in 13 triaxial and 11 DSS test. In addition, a number of tests were performed on unconfined specimens in an intact or remoulded state.

The bender element at one end of the specimen is used to transmit a vertically (v) propagating horizontally (h) polarized sinusoidal shear wave. The receiver bender element detects the arrival of this shear wave at the opposite end of the specimen, and the velocity of the shear wave can be determined.

The shear modulus at small strains, G_{max}, can then be computed from:

$$G_{max} = V_s^2 \cdot \rho$$

where:

$V_s = V_{vh}$ = the vertical shear wave velocity through the specimen
ρ = density of the soil specimen

Reference is made to Dyvik and Madshus (1985) and Dyvik and Olsen (1989) for more details. Determination of shear wave velocity on unconfined specimens were made using the portable bender element equipment described by e.g. Landon et al. (2007).

In the triaxial tests, V_s was determined at the final consolidation stresses, σ'_{ac} and σ'_{rc}. For the bender element tests performed in connection with the DSS tests, two determinations were generally made; one at minimal to no applied vertical load on the specimen, and one at the final consolidation stress, σ'_{ac}.

5.7.2 Bender Element Test Results

The bender element test results from DSS and triaxial test specimens are summarised in Table 1 of Appendix Q. Time, t, in the summary table refers to time after application of the load increment where V_s was measured.

The unconfined intact and remoulded V_s results are summarised in Table 2 of Appendix Q.

5.8 Soil Suction Tests

5.8.1 General

Attempts have been made to measure the soil suction on 7 test specimens using the UMass Amherst sample quality suction probe (SQSP) described by Poirier and DeGroot (2010).

Measurements were made on either unconfined or only radially confined specimens (confined by sampling tube). The soil suction at equilibrium (u_e) represents the sampling effective stress in the soil at the time of testing, i.e:

$\sigma'_s = - u_e$

5.8.2 Suction Probe Test Results

Suction measurements are summarised in Table 3 of Appendix Q. Only one specimen from HALB04 shows any sign of suction.

6 List of symbols and terms

6.1 General

According to ISO/DIS 19901-8 (E):

a	net area ratio of the cone penetrometer
c_v	coefficient of consolidation
C_s	swelling index (for consolidation tests)
h_{sf}	height of reference point above seafloor
f_s	cone sleeve friction
G_{max}	initial shear modulus
I_l	liquidity index
I_p	plasticity index
i	inclination
K_o	coefficient of earth pressure at rest (= $\sigma'_{h0} / \sigma'_{v0}$)
m_v	coefficient of compressibility
p_0'	in situ vertical effective stress (=σ'_{v0})
q_c	cone penetration resistance
q_t	cone penetration resistance corrected for pore water pressure effects
s	vane blade thickness
$s_u = c_u$	undrained (undisturbed) shear strength of soil
s_{uC}	static triaxial compression undrained shear strength
s_{uD}	static DSS undrained shear strength
s_{uE}	static triaxial extension undrained shear strength
s_{ufv}	shear strength by vane testing
$s_{ufv,rem}$	remoulded shear strength by vane testing
$s_{ufv,res}$	residual shear strength by vane testing
S_t	soil sensitivity
u_2	pore pressure
V_p	compression wave velocity
V_s	shear wave velocity
v_{vh}	vertically (v) propagated, horizontally (h) polarized shear wave velocity
ξ	material damping ratio
z	height above seafloor for drilling mode *in situ* probe zero reference readings
γ'	submerged unit weight of soil
γ_m	material factor
ν	Poisson's ratio
σ	stress
σ'_{v0}	in situ vertical effective stress (= p_0')
σ'_{h0}	in situ horizontal effective stress
ϕ'	effective angle of internal friction

6.2 Units

According to ISO/DIS 19901-8 (E):

Units to be used may vary somewhat from one clause to another based on historical use. For example, a CPT cone cross-sectional area should be given in units of square millimetres (mm^2) as used today, and not for example in square metres (m^2). However, if there are no special historical reasons for deviating from the units listed below, then the units to be used are:

force	kN
moment	kNm
density	kg/m^3
unit weight	kN/m^3
stress, pressure, strength and stiffness	kPa*
coefficient of permeability	m/s
coefficient of consolidation	m^2/s*
penetration rate CPT	cm/s*

Rate of penetration is reported in mm/s.
Tip resistance, sleeve friction and pore pressure are reported in MPa.

6.3 Abbreviated terms

According to ISO/DIS 19901-8 (E):

BHA	bottom hole assembly
CCV	consolidated constant volume
CD	consolidated drained test
CPT	cone penetration test
CPTU	cone penetration test with pore-pressure measurement
CRS	controlled rate of strain
CT	computerized tomography
CU	consolidated undrained
DS	direct shear (box)
DGPS	differential global positioning system
DSS	direct simple shear
ERP	emergency response plan
FVT	field vane test
GIS	geographical information system
GNSS	global navigation satellite system
HAZID	hazard identification
HAZOP	hazard and operability study
HSE	health, safety and environment
HVAC	heating, ventilation and air conditioning
IL	incremental loading
LAT	lowest astronomical tide
LBL	long baseline
MSL	mean sea level
MSCL	multi-sensory core logging
OCR	over-consolidation ratio
PEP	project execution plan
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RFID	radio-frequency identification
ROP	rate of penetration
ROV	remotely operated vehicle
RS	ring shear
SCPT	seismic CPT
SH	shear waves
SHANSEP	stress history and normalized soil engineering parameters
SIMOPS	simultaneous operations
SOW	scope of work
SRB	sulphate-reducing bacteria
SWL	safe working load
TC	triaxial compression
TE	triaxial extension
TOC	total organic content
UCT	unconfined compression test
USBL	ultra-short baseline
UU	unconsolidated-undrained

WGS	World Geographic System
VSP	vertical seismic profiling
YSR	yield stress ratio

Additional abbreviated terms:

ASTM	American Standard for Testing and Materials
CAD	Consolidated Anisotropic Drained
CAU	Consolidated Anisotropic Undrained
CPT	Cone Penetration Test
CPTU	Cone Penetration Test
CRSC	Constant Rate of Strain Consolidation
DIS	Draft International Standard
ISO	International Organization for Standardization
NGF	Norsk Geoteknisk Forening (Norwegian Geotechnical Society)
NS	Norsk Standard (Norwegian Standard)
PGA	Peak Ground Acceleration
PSV	Pseudo Velocity
UU	Unconsolidated Undrained

Coordinate table abbreviated terms:

ABBR/Group Name	Abbreviation definition Sampler & In situ test	Term in LOCA_ID-HOLE_ID
BH54C	54 mm composite sample borehole (with liner)	B
BH54	54 mm sample borehole (no liner)	B
BH72	72 mm sample borehole (no liner)	B
BH75	75 mm sample borehole (no liner)	B
BHSB	Sherbrooke block sample borehole (large)	B
BHSBm	Mini Sherbrooke block sample borehole	B
BHGPTr	Gel push Triple tube sampler	B
BHGPS	Gel push Static penetration	B
BHGUS	Gregory Undisturbed Fixed Piston Sample (GUS Sampler, manufactured by Acker Drill Company, PA)	B
BHDM	Dames and Moore Fixed Piston Sampler (DM Sampler, manufactured by GeoMatic, CA)	B
BG	Bag sample (unrelated to a BH)	BG
NA	Attempted test - no results reported	-
SCPTU-DIS	Seismic cone penetration tests with dissipation	C
CPTU-DIS	Cone penetration test with dissipation	C
RCPTU-DIS	Resistivity cone penetration test with dissipation	C
CPTU	Cone penetration test with pore pressure measurements	C

ABBR/Group Name	Abbreviation definition Sampler & In situ test	Term in LOCA_ID-HOLE_ID
CPT	Cone penetration test without pore pressure measurements	C
RCPTU	Resistivity cone penetration test	C
SCPTU	Seismic cone penetration tests	C
SDMT	Seismic dilatometer test	D
DMT	Dilatometer test	D
ERT	Electrical resistivity tomography	ER
MASW	Multichannel analysis of surface waves	M
SRefra	Seismic refraction	SRR
VSP	vertical seismic profiling	VP
SBP	Self boring pressuremeter test	P
EPCT	Earth pressure cell test (hydraulic, Glötzl)	EP
HFST	Hydraulic fracture stress test	H
FVT	Field vane	V
INC	Inclinometer	I
Piezo	Piezometer (Electric reading)	PI
StandP	Stand pipe	S
THS	Thermistor string	TH
RWS	Rotary weight sounding	RW
RCD	Rock control drilling	RC
SS	Simple Sounding	SS
RPS	Rotary pressure sounding	RP
TS	Total sounding	TS
SLU	Slug test	SL
PAC	Pack test	PA
XBseism	Crosshole seismic	XS
XBGPR	Crosshole GPR	XG
XBERT	Crosshole ERT	XE
DBseism	Downhole seismic	DS
DBGPR	Downhole GPR	DG
DBERT	Downhole ERT	DE
GPR	Ground penetrating radar	G
EM	Electromagnetic	E
SP	Self polarisation	SP
SRefle	Seismic reflection	SRL
HYP	Hydraulic piezometer (Manual reading)	HP
PS	Passive seismic	PS
SPLT	Screw-Plate Load Test	SPLT
WS	Weather station	WS

6.4 Classification system

6.4.1 Shear strength of clays or density of sands (ISO 14688-2:2004(E) and NGF (2011))

Undrained shear strength, s_u = c_u, of clays (in kPa)		Density index, I_D, of sands (in %)	
Extremely low	<10	Very loose	0 to 15
Very low	10 to 20	Loose	15 to 35
Low	20 to 40	Medium dense	35 to 65
Medium	40 to 75	Dense	65 to 85
High	75 to 150	Very dense	85 to 100
Very high	150 to 300		
Extremely high*⁾	>300		

*⁾ Materials with shear strength greater than 300 kPa may behave as weak rock. Can be described according to ISO 14689-1

Note: In this report D_r is used for the relative density of sands, i.e. $I_D = D_r$.

6.4.2 Grain size distribution (ISO 14688-1:2002(E) and NGF (2011))

The grain size distribution is presented as percentages of the various grain sizes present in the soil as determined by sieving and sedimentation. The terms used to describe grain sizes are:

Soil fractions	Sub-fractions	Particle size (in mm)
Very coarse soil	Large boulder Boulder Cobble	> 630 200 to 630 63 to 200
Coarse soil	Gravel Coarse gravel Medium gravel Fine gravel	2 to 63 20 to 63 6.3 to 20 2.0 to 6.3
	Sand Coarse sand Medium sand Fine sand	0.063 to 2.0 0.63 to 2.0 0.2 to 0.63 0.063 to 0.2
Fine soil	Silt Coarse silt Medium silt Fine silt	0.002 to 0.063 0.02 to 0.063 0.0063 to 0.02 0.002 to 0.0063
	Clay	≤ 0.002

6.4.3 Plasticity

The soil classification system used is described in NGF (2011).

Descriptions	I_p (%)
Low plasticity	< 10
Medium plasticity	10 – 20
High plasticity	> 20

6.4.4 Terms characterizing soil structure (NGI standard practice)

PARTING(S)	Horizontal inclusion(s) of different sediment type less than 3 mm thick
SEAM(S)	Horizontal inclusion(s) of different sediment type 3 mm to 75 mm thick
LAYER(S)	Horizontal inclusion(s) of different sediment type greater than 75 mm thick
POCKET(S)	Inclusion of different sediment type that is smaller than the diameter of the sample
BLOCKY	Containing discrete blocks of sediment set in a non-structured matrix
PSEUDO-BLOCKY	Block structures formed by intersecting fissures
PLATY	Containing discrete platelets with one dimension (vertical) limited and less than the other two
SLICKENSIDED	Having (inclined) planes of weakness that are slick and glossy in appearance
FISSURED	Containing small scale discontinuities in sediment fabric
LAMINATED	Composed of thin seams or partings of varying colour and texture
FOLIATED	Containing small scale laminar structure with no colour or textural variations
INTERLAYERED	Composed of alternate layers of different sediment types
WELL GRADED	Having a wide range of grain sizes. Similar to poorly sorted.
POORLY GRADED	Predominantly of one grain size. Similar to well sorted.

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Part 2: Principles for a classification

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Appendix A

MAPS OF HALDEN RESEARCH SITE

Halden site

View towards northeast

View towards north

View towards southwest

View towards south

NGTS locations

NGTS research sites

Location of NGTS sites

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.	**20160154-04**
Figure No.	**1**
Date	**2017-06-27**
Drawn by	**HCS/RCa**

NGTS

Sitelocations.pdf

Site extent

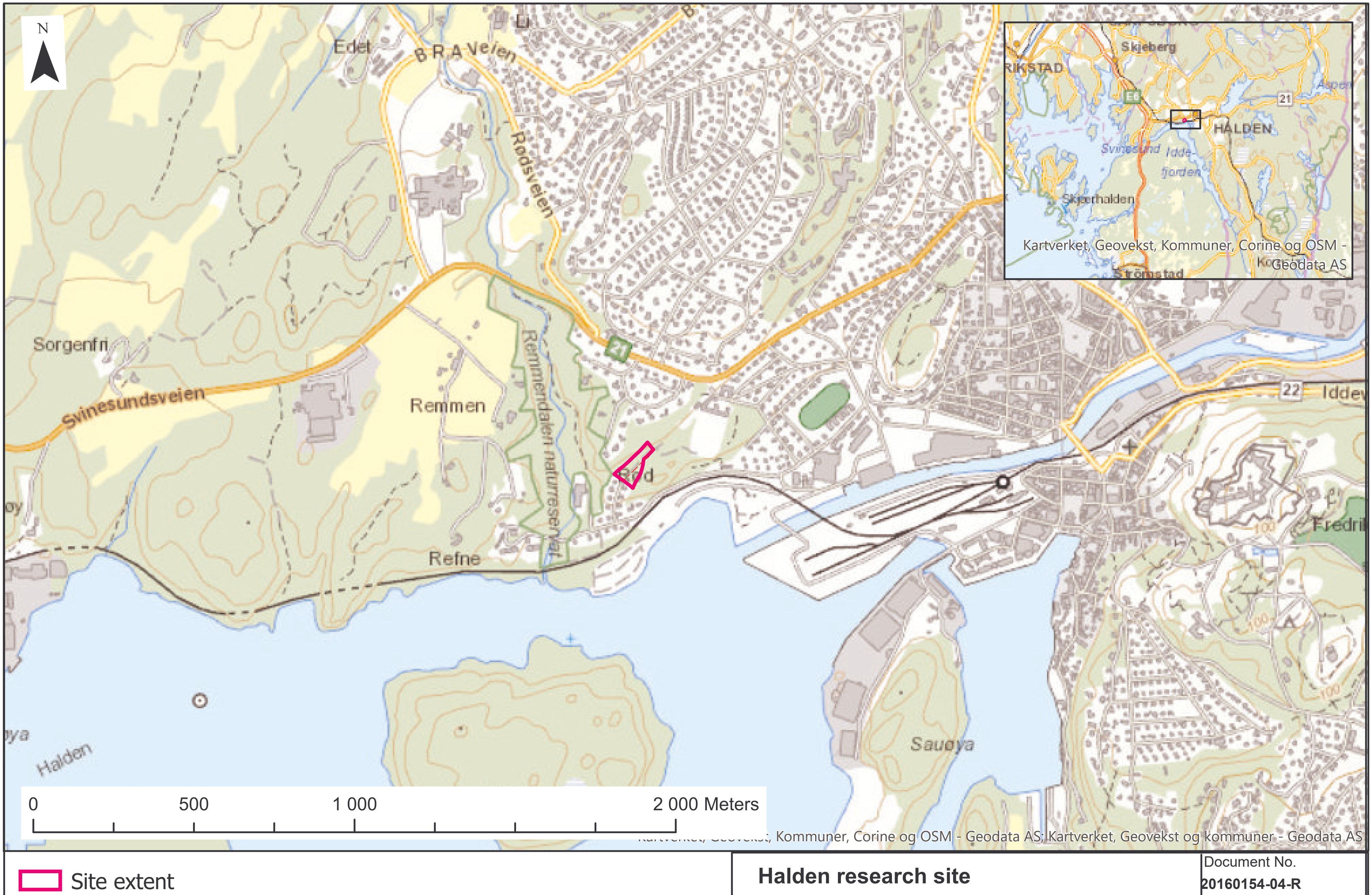
Halden research site

Site location

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No. **20160154-04-R**	
Figure No. **1.1**	
Date **2018-04-06**	Drawn by **HCS/RCa**

NGTS



Halden research site

Site location

Spatial Reference:
ETRS 1989 UTM Zone 32N

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20160154-04-R	
Figure No.	
1.2	
Date	Drawn by
2018-04-06	HCS/RCa

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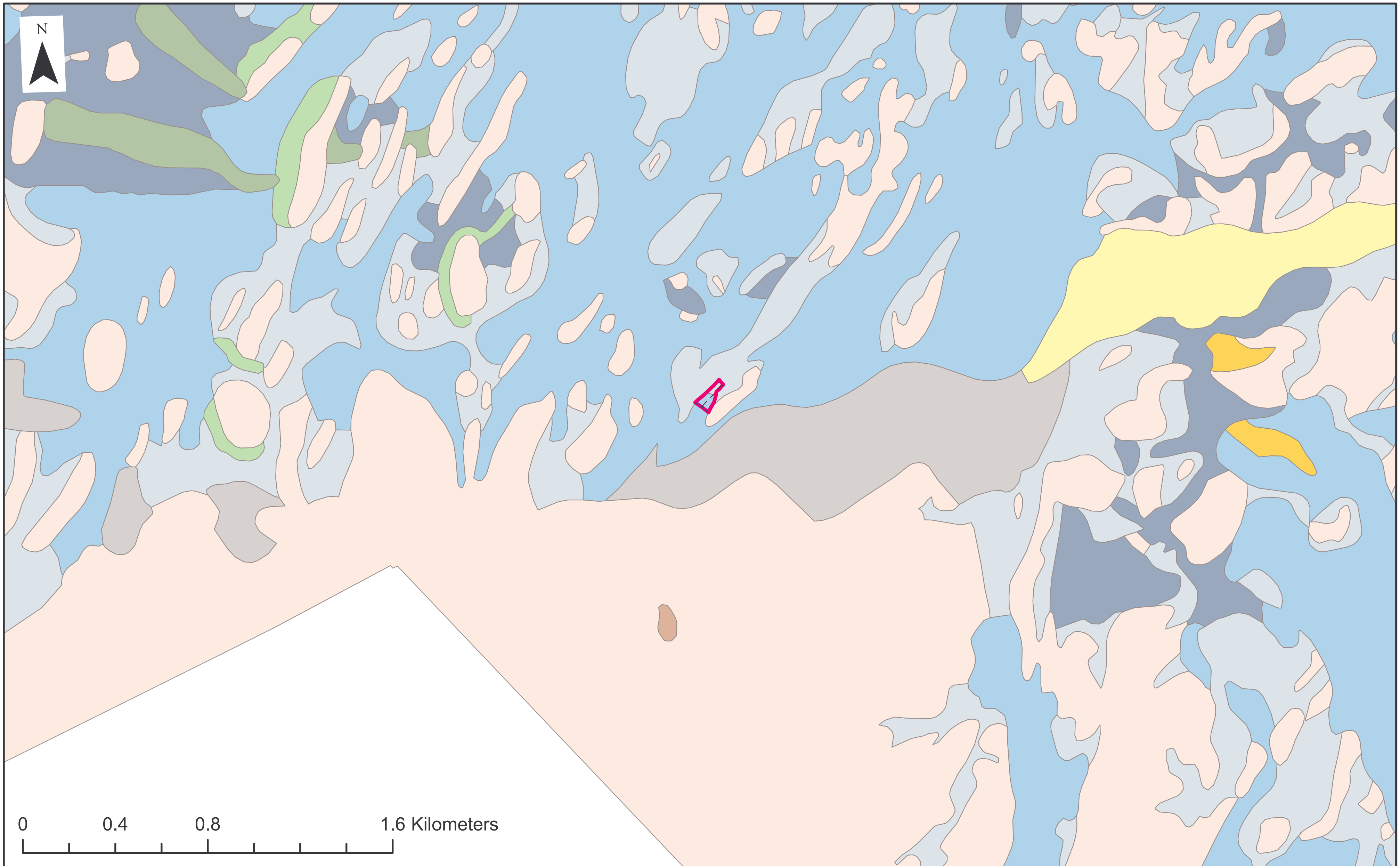


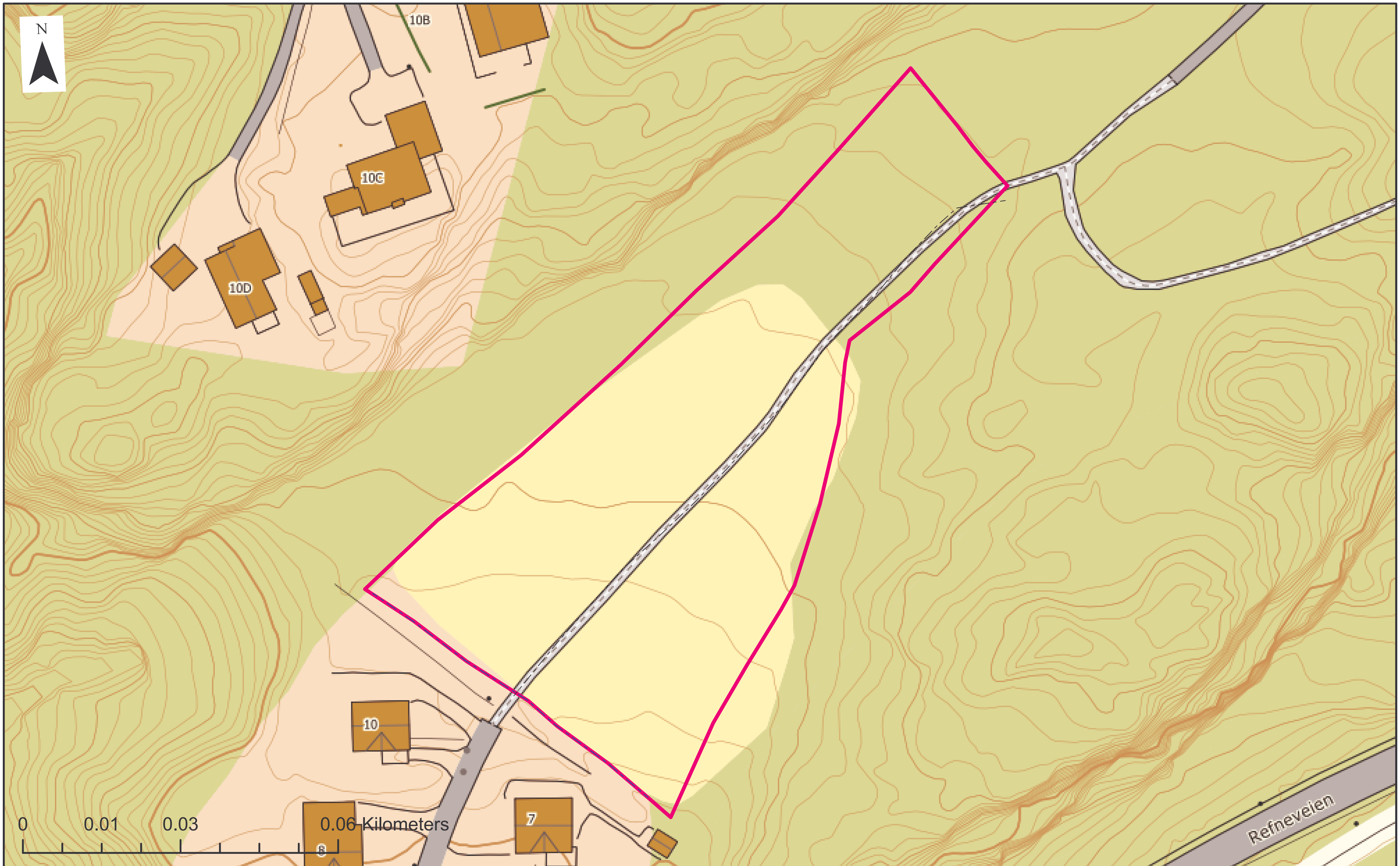
- - - Path
- - - Drain edge
Site extent
Thick moraine
Thin moraine
Moraine ridge
Glacioalluvial deposits
Glacioalluvial deposits
Glaciofluvial deposits
Thick marine deposits
Thin marine deposits
Marine alluvial deposits
Fluvial deposits
Peat and marsh
Thin humus/peat cover
Fiiling materials
Bare rock

NGTS - Halden research site	Document No. **20160154-04-R**
Site extent for Halden test site - aerial view Spatial Reference: ETRS 1989 UTM Zone 32N	Figure No. **1.3**
	Date **2018-06-18** / Drawn by **HCS/APP**
	NGTS

P:\2016\01\20160154\Kart\Halden\Figures\2017-07-10\ExtentMap_AP.pdf

Site extent
Electric cables

NGTS - Halden research site	Document No. 20160154-04-R	
Site extent for Halden test site - aerial view Spatial Reference: ETRS 1989 UTM Zone 32N	Figure No. 2.1	
	Date 2018-04-06	Drawn by HCS/RCa
	NGTS	



Path

Drain edge

Site extent

NGTS - Halden research site

Site extent for Halden test site - aerial view

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No. 20160154-04-R	
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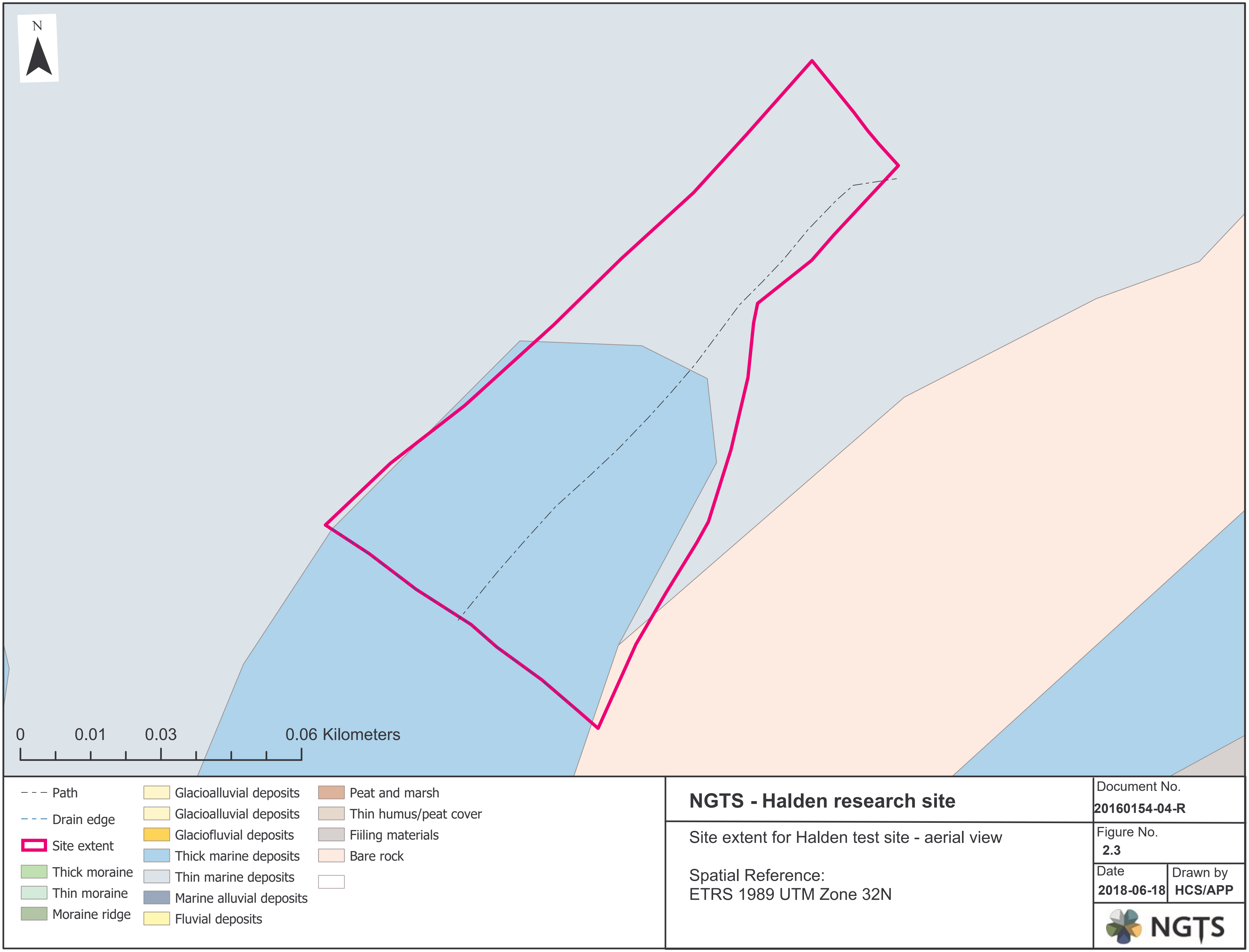
Date 2018-06-18	Drawn by HCS/APP

NGTS



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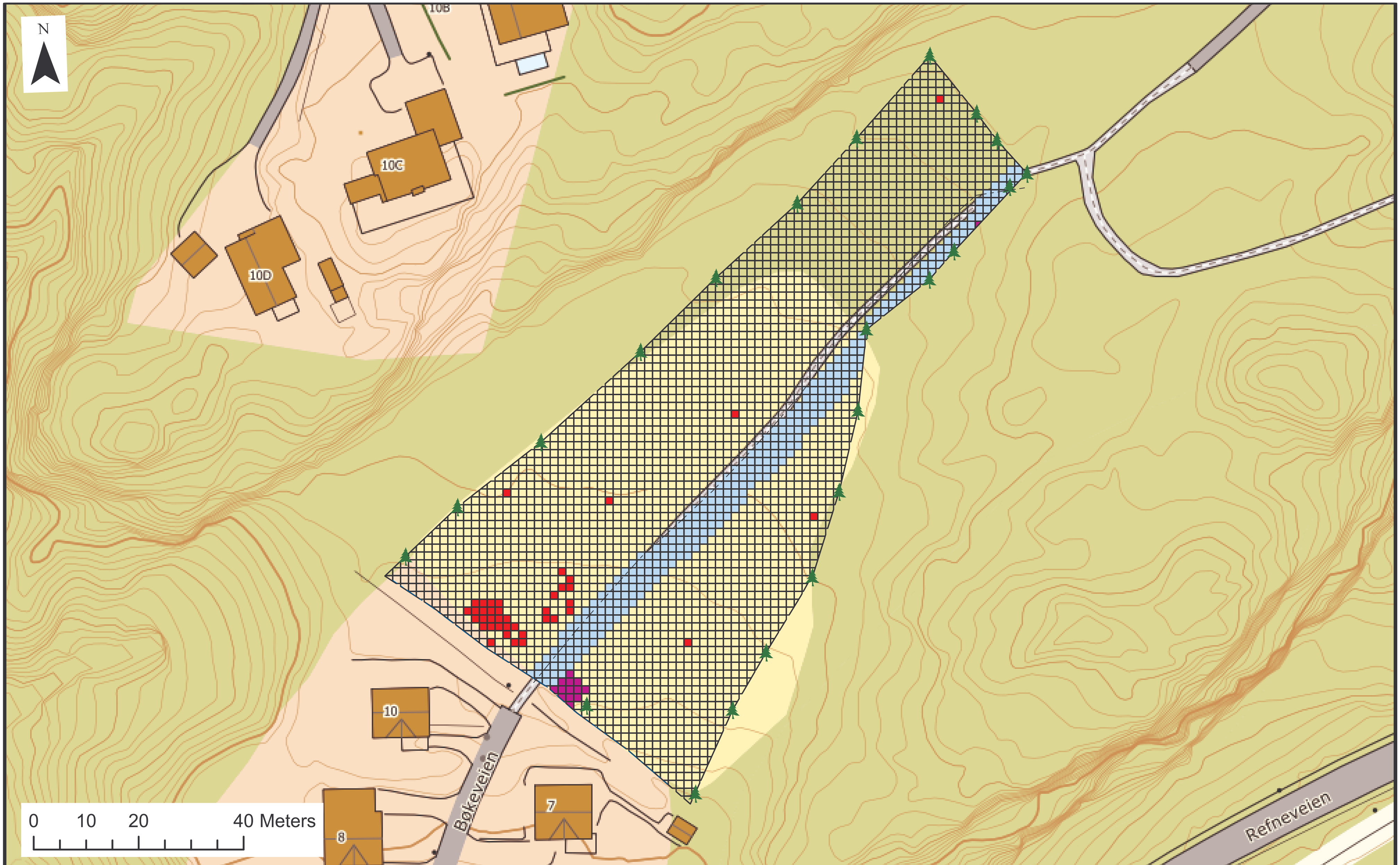
NGTS - Halden research site

Site extent for Halden test site - aerial view

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No. 20160154-04-R	
Figure No. 2.3	
Date 2018-06-18	Drawn by HCS/APP

NGTS



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Site grid status cells

- Unauthorised
- Used
- Planned
- Available
- Tree survey points

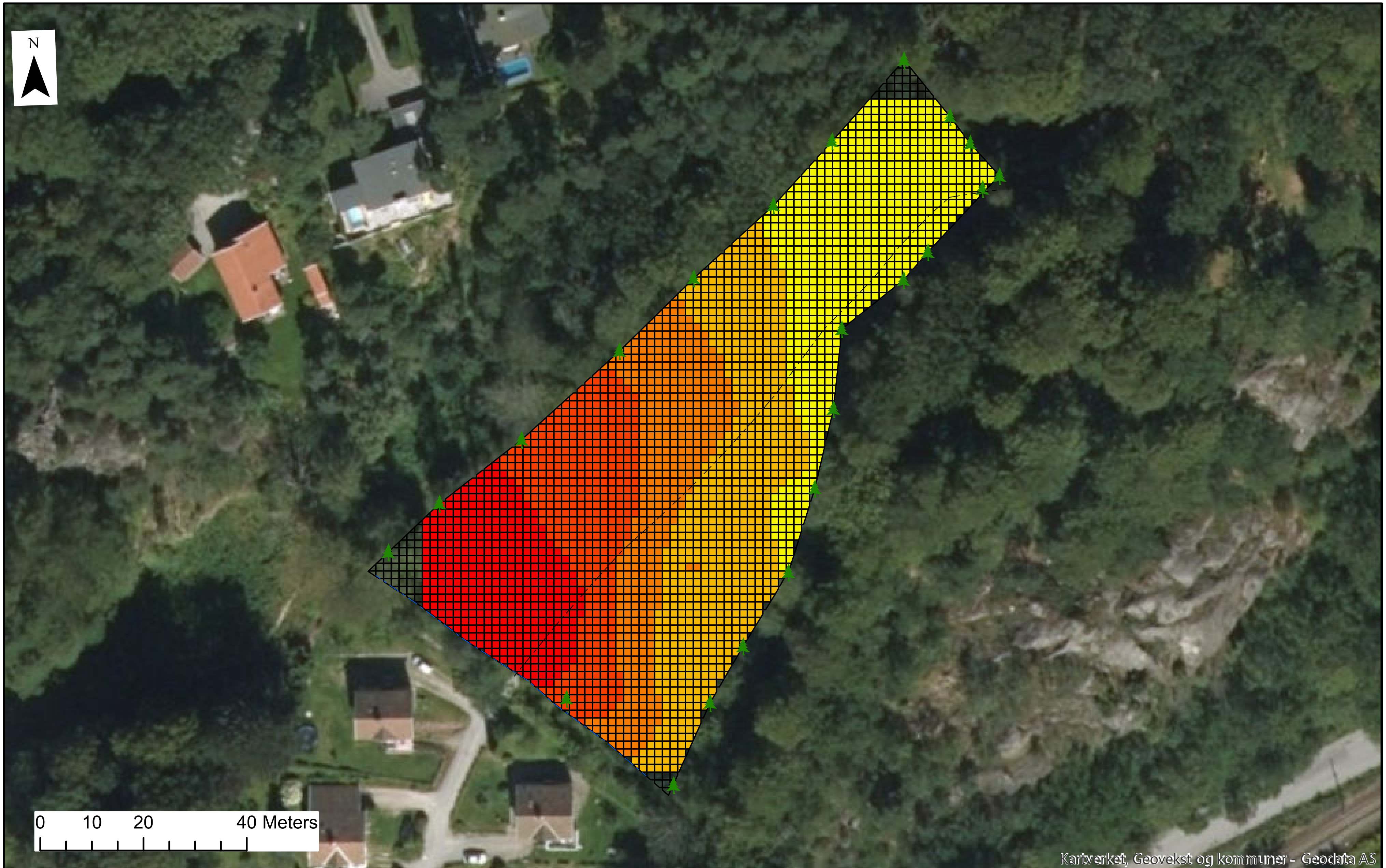
NGTS - Halden research site

Administration overview grid Halden - aerial view
Grid 1.5 x 1.5
Site area: 6150sqm
Available cells: 2505

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.	
20160154-04-R	
Figure No.	
3.1	
Date	Drawn by
2018-12-03	**HCS/APP**

NGTS



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Depth to bedrock

≤6.4	
≤10.7	
≤15.4	
≤20.6	
≤25.9	

- - - Drain edge
- - - Path
Tree survey points

NGTS - Halden research site	Document No. **20160154-04-R**
Depth to bedrock for Halden test site - aerial view Site area: 6150sqm Spatial Reference: ETRS 1989 UTM Zone 32N	Figure No. **4.1** Date **2018-12-03** Drawn by **HCS/APP** NGTS

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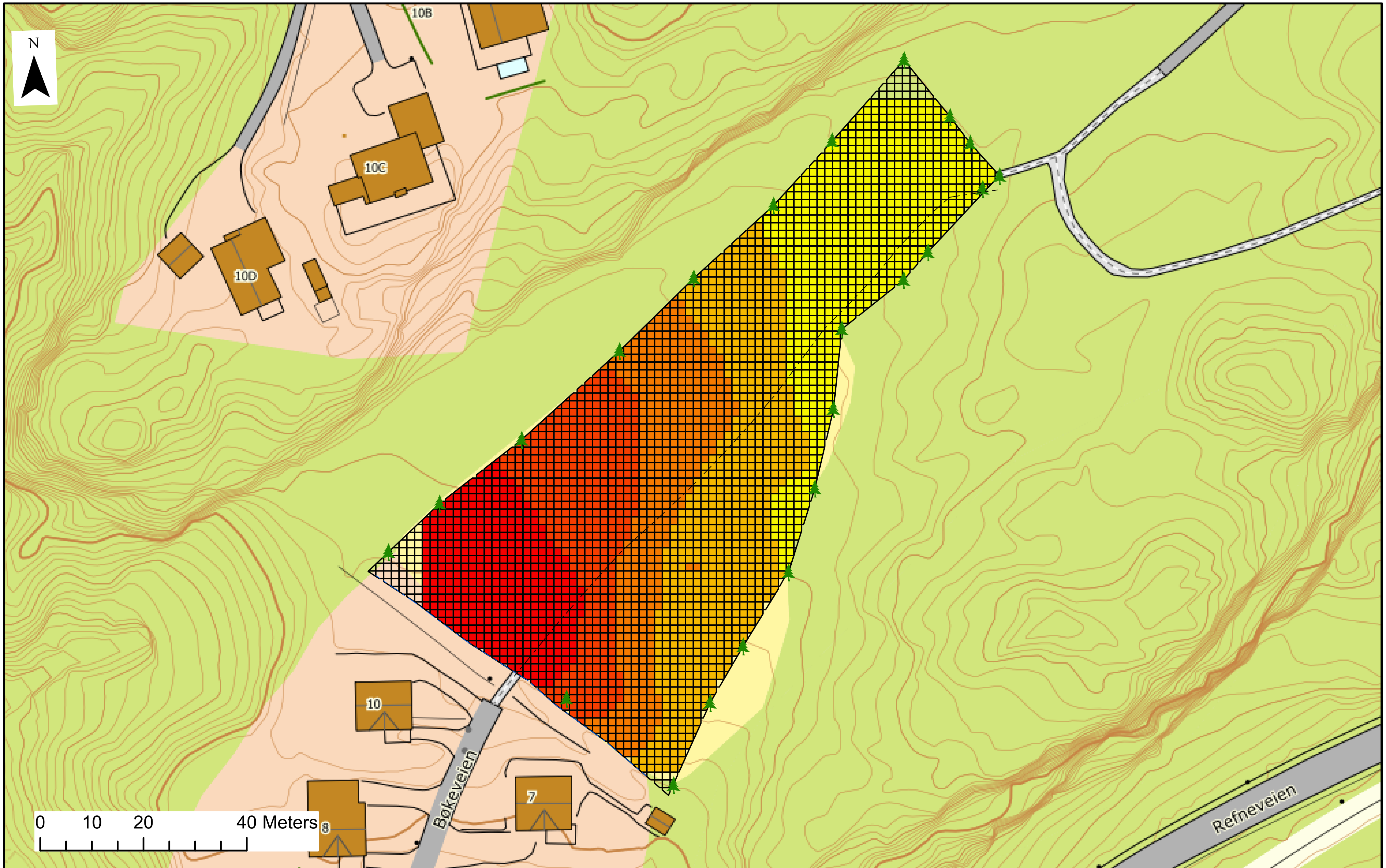


Depth to bedrock
- ≤6.4
- ≤10.7
- ≤15.4
- ≤20.6
- ≤25.9

Drain edge
Path
Tree survey points

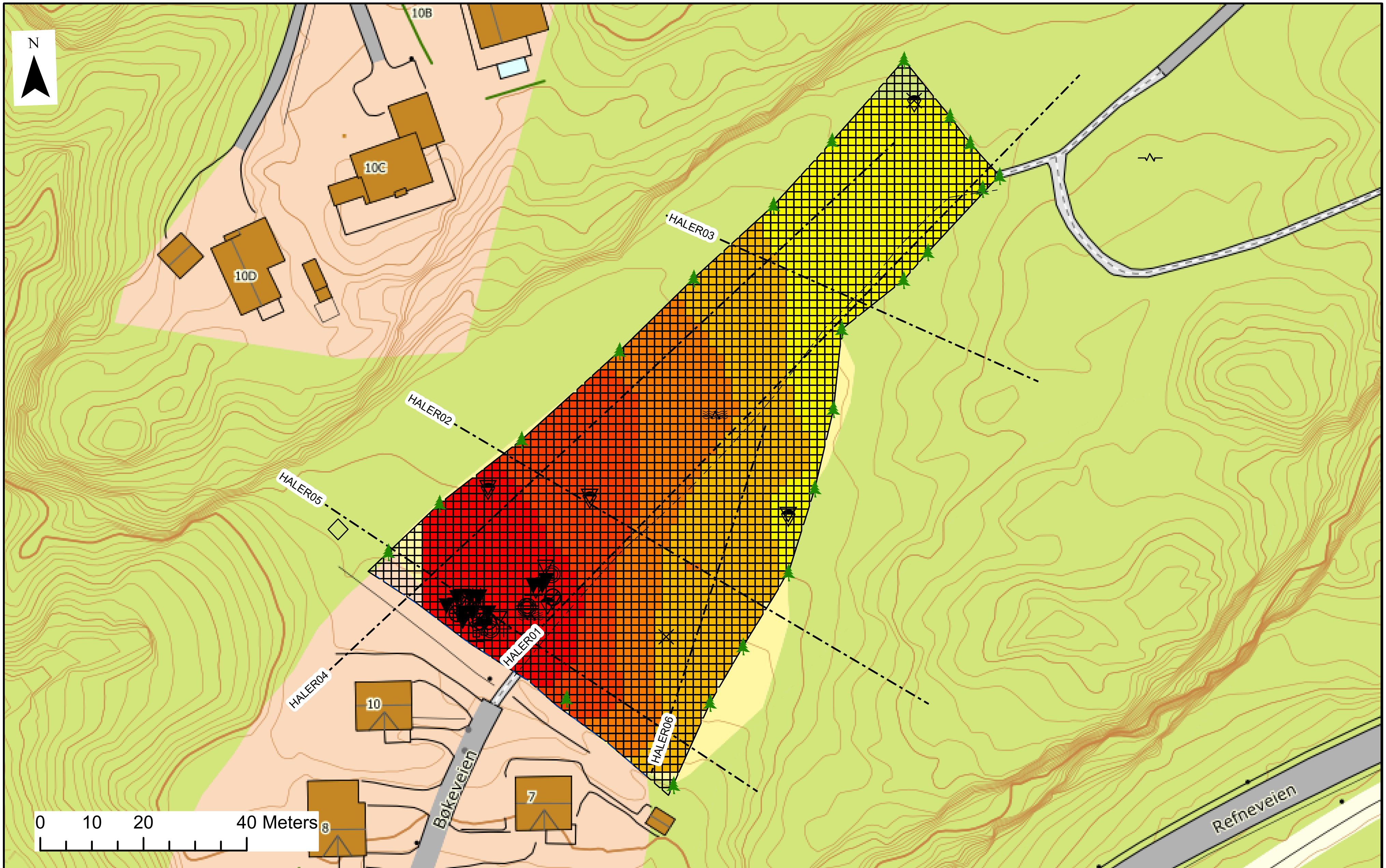
NGTS - Halden research site

Depth to bedrock for Halden test site - aerial view
Site area: 6150sqm

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.	**20160154-04-R**
Figure No.	**4.2**
Date	**2018-12-03**
Drawn by	**HCS/APP**

NGTS



Depth to bedrock

- ≤6.4
- ≤10.7
- ≤15.4
- ≤20.6
- ≤25.9

ERT_Lines

Drain edge

Path

Tree survey points

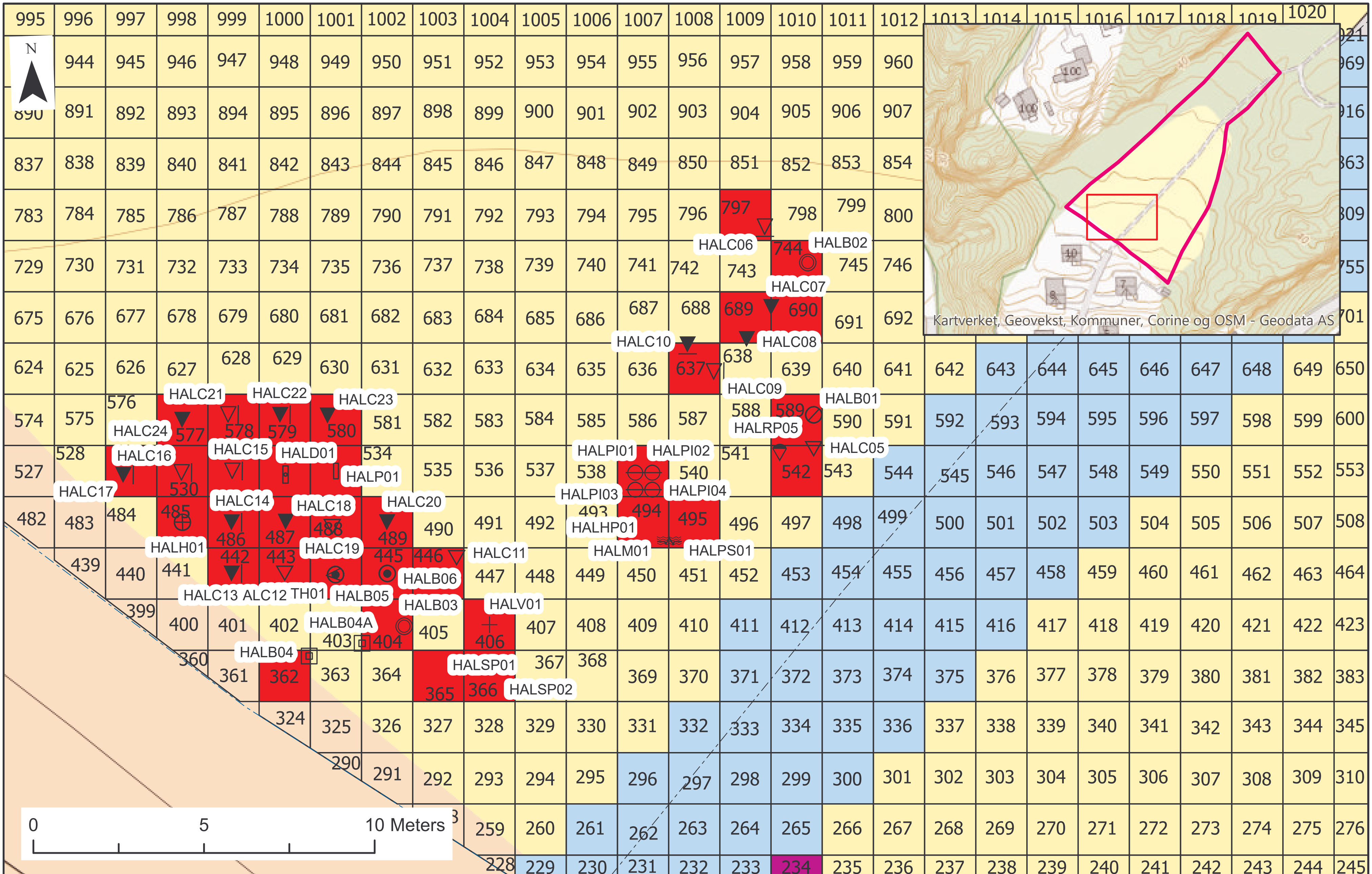
NGTS - Halden research site

Depth to bedrock for Halden test site - aerial view
Site area: 6150sqm

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.	
20160154-04-R	
Figure No.	
4.3	
Date	Drawn by
2018-12-03	HCS/APP

NGTS



Site grid status cells
- Unauthorised
- Used
- Planned
- Available
- Path
- Drain edge
- Tree survey points

Groundinvestigations

BG	CPTU	HFST	SS
BH54	CPTU-DIS	INC	THS
BH54C	RCPTU	PAC	TS
BH72	RCPTU-DIS	Piezo	VSP
BH75	SCPTU	RCD	XBERT
BHGPS	SCPTU-DIS	RPS	XBGPR
BHGPTr	DBERT	RWS	XBseism
BHSB	DBGPR	SBP	NA
BHSBm	DBseism	SDMT	StandP
CPT	FVT	SLU	MASW
	EPCT	SP	PS

NGTS - Halden research site

Detailed grid with tests Halden - topography view
Grid 1.5 x 1.5
Site area: 6150sqm
Available cells: 2505

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No. **20160154-04-R**

Figure No. **5.1**

Date **2018-12-03**

Drawn by **HCS/APP**

NGTS

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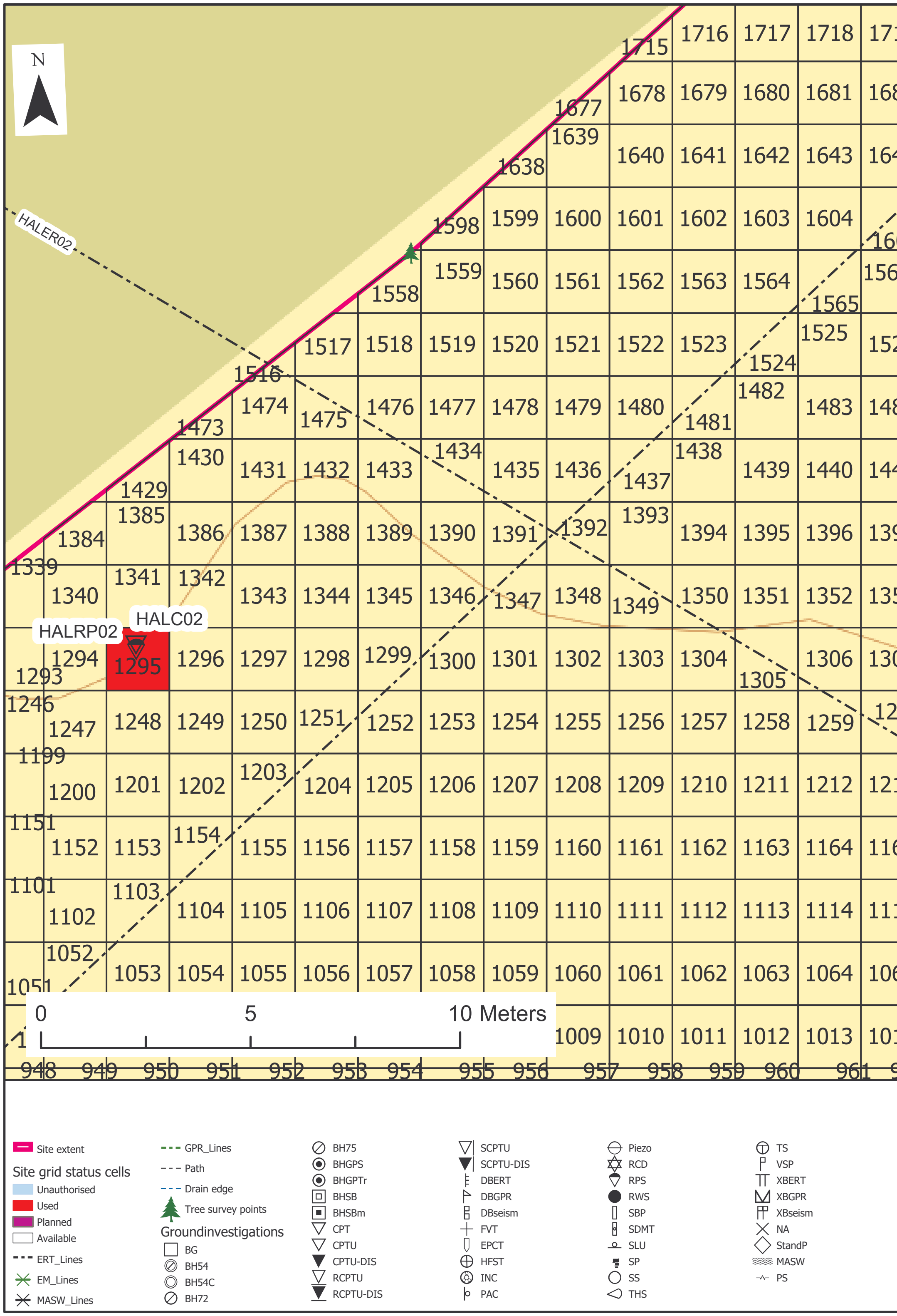

NGTS - Halden research site

Detailed grid with tests Halden - topography view
Grid 1.5 x 1.5
Site area: 6150sqm
Available cells: 2505

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.	
20160154-04-R	
Figure No.	
5.2	
Date	Drawn by
2018-04-06	HCS/RCa

NGTS

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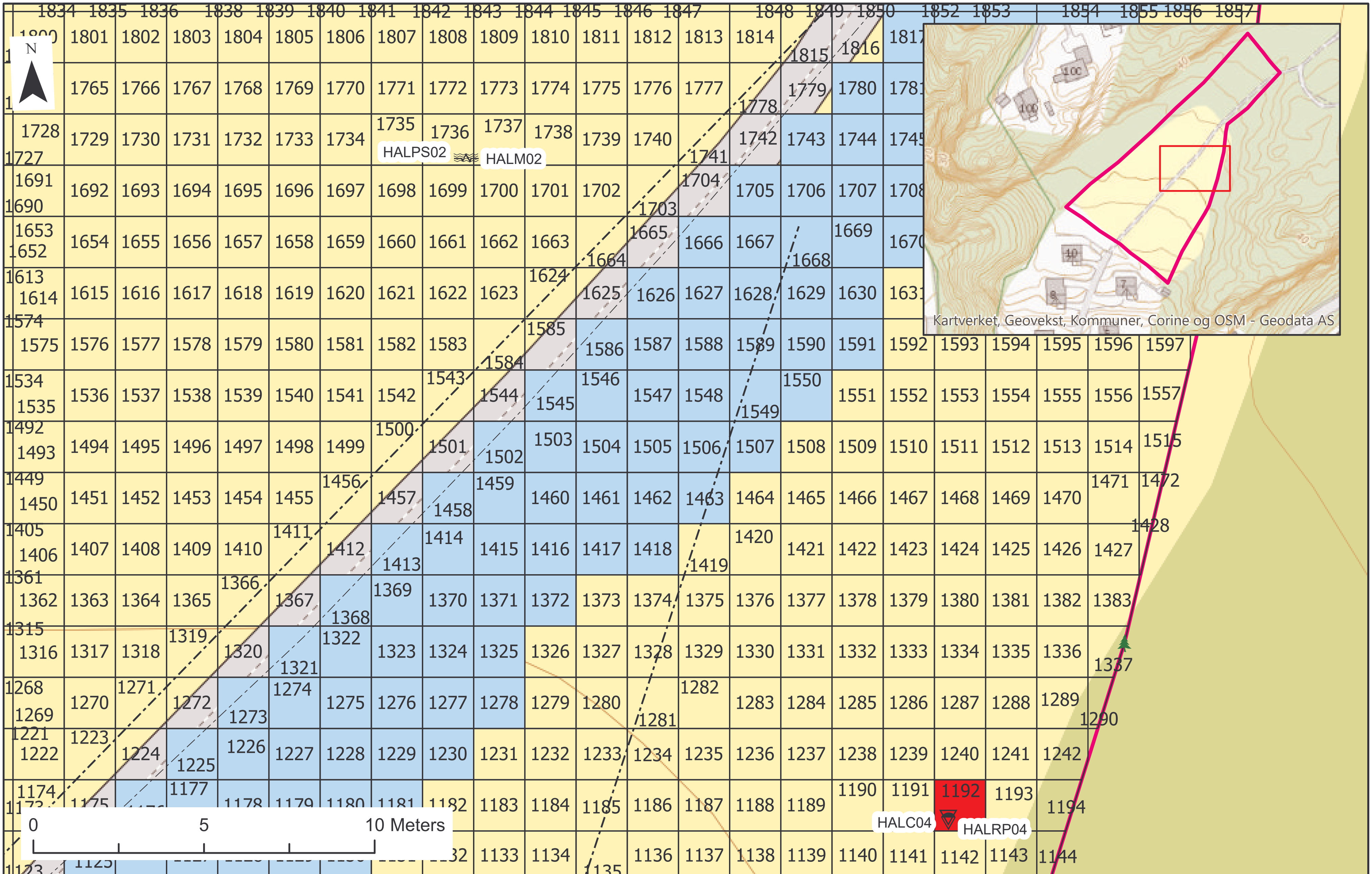

Site extent

Site grid status cells

- Unauthorised
- Used
- Planned
- Available

ERT_Lines

EM_Lines

MASW_Lines

GPR_Lines

Path

Drain edge

Tree survey points

Groundinvestigations

BG, BH54, BH54C, BH72, BH75, BHGPS, BHGPTr, BHSB, BHSBm, CPT, CPTU, CPTU-DIS, RCPTU, RCPTU-DIS, SCPTU, SCPTU-DIS, DBERT, DBGPR, DBseism, FVT, EPCT, HFST, INC, PAC, Piezo, RCD, RPS, RWS, SBP, SDMT, SLU, SP, SS, THS, TS, VSP, XBERT, XBGPR, XBseism, NA, StandP, MASW, PS

NGTS - Halden research site

Detailed grid with tests Halden - topography view
Grid 1.5 x 1.5
Site area: 6150sqm
Available cells: 2505

Spatial Reference:
ETRS 1989 UTM Zone 32N

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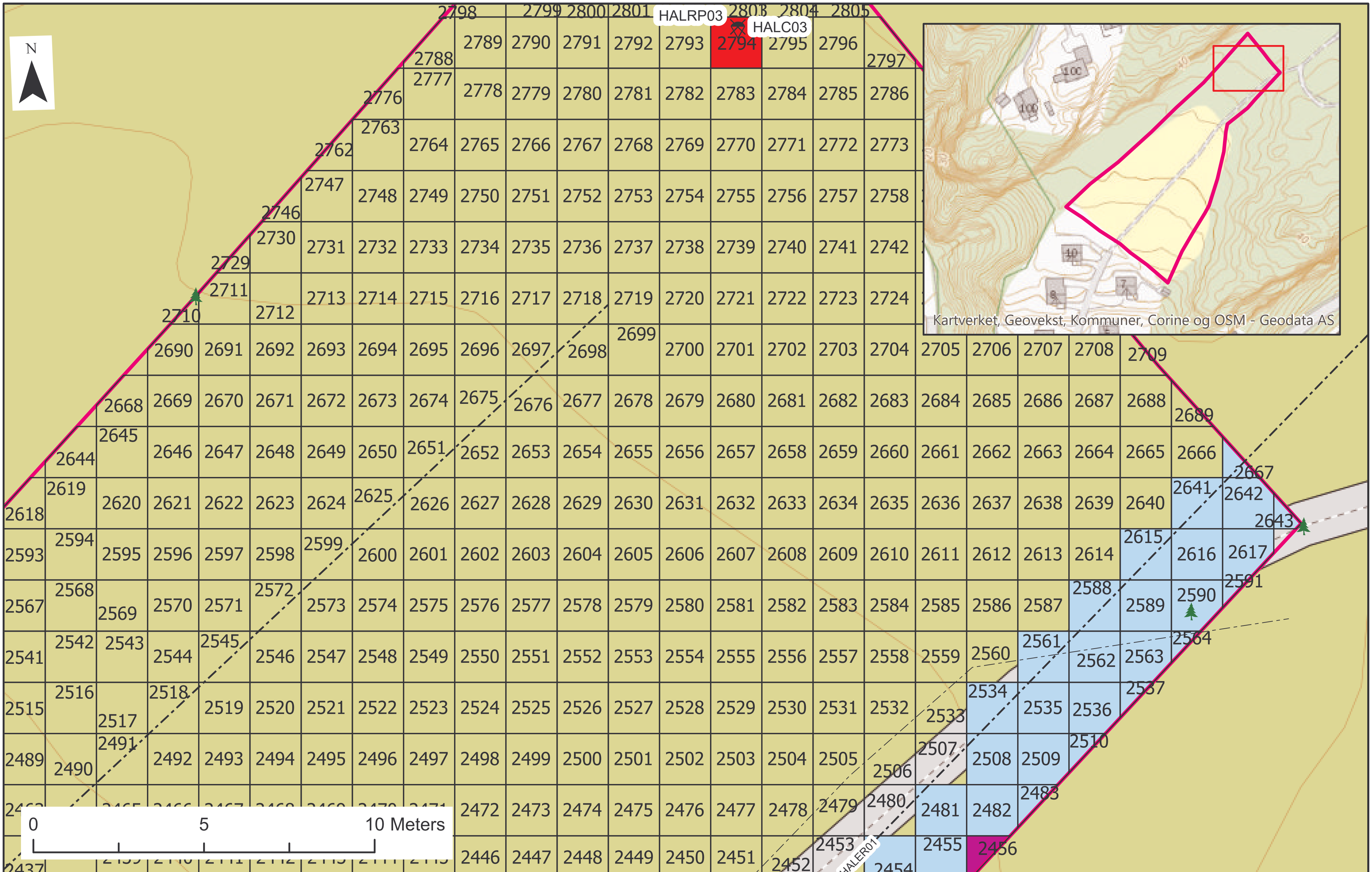
NGTS



Site extent
Site grid status cells
Unauthorised
Used
Planned
Available
ERT_Lines
EM_Lines
MASW_Lines
GPR_Lines
Path
Drain edge
Tree survey points
Groundinvestigations
BG
BH54
BH54C
BH72
BH75
BHGPS
BHGPTr
BHSB
BHSBm
CPT
CPTU
CPTU-DIS
RCPTU
RCPTU-DIS
SCPTU
SCPTU-DIS
DBERT
DBGPR
DBseism
FVT
EPCT
HFST
INC
PAC
Piezo
RCD
RPS
RWS
SBP
SDMT
SLU
SP
SS
THS
TS
VSP
XBERT
XBGPR
XBseism
NA
StandP
MASW
PS

NGTS - Halden research site

Detailed grid with tests Halden - topography view
Grid 1.5 x 1.5
Site area: 6150sqm
Available cells: 2505

Spatial Reference:
ETRS 1989 UTM Zone 32N

Document No.
20160154-04-R

Figure No.
5.4

Date
2018-04-06

Drawn by
HCS/RCa

NGTS

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Appendix B

COORDINATE TABLE

HEADING	Coordinate list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

OLD ID	LOCA_ID-HOLE_ID	ABBR	UTM	Datum	CM	Northing	Easting	Elevation surface	GPS Equipment ID	HDOP	VDOP	Field Equipment ID	Cone factor (a)	Depth to end of test	Depth to bedrock	DATE
-	-	-	-	-	-	m	m	m	-	m	m	-	-	m	m	YYYY-MM-YY
BH06	HALB01	BH72	32	EUREF89	9°E	6555905,691	635291,230	28,45	S-A 1	NR	NR	NGI Rig X	NA	12,80	NA	2015-05-18
BH07	HALB02	BH54C	32	EUREF89	9°E	6555910,153	635291,057	28,69	S-A 1	NR	NR	NGI Rig X	NA	16,50	NA	2015-10-19
BH14	HALB03	BH54C	32	EUREF89	9°E	6555899,500	635279,230	28,45	S-A 1	NR	NR	NGI Rig X	NA	14,80	NA	2016-06-06
BH15	HALB04	BHSB	32	EUREF89	9°E	6555898,627	635276,449	28,55	S-A 1	NR	NR	NGI Rig X	NA	15,20	NA	2016-06-13
BH15a	HALB04A	BHSB	32	EUREF89	9°E	6555899,000	635278,000	28,55	S-A 1	NR	NR	NGI Rig X	NA	3,00	NA	2016-06-13
CPT01	HALC01	CPTU	32	EUREF89	9°E	6555925,200	635298,395	29,83	S-A 1	NR	NR	NGI-E-20759	0,71	16,08	NA	2015-05-12
CPT02	HALC02	CPTU	32	EUREF89	9°E	6555926,878	635278,684	29,88	S-A 1	NR	NR	NGI-E-20759	0,71	14,08	NA	2015-05-12
CPT03	HALC03	NA	32	EUREF89	9°E	6556002,008	635361,275	35,09	S-A 1	NR	NR	NA	NA	NA	NA	2015-05-12
CPT05	HALC04	CPTU	32	EUREF89	9°E	6555921,682	635336,888	30,11	S-A 1	NR	NR	NGI-E-20759	0,71	4,99	NA	2015-05-13
CPT06	HALC05	CPTU	32	EUREF89	9°E	6555904,691	635291,230	28,45	S-A 1	NR	NR	NGI-E-20759	0,71	21,34	NA	2015-05-12
RCPT08	HALC06	RCPTU	32	EUREF89	9°E	6555911,174	635289,801	28,78	S-A 1	NR	NR	NGI-E-20856	0,71	15,15	NA	2015-10-20
CPT09	HALC07	CPTU-DIS	32	EUREF89	9°E	6555908,849	635289,989	28,63	S-A 1	NR	NR	NGI-E-50751	0,68	10,24	NA	2015-10-20
CPT10	HALC08	CPTU-DIS	32	EUREF89	9°E	6555907,910	635289,272	28,58	S-A 1	NR	NR	NGI-E-50751	0,68	10,13	NA	2015-10-20
SCPT11	HALC09	SCPTU	32	EUREF89	9°E	6555906,957	635288,359	28,56	S-A 1	NR	NR	NGI Rig X	NA	12,00	NA	2015-10-21
RCPT12	HALC10	RCPTU-DIS	32	EUREF89	9°E	6555907,724	635287,536	28,57	S-A 1	NR	NR	NGI-E-20856	0,71	22,34	NA	2015-10-21
CPT13	HALC11	CPTU	32	EUREF89	9°E	6555901,501	635280,768	28,48	S-A 1	NR	NR	NGI-E-50660	0,71	17,35	NA	2016-06-08
P1	HALER01A	ERT	32	EUREF89	9°E	6555892,780	635282,071	27,94	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P1	HALER01B	ERT	32	EUREF89	9°E	6556006,964	635393,374	34,25	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P2	HALER02A	ERT	32	EUREF89	9°E	6555944,445	635263,457	28,98	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P2	HALER02B	ERT	32	EUREF89	9°E	6555884,996	635364,110	36,32	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P3	HALER03A	ERT	32	EUREF89	9°E	6555981,750	635308,598	33,18	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P3	HALER03B	ERT	32	EUREF89	9°E	6555947,499	635385,350	38,00	S-A 1	NR	NR	NGI	NA	0,00	NA	2015-04-15
P4	HALER04A	ERT	32	EUREF89	9°E	6555884,602	635240,566	26,59	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
P4	HALER04B	ERT	32	EUREF89	9°E	6555993,859	635357,470	34,95	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
P5	HALER05A	ERT	32	EUREF89	9°E	6555929,400	635238,549	31,09	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
P5	HALER05B	ERT	32	EUREF89	9°E	6555868,020	635330,942	26,87	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
P6	HALER06A	ERT	32	EUREF89	9°E	6555871,598	635310,348	26,10	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
P6	HALER06B	ERT	32	EUREF89	9°E	6555939,003	635332,507	29,48	S-A 1	NR	NR	NGI	NA	0,00	NA	2016-11-29
Piezo-Plar	HALPI01	Piezo	32	EUREF89	9°E	6555904,000	635286,000	28,48	S-A 1	0,02	0,03	9329	NA	5,00	NA	2016-09-23
Piezo-Plar	HALPI02	Piezo	32	EUREF89	9°E	6555904,000	635286,500	28,49	S-A 1	0,05	0,10	9330	NA	10,00	NA	2016-09-23
Piezo-Plar	HALPI03	Piezo	32	EUREF89	9°E	6555903,500	635286,000	28,45	S-A 1	0,05	0,09	9331	NA	15,00	NA	2016-09-23
Piezo-Plar	HALPI04	Piezo	32	EUREF89	9°E	6555903,500	635286,500	28,57	S-A 1	0,03	0,06	9332	NA	20,00	NA	2016-09-23
20150030	HALRP01	RPS	32	EUREF89	9°E	6555925,200	635298,395	29,83	S-A 1	NR	NR	NGI Rig X	NA	18,48	18,48	2015-05-12
20150030	HALRP02	RPS	32	EUREF89	9°E	6555926,878	635278,684	29,88	S-A 1	NR	NR	NGI Rig X	NA	15,24	NA	2015-05-12

PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

NGTS

OLD ID	LOCA_ID-HOLE_ID	ABBR	UTM	Datum	CM	Northing	Easting	Elevation surface	GPS Equipmen t ID	HDOP	VDOP	Field Equipment ID	Cone factor (a)	Depth to end of test	Depth to bedrock	DATE
-	-	-	-	-	-	m	m	m	-	m	m	-	-	m	m	YYYY-MM-YY
sp8-3-drt	HALRP03	RPS	32	EUREF89	9°E	6556002,008	635361,275	35,09	S-A 1	NR	NR	NGI Rig X	NA	1,12	1,12	2015-05-13
20150030	HALRP04	RPS	32	EUREF89	9°E	6555921,682	635336,888	30,11	S-A 1	NR	NR	NGI Rig X	NA	5,16	5,16	2015-05-12
20150030	HALRP05	RPS	32	EUREF89	9°E	6555904,691	635290,230	28,45	S-A 1	NR	NR	NGI Rig X	NA	23,72	23,71	2015-05-13
	HALS01	StandP	32	EUREF89	9°E	6555918,860	635249,635	33,56	S-A 1	0,67	1,07	NA	NA	NA	NA	Pre NGTS
532	HALD01	SDMT	32	EUREF89	9°E	6555903,943	635275,751	28,38		NR	NR	NGI-SDMT	NA	20,00	NA	2017-09-12
444	HALTH01	THS	32	EUREF89	9°E	6555901,013	635277,213	28,44		NR	NR	NGI	NA	23,67	NA	2017-09-12
443	HALC12	CPTU	32	EUREF89	9°E	6555901,045	635275,730	28,60		NR	NR	Pagani-MKj485	0,78	19,76	NA	2017-09-05
442	HALC13	SCPTU-DIS	32	EUREF89	9°E	6555901,045	635274,230	28,69		NR	NR	Pagani-MKj485	0,78	20,65	NA	2017-09-05
486	HALC14	SCPTU-DIS	32	EUREF89	9°E	6555902,545	635274,230	28,73		NR	NR	Pagani-MKj485	0,78	20,43	NA	2017-09-06
531	HALC15	SCPTU	32	EUREF89	9°E	6555904,047	635274,248	28,64		NR	NR	NGI-G-4763	0,844	15,13	NA	2017-09-13
530	HALC16	SCPTU	32	EUREF89	9°E	6555904,000	635272,762	28,66		NR	NR	NGI-G-4763	0,844	12,51	NA	2017-09-14
529	HALC17	SCPTU-DIS	32	EUREF89	9°E	6555903,934	635271,055	28,63		NR	NR	NGI-G-4648	0,857	19,98	NA	2017-11-22
487	HALC18	CPTU-DIS	32	EUREF89	9°E	6555902,561	635275,764	28,57		NR	NR	Geomil-C14251	0,776	20,32	NA	2017-09-19
488	HALC19	CPTU	32	EUREF89	9°E	6555902,412	635277,123	28,54		NR	NR	Geomil-C14251	0,776	20,32	NA	2017-09-19
489	HALC20	CPTU-DIS	32	EUREF89	9°E	6555902,545	635278,730	28,54		NR	NR	Geomil-C14251	0,776	20,36	NA	2017-09-19
533	HALP01	SBP	32	EUREF89	9°E	6555904,045	635277,230	28,54		NR	NR	InSitu (SBP Beatrice)	NA	13,50	NA	2017-09-16
444	HALB05	BHGPS	32	EUREF89	9°E	6555901,013	635277,213	28,44		NR	NR	NGI	NA	13,30	NA	2017-09-11
578	HALC21	SCPTU	32	EUREF89	9°E	6555905,699	635274,128	28,68		NR	NR	APVandenB_I-CFXYP20-10_150912	0,75	24,70	NA	2017-12-13
579	HALC22	SCPTU-DIS	32	EUREF89	9°E	6555905,694	635275,652	28,74		NR	NR	APVandenB_I-CFXYP20-10_150912	0,75	20,50	NA	2017-12-12
580	HALC23	CPTU-DIS	32	EUREF89	9°E	6555905,672	635276,993	28,68		NR	NR	APVandenB_I-CFXYP20-10_150912	0,75	20,00	NA	2017-12-12
577	HALC24	CPTU-DIS	32	EUREF89	9°E	6555905,545	635272,730			NR	NR	NGI-G-4648	0,857	19,83	NA	2017-11-23
494	HALHP01	HYP	32	EUREF89	9°E	6555902,545	635286,230	28,45		NR	NR	NGI	NA	10,00	NA	2017-11-27
	HALM01	MASW	32	EUREF89	9°E	6555902,000	635287,000			NR	NR	NGI	NA	NA	NA	2018-03-09
	HALM02	MASW	32	EUREF89	9°E	6555941,010	635322,760			NR	NR	NGI	NA	NA	NA	2018-03-09
	HALPS01	PS	32	EUREF89	9°E	6555902,000	635287,000			NR	NR	NEID	NA	NA	NA	2018-03-07
	HALPS02	PS	32	EUREF89	9°E	6555941,010	635322,760			NR	NR	NEID	NA	NA	NA	2018-03-07
	HALPS03	PS	32	EUREF89	9°E	6555991,000	635407,000			NR	NR	NEID	NA	NA	NA	2018-03-07
445	HALB06	BHGPS	32	EUREF89	9°E	6555901,045	635278,730	28,46		NR	NR	NGI rig sonic	NA	13,40	NA	2018-05-09
365	HALSP01	SPLT	32	EUREF89	9°E	6555898,000	635280,730			NR	NR	NGI	NA	NA	NA	2018-08-29
366	HALSP02	SPLT	32	EUREF89	9°E	6555898,000	635282,230			NR	NR	NGI	NA	NA	NA	2018-08-30
485	HALH01	HFST	32	EUREF89	9°E	6555902,545	635272,730			NR	NR	NGI	NA	13,00	NA	2018-08-27
387	HALWS	NA	32	EUREF89	9°E	6555898,045	635313,230			NR	NR	NGI	NA	NA	NA	2018-07-12
406	HALV01	FVT	32	EUREF89	9°E	6555899,545	635281,730			NR	NR	NGI-VP-4856	NA	19,00	NA	2018-10-24
407	HALB07	BHGUS	32	EUREF89	9°E	6555899,545	635283,230			NR	NR	UMASS/UCDavis GUS sampler	NA	18,81	NA	2019-03-18
367	HALB08	BHDM	32	EUREF89	9°E	6555898,045	635283,230			NR	NR	UMASS/UCDavis Dames and Moore sa	NA	18,96	NA	2019-03-19

HEADING	Comments
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

LOCA_ID-HOLE_ID	ABBR	DATE	Comments
-	-	YYYY-MM-YY	-
HALB01	BH72	2015-05-18	
HALB02	BH54C	2015-10-19	Sent to NGU
HALB03	BH54C	2016-06-06	
HALB04	BHSB	2016-06-13	
HALB04A	BHSB	2016-06-13	Sampling stopped due to collapse of BH.
HALC01	CPTU	2015-05-12	
HALC02	CPTU	2015-05-12	Correction factor applied to sleeve friction
HALC03	NA	2015-05-12	No CPTU, use same coordinates as HALRP03
HALC04	CPTU	2015-05-13	
HALC05	CPTU	2015-05-12	Edit Northing (-1m)
HALC06	RCPTU	2015-10-20	
HALC07	CPTU-DIS	2015-10-20	Variable rate
HALC08	CPTU-DIS	2015-10-20	Variable rate. Edited due to logging issues, discontinuous data. Two tabs of data
HALC09	SCPTU	2015-10-21	Used SCPTU. No cone test results, only seismic - however was of low quality and not reported
HALC10	RCPTU-DIS	2015-10-21	Variable rate. CPTU file edited due to removal of inaccurate (repeat) data. Hence lines in interpretation CPTU file
HALC11	CPTU	2016-06-08	
HALER01A	ERT	2015-04-15	0m, spacing 2m
HALER01B	ERT	2015-04-15	160m
HALER02A	ERT	2015-04-15	0m, spacing 1.5m

PROJ_NAMI	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

LOCA_ID-HOLE_ID	ABBR	DATE	Comments
-	-	YYYY-MM-YY	-
HALER02B	ERT	2015-04-15	120m
HALER03A	ERT	2015-04-15	0m, spacing 1.0m
HALER03B	ERT	2015-04-15	80m
HALER04A	ERT	2016-11-29	0m, spacing 2.0m
HALER04B	ERT	2016-11-29	160m
HALER05A	ERT	2016-11-29	0m, spacing 1.5m
HALER05B	ERT	2016-11-29	110m
HALER06A	ERT	2016-11-29	0m, spacing 2.0m. Corrected coordinate
HALER06B	ERT	2016-11-29	72m
HALPI01	Piezo	2016-09-23	
HALPI02	Piezo	2016-09-23	
HALPI03	Piezo	2016-09-23	
HALPI04	Piezo	2016-09-23	
HALRP01	RPS	2015-05-12	
HALRP02	RPS	2015-05-12	Marking for increased rotationspeed corrected
HALRP03	RPS	2015-05-13	Marking for increased rotationspeed corrected
HALRP04	RPS	2015-05-12	No penetration force in file?
HALRP05	RPS	2015-05-13	Marking for increased rotationspeed corrected. Edit Northing and Easting (-1,-1)
HALS01	StandP	Pre NGTS	
HALD01	SDMT	2017-09-12	
HALTH01	THS	2017-09-12	
HALC12	CPTU	2017-09-05	

PROJ_NAMI	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

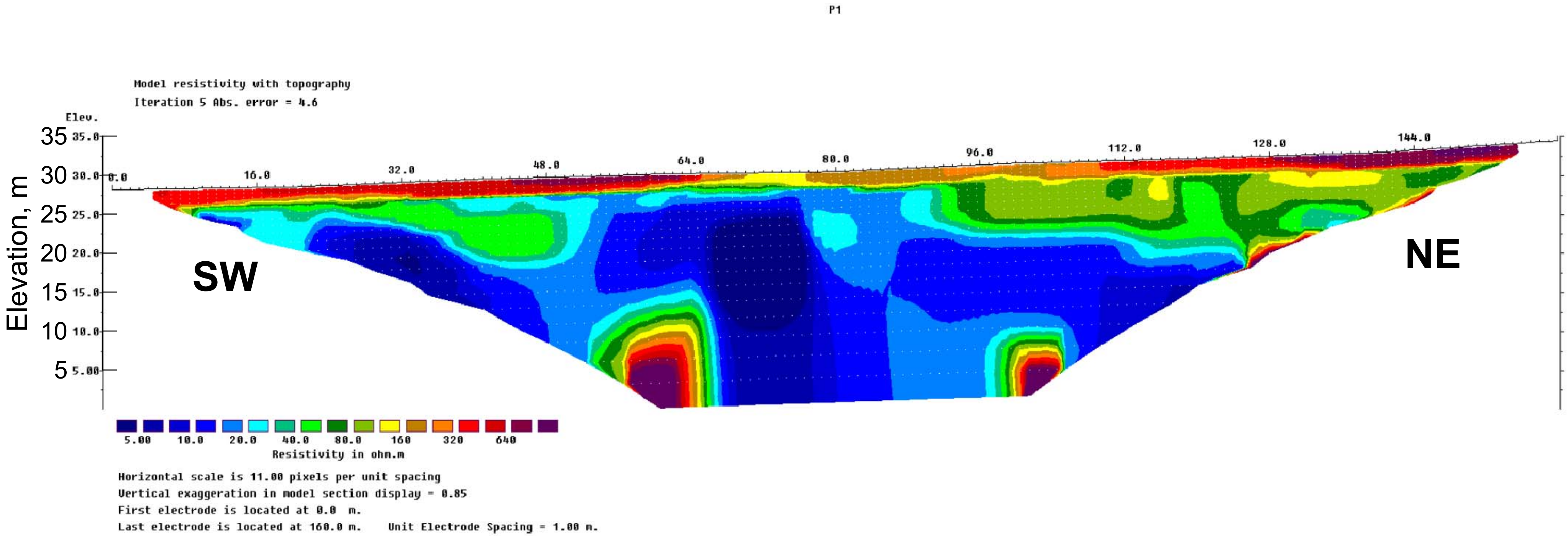
LOCA_ID-HOLE_ID	ABBR	DATE	Comments
-	-	YYYY-MM-YY	-
HALC13	SCPTU-DIS	2017-09-05	
HALC14	SCPTU-DIS	2017-09-06	Variable rate.
HALC15	SCPTU	2017-09-13	CPTU End at 7.36 m. Issue with data logging after 7.36 m. Shear wave recorded to 15.13 m
HALC16	SCPTU	2017-09-14	Logged in a (0-2.38m) and b (8.5-12.51) files, later combined.
HALC17	SCPTU-DIS	2017-11-22	Variable rate.
HALC18	CPTU-DIS	2017-09-19	
HALC19	CPTU	2017-09-19	
HALC20	CPTU-DIS	2017-09-19	Variable rate.
HALP01	SBP	2017-09-16	
HALB05	BHGPS	2017-09-11	
HALC21	SCPTU	2017-12-13	
HALC22	SCPTU-DIS	2017-12-12	
HALC23	CPTU-DIS	2017-12-12	Variable rate.
HALC24	CPTU-DIS	2017-11-23	
HALHP01	HYP	2017-11-27	
HALB06	BHGPS	2018-05-09	First 2 samples (between 4,3-5,2 m and 6-6,8 m) collected where very disturbed (slurry). Low cohesion in the material and the sample collapses.
HALPS01	PS	2018-06-12	Position intially measured by NEID but SaB found out that it was inaccurate. Remeasured by Iceland Univ.
HALPS02	PS	2018-06-12	Position intially measured by NEID but SaB found out that it was inaccurate. Remeasured by Iceland Univ.
HALPS03	PS	2018-06-12	Position intially measured by NEID but SaB found out that it was inaccurate. Cannot be remeasured.
HALM01	MASW	2018-06-12	Position intially measured by NEID but SaB found out that it was inaccurate. Remeasured by Iceland Univ.
HAMS02	MASW	2018-06-12	Position intially measured by NEID but SaB found out that it was inaccurate. Remeasured by Iceland Univ.

PROJ_NAMI	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_END	NGI

LOCA_ID-HOLE_ID	ABBR	DATE	Comments
-	-	YYYY-MM-YY	-
HALSP01	SPLT	2018-08-29	Performed in august 2018, week 35
HALSP01	SPLT	2018-08-30	Performed in august 2018, week 35
HALH01	HFST	2018-08-27	Test performed at 8 m and 13 m. At 13 m, something went wrong with the valve but the pressure went high up. At 8 m, it went well, it was used more fluid than in clay.
HALWS	WS	2018-07-12	Data at: vistadv01.ngi.no/vdv/index.html. User: NGTS, Password: NGTS2017
HALB07	BHGUS	2018-03-18	See file in P:\2016\01\20160154\Fieldwork\Halden\02-Planning\2019-03-06 Fieldwork for 2019\UMass-Fieldwork
HALB08	BHDM	2018-03-19	See file in P:\2016\01\20160154\Fieldwork\Halden\02-Planning\2019-03-06 Fieldwork for 2019\UMass-Fieldwork

Appendix C

ERT RESULTS

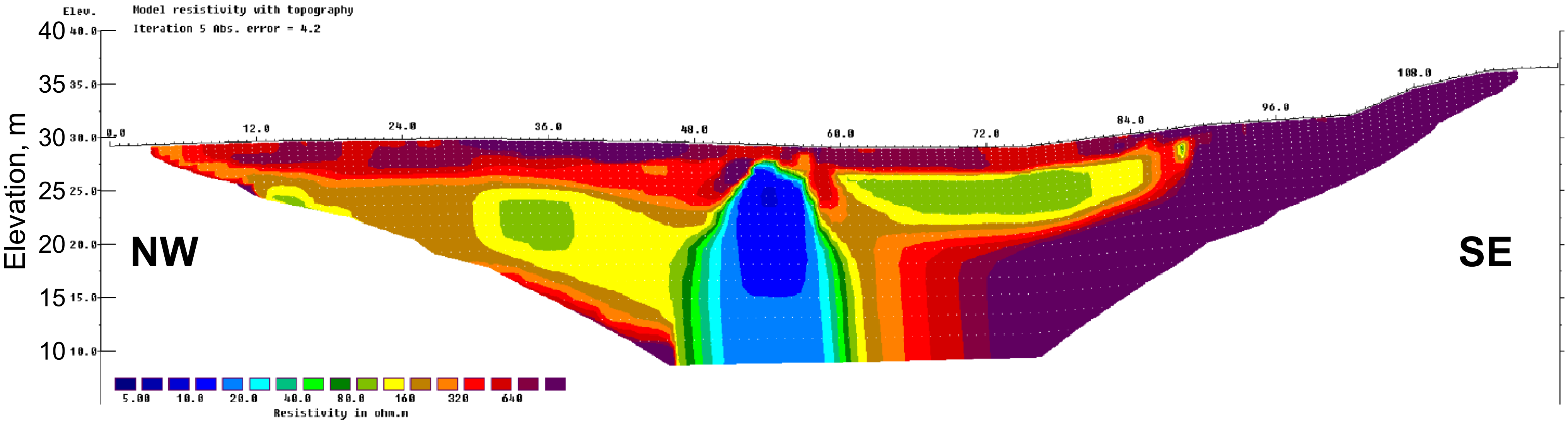


P:\2016\01\20160154\Fieldwork\Halden\Interp-ERT\Figures\Fig_01_ERT_P1.grf

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P1	Figure No. 01
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
HALER01A-HALER01B	NGTS

P2

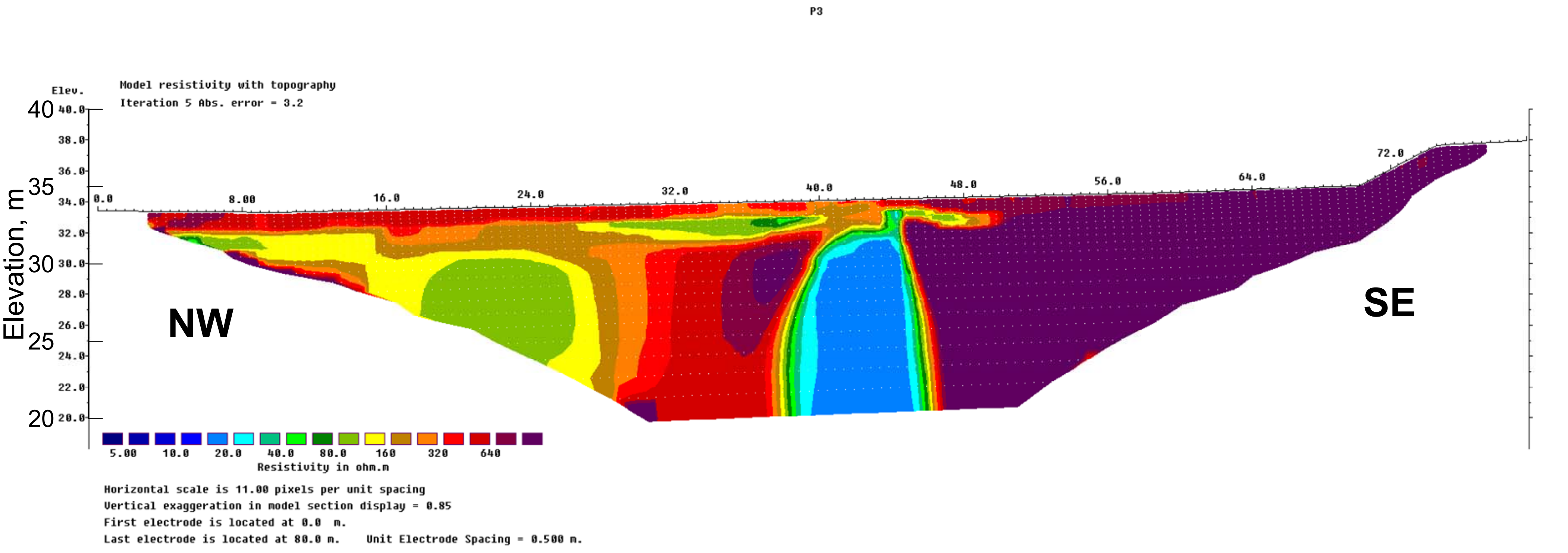


Horizontal scale is 10.88 pixels per unit spacing
Vertical exaggeration in model section display = 0.86
First electrode is located at 0.0 m.
Last electrode is located at 120.0 m. Unit Electrode Spacing = 0.750 m.

Date/Rev.: 2015-01-21/01

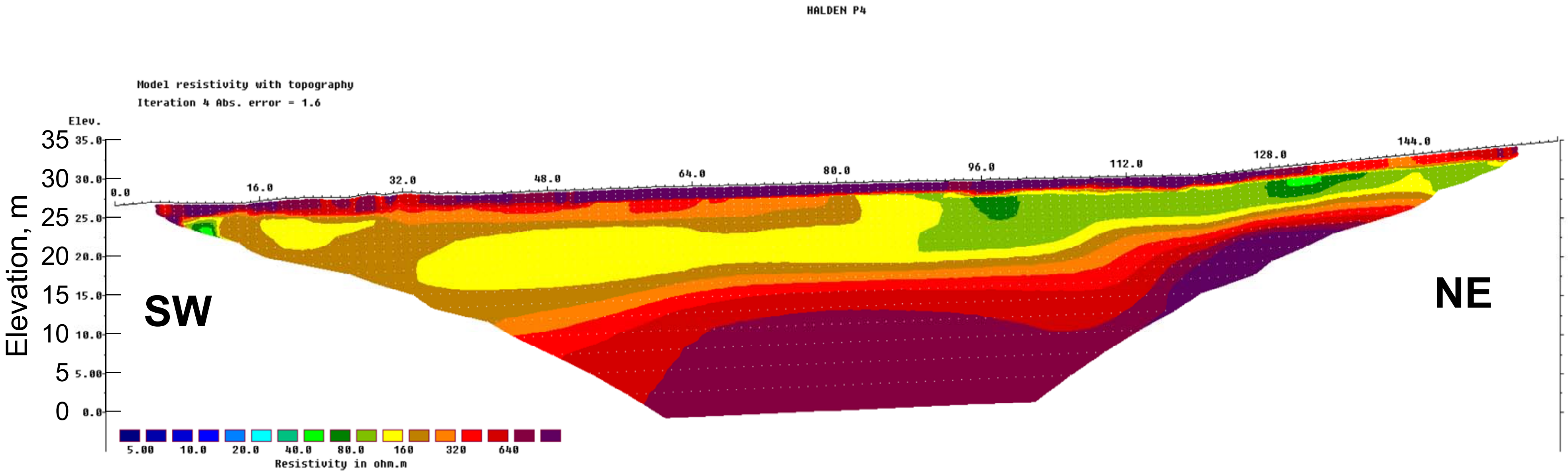
NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P2	Figure No. 02
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
HALER02A-HALER02B	NGTS

P:\2016\01\20160154\Fieldwork\Halden\Interp-ERT\Figures\Fig_02_ERT_P2.grf



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P3 HALER03A-HALER03B	Figure No. 03
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
	NGTS

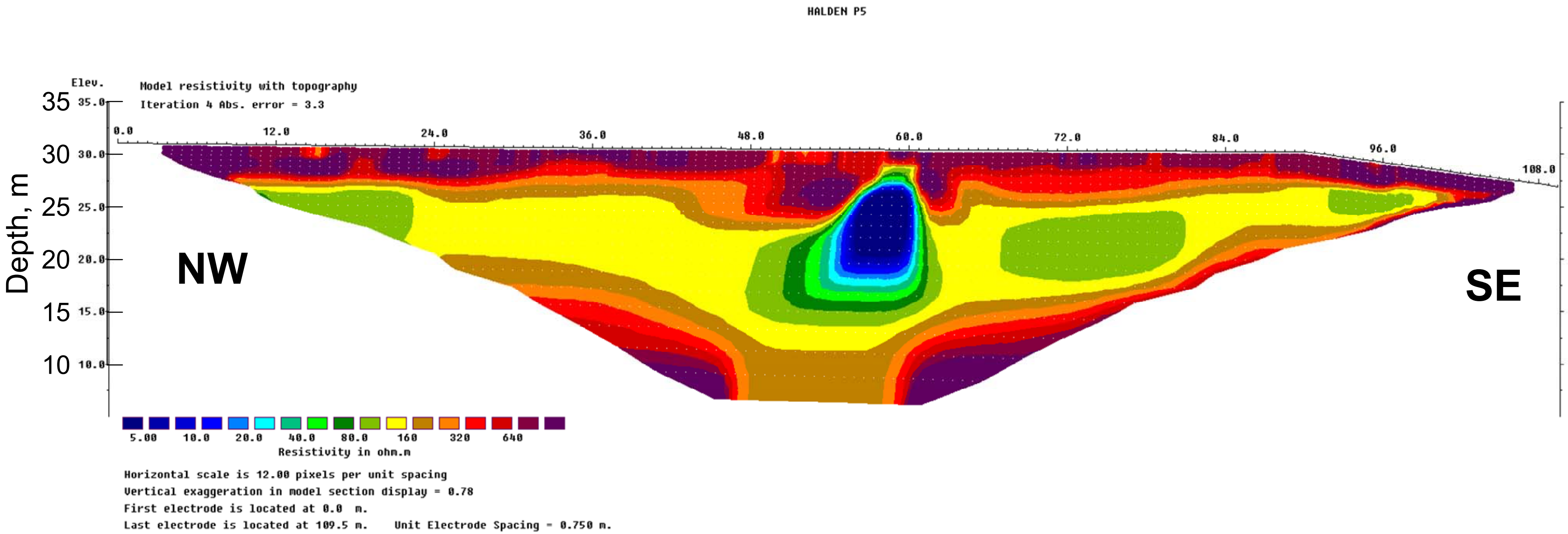


Horizontal scale is 11.00 pixels per unit spacing
Vertical exaggeration in model section display = 0.85
First electrode is located at 0.0 m.
Last electrode is located at 160.0 m. Unit Electrode Spacing = 1.00 m.

P:\2016\01\20160154\Fieldwork\Halden\Interp-ERT\Figures\Fig_04_ERT_P4.grf

Date/Rev.: 2015-01-21/01

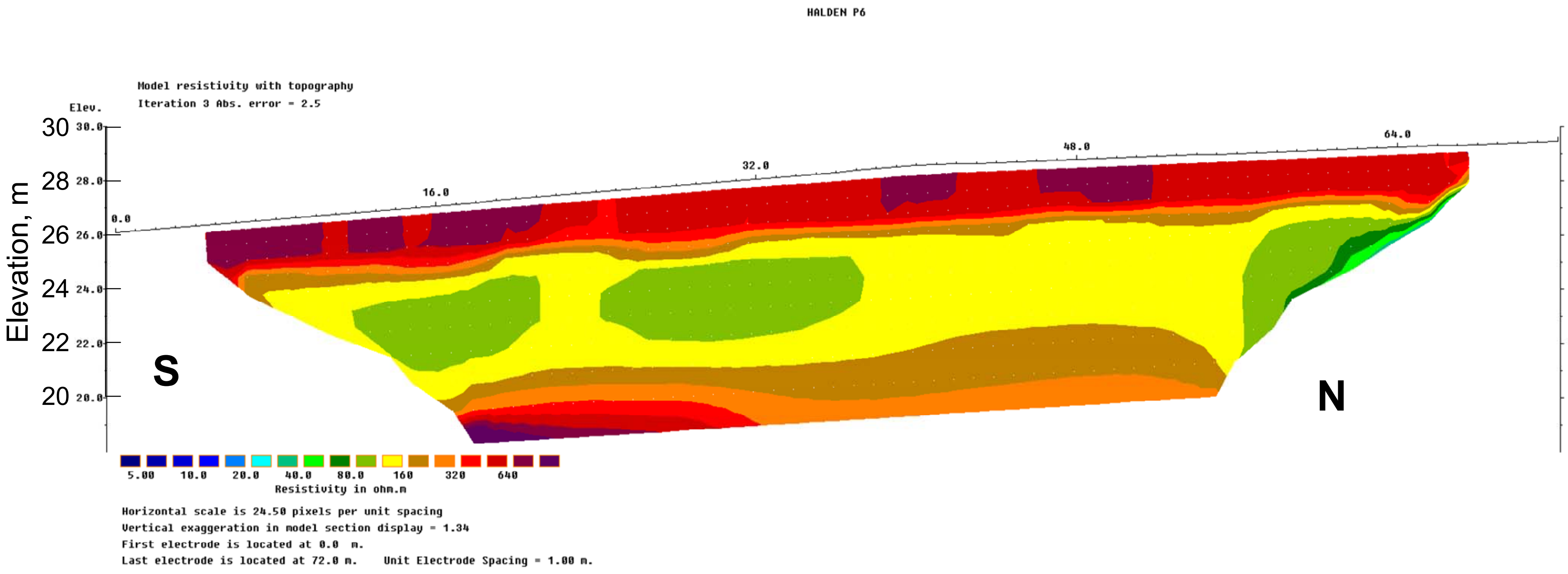
NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P4	Figure No. 04
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
HALER04A-HALER04B	NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P5	Figure No. 05
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
HALER05A-HALER05B	NGTS

P:\2016\01\20160154\Fieldwork\Halden\Interp-ERT\Figures\Fig_05_ERT_P5.grf



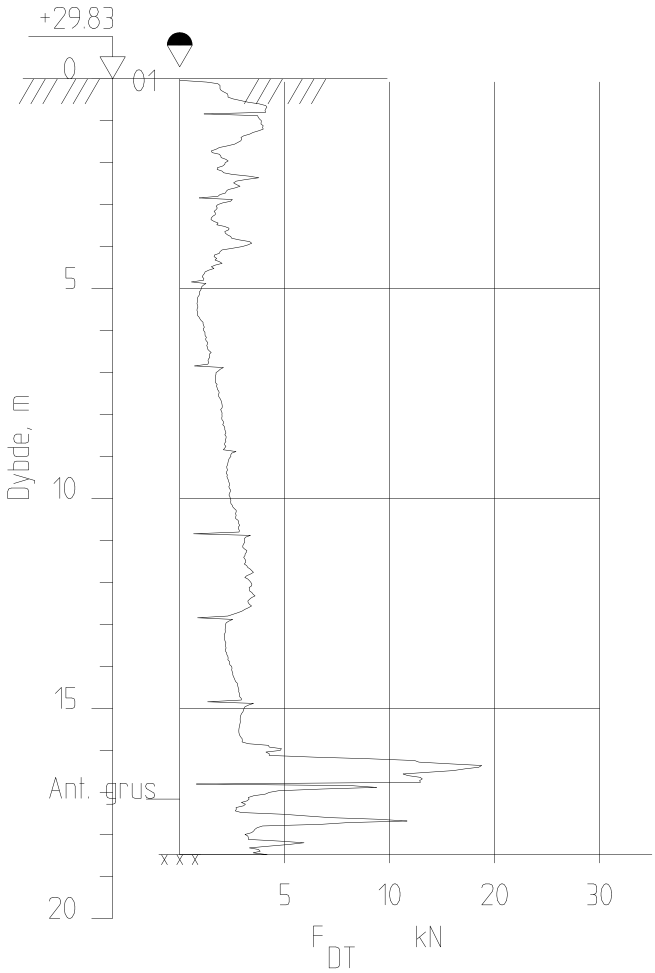
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Resistivity profile P6	Figure No. 06
	Date 2018-04-06 / Drawn by SBa/OyB/RCa
HALER06A-HALER06B	NGTS

P:\2016\01\20160154\Fieldwork\Halden\Interp-ERT\Figures\Fig_06_ERT_P6.grf

Appendix D

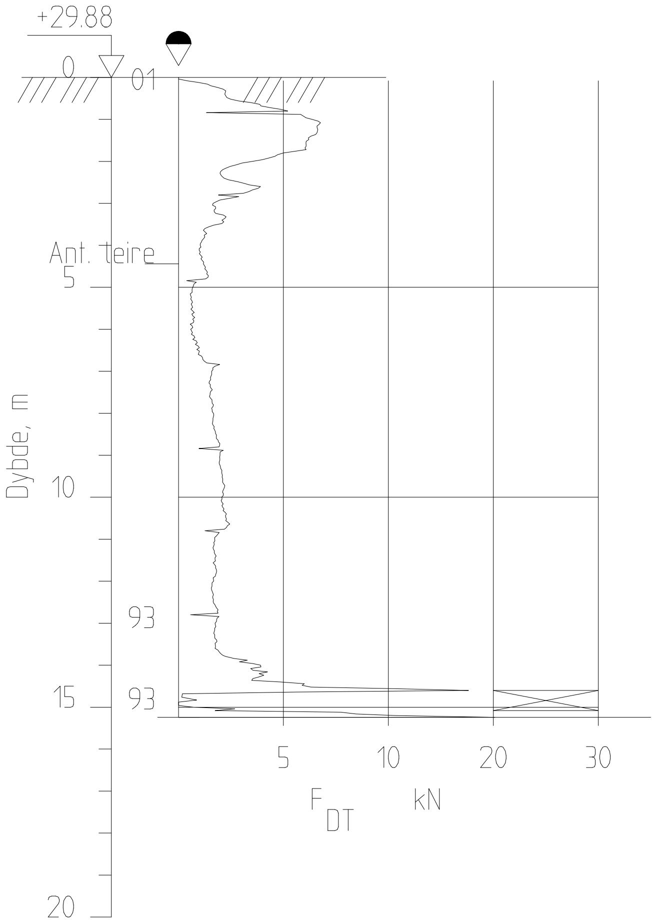
ROTARY PRESSURE SOUNDING RESULTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Rotary pressure sounding HALRP01 N: 6 555 926.2 E: 635 298.3	Figure No. 01 Date 2018-04-06 · Drawn by OyB

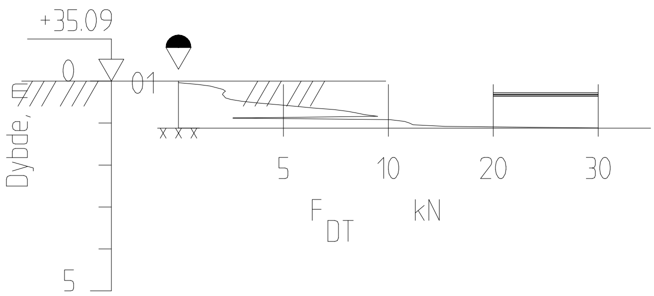
P:\2016\01\20160154\Fieldwork\Halden\RPS\Fig_01_HALRP01.grf



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Rotary pressure sounding	Figure No. 02
	Date 2018-04-06 / Drawn by OyB
HALRP02 N: 6 555 927.9 E: 635 278.7	NGTS

P:\2016\01\20160154\Fieldwork\Halden\RPS\Fig_02_HALRP02.grf



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Document No.
20160154-04-R

Figure No.
03

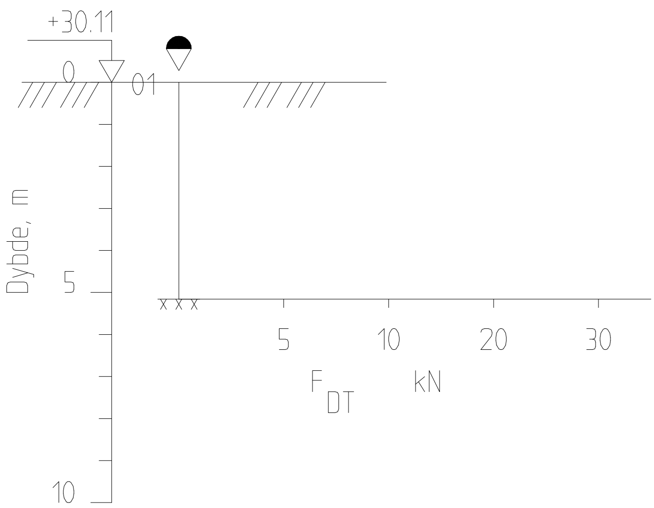
Rotary pressure sounding

Date
2018-04-06

Drawn by
OyB

HALRP03
N: 6 556 002.0 E: 635 361.3

P:\2016\01\20160154\Fieldwork\Halden\RPS\Fig_03_HALRP03.grf



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

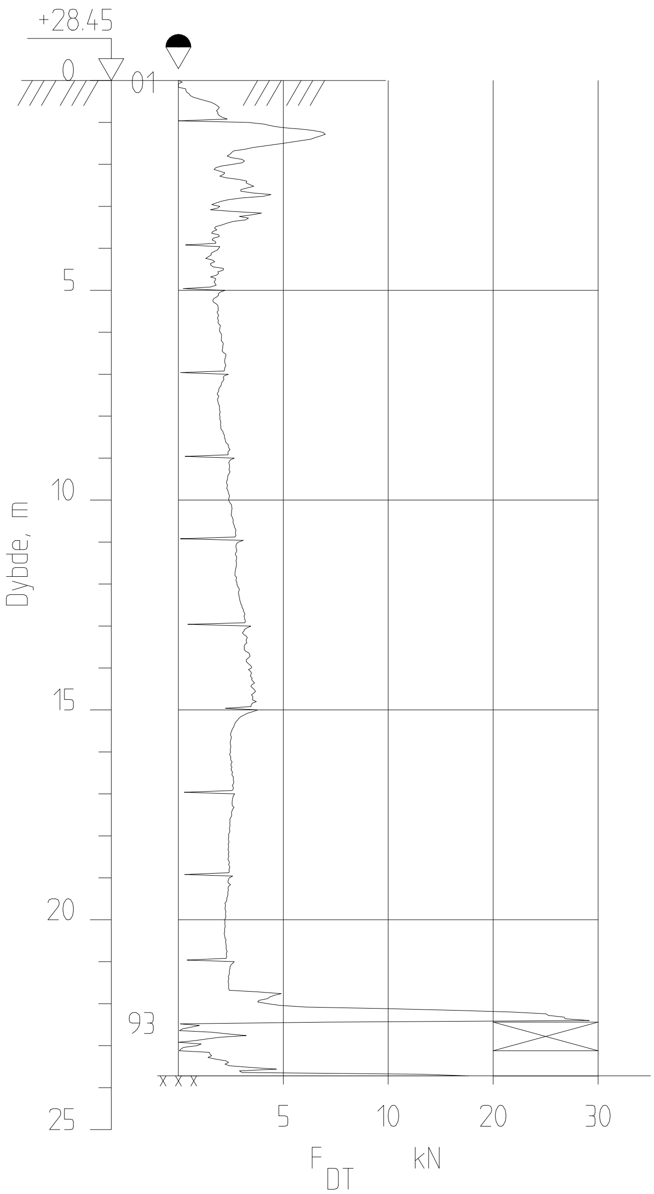
Rotary pressure sounding

HALRP04
N: 6 555 922.7 E: 635 336.9

Document No.	
20160154-04-R	
Figure No. 04	
Date: 2018-04-06	Drawn by: OyB

NGTS

P:\2016\01\20160154\Fieldwork\Halden\RPS\Fig_04_HALRP04.grf

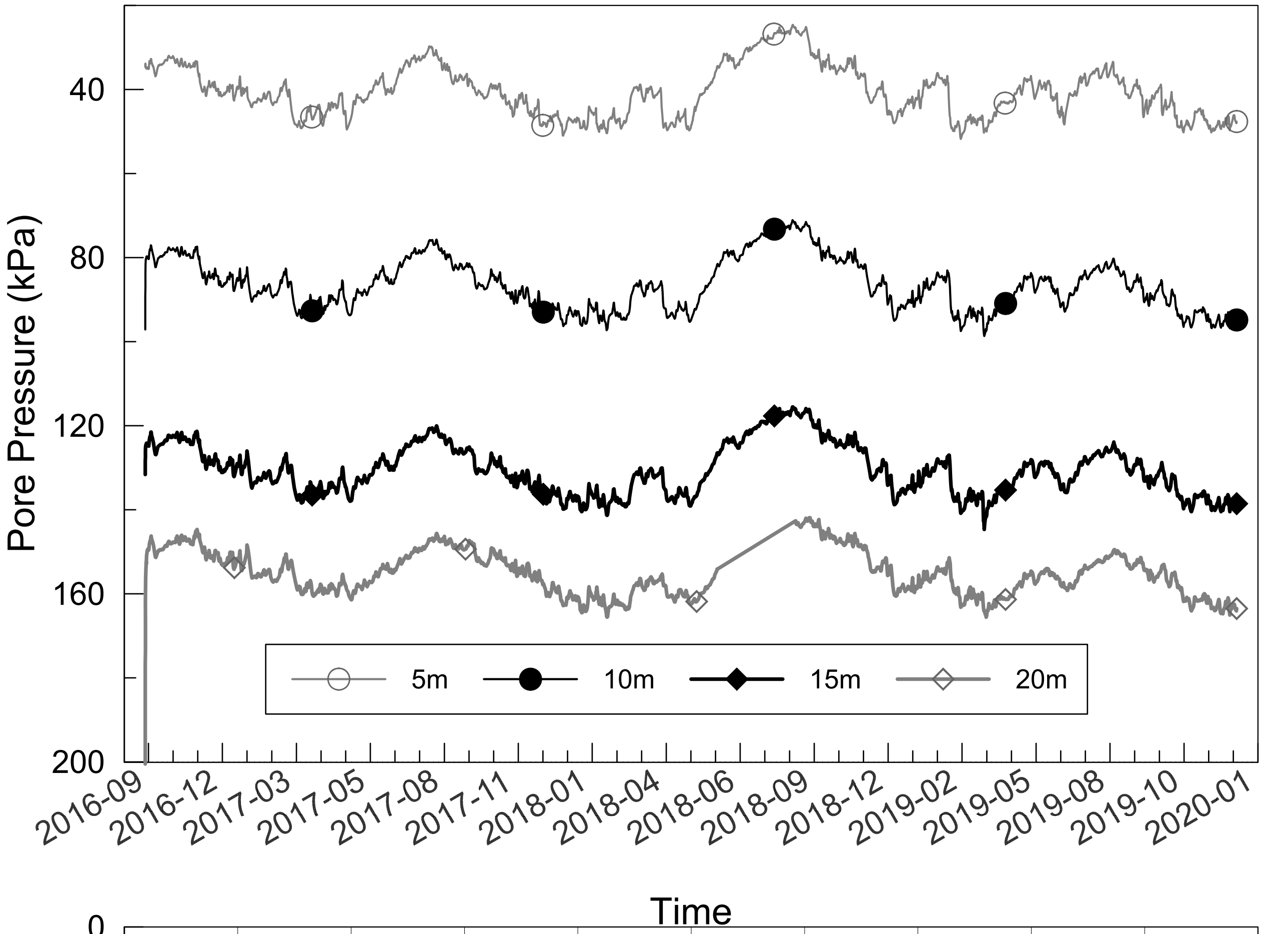


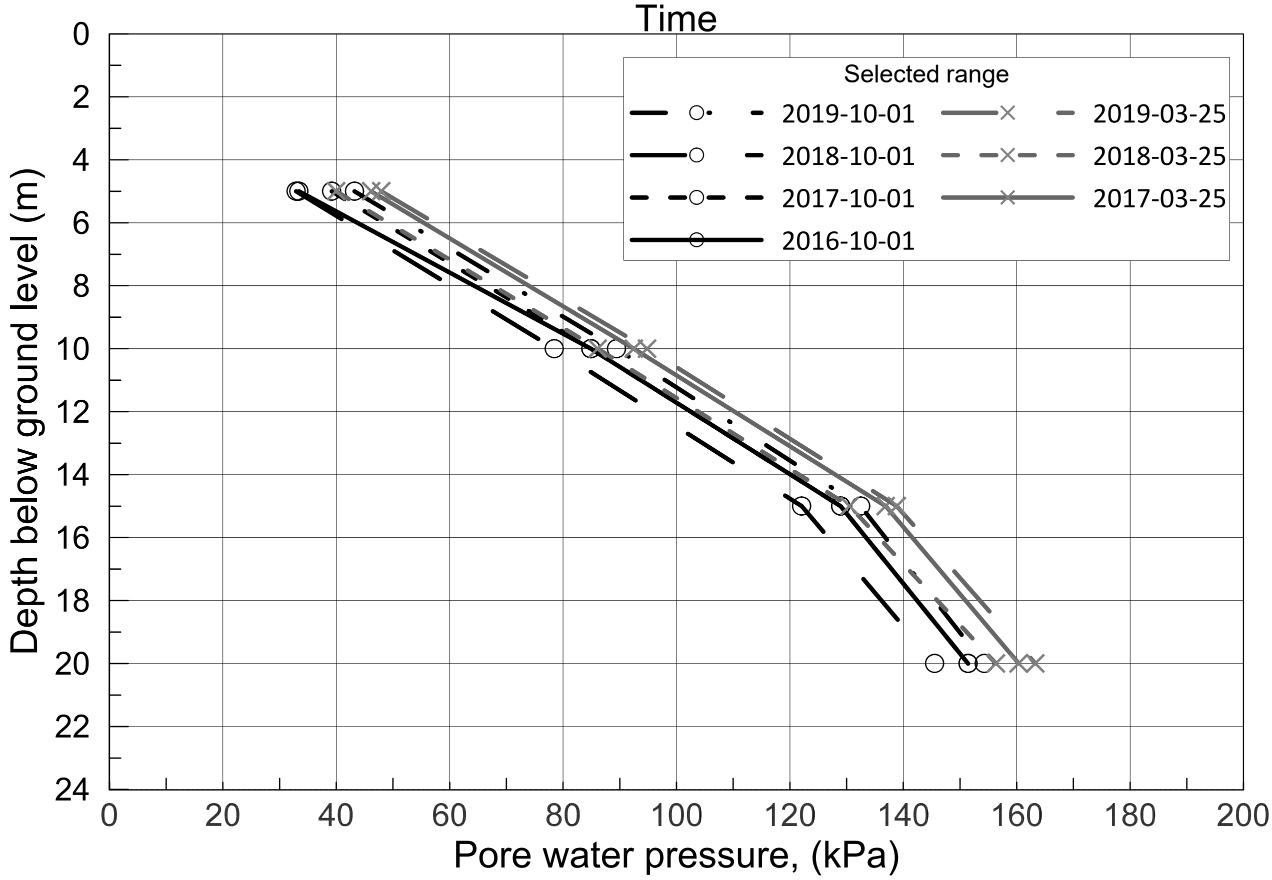
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Rotary pressure sounding	Figure No. 05
	Date 2018-04-06 / Drawn by OyB
HALRP05 N: 6 555 908.8 E: 635 291.2	NGTS

Appendix E

PIEZOMETER RESULTS





Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Piezometer

Depth interval: 5, 10, 15 and 20 m

Document No.	
20160154-04-R	
Figure No. 01	
Date 2019-01-06	Drawn by RCa/APP

NGTS

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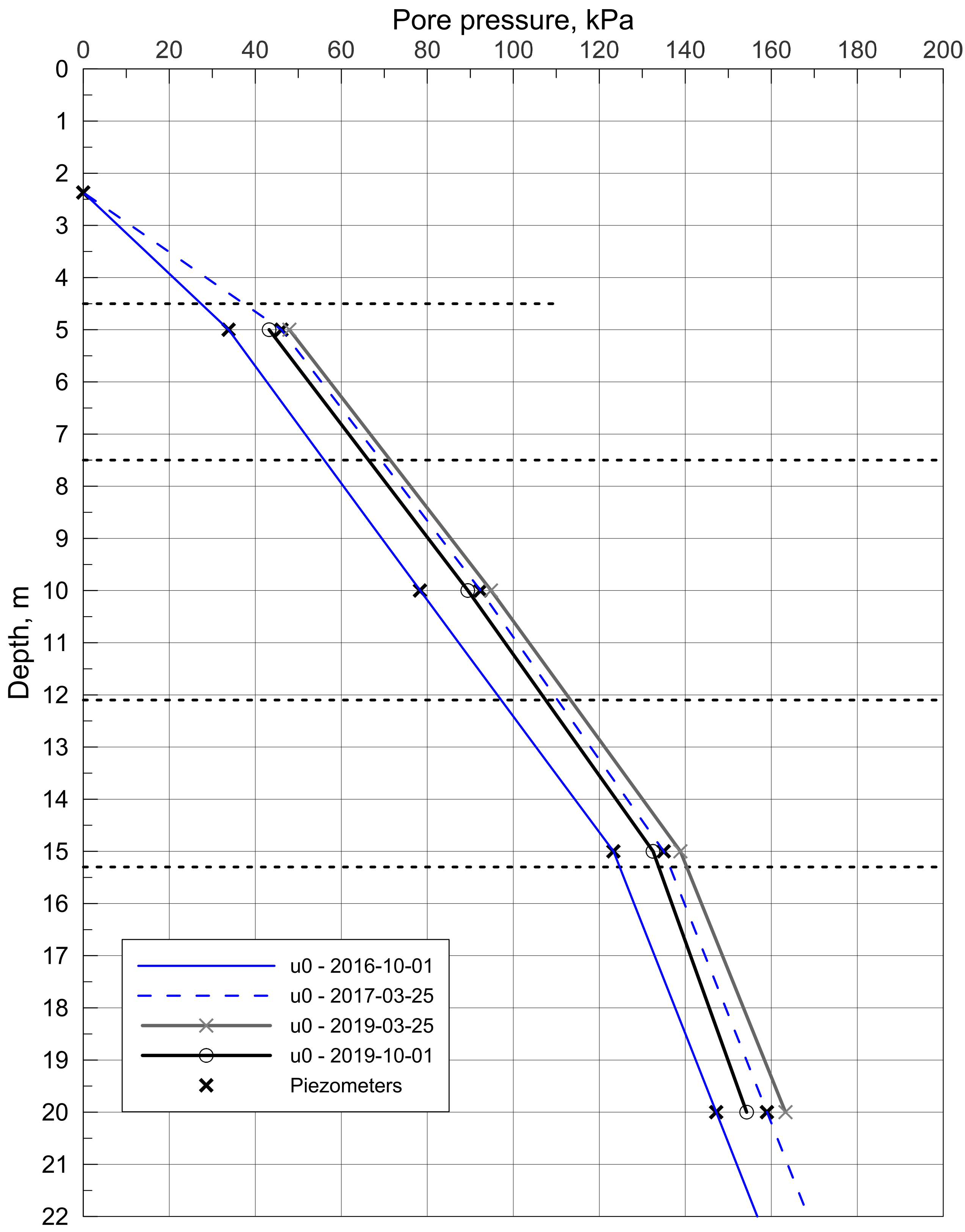


P:\2016\01\20160154\Fieldwork\Halden\Interp-Stresses\Fig_02_Pore water pressureInSitu.grf

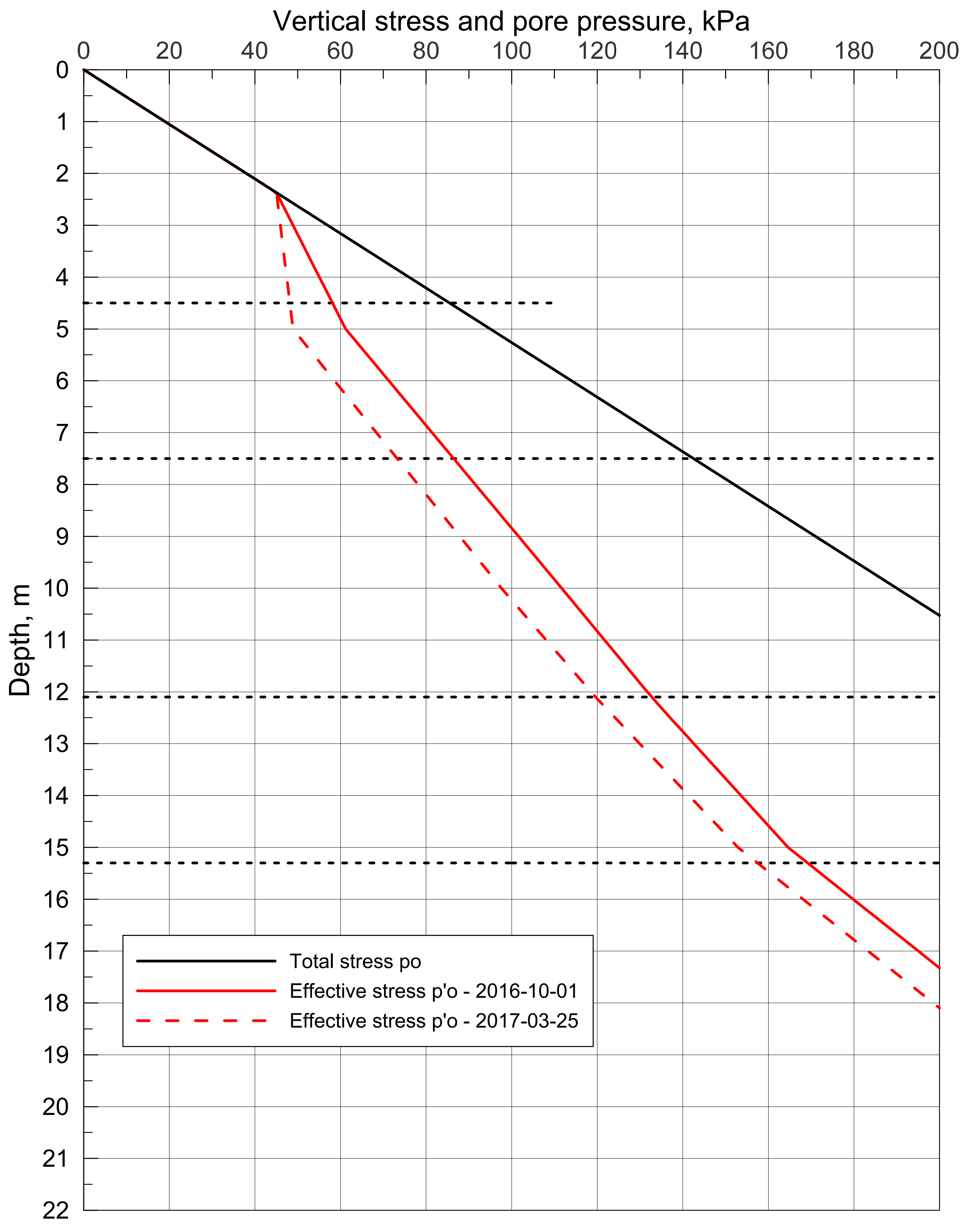
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
In situ pore pressure versus depth	Figure No. 02	
	Date 2020-01-06	Drawn by RCa/OyB/APP

NGTS

Appendix F

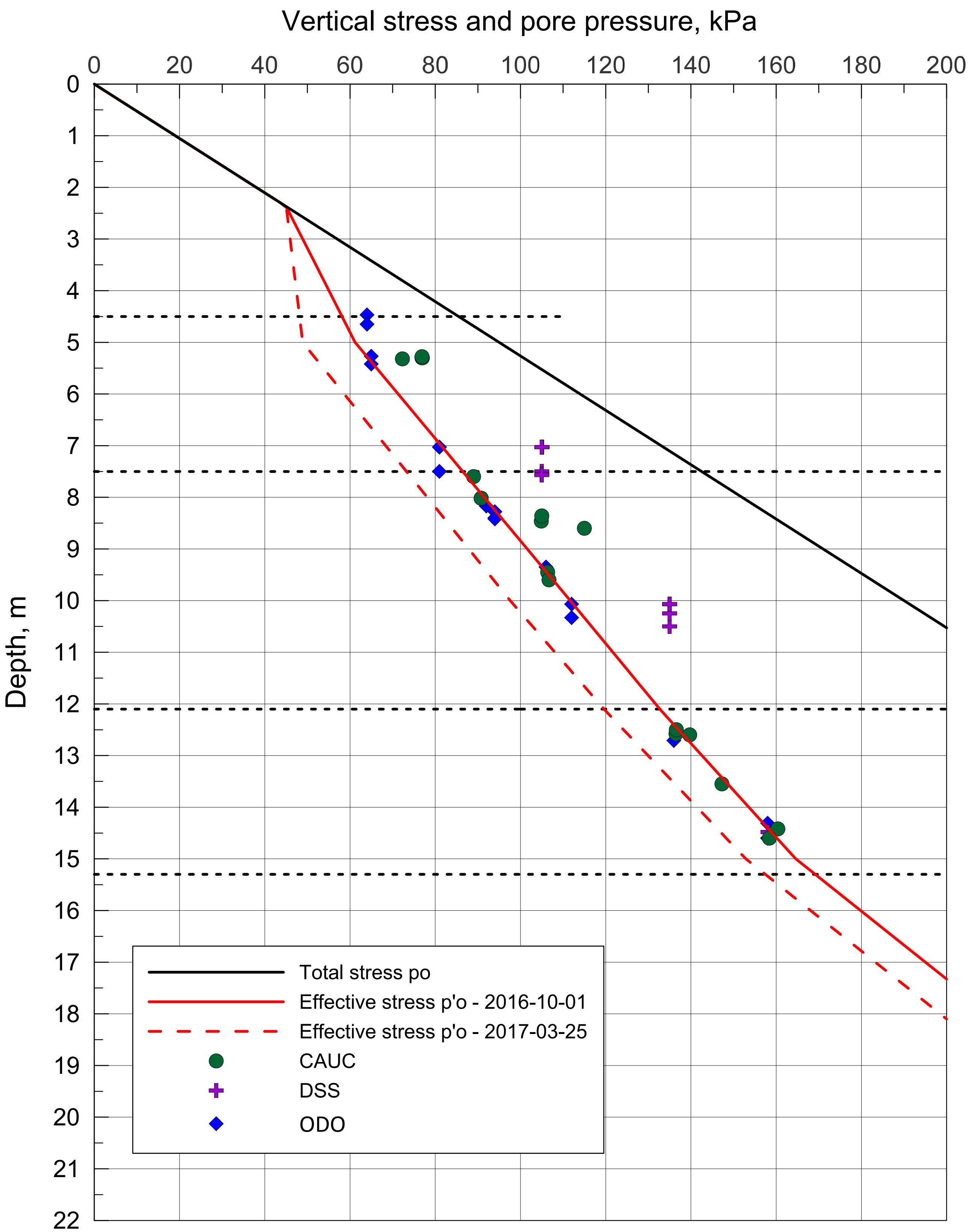
STRESS PROFILE



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Total and effective stress versus depth	Figure No. 01	
	Date 2016-10-12	Drawn by RCa/OyB
	NGTS	

P:\2016\01\20160154\Fieldwork\Halden\Interp-Stresses\Fig_01_Stresses- total and effective.grf



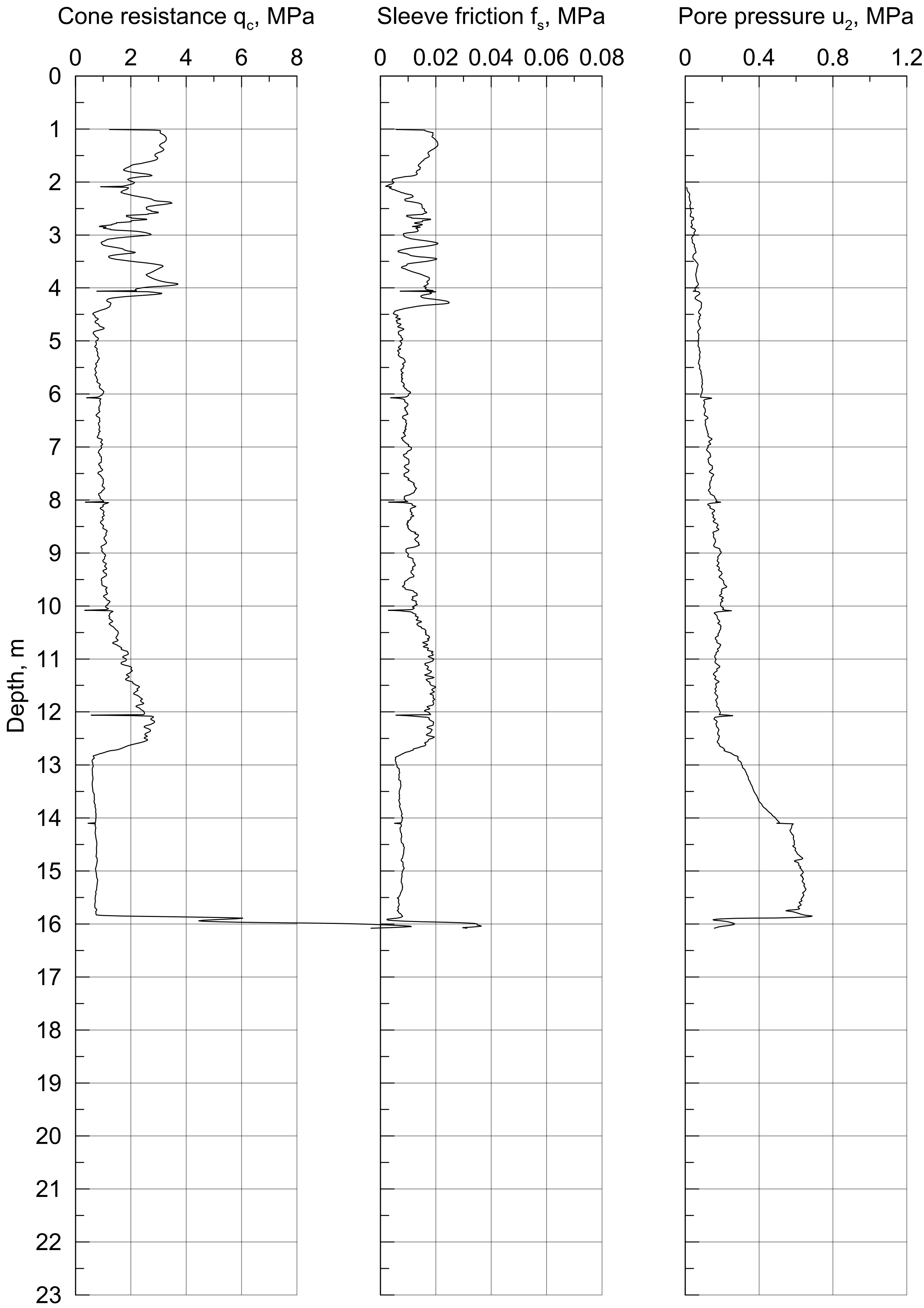
P:\2016\01\20160154\Fieldwork\Halden\Interp-Stresses\Fig_02_Stresses- total and effective and consolidaton stresses.grf

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Total, effective overburden pressure and consolidation stresses used for laboratory tests versus depth	Figure No. 02	
	Date 2018-06-18	Drawn by RCa/OyB/APP
	NGTS	

Appendix G

CPTU, SCPTU AND RCPTU RESULTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 01
	Date 2018-04-06 / Drawn by OyB/RCa
HALC01 **NGI Envi. Standard rate**	NGTS

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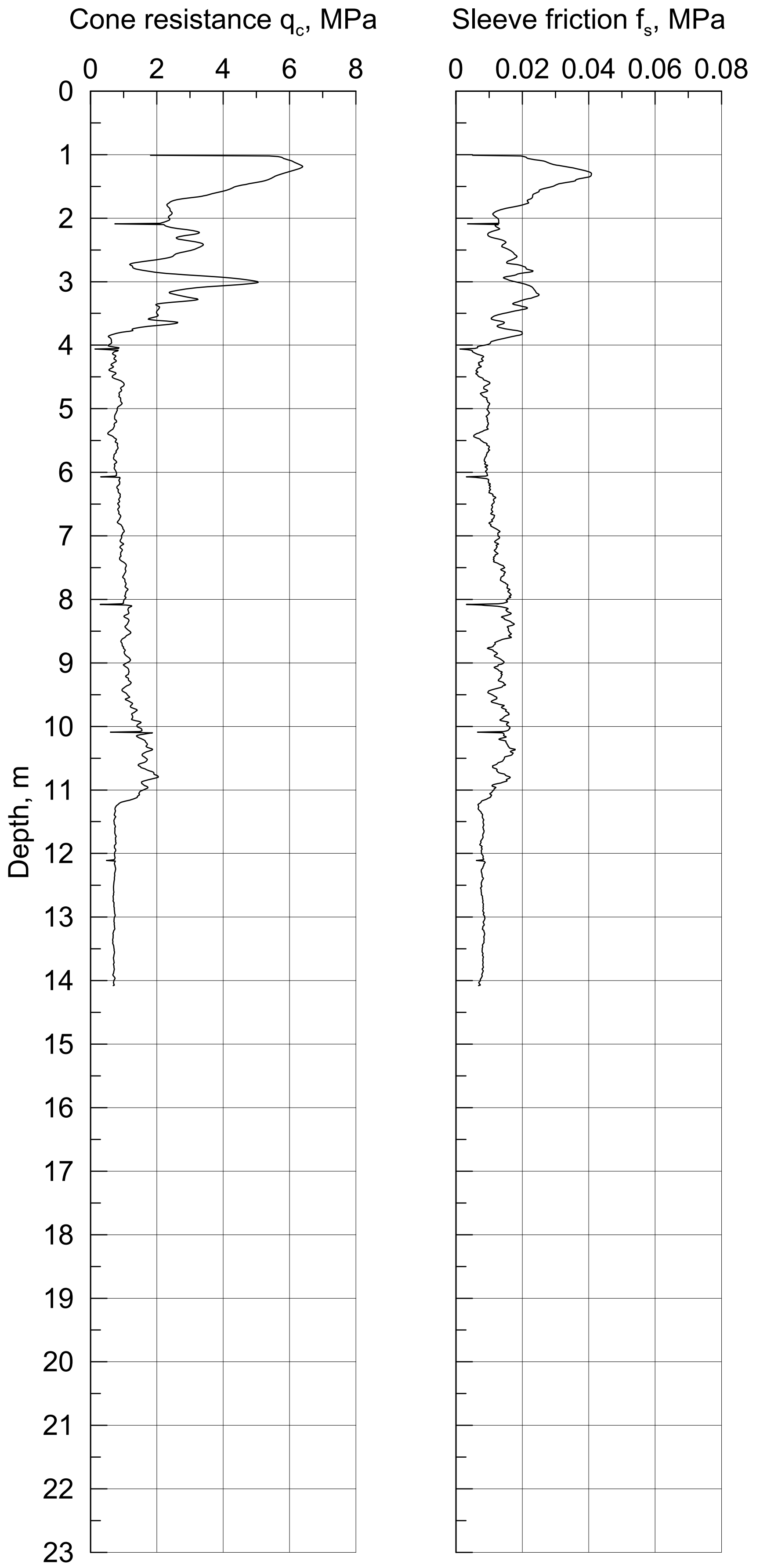

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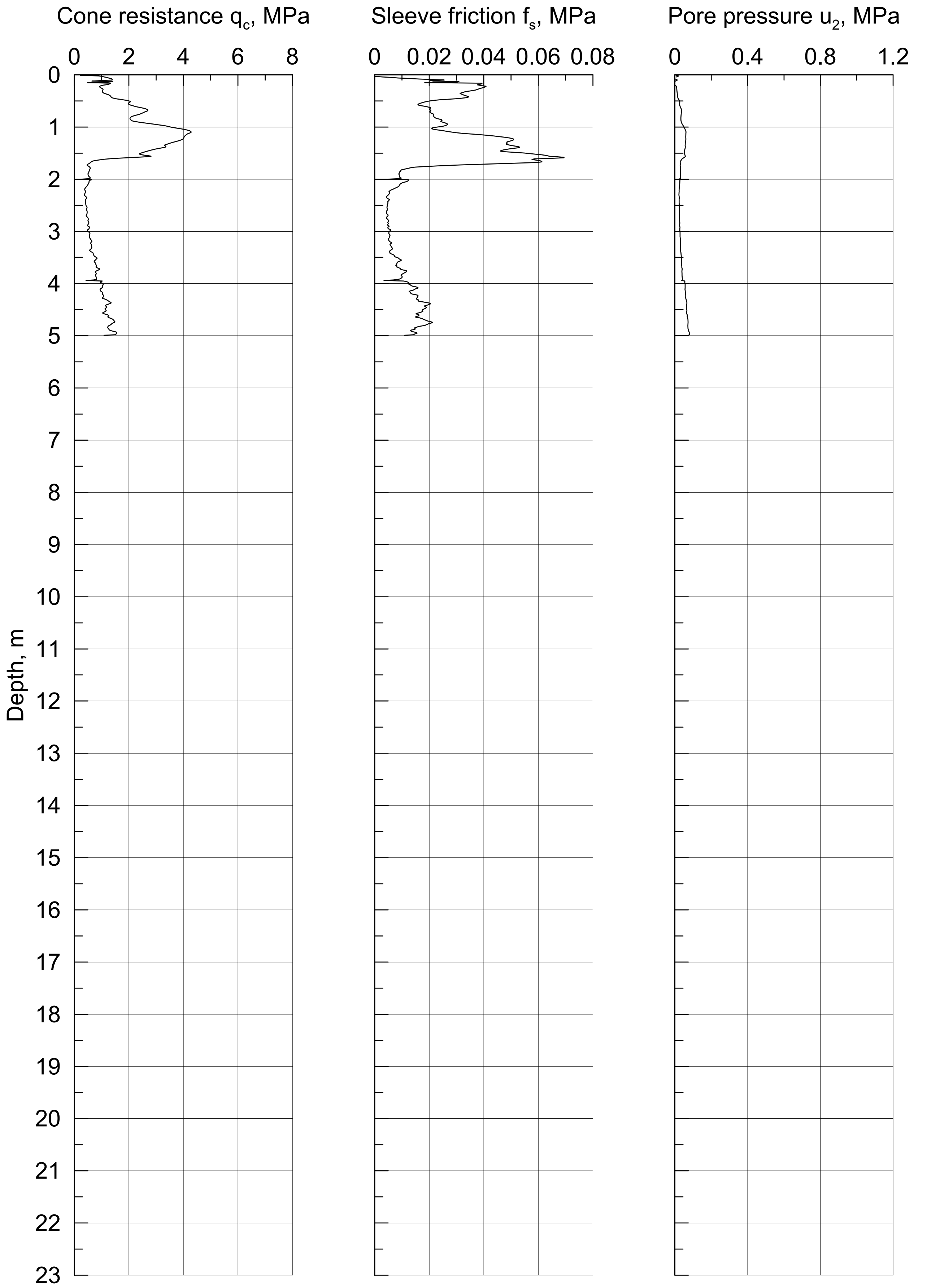
Date/Rev.: 2015-01-21/01

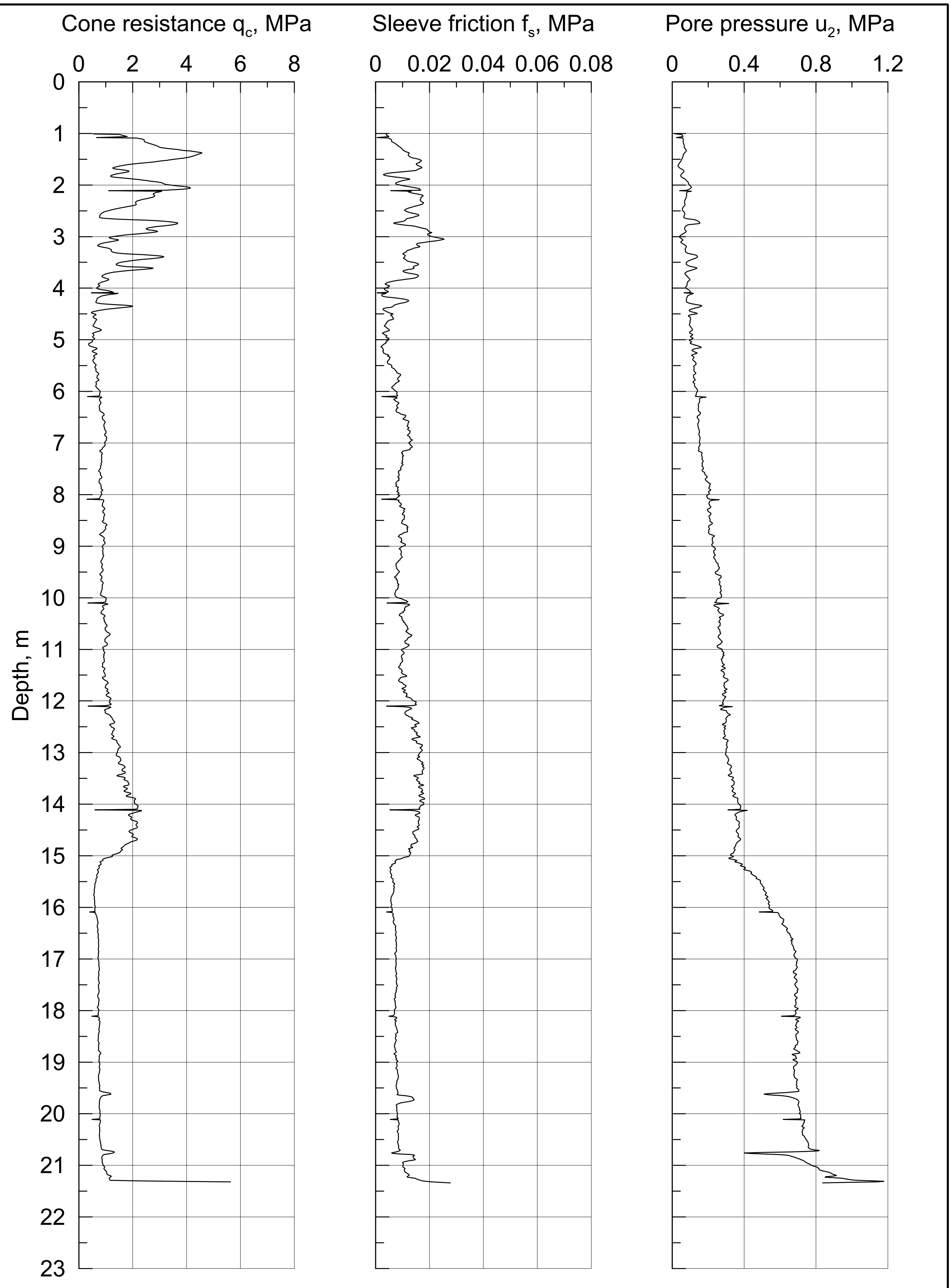
NGTS - Halden Research Site	Document No. 20160154-04-R	
q_c, f_s and u_2 from CPTU tests	Figure No. 02	
	Date 2018-04-07	Drawn by OyB/RCa
HALC02 **NGI Envi. Standard rate**	NGTS	



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 03
	Date 2018-04-06
	Drawn by OyB/RCa
HALC04 **NGI Envi. Standard rate**	NGTS

P:\2016\01\20160154\Fieldwork\Halden\Interp-CPT-R-S-DIS\F_03_qc_fs_u2_HALC04.grf



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 04
	Date 2018-04-06 / Drawn by OyB/RCa
HALC05 **NGI Envi. Standard rate**	NGTS

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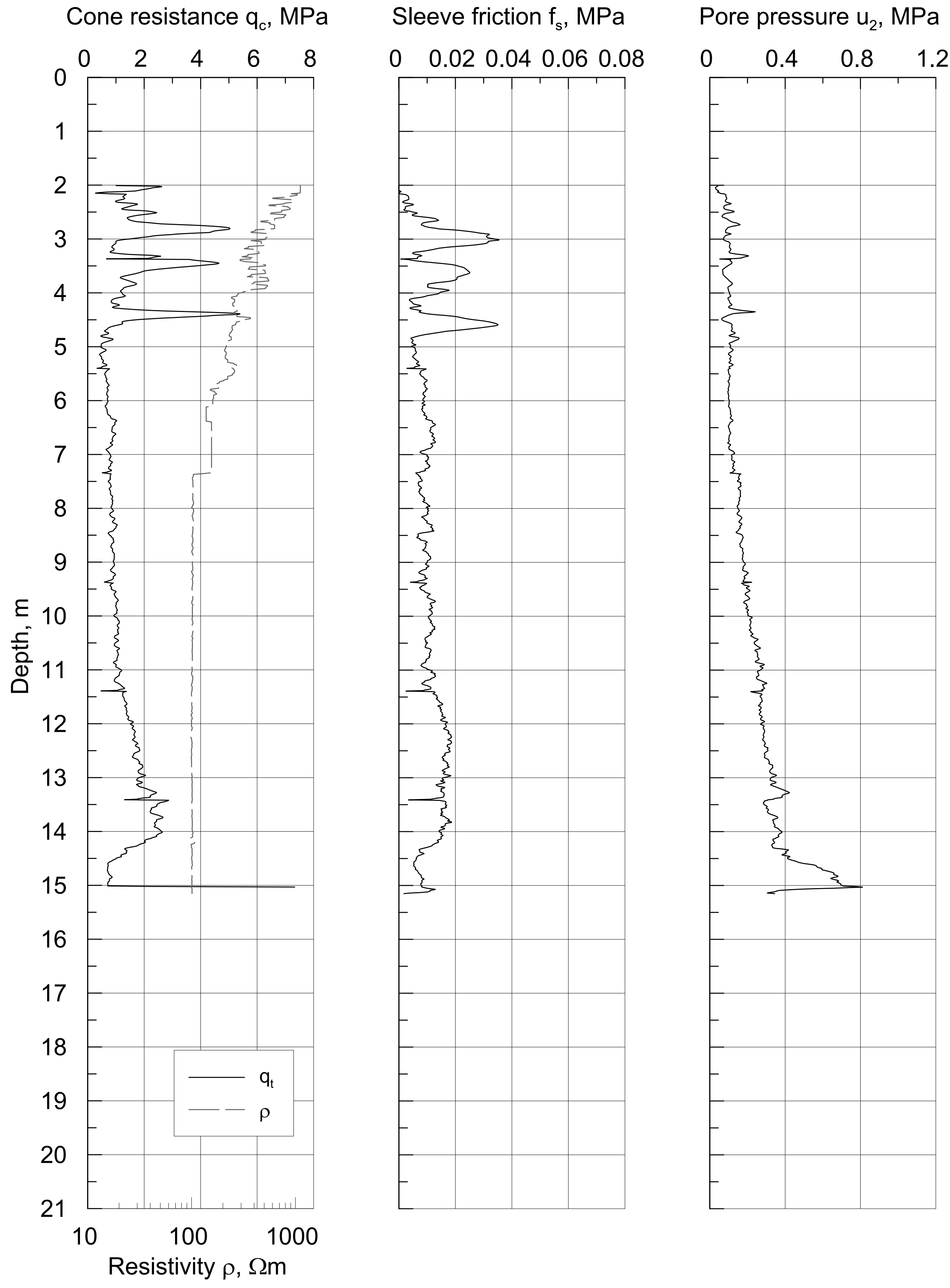

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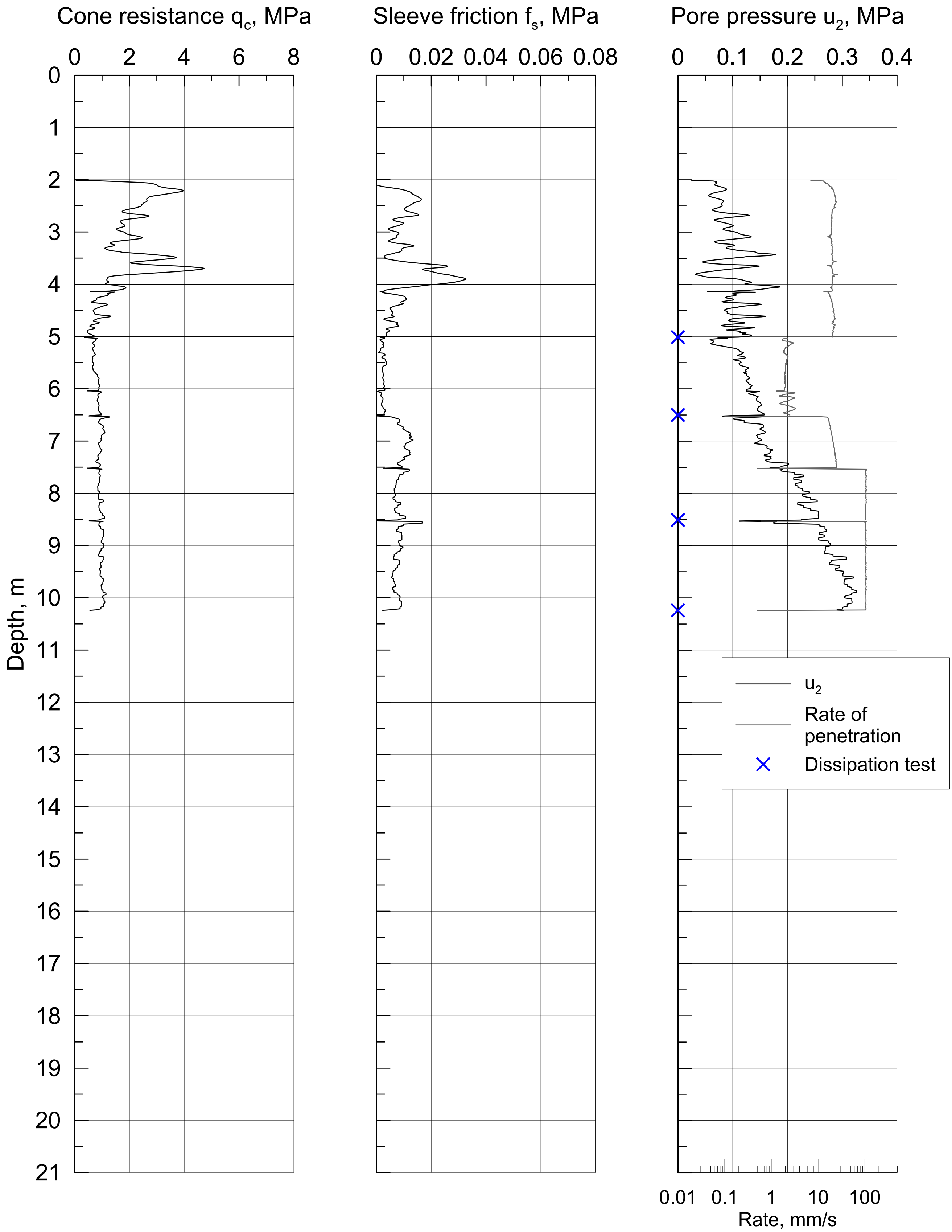
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s, u_2 and ρ from RCPTU tests	Figure No. 05
	Date 2018-10-21 / Drawn by OyB/RCa
HALC06 **NGI Envi. Standard rate, RCPTU**	NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 06
	Date 2018-04-06 / Drawn by OyB/RCa
HALC07 **NGI Envi. Variable rate, Dissipation tests**	NGTS

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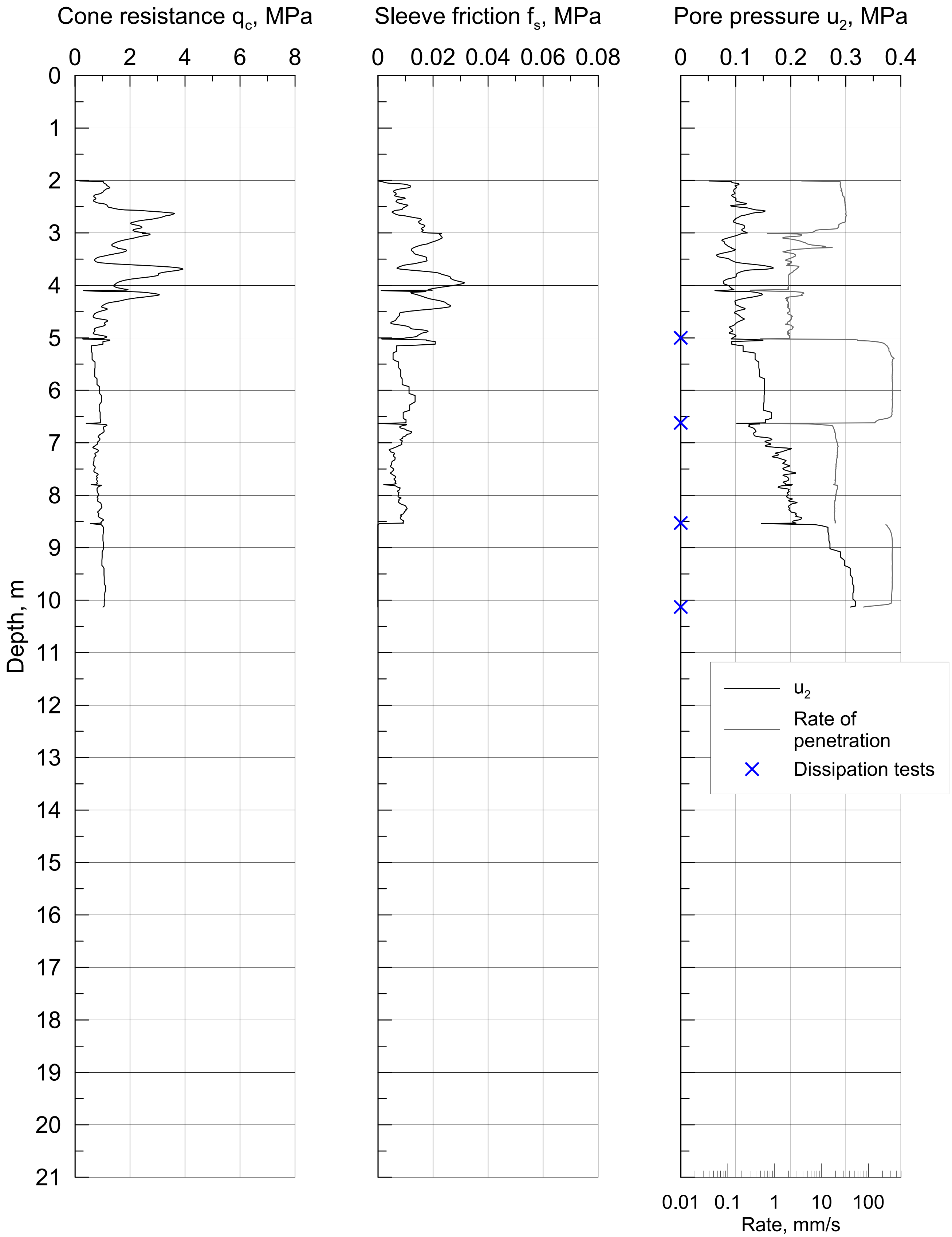

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
q_c, f_s and u_2 from CPTU tests	Figure No. 07	
	Date 2018-04-06	Drawn by OyB/RCa
HALC08 **NGI Envi. Variable rate, Dissipation tests**	NGTS	

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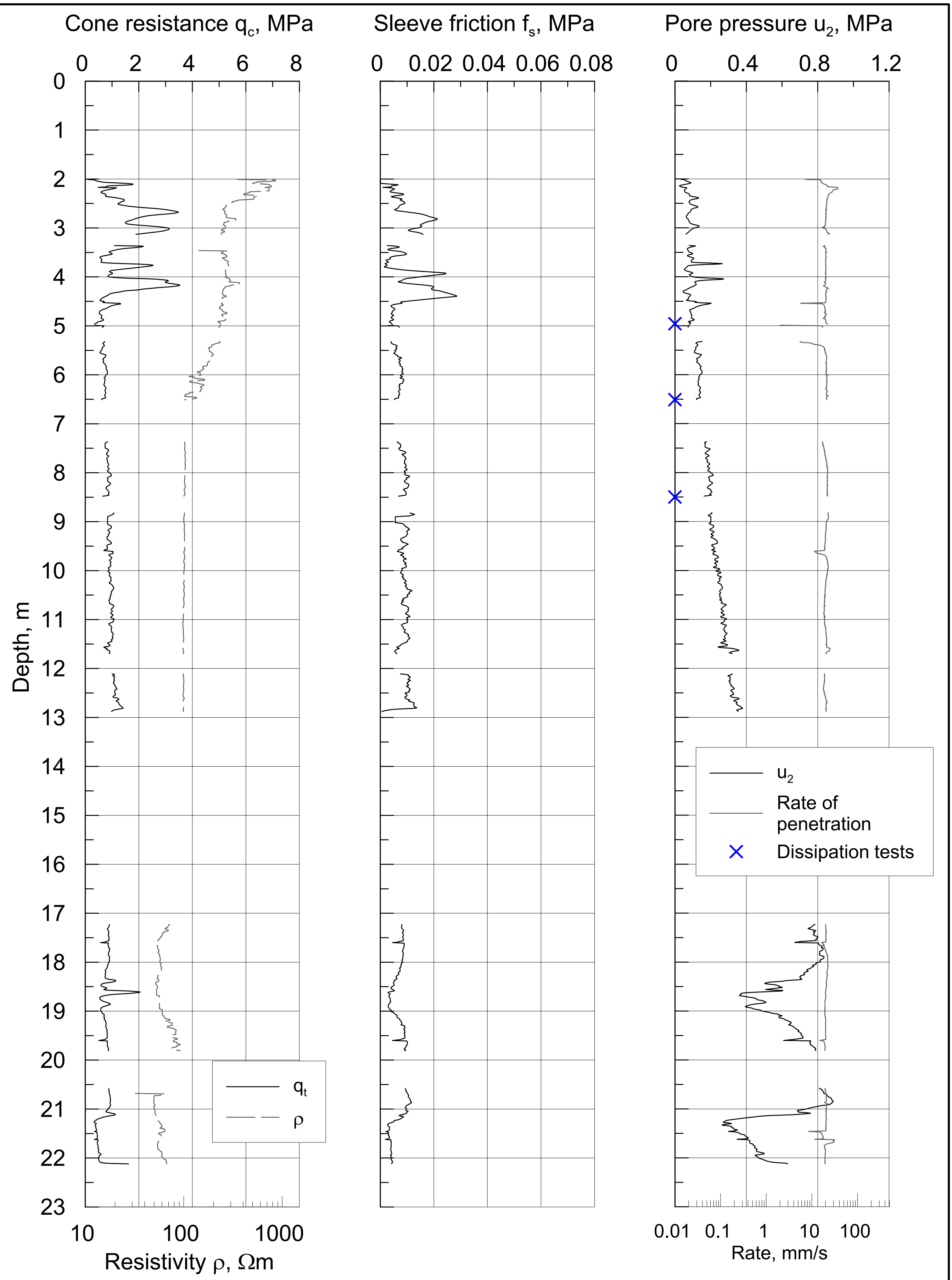

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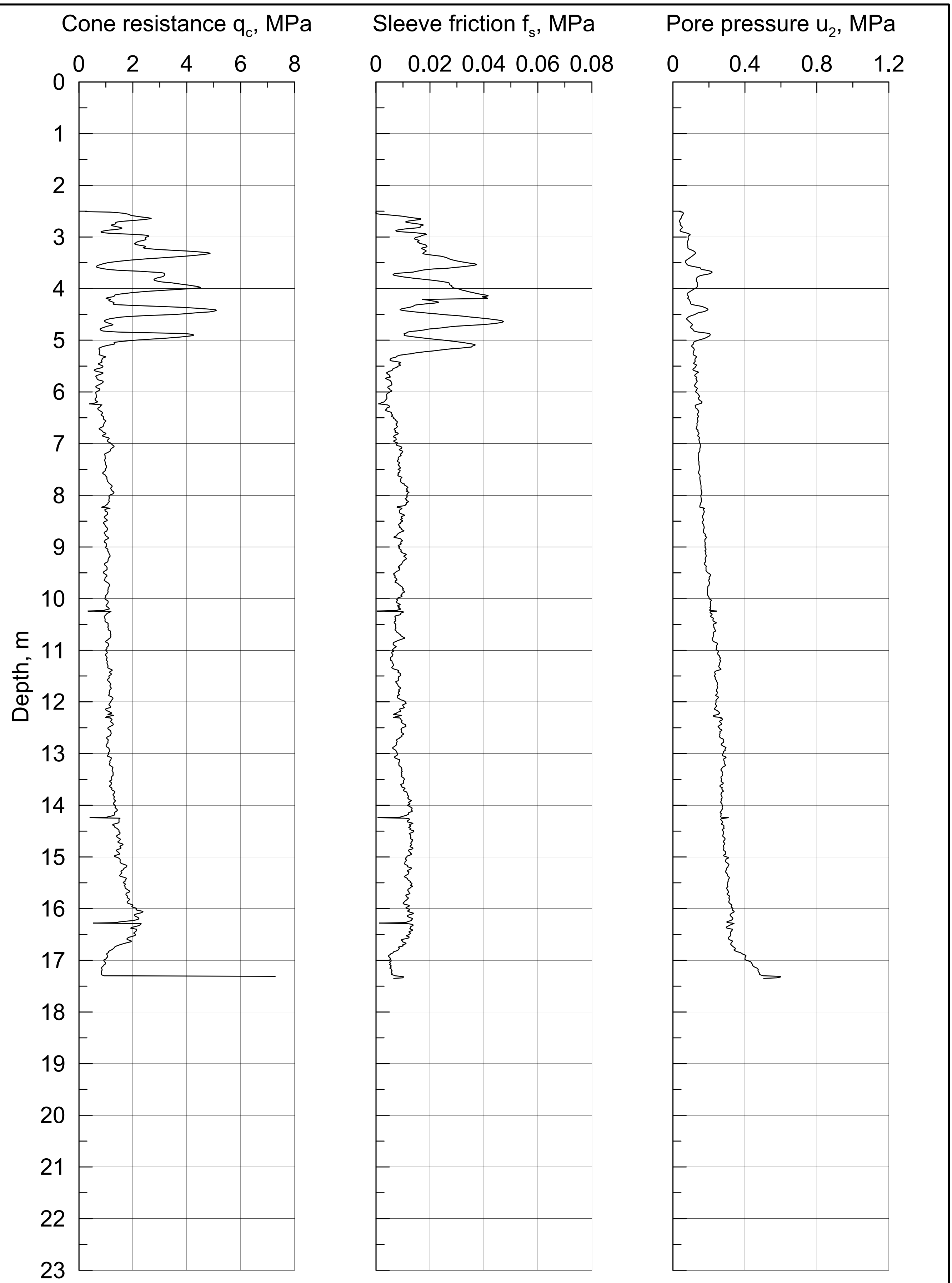
NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s, u_2 and ρ from RCPTU tests	Figure No. 08
	Date 2018-10-21 / Drawn by OyB/RCa
HALC10 **NGI Envi. Variable rate, RCPTU & Dissipation tests**	NGTS



Date/Rev.: 2015-01-21/01

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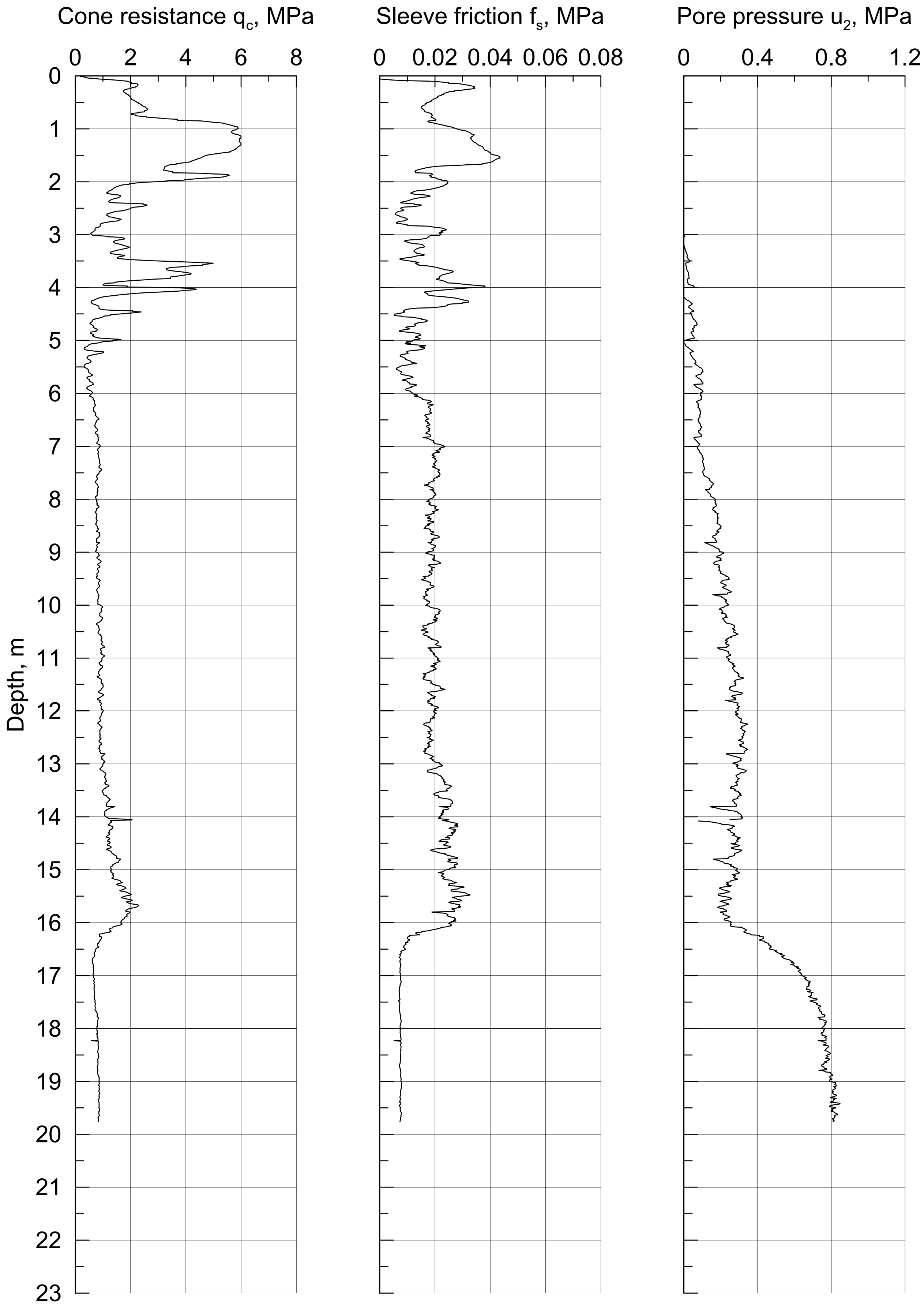
NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 09
	Date 2018-04-06 / Drawn by OyB/RCa
HALC11 **NGI Envi. Standard rate**	NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
q_c, f_s and u_2 from CPTU tests	Figure No. 10	
	Date 2018-04-06	Drawn by RCa/AGu
HALC12 Pagani. Standard rate	NGTS	

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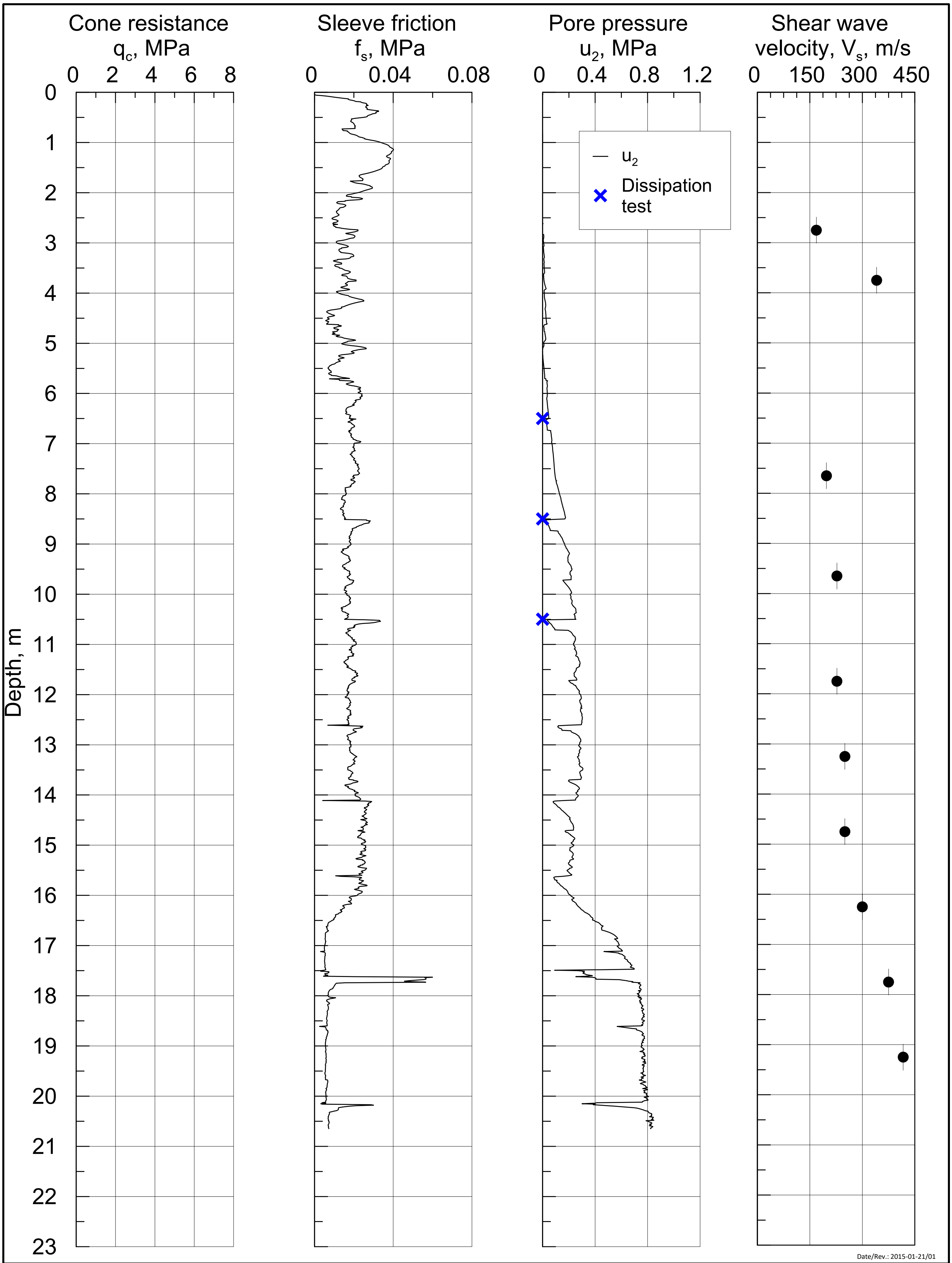

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NGTS - Halden Research Site

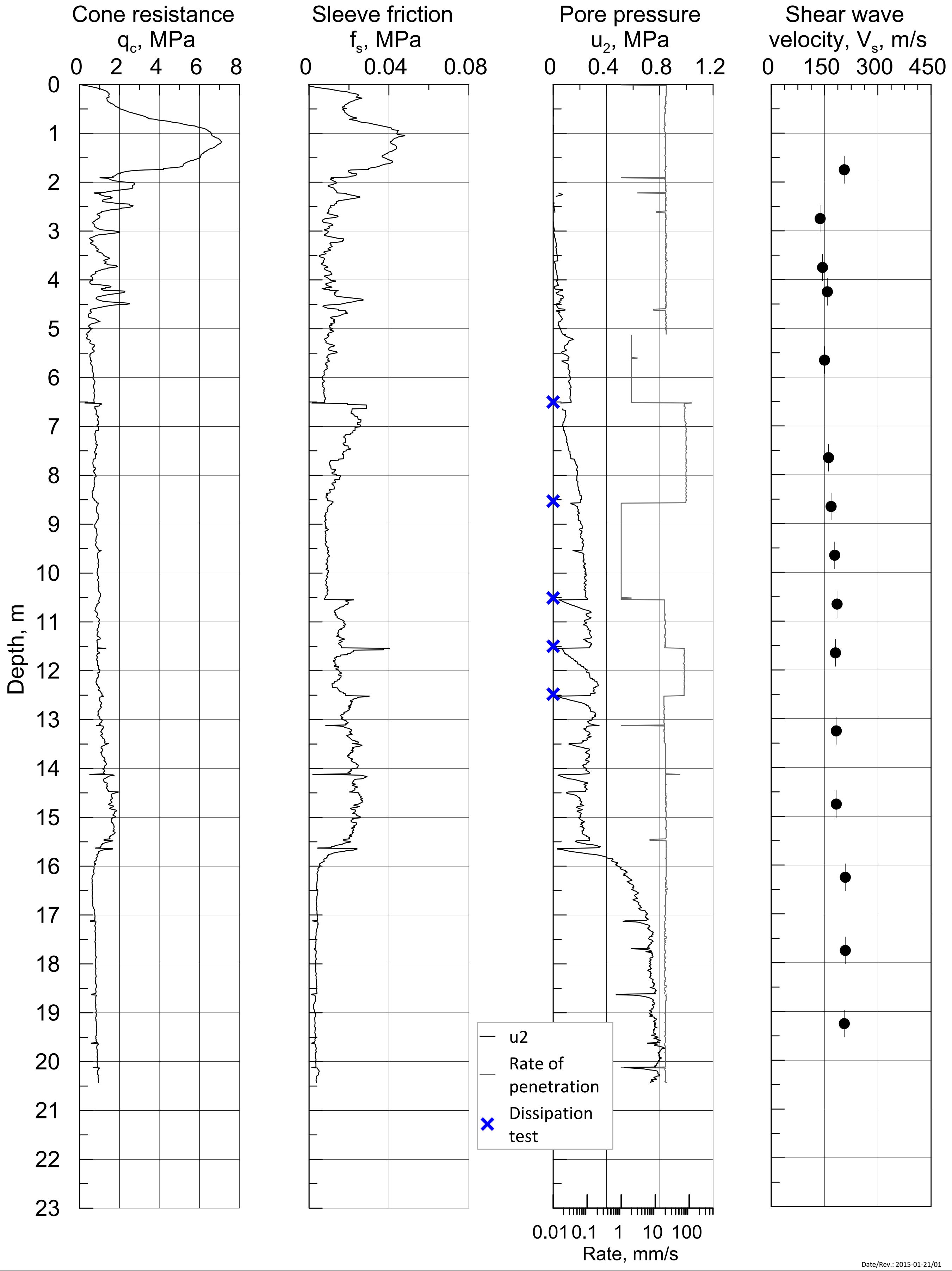
q_c, f_s, u_2 and V_s from SCPTU tests

HALC13

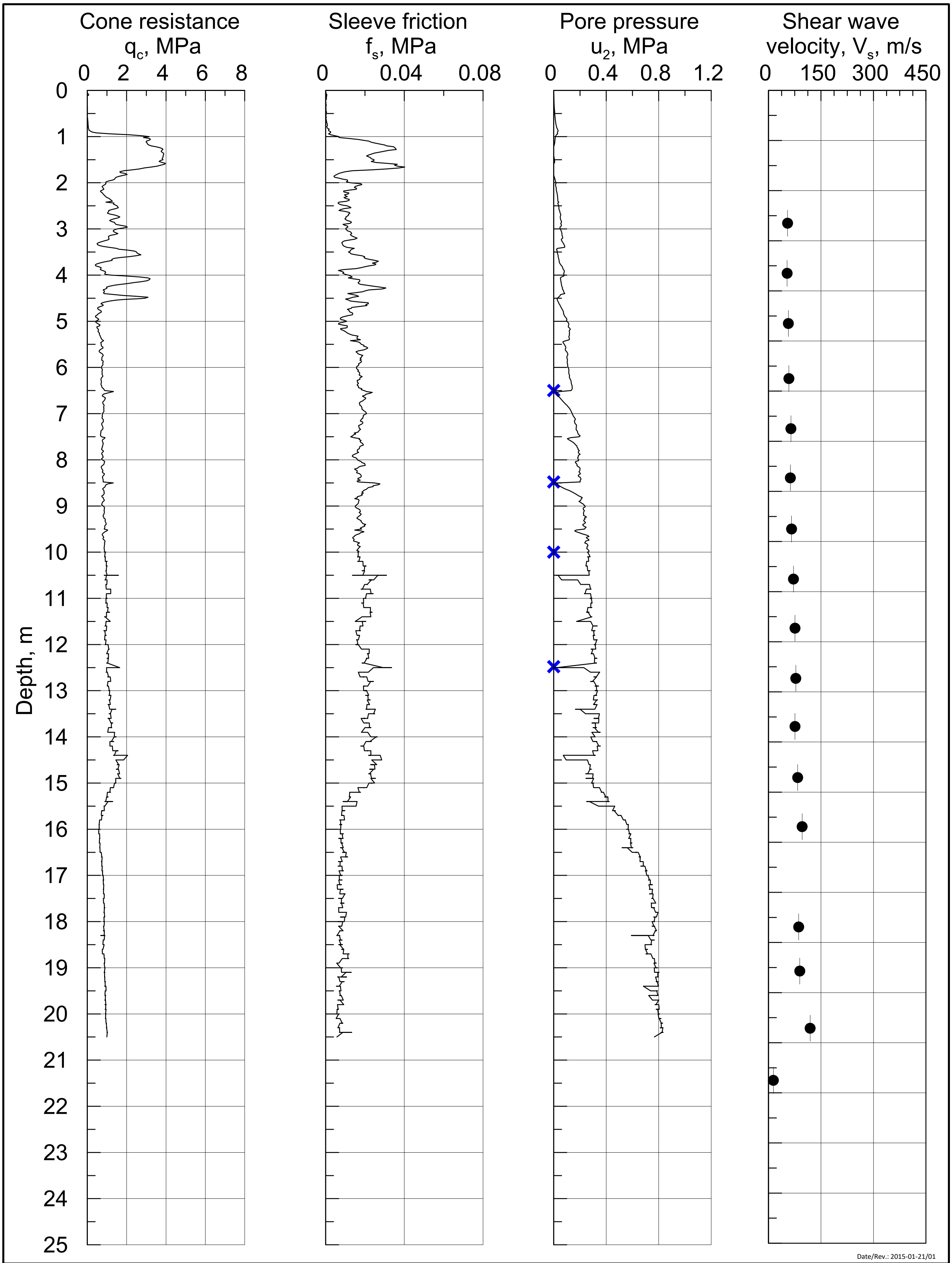
Pagani. Standard rate, SCPTU & Dissipation tests

Document No.	20160154-04-R
Figure No.	11
Date	2018-10-21
Drawn by	RCa/AGu/APP

NGTS



NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s, u_2 and V_s from SCPTU tests	Figure No. 12
	Date 2018-10-21 / Drawn by RCa/AGu/APP
HALC14 **Pagani. Variable rate, SCPTU & Dissipation tests**	NGTS



NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 20

q_c, f_s, u_2 and V_s from SCPTU tests

Date 2018-10-21

Drawn by OyB/RCa/APP

HALC22

A.P. van den Berg. Standard rate, Dissipation tests, SCPTU

NGTS

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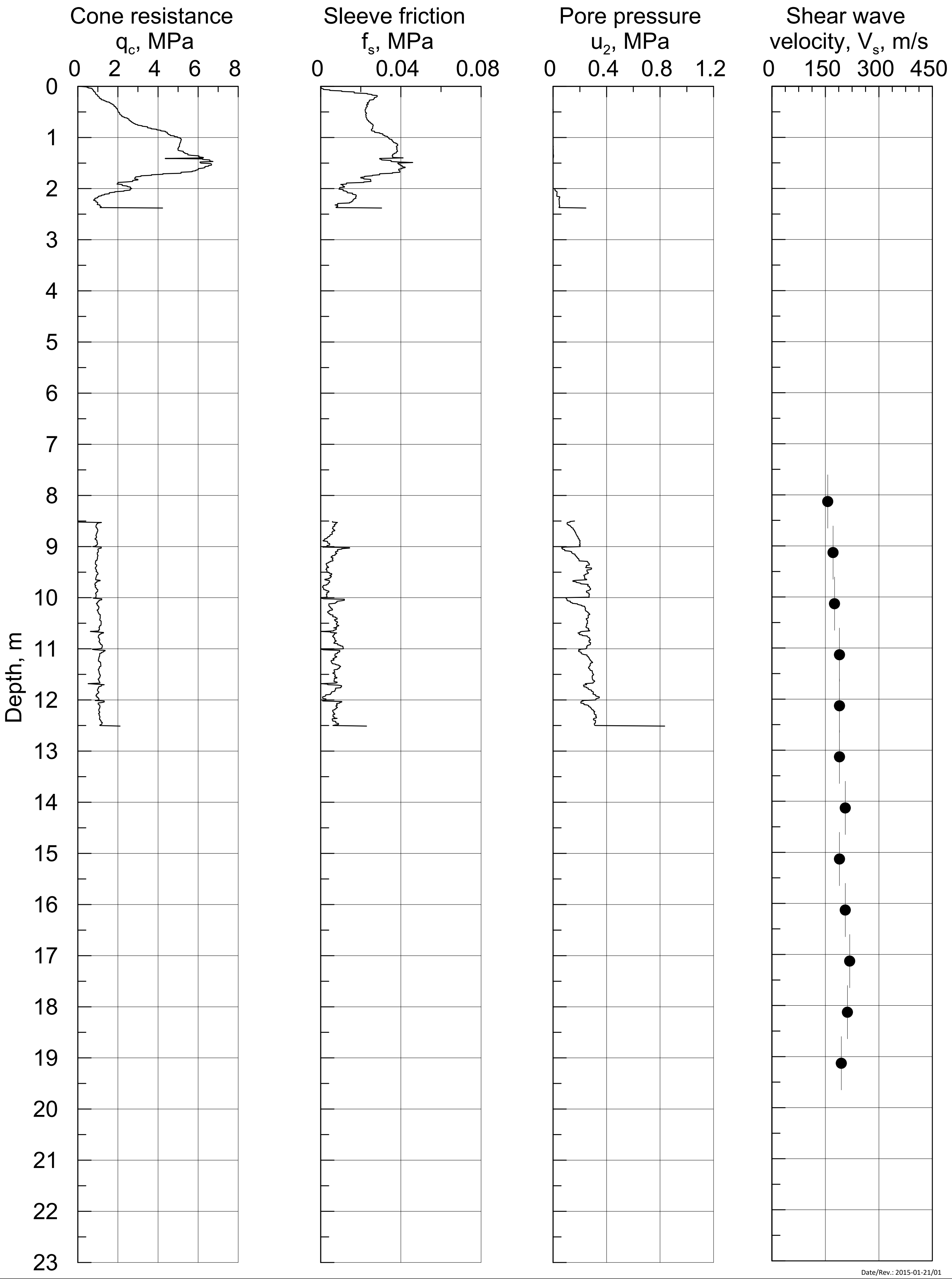

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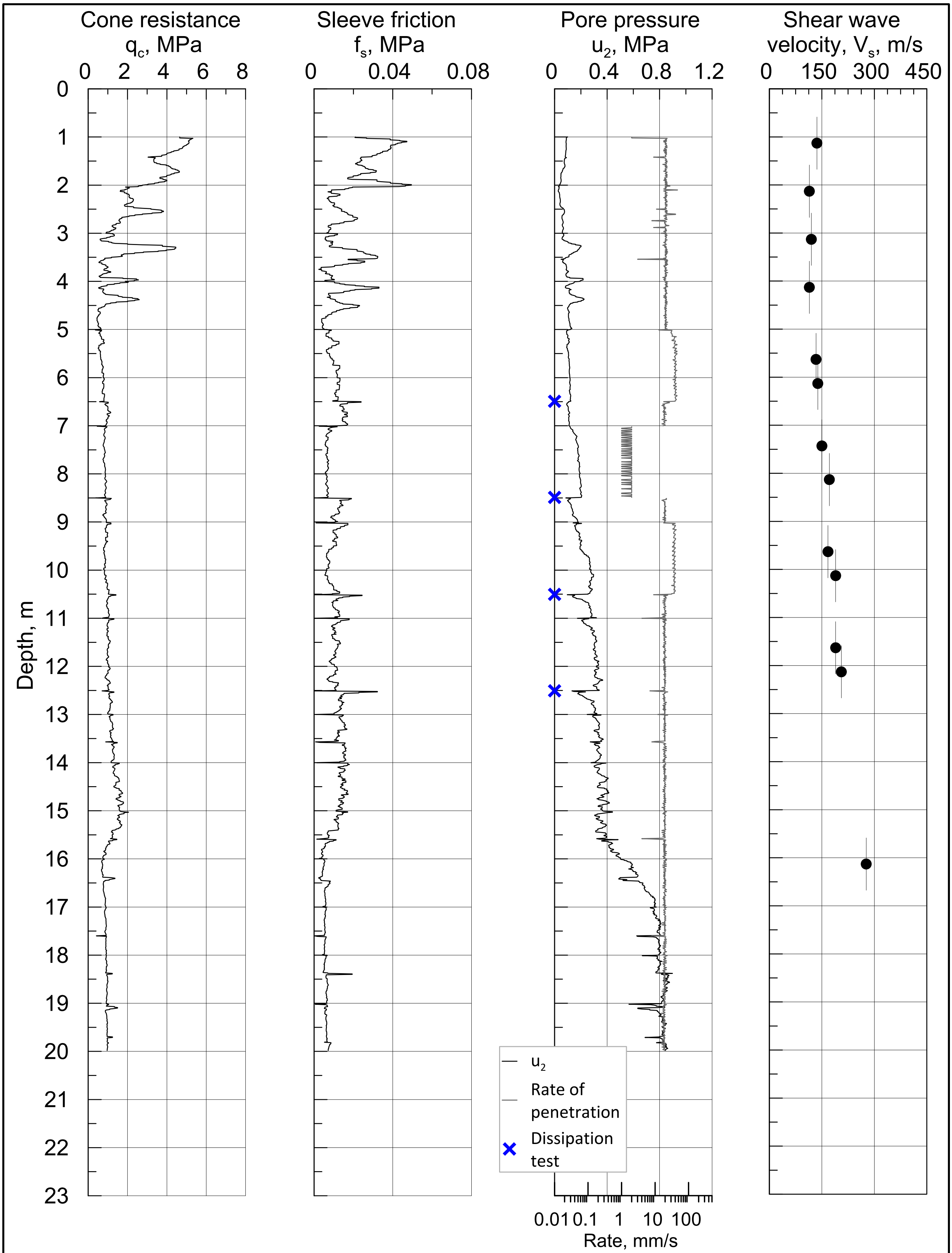
NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s, u_2 and V_s from SCPTU tests	Figure No. 14
	Date 2018-10-21 / Drawn by RCa/AGu/APP
HALC16 **NGI Geotech. Standard rate, SCPTU**	NGTS



NGTS - Halden Research Site

q_c, f_s, u_2 and V_s from SCPTU tests

HALC17
NGI Geotech. Variable rate, Dissipation tests

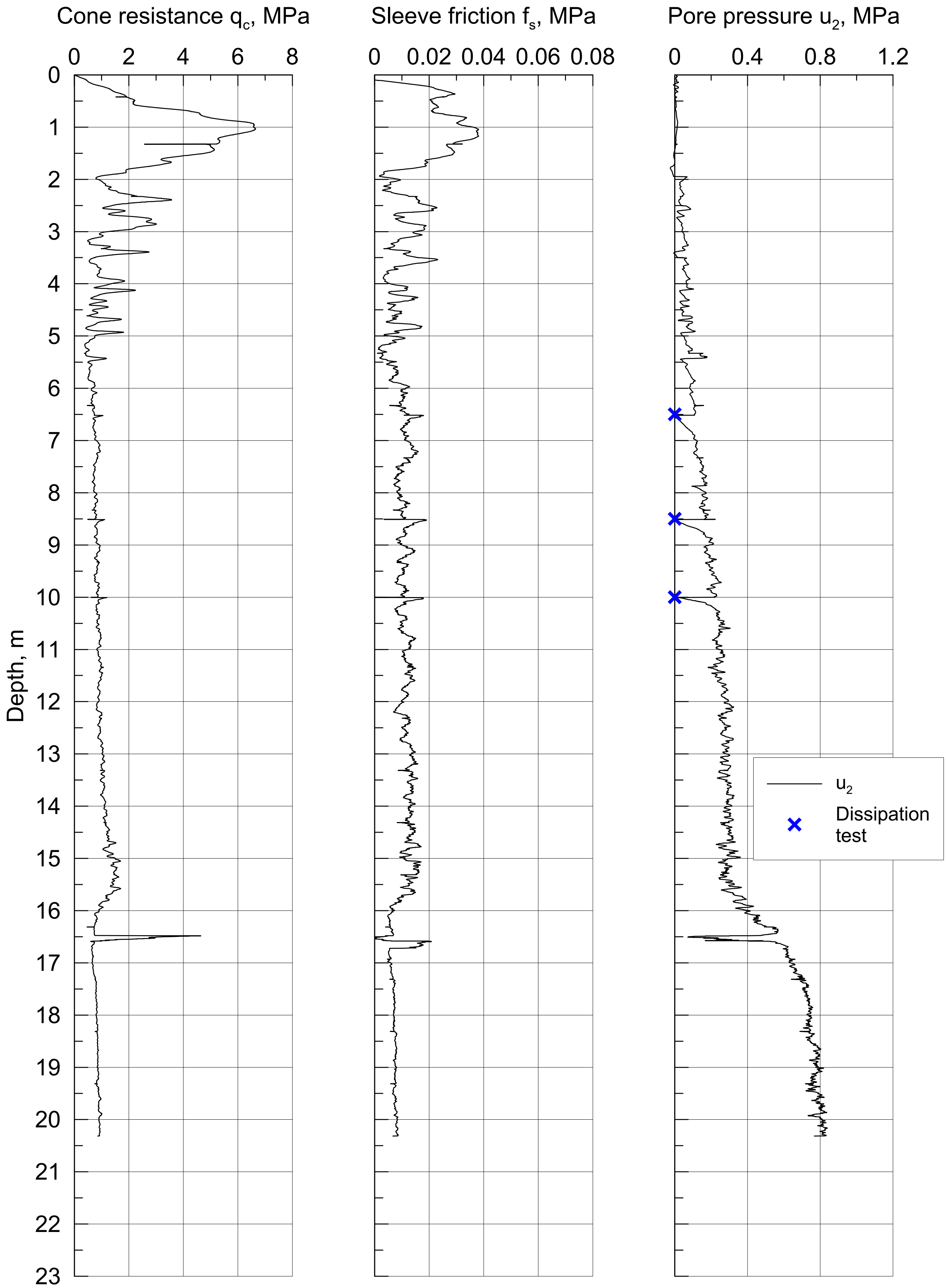
Document No.
20160154-04-R

Figure No.
15

Date
2018-10-21

Drawn by
OyB/RCa/APP

NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 16
	Date 2018-04-06 / Drawn by RCa/AGu
HALC18 **Geomil. Standard rate, Dissipation tests**	NGTS

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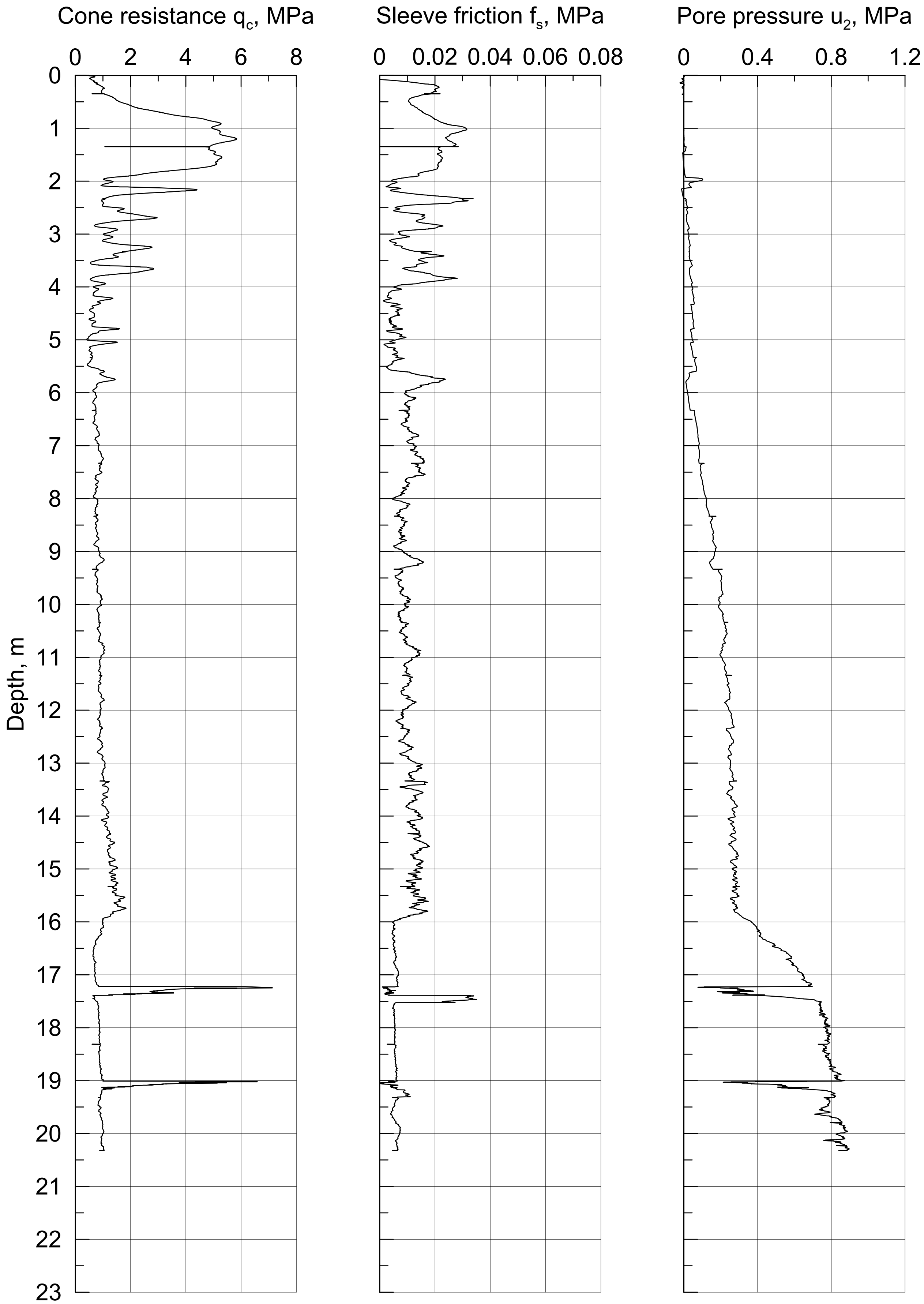

Date/Rev.: 2015-01-21/01

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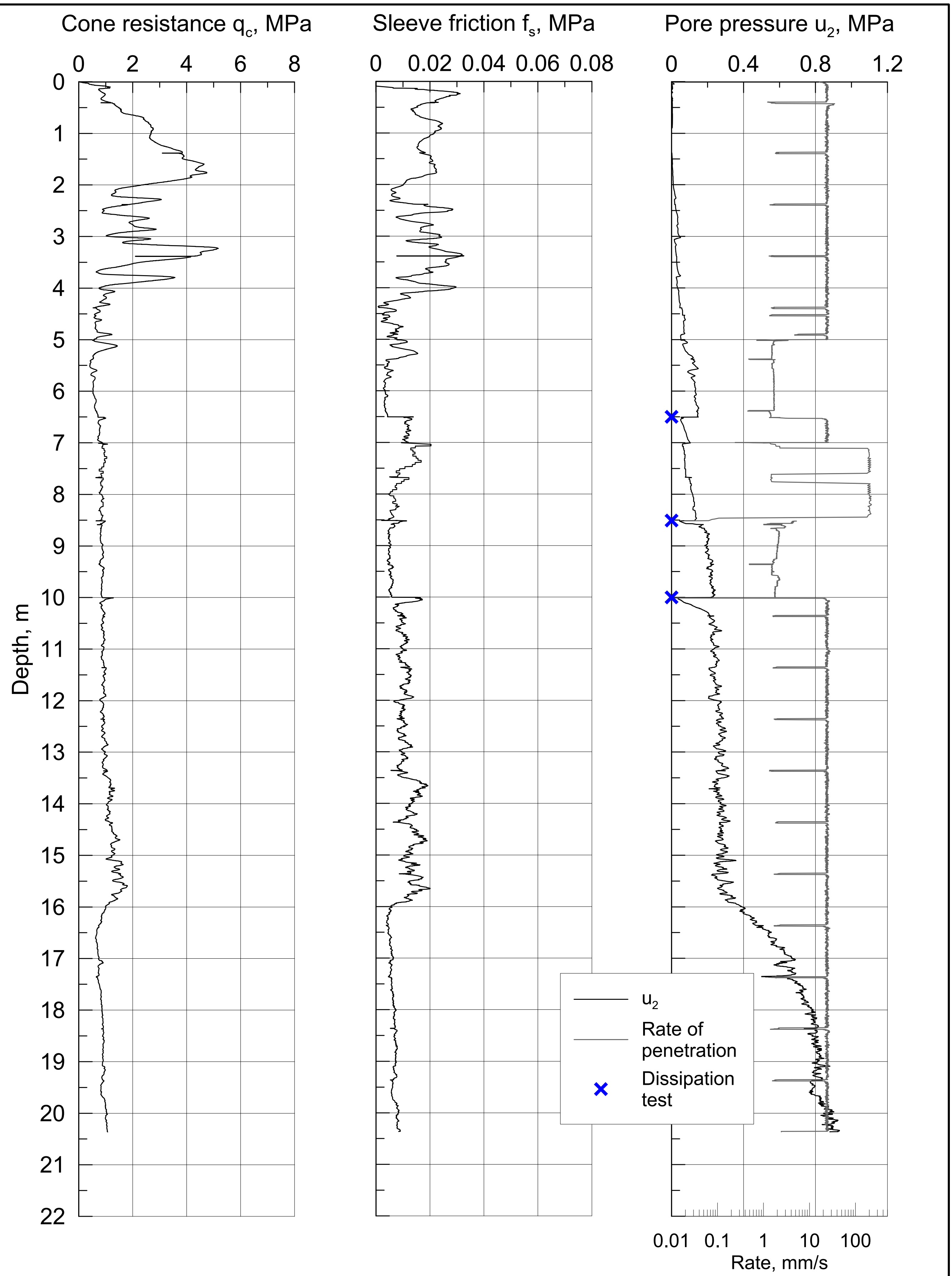
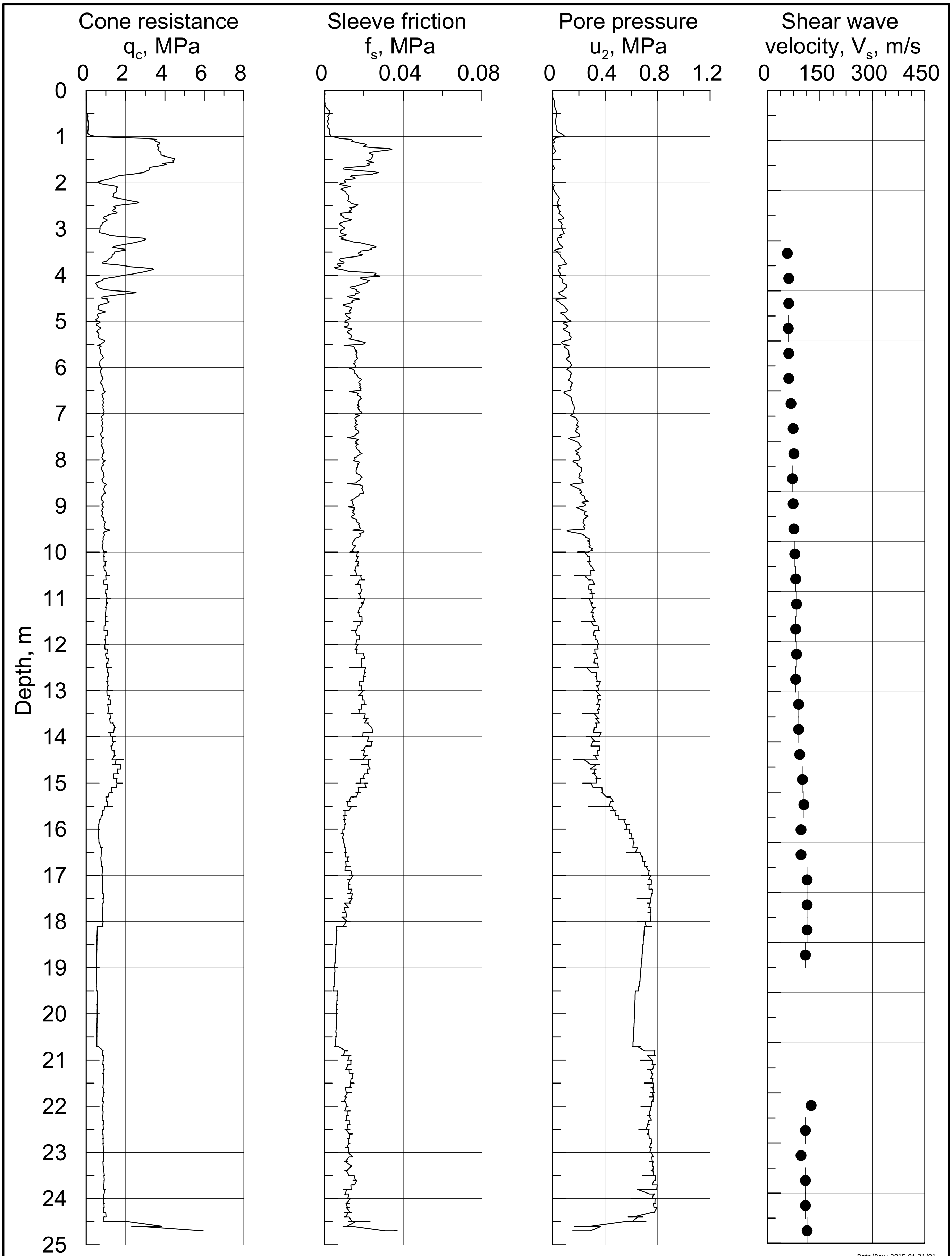
NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 17
	Date 2018-04-06 / Drawn by RCa/AGu
HALC19 **Geomil. Standard rate**	NGTS



NGTS - Halden Research Site	Document No. 20160154-04-R	
q_c, f_s and u_2 from CPTU tests	Figure No. 18	
	Date 2018-04-06	Drawn by RCa/AGu
HALC20 Geomil. Variable rate, Dissipation tests	NGTS	



Date/Rev.: 2015-01-21/01

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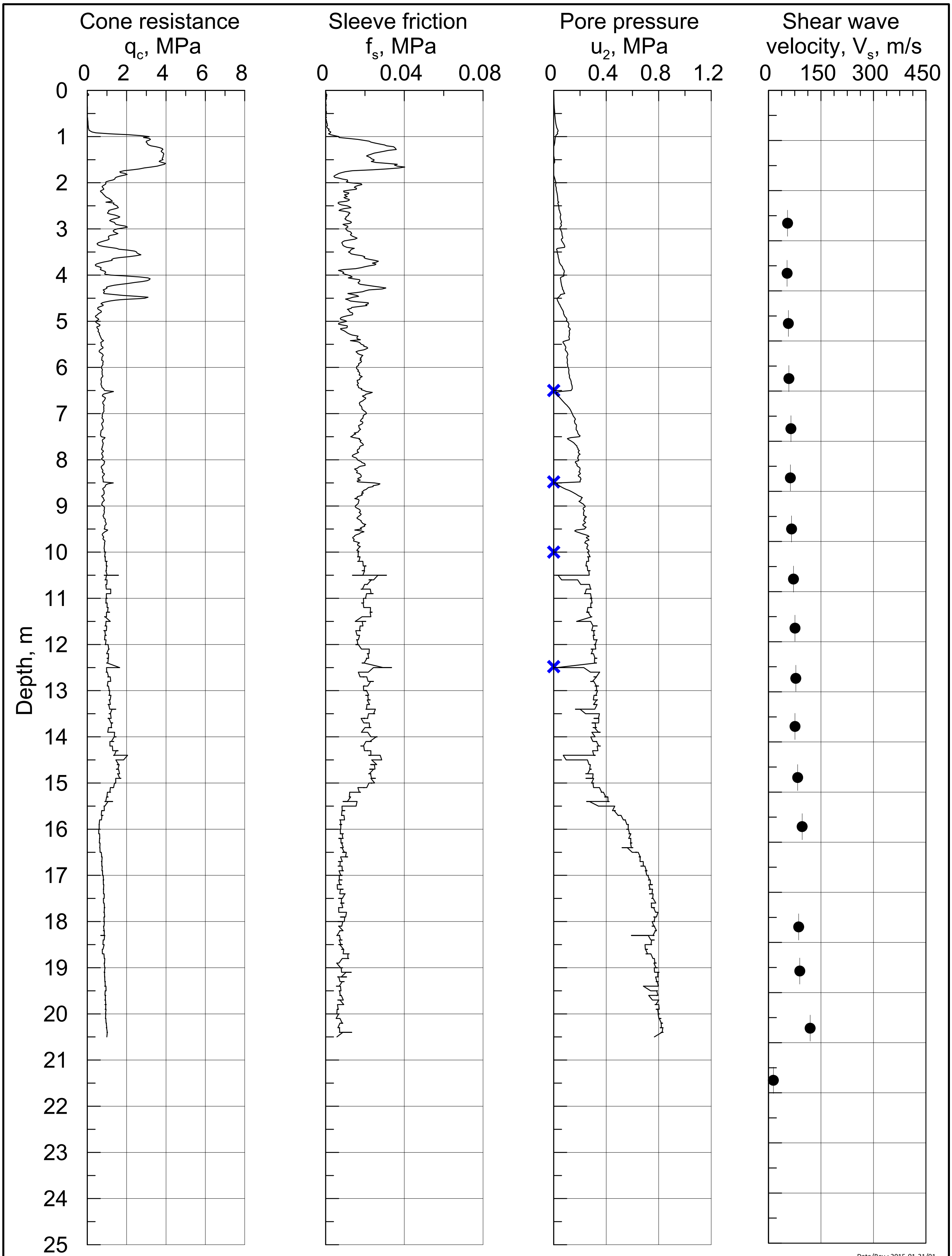
NGTS - Halden Research Site

q_c, f_s, u_2 and V_s from SCPTU tests

HALC21
A.P. van den Berg. Standard rate, SCPTU

Document No.	20160154-04-R
Figure No.	19
Date	2018-10-21
Drawn by	OyB/RCa/APP

NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

q_c, f_s, u_2 and V_s from SCPTU tests

HALC22
A.P. van den Berg. Standard rate, Dissipation tests, SCPTU

Document No.	
20160154-04-R	
Figure No. 20	
Date 2018-10-21	Drawn by OyB/RCa/APP

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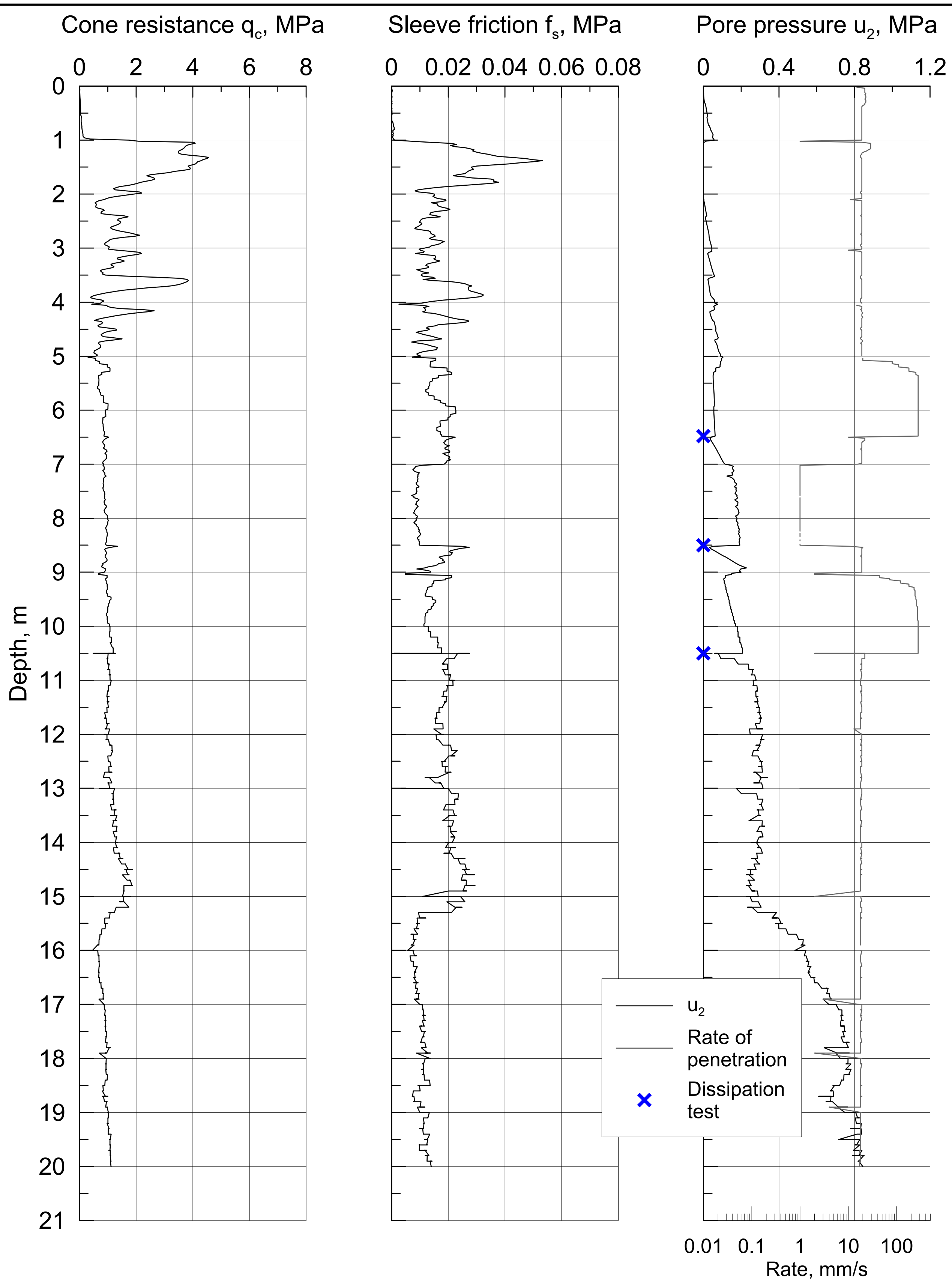

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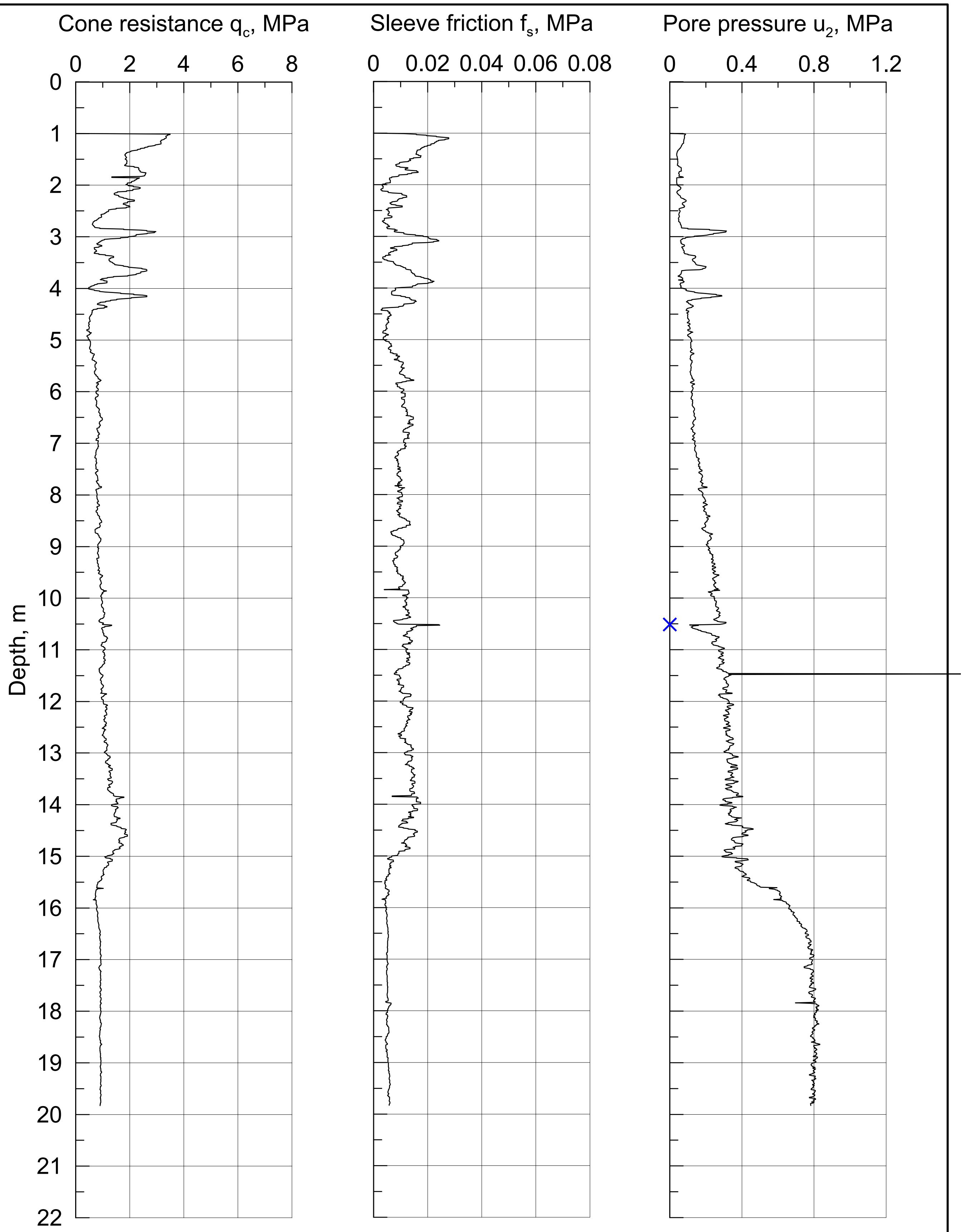
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 21
	Date 2018-04-06 / Drawn by OyB/RCa
HALC23 **A.P. van den Berg. Variable rate, Dissipation tests**	NGTS



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Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
q_c, f_s and u_2 from CPTU tests	Figure No. 22
	Date 2018-04-06 / Drawn by RCa/AGu
HALC24 **NGI Geotech. Standard rate, Dissipation tests**	NGTS

Boring ID	Measurements	TE_{maks}/TO (kPa/°)	ΔR	ΔT (°)	$ΔT*TE_{max}/TO$	Max measurement	ΔN	$Δ_{TOT}$	Relative accuracy	Quality class						Quality Class*
										A1		A2		A3		
HALC01	q_c (kPa)	-	-		-	12129	2	**2**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	-	-	36	1	**1**	**1 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	688	19	**19**	**3 %**	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC02	q_c (kPa)	-	-		-	6396	12	**12**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	-	-	41	20	**20**	**49 %**	5	10 %	15	15 %	25	15 %	Not A3
	u_2 (kPa)	-	-		-	622	14	**14**	**2 %**	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,1 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC04	q_c (kPa)	-	-		-	4281	6	**6**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	-	-	69	0	**0**	**1 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	81	8	**8**	**10 %**	10	2 %	25	3 %	50	5 %	Not A3
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,2 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC05	q_c (kPa)	-	-		-	16575	14	**14**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	-	-	28	1	**1**	**4 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	1178	3	**3**	**0 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,1**	**0,4 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC06	q_c (kPa)	-	-		-	32841	4	**4**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	-	-	35	1	**1**	**2 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	810	1	**1**	**0 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,1 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC07	q_c (kPa)	-	-		-	4723	2	**2**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	5,0	-	33	0	**0**	**1 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	326	5	**5**	**2 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,3 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC08	q_c (kPa)	-	-		-	3921	6	**6**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	-	-	5,0	-	31	0	**0**	**1 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	318	8	**8**	**2 %**	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,3 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1
HALC10	q_c (kPa)	-	-		-	3478	120,0	**120**	**3 %**	35	5 %	100	5 %	200	5 %	A3
	fs (kPa)	-	-	7,5	-	21	0,7	**1**	**3 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	136	9,8	**10**	**7 %**	10	2 %	25	3 %	50	5 %	Not A3
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,1 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**10**	**-**	20		20		50		A1

$$\Delta_{TOT} = \Delta N + \Delta R + \Delta T(TE_{maks}/TO)$$

Relative accuracy = Δ_{TOT} / Max measurement

Δ_{TOT}: Measurement accuracy (kPa)

From raw data file:

ΔN: Difference between zero measurements (kPa)

ΔT: Change of temperature (°)

From calibration certificate:

ΔR: Resolution (kPa)

TE_{max}: Max. temperature effect when not loaded (kPa)

TO: Temperature range (°)

The accuracy of the measurements must be higher than the maximum specified value in Table 5.2 in NGF-publication no. 5

*Class in red indicate that the quality class assigned is just based on ΔN.

NGTS - Halden Research Site	Report no. 20160154-04-R	Figure no. G1	
	Drawn by APP	Date 20.09.2018	
CPTU quality class according to Norwegian Geotechnical Society publication no. 5	Checked VG	NGTS	
	Approved APP		

Boring ID	Measurements	TE_{maks}/TO (kPa/°)	ΔR	ΔT (°)	$\Delta T*TE_{max}/TO$	Max measurement	ΔN	Δ_{TOT}	Relative accuracy	Quality class						Quality Class*
										A1		A2		A3		
HALC11	q_c (kPa)	-	-		-	14003	164,0	164	1 %	35	5 %	100	5 %	200	5 %	A3
	fs (kPa)	-	-	14,5	-	47	0,8	1	2 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	-	-		-	599	8,2	8	1 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	0,1	0,4 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	10	-	20		20		50		A1
HALC12	q_c (kPa)	11,75	5,20		170,4	6000	20,8	196	3 %	35	5 %	100	5 %	200	5 %	A3
	fs (kPa)	0,11	0,03	14,5	1,7	44	0,2	2	4 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,10	0,09		1,5	847	0,5	2	0 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	10	-	20		20		50		A1
HALC13	q_c (kPa)	11,75	5,20		170,4	11030	46,8	222	2,0 %	35	5 %	100	5 %	200	5 %	Not A3
	fs (kPa)	0,11	0,03	14,5	1,7	60	0,5	2,2	3,7 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,10	0,09		1,5	848	0,9	2,5	0,3 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	10	-	20		20		50		A1
HALC14	q_c (kPa)	11,75	5,20		152,8	7090	104,0	262	3,7 %	35	5 %	100	5 %	200	5 %	Not A3
	fs (kPa)	0,11	0,03	13,0	1,5	48	0,8	2,3	4,8 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,10	0,09		1,3	835	2,3	3,7	0,4 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-	-	-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	10	-	20		20		50		A1
HALC15	q_c (kPa)	0,43	0,48		6,0	5277	1,0	7	0,1 %	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	0,01	0,01	14,0	0,21	45	0,2	0,4	0,9 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,03	0,02		0,48	354	0,5	1,0	0,3 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	10	-	20		20		50		A1
HALC16	q_c (kPa)	0,43	0,48		5,4	6737	12,9	19	0,3 %	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	0,01	0,01	12,5	0,2	46	0,1	0,3	0,6 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,03	0,02		0,4	835	3,7	4,2	0,5 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	10	-	20		20		50		A1
HALC17	q_c (kPa)	0,77	0,90		-1,92	5320	33,2	36	0,7 %	35	5 %	100	5 %	200	5 %	A2
	fs (kPa)	0,01	0,01	-2,5	-0,03	50	0,3	0,3	0,7 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,06	0,02		-0,15	898	8,3	8,5	0,9 %	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	0,01	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	10	-	20		20		50		A1
HALC18	q_c (kPa)	3,32	0,01		39,8	6651	180,8	221	3 %	35	5 %	100	5 %	200	5 %	Not A3
	fs (kPa)	0,043	0,00	12,0	0,5	38	0,0	0,5	1 %	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,89	0,00		10,7	841	8,7	19,4	2 %	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	-	-	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	0,0	0,0 %	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	9	-	20		20		50		A1

$$\Delta_{TOT} = \Delta N + \Delta R + \Delta T(TE_{maks}/TO)$$

Relative accuracy = Δ_{TOT} / Max measurement

Δ_{TOT}: Measurement accuracy (kPa)

From raw data file:

ΔN: Difference between zero measurements (kPa)

ΔT: Change of temperature (°)

From calibration certificate:

ΔR: Resolution (kPa)

TE_{max}: Max. temperature effect when not loaded (kPa)

TO: Temperature range (°)

The accuracy of the measurements must be higher than the maximum specified value in Table 5.2 in NGF-publication no. 5

*Class in red indicate that the quality class assigned is just based on ΔN.

NGTS - Halden Research Site

CPTU quality class according to Norwegian Geotechnical Society publication no. 5

Report no.	Figure no.
20160154-04-R	G2
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Boring ID	Measurements	TE_{maks}/TO (kPa/°)	ΔR	ΔT (°)	$ΔT*TE_{max}/TO$	Max measurement	ΔN	$Δ_{TOT}$	Relative accuracy	Quality class A1		A2		A3		Quality Class*
HALC19	q_c (kPa)	3,32	0,01	12,0	39,8	12233	27,1	**67**	**1 %**	35	5 %	100	5 %	200	5 %	A2
	fs (kPa)	0,043	0,00		0,5	35	0,0	**0,5**	**1 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,89	0,00		10,7	898	24,2	**34,9**	**4 %**	10	2 %	25	3 %	50	5 %	A3
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,0 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**17**	**-**	20		20		50		A1
HALC20	q_c (kPa)	3,32	0,01	12,0	39,8	5174	15,0	**55**	**1 %**	35	5 %	100	5 %	200	5 %	A2
	fs (kPa)	0,043	0,00		0,5	33	0,1	**0,6**	**2 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,89	0,00		10,7	934	0,5	**11,2**	**1 %**	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,0 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**38**	**-**	20		20		50		A3
HALC21	q_c (kPa)	2,6667	-	-4,0	-10,67	10914	20,8	**31**	**0 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	0,0333	-		-0,13	37	1,9	**2**	**6 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,8333	-		-3,33	797	7,7	**11**	**1 %**	10	2 %	25	3 %	50	5 %	A2
	Tilt (°)	-	-	-	-	-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-	-	-	-	**0,0**	**0,1 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-	-	-	-	**100**	**-**	20		20		50		Not A3
HALC22	q_c (kPa)	2,6667	-	-4,5	-12,00	3976	12,1	**24**	**0,6 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	0,0333	-		-0,15	40	0,4	**1**	**1,4 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,8333	-		-3,75	833	0,1	**4**	**0,5 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	**0,0**	**0,1 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	**100**	**-**	20		20		50		Not A3
HALC23	q_c (kPa)	2,6667	-	-4,5	-12,00	4552	55,2	**67**	**1,5 %**	35	5 %	100	5 %	200	5 %	A2
	fs (kPa)	0,0333	-		-0,15	53	0,6	**1**	**1,4 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,8333	-		-3,75	851	4,3	**8**	**0,9 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	**0,0**	**0,0 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	**100**	**-**	20		20		50		Not A3
HALC24	q_c (kPa)	0,7698	0,899	9,0	6,93	25023	8,9	**17**	**0,1 %**	35	5 %	100	5 %	200	5 %	A1
	fs (kPa)	0,0103	0,01		0,09	28	0,0	**0,1**	**0,4 %**	5	10 %	15	15 %	25	15 %	A1
	u_2 (kPa)	0,0602	0,022		0,54	1717	7,4	**8,0**	**0,5 %**	10	2 %	25	3 %	50	5 %	A1
	Tilt (°)	-	-	-		-	-	**-**	**-**	2		2		5		No data in calibration sheet
	Penetration-length (m)	-	-	-		-	-	**0,0**	**0,0 %**	0,1	1 %	0,1	1 %	0,2	1 %	A1
	Distance between measurements (mm)	-	-	-		-	-	**10**	**-**	20		20		50		A1

$$\Delta_{TOT} = \Delta N + \Delta R + \Delta T(TE_{maks}/TO)$$

Relative accuracy = Δ_{TOT} */ Max measurement*

Δ_{TOT}: Measurement accuracy (kPa)

From raw data file:

ΔN: Difference between zero measurements (kPa)

ΔT: Change of temperature (°)

From calibration certificate:

ΔR: Resolution (kPa)

TE_{max}: Max. temperature effect when not loaded (kPa)

TO: Temperature range (°)

The accuracy of the measurements must be higher than the maximum specified value in Table 5.2 in NGF-publication no. 5

*Class in red indicate that the quality class does not include ΔR.

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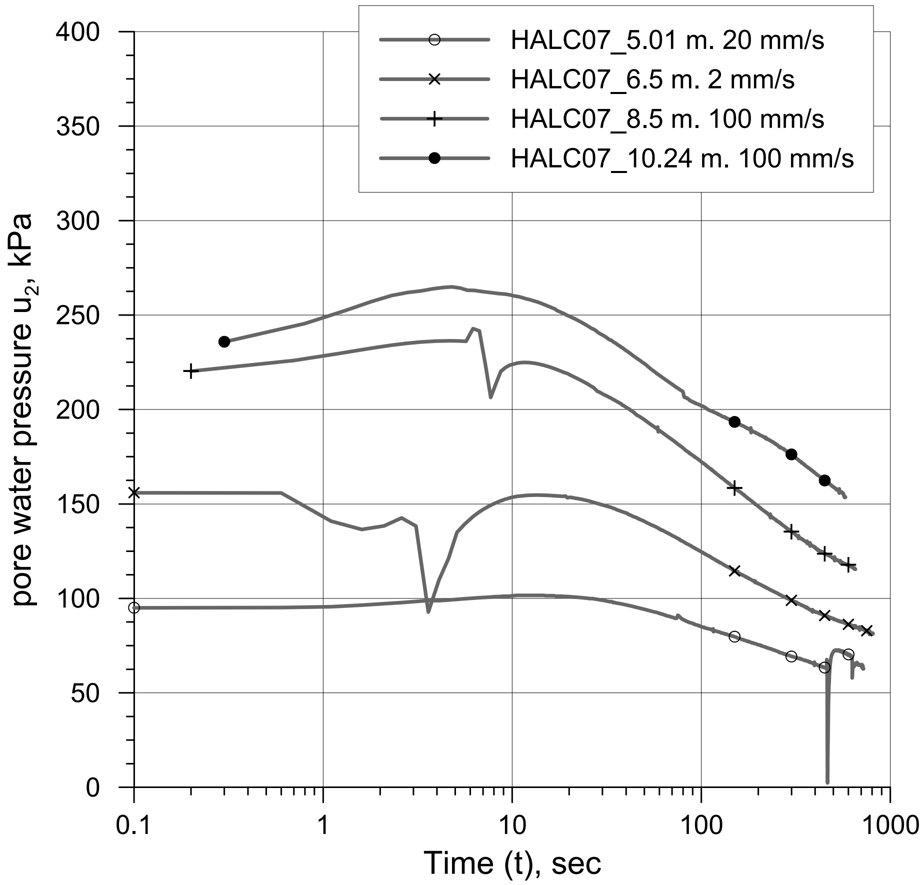
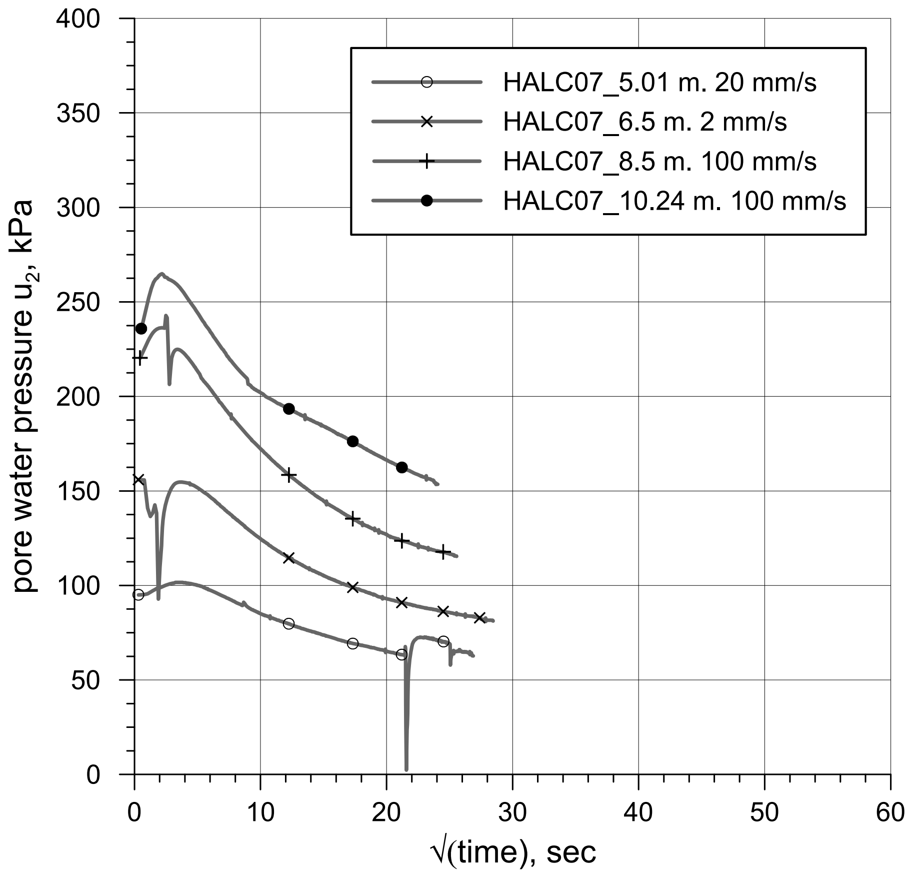
CPTU quality class according to Norwegian Geotechnical Society publication no. 5	Checked VG	NGTS
	Approved APP	

Appendix H

DISSIPATION TEST RESULTS





Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Dissipation tests HALC07	Figure No. 1
	Date 2018-03-26 — Drawn by RCa

NGTS

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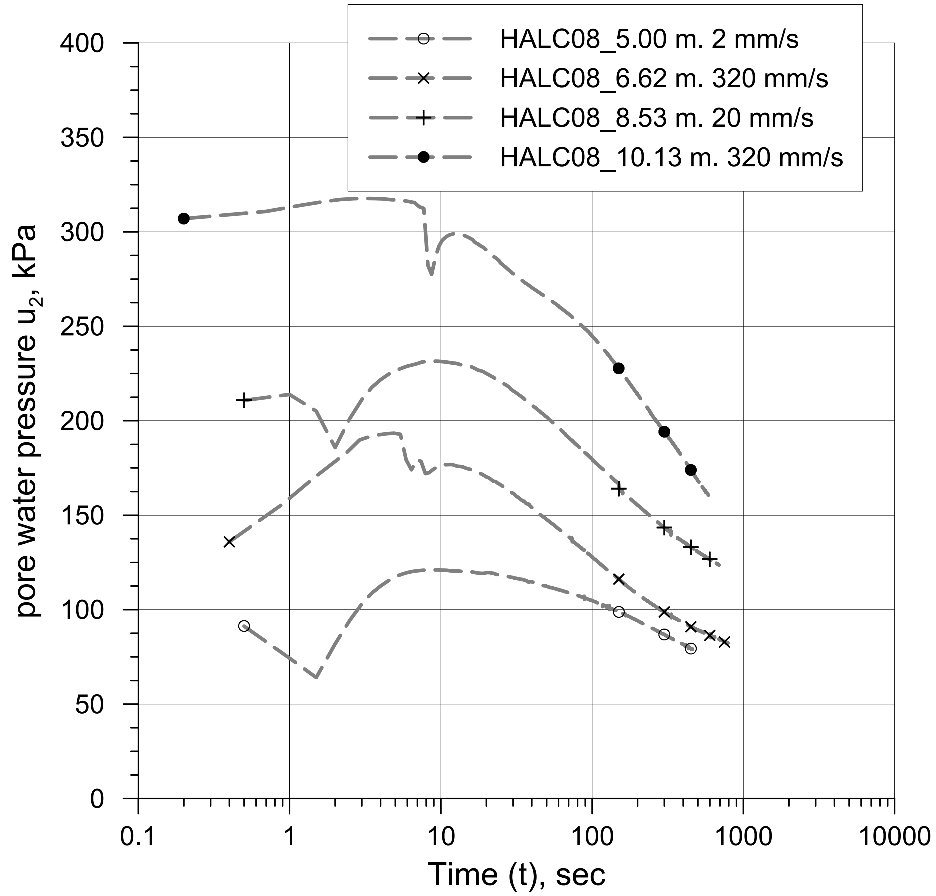

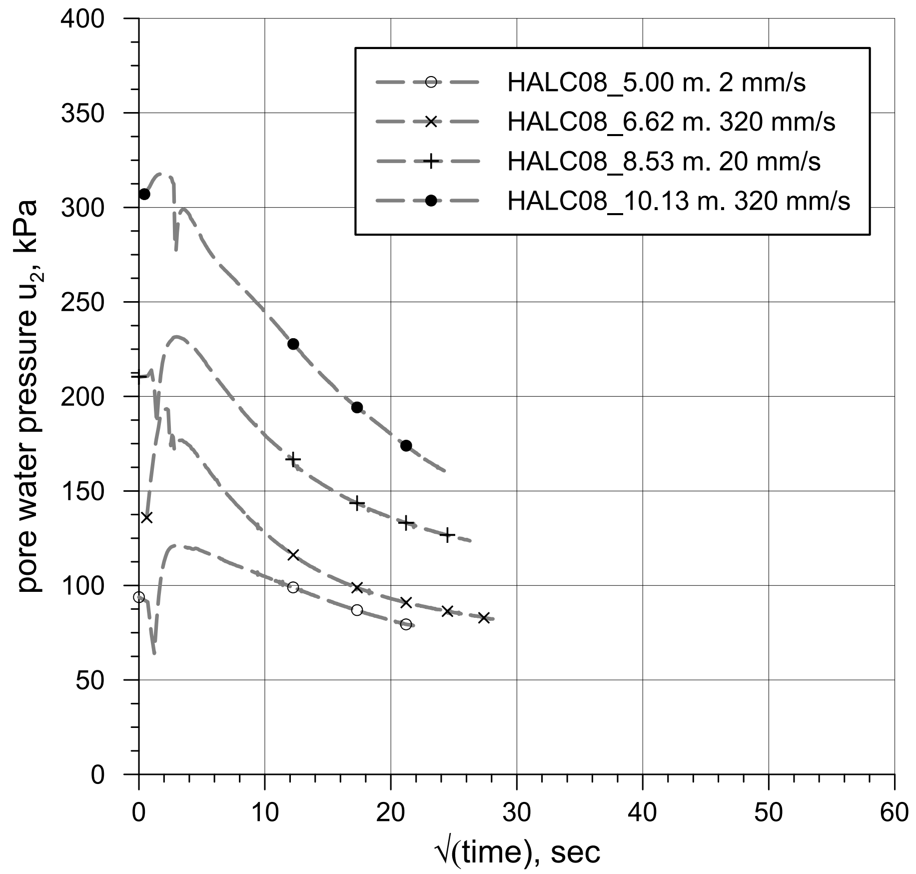

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Dissipation tests HALC08	Figure No. 2	
	Date 2018-03-26	Drawn by RCa
	NGTS	

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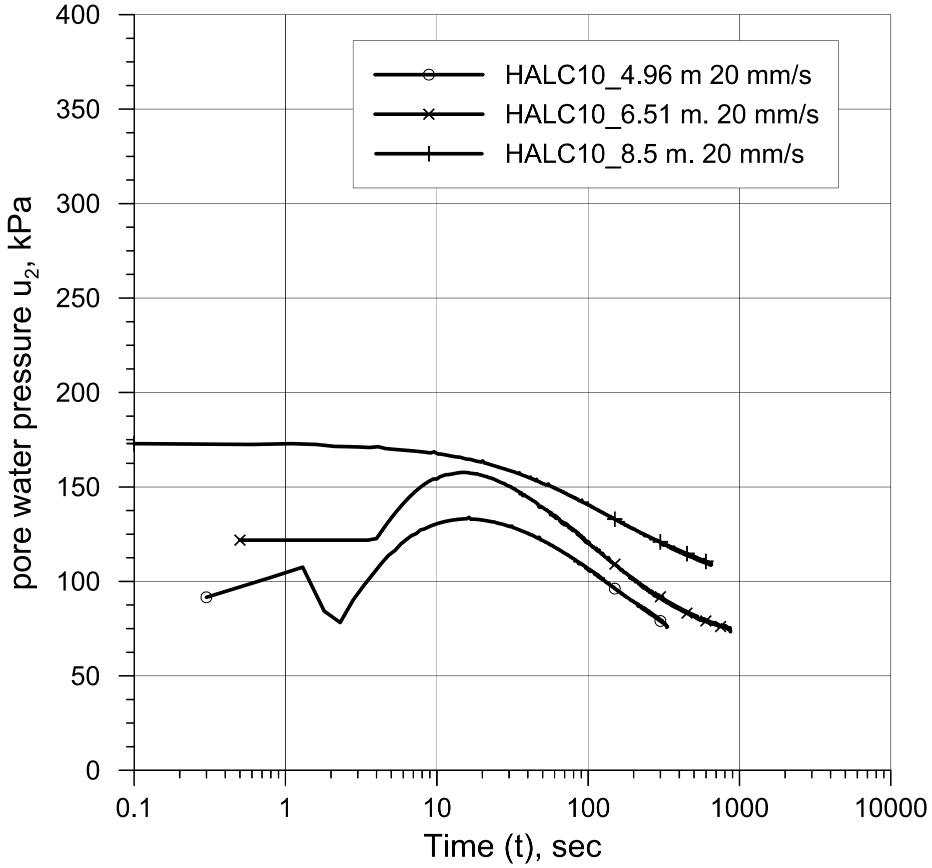

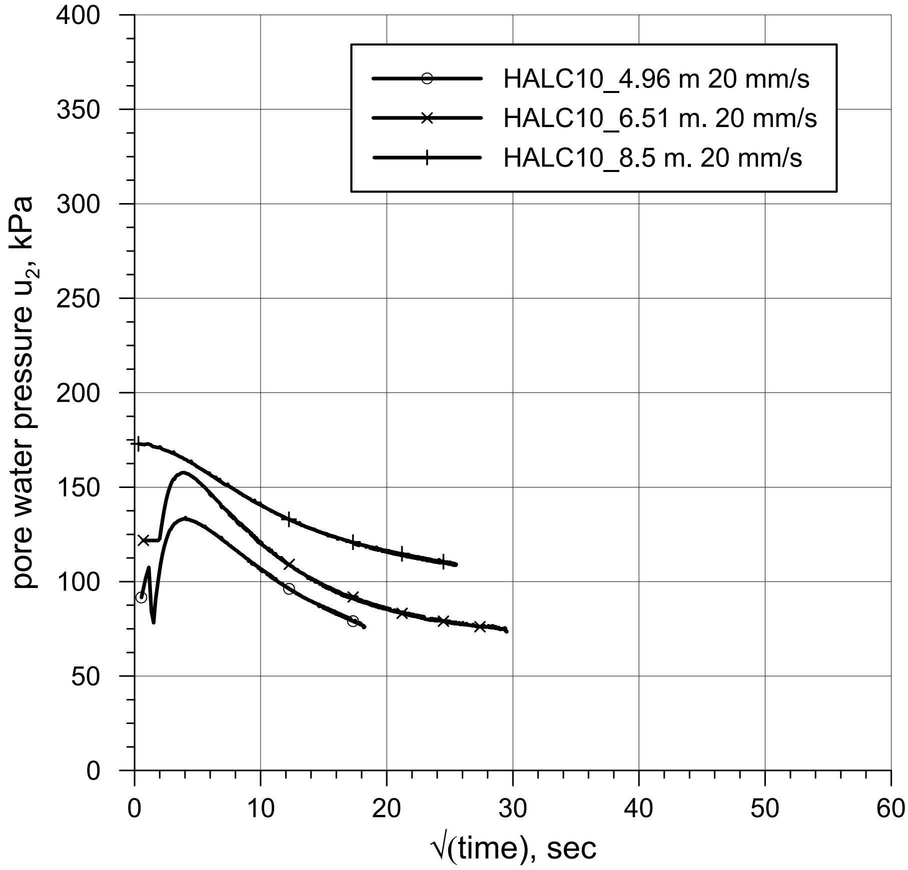

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Dissipation tests HALC10	Figure No. 3
	Date 2018-03-26 / Drawn by RCa
	NGTS

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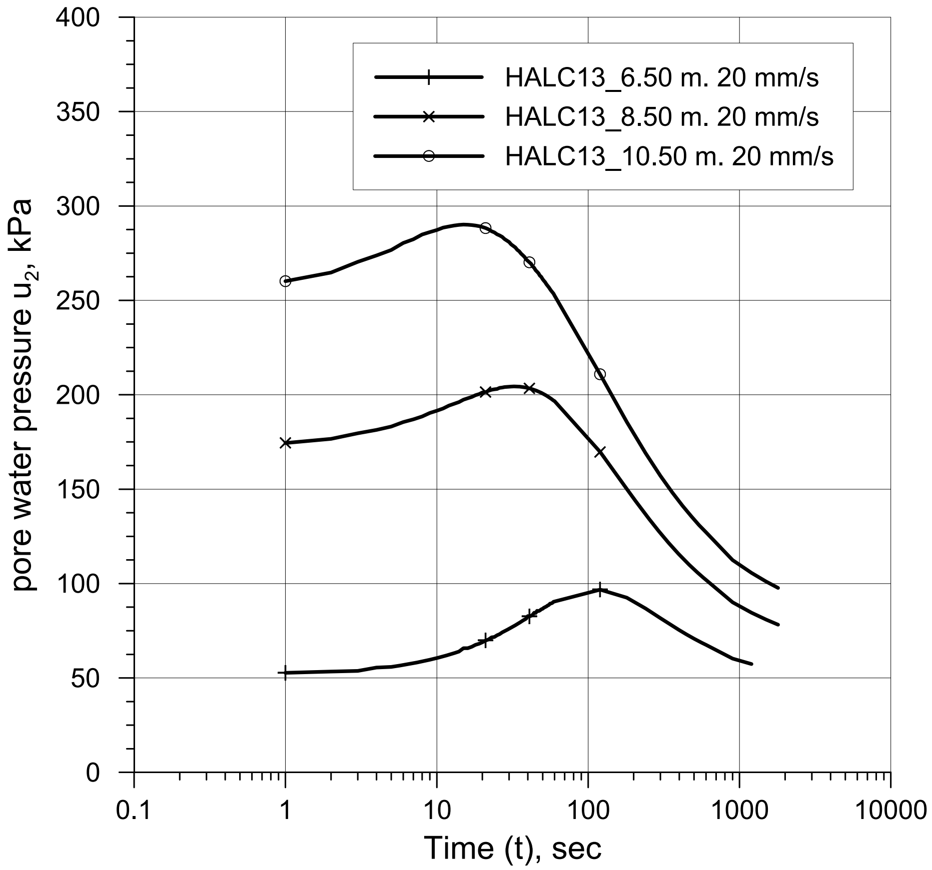

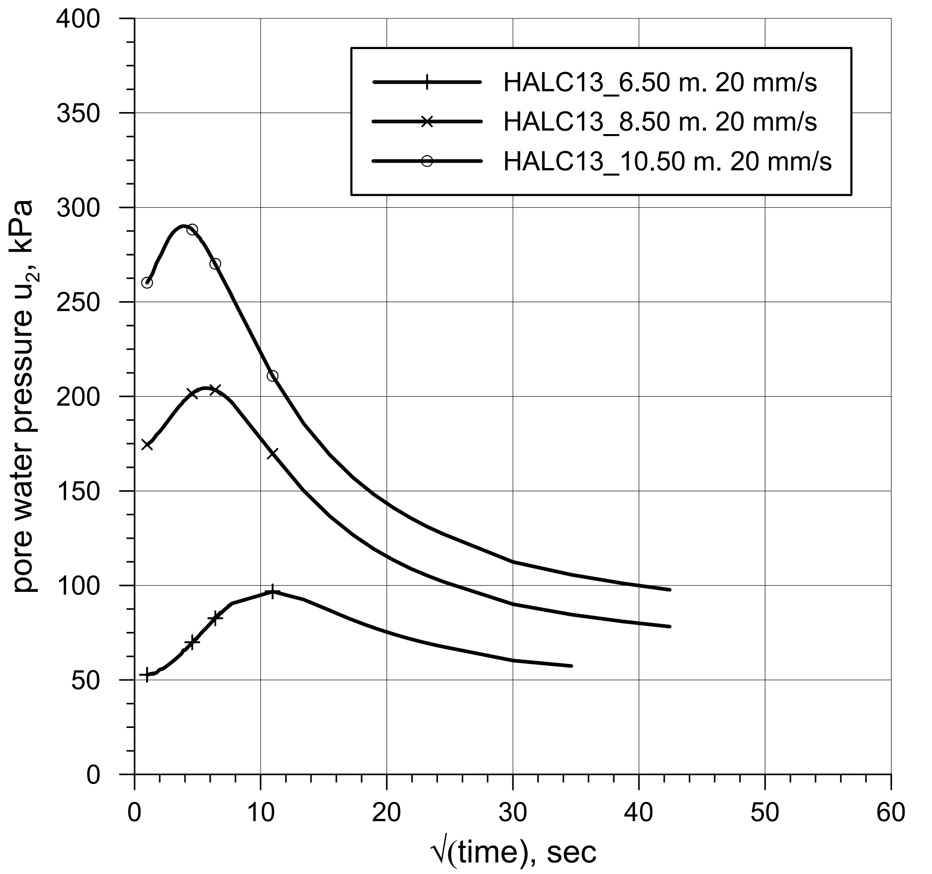

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Dissipation tests

HALC13

Document No. 20160154-04-R

Figure No. 4

Date 2018-03-26

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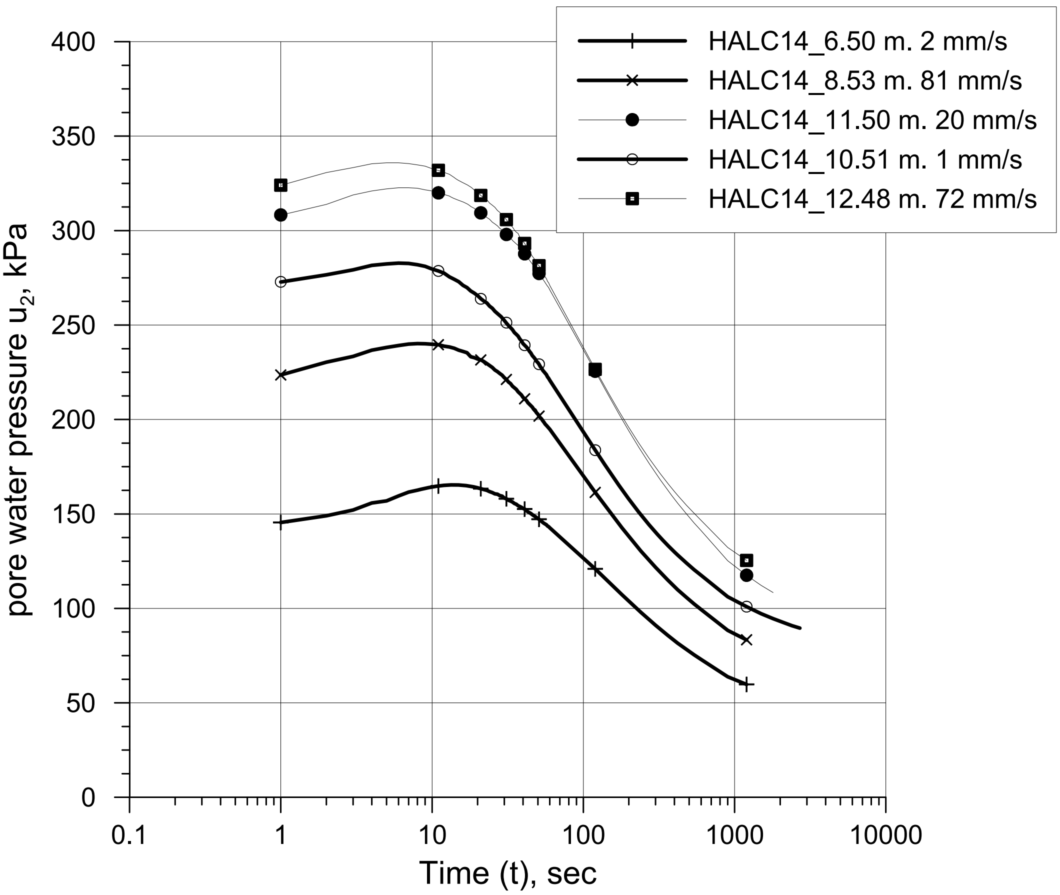

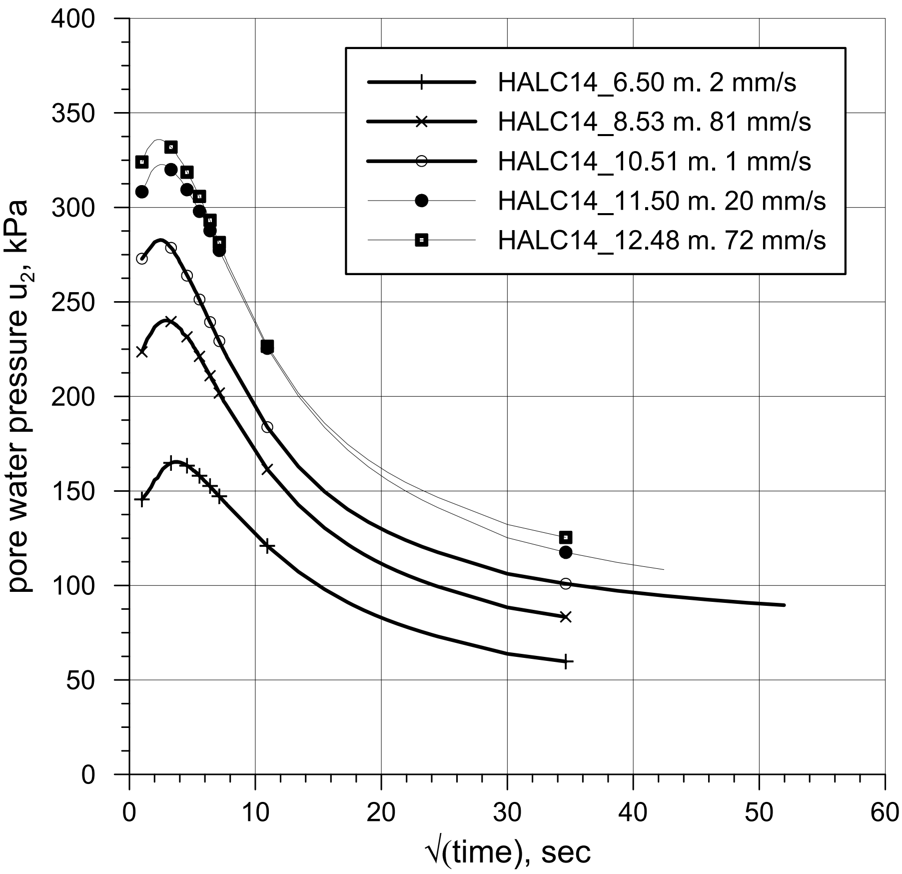

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Dissipation tests HALC14	Figure No. 5	
	Date 2018-03-26	Drawn by RCa
	NGTS	

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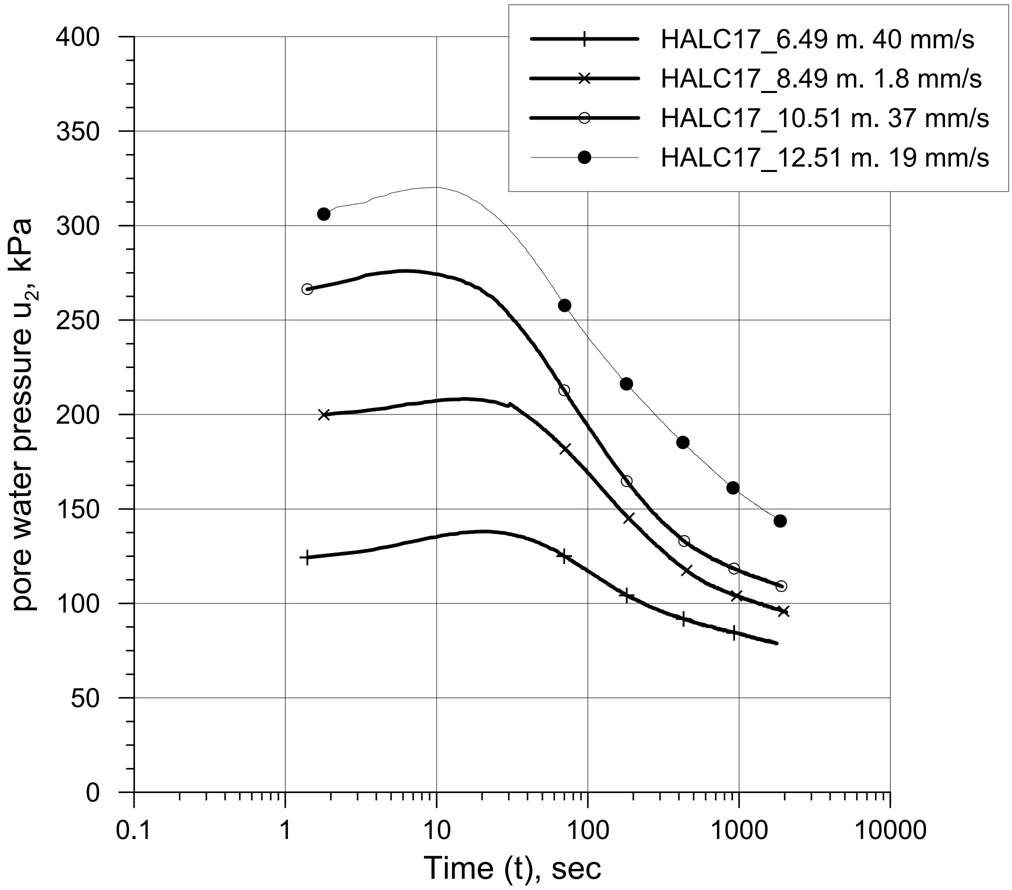

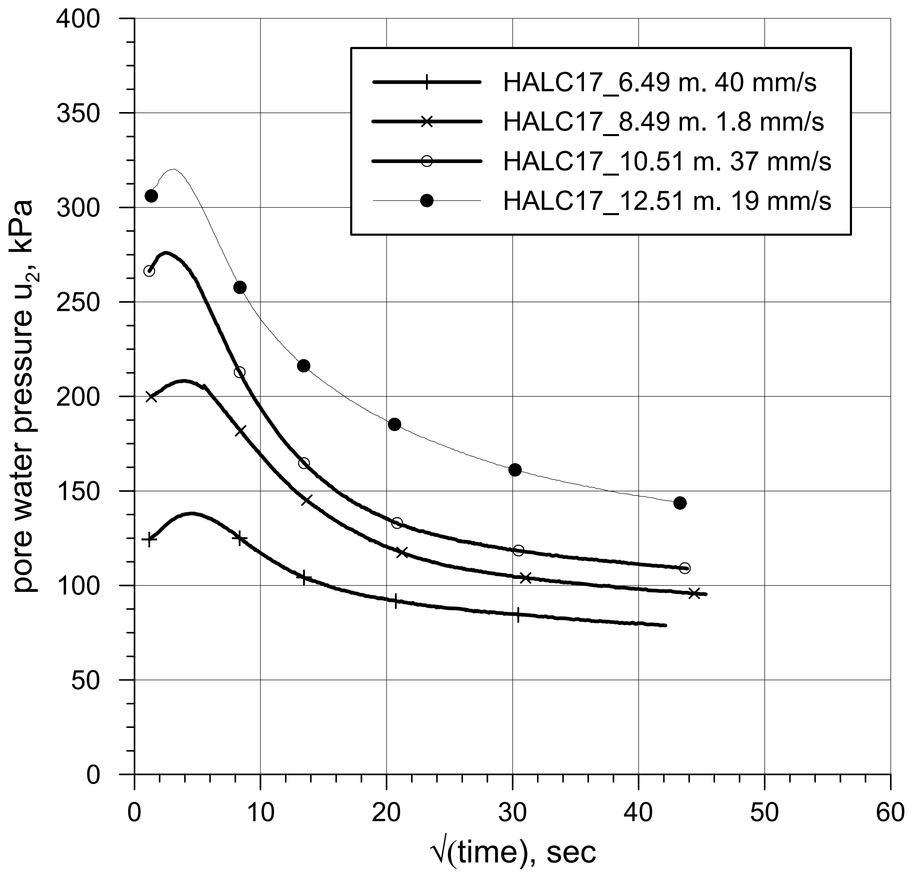

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Dissipation tests

HALC17

Document No. 20160154-04-R

Figure No. 6

Date 2018-03-26

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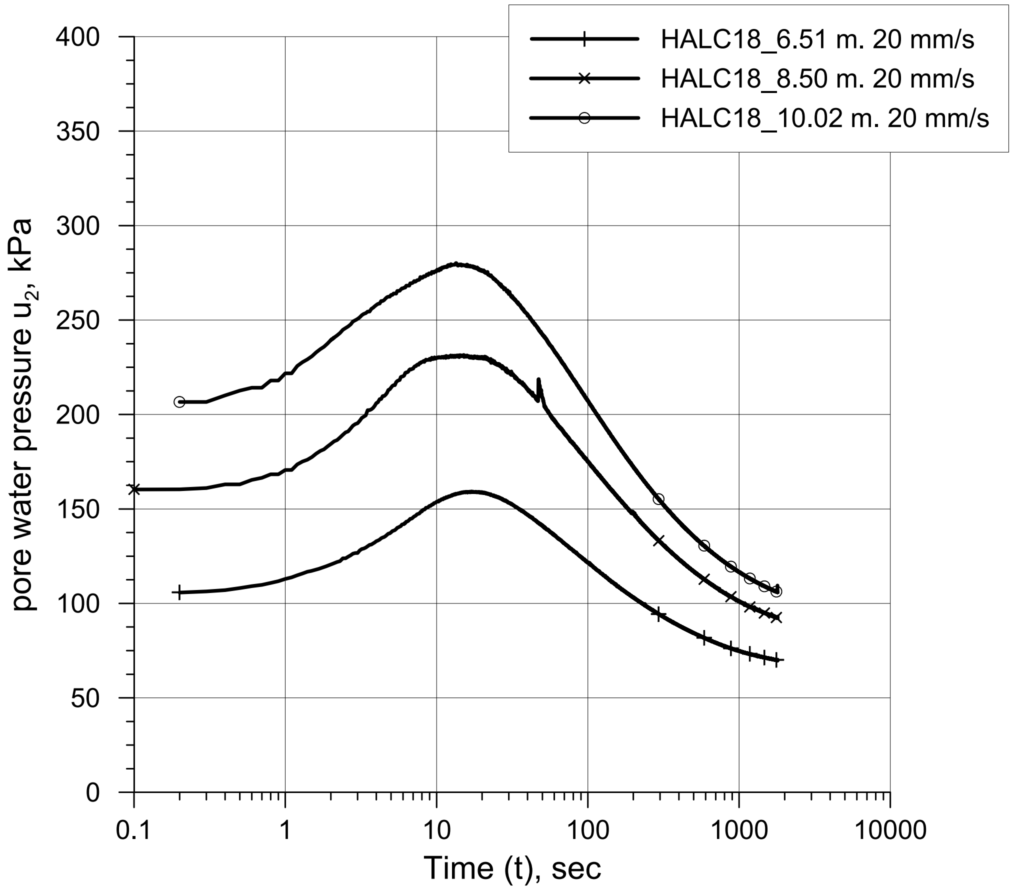

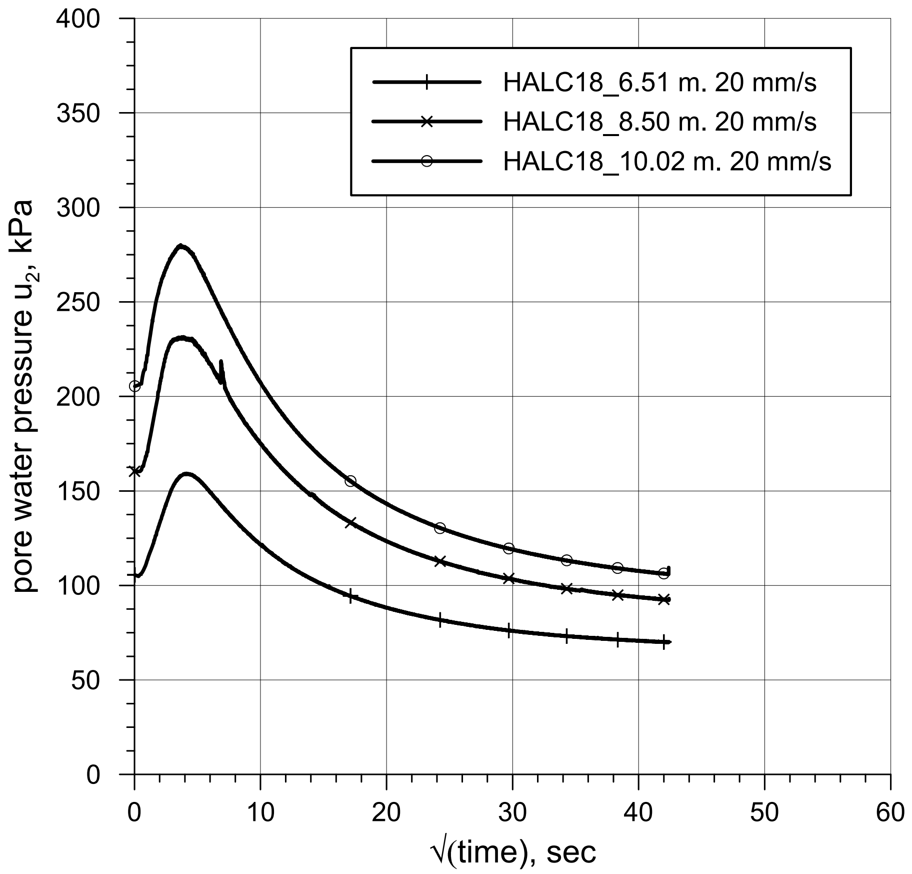

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Dissipation tests HALC18	Figure No. 7
	Date 2018-03-26 / Drawn by RCa
	NGTS

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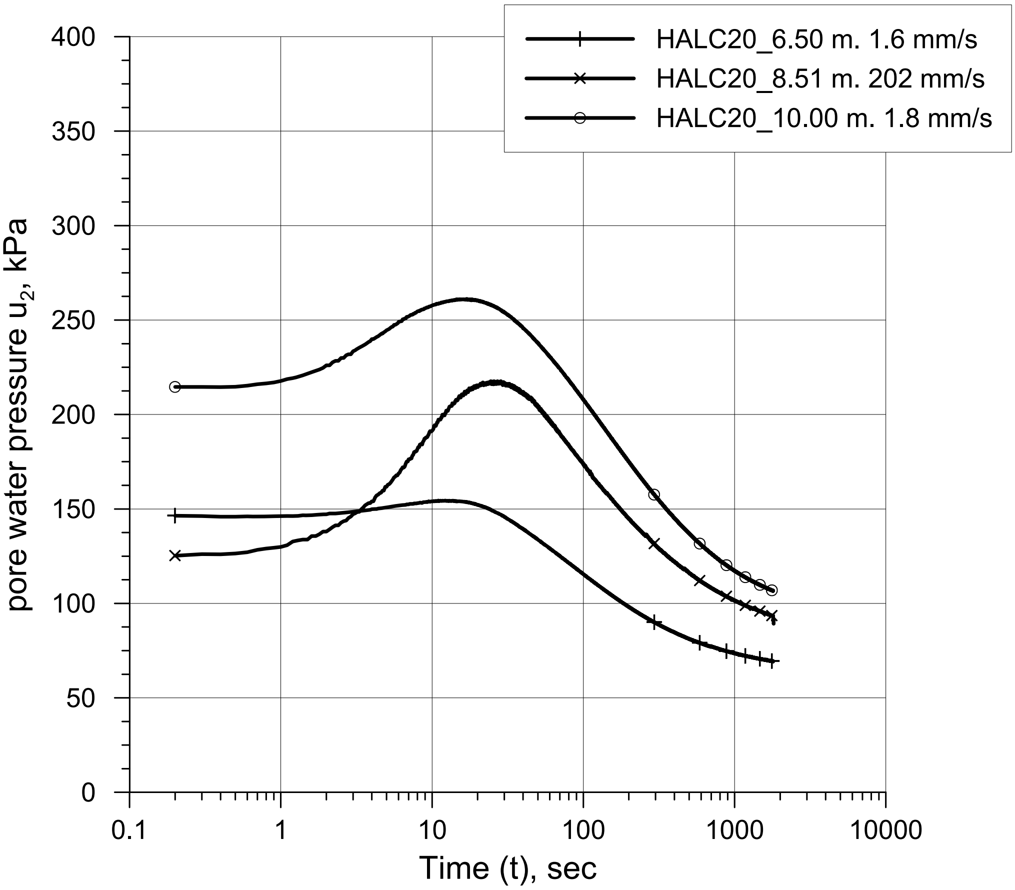

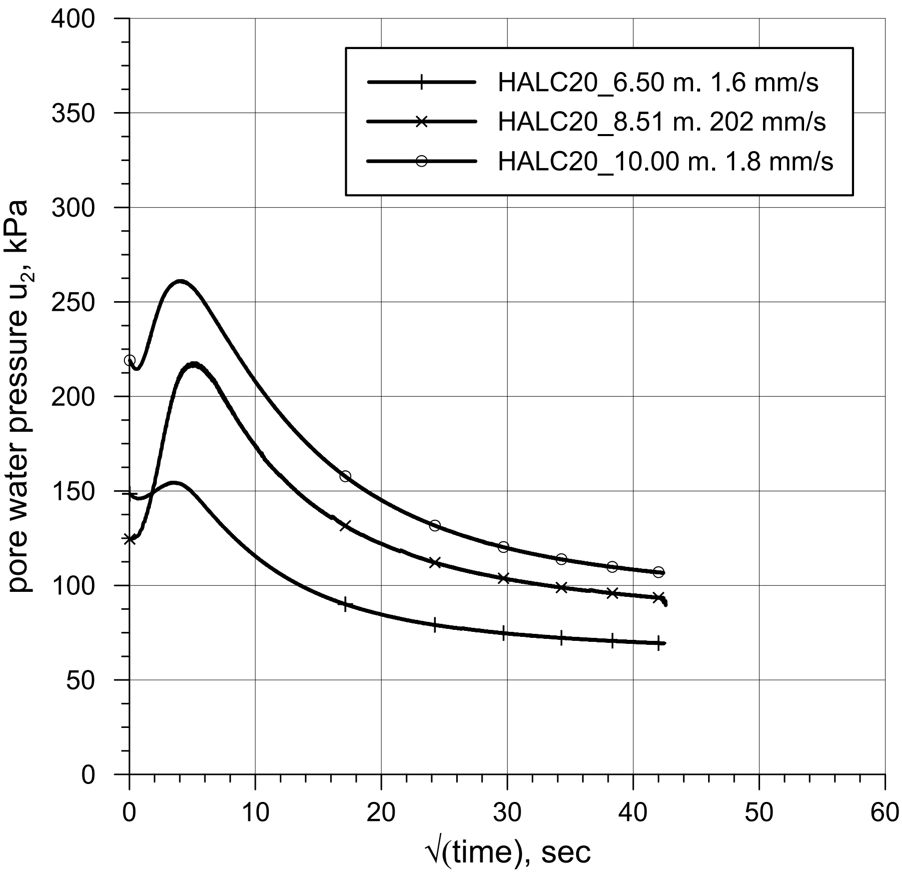

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NGTS - Halden Research Site	Document No. 20160154-04-R	
Dissipation tests HALC20	Figure No. 8	
	Date 2018-03-26	Drawn by RCa

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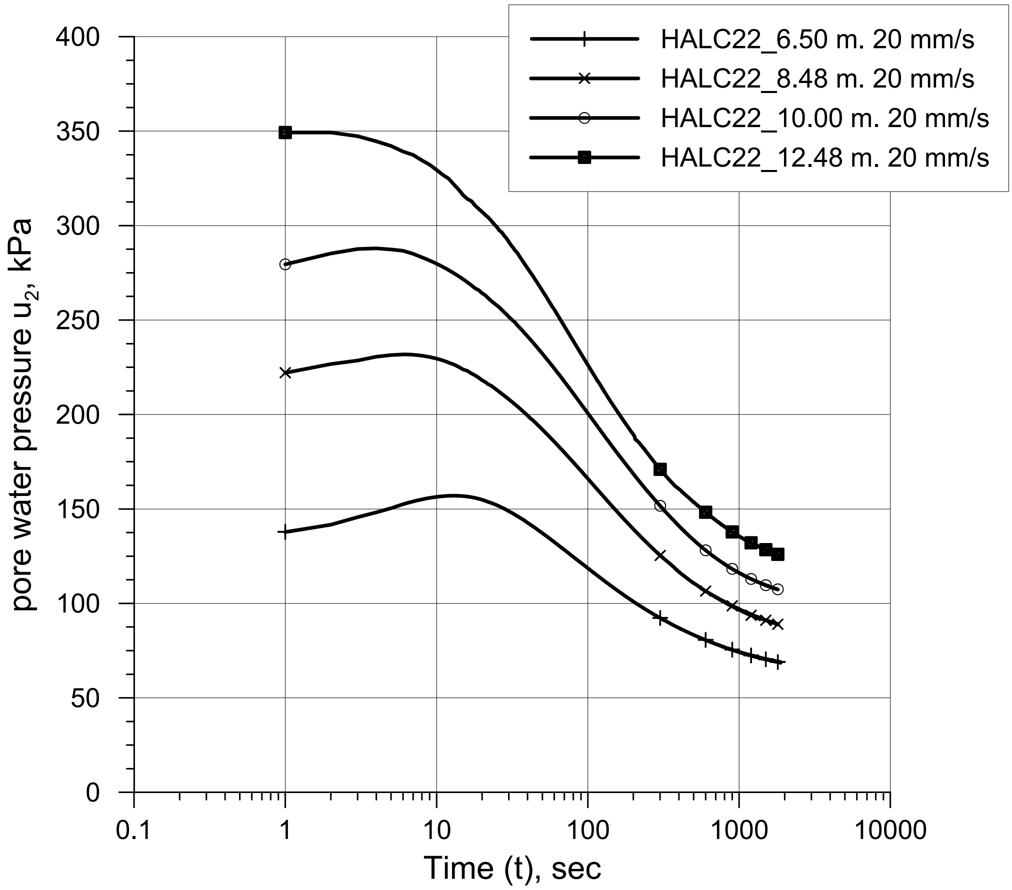

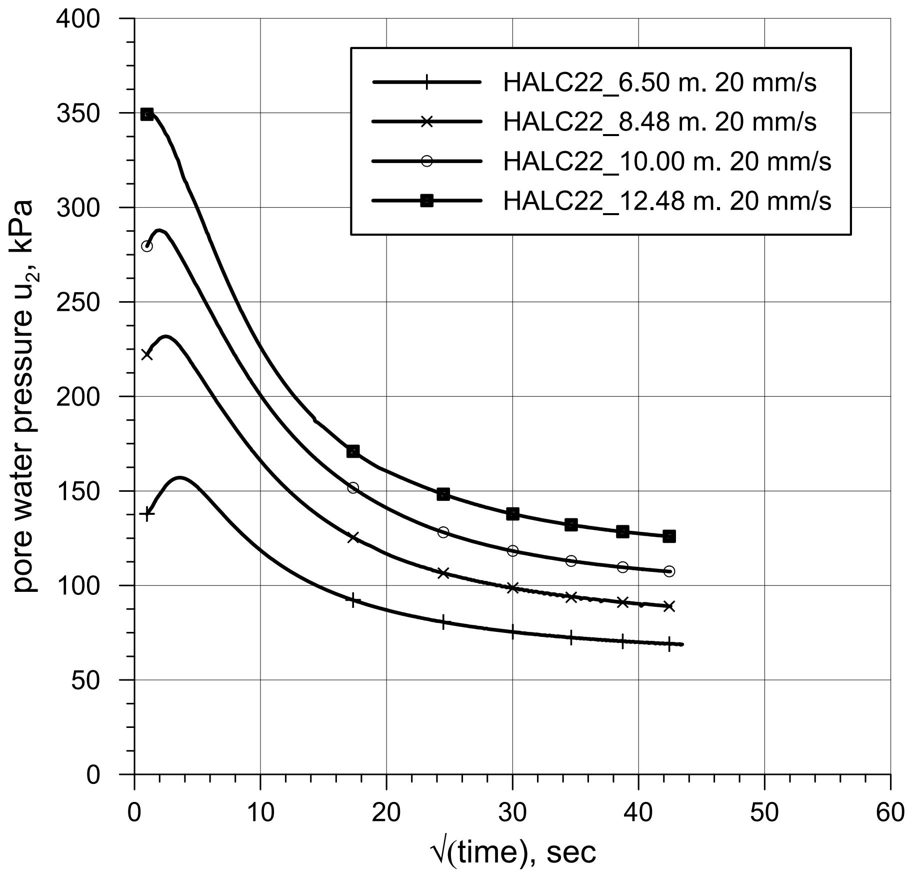

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Dissipation tests HALC22	Figure No. 9
	Date 2018-03-26 / Drawn by RCa
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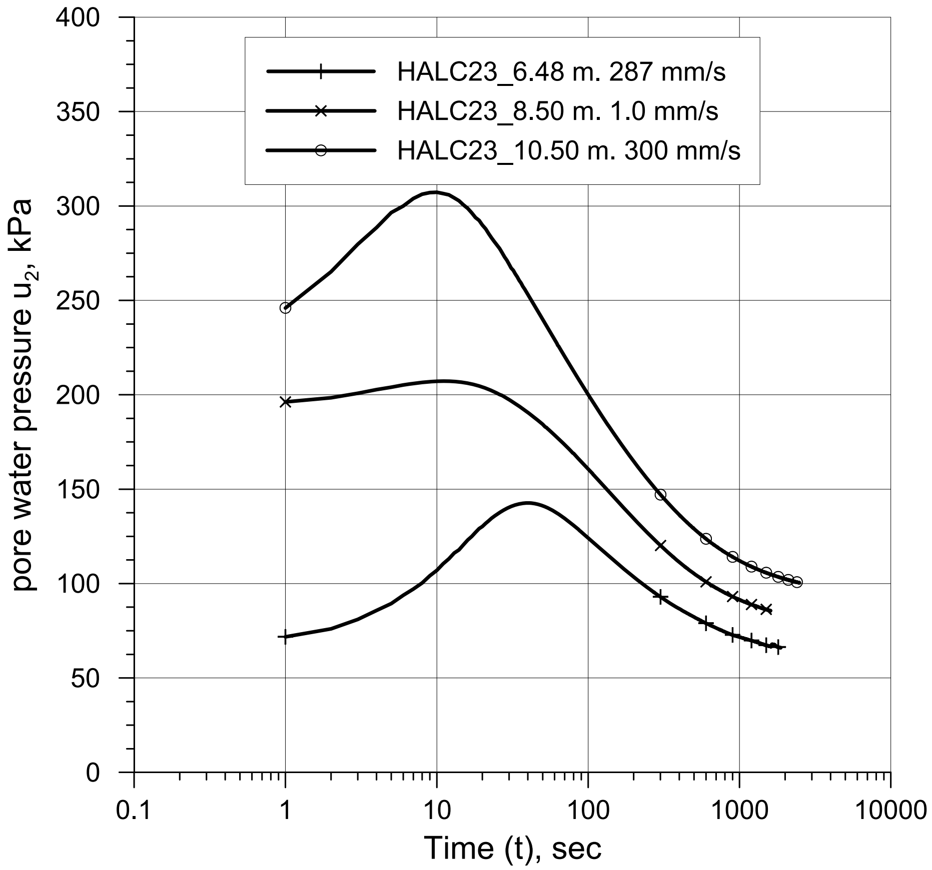

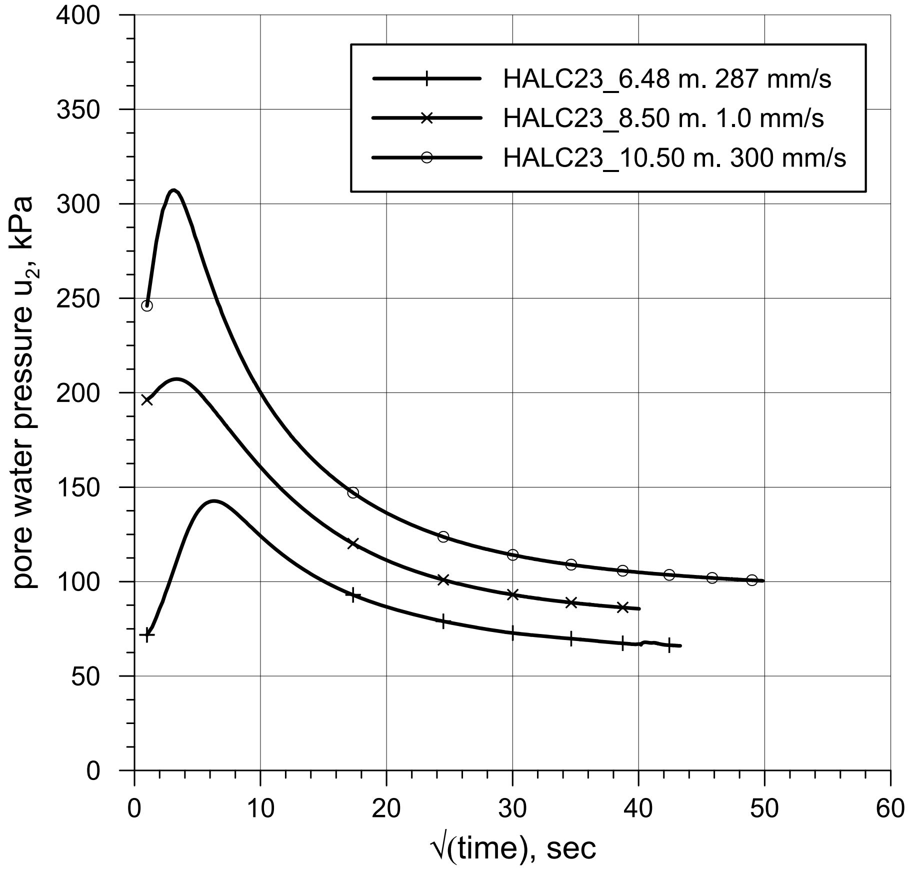

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Dissipation tests

HALC23

Document No.	20160154-04-R
Figure No.	10
Date	2018-03-26
Drawn by	RCa

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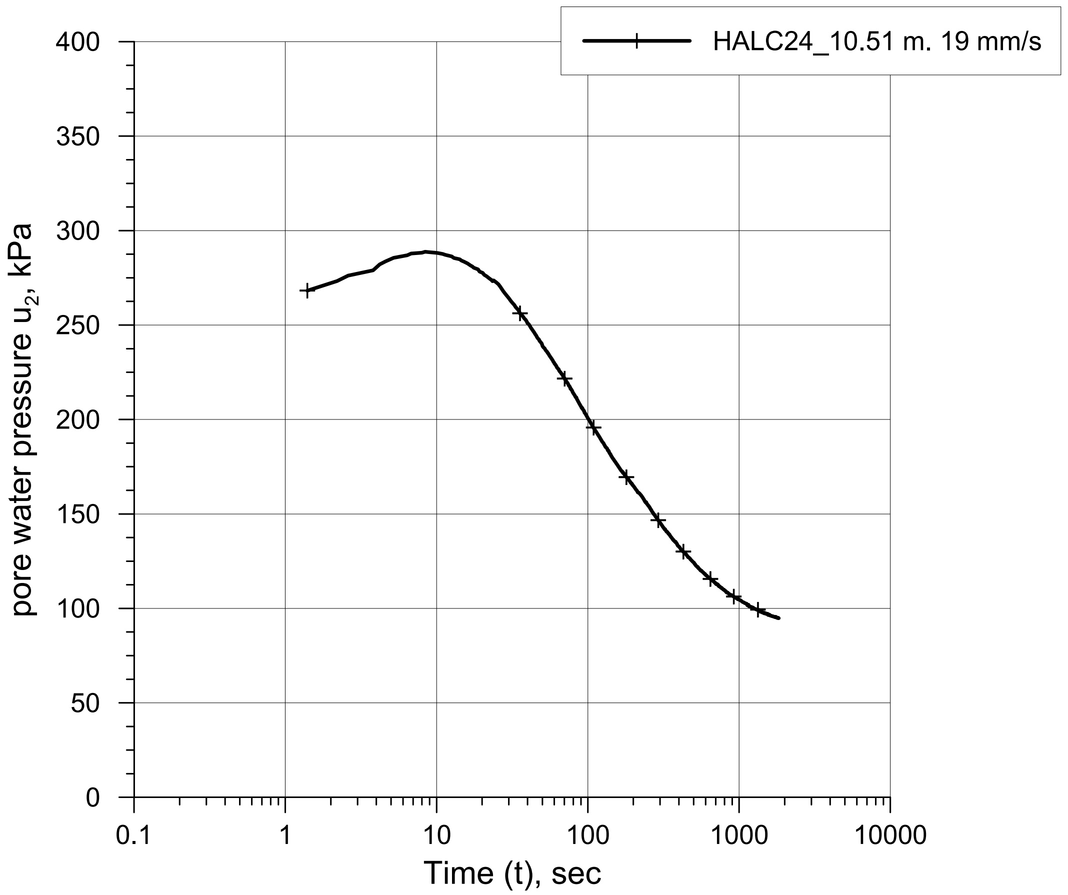

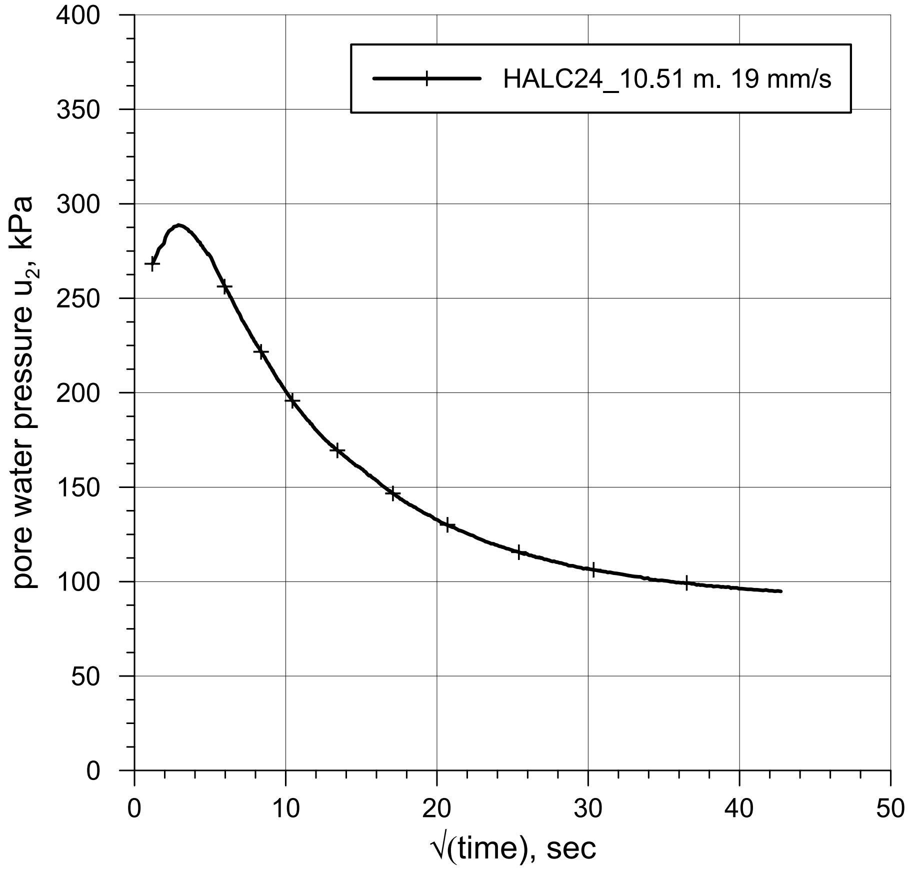

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Dissipation tests

HALC24

Document No.	20160154-04-R
Figure No.	11
Date	2018-03-26
Drawn by	RCa

NGTS

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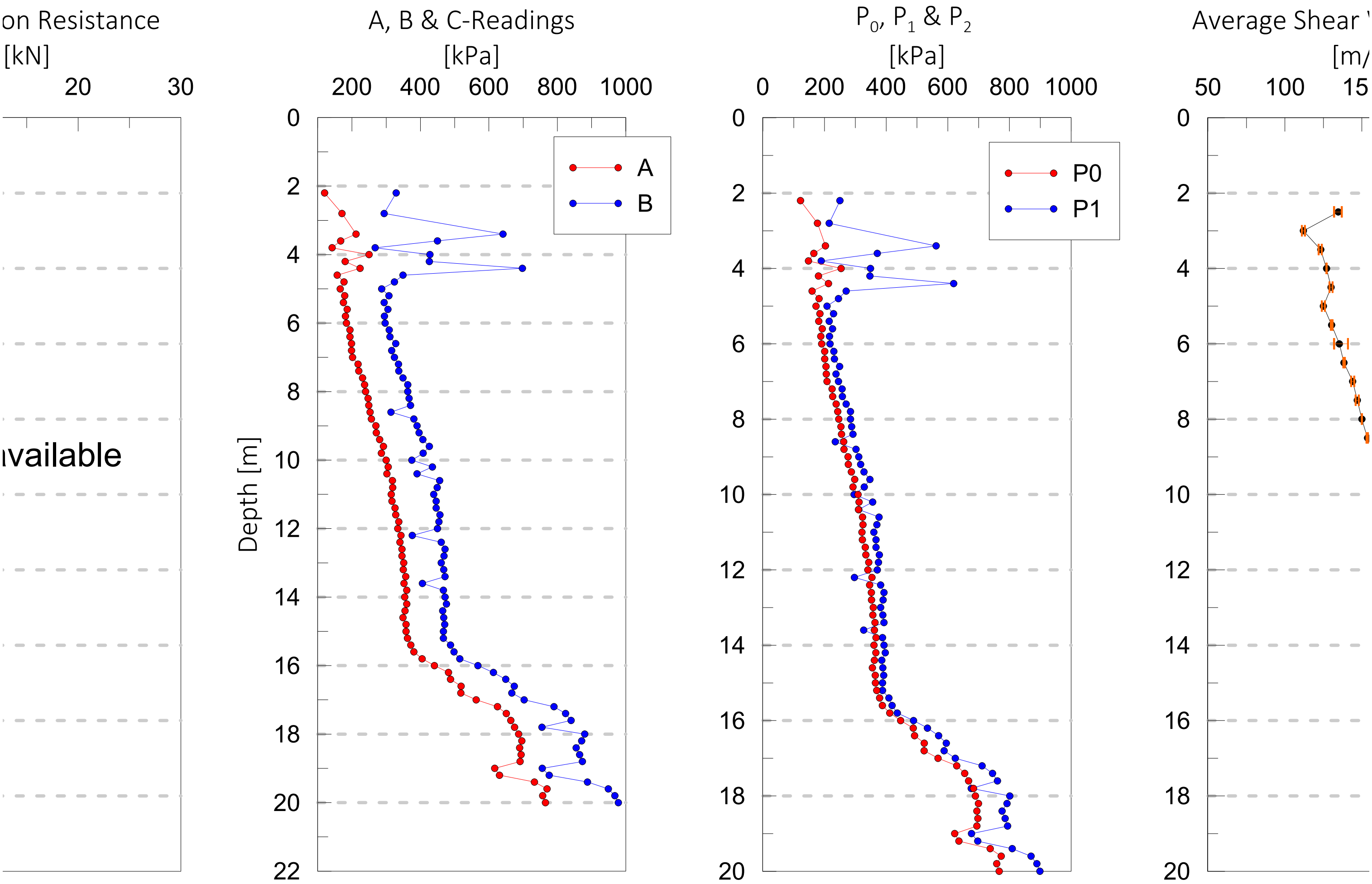
LOCA_ID-HOLE_ID	Dissipation test depth	Rate *1 m before	Operator	Cone
	m	mm/s		
HALC07	5.01	20.0	Envi - NGI	20759
HALC07	6.50	2.0	Envi - NGI	20759
HALC07	8.51	100.0	Envi - NGI	20759
HALC07	10.24	100.0	Envi - NGI	20759
HALC08	5.00	2.0	Envi - NGI	20759
HALC08	6.62	320.0	Envi - NGI	20759
HALC08	8.53	20.0	Envi - NGI	20759
HALC08	10.13	320.0	Envi - NGI	20759
HALC10	4.96	20.0	Envi - NGI	20856
HALC10	6.51	20.0	Envi - NGI	20856
HALC10	8.50	20.0	Envi - NGI	20856
HALC13	6.50	19.6	Pagani	
HALC13	8.50	19.6	Pagani	
HALC13	10.50	19.6	Pagani	
HALC14	6.5	2.0	Pagani	
HALC14	8.53	80.9	Pagani	
HALC14	10.51	1.0	Pagani	
HALC14	11.5	20.0	Pagani	
HALC14	12.48	72.0	Pagani	
HALC17	6.49	40.3	Geotech - NGI	4648
HALC17	8.49	1.8	Geotech - NGI	4648
HALC17	10.51	37.3	Geotech - NGI	4648
HALC17	12.51	19.4	Geotech - NGI	4648
HALC18	6.51	20.0	Geomil	C14251
HALC18	8.51	20.0	Geomil	C14251
HALC18	10.02	20.0	Geomil	C14251
HALC20	6.50	1.6	Geomil	C14251
HALC20	8.51	202.0	Geomil	C14251
HALC20	10.00	1.8	Geomil	C14251
HALC22	6.50	20.0	APvandenBerg	I-CFXYP20-10_150912
HALC22	8.48	20.0	APvandenBerg	I-CFXYP20-10_150912
HALC22	10.00	20.0	APvandenBerg	I-CFXYP20-10_150912
HALC22	12.48	20.0	APvandenBerg	I-CFXYP20-10_150912
HALC23	6.48	287.0	APvandenBerg	I-CFXYP20-10_150912
HALC23	8.50	1.0	APvandenBerg	I-CFXYP20-10_150912
HALC23	10.50	300.0	APvandenBerg	I-CFXYP20-10_150912
HALC24	10.51	18.6	Geotech - NGI	4648

* 1 m where possible. If rate was changed over say 0.7 m or 0.5 m before dissiaption tests then this interval is used

Appendix I

SDMT RESULTS



bration Constants

7 kPa ΔA_{After} = 9 kPa

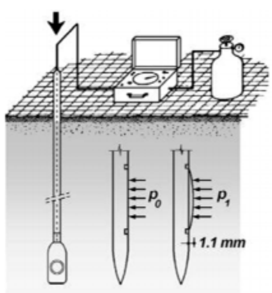
0 kPa ΔB_{After} = 78 kPa

National Geotest Site: Halden silt site

Test Type: Seismic Dilatometer Test

Test ID: HALD01

Location: Halden



Appendix J

SELF BORING PRESSURE METER TESTING

PROJECT: NGI - Halden & Onsøy SBP

PRESSUREMETER TESTING

FACTUAL REPORT

CLIENT: Norwegian Geotechnical Institute (NGI)

CONTRACT No.: P1170112

Issue	Date	Description	Prepared	Checked	Approved
01	20/10/17	Draft	MT	RC	DW
02	10/02/18	Revised	RC	MT	DW

Date: 10th January 2018
Our Ref: P1170112

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Email: mail@insitusi.com
www.insitusi.com
Company Reg No.: 6339499
VAT No.: 922 3561 41

Attention: Tom Lunne

PRESSUREMETER TESTING AT
NGI - HALDEN & ONSØY

We have pleasure in providing a digital copy of our report for the above project.

We hope that you are satisfied with the performance of our staff, equipment and reporting on this project. If you should have any queries about any aspect of the works carried out, please do not hesitate to contact us. We look forward to being of service to you in the future.

Yours faithfully,
In Situ Site Investigation Limited

Darren Ward
Director

Contents

1.0 INTRODUCTION

1.1 Site Details

At the request of NGI, In Situ Site Investigation Limited (In Situ S.I.) carried out pressuremeter testing at the Halden and Onsøy sites, Norway.

Both Halden and Onsøy are NGI research sites in south eastern Norway. Halden is located close to the Sweden-Norway border and is characterised by thick deposits of post-glacial SILT to approximately 15m depth. The SILT is normally consolidated and considered to be marine to fjord marine in origin. Onsøy is located approximately 3km to the north west of the city of Fredrikstad. The site is characterised by over 20m thickness of marine CLAY, which is normally consolidated, and of medium to high plasticity.

The pressuremeter testing was carried out between 16th and 23rd September 2017.

This report presents the factual records of the pressuremeter testing, together with an interpretation of the test results to derive material parameters.

2.0 FIELDWORK

2.1 General

In total fifteen pressuremeter tests were attempted. Five tests were attempted in one borehole at Halden, whilst ten tests were carried out in a single borehole at Onsøy. The boreholes at both sites were constructed using rotary drilling rigs operated by NGI. The tests were carried out using a self boring pressuremeter (SBP). The testing was carried out in general accordance with BS EN ISO 22476-5 (2012) and BS 5930 (2015). The test depths were scheduled by NGI. A summary table of the tests carried out is presented below:

Table 2.1. *Summary of pressuremeter tests.*

Borehole Reference	Test Reference	Date	Test Depth	Probe	Operator	Drilling Time	Remarks
HALDEN SITE							
HALP01	T01	16/09/2017	6.10m	SBP Beatrice	D Lewins	3mins	Fish tail bit used
HALP01	T02	16/09/2017	8.00m	SBP Beatrice	D Lewins	6mins	Drilled on from T01
HALP01	T03	16/09/2017	10.00m	SBP Beatrice	D Lewins	2mins	Drilled on from T02
HALP01	T04	18/09/2017	12.00m	SBP Beatrice	D Lewins	3mins	Fish tail bit used
HALP01	T05	18/09/2017	13.50m	SBP Beatrice	D Lewins	3mins	Drilled on from T04
ONSØY SITE							
ONSP01	T01	20/09/2017	5.00m	SBP Beatrice	D Lewins	3mins	Fish tail bit used
ONSP01	T02	20/09/2017	6.10m	SBP Beatrice	D Lewins	1min	Drilled on from T01
ONSP01	T03	20/09/2017	7.10m	SBP Beatrice	D Lewins	2mins	Drilled on from T02
ONSP01	T04	21/09/2017	8.00m	SBP Beatrice	D Lewins	2mins	Fish tail bit used
ONSP01	T05	21/09/2017	9.10m	SBP Beatrice	D Lewins	2mins	Drilled on from T04
ONSP01	T06	21/09/2017	10.20m	SBP Beatrice	D Lewins	2mins	Drilled on from T05
ONSP01	T07	22/09/2017	12.10m	SBP Beatrice	D Lewins	2mins	Fish tail bit used
ONSP01	T08	22/09/2017	14.00m	SBP Beatrice	D Lewins	2mins	Drilled on from T07
ONSP01	T09	22/09/2017	16.30m	SBP Beatrice	D Lewins	3mins	Drilled on from T08
ONSP01	T10	23/09/2017	18.00m	SBP Beatrice	D Lewins	15mins	Fish tail bit used

2.2 Self Boring Pressuremeter (SBP)

The SBP comprises a cylindrical instrument with integral cutter that is drilled into the ground using a top drive rotary drilling rig. The rotary rig provides rotation to the SBP cutter through inner rods (RW size), and thrust to advance the pressuremeter, via the non-rotating outer rods (2 inch diameter). Water or drilling mud is flushed by the rotary rig pump down the inner rods, and back up through the inner/outer rod annulus to remove the cuttings, and provide lubrication and cooling to the cutter. The outside of the pressuremeter remains in contact with the ground during insertion and the test pocket is, in theory, less disturbed than for other pressuremeters which are inserted into pre-bored test sections.

The probe, approximately 1.20m in length, has a central section which is covered by a natural rubber membrane. Pressure applied to the inside of the instrument, via compressed air, forces the membrane to expand against the test pocket wall. The radial displacement of the inside boundary of the membrane is measured at six points equally distributed around the centre of the expanding section by free moving arms. This displacement, and the pressure necessary to cause the movement of the membrane, is continuously monitored by transducers contained within the instrument. The SBP is linked to the ground surface via a combined pressure hose and electrical power/communication umbilical cable which connects the instrument to the pressure source and readout unit.

Analogue to digital conversion of the displacement and pressure transducers is carried out within the pressuremeter electronics package. The pressuremeter output comprises a multiplexed signal which connects through the pressuremeter interface unit to a laptop computer. Software, supplied by Cambridge InSitu Ltd, is used to record the data, convert the received signals to engineering units, using the pressure and displacement transducer calibrations, and display these in real time on the laptop computer to allow control of the test by the operator. Plotting these readings of displacement against pressure produces a loading curve for the material being tested. A number of mathematical analyses are applied to translate this loading curve into material strength and stiffness parameters.

The testing on this project was undertaken using a 6-arm probe, manufactured by Cambridge InSitu Ltd. Details of the instrument are provided below. Instrument calibrations were carried out prior to and after the testing program. Corrections measured for membrane stiffness (essentially resistance to inflation in air) were carried out prior to testing. Only a single SBP membrane was used during the testing program.

Table 2.2. *SBP instrument details.*

Instrument	Diameter (mm)	Pressure Capacity (MPa)	Displacement Measurement	Serial No.
SBP	89.1	10	6 arms at 60° 3 opposite pairs	Beatrice

2.3 SBP Testing Procedure

The boreholes were constructed by rotary drilling using conventional open holing techniques via an auger bit at a nominal size of 120mm at Halden and 98mm ay Onsøy, using water flush. Temporary steel casing was used at both sites from the ground surface to stabilise the borehole sequence. At Halden, the casing was advanced to 11.50m, after the first three tests had been carried out. At Onsøy, the casing was advanced to 7.30m after the first three tests. It was then advanced to 11.50m after the completion of test T06. After test T09, the casing was advanced to 15.00m, prior to drilling in the SBP for T10.

The SBP was lowered to the base of the hole at the start of each day and self bored to the required test depth. The cutter position and rate of progress were optimised to achieve minimum disturbance during installation. The fish tail bit was set 10mm behind the shoe edge. Following the completion of the first test of the day, the SBP was immediately advanced to the next required test depth. The instrument was not removed from the borehole during the daily testing operations, such that up to three tests could be completed on each day.

The pressuremeter tests were carried out in a stress controlled manner using a manually operated gas control box to pressurise the SBP at an appropriate rate for the ground conditions. During the tests a number of unload-reload loops were performed. The loading was continued until either the ground had failed or maximum arm displacement had occurred.

3.0 TEST INTERPRETATION

3.1 Introduction

The pressure / cavity strain curve has been analysed to determine various parameters as appropriate including:

In situ horizontal stress	σ_{ho}
Initial shear modulus	G_i
Yield	Pf
Unload-reload shear modulus	G_{ur}
Circumferential strain at cavity wall (cavity strain range, %)	ε_c
Undrained shear strength	s_u
Limit Pressure	P_L

The analysis methodologies used have followed accepted practice for interpretation of pressuremeter tests (e.g. Clarke, 1996; Mair & Wood, 1987).

3.2 In Situ Horizontal Stress

The act of drilling into ground relieves the in situ horizontal stress. This is effectively restored as a pressuremeter is pressurised against the surrounding ground, and in affect the cavity pressure (p_o) recorded by the instrument approximates to the in situ horizontal stress. During initial pressurisation, a linear pressure / displacement curve is anticipated as the pressure is re-instated and then exceeds the in situ horizontal stress. In theory, the SBP is inserted into the ground with no disturbance, and in situ horizontal stress should be readily apparent. In reality, however, there is often some indication of small scale disturbance to the ground around the instrument. This disturbance must be carefully assessed to ensure that any method of interpreting in situ horizontal stress from the initial loading curve is realistic.

Three methods can be used to assess the in situ horizontal stress. The first is lift-off, whereby after initial pressurisation of the SBP, the internal cavity pressure (p_o) exceeds in situ horizontal stress, and as cavity expansion starts to occur, radial movement of the membrane is recorded by the arms. Use of lift off can be problematic in cases where insertion of the SBP has disturbed the surrounding ground, such that the estimated p_o

merely reflects the membrane pushing against the disturbed zone. Often a second linear increase in pressure and arm displacement can be seen when undisturbed material is reached. In some cases the derived in situ horizontal stress may be slightly under- or over-estimated, depending on the width of the disturbed zone.

Circumferential disturbance around the instrument can also result in variance in the individual displacement arm lift off. For practical purposes, in the very low strength material tested, the average arm lift off has been used, as at the low pressures recorded during initial membrane inflation and subsequent loading, removal of arm data from the analysis routine can cause unrealistically large changes to the overall pressure displacement curve and subsequent interpreted material parameters.

Marsland and Randolph (1977) proposed that in the vicinity of in situ horizontal stress, soil behaves elastically and therefore the initial loading curve is linear. This elastic behaviour will cease when the undrained shear strength of the soil in the cavity wall is reached, and hence the loading curve derived from the SBP will then begin to curve away from linearity. The point at which the loading curve becomes non-linear (or the onset of yield, Pf), represents the in situ horizontal stress plus the undrained shear strength at this point:

$$Pf = \sigma_{ho} + s_u.$$

A third method proposed to estimate in situ horizontal stress is a comparison of pore pressure data against total test pressure, obtained from the SBP. A relationship has been suggested (Wroth, 1982) whereby excess pore pressure is generated as the cavity wall material starts to deform during initial loading. This method is highly susceptible to disturbance and the material type, especially in low strength material as tested in Norway, and is often not able to provide reliable results, consistent with those from the above two methods. For this project, it is noted that the data from pore pressure cell A was more reliable during the testing program than that from cell B.

3.3 Shear Modulus

A pressuremeter test, in an elastic, perfectly plastic material, imparts a pure shear failure, hence it is normal to report shear modulus in preference to an elastic modulus. Shear modulus is determined from the initial loading curve, and from unload reload loops, performed at intervals during the test. The relationship used to determine shear modulus (G) is:

$$G = \frac{1}{2} \cdot \frac{dp}{d\varepsilon_c}$$

The various plots for both initial loading shear modulus (G_i) and the shear modulus derived from unload reload loops (G_{ur}) are presented graphically in the test results.

Note is also made that in clays and sands, some hysteresis is generally evident, and it is possible to determine a secant modulus from the unloading or reloading portion of an unload reload loop. A high degree of consistency is often possible when plotting secant shear modulus results from individual tests. This may be further extended to a series of tests in a geological formation by normalising by undrained shear strength, or in situ stress.

Pressuremeter tests determine shear modulus (G). This can be converted to an undrained elastic modulus (E_u) by use of the following relationship:

$$E_u = 2.G(1 + \upsilon) \qquad \text{Where } \upsilon = \text{Poisson's ratio}$$

Individual loops have also been analysed to determine small strain stiffness. This has been achieved by taking a secant modulus from the base of the loop, to the points on the reloading curve. Plotting the cavity strain range against shear modulus, gives an indication of how stiffness varies with strain. A Bolton and Whittle (1999) analysis has also been performed to investigate the non linear elastic / plastic behaviour. Plots of calculated secant modulus values at varying shear strain % are provided within the analysis results.

3.4 Strength

Undrained shear strength has been determined using Gibson and Anderson (1961). This is the generally accepted method for the determination of strength and is based on the assumption of an elastic - perfectly plastic material. The analysis also provides a Limit Pressure (P_L). This is a limiting pressure defined as the pressure at which the change in volume (ΔV) divided by the current volume (V) is equal to one. While this is not achieved in practice, it can be determined by extrapolation. Note is also made that the definition of P_L is different to that associated with a Ménard Limit Pressure, and the two should not be interchanged.

3.5 Note on Groundwater Levels

The estimation of groundwater levels during SBP testing can be problematic due to the necessity of using water flush during insertion. For almost all the tests carried out, the water level as noted by the operator was shallow, generally <2.00m depth. Estimation of the test water level can be attempted from the membrane inflation or deflation characteristics, although the assessment of groundwater level from this data is not without its problems, largely due to any disturbance around the instrument affecting its accurate interpretation. Groundwater, or ambient pore pressure, values used to determine effective stress parameters are based on values provided to In Situ S.I. by NGI. Some caution should be applied to the effective stress values provided and their further use, due to uncertainty as to the true ambient pore pressure values, and the effect of material disturbance and its implications for the assessment of insitu horizontal stress. Total vertical stresses have been provided by NGI.

3.6 Summary of Results

A summary of the results is presented in Appendix A, followed by the full graphical analysis.

3.7 Notes on Individual Tests

Halden - Borehole HALP01

Test 1 – This test was conducted at 6.10m. During initial drilling there was a good seal around the instrument, with an insertion time of 3 minutes.

Arm lift off at the start of linear loading was good, with slight higher variance seen on arms 3 and 4. Initial membrane response is seen at 47kPa, which is close to an initial pore pressure response at 51kPa, although the overall pore pressure response during the test is not well defined. The average arm lift off is interpreted at 91kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with interpreted yield at 130kPa. The overall pressure-displacement response during the test was good with only arm 5 indicating some circumferential variability in the material around the instrument. Four unload-reload loops were attempted over the length of the loading curve. The derived modulus values are in the range 8.3 to 9.9MPa, with lower values following the yield point, at increasing cavity strain ranges. Derived undrained shear strengths are close at 38 to 39kPa.

Test 2 – This test was conducted at 8.00m. The instrument was bored to test depth immediately after completion of Test 1. During drilling there was a good seal around the instrument, with the insertion time to depth of 6 minutes.

Arm lift off at the start of linear loading was good, with slight higher variance seen on arms 2 and 4. Arm 1 showed a slightly lower response during initial membrane inflation. Initial response of the membrane is seen at 61kPa, which is similar to an initial pore pressure response at 63kPa. Average arm lift off is interpreted at 117kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with interpreted yield at 157kPa, unfortunately coinciding with the onset of the first unload-reload loop. The overall pressure-displacement response during the test was good with only arm 5 again indicating some circumferential variability in the material around the instrument. Four unload-reload loops were attempted over the length of the loading curve, with a single loop carried out on the unload section. The derived modulus values are in the range 9.5 to 11.7MPa. Derived undrained shear strengths are in the range 40 to 59kPa.

Test 3 – This test was conducted at 10.00m. The instrument was bored to test depth immediately after completion of Test 2. During drilling there was a good seal around the instrument, with the insertion time to depth of 2 minutes.

Arm lift off at the start of linear loading was good, with very slight variance seen on arms 1 and 2. Initial membrane response is indicated at 79kPa, which is close to an initial pore pressure response at 79kPa. Average arm lift off is interpreted at 147kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with interpreted yield at 198kPa, coinciding with the onset of the first unload-reload loop. The overall pressure-displacement response during the test was good with some variability seen in arms 2, 3 and 5. Four unload-reload loops were attempted over the length of the loading curve, with a single loop carried out on the unload section. The derived modulus values are in the range 12.2 to 14.6MPa. Derived undrained shear strengths are in the range 51 to a possible over estimate of 78kPa.

Test 4 – This test was conducted at 12.00m. The instrument was initially lowered down the cased borehole to 11.50m and then bored to the test depth. The insertion time to depth was 3 minutes.

Unfortunately at the start of the test arms 5 and 6 were offline. This was later investigated and was a result of some water ingress into the probe, via the top membrane clamping ring. Arm lift off at the start of linear loading was good for the remaining 4 arms. An initial membrane response is indicated at around 115kPa, although this is not well defined.

Similarly the pore pressure response is also inconclusive, at 130kPa. Average arm lift off is well defined at 175kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with interpreted yield at 226kPa. The overall pressure-displacement response during the test was good with some variability seen in arms 1 and 2. The shape of the loading curve is consistent with possible increased granular component in the tested material. Three unload-reload loops were attempted over the length of the loading curve. The derived modulus values increase from 10.0 to 14.1MPa. Derived undrained shear strengths are in the range 51kPa, to a possible over estimate of 78kPa.

Test 5 – This test was conducted at 13.50m. The instrument was bored to test depth immediately after completion of Test 4. During drilling there was a good seal around the instrument, with the insertion time to depth of 3 minutes.

As in Test 4, at the start of the test arms 5 and 6 were offline. The remaining arm lift off at the start of linear loading was good, although some slight variance was seen on arm 1. Initial membrane response is indicated at 110kPa, whilst initial pore pressure response is suggested at 145kPa. Average arm lift off is interpreted at 209kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with interpreted yield at 257kPa. The overall pressure-displacement response during the test was slightly variable on all working arms, which together with the shape of the loading curve is consistent with either pervasive ground disturbance around the instrument or possible increased granular component in the tested material. Three unload-reload loops were attempted over the length of the loading curve, with derived modulus values increasing from 7.1 to 12.7MPa. Derived undrained shear strengths are in the range 50 to a possible over estimate of 89kPa.

Onsøy - Borehole ONSP01

Test 1 – This test was conducted at 5.00m. During initial drilling there was a good seal around the instrument, with an insertion time of 3 minutes.

Arm lift off at the start of linear loading was good, with slight higher variance seen on arms 3 and 4. Initial membrane response is indicated at 49kPa. The initial pore pressure response is higher at around 90kPa, which is close to the average arm lift off interpreted at 84kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with a well defined yield at 110kPa. The overall pressure-displacement response during the test was very good with only arm 5 being slightly variable. Two unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the close range of 1.1 to 1.8MPa, at increasing cavity strain ranges. Derived undrained shear strengths are close at 19 to 26kPa.

Test 2 – This test was conducted at 6.10m. The instrument was bored to test depth immediately after completion of Test 1. During drilling there was a good seal around the instrument, with the insertion time to depth of only 1 minute.

Arm lift off at the start of linear loading was good, with slight higher variance seen on arms 4 and 5. Initial membrane response is indicated at around 59kPa. The initial pore pressure response is higher at around 105kPa, which is close to the average arm lift off interpreted at 98kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with a well defined yield at 119kPa. The overall pressure-displacement response during the test was very good with again only arm 5 being slightly variable. Three unload-reload loops were attempted over the length of the loading curve. The derived modulus values are in the close range of 1.8 to 2.3MPa, at increasing cavity strain ranges. Derived undrained shear strengths are close at 15 to 21kPa.

Test 3 – This test was conducted at 7.10m. The instrument was bored to test depth immediately after completion of Test 2. During drilling there was a good seal around the instrument, with the insertion time to depth of 2 minutes.

Arm lift off at the start of linear loading was good, with slight high variance seen on arms 4 and 5. Initial membrane response is indicated at around 69kPa. The initial pore pressure response is higher at around 119kPa, which is close to the average arm lift off interpreted at 115kPa, with this value being used as the cavity reference pressure. The linear loading path was relatively short with a well defined yield at 139kPa. The overall pressure-displacement response during the test was reasonable with arms 2 and 5 being slightly variable at larger displacement. Five unload-reload loops were attempted over the length of the loading curve. The derived modulus values are in the close range of 1.6 to 2.4MPa. Derived undrained shear strengths are reasonably close at 17 to 24kPa.

Test 4 – This test was conducted at 8.00m. The instrument was initially lowered down the cased borehole to 7.30m and then bored to the test depth. The insertion time to depth was 2 minutes.

Arm lift off at the start of linear loading was good, with slight higher variance seen on arms 2 and 4. Initial membrane response is indicated at around 78kPa. The initial pore pressure response is higher at around 104kPa, which is close to the average arm lift off interpreted at 110kPa, with this value being use as the cavity reference pressure. There is some suggestion of disturbance around the instrument. The linear loading path was relatively short with a reasonably defined yield at 130kPa. The overall pressure-displacement response during the test was variable at large displacements, further indicating some material variation, or probable disturbance. Three unload-reload loops were attempted over the length of the loading curve. The derived modulus values are in the close range of 3.0 to 3.8MPa, at increasing cavity strain. Derived undrained shear strengths are reasonably close at 20 to 22kPa.

Test 5 – This test was conducted at 9.10m. The instrument was bored to test depth immediately after completion of Test 4. During drilling there was a good seal around the instrument, with the insertion time to depth of 2 minutes.

Arm lift off at the start of linear loading was good, with high variance seen on arm 4. Initial membrane response is indicated at around 84kPa. The initial pore pressure response is higher at around 110kPa, which is close to the average arm lift off interpreted at 118kPa, with this value being used as the cavity reference pressure. There is some suggestion of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 146kPa. The overall pressure-displacement response during the test was variable at large displacements, further indicating some material variation, or probable disturbance. Four unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the range of 3.0 to 5.1MPa. Derived undrained shear strengths are identical at 28kPa.

Test 6 – This test was conducted at 10.20m. The instrument was bored to test depth immediately after completion of Test 5. During drilling there was a good seal around the instrument, with the insertion time to depth of 2 minutes.

Arm lift off at the start of linear loading was good, with some higher variance seen on arms 3, 4 and 5. Initial membrane response is indicated at around 95kPa. The initial pore pressure response is higher at around 132kPa, which is close to the average arm lift off interpreted at 137kPa, with this value being used as the cavity reference pressure. There is some suggestion of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 165kPa. The overall pressure-displacement response during the test was slightly variable at large displacements, with arms 5, 6 and 1 indicating some material variation, or probable disturbance. Three unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the range of 2.6 to 5.0MPa. Derived undrained shear strengths are identical again at 28kPa.

Test 7 – This test was conducted at 12.10m. The instrument was initially lowered down the cased borehole to 11.50m and then bored to the test depth. The insertion time to depth was 2 minutes.

Arm lift off at the start of linear loading was reasonable, with some higher variance seen on arms 4, 5 and 6. Initial membrane response is indicated at around 118kPa. The initial pore pressure response is not particularly well defined, presumably due to disturbance. There is a response at around 185kPa, although this should treated with caution. Average arm lift off is interpreted at 163kPa, with this value being use as the cavity reference pressure. There is some suggestion of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 208Pa. The overall pressure-displacement response during the test was variable at large displacements, with all arms showing some variation. Three unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the range of 3.3 to 6.1MPa. Derived undrained shear strengths are variable at 35 to 45kPa.

Test 8 – This test was conducted at 14.00m. The instrument was bored to test depth immediately after completion of Test 7. During drilling there was a good seal around the instrument, with the insertion time to depth of 2 minutes.

Arm lift off at the start of linear loading was slightly variable on most arms, with high response on arms 5 and 6. Initial membrane response is indicated at 136kPa. The initial pore pressure response is higher at around 175kPa, which is close to the average arm lift off interpreted at 186kPa, with this value being used as the cavity reference pressure. There is some clear suggestion of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 220kPa. The overall pressure-displacement response during the test was variable at large displacements. Three unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the range of 3.9 to 8.8MPa. Derived undrained shear strengths are close at 34 to 39kPa.

Test 9 – This test was conducted at 16.30m. The instrument was bored to test depth immediately after completion of Test 8. During drilling there was a good seal around the instrument, with the insertion time to depth of 3 minutes.

Arm lift off at the start of linear loading was variable on most arms. Initial membrane response is indicated at 160kPa. The initial pore pressure response is higher at around 178kPa. The average arm lift off interpreted at 221kPa, with this value being used as the cavity reference pressure. There is some clear suggestion of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 265kPa. The overall pressure-displacement response during the test was reasonable, with variation at large displacements seen in arms 2 and 5. Three unload-reload loops were attempted over the length of the loading curve, with a single loop on the unloading. The derived modulus values are in the range of 4.6 to 7.9MPa. Derived undrained shear strengths are close at 44 to 45kPa.

Test 10 – This test was conducted at 18.00m. The instrument was initially lowered down the cased borehole to 15.00m and then bored to the test depth. The insertion time to depth was 15 minutes. This greater insertion time is attributed to the increased depth to self bore, and the observation of fine gravel and sand in the penetrated material.

Arm lift off at the start of linear loading was variable with differing response seen on most arms. Initial membrane response is vaguely indicated at around 175kPa. The pore pressure response is not defined during the test, as unfortunately pore pressure cell A provided a wildly fluctuating output, whilst cell B was relatively unresponsive. Average arm lift off is interpreted at 249kPa, with this value being used as the cavity reference pressure. There are clear indications of disturbance around the instrument. The linear loading path was relatively short with interpreted yield at 315kPa. The overall pressure-displacement response during the test was reasonable, although arms 1 and 4 showed highly variable displacement. Three unload-reload loops were attempted over the length of the loading curve with the derived modulus values in the range of 7.2 to 10.7MPa. Following completion of the third loop, leakage occurred from the membrane and the test was halted. Upon inspection when recovered back to the ground surface, the membrane was seen to have partially pulled out from the clamping ring at the bottom end of the instrument. Derived undrained shear strengths are very close at 55 to 66kPa.

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APPENDIX A

Test Data Analysis

Description	Figure No.
Pressuremeter Results Summary	HALP01 & ONSP01
Pressuremeter Test Details	1
Pressuremeter Shear Modulus Plot & Undrained Shear Strength Plot - Halden	2
Pressuremeter In Situ Horizontal Stress, Yield & Limit Pressure Plot - Halden	3
Pressuremeter ko Plot - Halden	4
Pressuremeter Shear Modulus Plot & Undrained Shear Strength Plot - Onsøy	5
Pressuremeter In Situ Horizontal Stress, Yield & Limit Pressure Plot - Onsøy	6
Pressuremeter ko Plot - Onsøy	7
Pressuremeter Results Summary - Stress	8
Pressuremeter Test Analysis	
HALP01	T01 – T05
ONSP01	T01 - T10

Pressuremeter Results Summary

Test	Depth (m)	Material description from borehole log	p_o (kPa)	Undrained strength: $S_{u\,(M\&R)}$ (kPa)	Undrained strength: S_u (kPa)	Undrained strength: P_L (kPa)	G_i (MPa)	Loop No.	G_{ur} (MPa)	ε_c (%)	Non linear stiffness: α (MPa)	Non linear stiffness: β	Secant shear modulus G (MPa), Shear strain: 0.1%	0.01%	0.001%
HALP01															
1	6.10	SILT	92	38	39	283	2.8	1	9.3	0.105	0.399	0.576	7	20	53
								2	9.9	0.123	0.634	0.620	9	21	50
								3	9.3	0.170	0.708	0.626	9	22	52
								4	8.3	0.209	0.606	0.608	9	22	55
2	8.00	SILT	117	40	59	390	3.6	1	9.5	0.132	0.409	0.567	8	22	60
								2	10.0	0.172	0.720	0.618	10	24	59
								3	11.3	0.168	0.817	0.620	11	27	65
								4	11.7	0.178	0.756	0.600	12	30	76
								5	10.6	0.293	0.825	0.610	12	30	73
3	10.00	SILT	147	51	78	514	5.6	1	12.2	0.145	0.441	0.536	11	32	92
								2	12.9	0.185	0.719	0.576	13	36	94
								3	13.9	0.196	0.935	0.600	15	37	94
								4	14.6	0.190	0.817	0.580	15	39	103
								5	14.3	0.215	1.016	0.617	14	35	84
4	12.00	SILT	175	51	91	597	7.2	1	10.0	0.286	0.315	0.474	12	40	135
								2	12.1	0.287	0.562	0.529	15	43	127
								3	14.1	0.243	0.599	0.529	16	46	136
5	13.50	SILT	209	48	89	561	2.7	1	7.1	0.285	0.134	0.409	8	31	120
								2	8.9	0.320	0.293	0.476	11	37	123
								3	12.7	0.275	0.382	0.474	14	48	162

Project: NGI - Halden Site
Client: NGI
Project No.: P11170112
Figure No.: HALP01

Pressuremeter Results Summary

Test	Depth (m)	Material description from borehole log	p_o (kPa)	Undrained strength $S_{u\,(M\&R)}$ (kPa)	S_u (kPa)	P_L (kPa)	G_i (MPa)	Loop No.	G_{ur} (MPa)	ε_c (%)	Non linear stiffness α (MPa)	β	Secant shear modulus G (MPa), Shear strain 0.1%	0.01%	0.001%
ONSP01															
1	5.00	CLAY	85	25	19	188	2.1	1	1.8	0.439	0.241	0.660	3	6	12
								2	1.6	0.650	0.215	0.647	2	6	12
								3	1.1	1.183	0.161	0.618	2	5	13
2	6.10	CLAY	98	21	15	199	4.2	1	2.3	0.479	0.230	0.616	3	8	19
								2	1.9	0.639	0.189	0.598	3	8	19
								3	1.8	0.724	0.185	0.601	3	7	18
3	7.10	CLAY	115	24	17	229	5.0	1	2.4	0.558	0.291	0.633	4	9	20
								2	2.1	0.594	0.236	0.617	3	8	19
								3	1.9	0.797	0.249	0.626	3	8	19
								4	1.6	1.244	0.185	0.599	3	7	19
								5	1.8	0.765	0.185	0.591	3	8	21
4	8.00	CLAY	110	20	22	251	6.3	1	3.8	0.386	0.533	0.678	5	10	22
								2	3.1	0.499	0.403	0.652	4	10	22
								3	3.0	0.600	0.423	0.655	5	10	22
5	9.10	CLAY	118	28	28	297	6.4	1	5.1	0.358	0.695	0.681	6	13	27
								2	3.7	0.571	0.511	0.657	5	12	27
								3	3.6	0.515	0.450	0.645	5	12	27
								4	3.0	0.651	0.343	0.619	5	11	28
								5	3.1	0.570	0.406	0.640	5	11	26
6	10.20	CLAY	137	28	28	319	7.8	1	5.0	0.319	0.528	0.645	6	14	31
								2	4.0	0.410	0.379	0.617	5	13	31
								3	3.6	0.541	0.409	0.627	5	13	30
								4	2.6	0.885	0.268	0.583	5	12	32
7	12.10	CLAY	163	45	35	387	6.1	1	6.1	0.444	1.144	0.681	10	22	45
								2	4.9	0.489	0.574	0.638	7	16	37
								3	4.4	0.557	0.471	0.619	7	16	38
								4	3.3	0.850	0.338	0.589	6	15	39
8	14.00	CLAY	186	34	39	436	8.5	1	8.8	0.327	1.099	0.668	11	23	50
								2	5.5	0.569	0.586	0.612	9	21	51
								3	5.3	0.630	0.580	0.611	9	21	51
								4	3.9	1.033	0.432	0.584	8	20	52
9	16.30	CLAY	221	44	45	495	8.8	1	7.9	0.370	0.959	0.657	10	23	50
								2	6.9	0.425	0.744	0.633	9	22	51
								3	5.9	0.510	0.623	0.620	9	21	49
								4	4.6	0.750	0.439	0.586	8	20	52
10	18.00	CLAY	249	66	55	606	10.3	1	10.7	0.272	1.253	0.667	13	27	58
								2	8.3	0.422	1.008	0.651	11	25	56
								3	7.2	0.466	0.750	0.623	10	24	58

IN SITU SITE INVESTIGATION

Project	NGI - Onsøy Site
Client	NGI
Project No.	P1170112
Figure No.	ONSP01

Pressuremeter Test Details

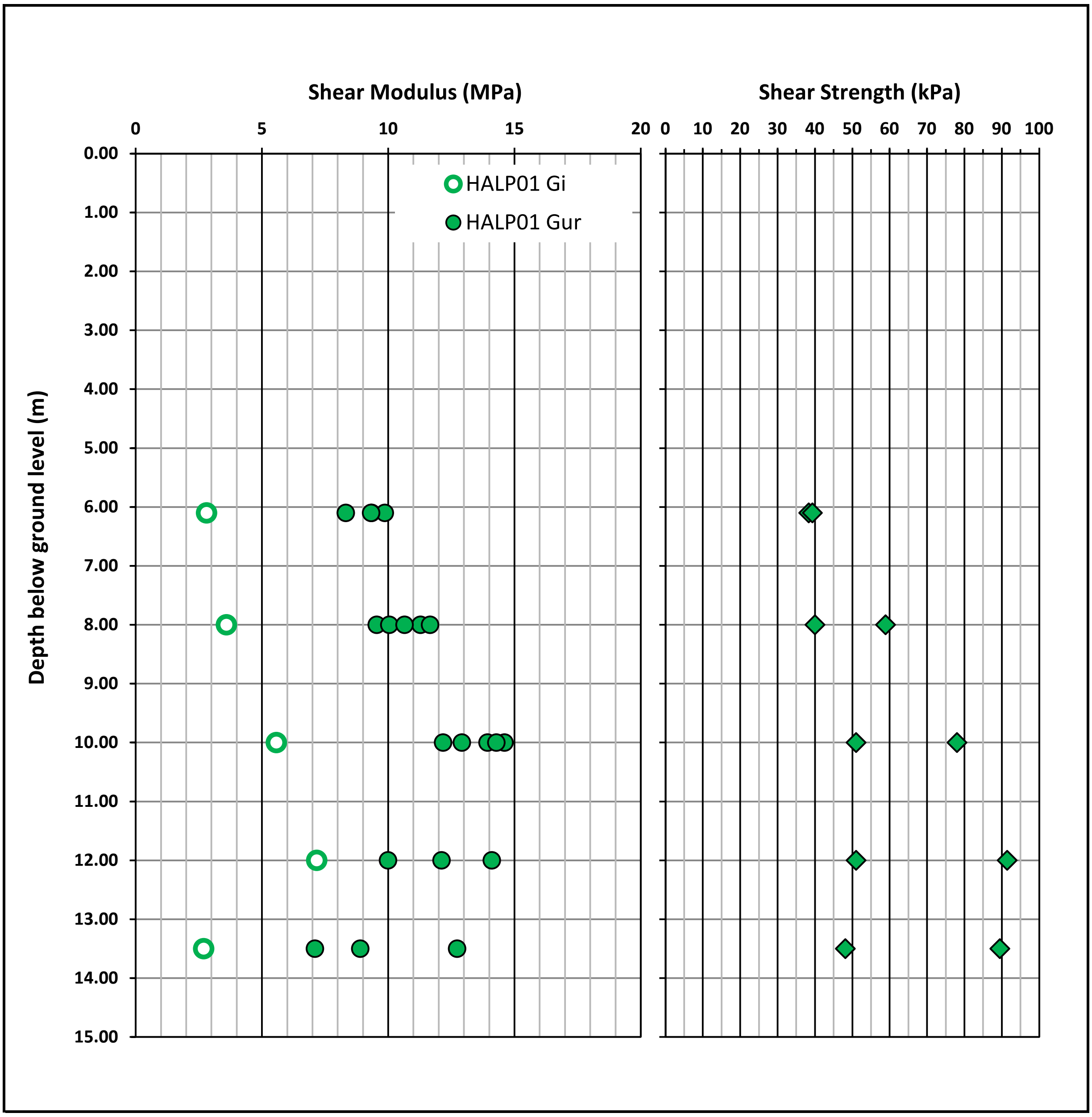
Test	Test Depth (m)	Boring interval		Insertion time	Initial Arm Response						Overall Pressure Displacement	No. of unload - reload loops	Comments
		From (m)	To (m)	(mins)	Arm 1	Arm 2	Arm 3	Arm 4	Arm 5	Arm 6			
HALP01													
1	6.10	5.60	6.60	3	Good	Good	Good	High	Good	Low	Good - arm 5 variance	4	Reliable test
2	8.00	7.50	8.50	6	Good	High	Good	High	Good	Good	Good - arm 5 variance	5	Reliable test
3	10.00	9.50	10.50	2	Low	High	Good	Good	Good	Good	Variable on arms 2, 3 & 5	5	Reliable test
4	12.00	11.50	12.50	3	Good	Good	Good	Good	Offline	Offline	Variable on arms 1 & 2	3	Reliable test
5	13.50	13.00	14.00	3	Low	High	Good	Good	Offline	Offline	Variable	3	Disturbance noted. Insitu Ho questionable.
ONSP01													
1	5.00	4.50	5.50	3	Good	Good	Good	High	High	Good	Good - arm 5 variance	3	Reliable test
2	6.10	5.60	6.60	1	Low	Good	Good	High	High	Good	Good - arm 5 variance	3	Reliable test
3	7.10	6.60	7.60	2	Good	Good	Good	High	High	Good	Variable on arms 2 & 5	5	Reliable test
4	8.00	7.50	8.50	2	Good	High	Good	High	Good	Good	Variable	3	Disturbance noted. Insitu Ho questionable.
5	9.10	8.60	9.60	2	Good	Good	Good	High	Good	Good	Variable	5	Disturbance noted. Insitu Ho questionable.
6	10.20	9.70	10.70	2	Good	Good	High	High	High	Good	Variable on arms 1, 5 & 6	4	Disturbance noted.
7	12.10	11.60	12.60	2	Good	Good	Good	High	High	High	Variable	4	Disturbance noted.
8	14.00	13.50	14.50	2	Good	Good	Good	Good	High	High	Variable	4	Disturbance noted.
9	16.30	15.80	16.80	3	Good	Good	Low	High	High	High	Variable on arms 2 & 5	4	Disturbance noted.
10	18.00	17.50	18.50	15	Good	Good	High	High	High	Good	Variable on arm 1	3	Disturbance noted. Membrane pulled out.

Project	NGI - Halden & Onsøy
Client	NGI
Project No.	P1170112
Figure No.	1

IN SITU SITE INVESTIGATION

Pressuremeter Shear Modulus & Undrained Shear Strength Plot

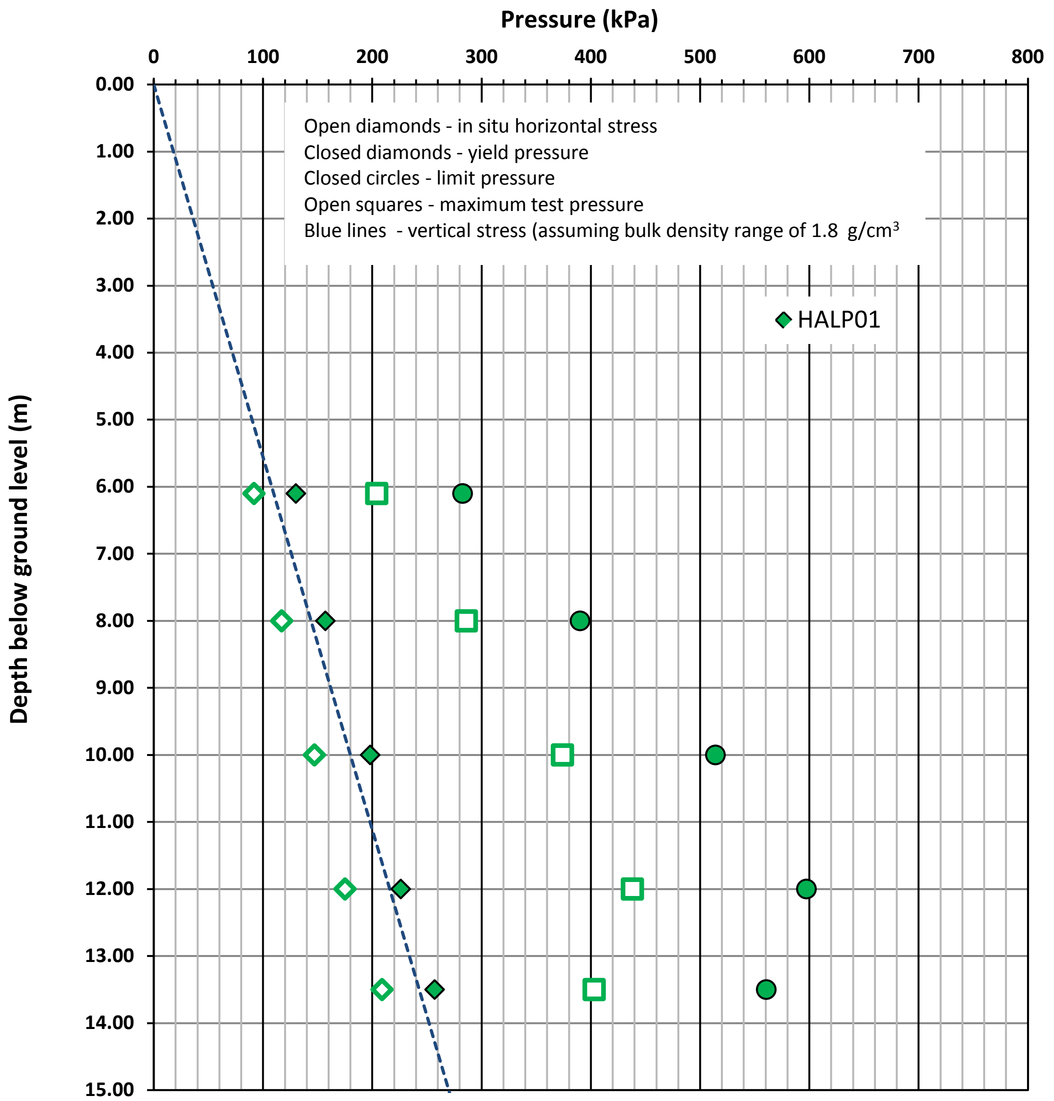
IN SITU SITE INVESTIGATION



Project	NGI - Halden Site	**Figure No.**	2
Client	NGI		
Project No.	P1170112		

Pressuremeter In Situ Horizontal Stress, Yield & Limit Pressure Plot

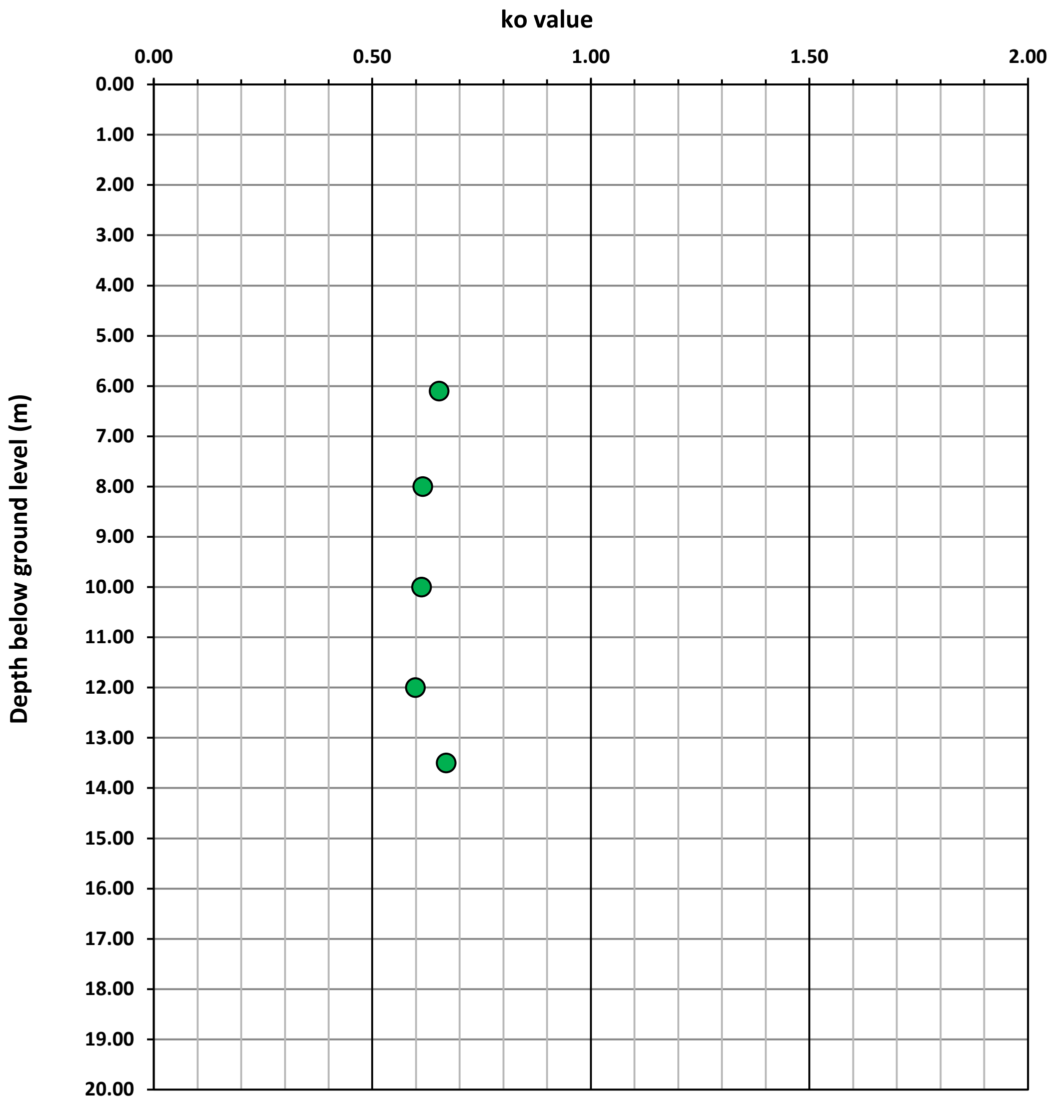
IN SITU
SITE INVESTIGATION



Project	NGI - Halden Site	**Figure No.**	3
Client	NGI		
Project No.	P1170112		

Pressuremeter ko Plot

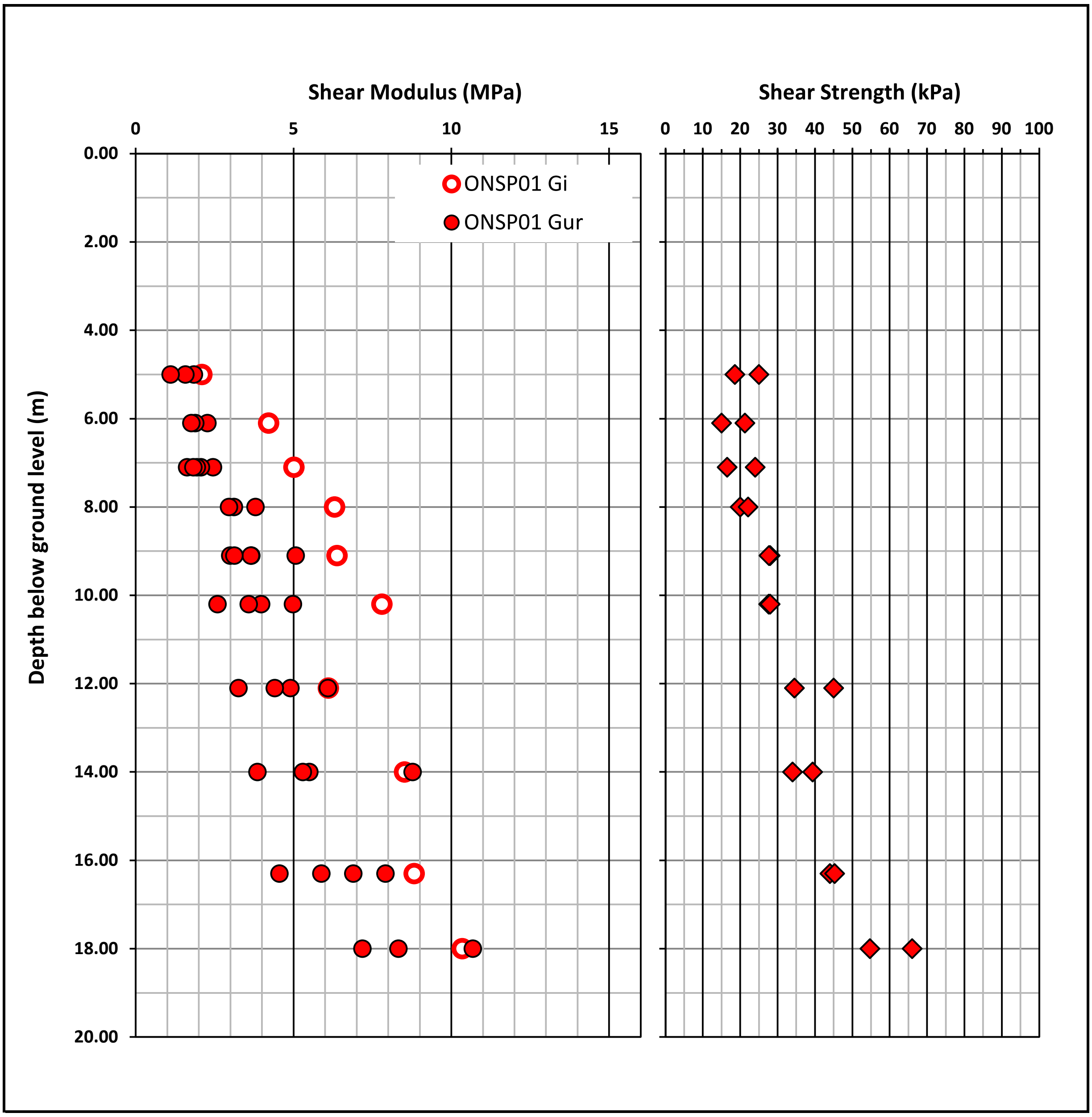
IN SITU
SITE INVESTIGATION



Project	NGI - Halden Site	**Figure No.**	4
Client	NGI		
Project No.	P1170112		

Pressuremeter Shear Modulus & Undrained Shear Strength Plot

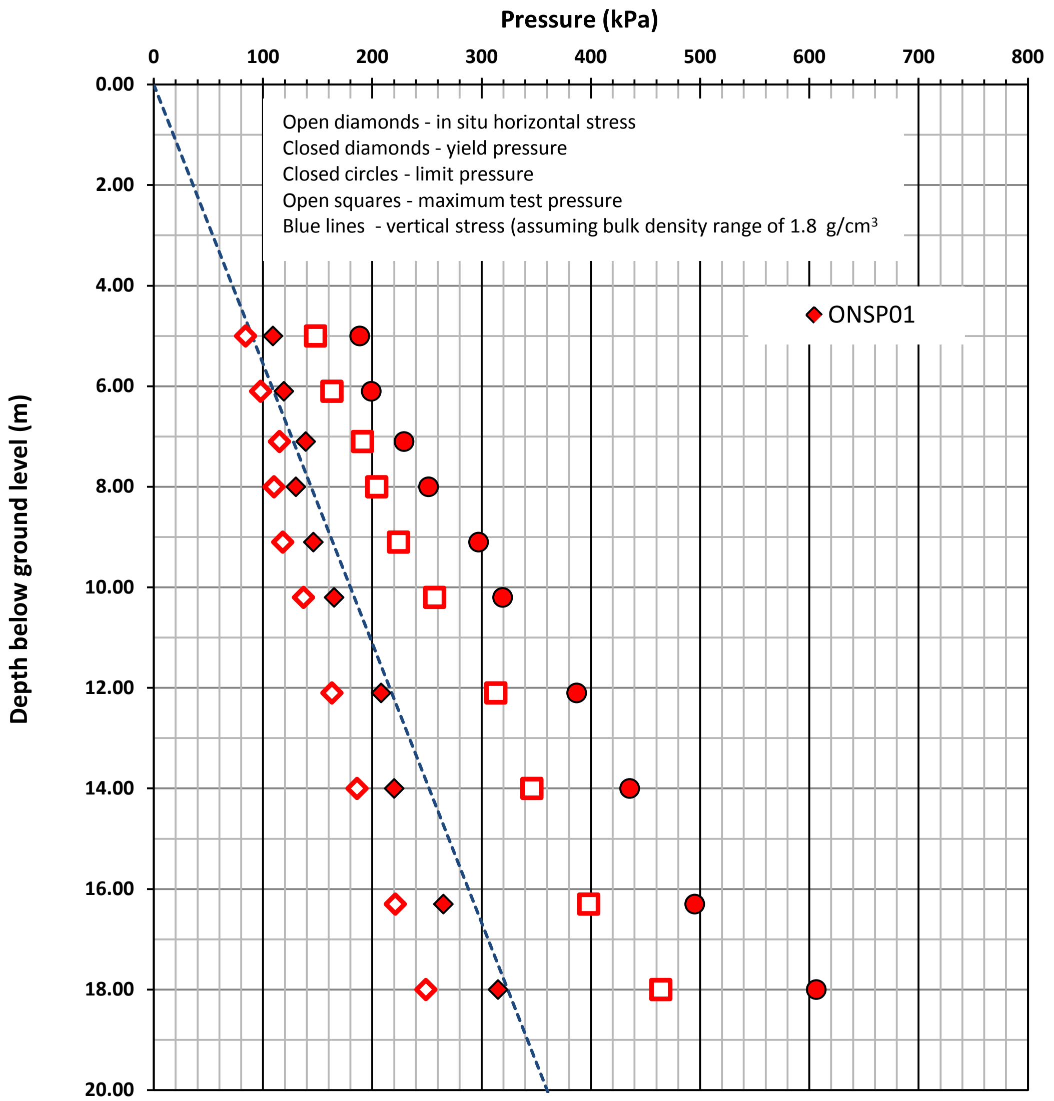
IN SITU
SITE INVESTIGATION



Project	NGI - Onsøy Site	Figure No.	5
Client	NGI		
Project No.	P1170112		

Pressuremeter In Situ Horizontal Stress, Yield & Limit Pressure Plot

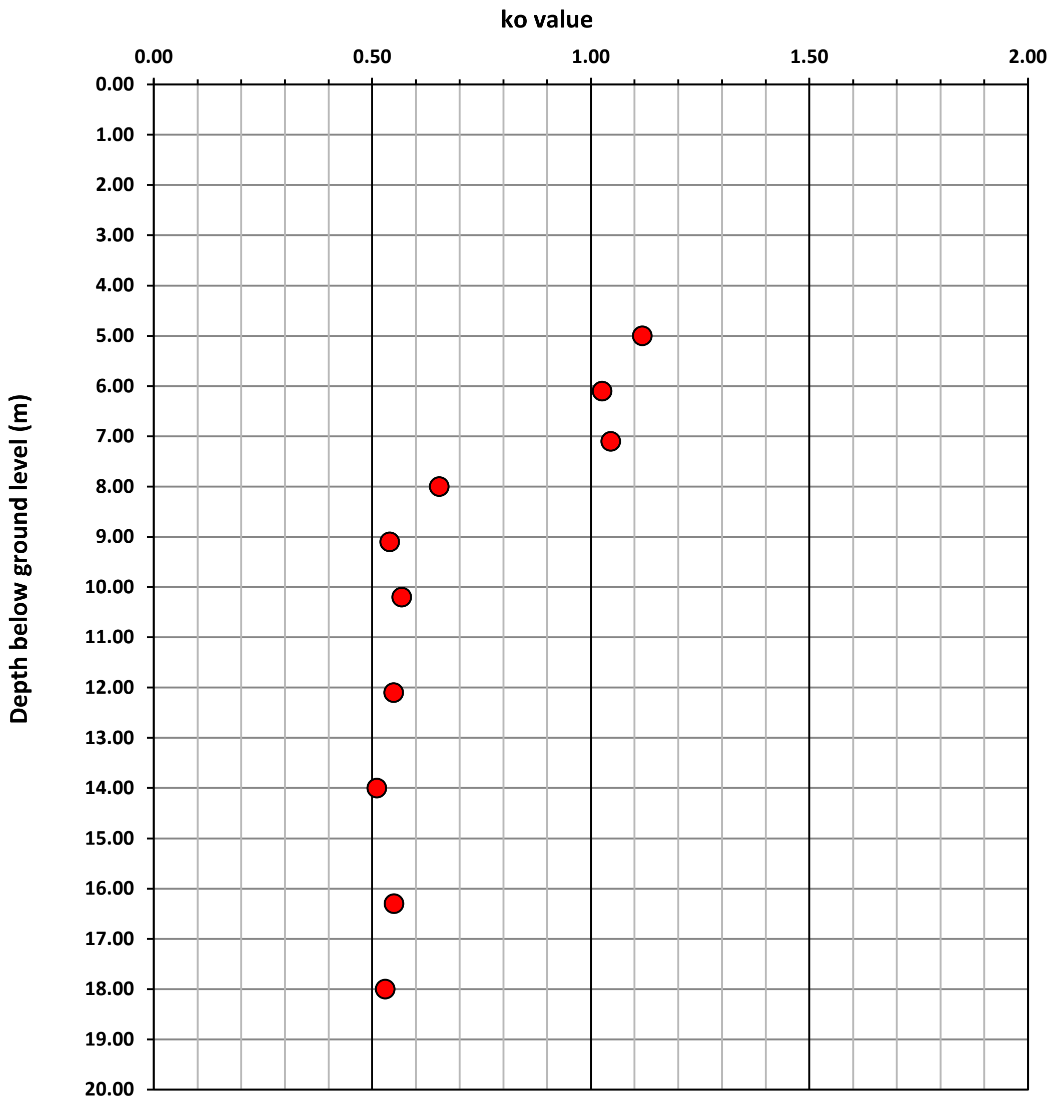
IN SITU SITE INVESTIGATION



Project	NGI - Onsøy Site	Figure No.	6
Client	NGI		
Project No.	P1170112		

Pressuremeter ko Plot

IN SITU
SITE INVESTIGATION



Project	NGI - Onsøy Site	**Figure No.**	7
Client	NGI		
Project No.	P1170112		

Pressuremeter Results Summary - Stress

Test	Depth (m)	Groundwater level*	σ_{ho}	$\sigma_{ho'}$	σ_{vo}	$\sigma_{vo'}$	ko
		(kPa)					
HALP01							
1	6.10	44	91	47	116	72	0.65
2	8.00	61	117	56	152	91	0.62
3	10.00	79	147	68	190	111	0.61
4	12.00	96	175	79	228	132	0.60
5	13.50	110	209	99	258	148	0.67
ONSP01							
1	5.00	46	84	38	80	34	1.12
2	6.10	58	98	40	97	39	1.03
3	7.10	69	115	46	113	44	1.05
4	8.00	78	110	32	127	49	0.65
5	9.10	84	118	34	147	63	0.54
6	10.20	99	137	38	166	67	0.57
7	12.10	118	163	45	200	82	0.55
8	14.00	136	186	50	234	98	0.51
9	16.30	160	221	61	271	111	0.55
10	18.00	186	249	63	305	119	0.53

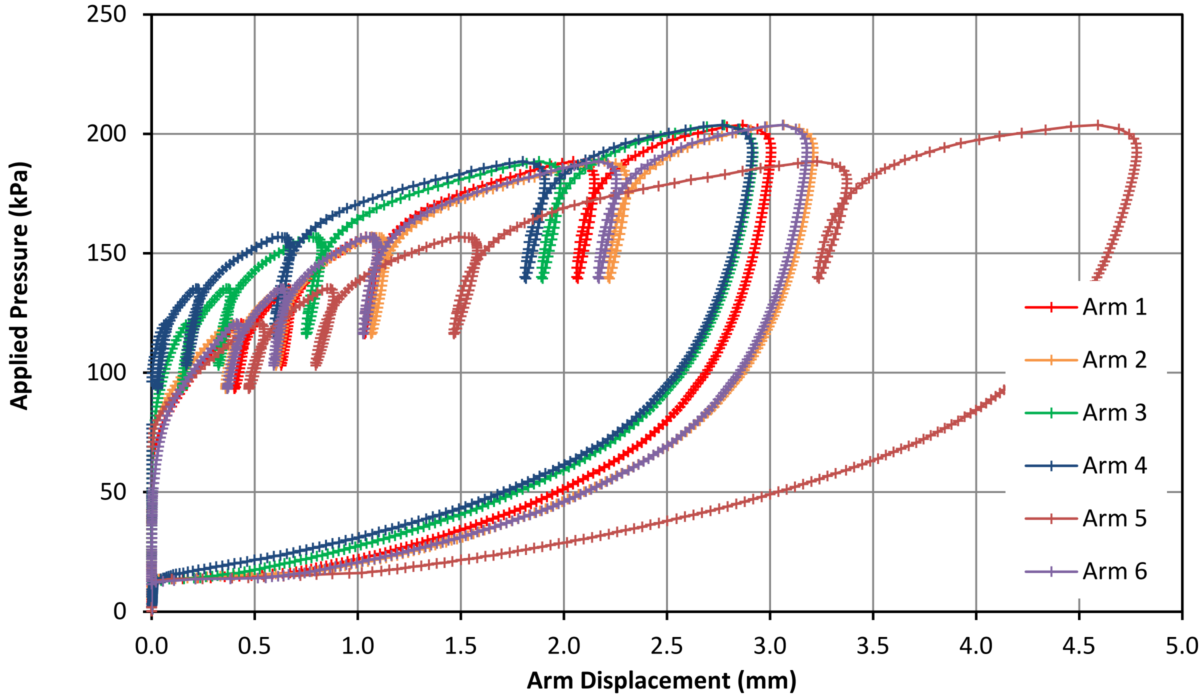
σ_{vo} values provided by NGI

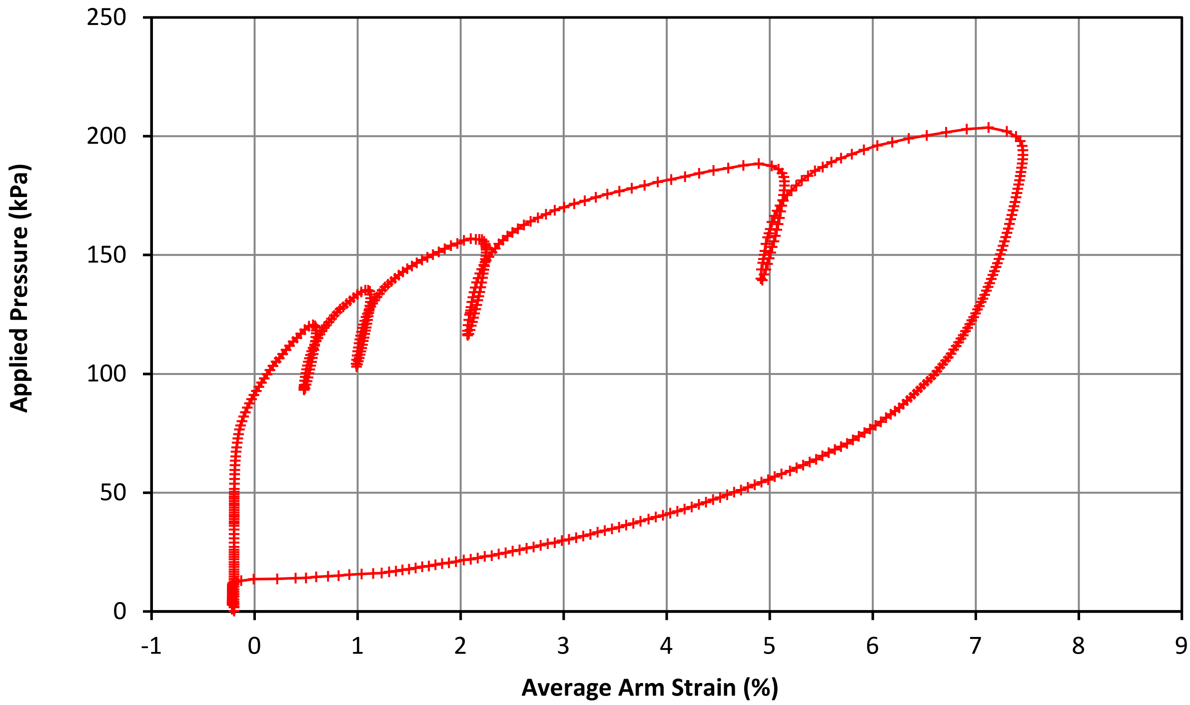
* groundwater levels based on NGI data

Project	NGI - Halden & Onsøy
Client	NGI
Project No.	P1170112
Figure No.	8

Pressuremeter Test Overview

Test Date	16/09/2017	Test No.	1
Borehole	HALP01	Test Depth (m)	6.10



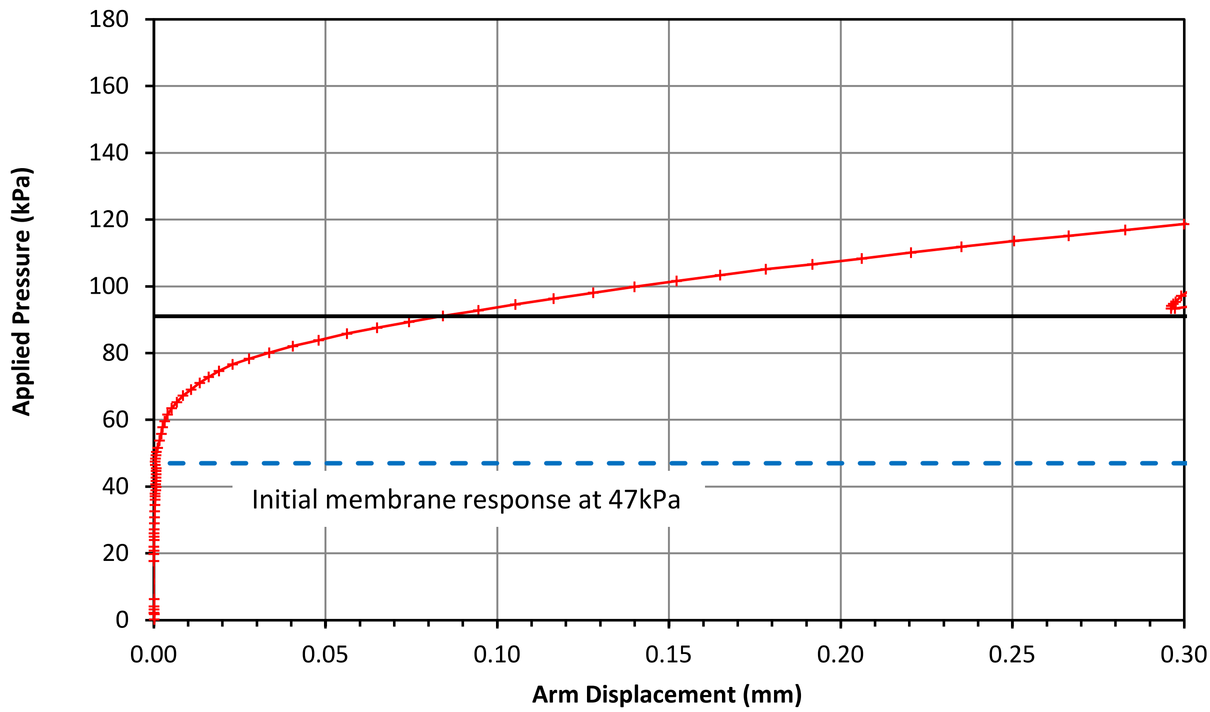


Comments

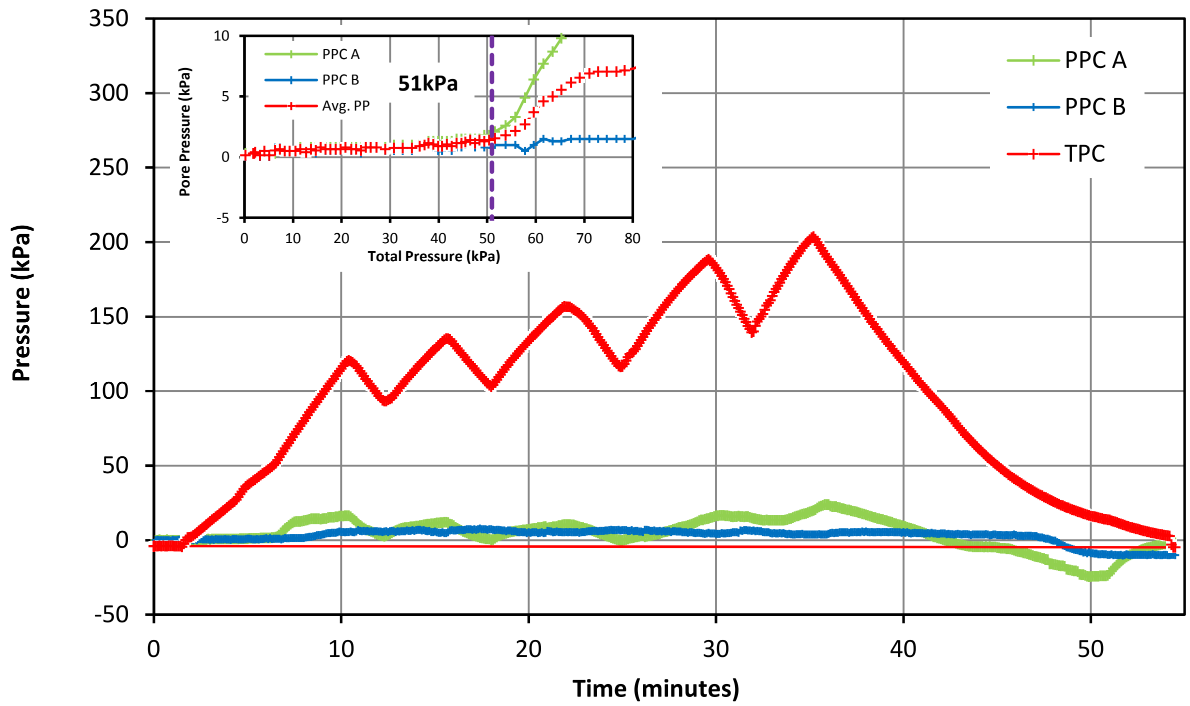
Project	NGI - Halden Site	Figure No.	HALP01 T01 - 01
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Lift Off Stress & Pore Pressure Record

Test Date	16/09/2017	Test No.	1
Borehole	HALP01	Test Depth (m)	6.10



Lift Off Stress (Po)	91 kPa

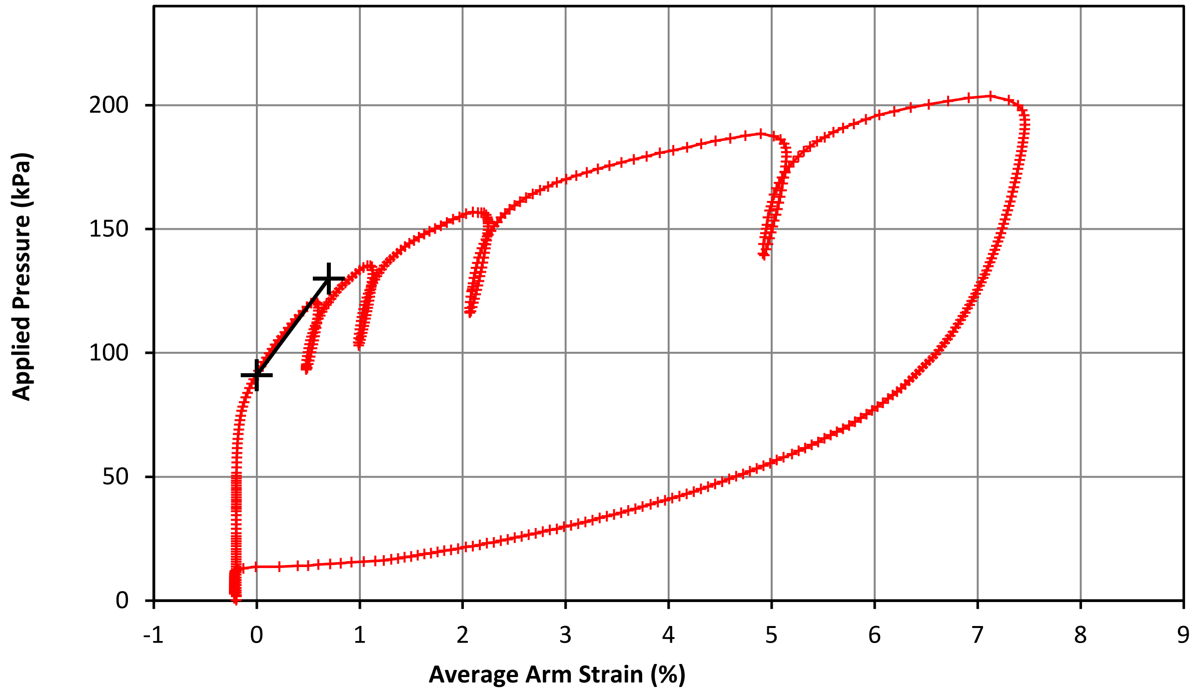


Project	NGI - Halden Site	Figure No.	HALP01 T01 - 02
Client	NGI		
Project No.	P1170112		

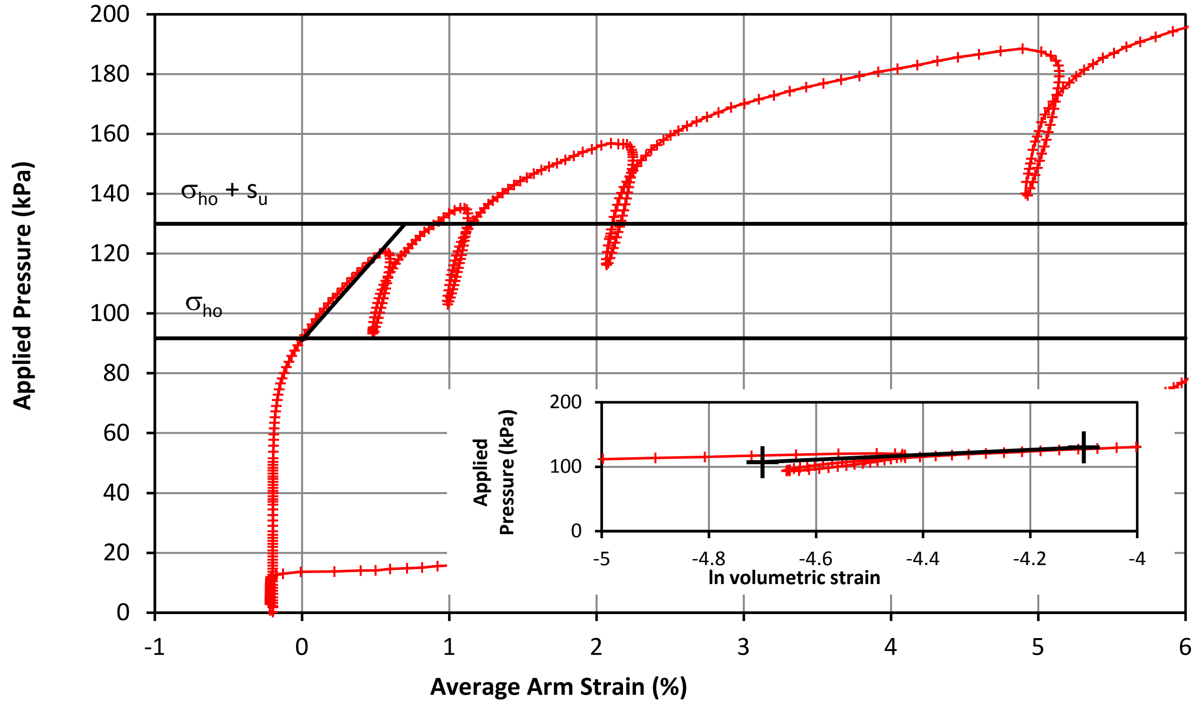
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	1
Borehole	HALP01	Test Depth (m)	6.10



Initial Modulus	Shear Modulus	2.8 MPa



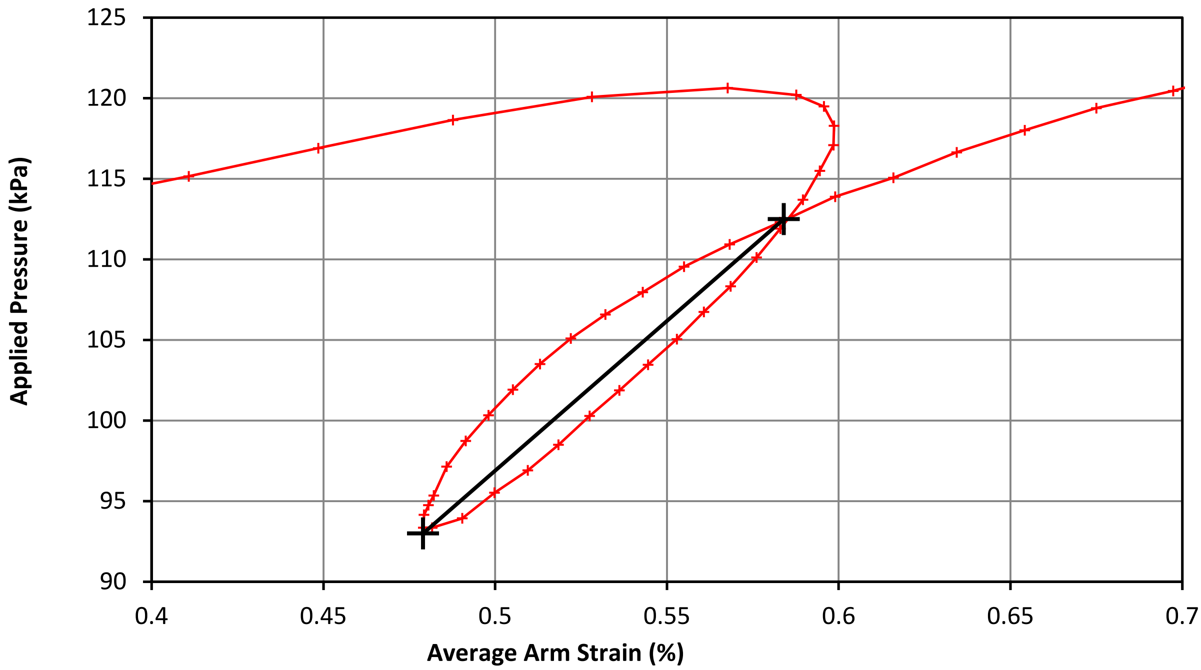
Marsland & Randolph	In situ horizontal stress	92 kPa
	Undrained Strength	38 kPa

Project	NGI - Halden Site	Figure No.	HALP01 T01 - 03
Client	NGI		
Project No.	P1170112		

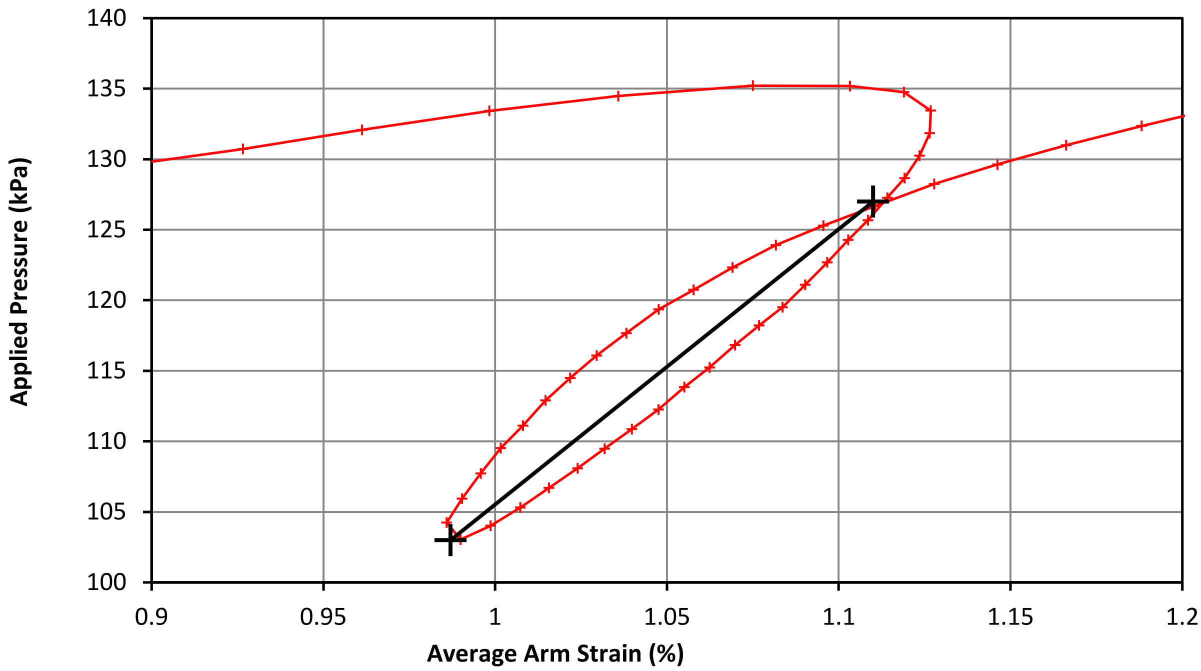
Pressuremeter Test Unload Reload Loop

IN SITU
SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	1
Borehole	HALP01	**Test Depth (m)**	6.10



Loop 1	Shear Modulus	9.3	MPa
	Cavity Strain Range	0.105	%



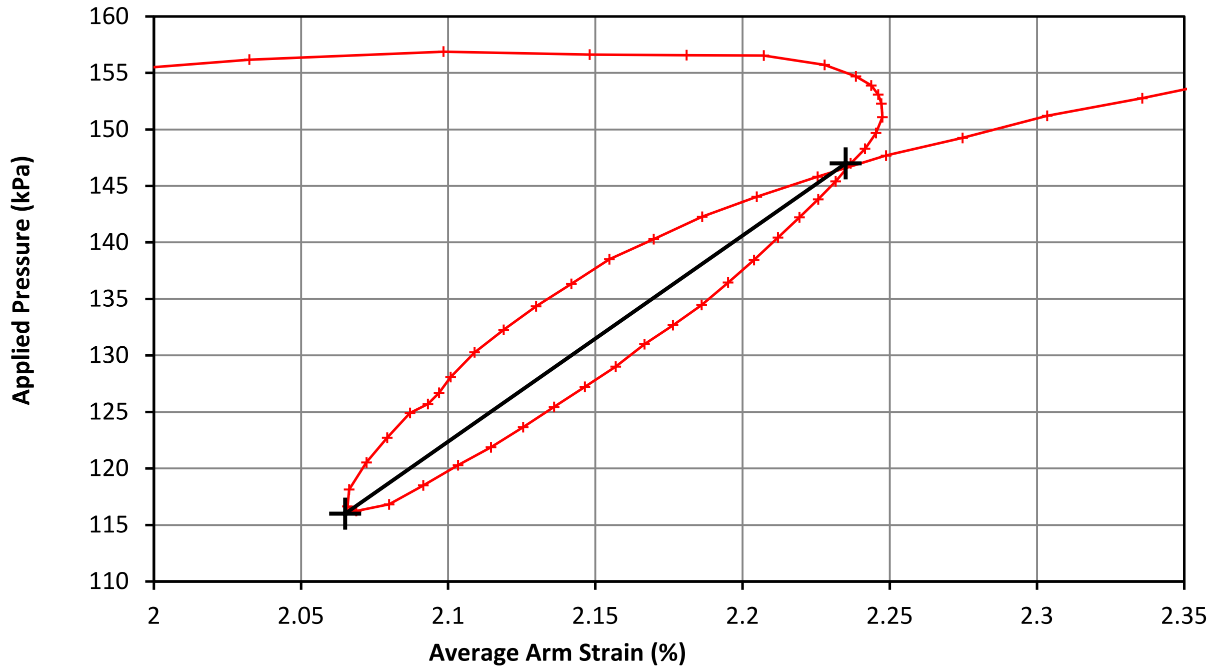
Loop 2	Shear Modulus	9.9	MPa
	Cavity Strain Range	0.123	%

Project	NGI - Halden Site	**Figure No.**	**HALP01 T01 - 04**
Client	NGI		
Project No.	P1170112		

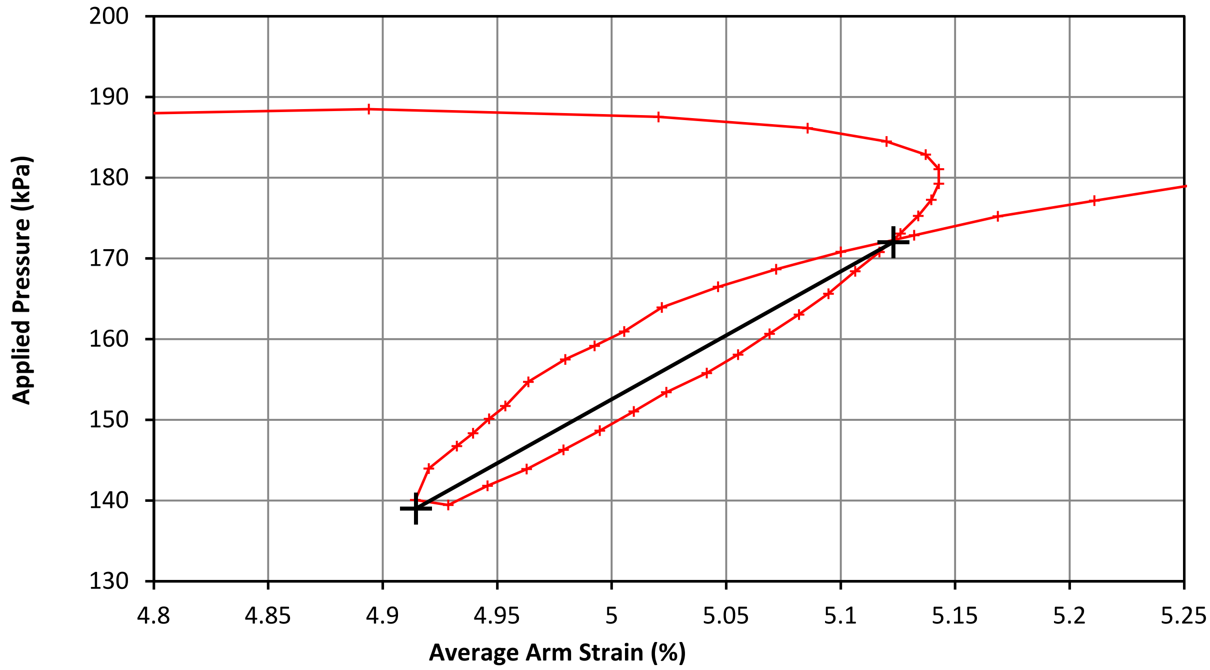
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	1
Borehole	HALP01	**Test Depth (m)**	6.10



Loop 3	Shear Modulus	9.3	MPa
	Cavity Strain Range	0.170	%



Loop 4	Shear Modulus	8.3	MPa
	Cavity Strain Range	0.209	%

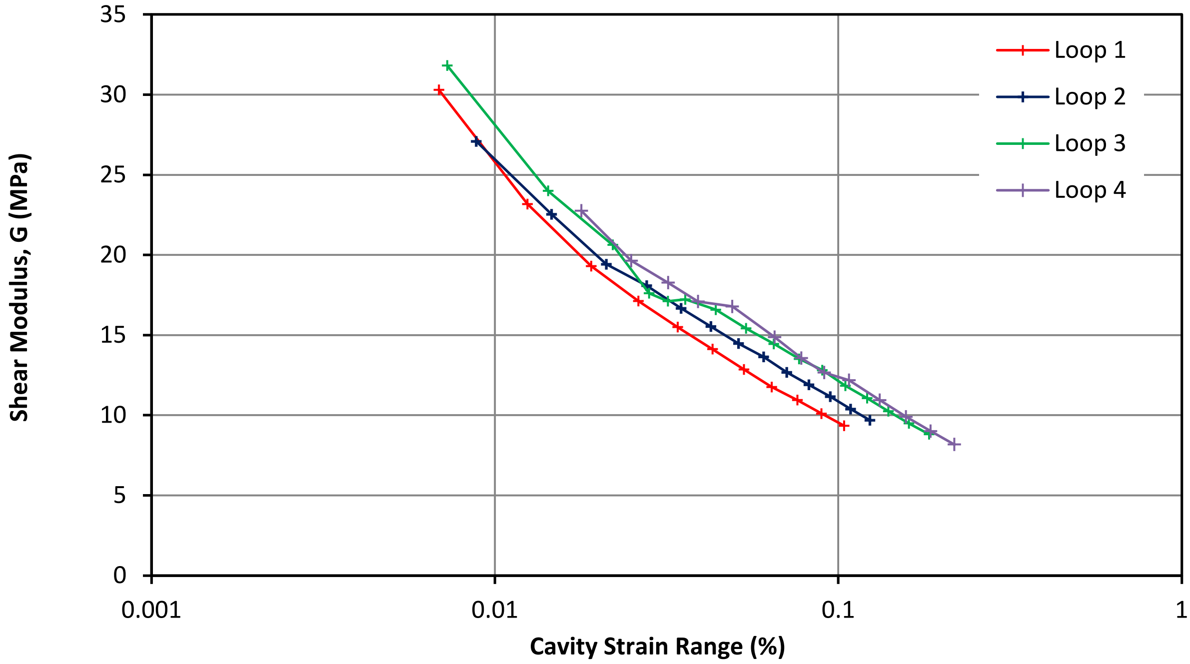
Project	NGI - Halden Site	**Figure No.**	HALP01 T01 - 05
Client	NGI		
Project No.	P1170112		

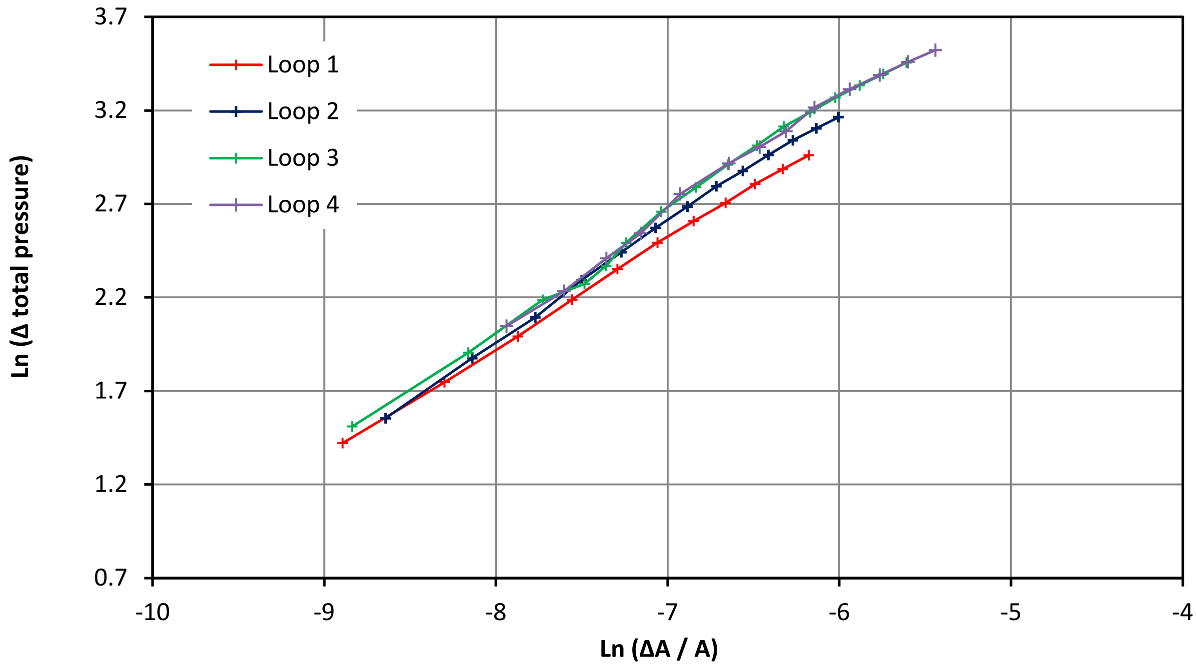
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	1
Borehole	HALP01	Test Depth (m)	6.10





Loop 1		Loop 2		Loop 3		Loop 4	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.576	0.693 (MPa)	0.620	1.023 (MPa)	0.626	1.130 (MPa)	0.608	0.997 (MPa)

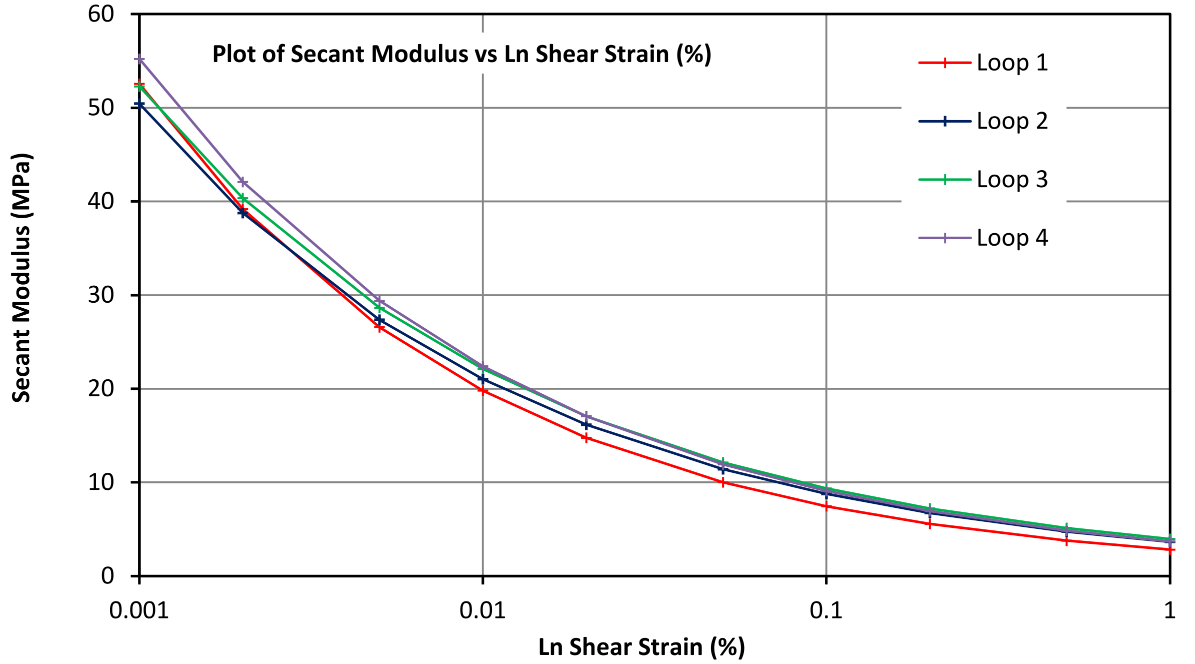
Project	NGI - Halden Site	Figure No.	HALP01 T01 - 06
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	1
Borehole	HALP01	Test Depth (m)	6.10



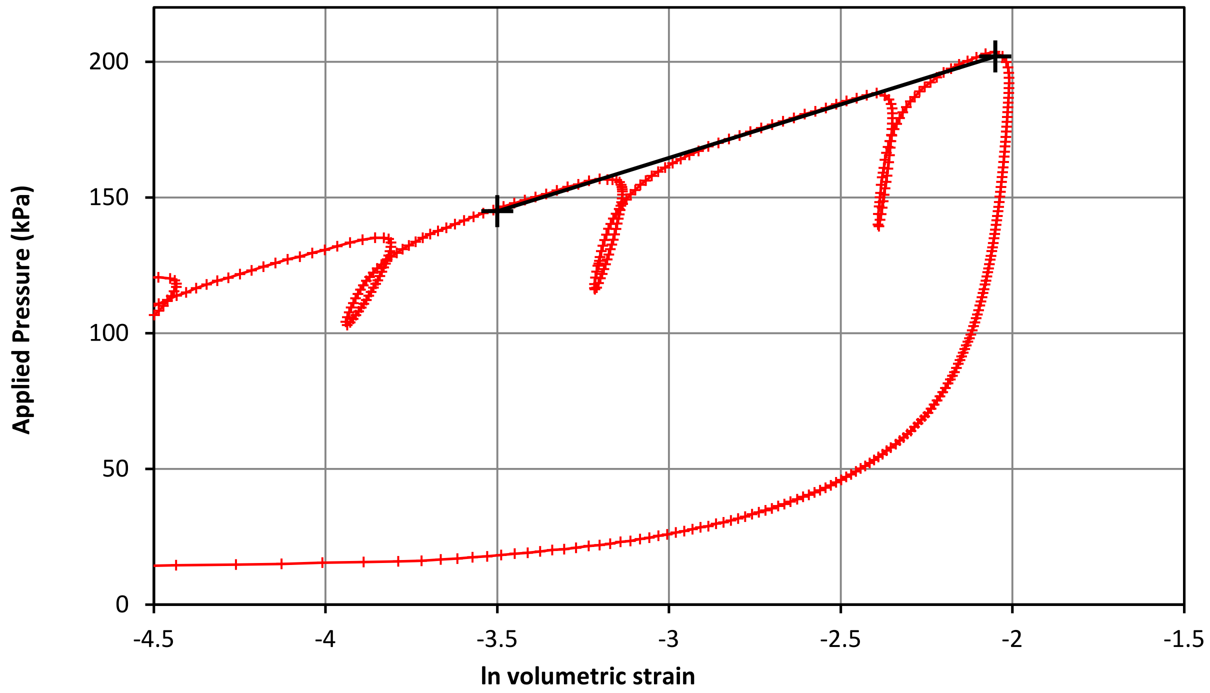
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4
0.001%	**53**	**50**	**52**	**55**
0.002%	39	39	40	42
0.005%	27	27	29	29
0.010%	**20**	**21**	**22**	**22**
0.020%	15	16	17	17
0.050%	10	11	12	12
0.100%	**7**	**9**	**9**	**9**
0.200%	6	7	7	7
0.500%	4	5	5	5
1.000%	**3**	**4**	**4**	**4**

Project	NGI - Halden Site	Figure No.	HALP01 T01 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	1
Borehole	HALP01	**Test Depth (m)**	6.10

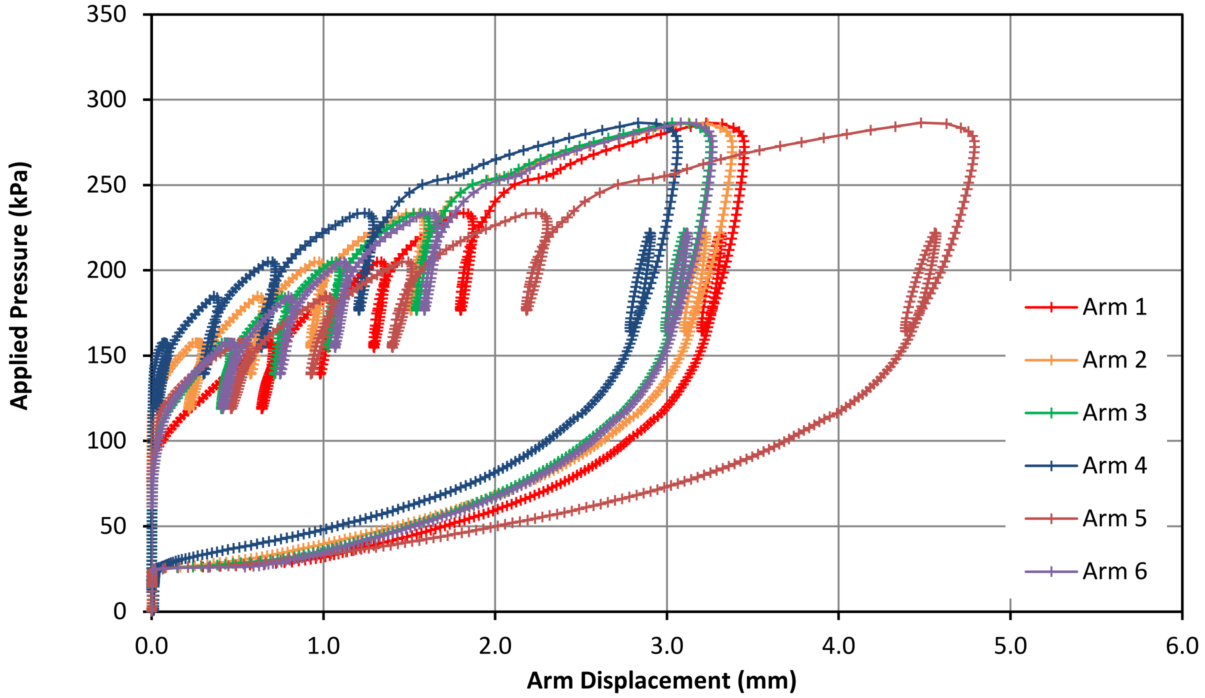


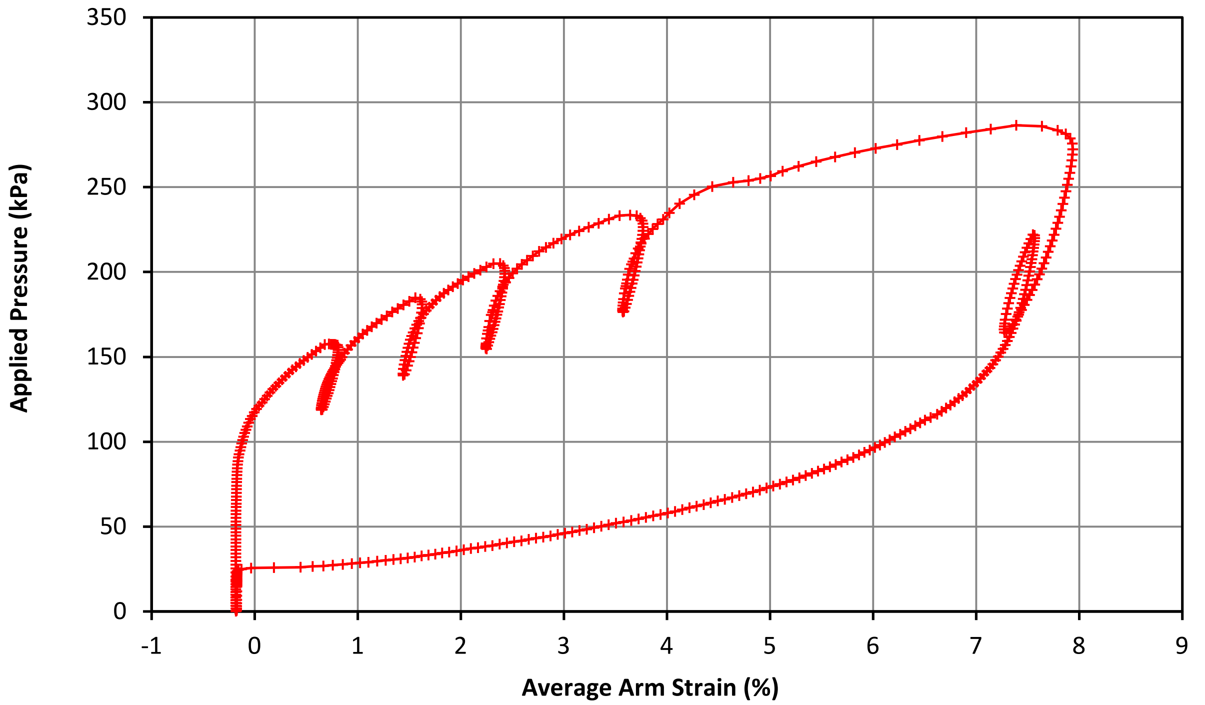
Strength	Undrained Shear	39	kPa
	Limit Pressure	283	kPa

Project	NGI - Halden Site	**Figure No.**	**HALP01 T01 - 08**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	16/09/2017	Test No.	2
Borehole	HALP01	Test Depth (m)	8.00





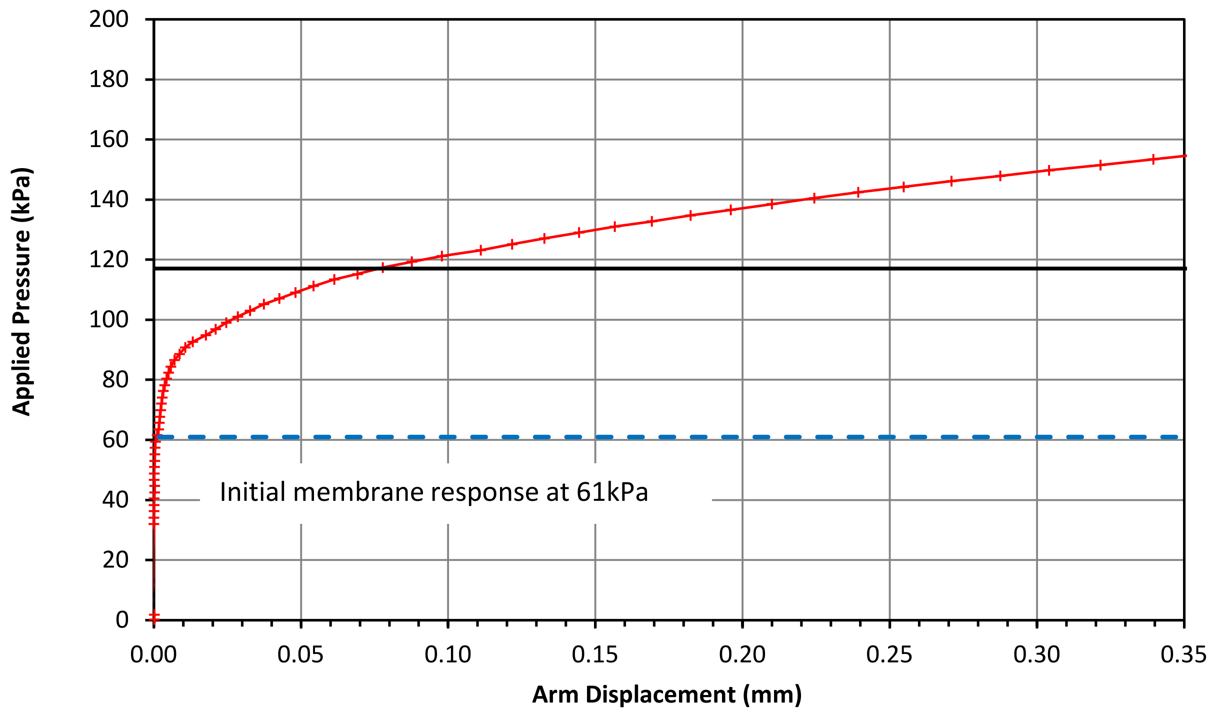
Comments

Project	NGI - Halden Site	Figure No.	HALP01 T02 - 01
Client	NGI		
Project No.	P1170112		

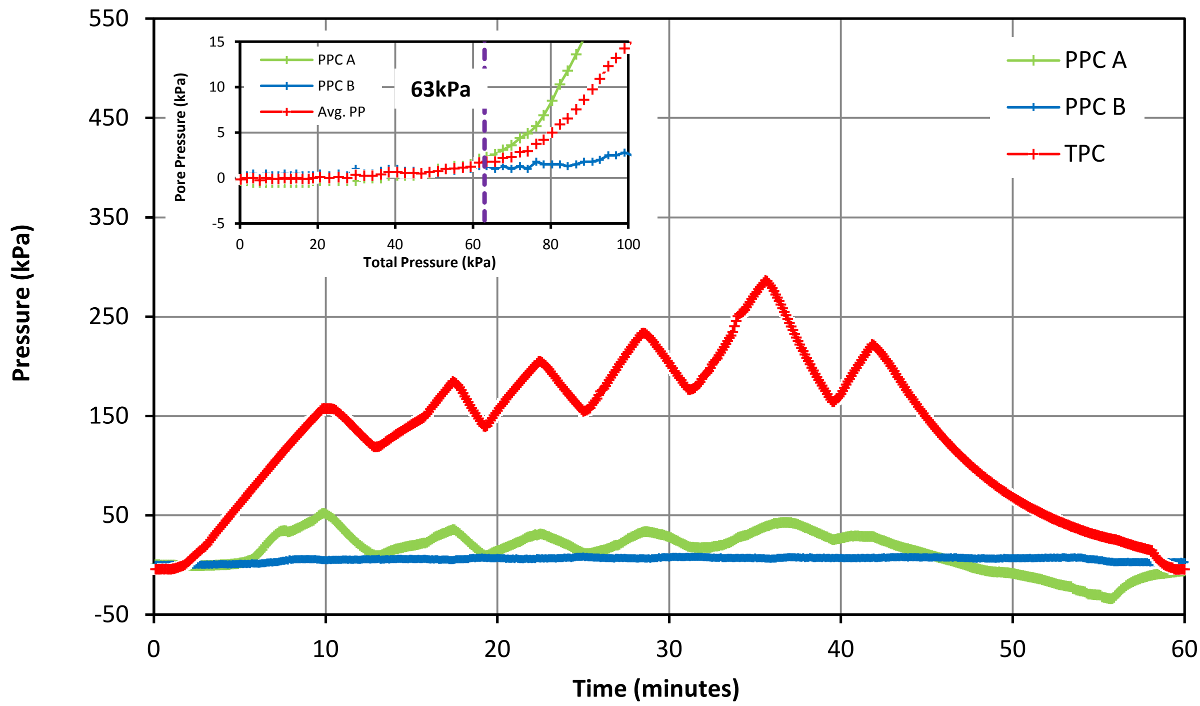
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU
SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00



Lift Off Stress (Po)	117 kPa

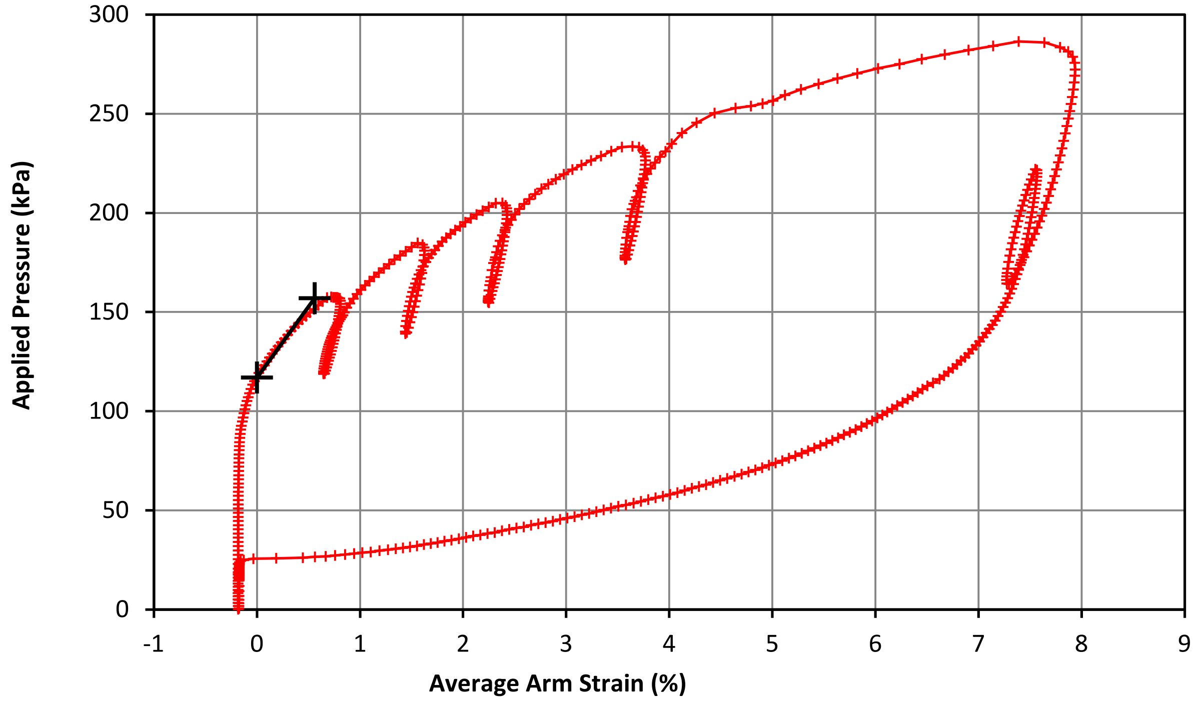


Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 02**
Client	NGI		
Project No.	P1170112		

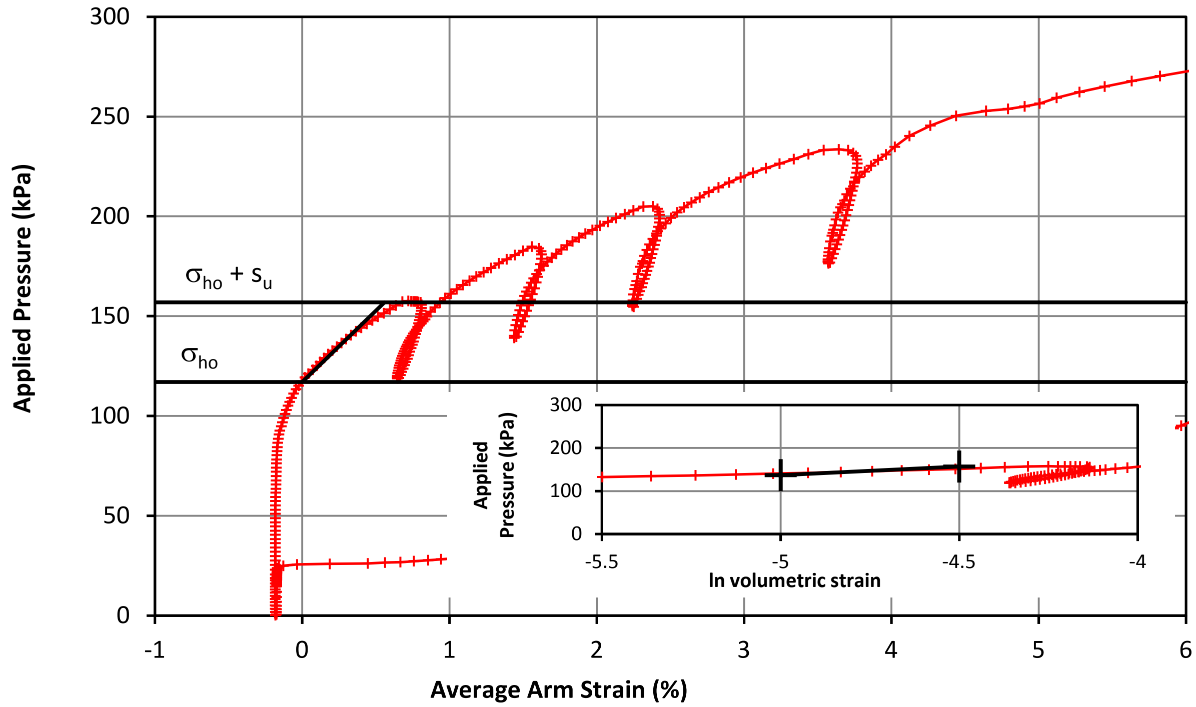
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00



Initial Modulus	Shear Modulus	3.6 MPa



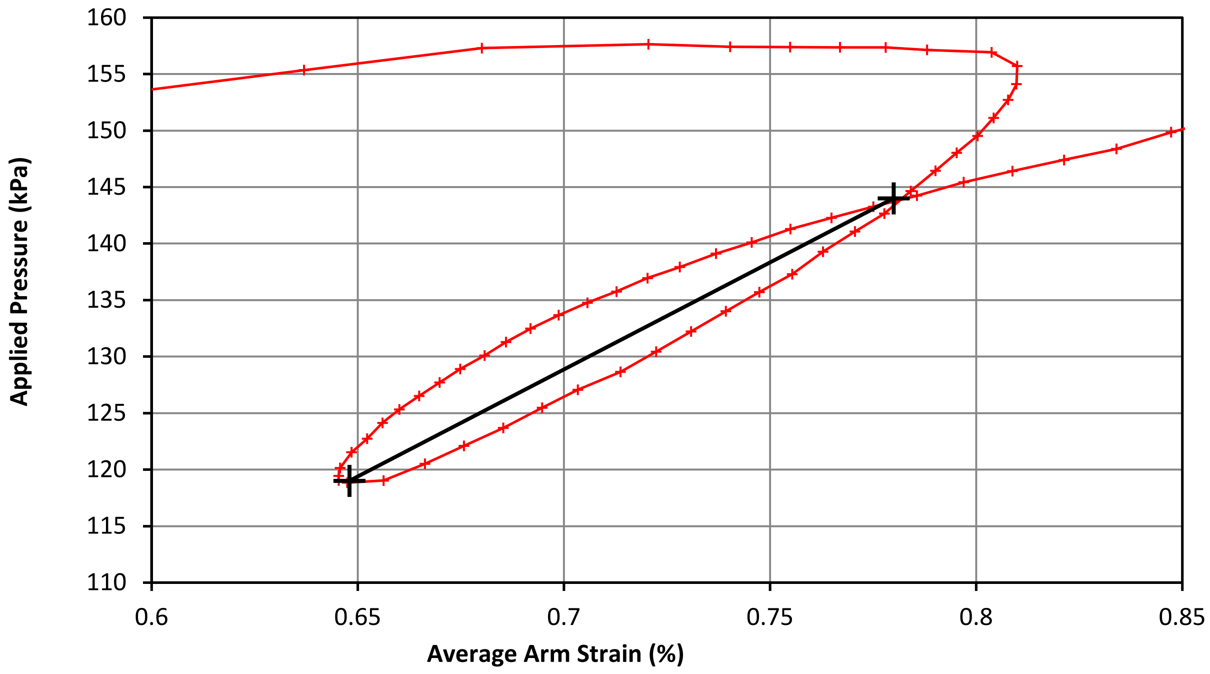
Marsland & Randolph	In situ horizontal stress	117 kPa
	Undrained Strength	40 kPa

Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 03**
Client	NGI		
Project No.	P1170112		

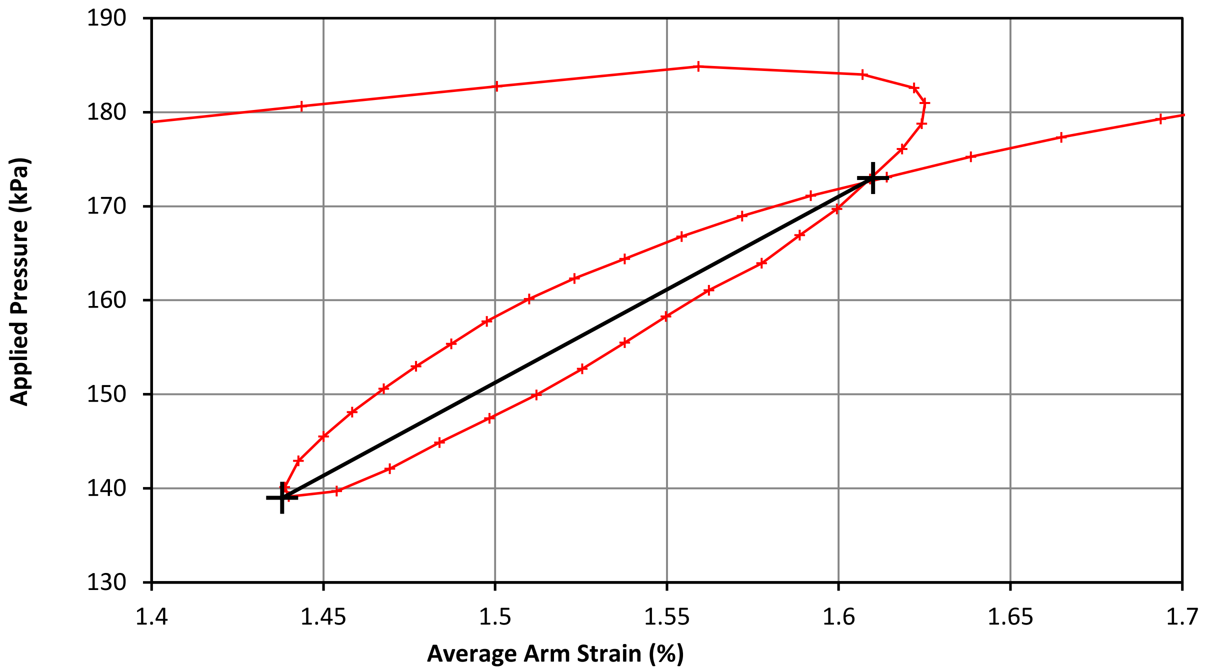
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00



Loop 1	Shear Modulus	9.5	MPa
	Cavity Strain Range	0.132	%



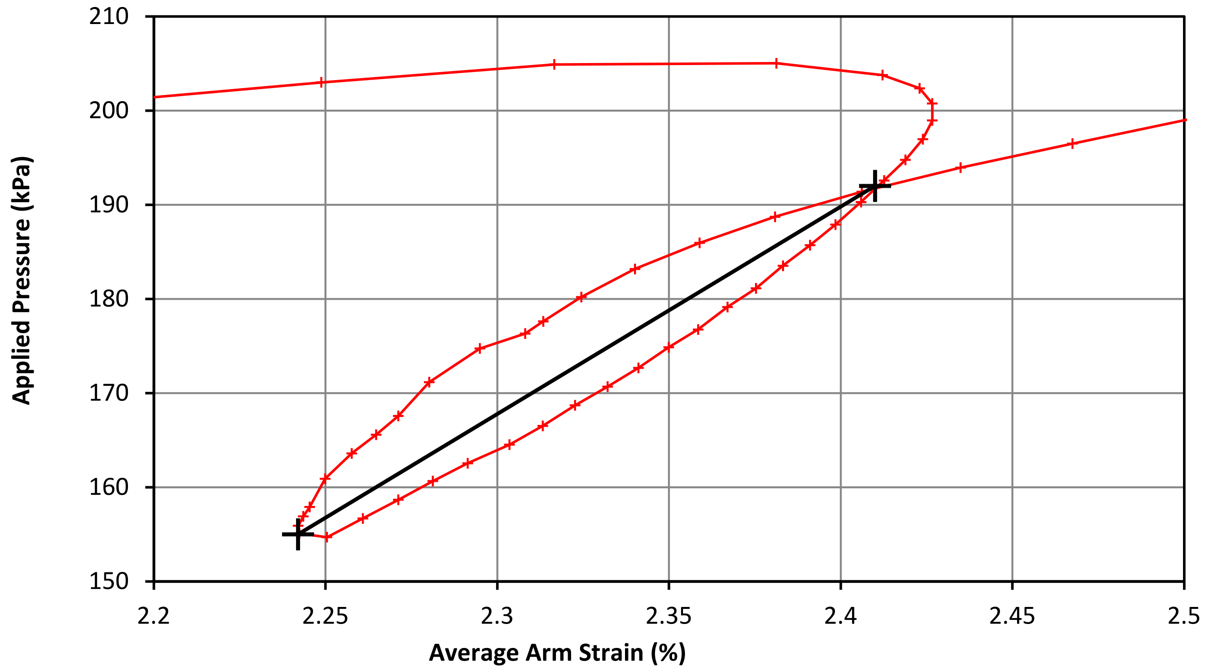
Loop 2	Shear Modulus	10.0	MPa
	Cavity Strain Range	0.172	%

Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 04**
Client	NGI		
Project No.	P1170112		

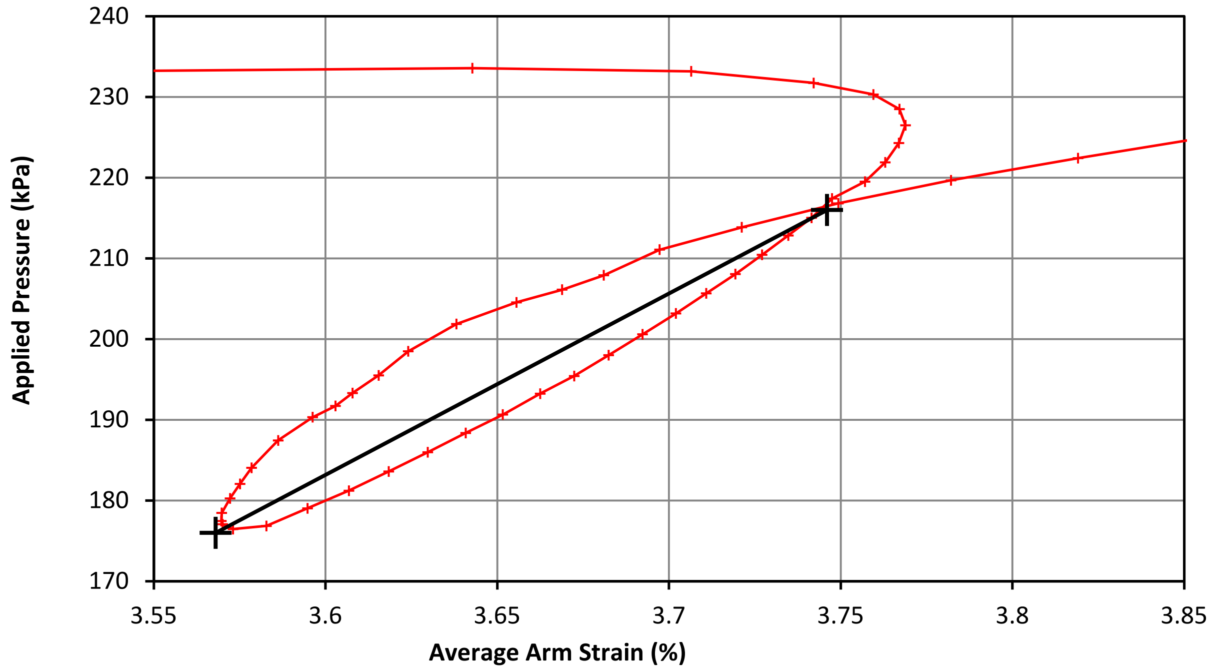
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00



Loop 3	Shear Modulus	11.3	MPa
	Cavity Strain Range	0.168	%

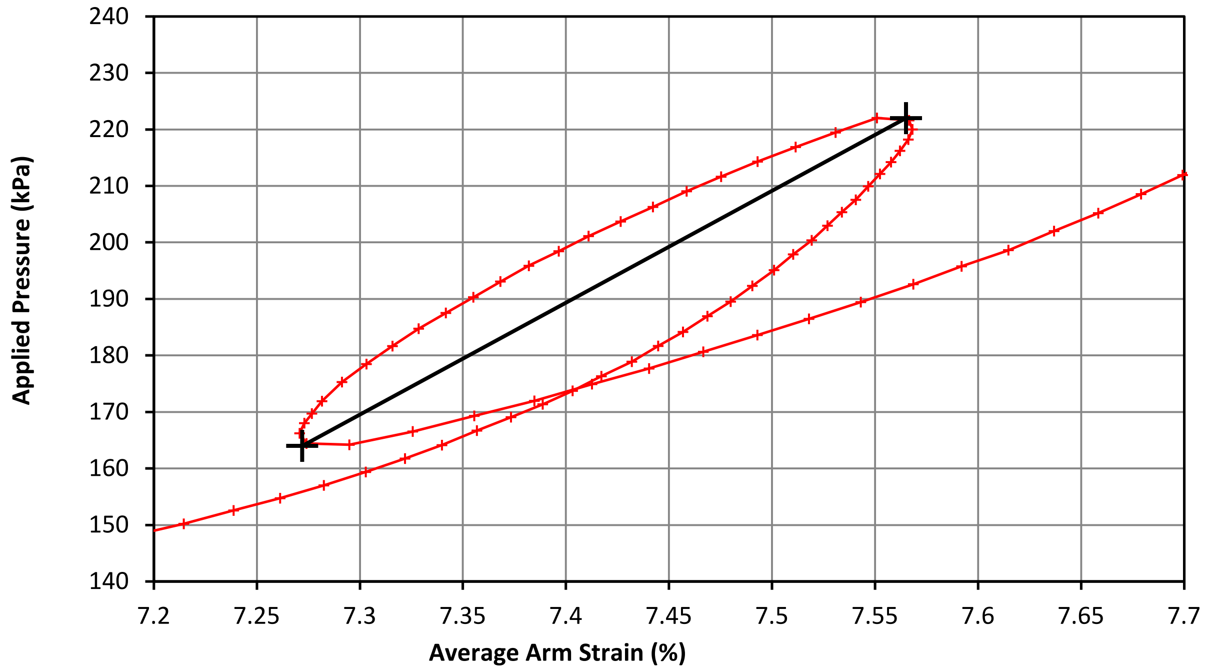


Loop 4	Shear Modulus	11.7	MPa
	Cavity Strain Range	0.178	%

Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 05**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00



Loop 5	Shear Modulus	10.6	MPa
	Cavity Strain Range	0.293	%

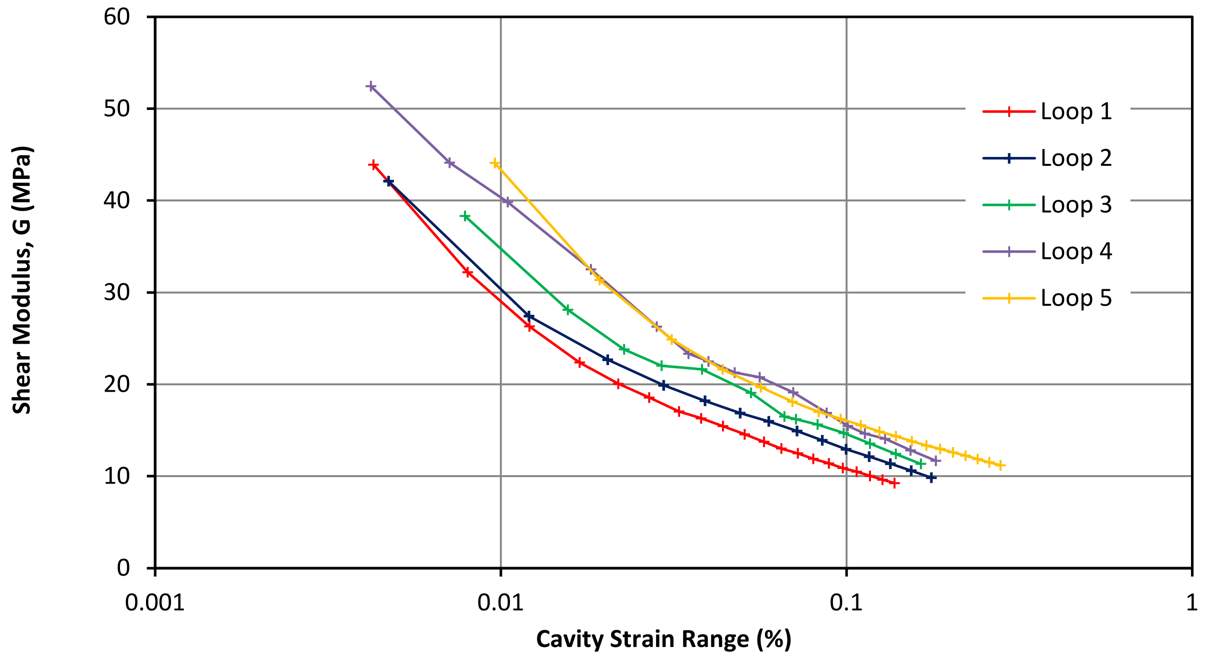
Loop 6	Shear Modulus	27.9	MPa
	Cavity Strain Range	0.148	%

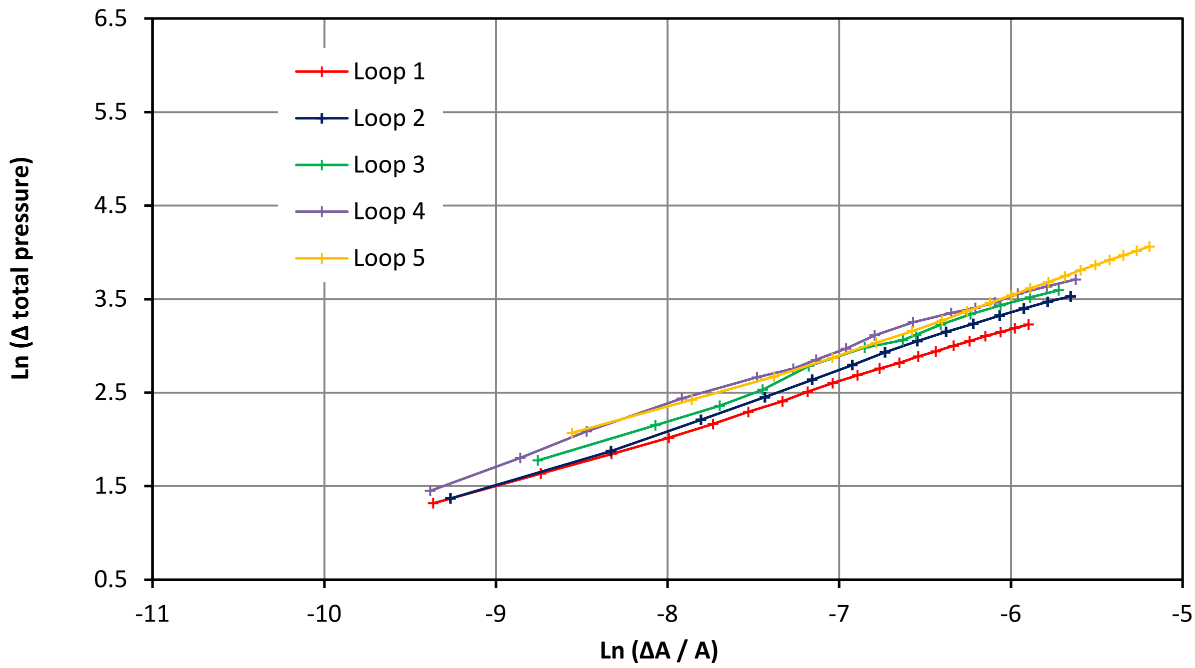
Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis
Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	2
Borehole	HALP01	Test Depth (m)	8.00





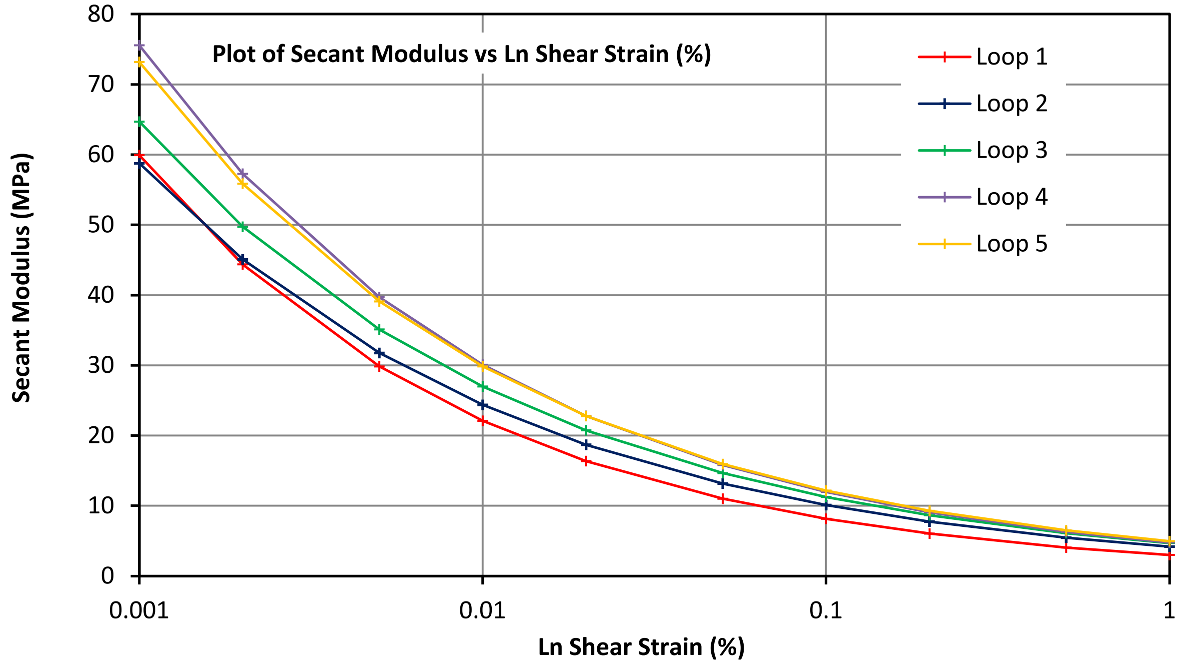
Loop 1		Loop 2		Loop 3		Loop 4		Loop 5	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.567	0.721 (MPa)	0.618	1.166 (MPa)	0.620	1.318 (MPa)	0.600	1.260 (MPa)	0.610	1.351 (MPa)

Project	NGI - Halden Site	Figure No.	HALP01 T02 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis
Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	16/09/2017	Test No.	2
Borehole	HALP01	Test Depth (m)	8.00



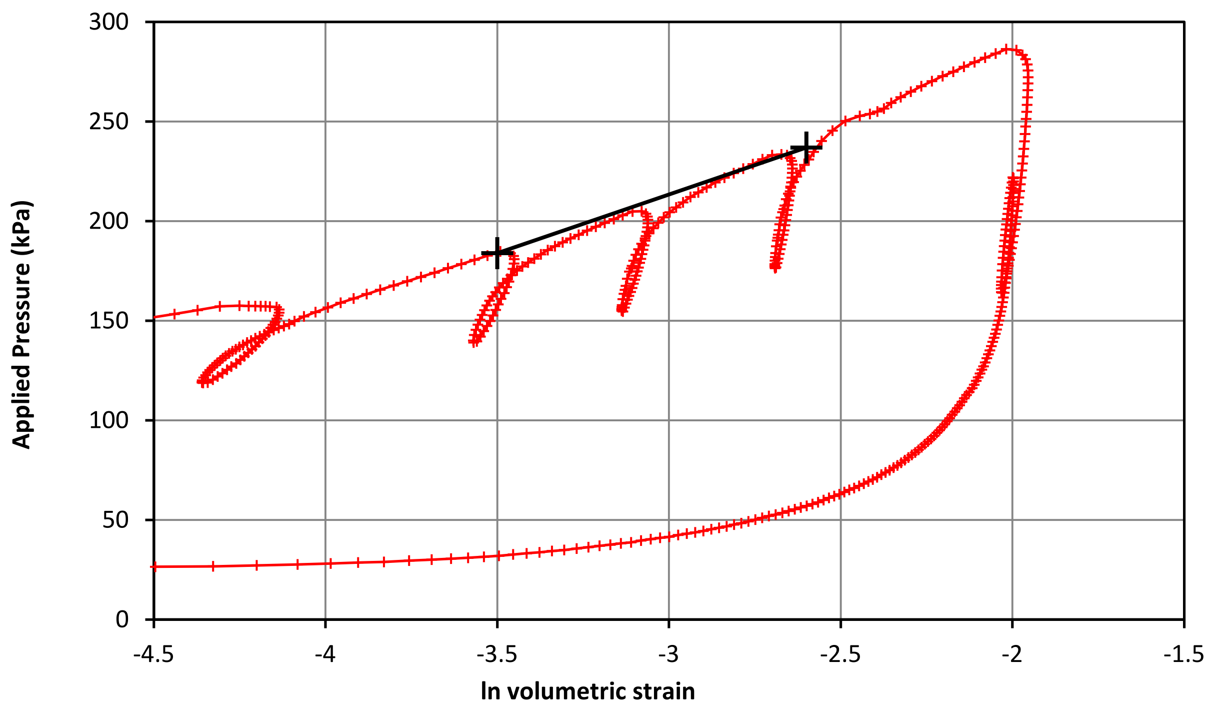
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5
0.001%	**60**	**59**	**65**	**76**	**73**
0.002%	44	45	50	57	56
0.005%	30	32	35	40	39
0.010%	**22**	**24**	**27**	**30**	**30**
0.020%	16	19	21	23	23
0.050%	11	13	15	16	16
0.100%	**8**	**10**	**11**	**12**	**12**
0.200%	6	8	9	9	9
0.500%	4	5	6	6	6
1.000%	**3**	**4**	**5**	**5**	**5**

Project	NGI - Halden Site	Figure No.	HALP01 T02 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU
SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	2
Borehole	HALP01	**Test Depth (m)**	8.00

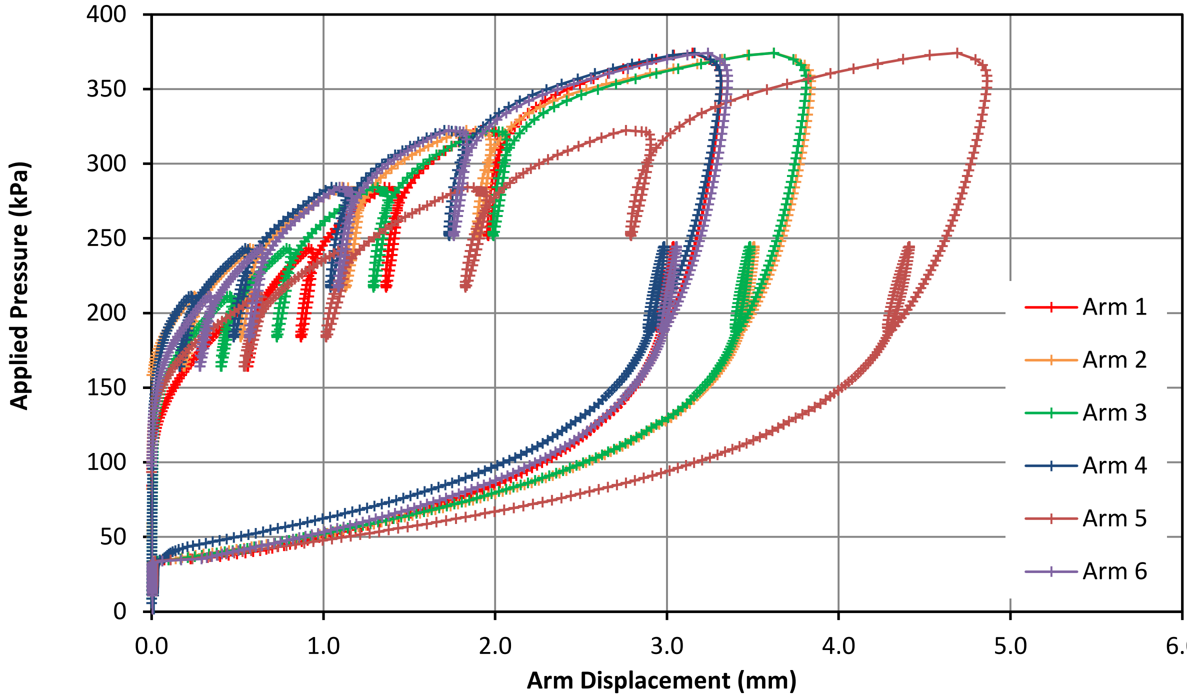


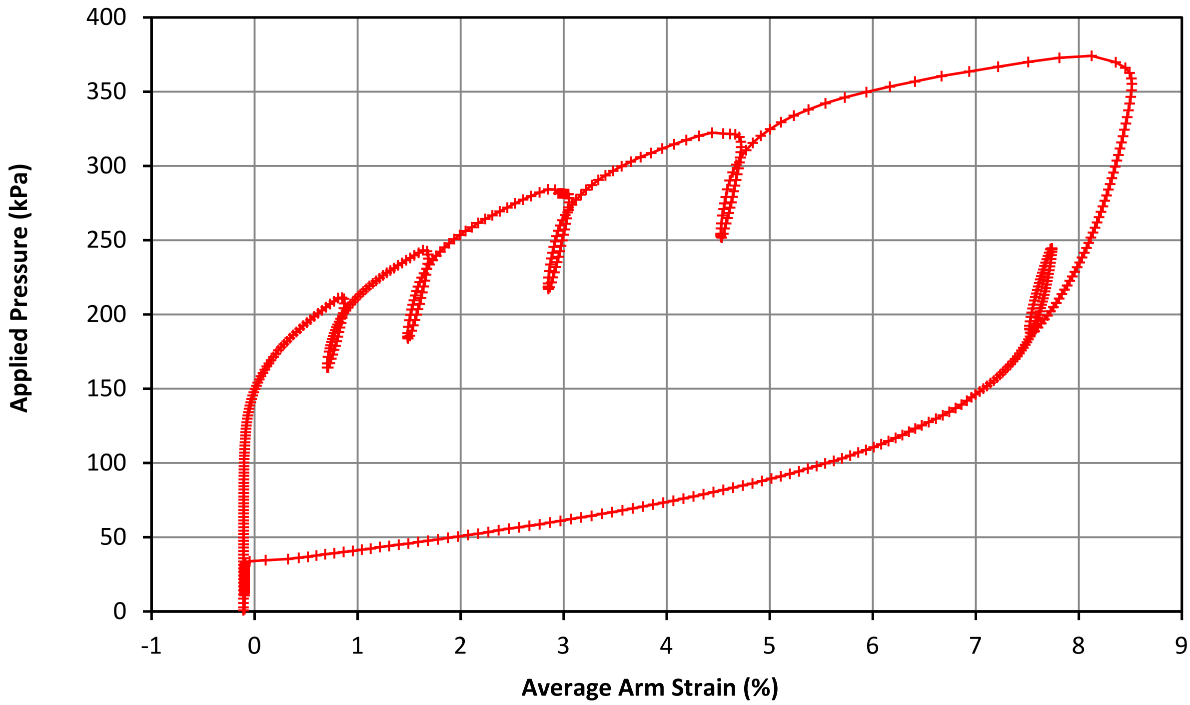
Strength	Undrained Shear	59	kPa
	Limit Pressure	390	kPa

Project	NGI - Halden Site	**Figure No.**	**HALP01 T02 - 09**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00



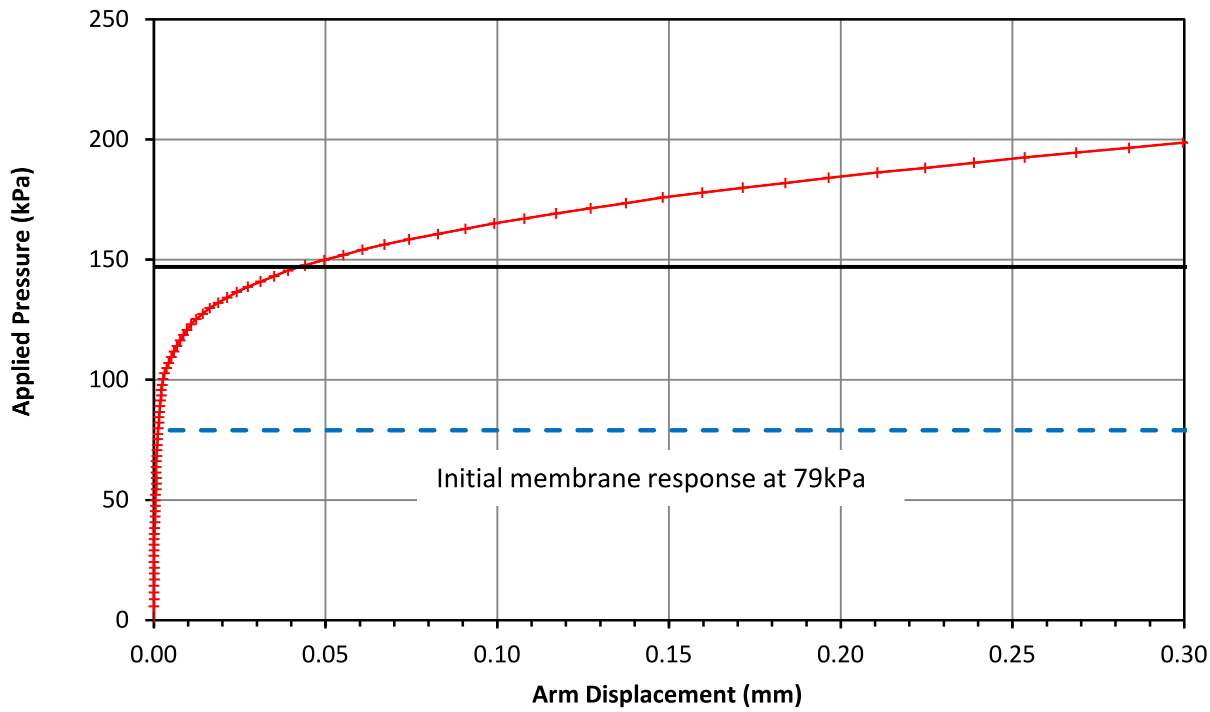


Comments

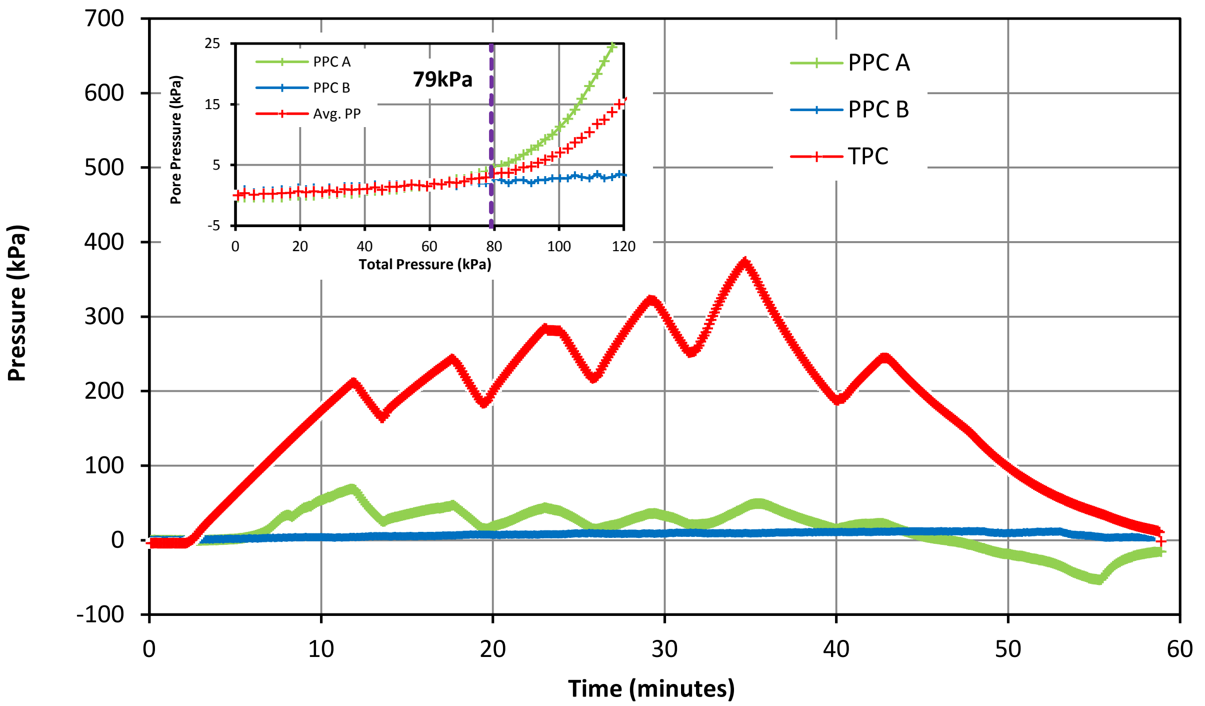
Project	NGI - Halden Site	**Figure No.**	**HALP01 T03 - 01**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Lift Off Stress & Pore Pressure Record

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00



Lift Off Stress (Po)	147 kPa

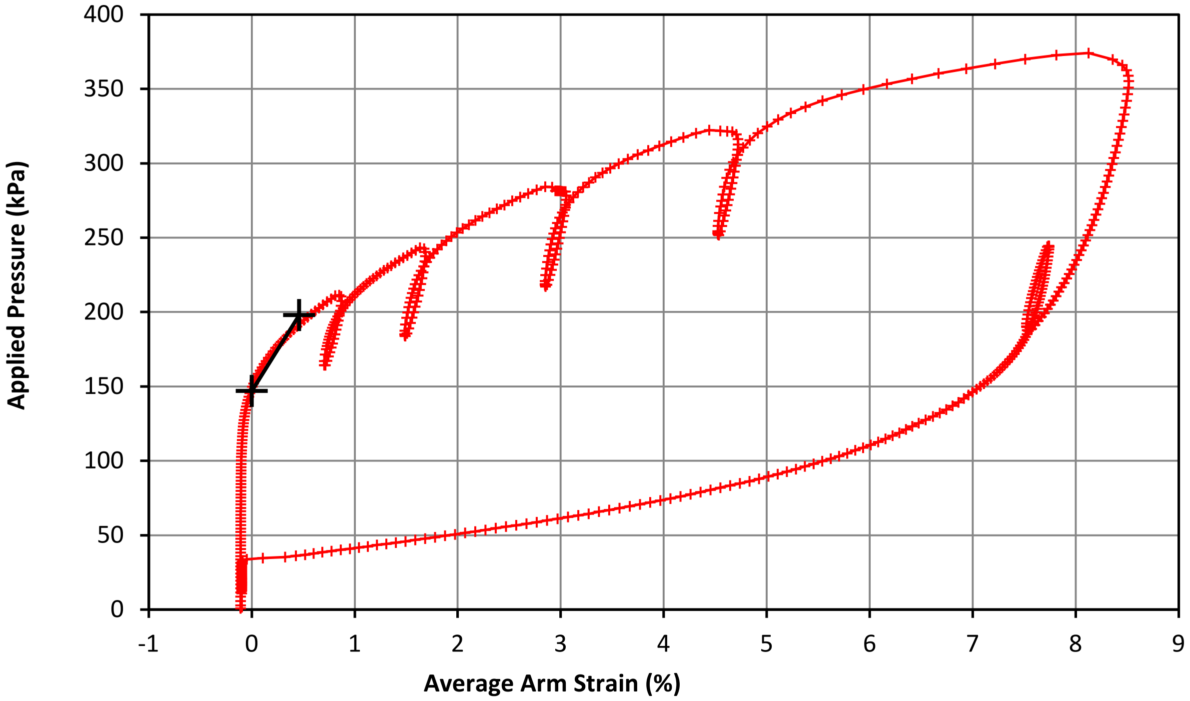


Project	NGI - Halden Site	**Figure No.**	**HALP01 T03 - 02**
Client	NGI		
Project No.	P1170112		

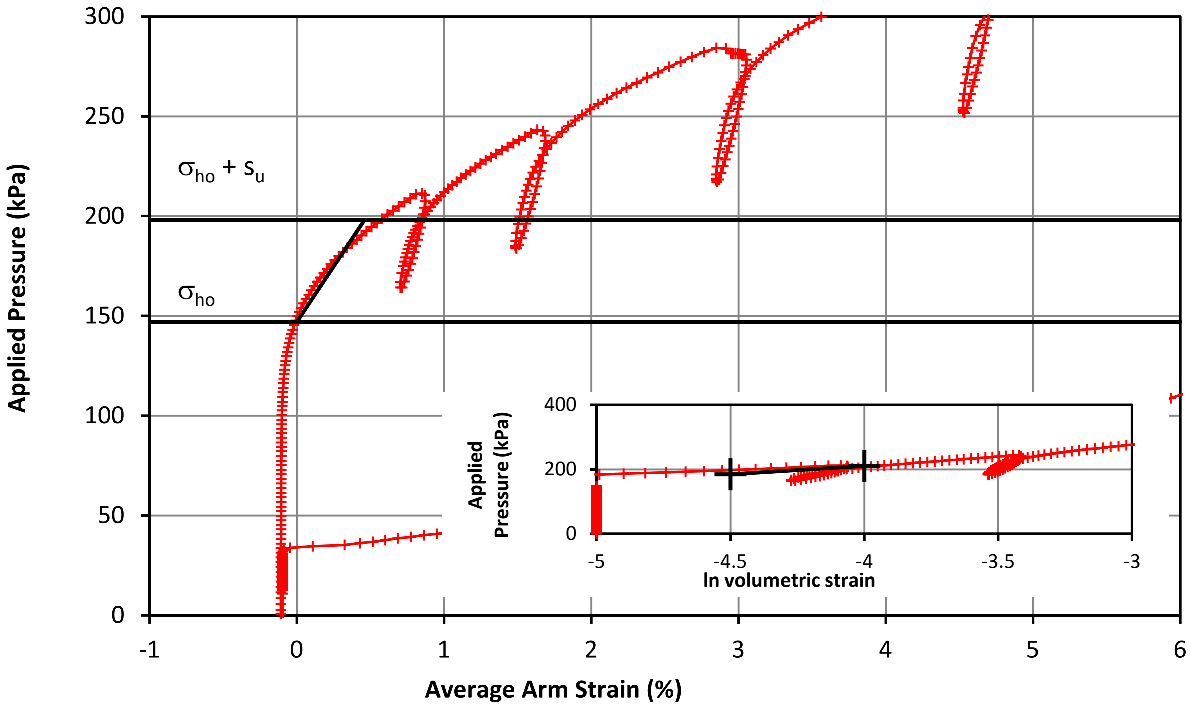
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	3
Borehole	HALP01	Test Depth (m)	10.00



Initial Modulus	Shear Modulus	5.6 MPa



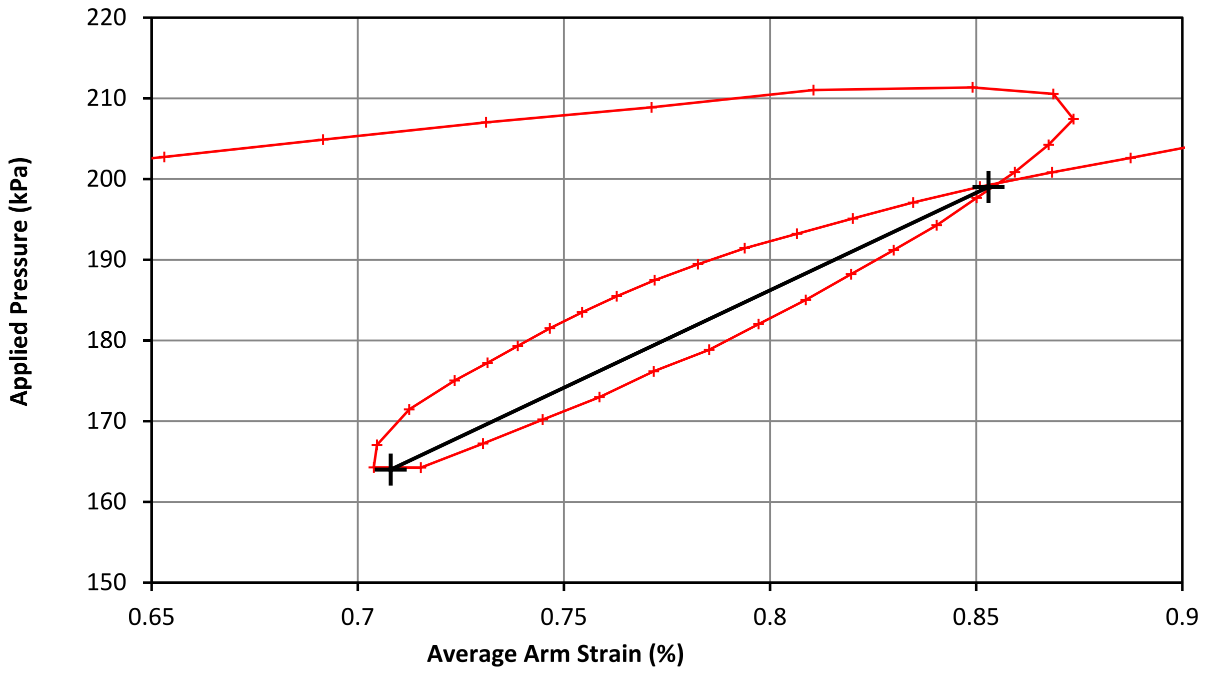
Marsland & Randolph	In situ horizontal stress	147 kPa
	Undrained Strength	51 kPa

Project	NGI - Halden Site	Figure No.	HALP01 T03 - 03
Client	NGI		
Project No.	P1170112		

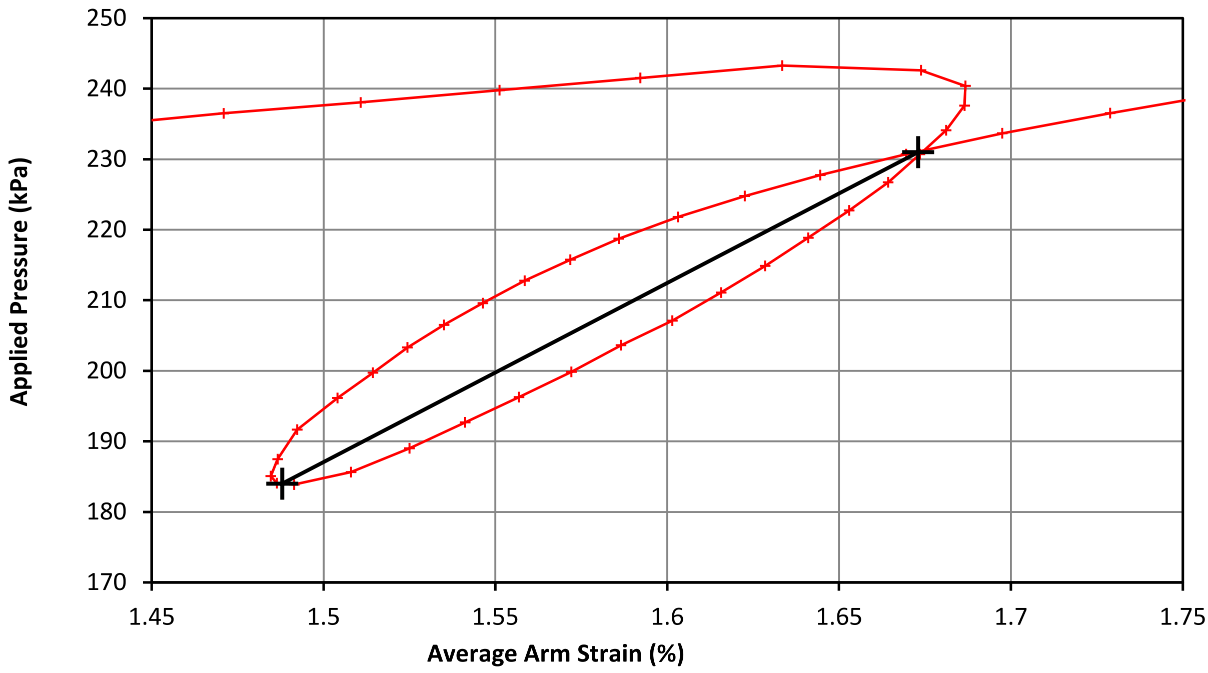
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00



Loop 1	Shear Modulus	12.2 MPa
	Cavity Strain Range	0.145 %



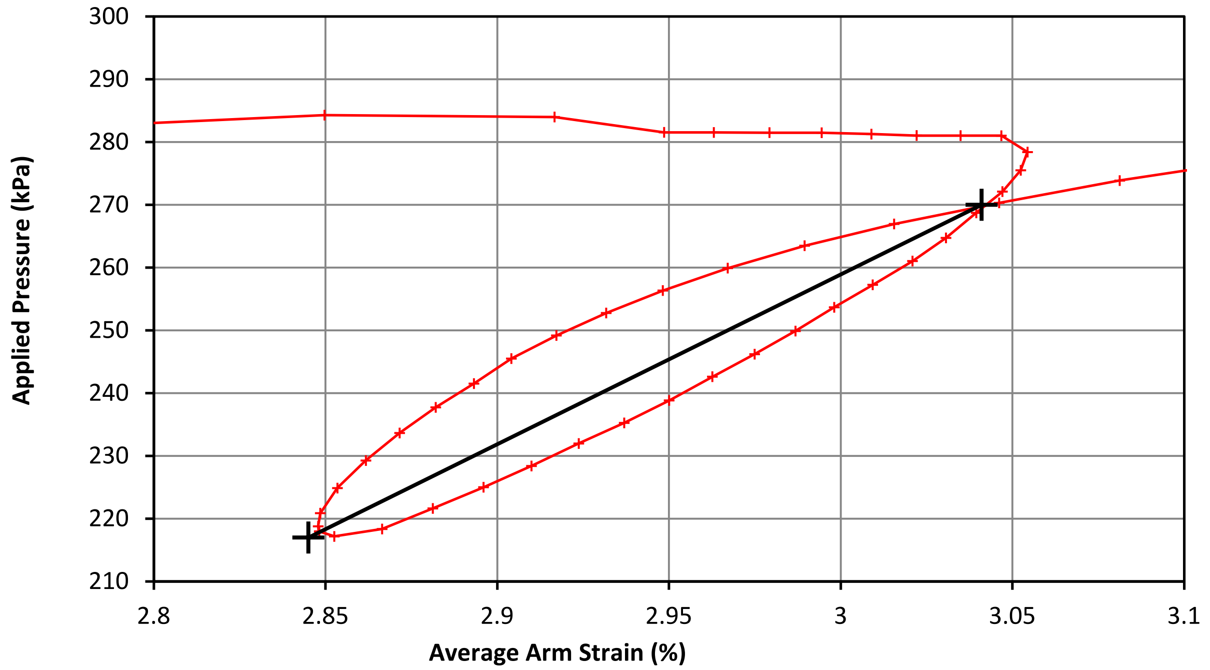
Loop 2	Shear Modulus	12.9 MPa
	Cavity Strain Range	0.185 %

Project	NGI - Halden Site	**Figure No.**	**HALP01 T03 - 04**
Client	NGI		
Project No.	P1170112		

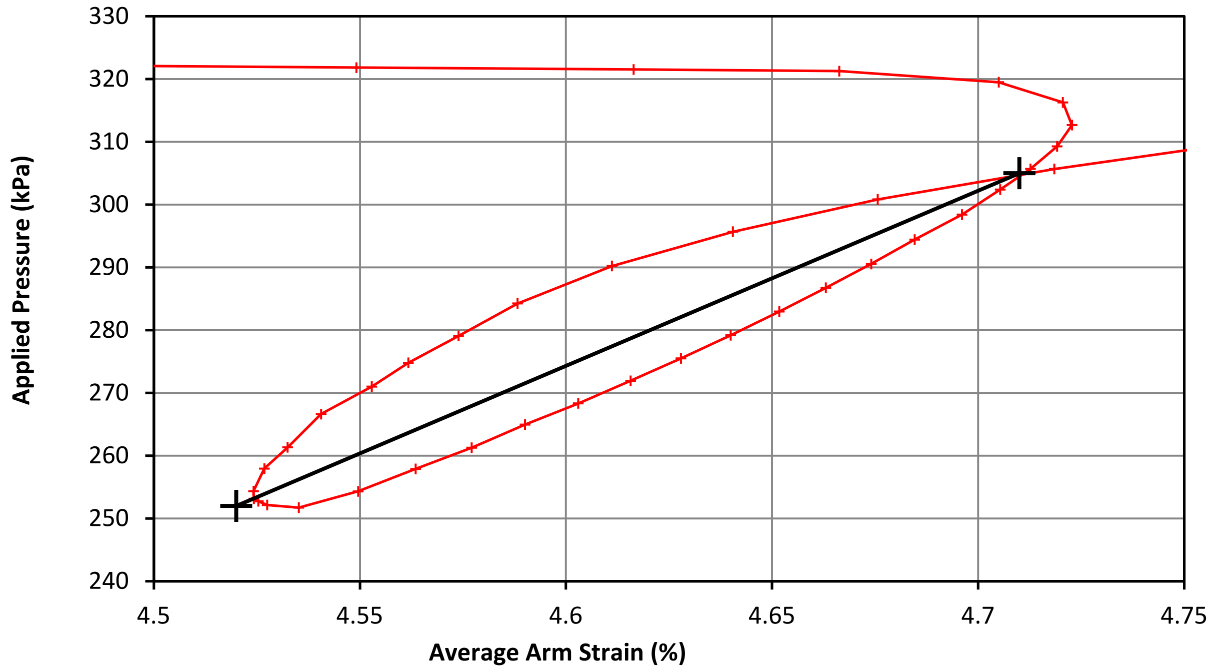
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00



Loop 3	Shear Modulus	13.9	MPa
	Cavity Strain Range	0.196	%

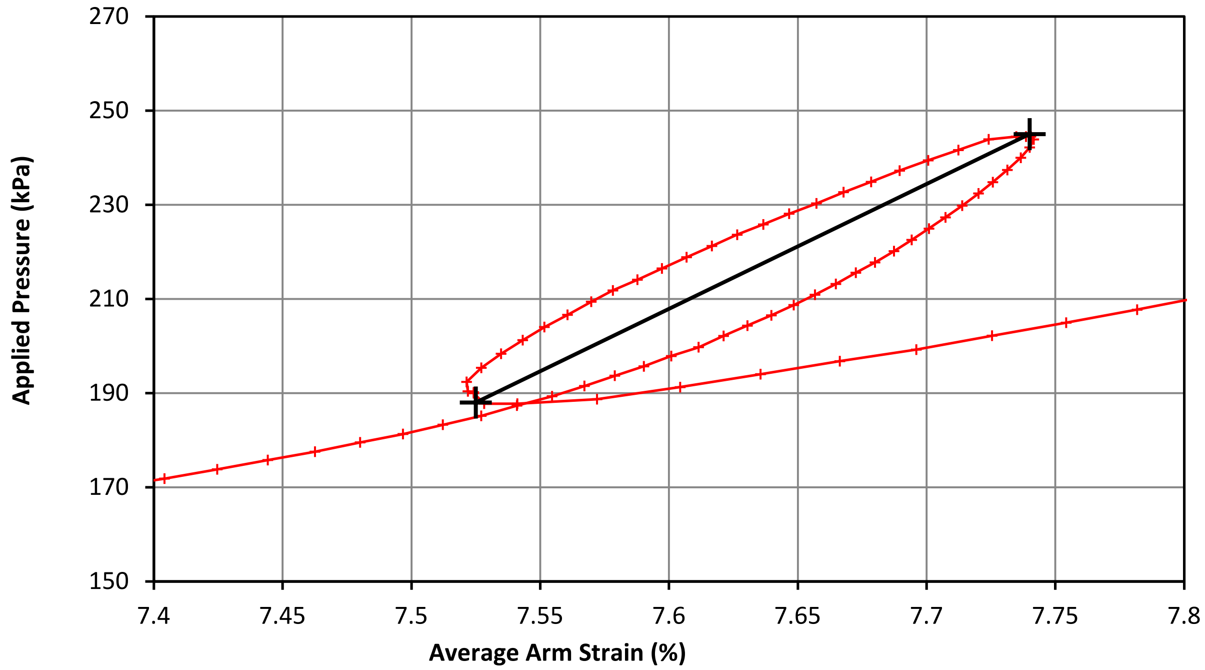


Loop 4	Shear Modulus	14.6	MPa
	Cavity Strain Range	0.190	%

Project	NGI - Halden Site	**Figure No.**	**HALP01 T03 - 05**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00



Loop 5	Shear Modulus	14.3	MPa
	Cavity Strain Range	0.215	%

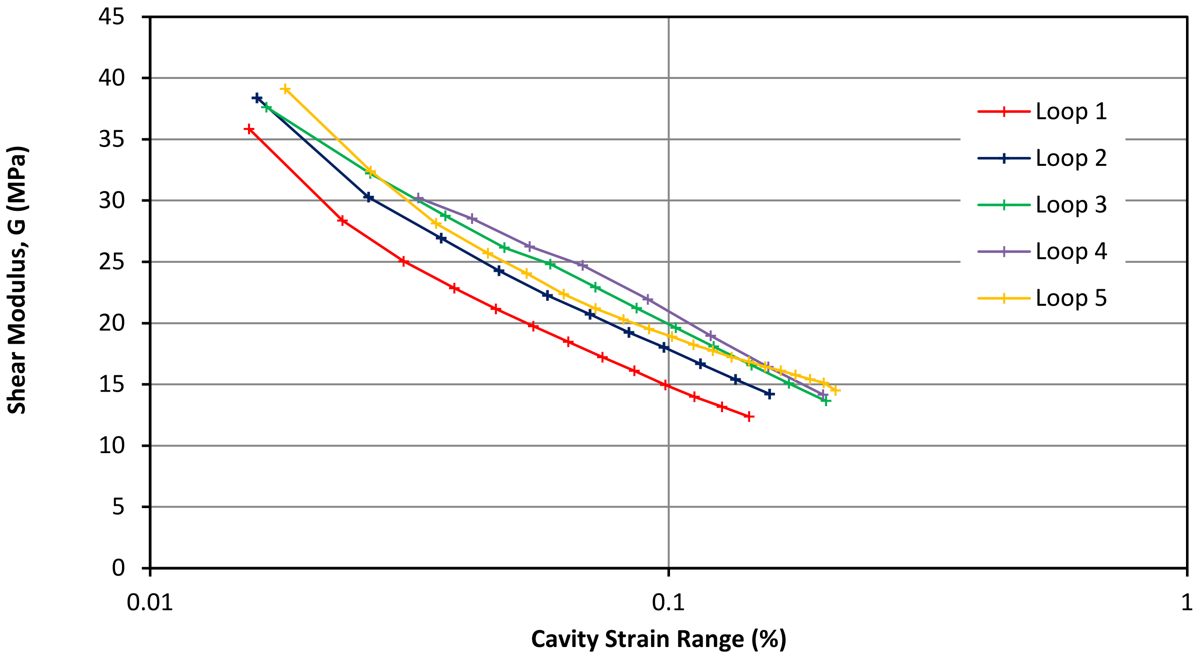
Project	NGI - Halden Site	**Figure No.**	HALP01 T03 - 06
Client	NGI		
Project No.	P1170112		

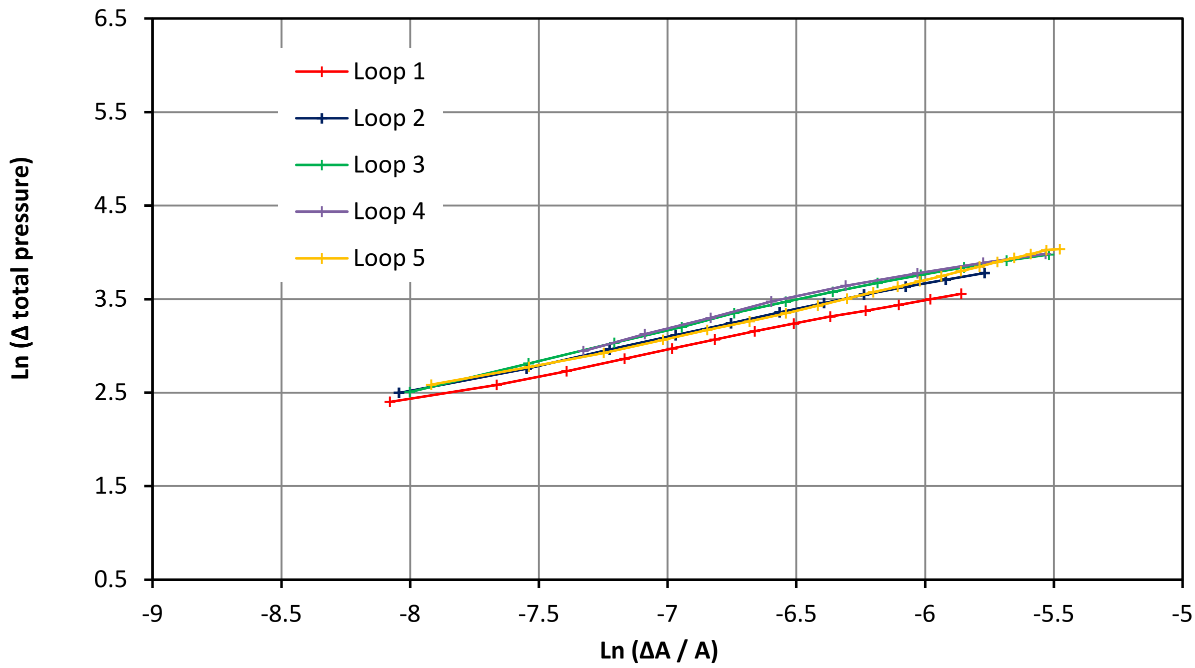
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	3
Borehole	HALP01	Test Depth (m)	10.00





Loop 1		Loop 2		Loop 3		Loop 4		Loop 5	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.536	0.822 (MPa)	0.576	1.247 (MPa)	0.600	1.559 (MPa)	0.580	1.409 (MPa)	0.617	1.648 (MPa)

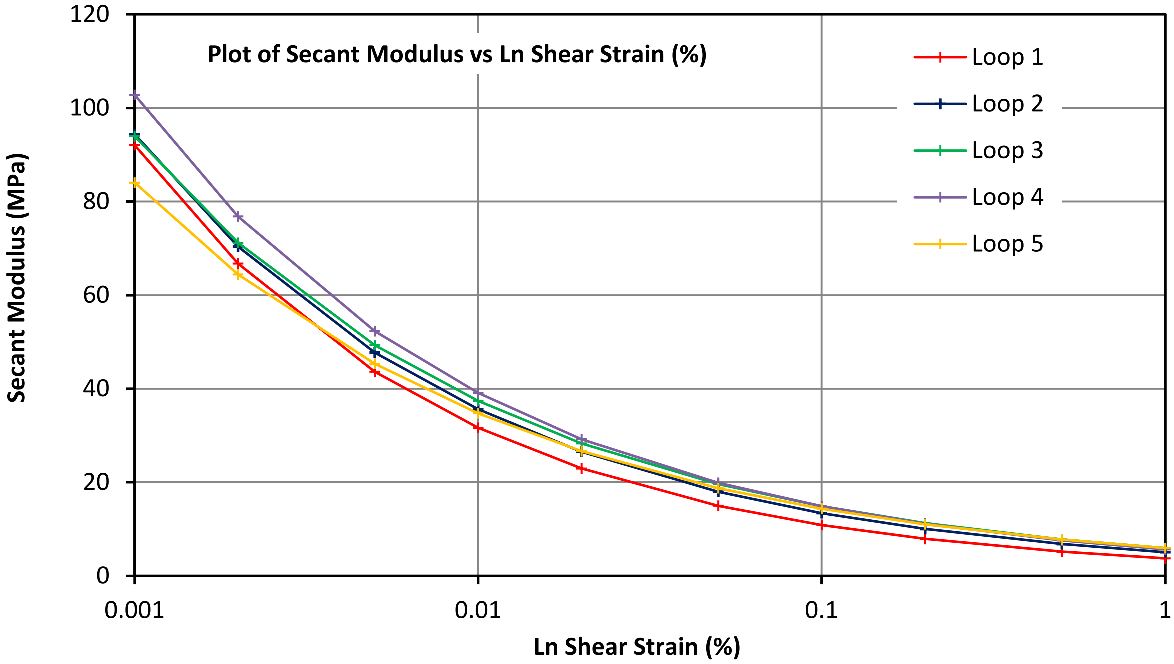
Project	NGI - Halden Site	Figure No.	HALP01 T03 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	Test No.	3
Borehole	HALP01	Test Depth (m)	10.00



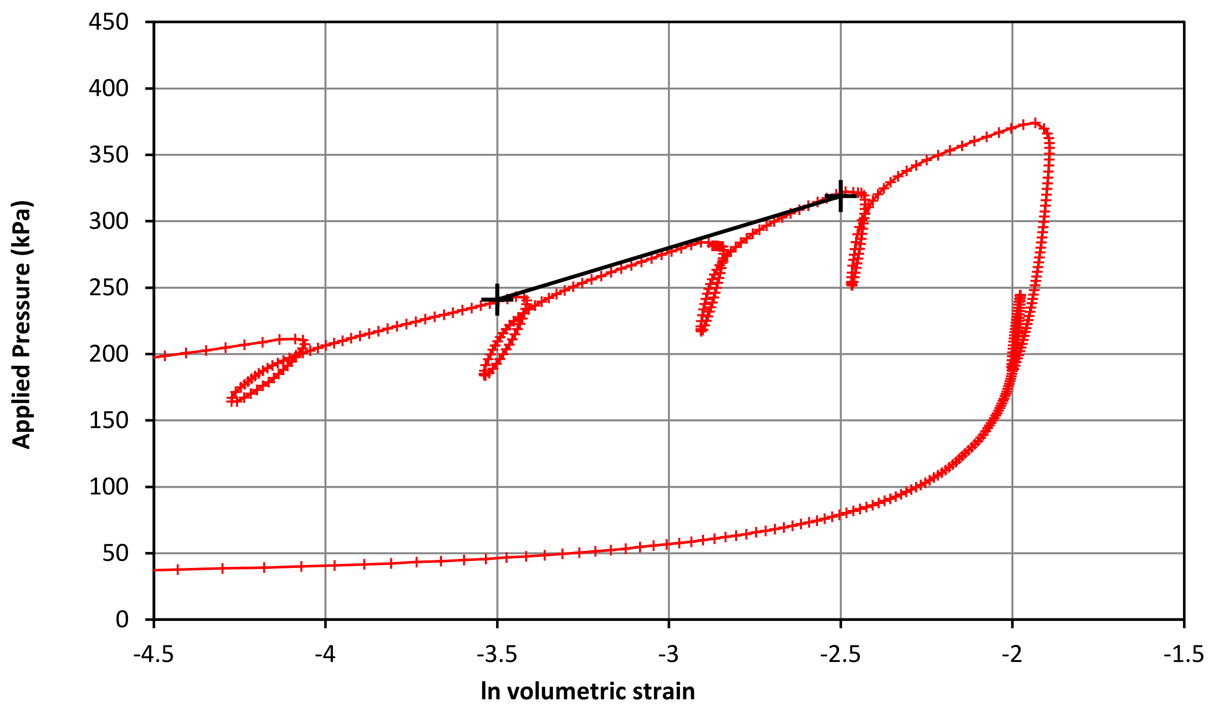
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5
0.001%	**92**	**94**	**94**	**103**	**84**
0.002%	67	70	71	77	64
0.005%	44	48	49	52	45
0.010%	**32**	**36**	**37**	**39**	**35**
0.020%	23	27	28	29	27
0.050%	15	18	20	20	19
0.100%	**11**	**13**	**15**	**15**	**14**
0.200%	8	10	11	11	11
0.500%	5	7	8	8	8
1.000%	**4**	**5**	**6**	**6**	**6**

Project	NGI - Halden Site	Figure No.	HALP01 T03 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	16/09/2017	**Test No.**	3
Borehole	HALP01	**Test Depth (m)**	10.00

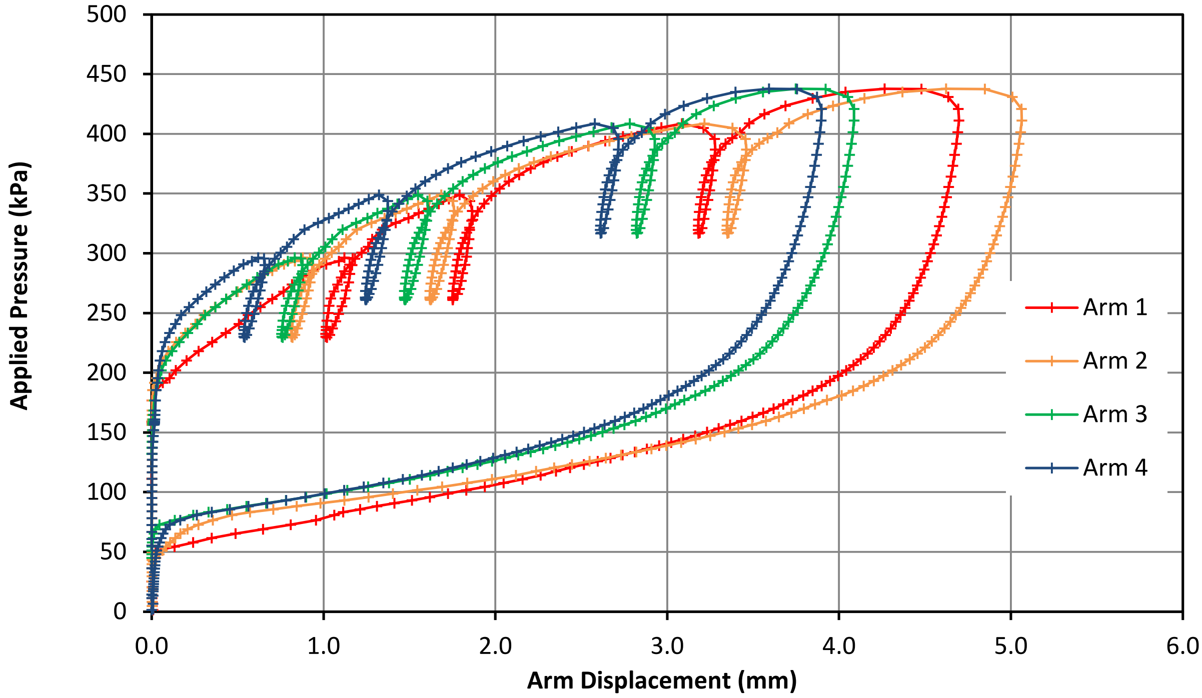


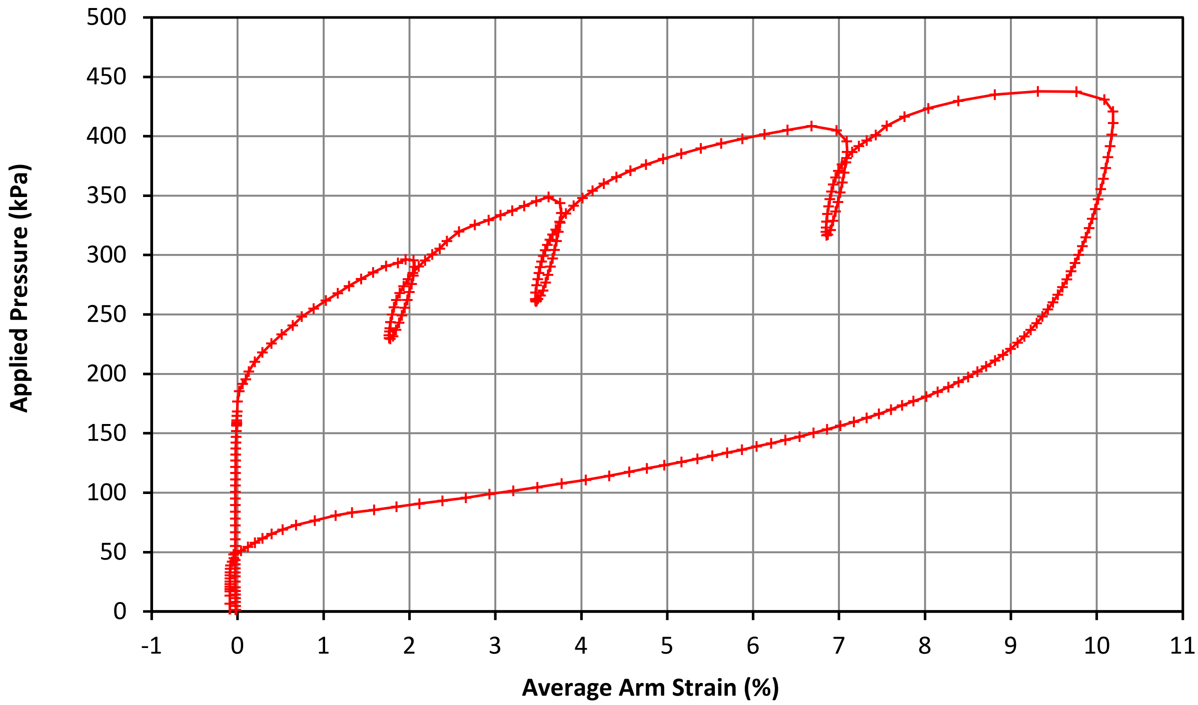
Strength	Undrained Shear	78	kPa
	Limit Pressure	514	kPa

Project	NGI - Halden Site	**Figure No.**	HALP01 T03 - 09
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	18/09/2017	**Test No.**	4
Borehole	HALP01	**Test Depth (m)**	12.00





Comments

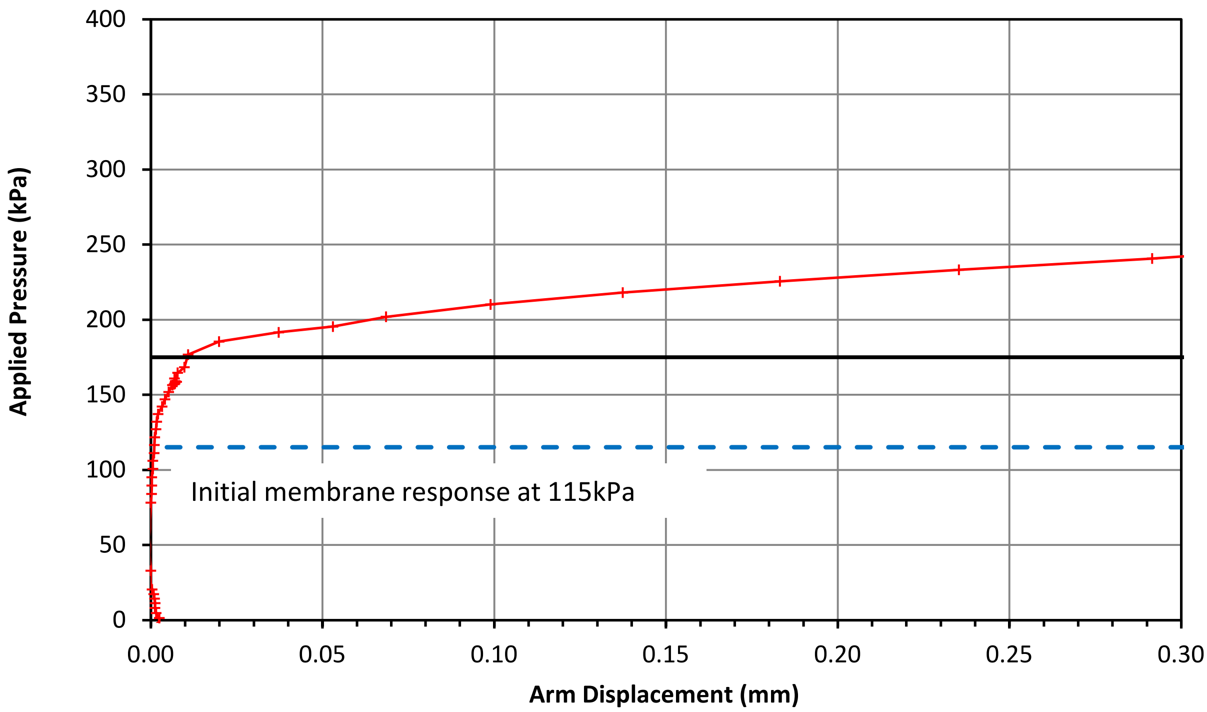
Arms 5 & 6 offline. Probable moisture ingress into probe.

Project	NGI - Halden Site	**Figure No.**	**HALP01 T04 - 01**
Client	NGI		
Project No.	P1170112		

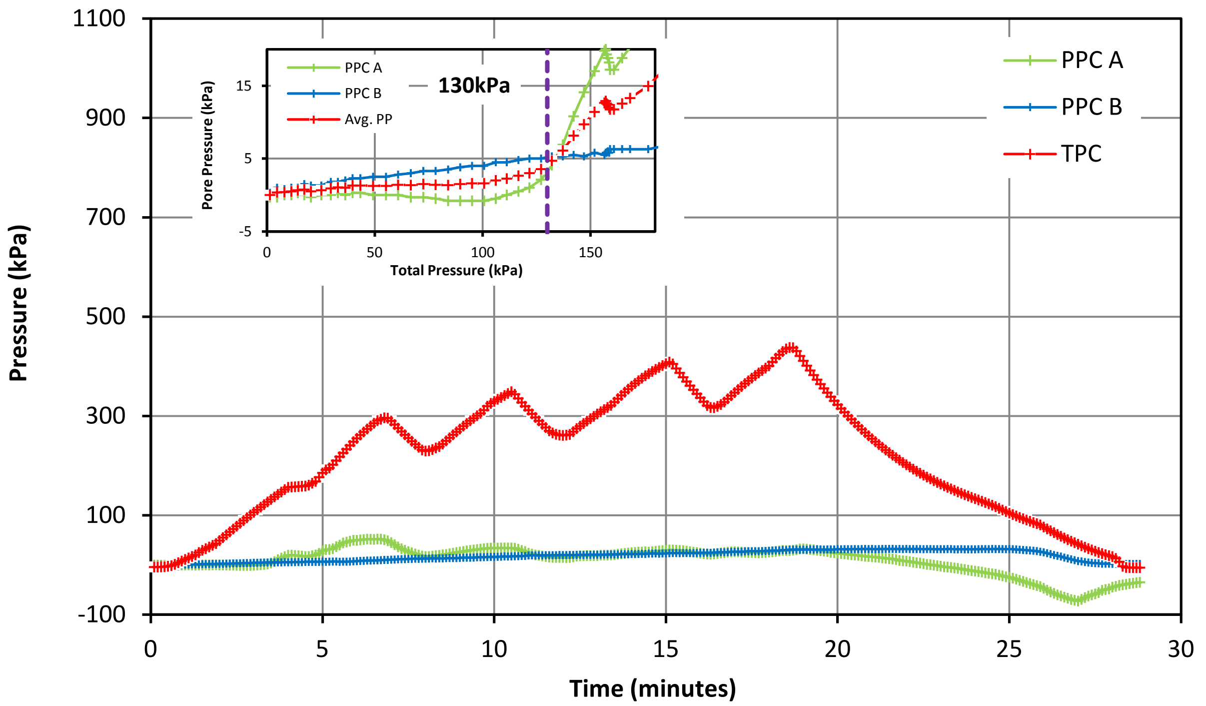
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	4
Borehole	HALP01	**Test Depth (m)**	12.00



Lift Off Stress (Po)	175 kPa

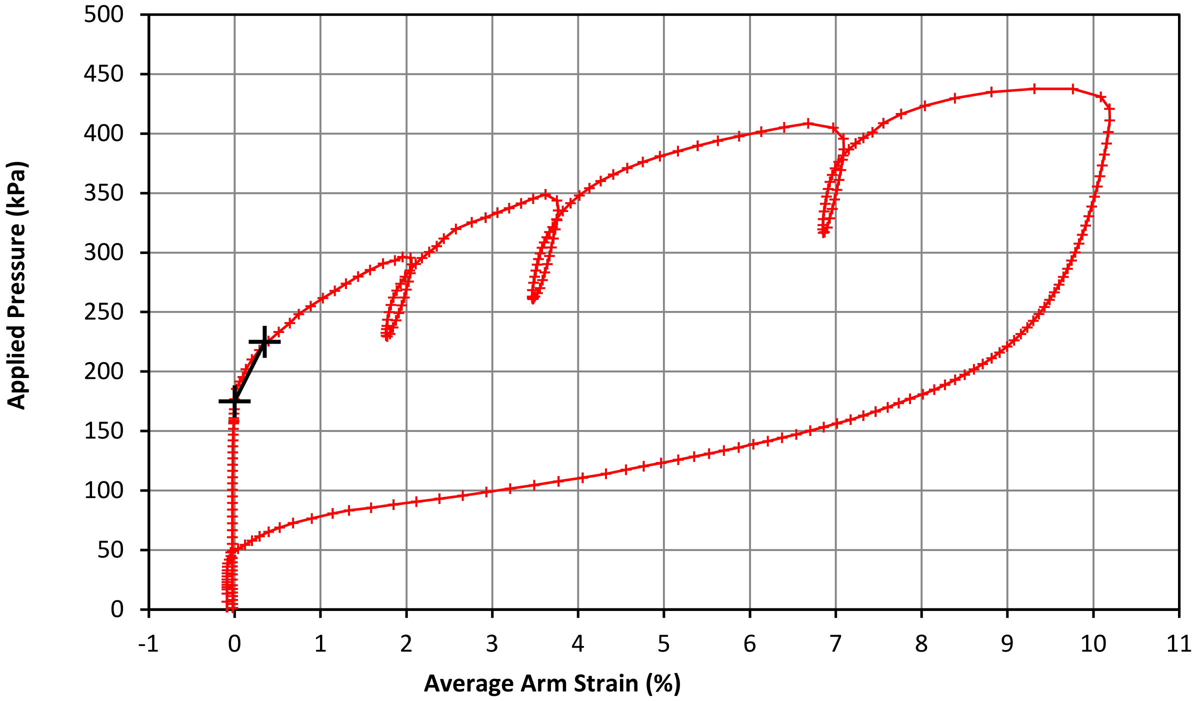


Project	NGI - Halden Site	**Figure No.**	**HALP01 T04 - 02**
Client	NGI		
Project No.	P1170112		

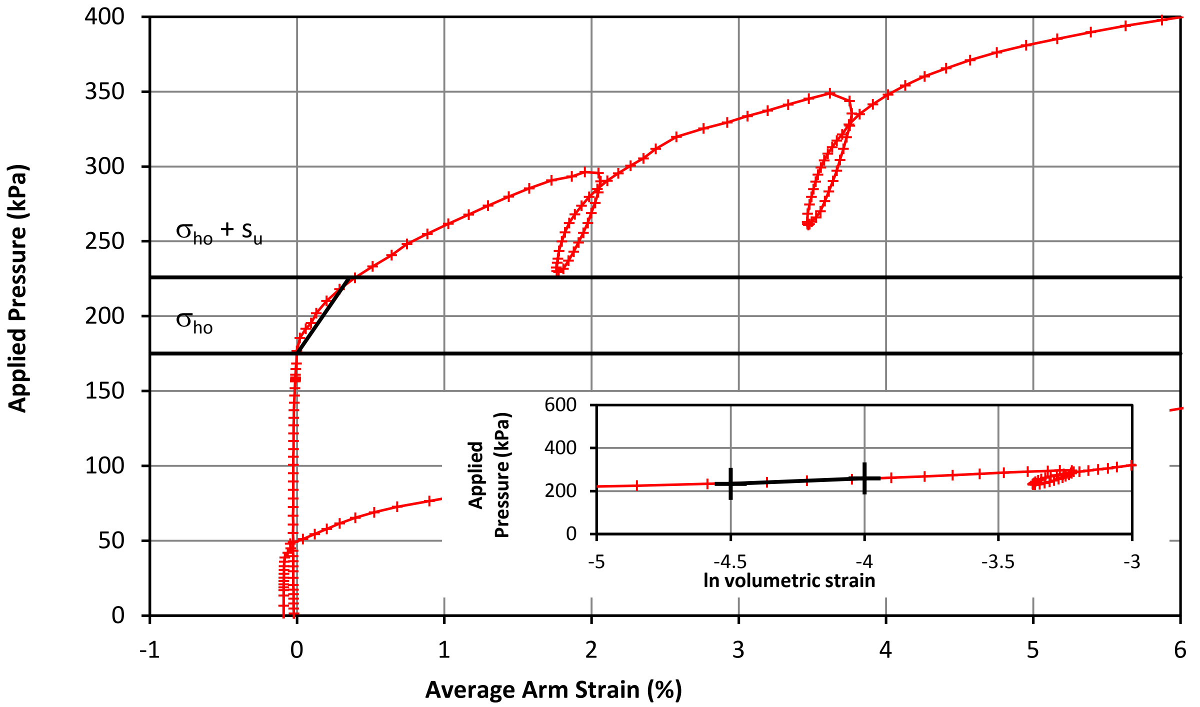
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	4
Borehole	HALP01	**Test Depth (m)**	12.00



Initial Modulus	Shear Modulus	7.2 MPa



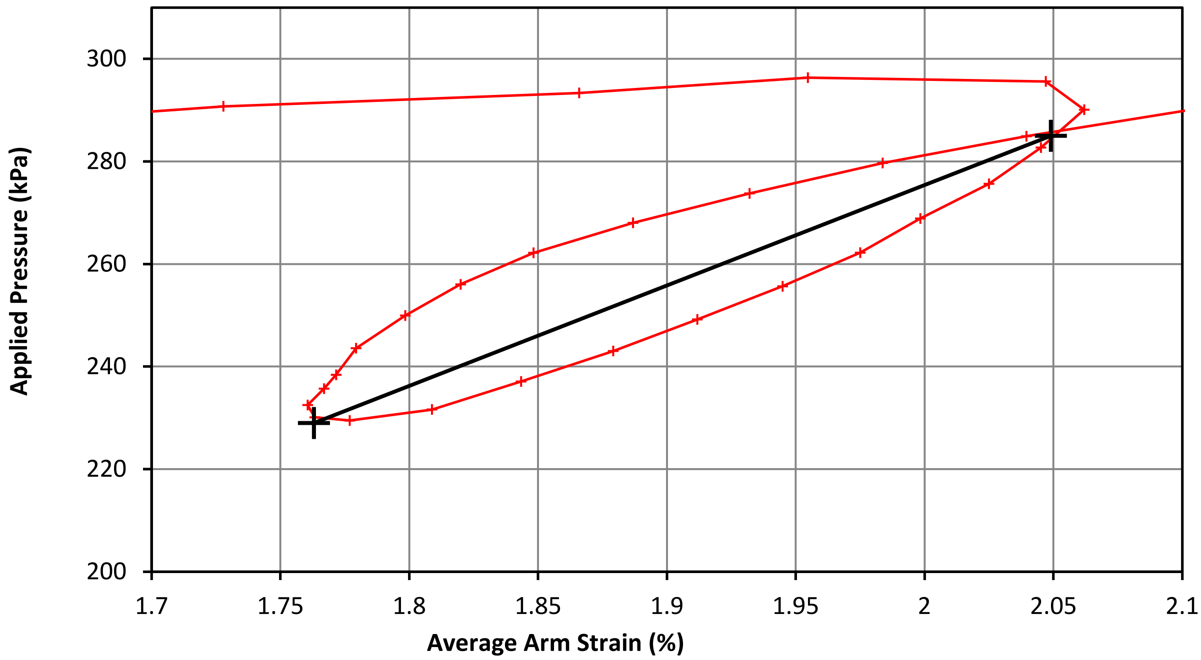
Marsland & Randolph	In situ horizontal stress	175 kPa
	Undrained Strength	51 kPa

Project	NGI - Halden Site	**Figure No.**	HALP01 T04 - 03
Client	NGI		
Project No.	P1170112		

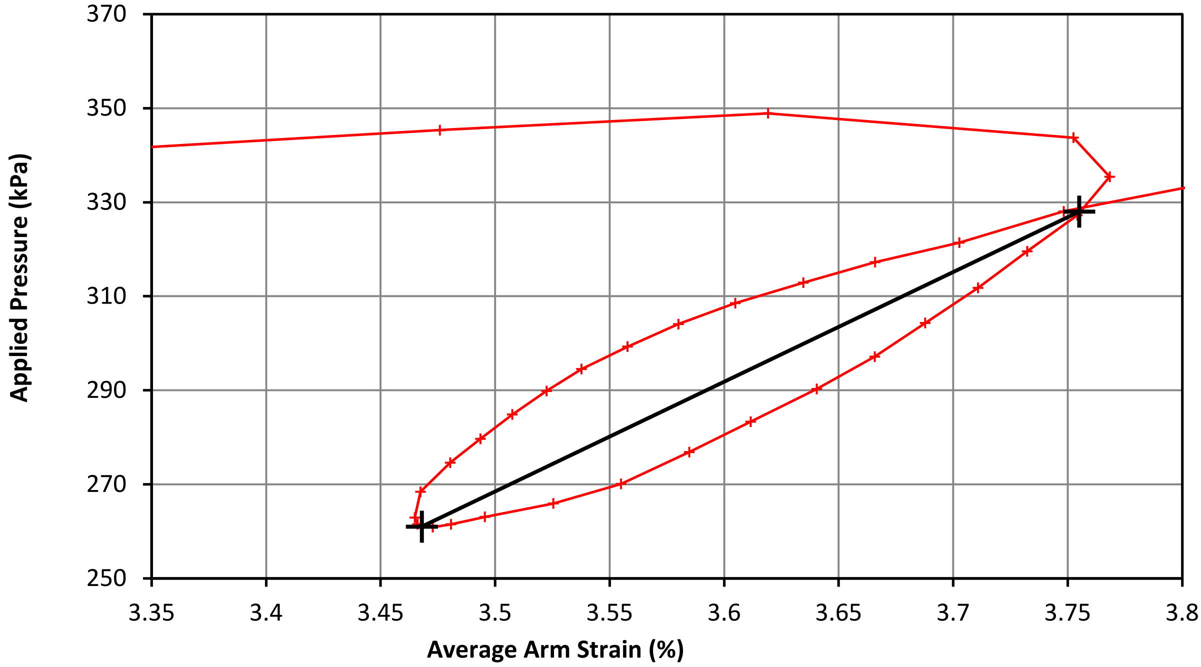
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	4
Borehole	HALP01	Test Depth (m)	12.00



Loop 1	Shear Modulus	10.0 MPa
	Cavity Strain Range	0.286 %



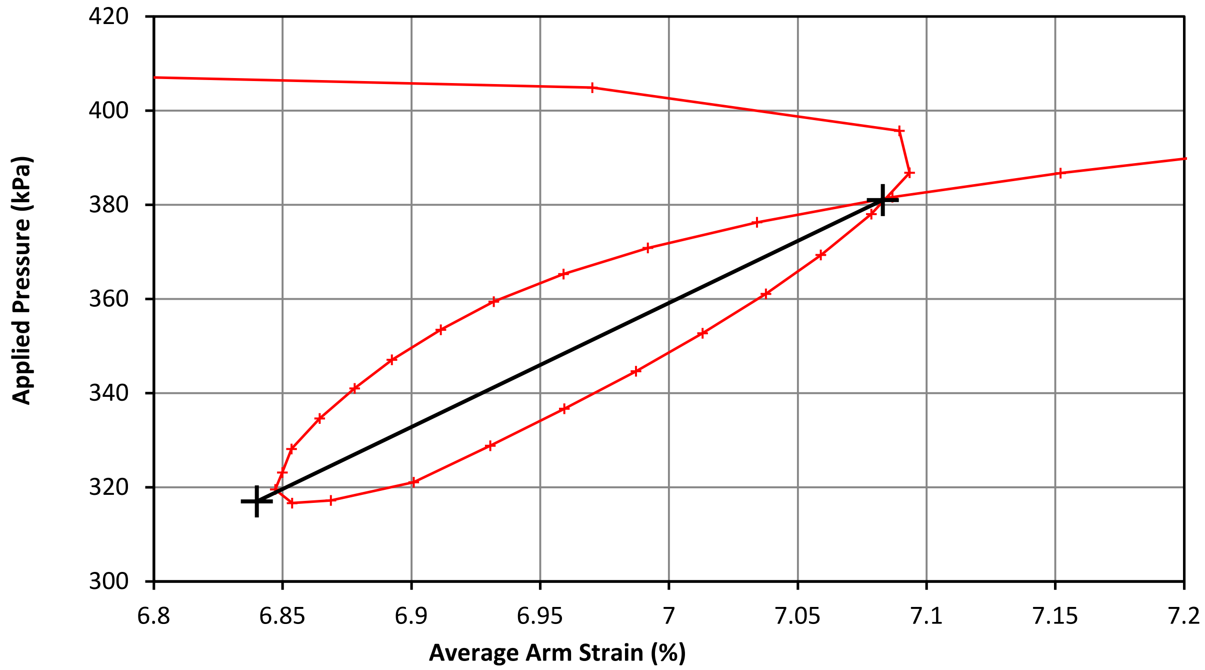
Loop 2	Shear Modulus	12.1 MPa
	Cavity Strain Range	0.287 %

Project	NGI - Halden Site	Figure No.	HALP01 T04 - 04
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	4
Borehole	HALP01	Test Depth (m)	12.00



Loop 3	Shear Modulus	14.1	MPa
	Cavity Strain Range	0.243	%

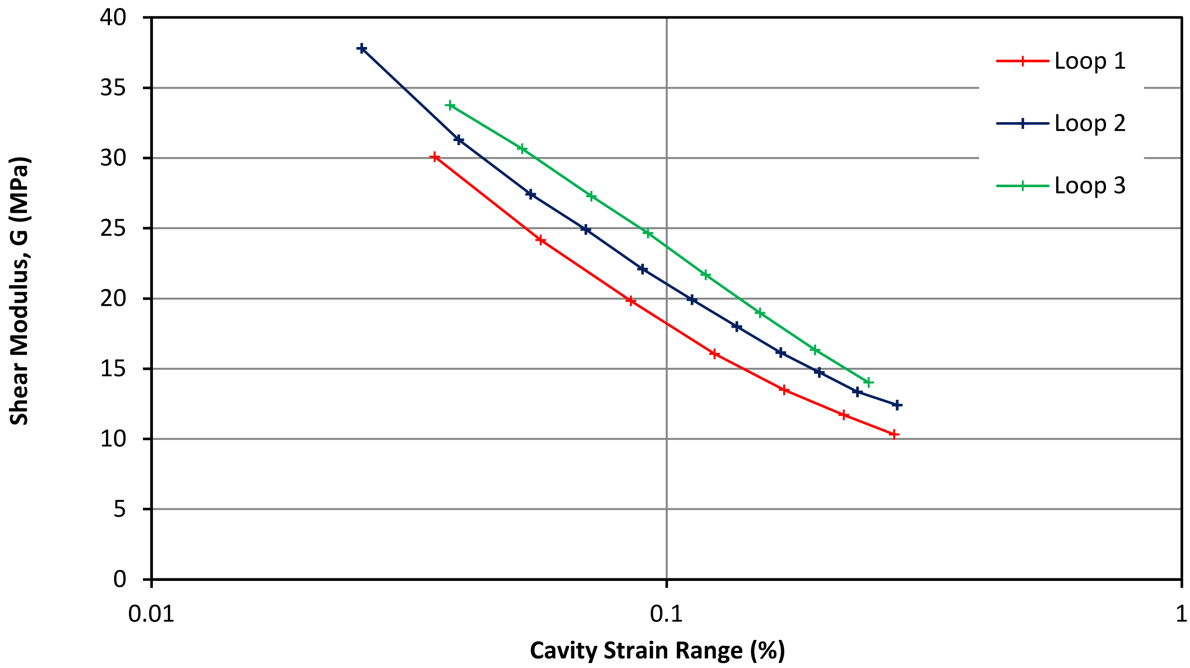
Project	NGI - Halden Site	Figure No.	HALP01 T04 - 05
Client	NGI		
Project No.	P1170112		

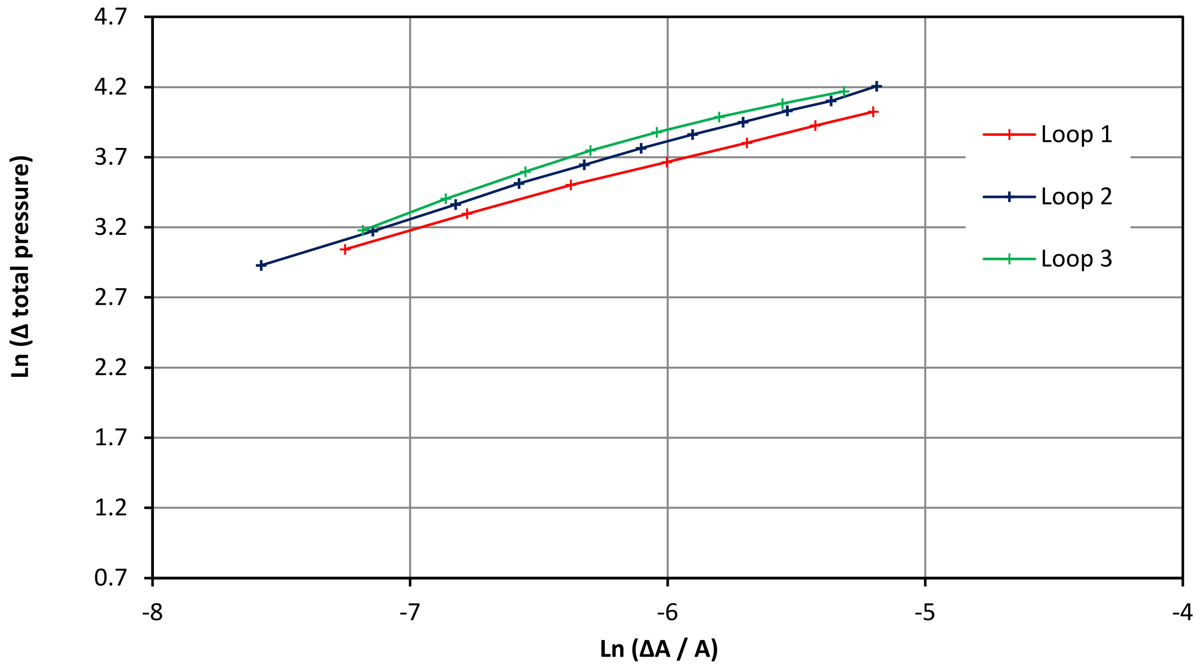
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	4
Borehole	HALP01	**Test Depth (m)**	12.00





Loop 1		**Loop 2**		**Loop 3**	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.474	0.666 (MPa)	0.529	1.063 (MPa)	0.529	1.133 (MPa)

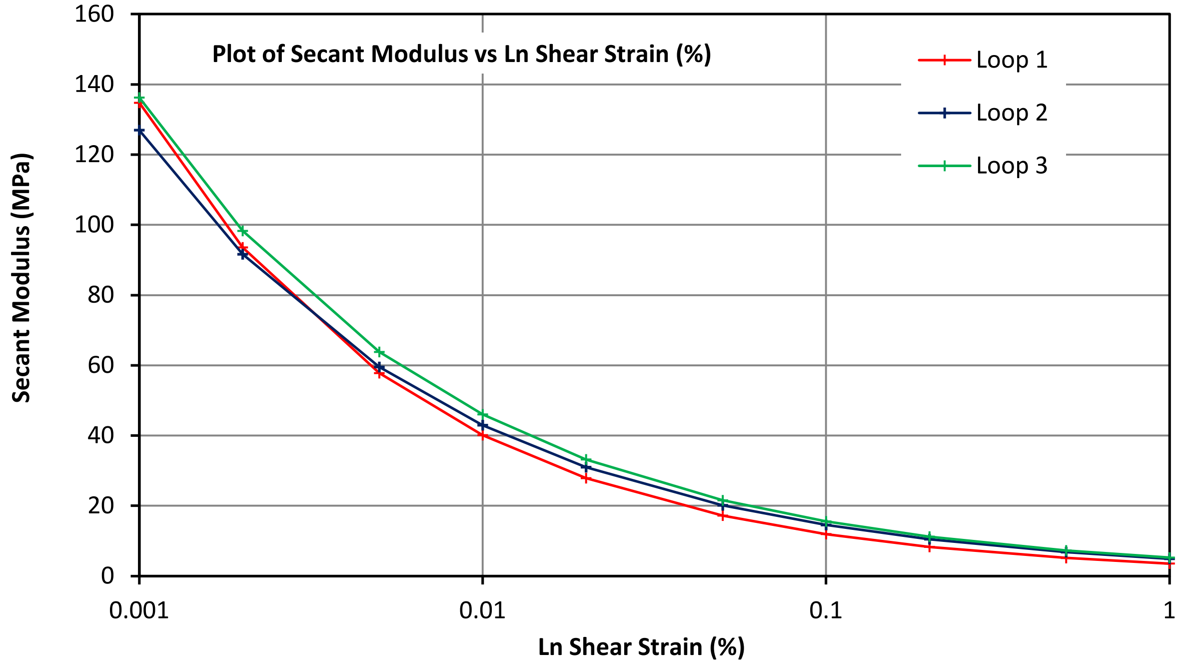
Project	NGI - Halden Site	**Figure No.**	**HALP01 T04 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	4
Borehole	HALP01	Test Depth (m)	12.00

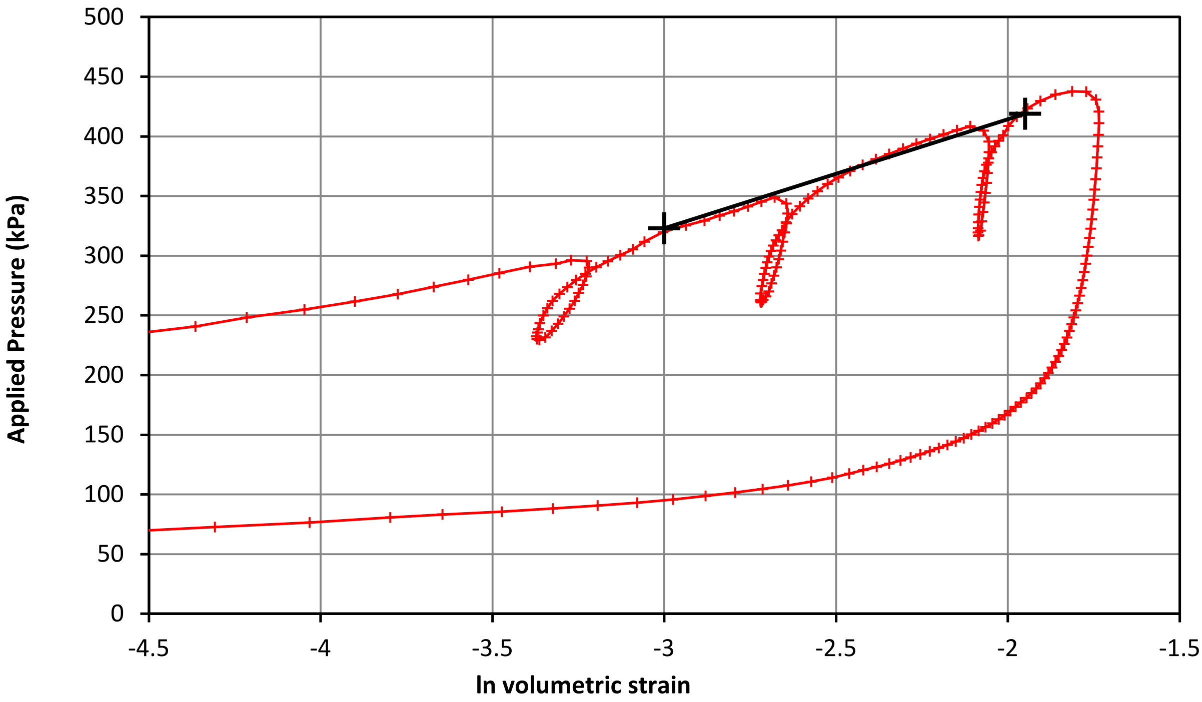


Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**135**	**127**	**136**
0.002%	94	92	98
0.005%	58	60	64
0.010%	**40**	**43**	**46**
0.020%	28	31	33
0.050%	17	20	22
0.100%	**12**	**15**	**16**
0.200%	8	10	11
0.500%	5	7	7
1.000%	**4**	**5**	**5**

Project	NGI - Halden Site	Figure No.	HALP01 T04 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

Test Date	18/09/2017	Test No.	4
Borehole	HALP01	Test Depth (m)	12.00



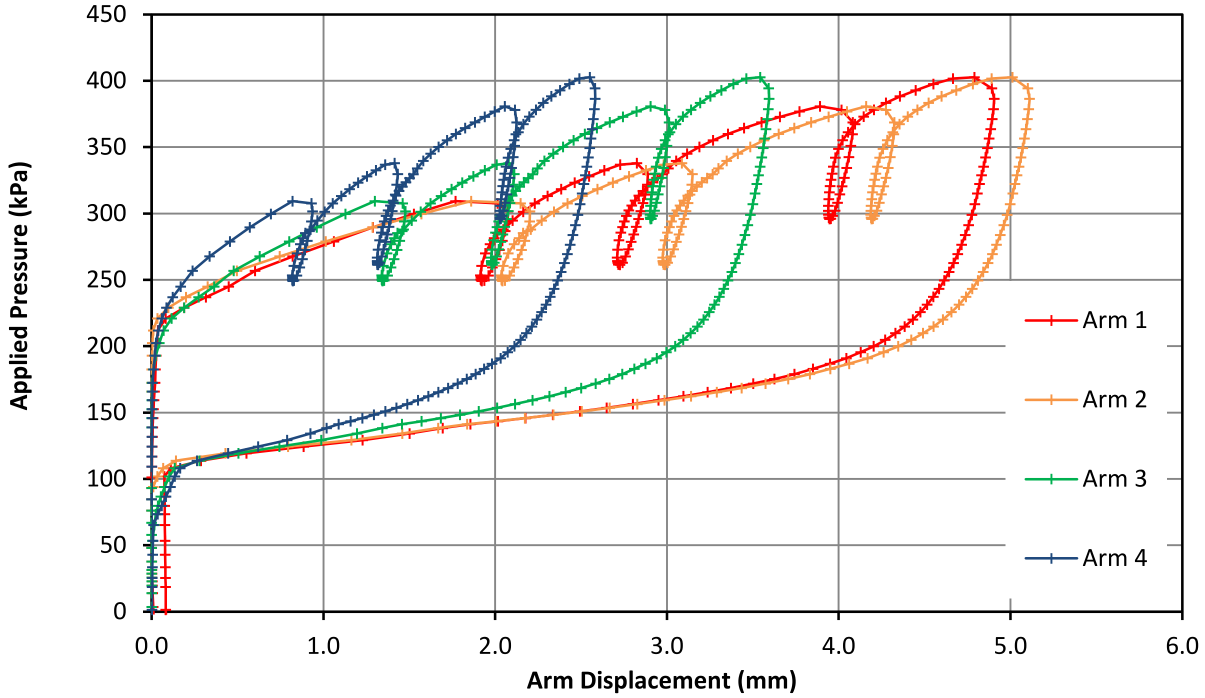
Strength	Undrained Shear	91 kPa
	Limit Pressure	597 kPa

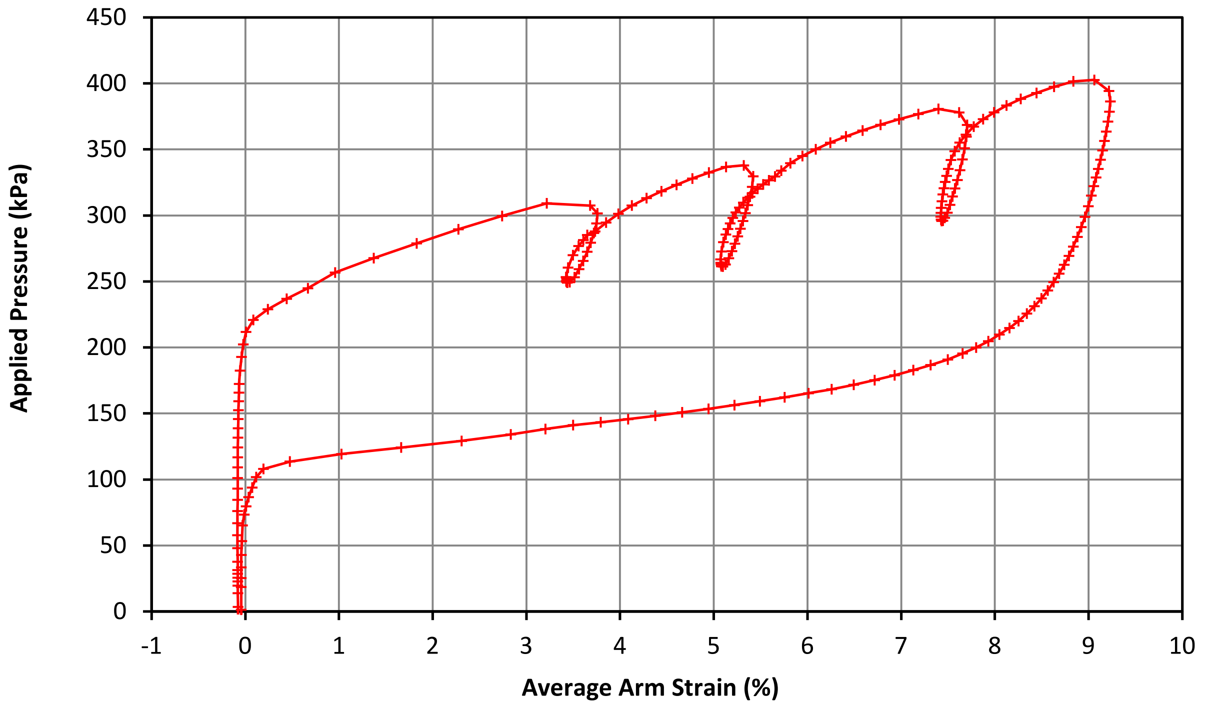
Project	NGI - Halden Site	Figure No.	HALP01 T04 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	5
Borehole	HALP01	Test Depth (m)	13.50





Comments

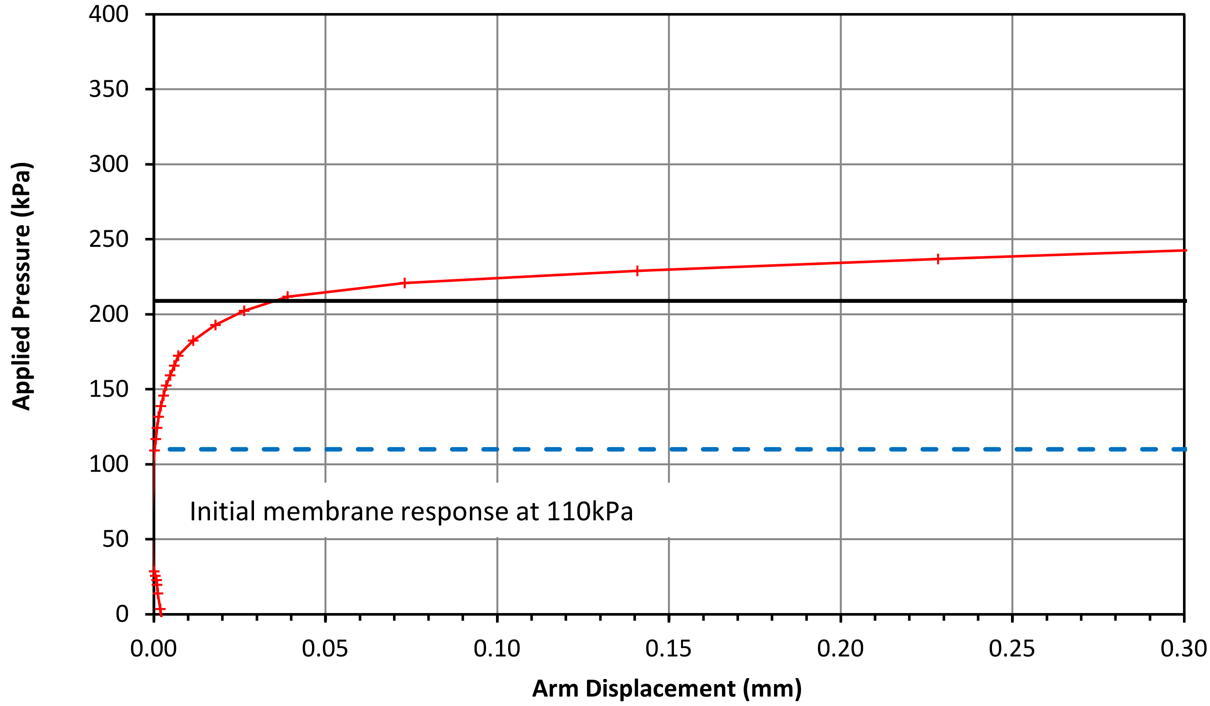
Arms 5 & 6 offline. Probable moisture ingress into probe.

Project	NGI - Halden Site	Figure No.	HALP01 T05 - 01
Client	NGI		
Project No.	P1170112		

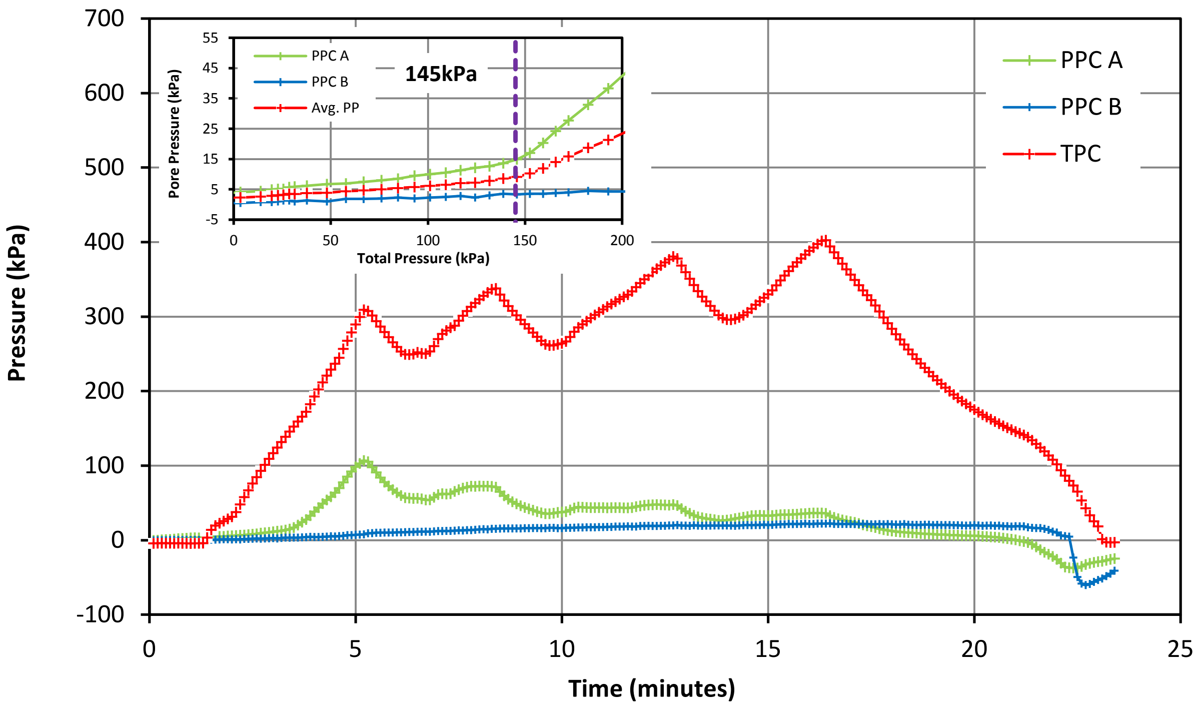
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	5
Borehole	HALP01	Test Depth (m)	13.50



Lift Off Stress (Po)	209 kPa

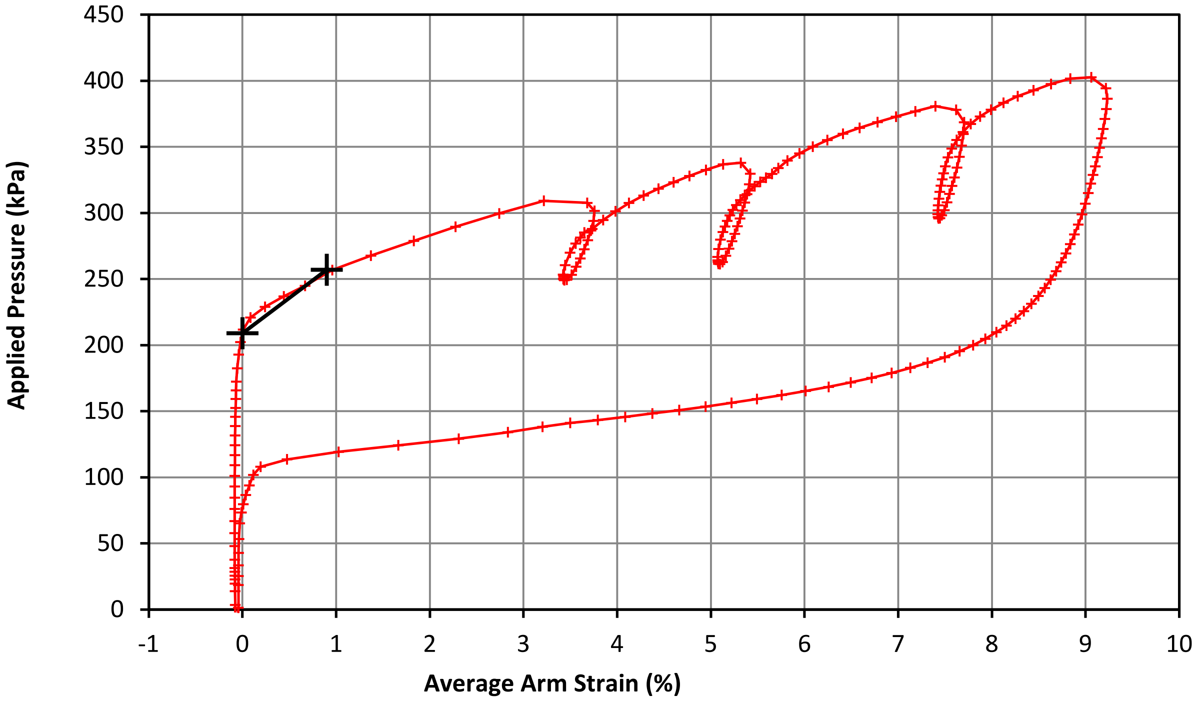


Project	NGI - Halden Site	Figure No.	HALP01 T05 - 02
Client	NGI		
Project No.	P1170112		

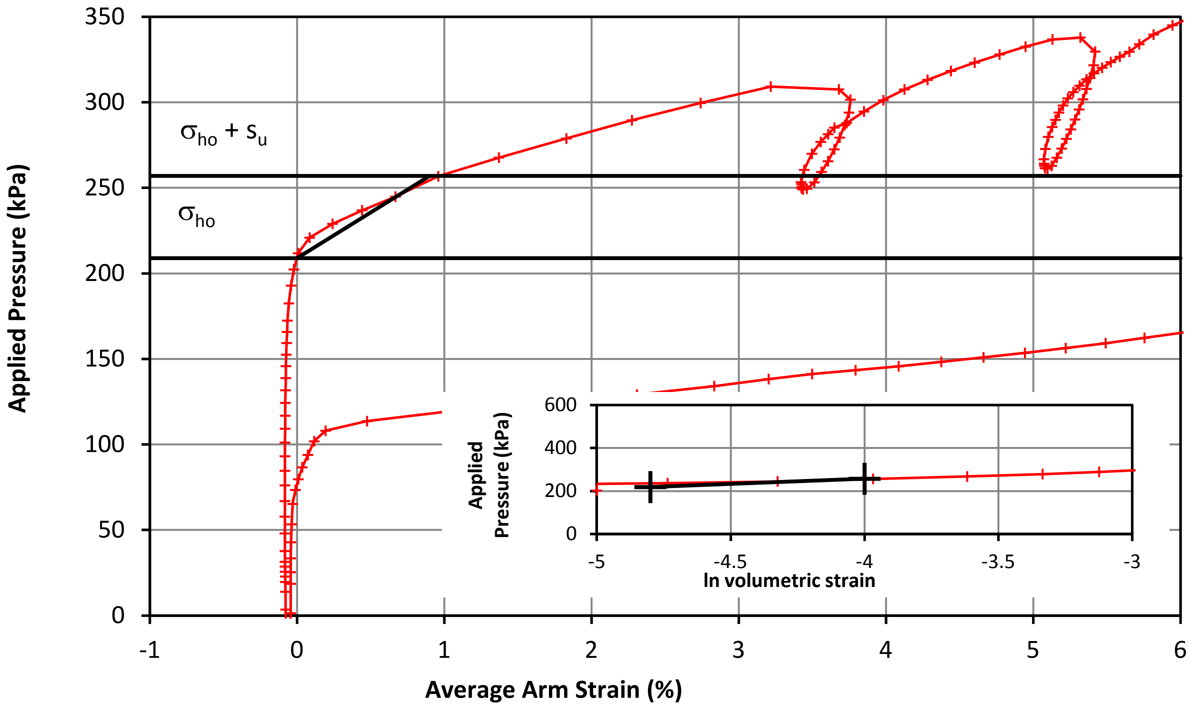
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	5
Borehole	HALP01	**Test Depth (m)**	13.50



Initial Modulus	Shear Modulus	2.7 MPa



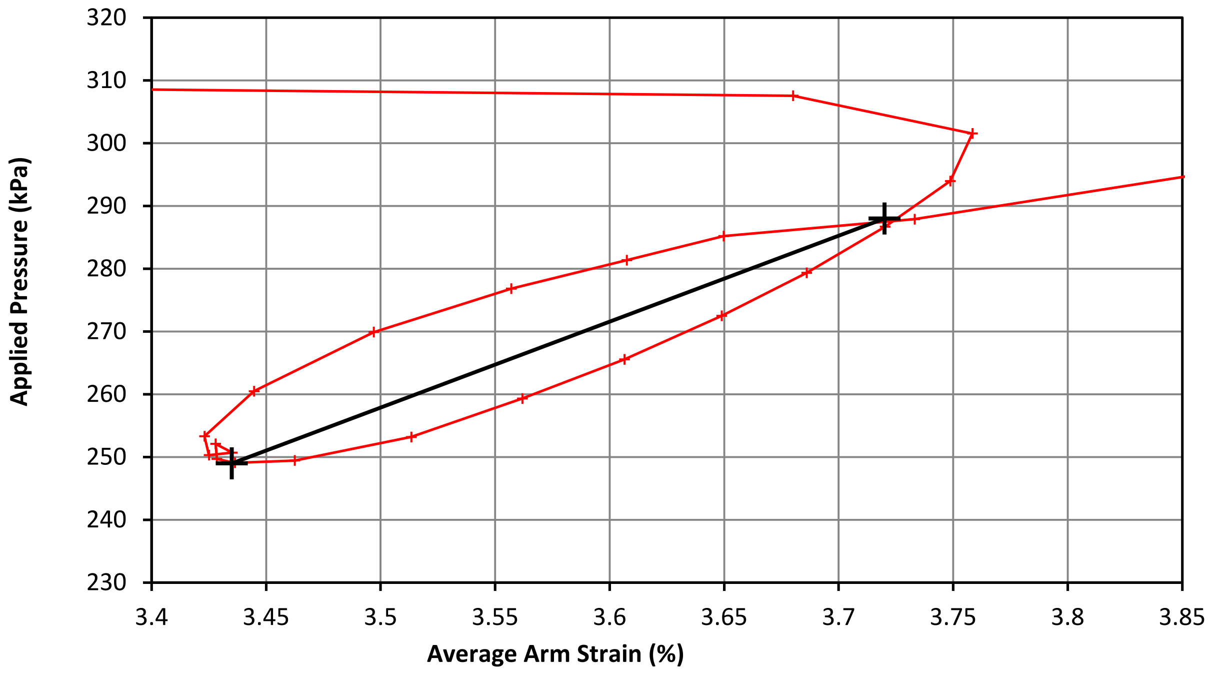
Marsland & Randolph	In situ horizontal stress	209 kPa
	Undrained Strength	48 kPa

Project	NGI - Halden Site	**Figure No.**	HALP01 T05 - 03
Client	NGI		
Project No.	P1170112		

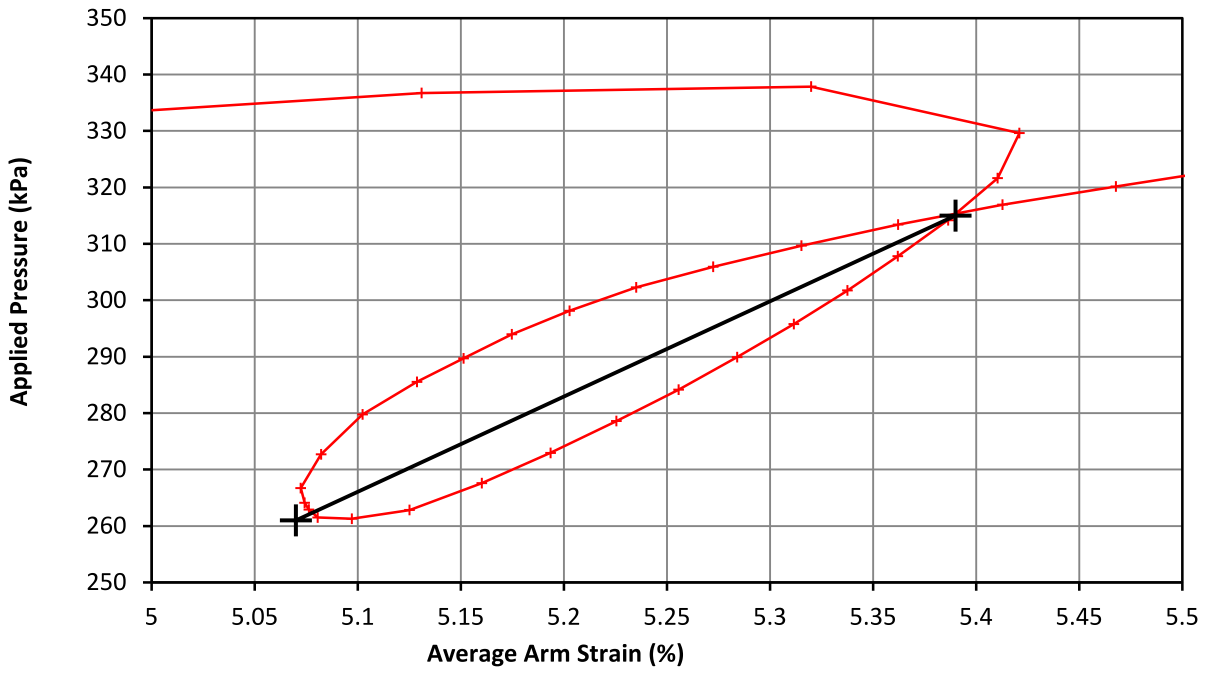
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	5
Borehole	HALP01	**Test Depth (m)**	13.50



Loop 1	Shear Modulus	7.1 MPa
	Cavity Strain Range	0.285 %



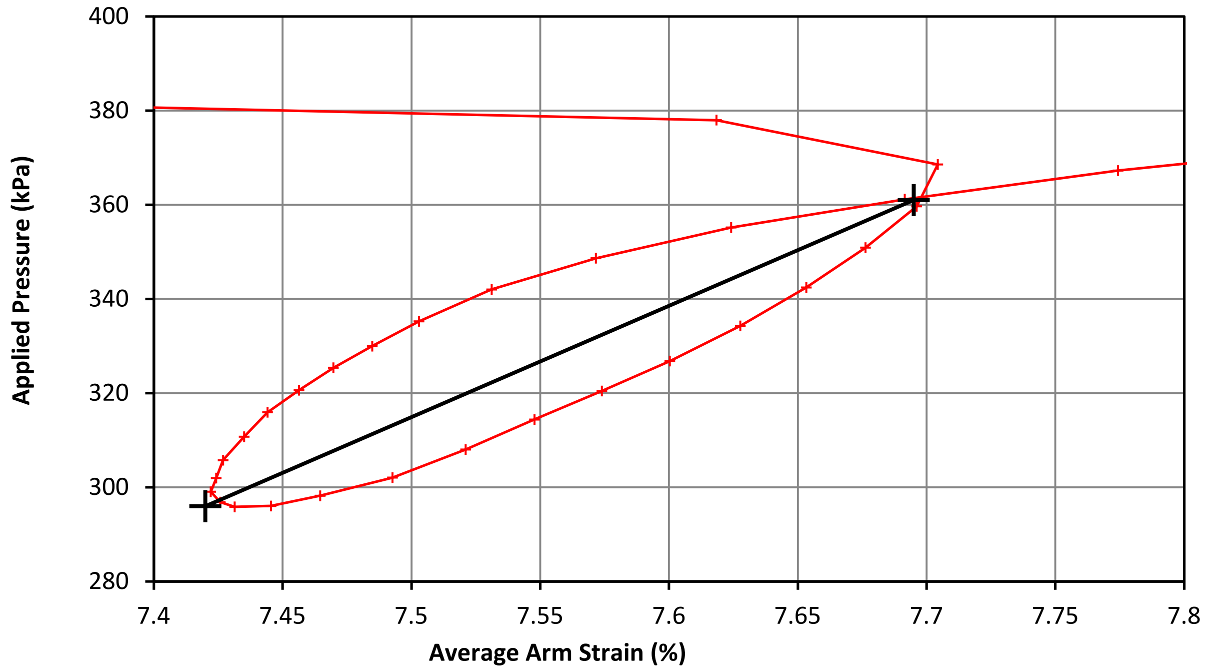
Loop 2	Shear Modulus	8.9 MPa
	Cavity Strain Range	0.320 %

Project	NGI - Halden Site	**Figure No.**	**HALP01 T05 - 04**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	5
Borehole	HALP01	**Test Depth (m)**	13.50



Loop 3	Shear Modulus	12.7	MPa
	Cavity Strain Range	0.275	%

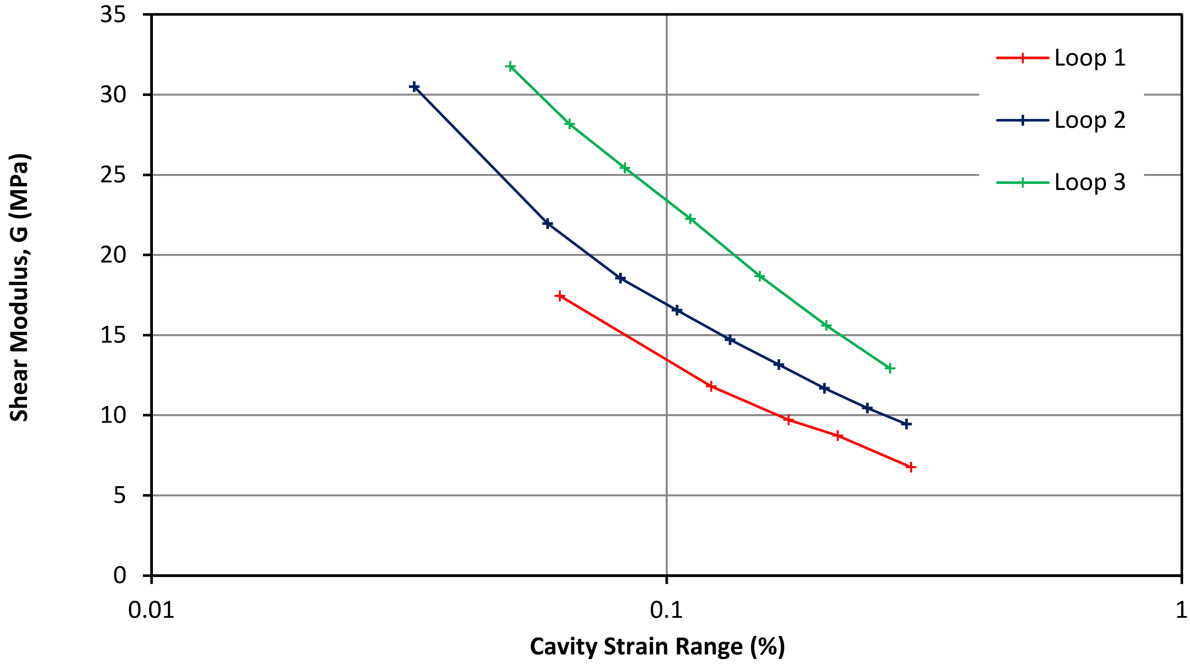
Project	NGI - Halden Site	**Figure No.**	HALP01 T05 - 05
Client	NGI		
Project No.	P1170112		

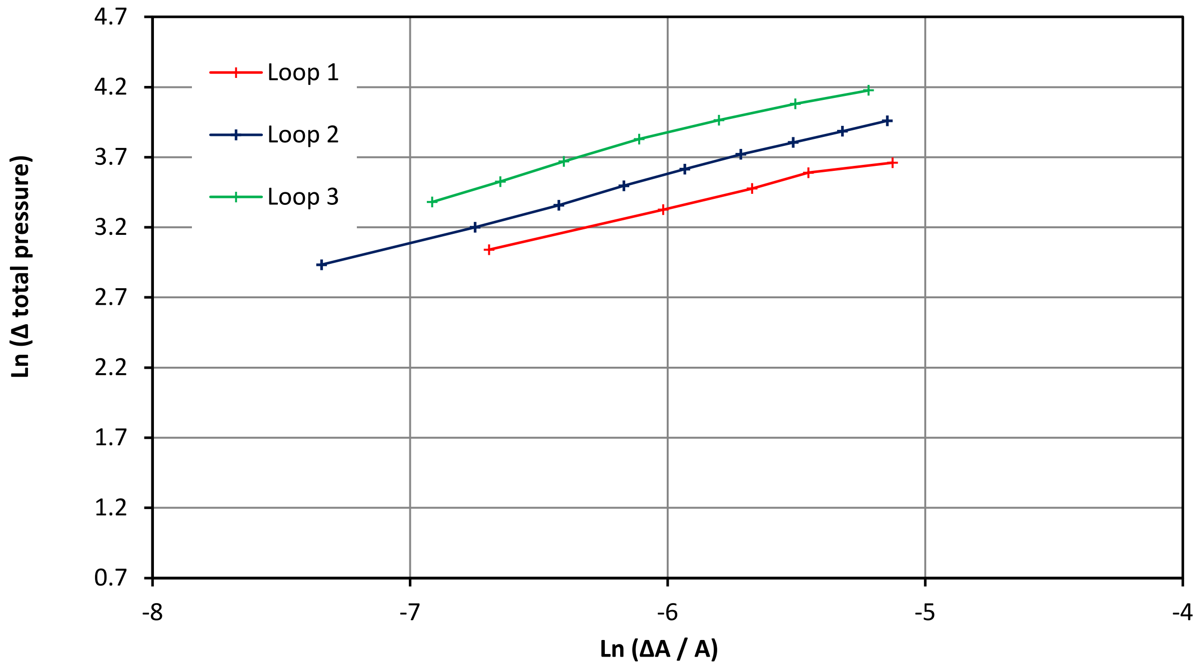
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	Test No.	5
Borehole	HALP01	Test Depth (m)	13.50





Loop 1		Loop 2		Loop 3	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.409	0.327 (MPa)	0.476	0.615 (MPa)	0.474	0.805 (MPa)

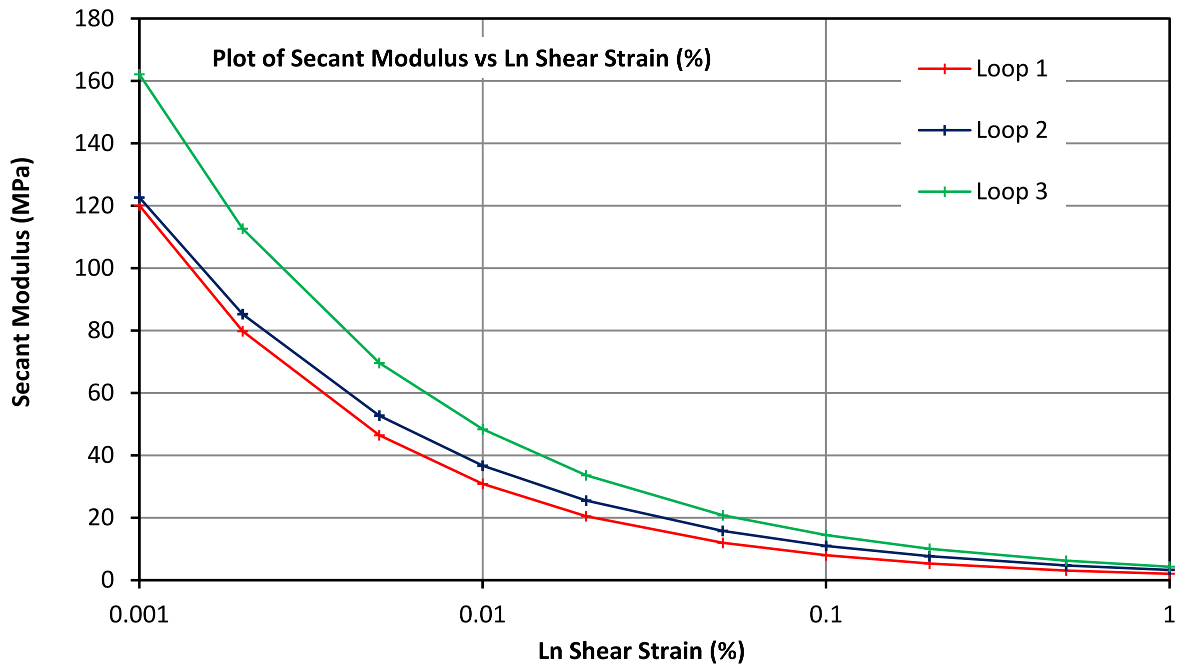
Project	NGI - Halden Site	Figure No.	HALP01 T05 - 06
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	18/09/2017	Test No.	5
Borehole	HALP01	Test Depth (m)	13.50



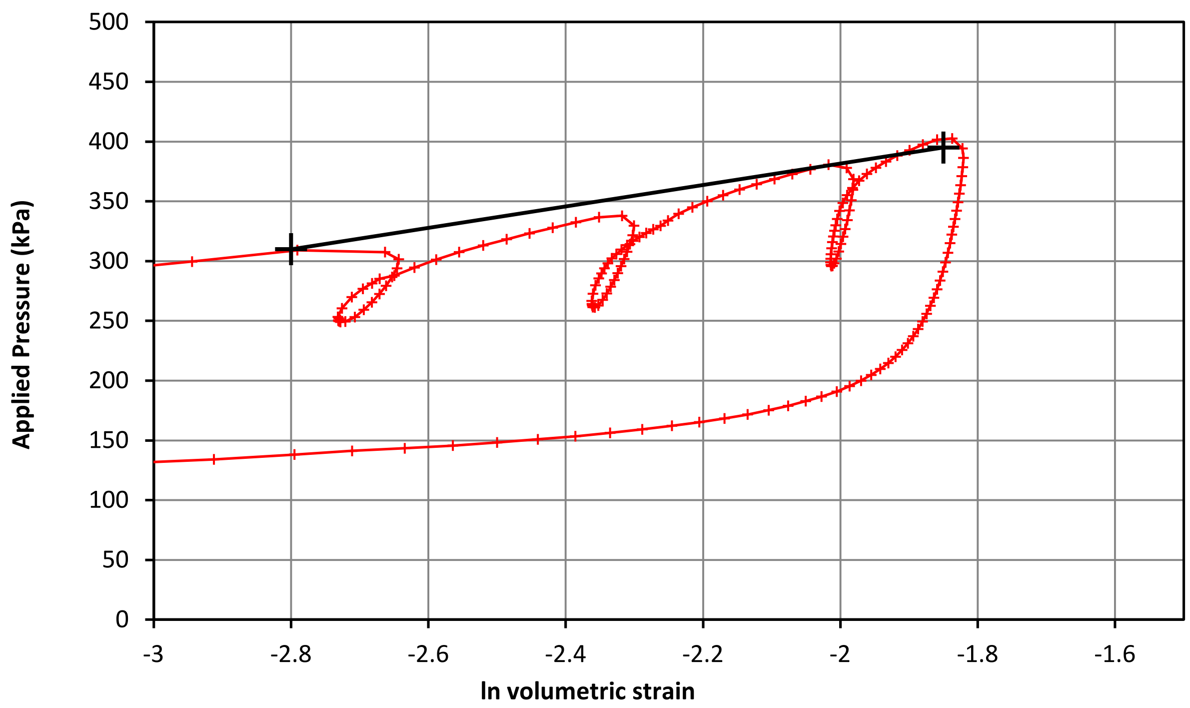
Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**120**	**123**	**162**
0.002%	80	85	113
0.005%	46	53	70
0.010%	**31**	**37**	**48**
0.020%	20	25	34
0.050%	12	16	21
0.100%	**8**	**11**	**14**
0.200%	5	8	10
0.500%	3	5	6
1.000%	**2**	**3**	**4**

Project	NGI - Halden Site	Figure No.	HALP01 T05 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	18/09/2017	**Test No.**	5
Borehole	HALP01	**Test Depth (m)**	13.50

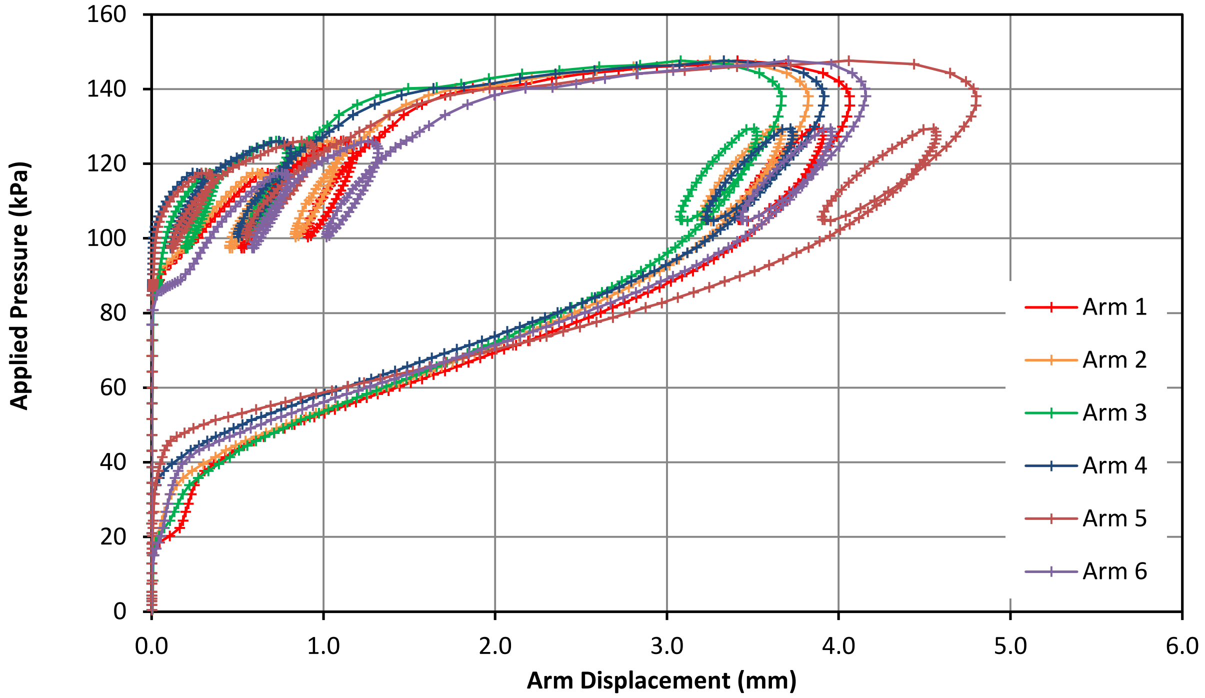


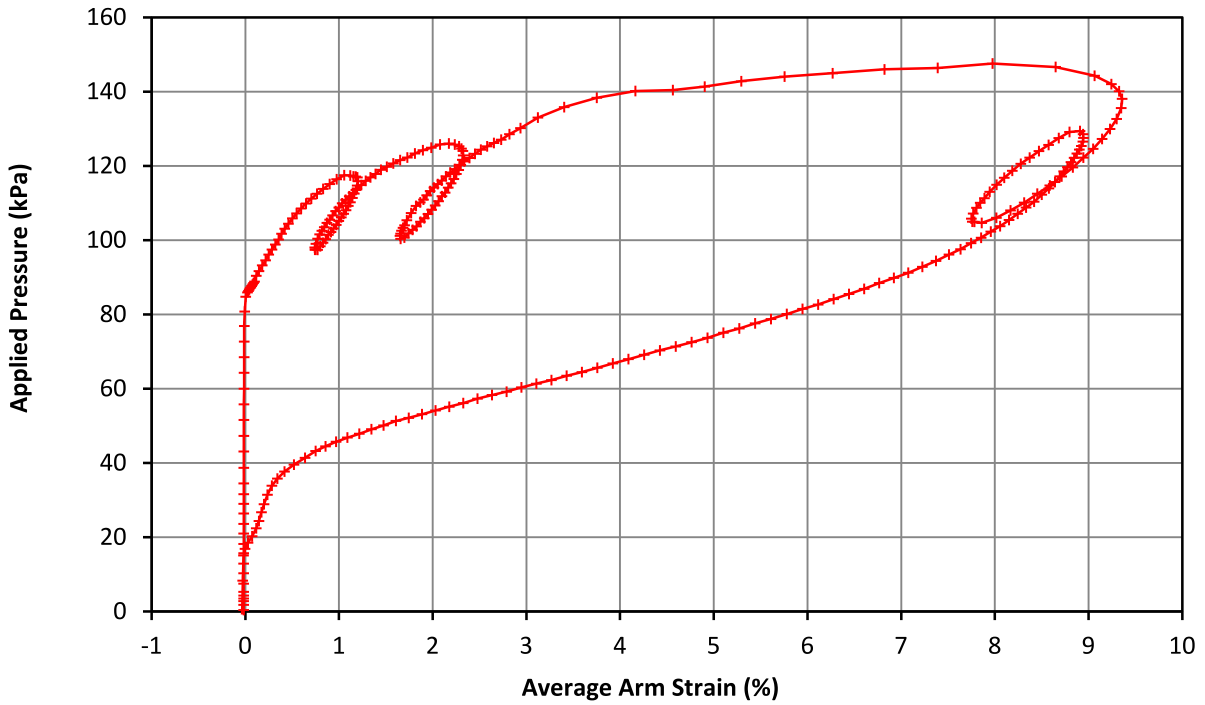
Strength	Undrained Shear	89	kPa
	Limit Pressure	561	kPa

Project	NGI - Halden Site	**Figure No.**	HALP01 T05 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00





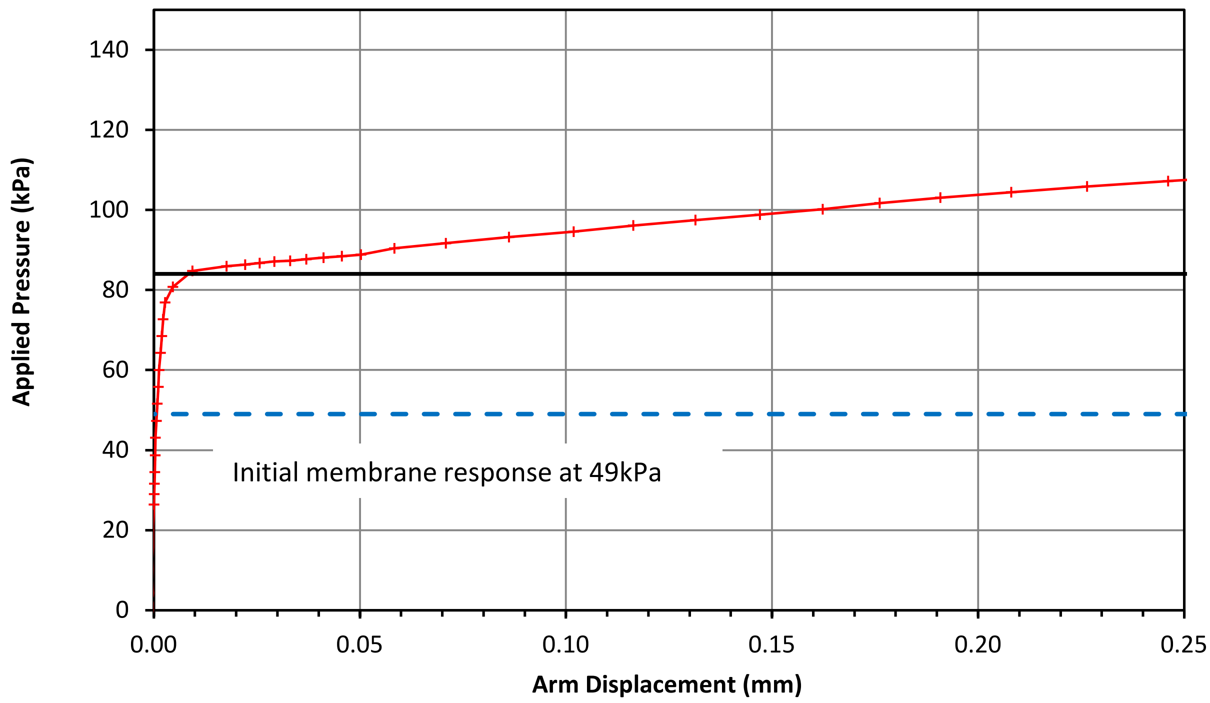
Comments

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 01**
Client	NGI		
Project No.	P1170112		

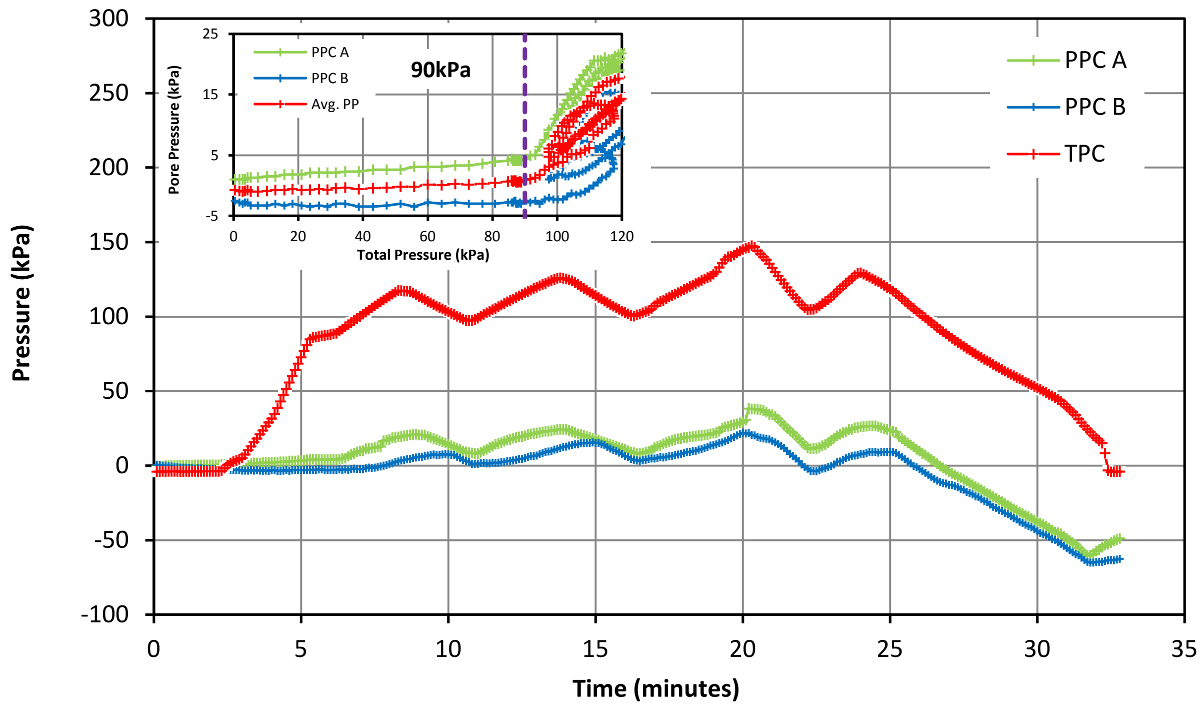
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00



Lift Off Stress (Po)	84 kPa

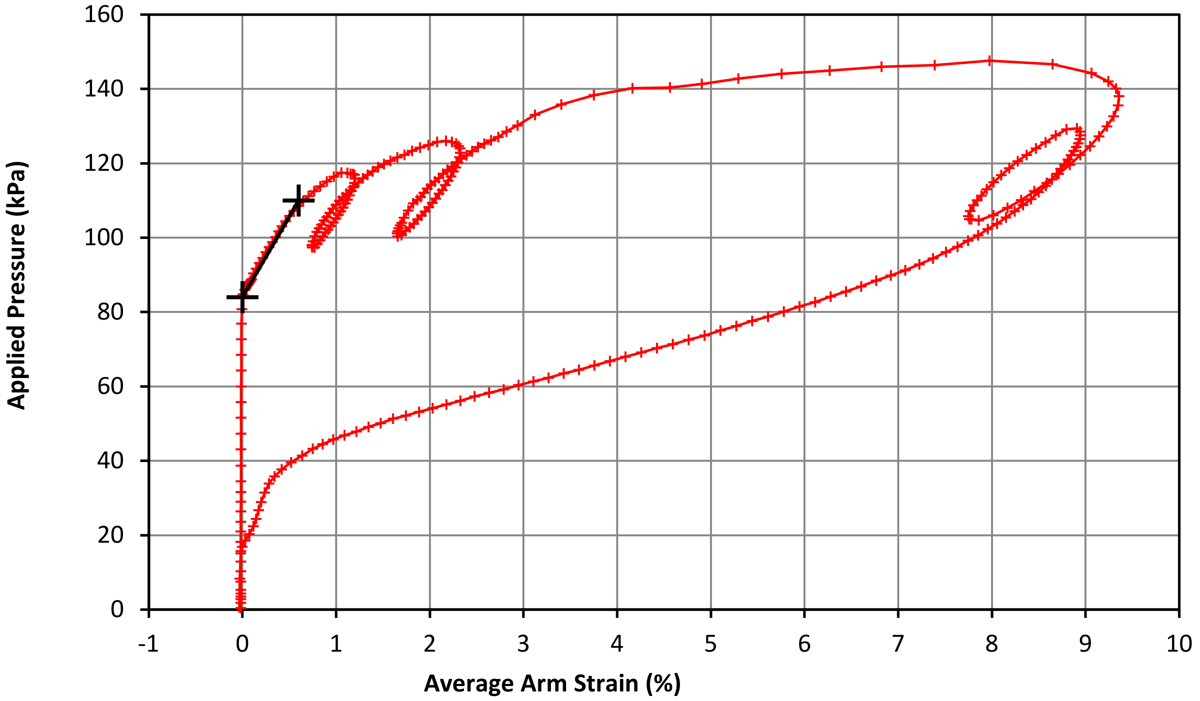


Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 02**
Client	NGI		
Project No.	P1170112		

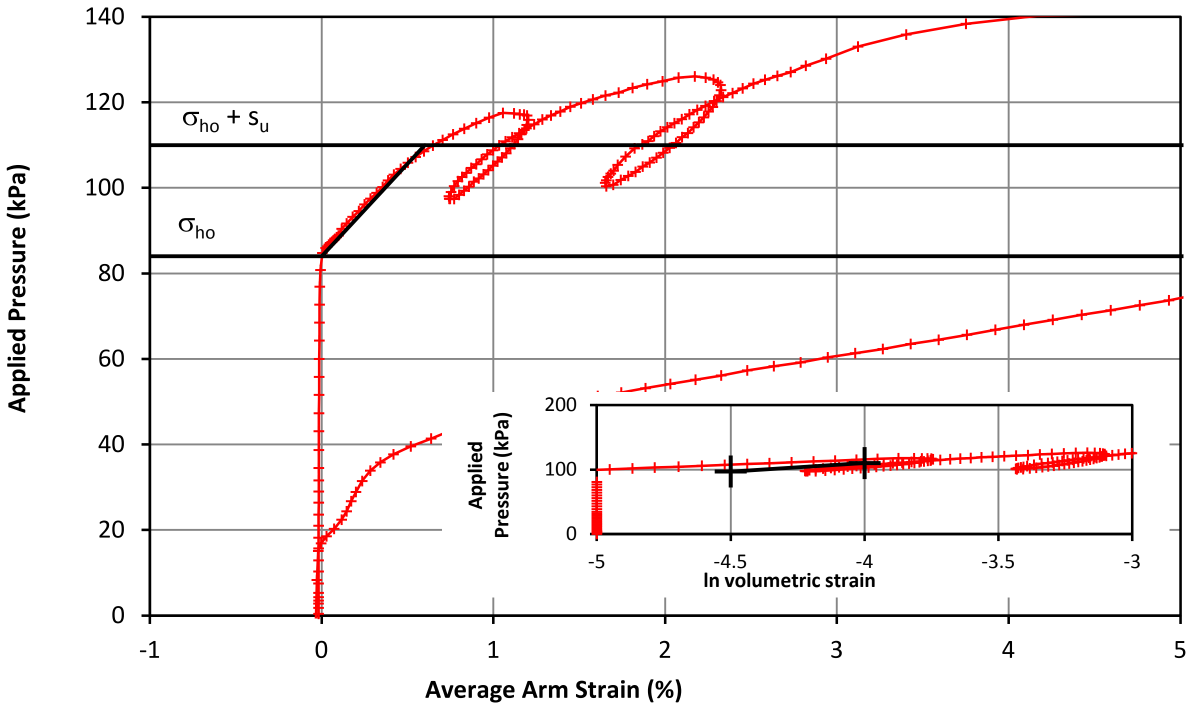
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00



Initial Modulus	Shear Modulus	2.2 MPa

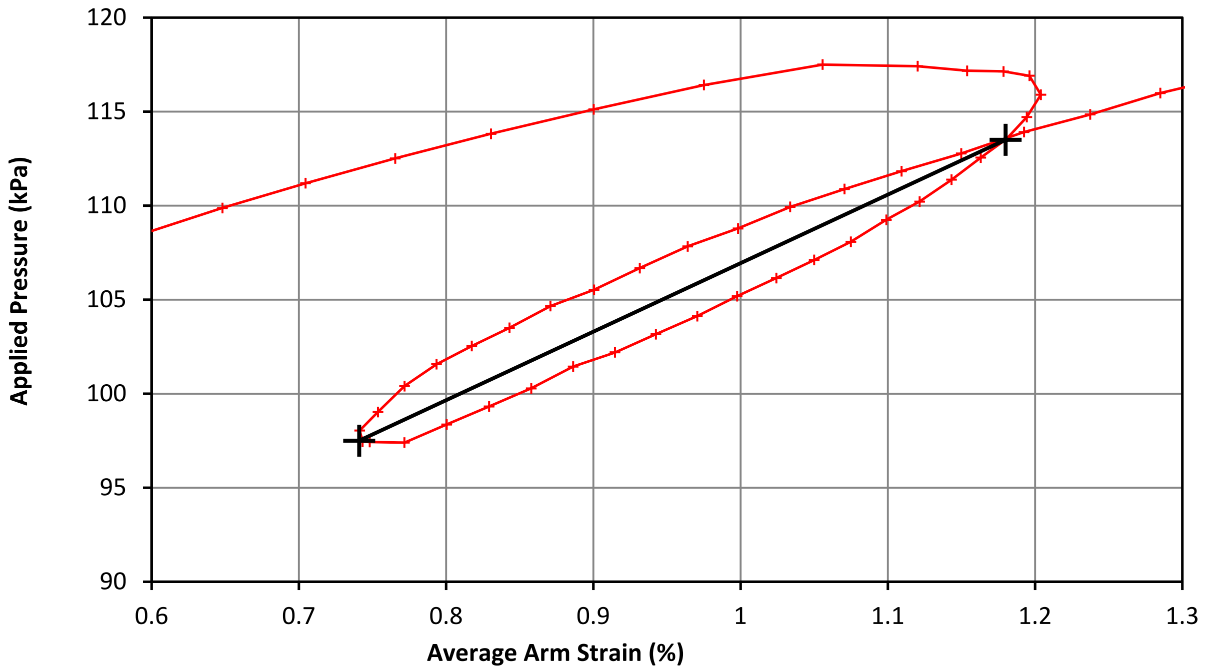


Marsland & Randolph	In situ horizontal stress	84 kPa
	Undrained Strength	26 kPa

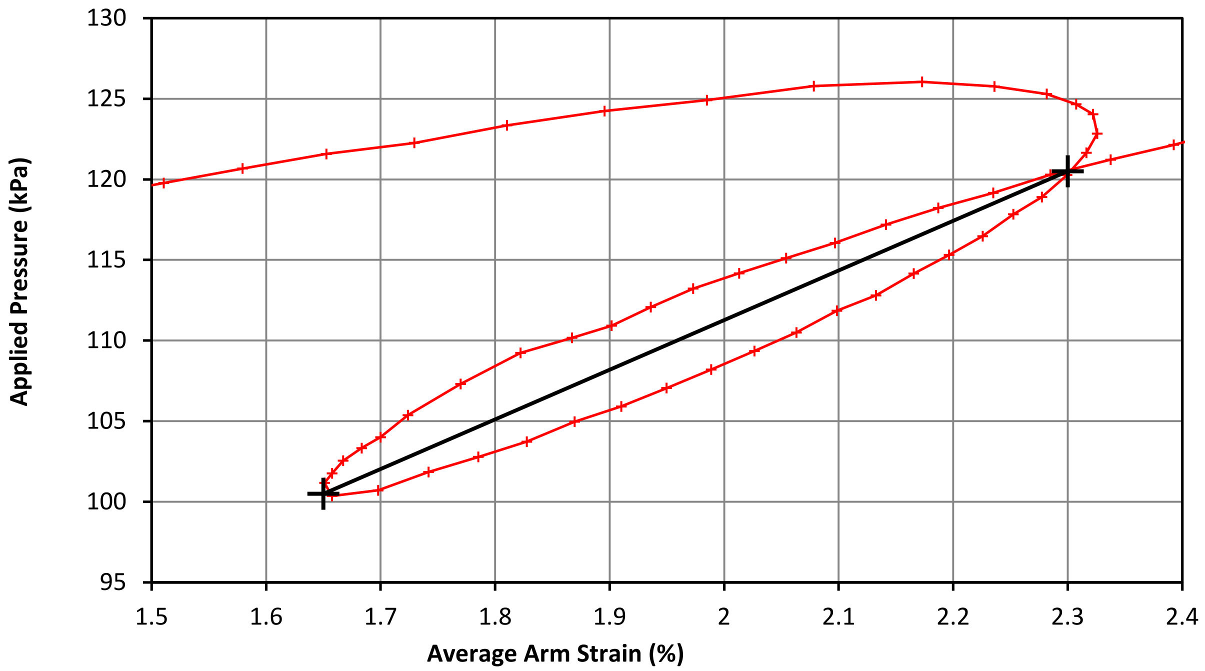
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 03**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00



Loop 1	Shear Modulus	1.8	MPa
	Cavity Strain Range	0.439	%

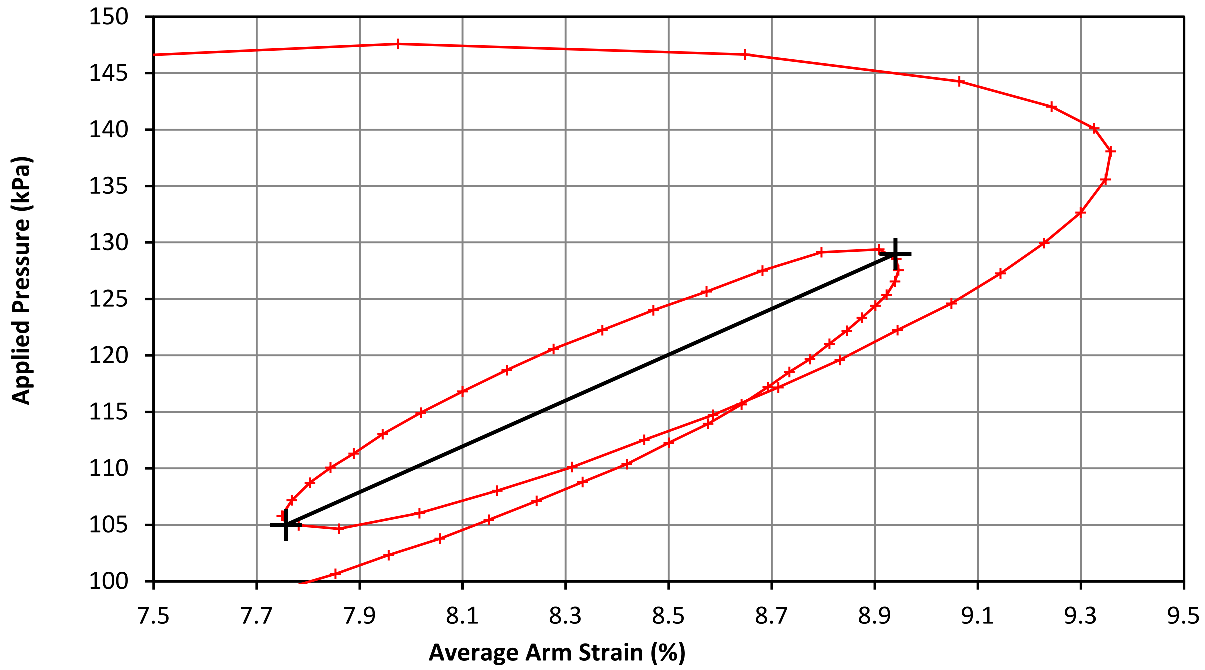


Loop 2	Shear Modulus	1.6	MPa
	Cavity Strain Range	0.650	%

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 04**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00



Loop 3	Shear Modulus	1.1	MPa
	Cavity Strain Range	1.183	%

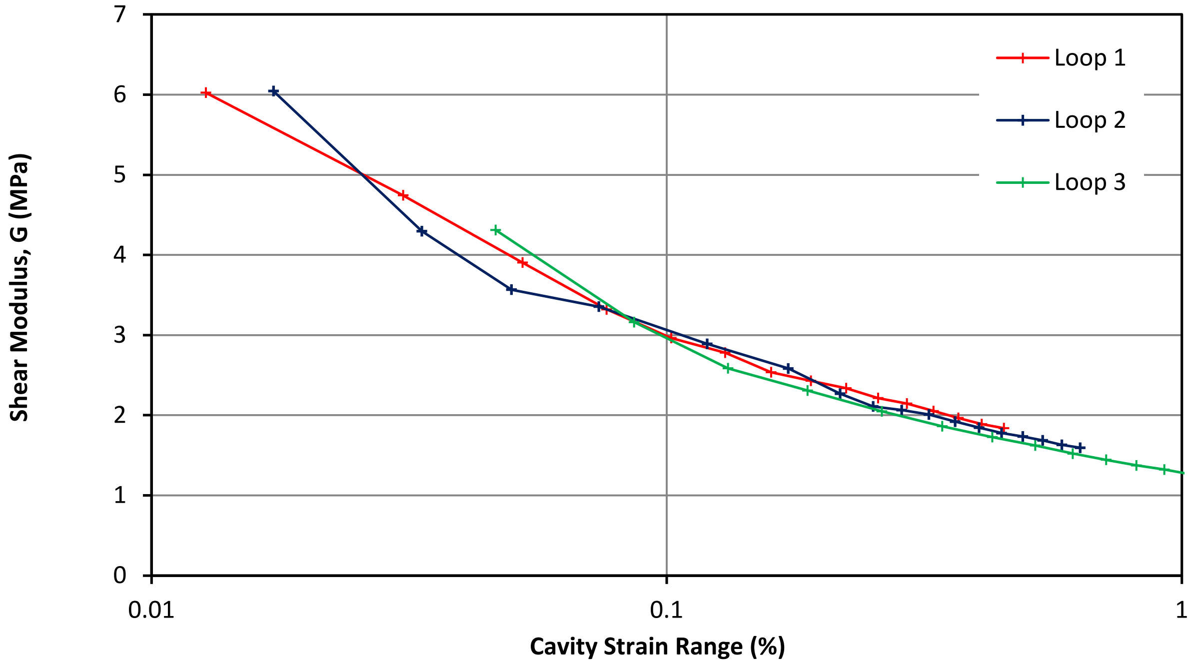
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 05**
Client	NGI		
Project No.	P1170112		

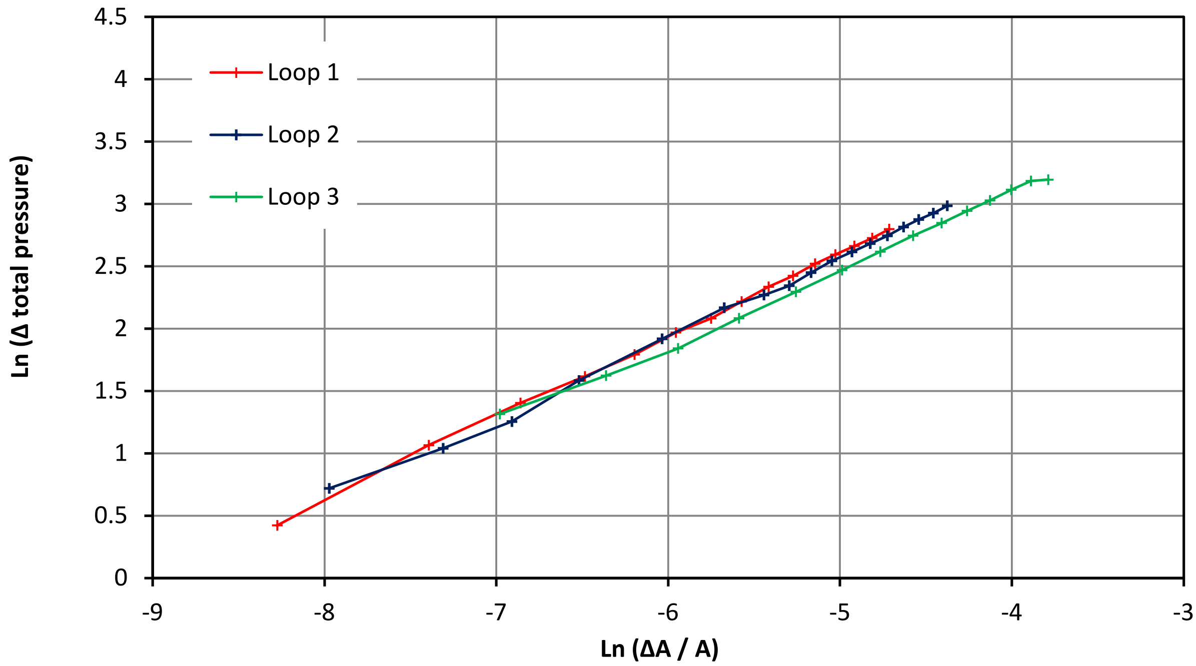
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00





Loop 1		**Loop 2**		**Loop 3**	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.660	0.366 (MPa)	0.647	0.332 (MPa)	0.618	0.261 (MPa)

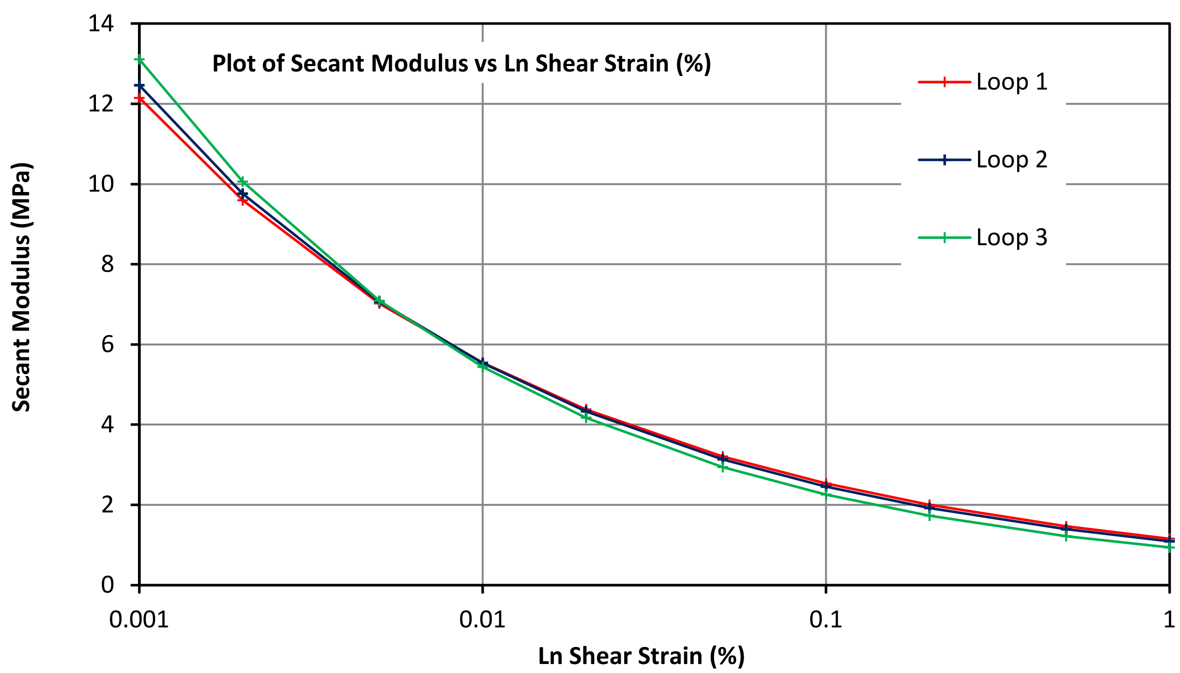
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	1
Borehole	ONSP01	Test Depth (m)	5.00



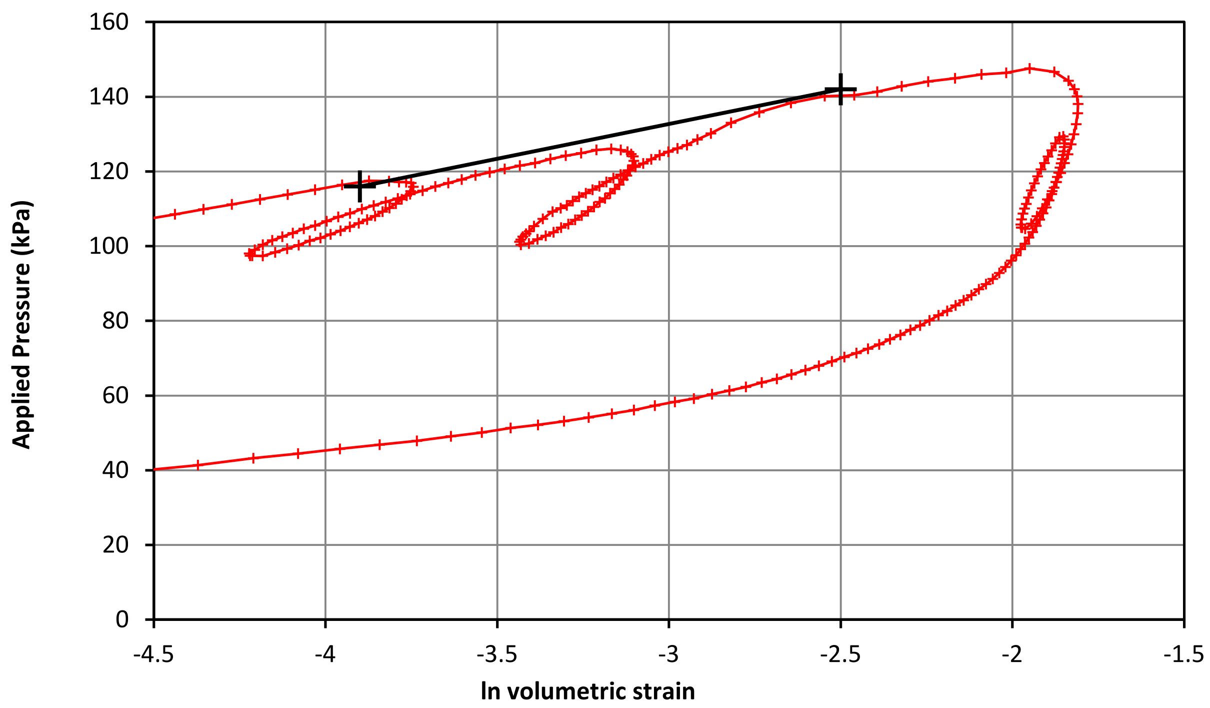
Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**12**	**12**	**13**
0.002%	10	10	10
0.005%	7	7	7
0.010%	**6**	**6**	**5**
0.020%	4	4	4
0.050%	3	3	3
0.100%	**3**	**2**	**2**
0.200%	2	2	2
0.500%	1	1	1
1.000%	**1**	**1**	**1**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T01 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	1
Borehole	ONSP01	**Test Depth (m)**	5.00



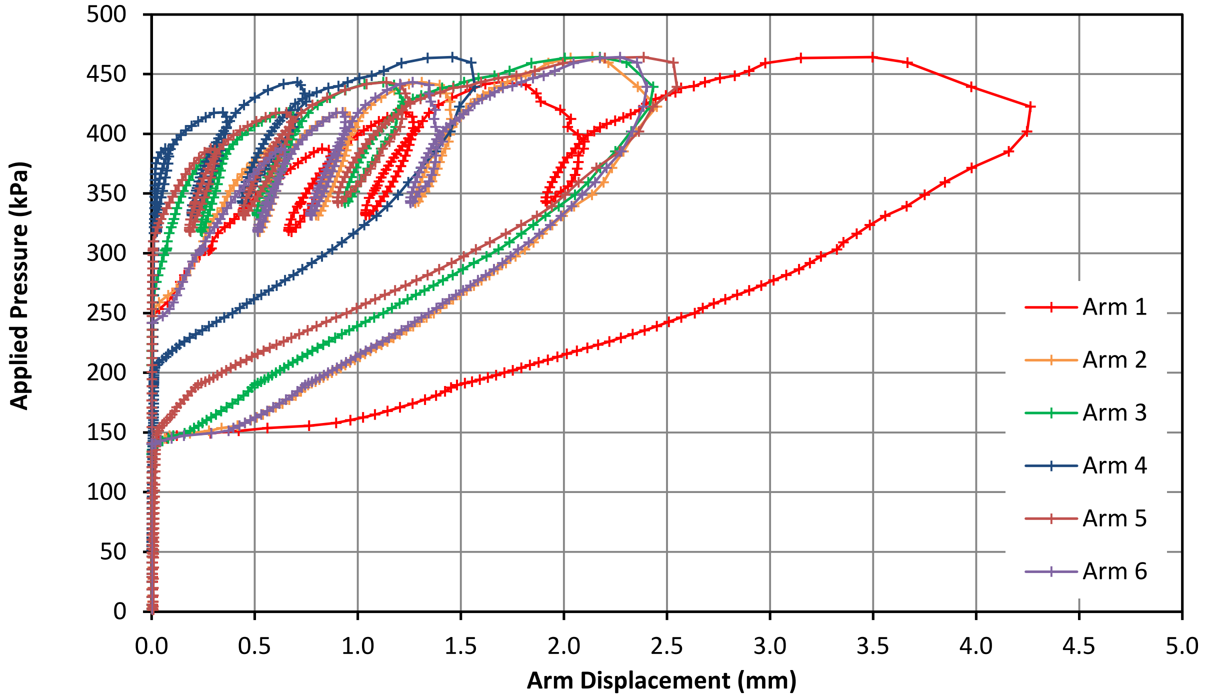
Strength	Undrained Shear	19	kPa
	Limit Pressure	188	kPa

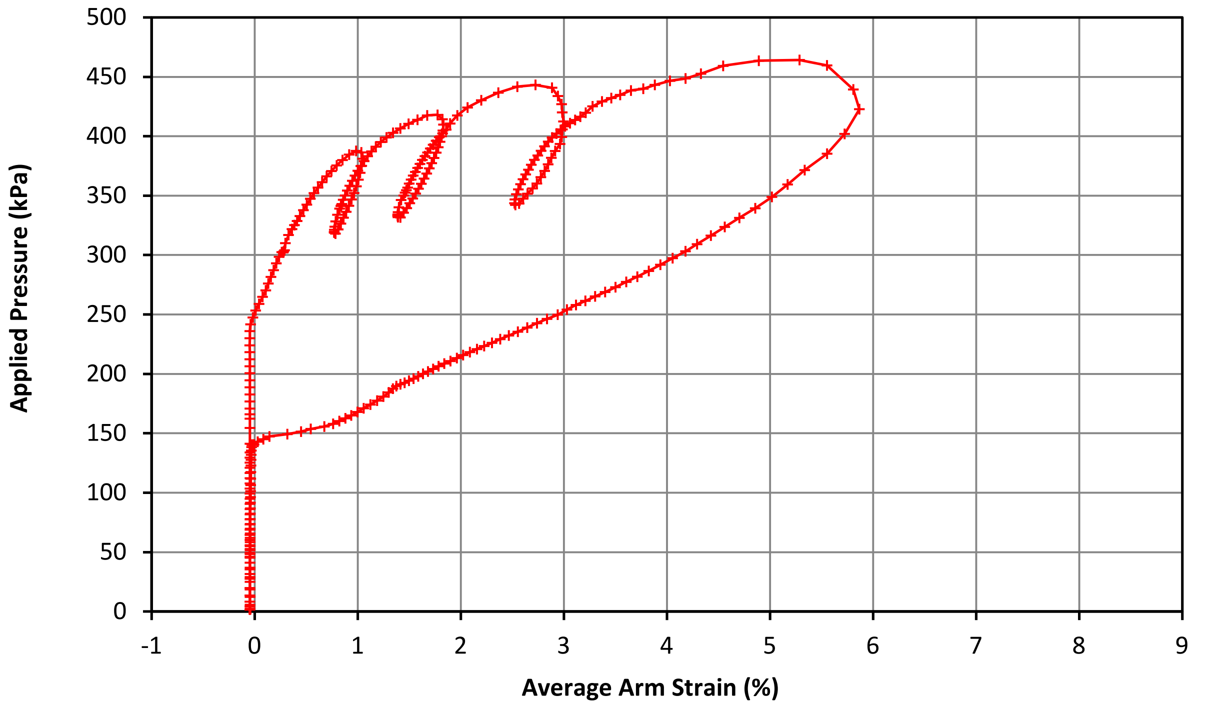
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T01 - 08**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	23/09/2017	Test No.	10
Borehole	ONSP01	Test Depth (m)	18.00





Comments

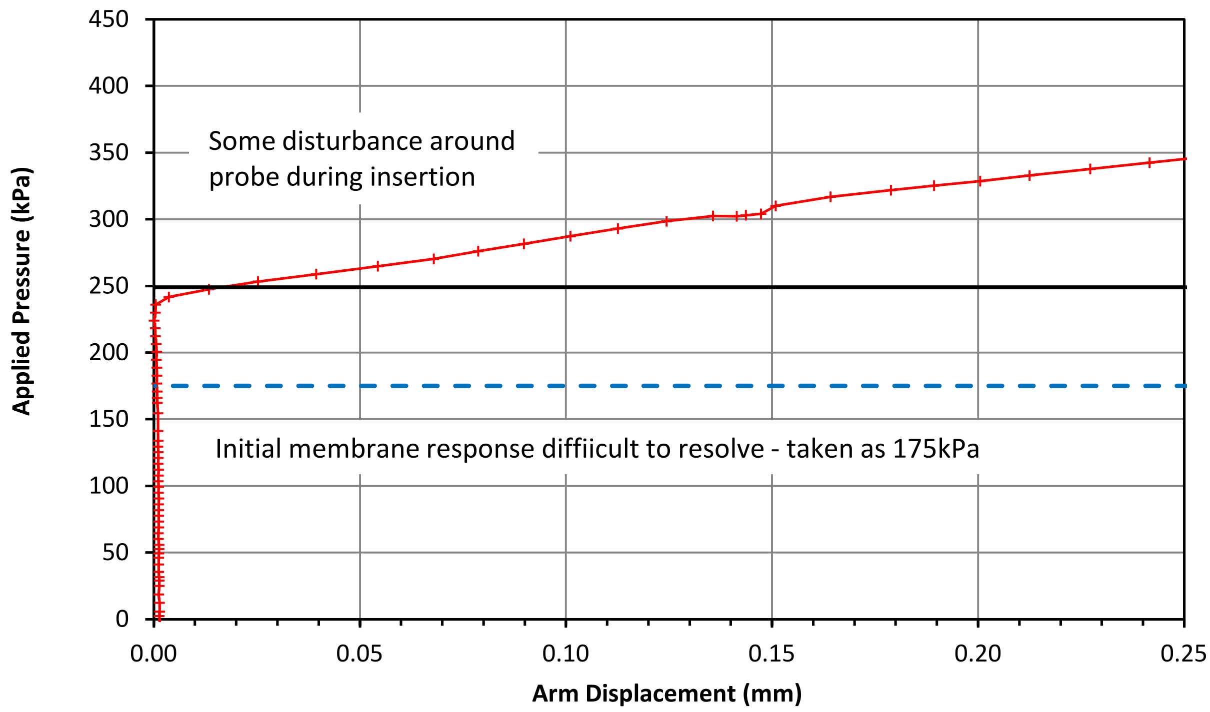
Large uneven displacement on arm 1, membrane pulled out of instrument.
Pore pressure cell A fluctuating.

Project	NGI - Onsøy Site	Figure No.	ONSP01 T10 - 01
Client	NGI		
Project No.	P1170112		

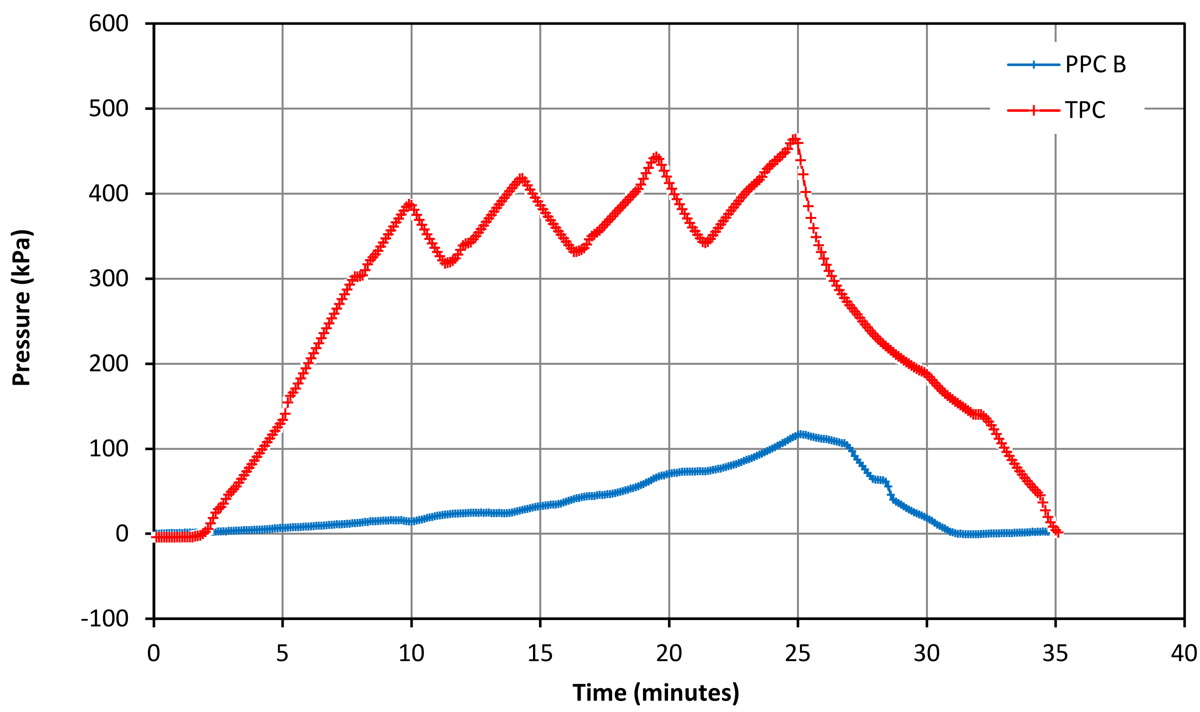
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	23/09/2017	Test No.	10
Borehole	ONSP01	Test Depth (m)	18.00



Lift Off Stress (Po)	249 kPa

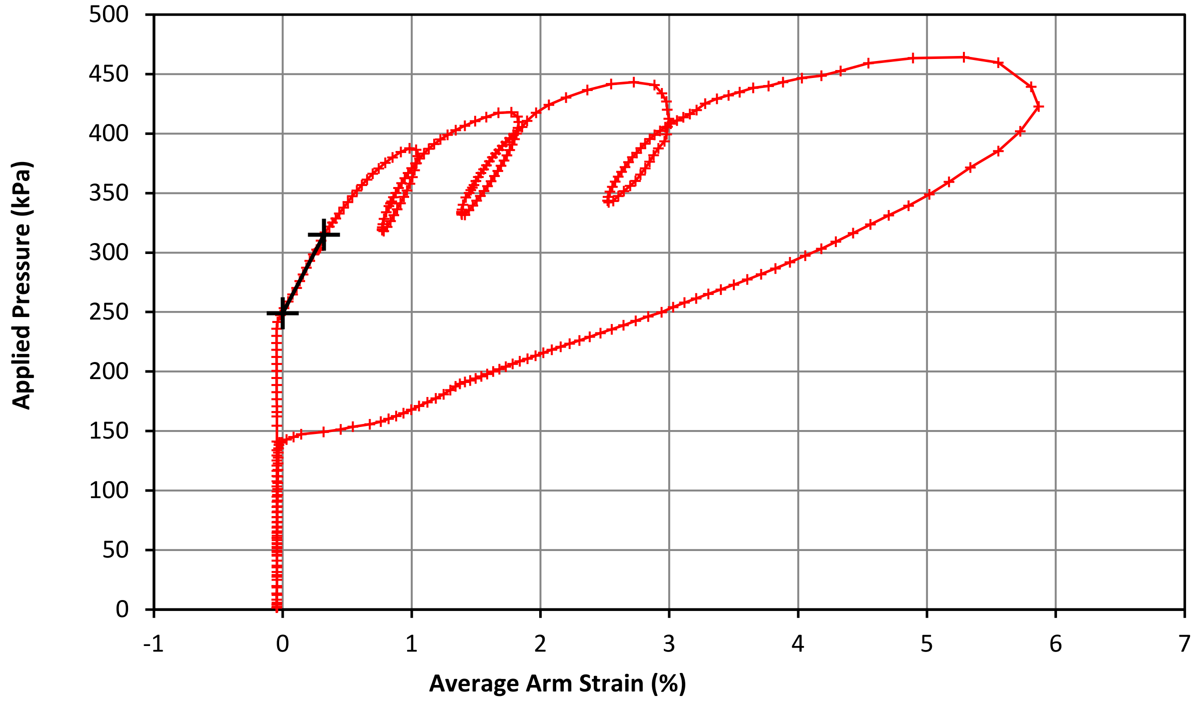


Project	NGI - Onsøy Site	Figure No.	ONSP01 T10 - 02
Client	NGI		
Project No.	P1170112		

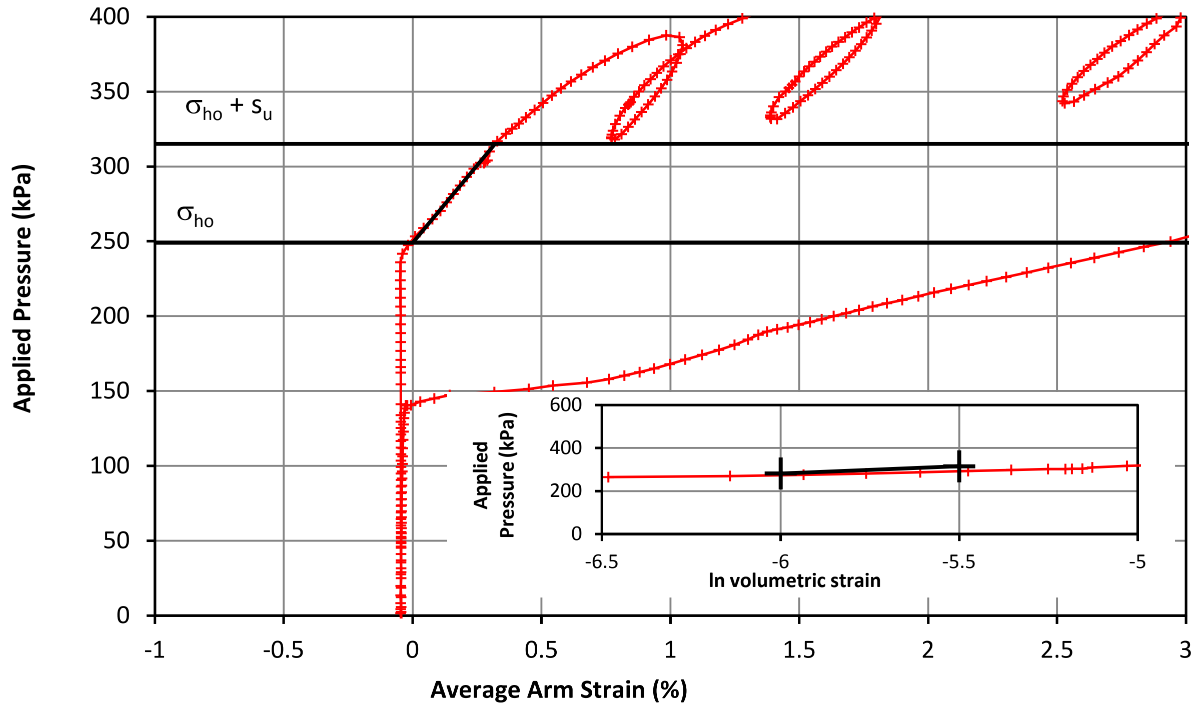
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU
SITE INVESTIGATION

Test Date	23/09/2017	Test No.	10
Borehole	ONSP01	Test Depth (m)	18.00



Initial Modulus	Shear Modulus	10.3 MPa



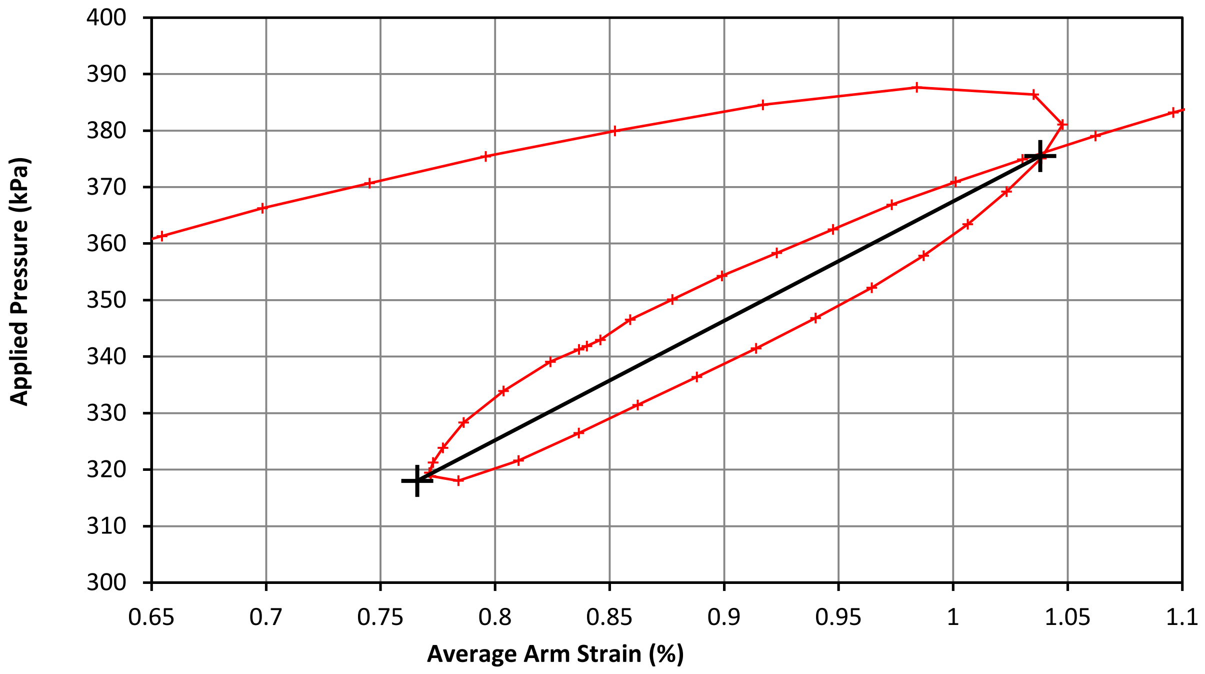
Marsland & Randolph	In situ horizontal stress	249 kPa
	Undrained Strength	66 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T10 - 03
Client	NGI		
Project No.	P1170112		

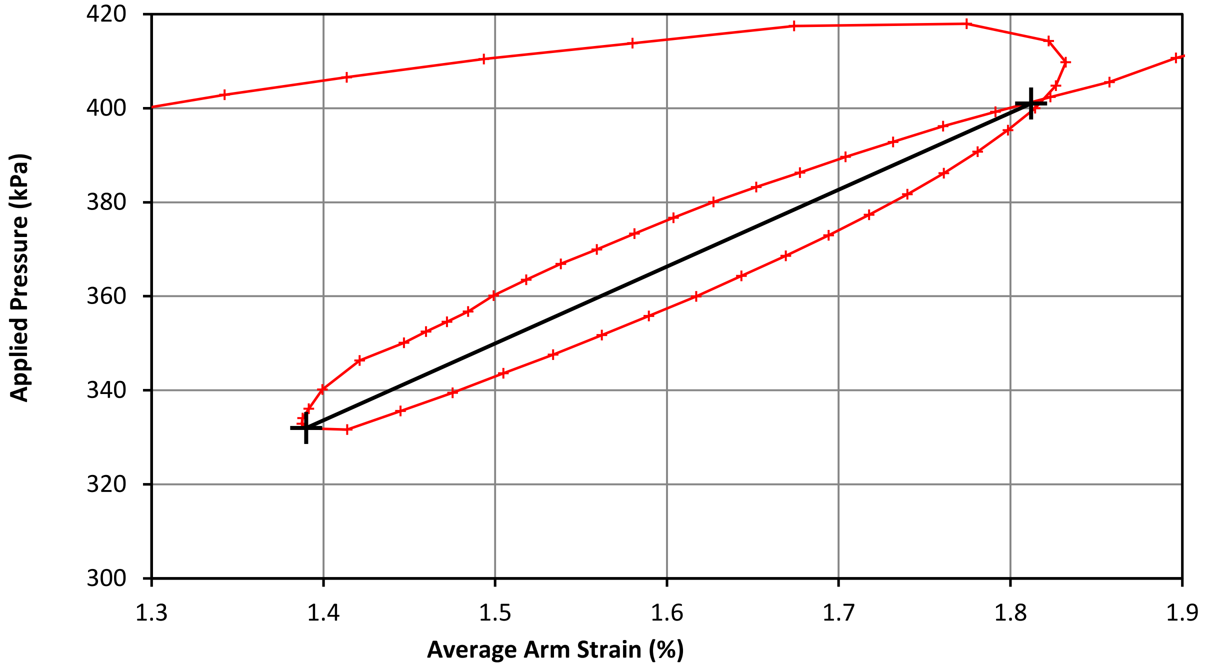
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	23/09/2017	**Test No.**	10
Borehole	ONSP01	**Test Depth (m)**	18.00



Loop 1	Shear Modulus	10.7	MPa
	Cavity Strain Range	0.272	%



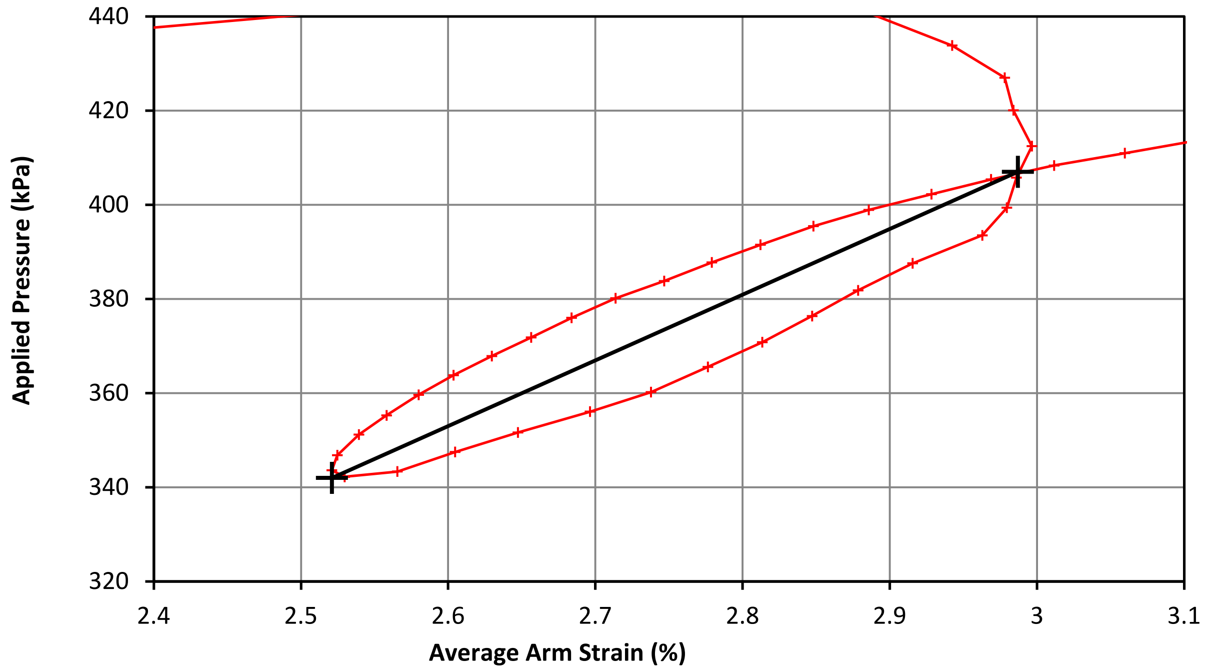
Loop 2	Shear Modulus	8.3	MPa
	Cavity Strain Range	0.422	%

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T10 - 04**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	23/09/2017	**Test No.**	10
Borehole	ONSP01	**Test Depth (m)**	18.00



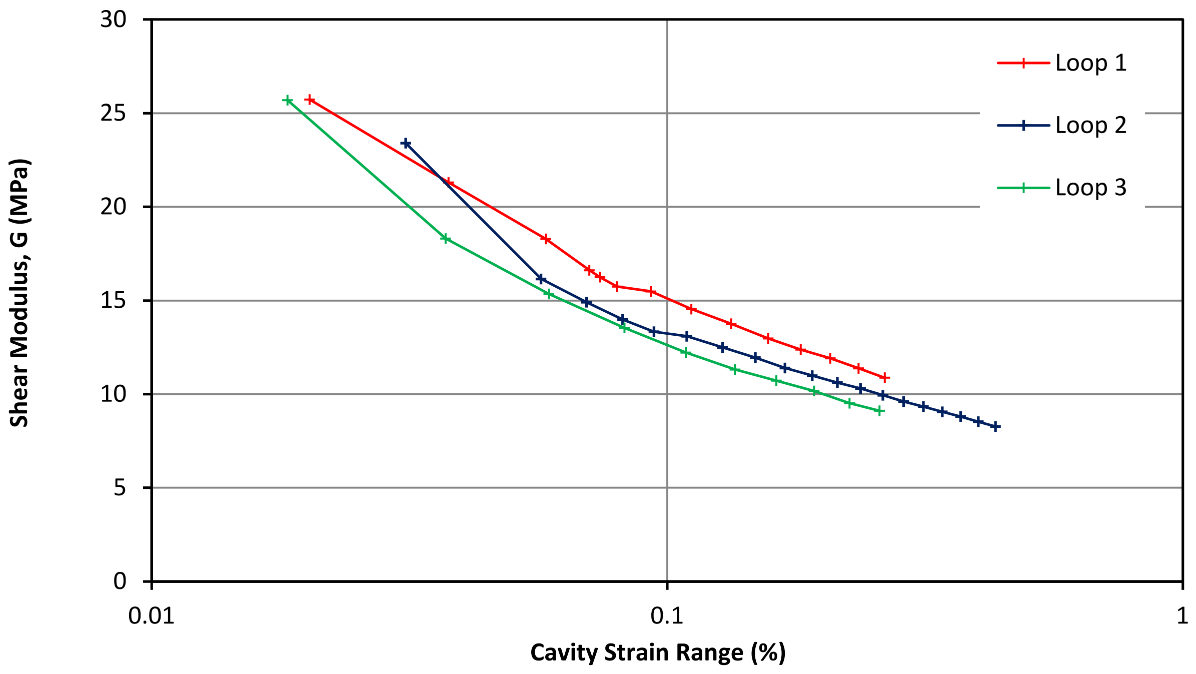
Loop 3	Shear Modulus	7.2 MPa
	Cavity Strain Range	0.466 %

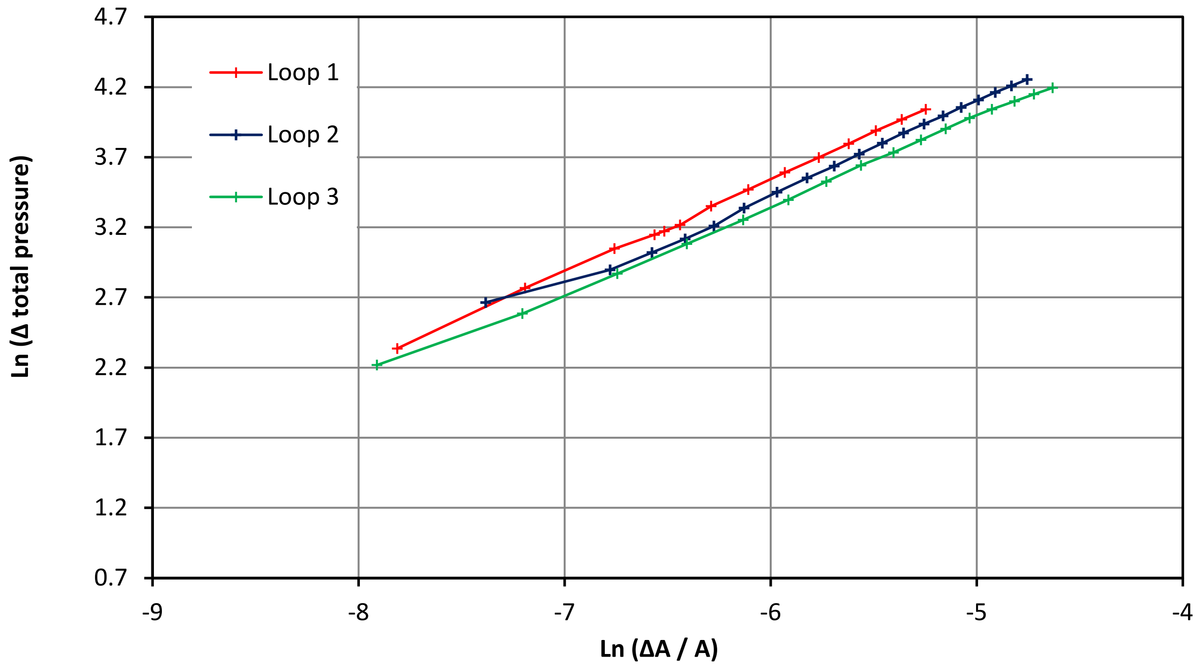
Project	NGI - Onsøy Site	**Figure No.**	ONSP01 T10 - 05
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

Test Date	23/09/2017	**Test No.**	10
Borehole	ONSP01	**Test Depth (m)**	18.00





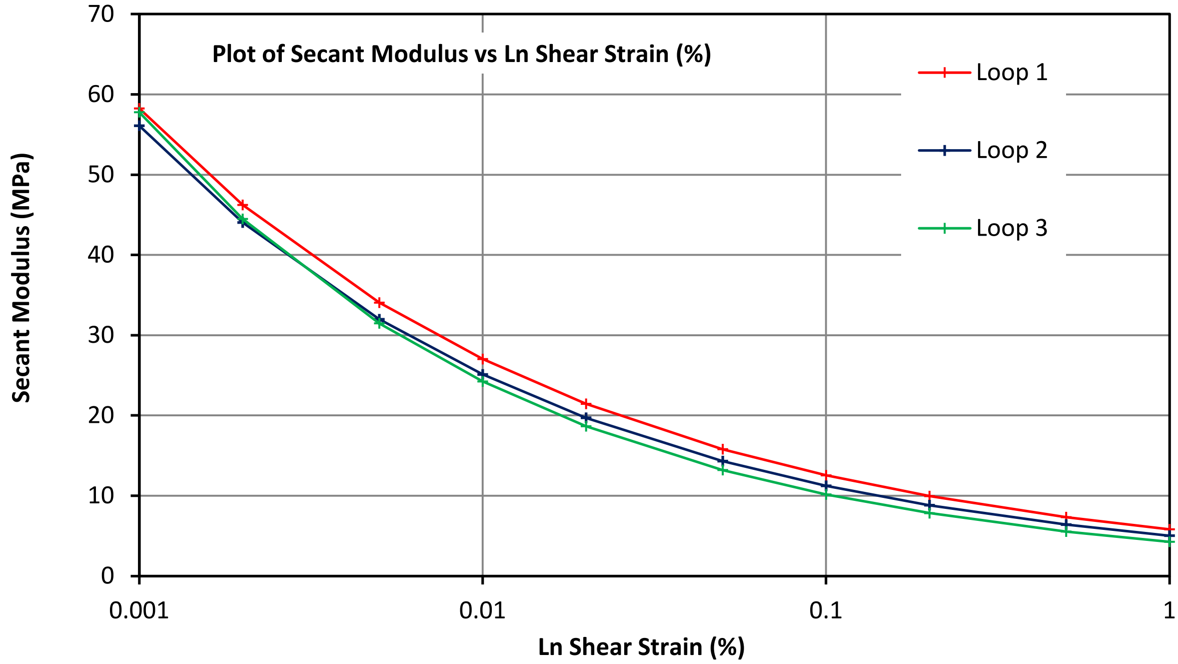
Loop 1		Loop 2		Loop 3	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.667	1.880 (MPa)	0.651	1.548 (MPa)	0.623	1.205 (MPa)

Project	NGI - Onsøy Site	**Figure No.**	ONSP01 T10 - 06
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

Test Date	23/09/2017	**Test No.**	10
Borehole	ONSP01	**Test Depth (m)**	18.00



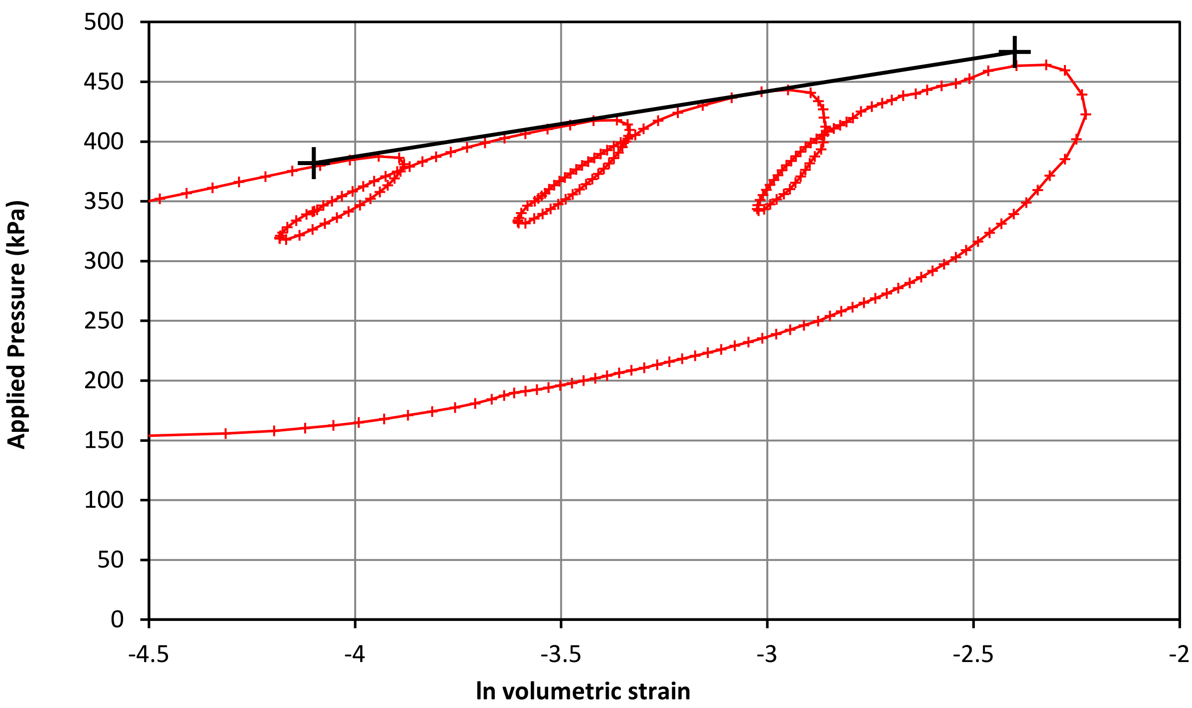
Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**58**	**56**	**58**
0.002%	46	44	44
0.005%	34	32	31
0.010%	**27**	**25**	**24**
0.020%	21	20	19
0.050%	16	14	13
0.100%	**13**	**11**	**10**
0.200%	10	9	8
0.500%	7	6	6
1.000%	**6**	**5**	**4**

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T10 - 07**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU
SITE INVESTIGATION

Test Date	23/09/2017	**Test No.**	10
Borehole	ONSP01	**Test Depth (m)**	18.00

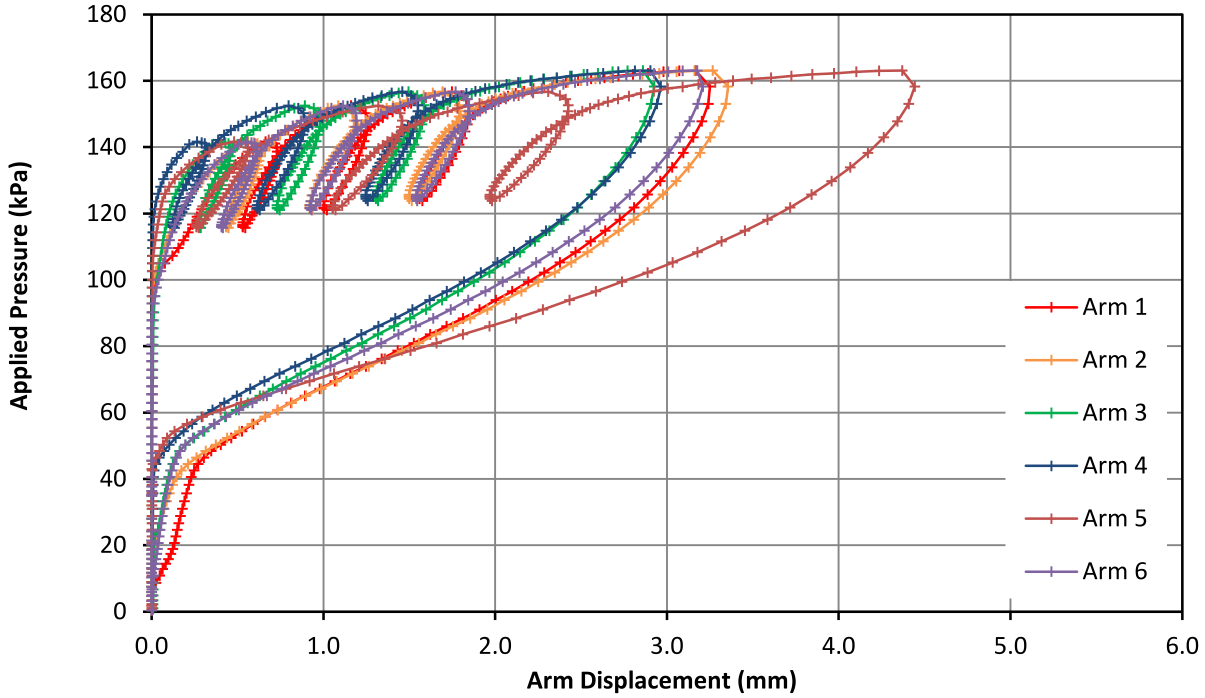


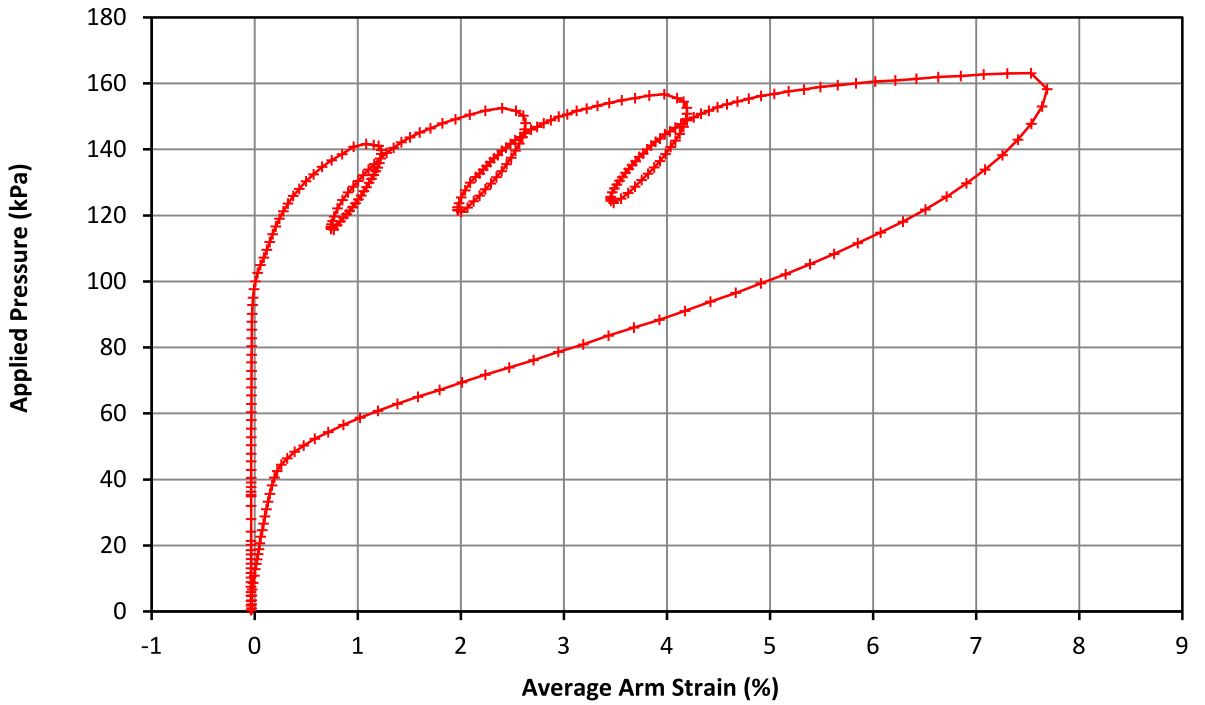
Strength	Undrained Shear	55	kPa
	Limit Pressure	606	kPa

Project	NGI - Onsøy Site	**Figure No.**	ONSP01 T10 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	20/09/2017	Test No.	2
Borehole	ONSP01	Test Depth (m)	6.10



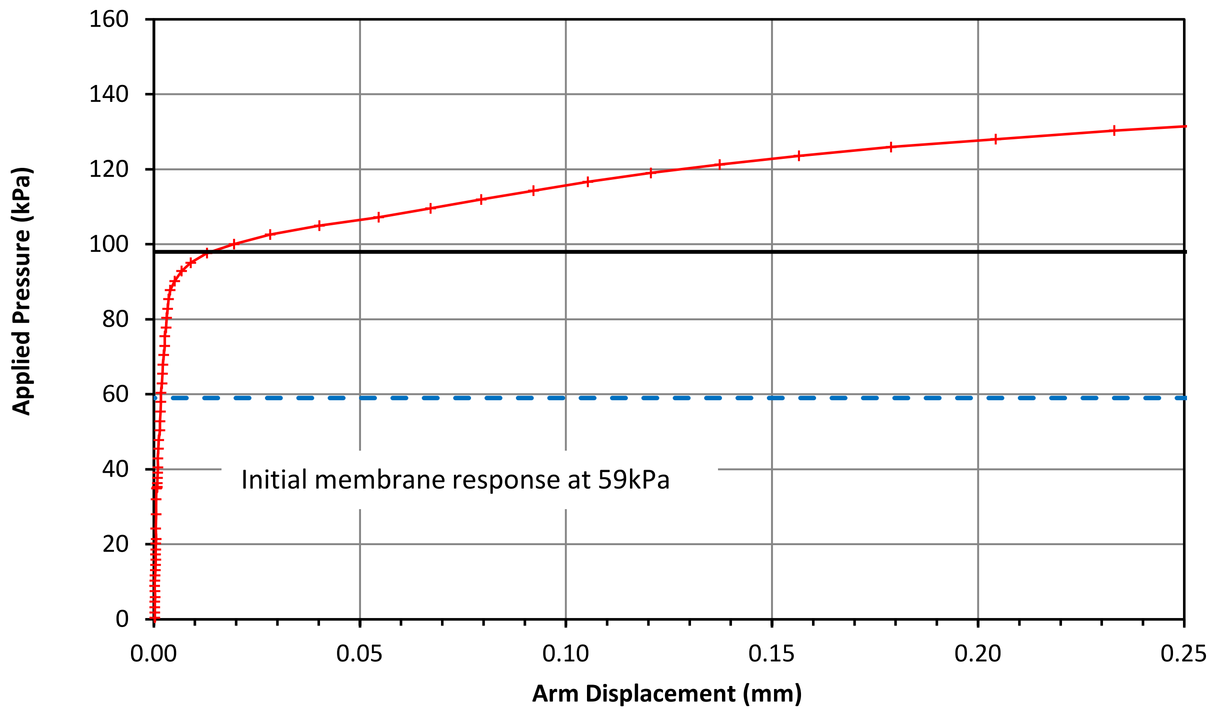


Comments

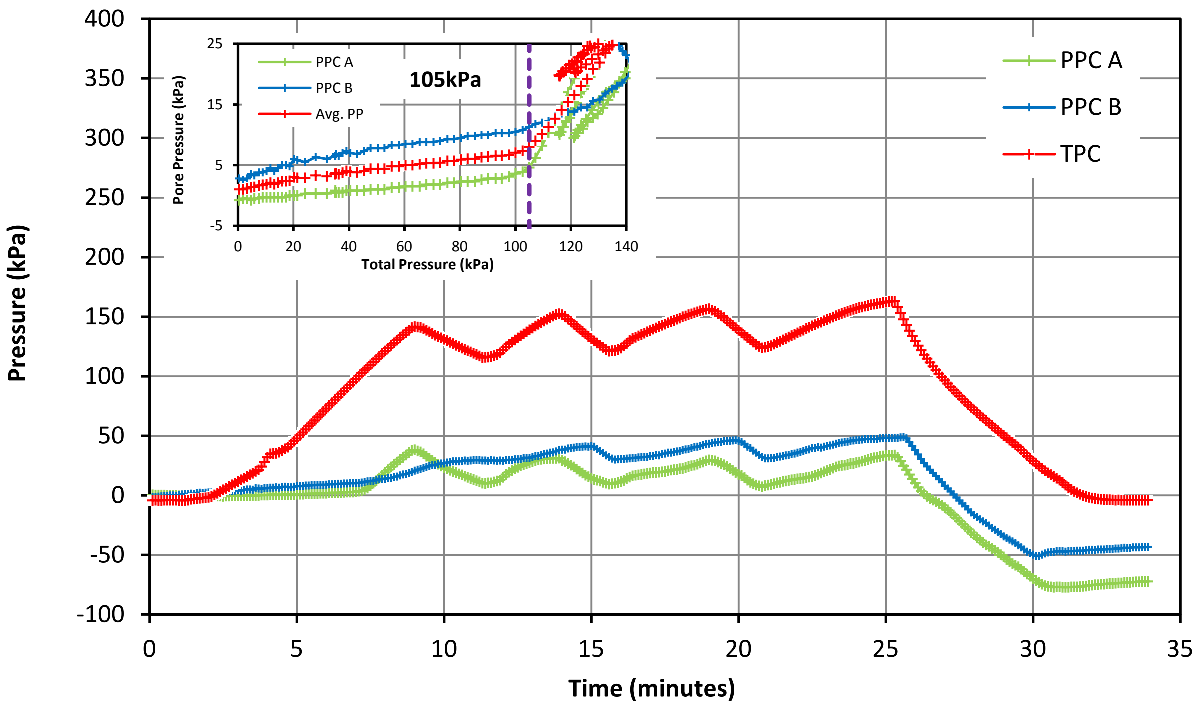
Project	NGI - Onsøy Site	Figure No.	ONSP01 T02 - 01
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Lift Off Stress & Pore Pressure Record

Test Date	20/09/2017	Test No.	2
Borehole	ONSP01	Test Depth (m)	6.10



Lift Off Stress (Po)	98 kPa

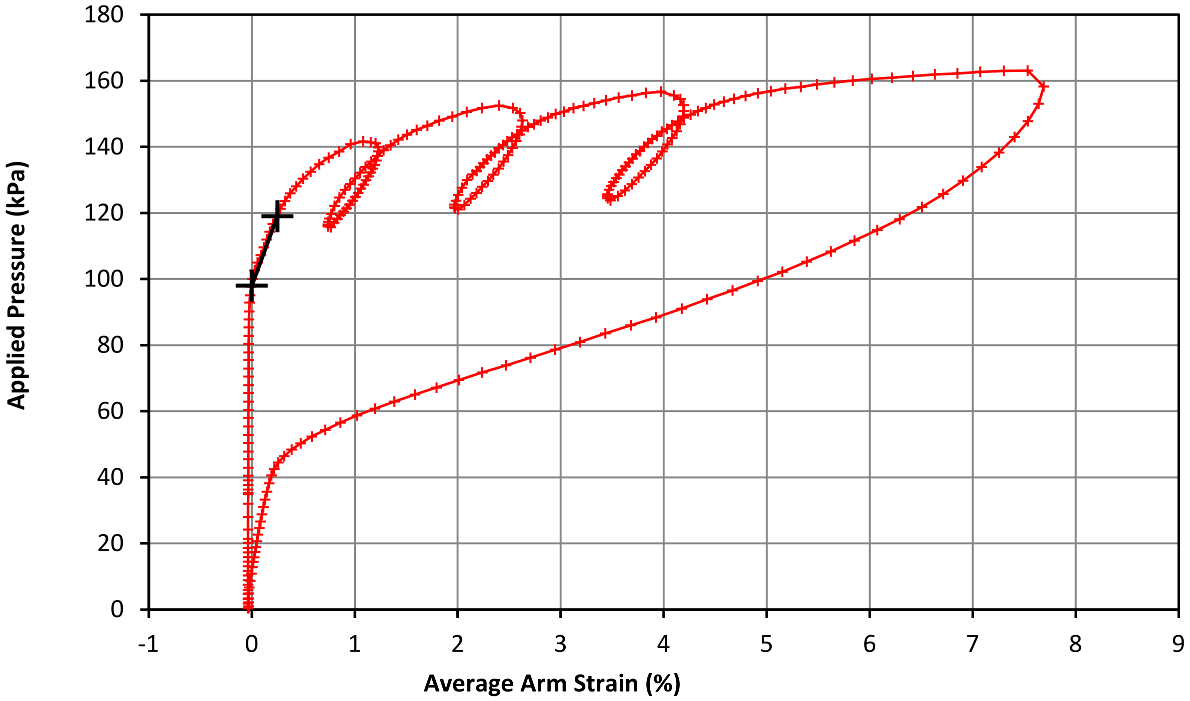


Project	NGI - Onsøy Site	Figure No.	ONSP01 T02 - 02
Client	NGI		
Project No.	P1170112		

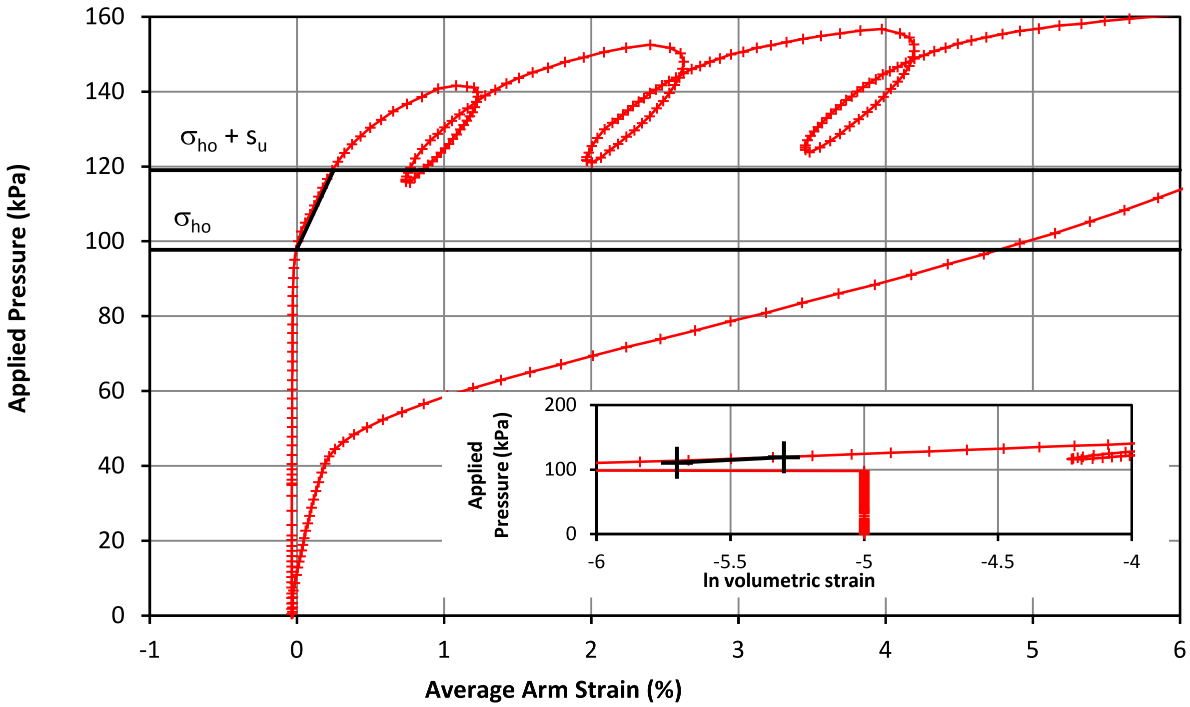
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	2
Borehole	ONSP01	Test Depth (m)	6.10



Initial Modulus	Shear Modulus	4.2 MPa



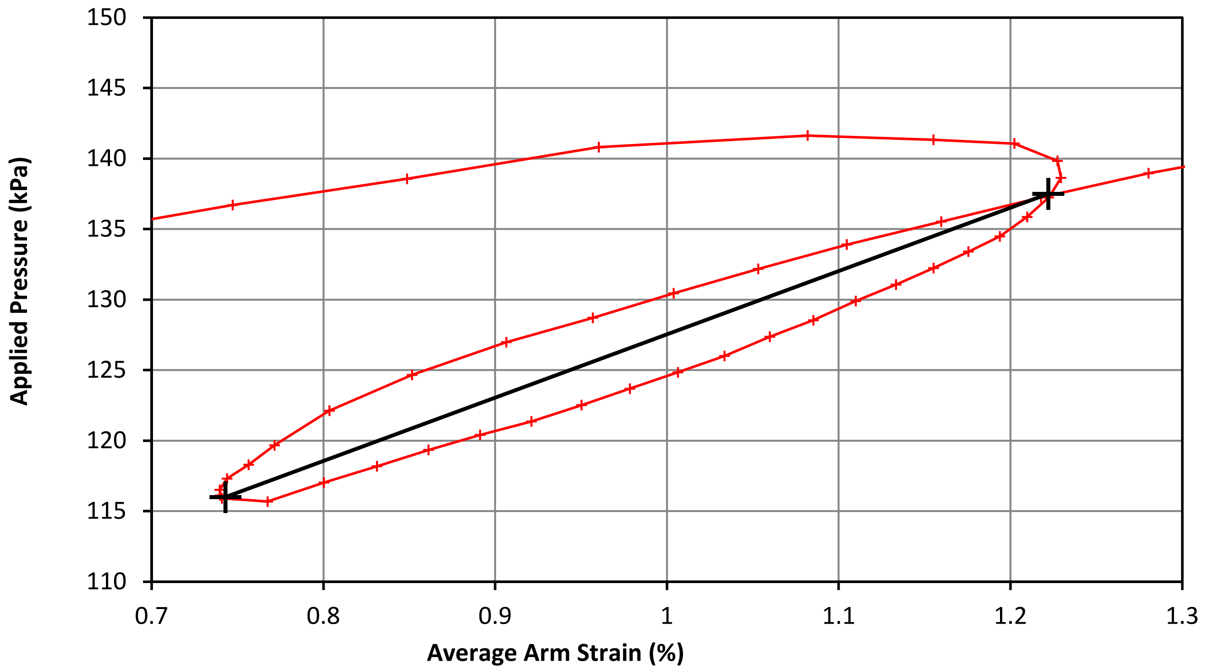
Marsland & Randolph	In situ horizontal stress	98 kPa
	Undrained Strength	21 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T02 - 03
Client	NGI		
Project No.	P1170112		

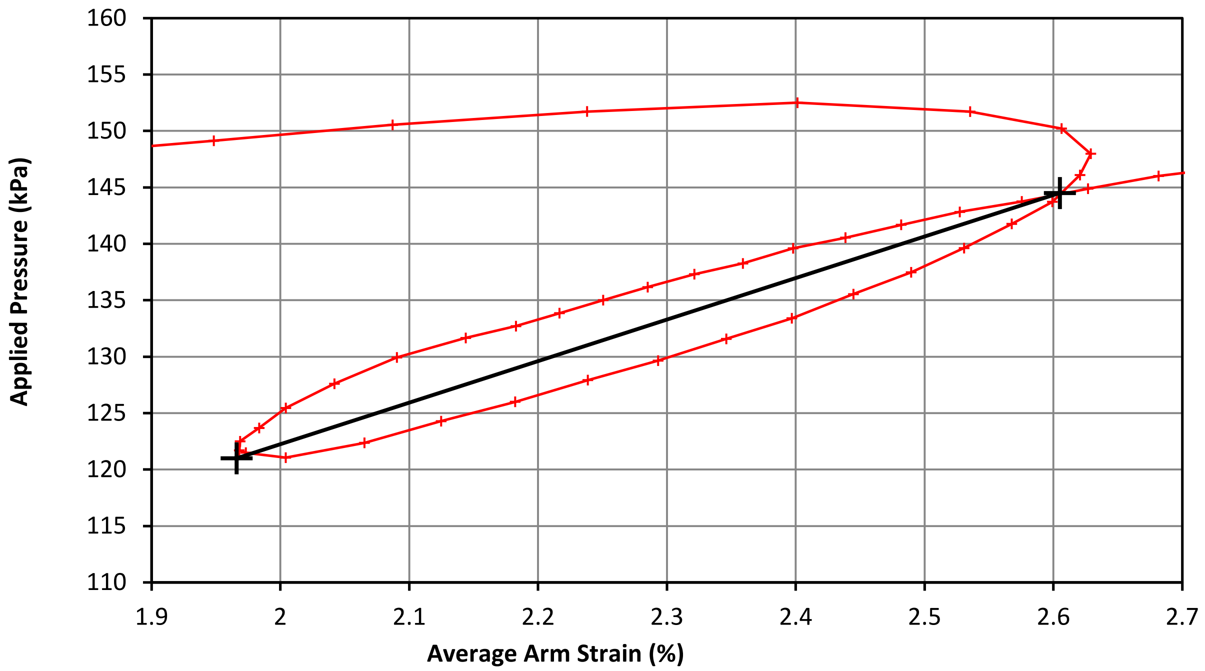
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	2
Borehole	ONSP01	**Test Depth (m)**	6.10



Loop 1	Shear Modulus	2.3	MPa
	Cavity Strain Range	0.479	%



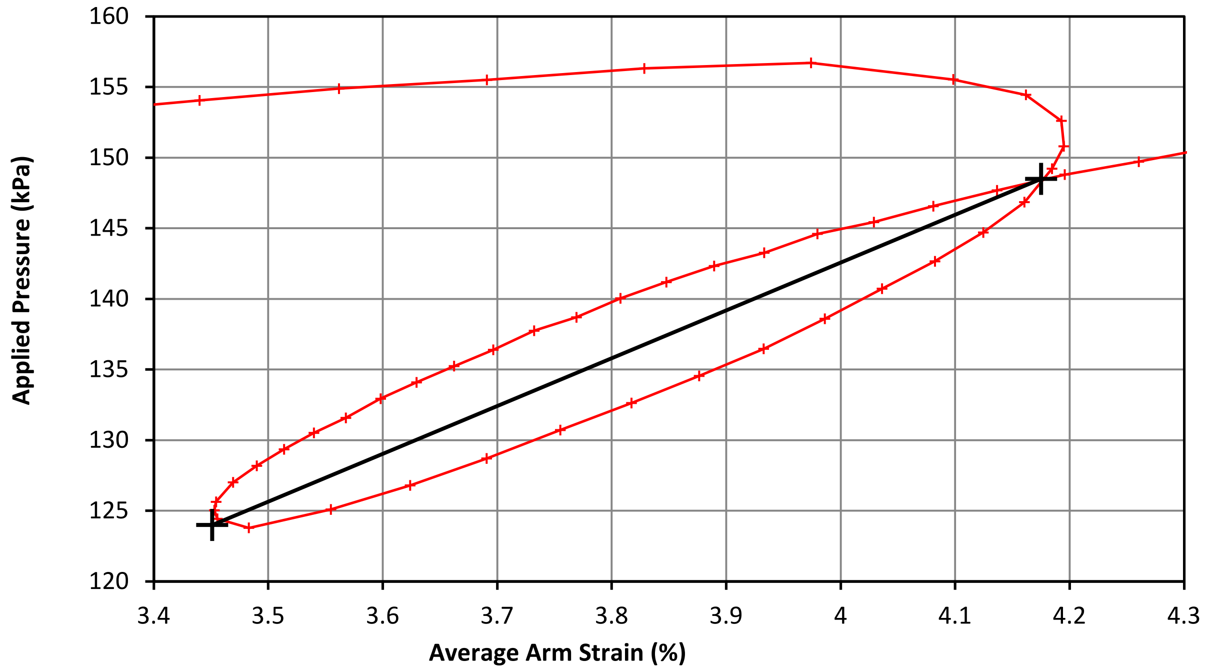
Loop 2	Shear Modulus	1.9	MPa
	Cavity Strain Range	0.639	%

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T02 - 04**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	2
Borehole	ONSP01	**Test Depth (m)**	6.10



Loop 3	Shear Modulus	1.8 MPa
	Cavity Strain Range	0.724 %

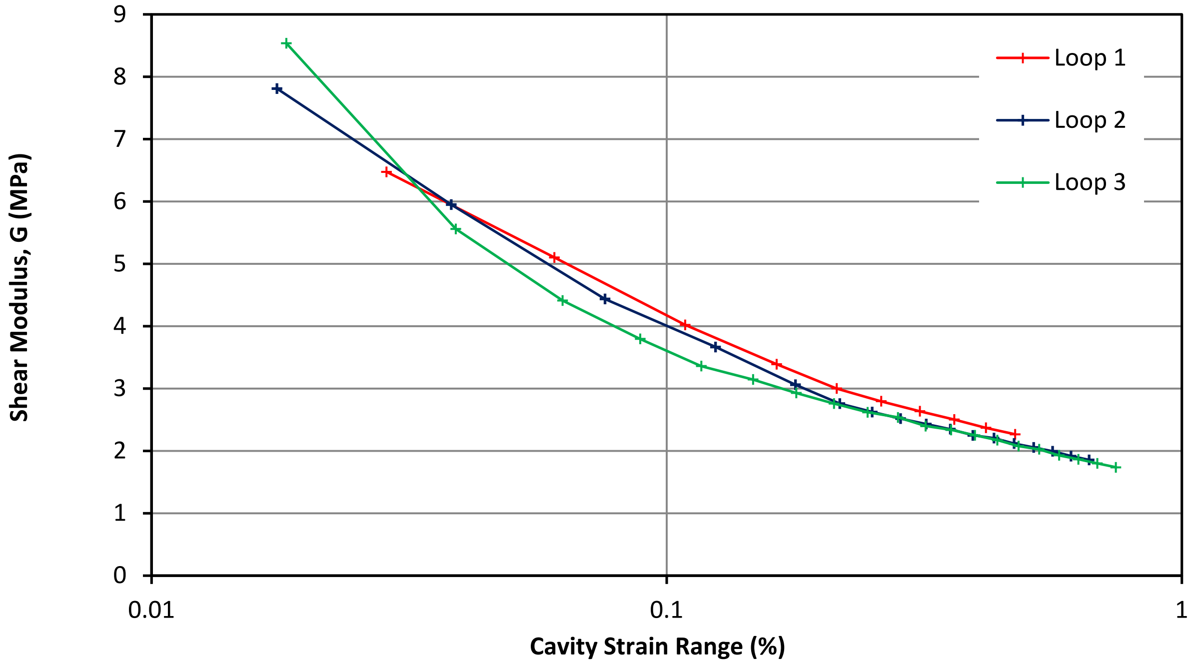
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T02 - 05**
Client	NGI		
Project No.	P1170112		

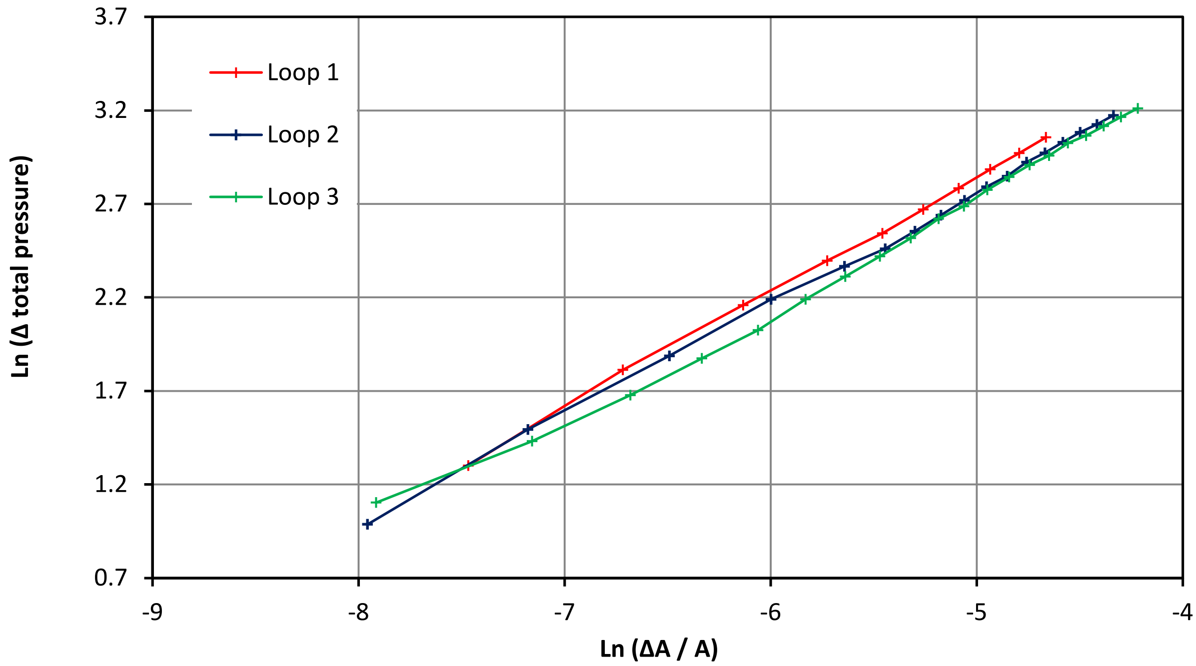
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU
SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	2
Borehole	ONSP01	**Test Depth (m)**	6.10





Loop 1		Loop 2		Loop 3	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.616	0.374 (MPa)	0.598	0.316 (MPa)	0.601	0.309 (MPa)

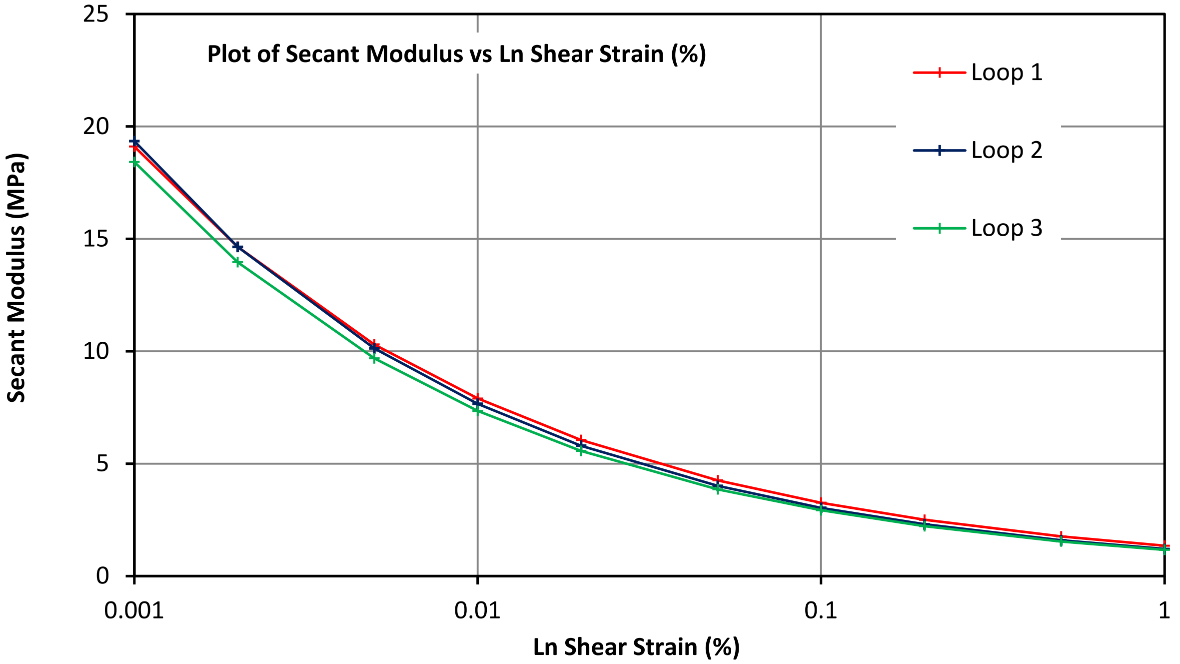
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T02 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	20/09/2017	Test No.	2
Borehole	ONSP01	Test Depth (m)	6.10



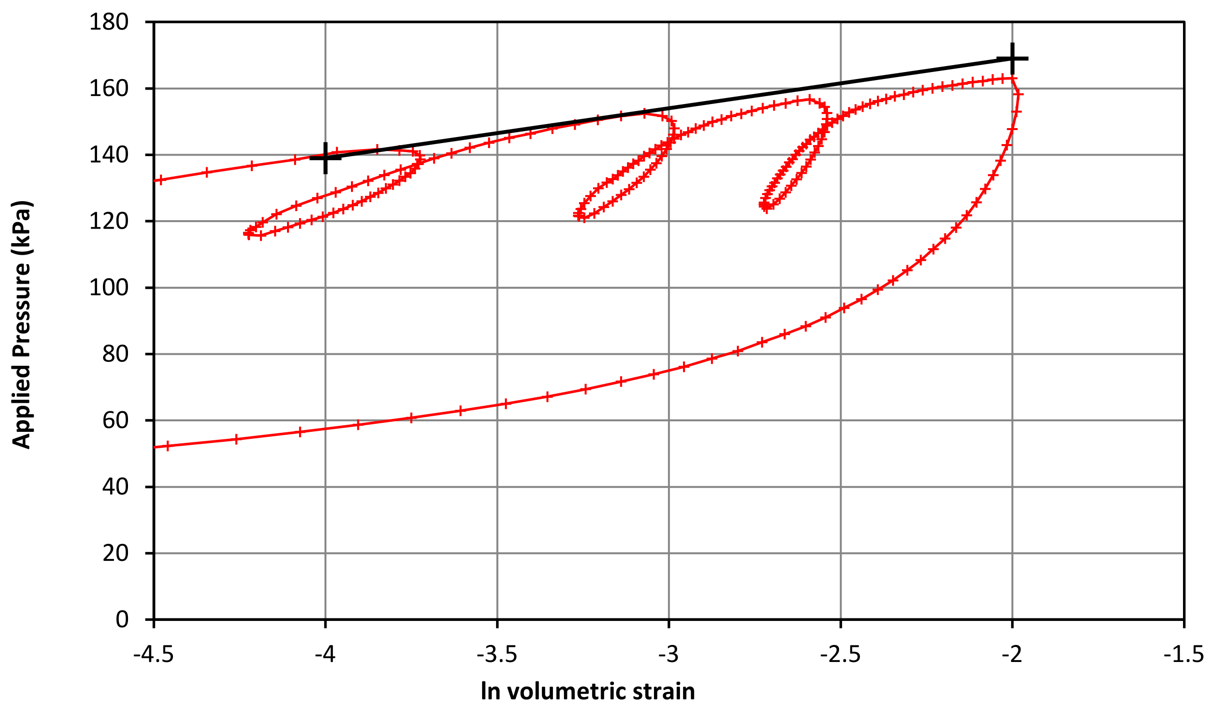
Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**19**	**19**	**18**
0.002%	15	15	14
0.005%	10	10	10
0.010%	**8**	**8**	**7**
0.020%	6	6	6
0.050%	4	4	4
0.100%	**3**	**3**	**3**
0.200%	3	2	2
0.500%	2	2	2
1.000%	**1**	**1**	**1**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T02 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	2
Borehole	ONSP01	Test Depth (m)	6.10

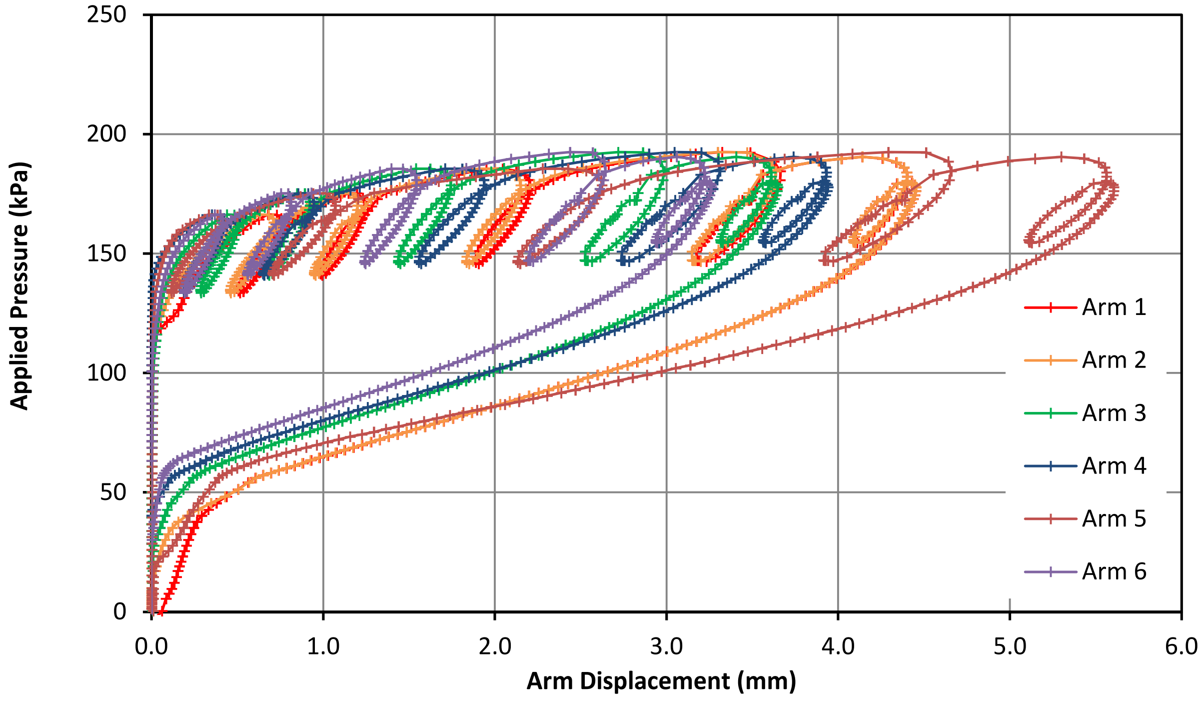


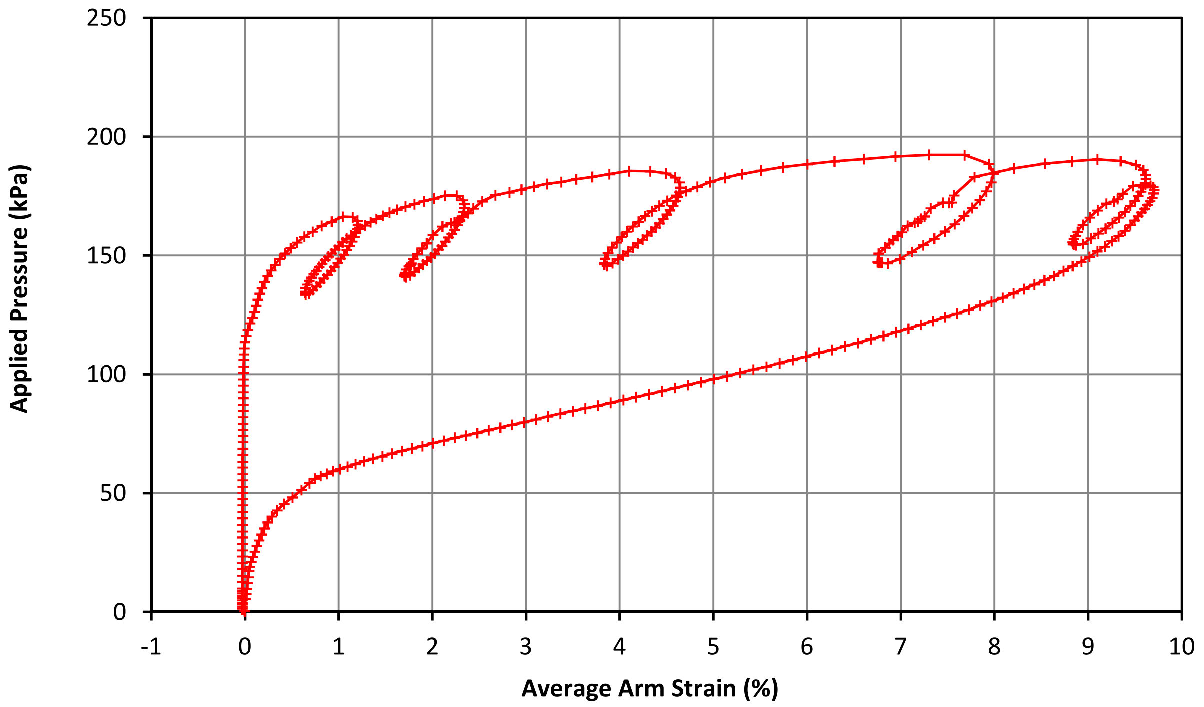
Strength	Undrained Shear	15 kPa
	Limit Pressure	199 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T02 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	20/09/2017	**Test No.**	3
Borehole	ONSP01	**Test Depth (m)**	7.10





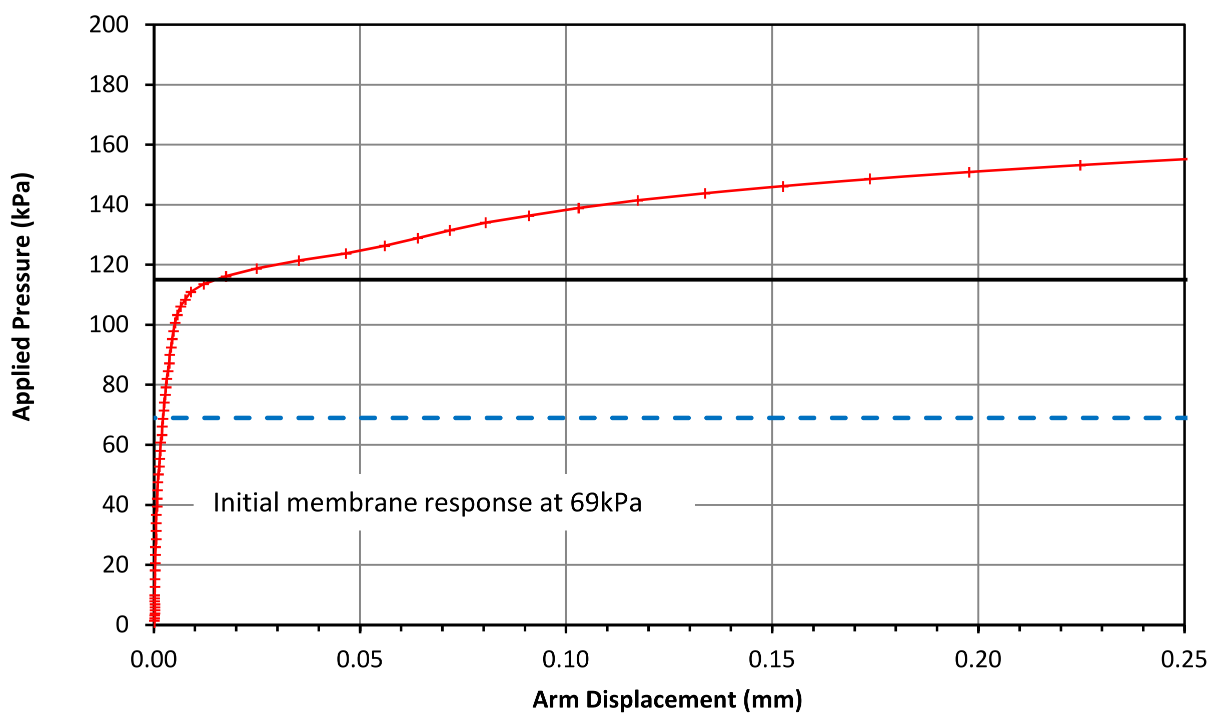
Comments

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T03 - 01**
Client	NGI		
Project No.	P1170112		

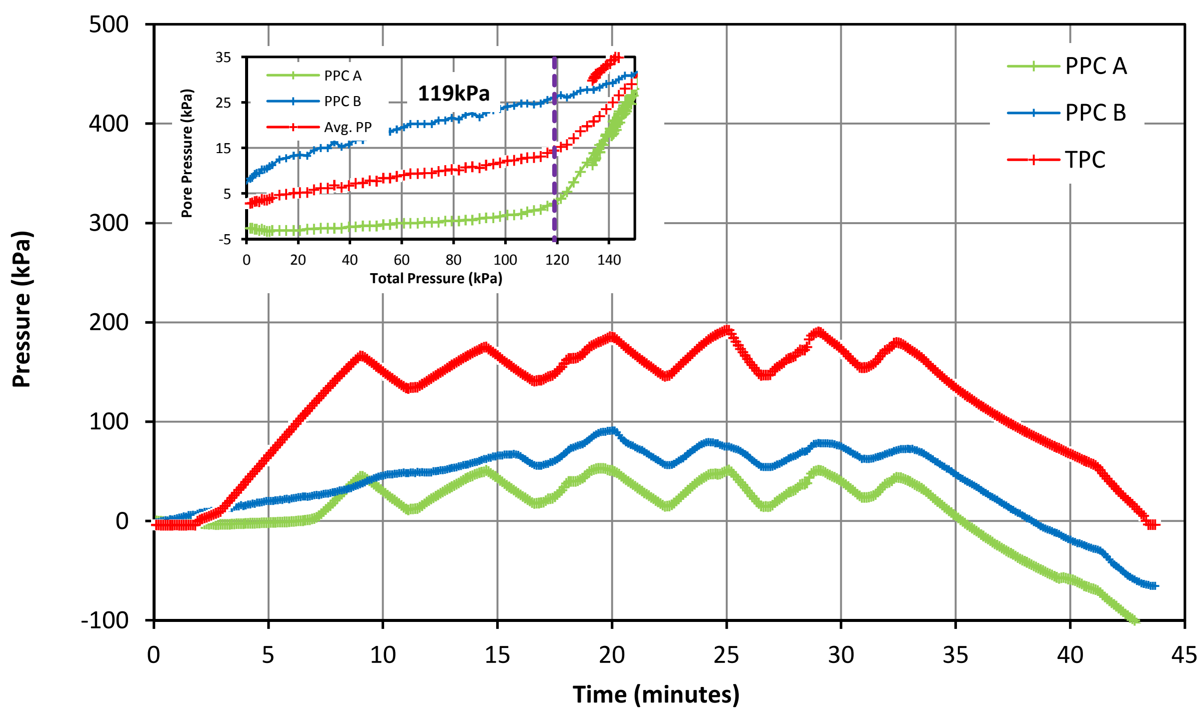
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU
SITE INVESTIGATION

Test Date	20/09/2017	Test No.	3
Borehole	ONSP01	Test Depth (m)	7.10



Lift Off Stress (Po)	115 kPa

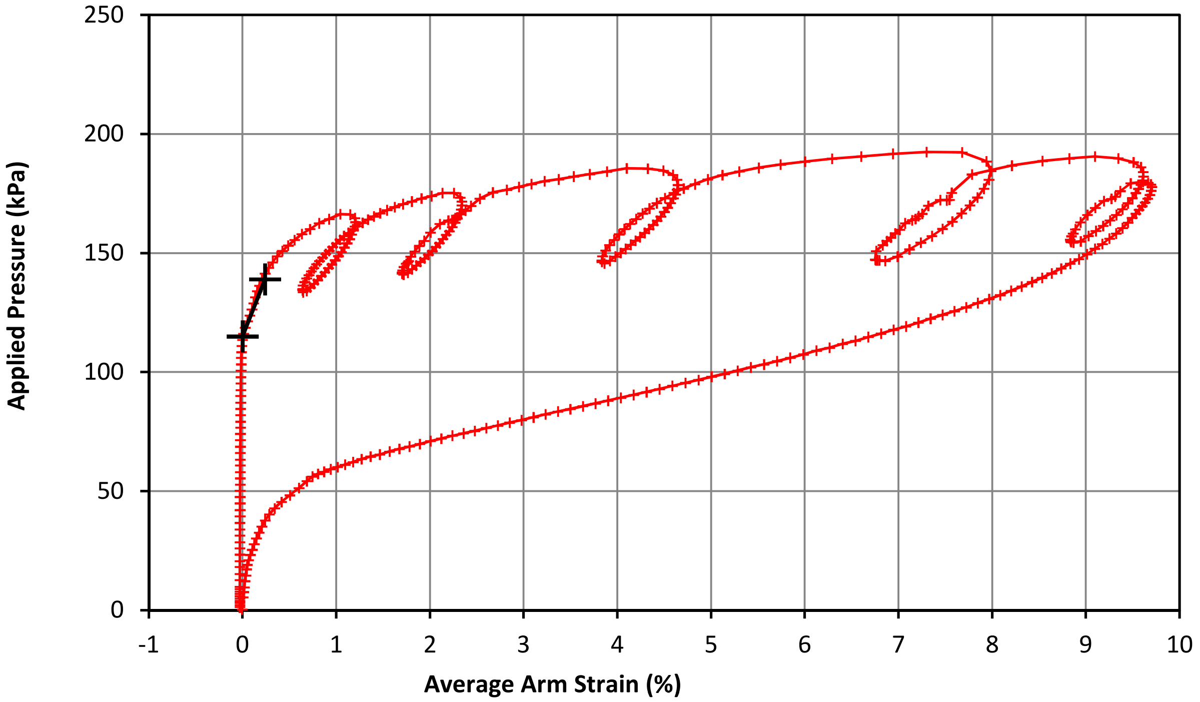


Project	NGI - Onsøy Site	Figure No.	ONSP01 T03 - 02
Client	NGI		
Project No.	P1170112		

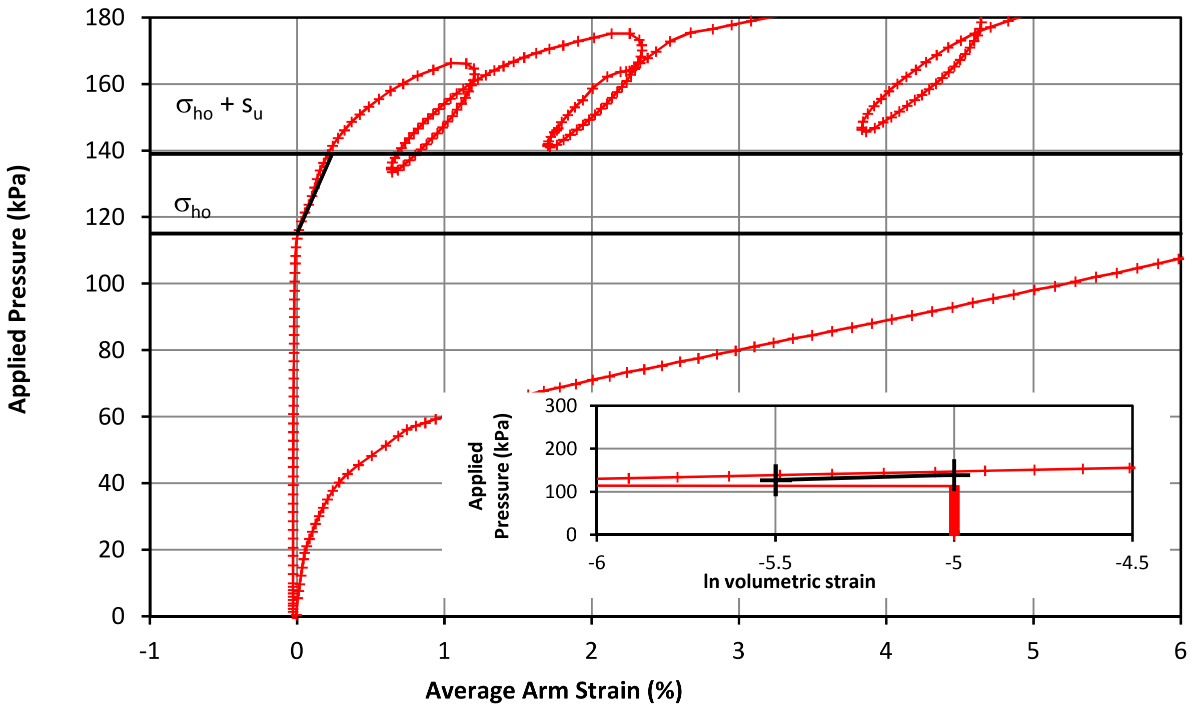
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	3
Borehole	ONSP01	Test Depth (m)	7.10



Initial Modulus	Shear Modulus	5.0 MPa



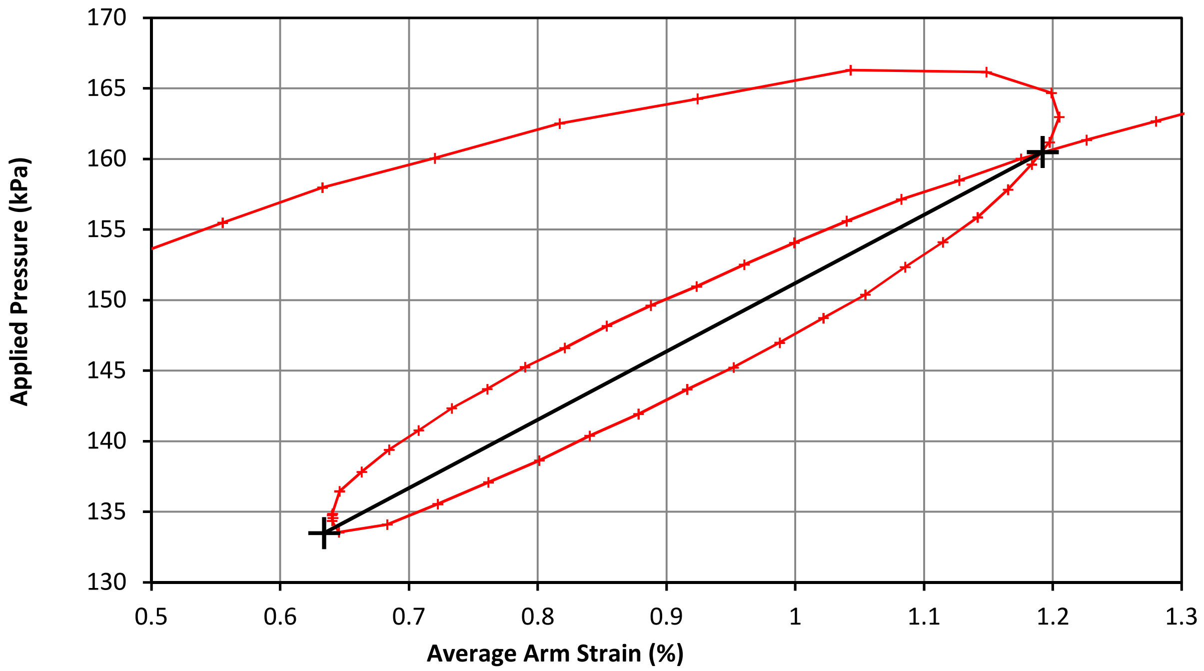
Marsland & Randolph	In situ horizontal stress	115 kPa
	Undrained Strength	24 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T03 - 03
Client	NGI		
Project No.	P1170112		

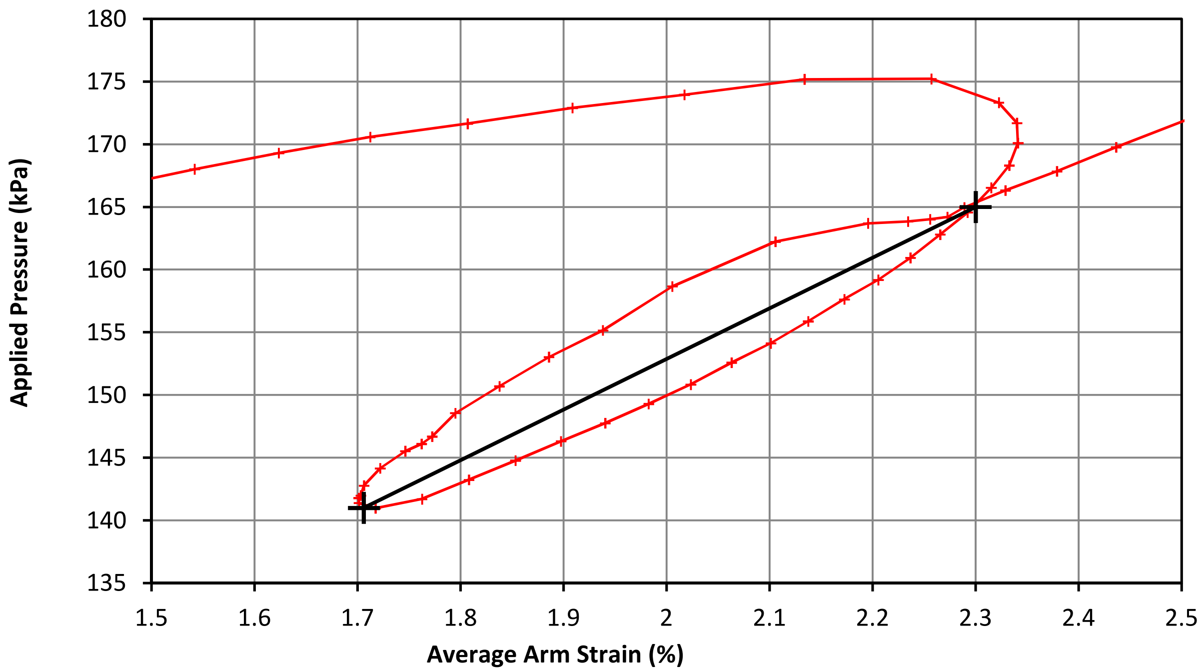
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	3
Borehole	ONSP01	**Test Depth (m)**	7.10



Loop 1	Shear Modulus	2.4 MPa
	Cavity Strain Range	0.558 %



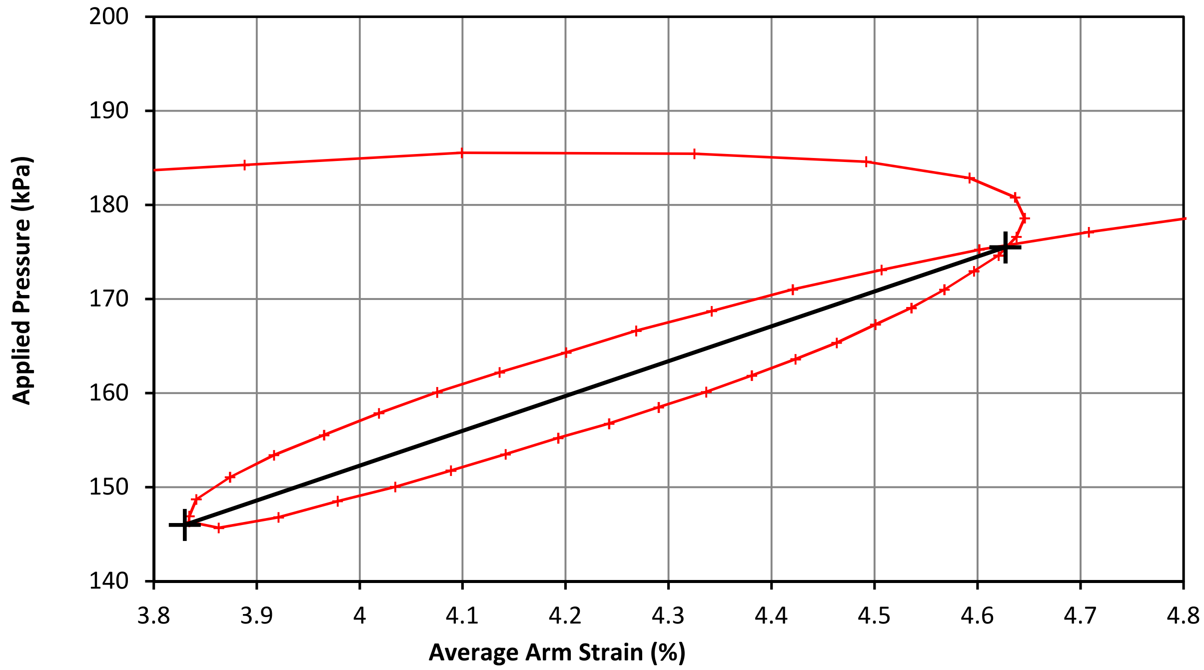
Loop 2	Shear Modulus	2.1 MPa
	Cavity Strain Range	0.594 %

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T03 - 04**
Client	NGI		
Project No.	P1170112		

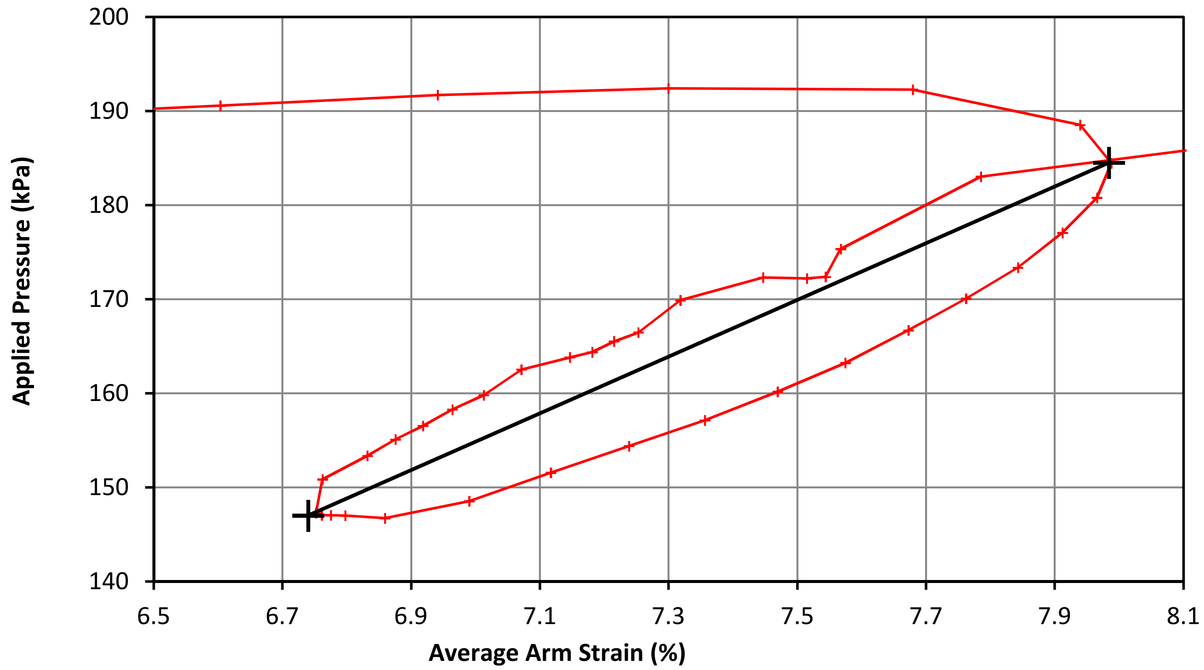
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	3
Borehole	ONSP01	**Test Depth (m)**	7.10



Loop 3	Shear Modulus	1.9	MPa
	Cavity Strain Range	0.797	%



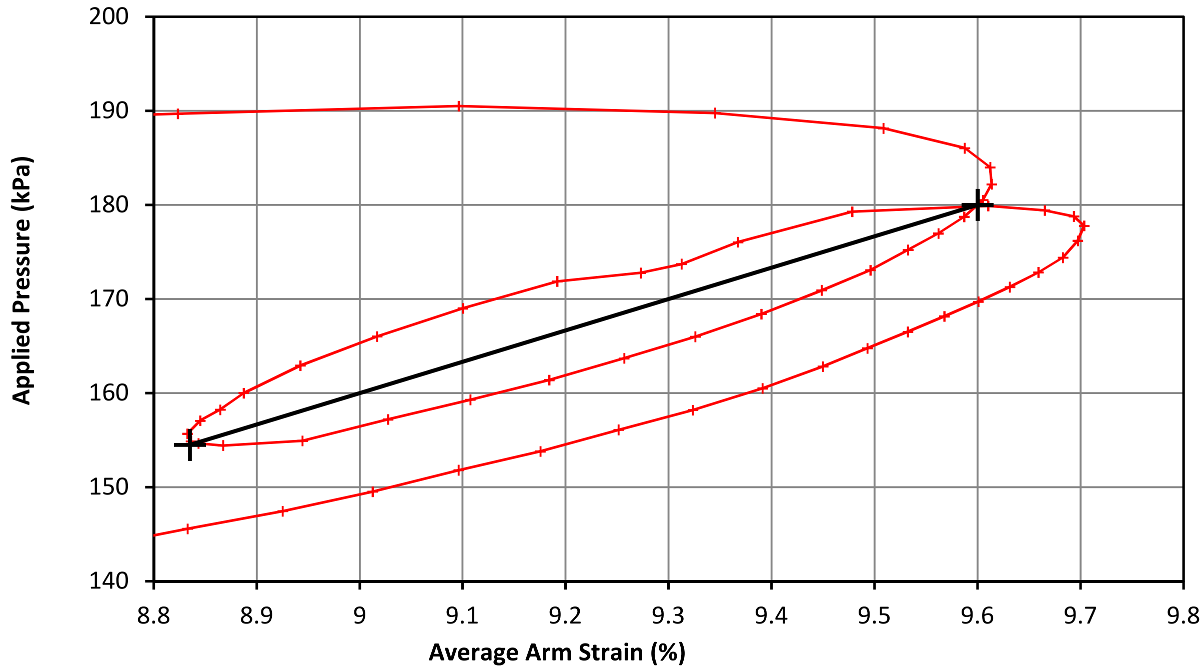
Loop 4	Shear Modulus	1.6	MPa
	Cavity Strain Range	1.244	%

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T03 - 05**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	**Test No.**	3
Borehole	ONSP01	**Test Depth (m)**	7.10



Loop 5	Shear Modulus	1.8	MPa
	Cavity Strain Range	0.765	%

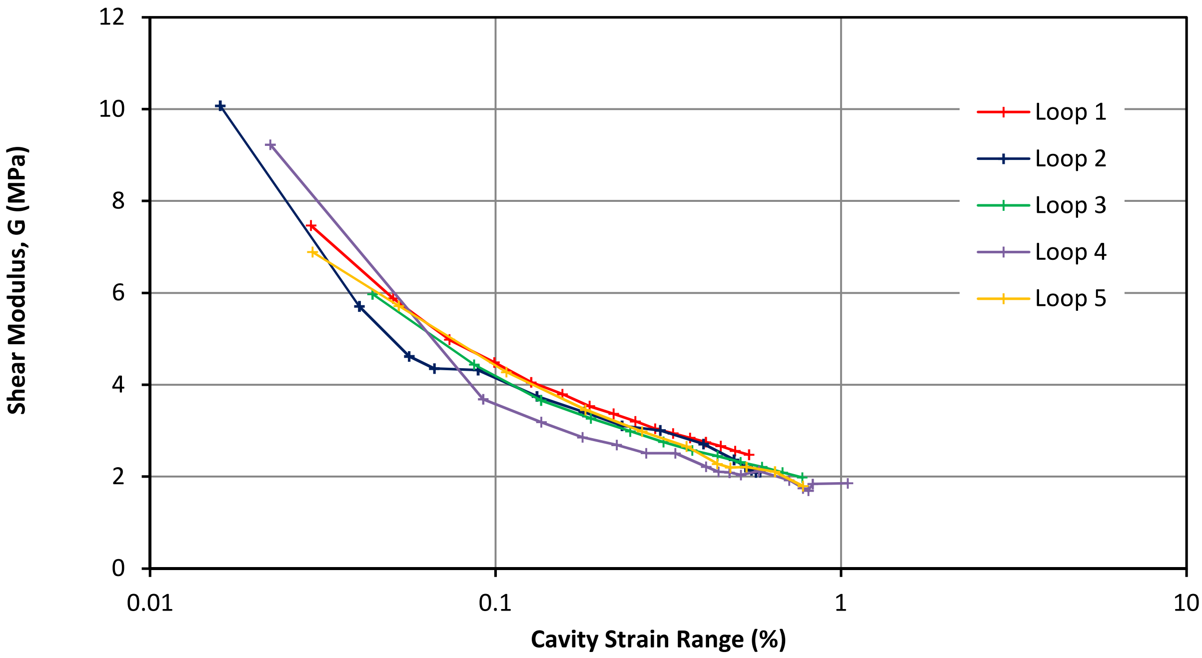
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T03 - 06**
Client	NGI		
Project No.	P1170112		

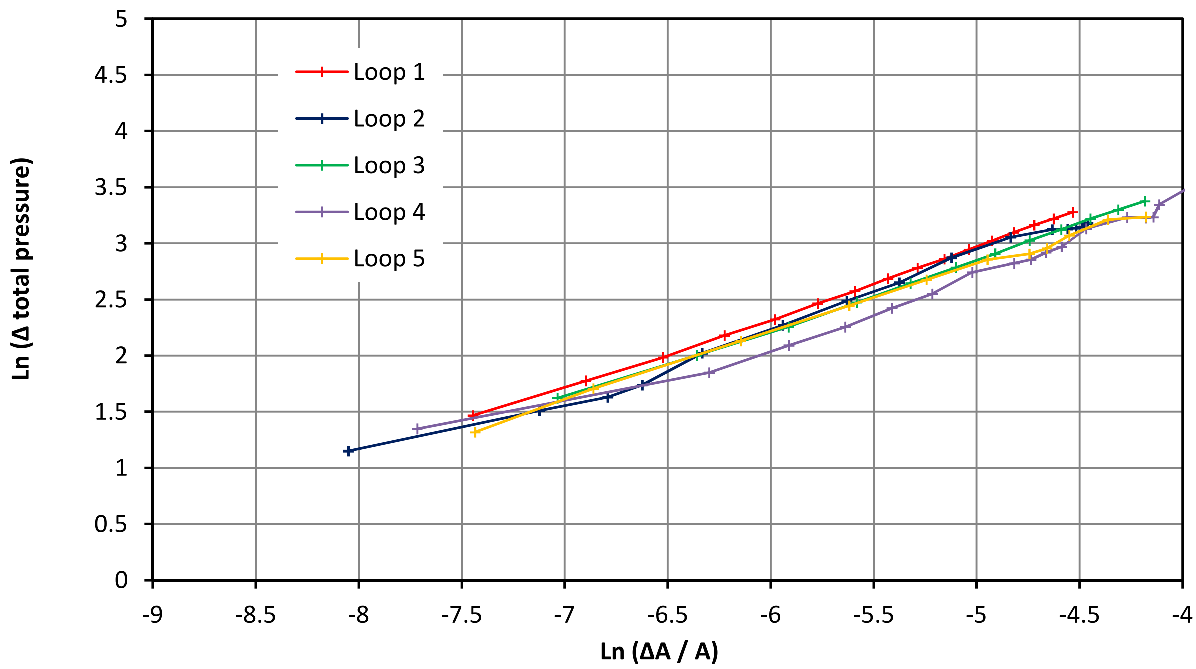
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	3
Borehole	ONSP01	Test Depth (m)	7.10





Loop 1		Loop 2		Loop 3		Loop 4		Loop 5	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.633	0.460 (MPa)	0.617	0.383 (MPa)	0.626	0.399 (MPa)	0.599	0.310 (MPa)	0.591	0.314 (MPa)

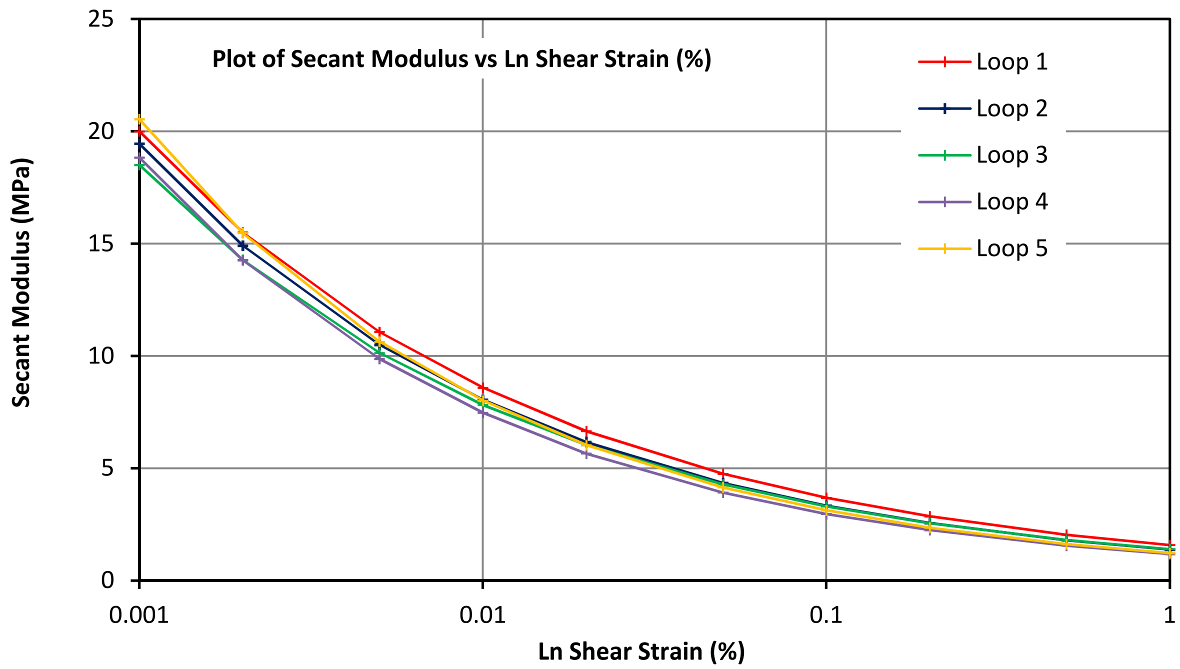
Project	NGI - Onsøy Site	Figure No.	ONSP01 T03 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	3
Borehole	ONSP01	Test Depth (m)	7.10



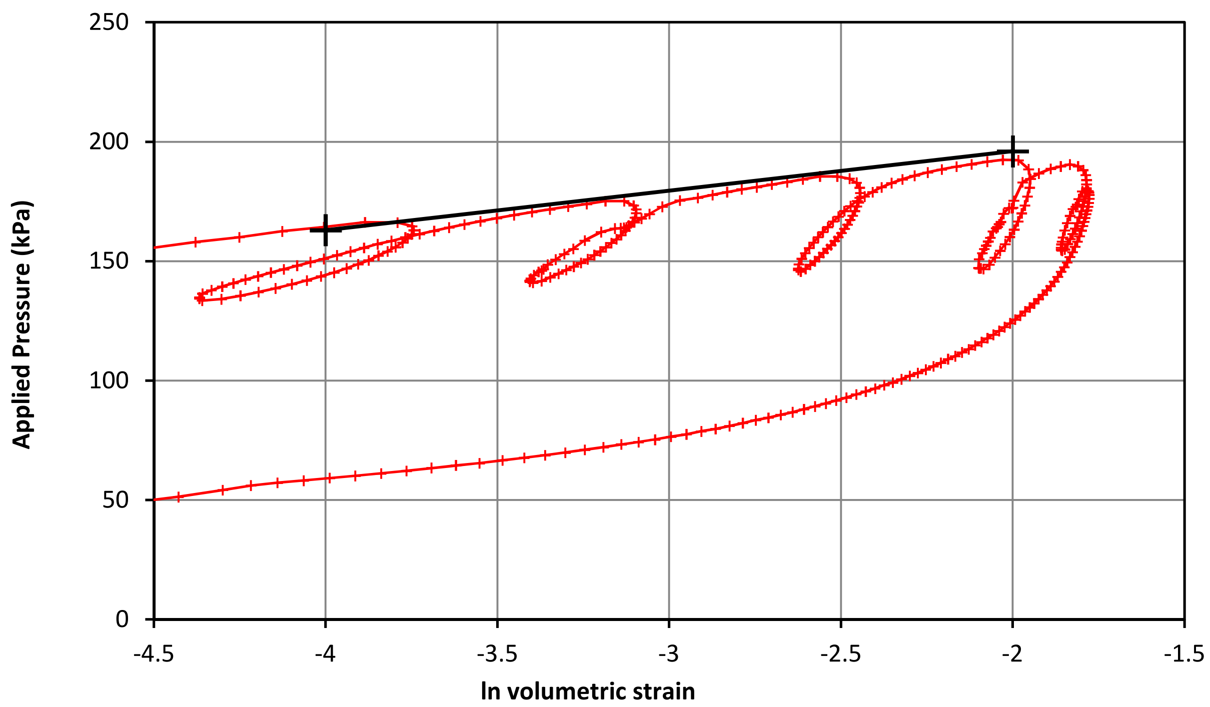
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5
0.001%	**20**	**19**	**19**	**19**	**21**
0.002%	16	15	14	14	15
0.005%	11	10	10	10	11
0.010%	**9**	**8**	**8**	**7**	**8**
0.020%	7	6	6	6	6
0.050%	5	4	4	4	4
0.100%	**4**	**3**	**3**	**3**	**3**
0.200%	3	3	3	2	2
0.500%	2	2	2	2	2
1.000%	**2**	**1**	**1**	**1**	**1**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T03 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	20/09/2017	Test No.	3
Borehole	ONSP01	Test Depth (m)	7.10



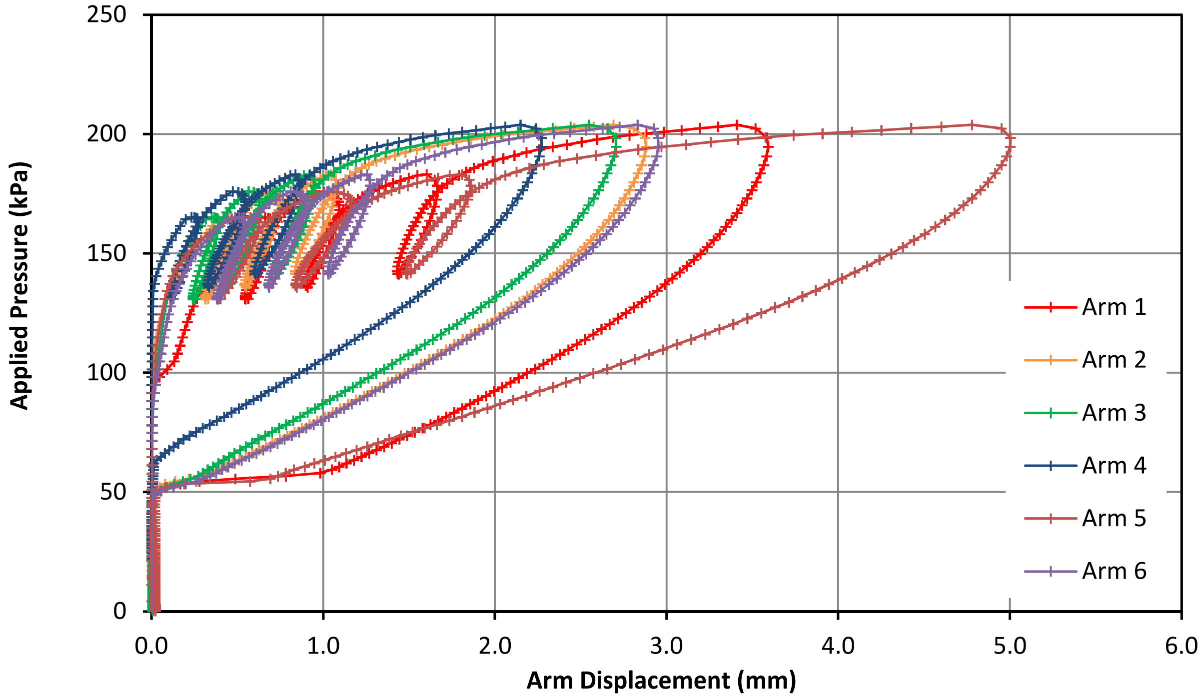
Strength			
Strength	Undrained Shear	17	kPa
	Limit Pressure	229	kPa

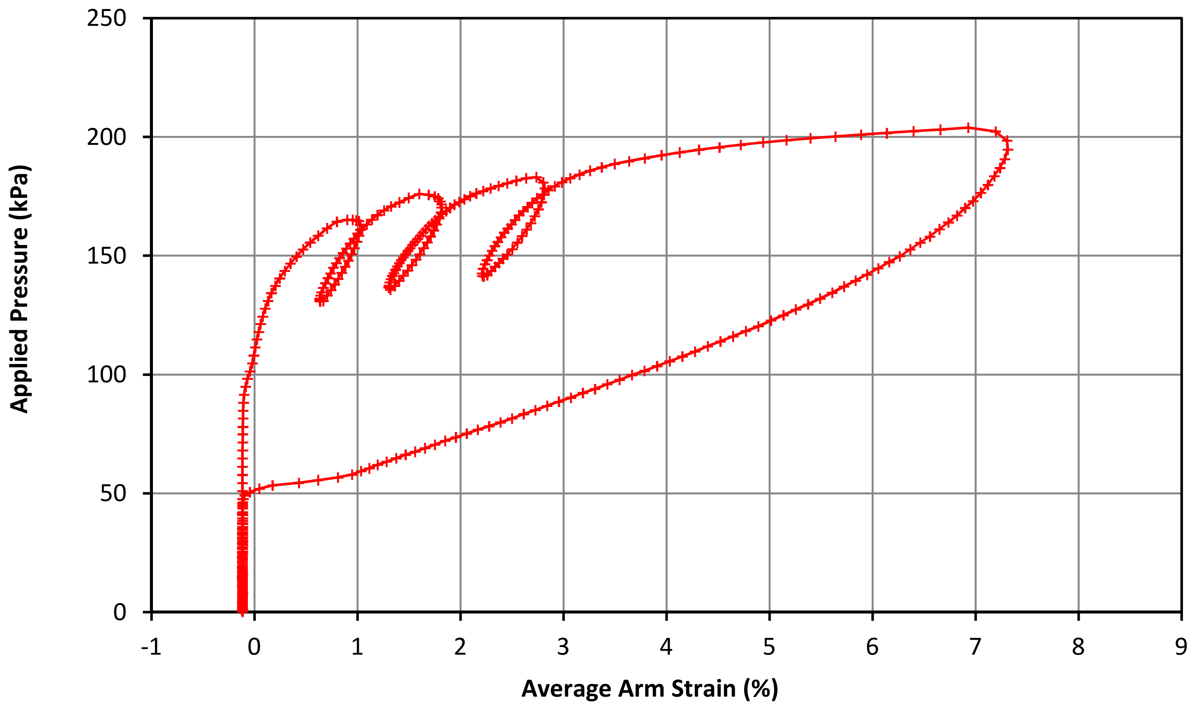
Project	NGI - Onsøy Site	Figure No.	ONSP01 T03 - 09
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	4
Borehole	ONSP01	Test Depth (m)	8.00





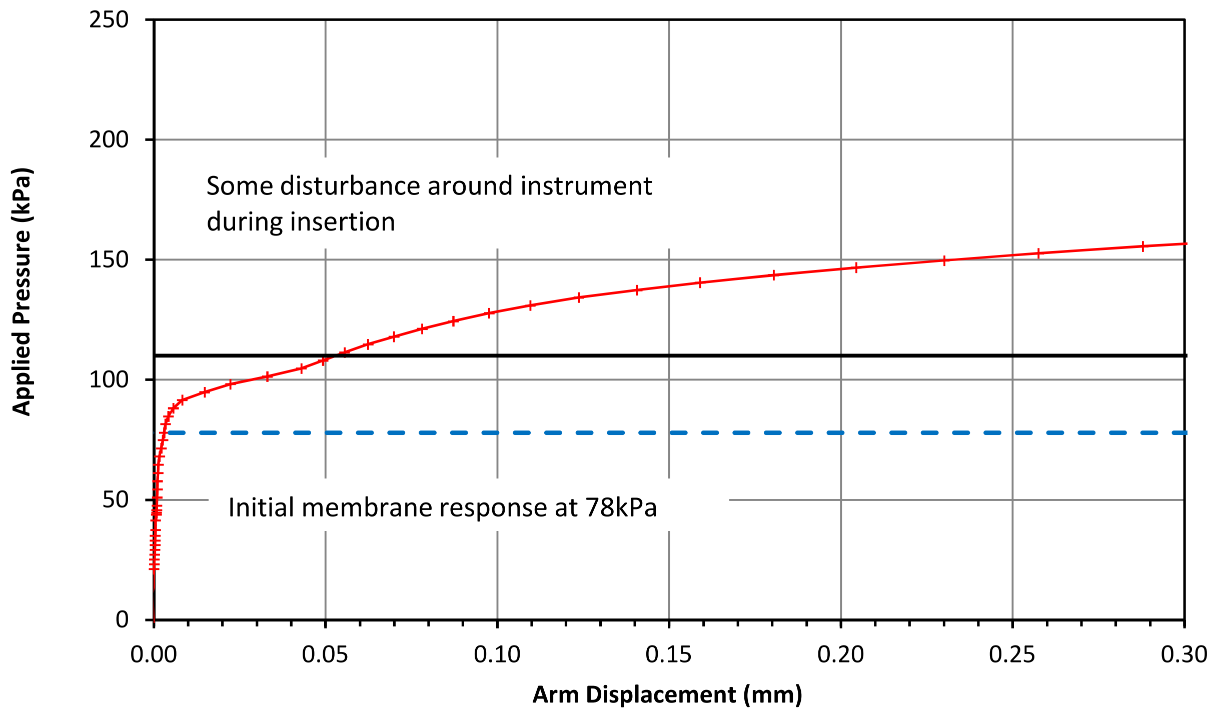
Comments

Project	NGI - Onsøy Site	Figure No.	ONSP01 T04 - 01
Client	NGI		
Project No.	P1170112		

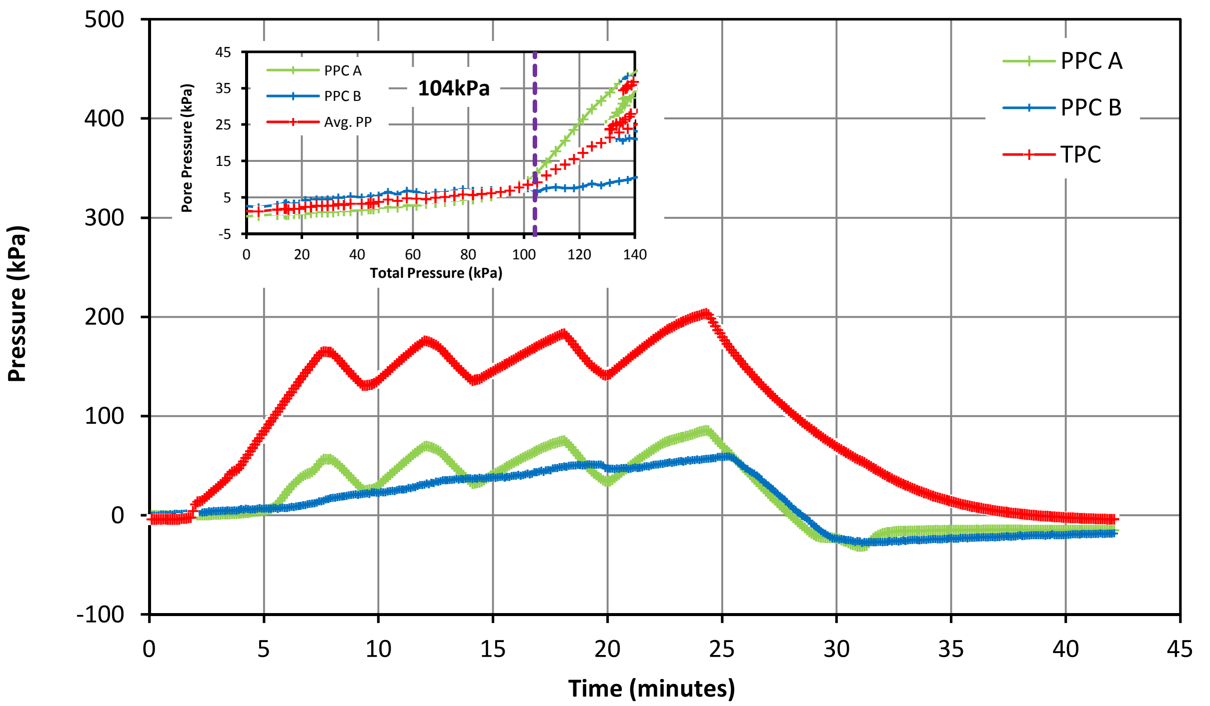
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	4
Borehole	ONSP01	**Test Depth (m)**	8.00



Lift Off Stress (Po)	110 kPa

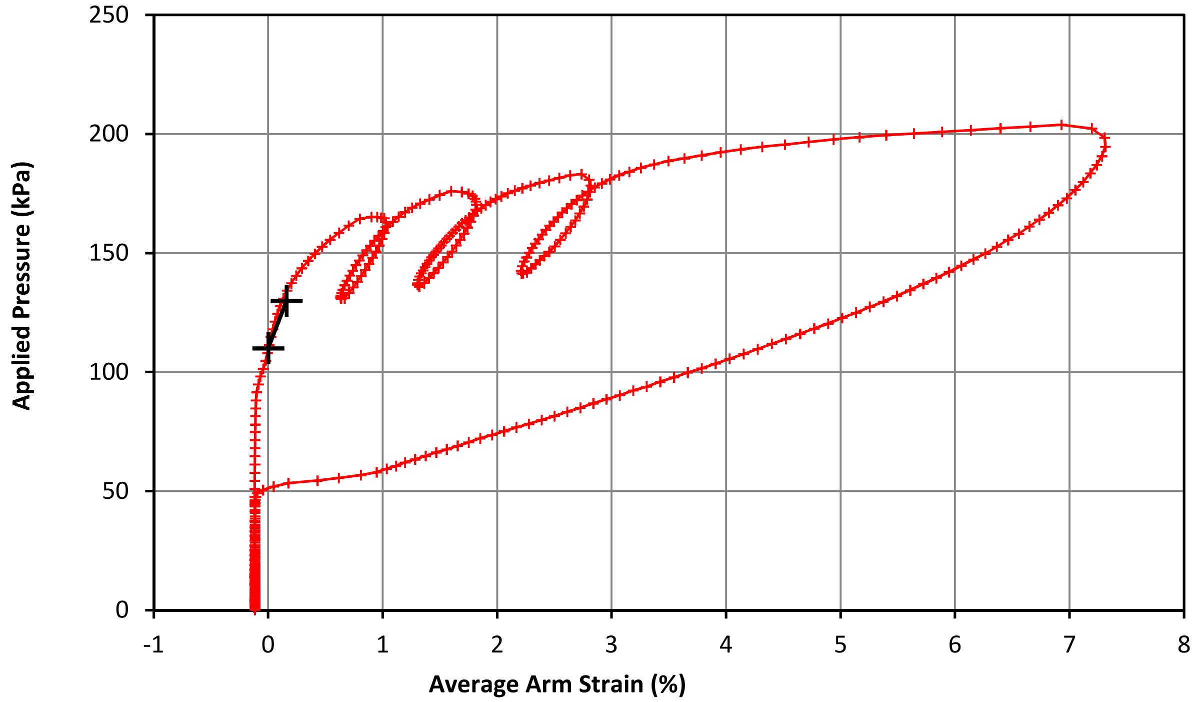


Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T04 - 02**
Client	NGI		
Project No.	P1170112		

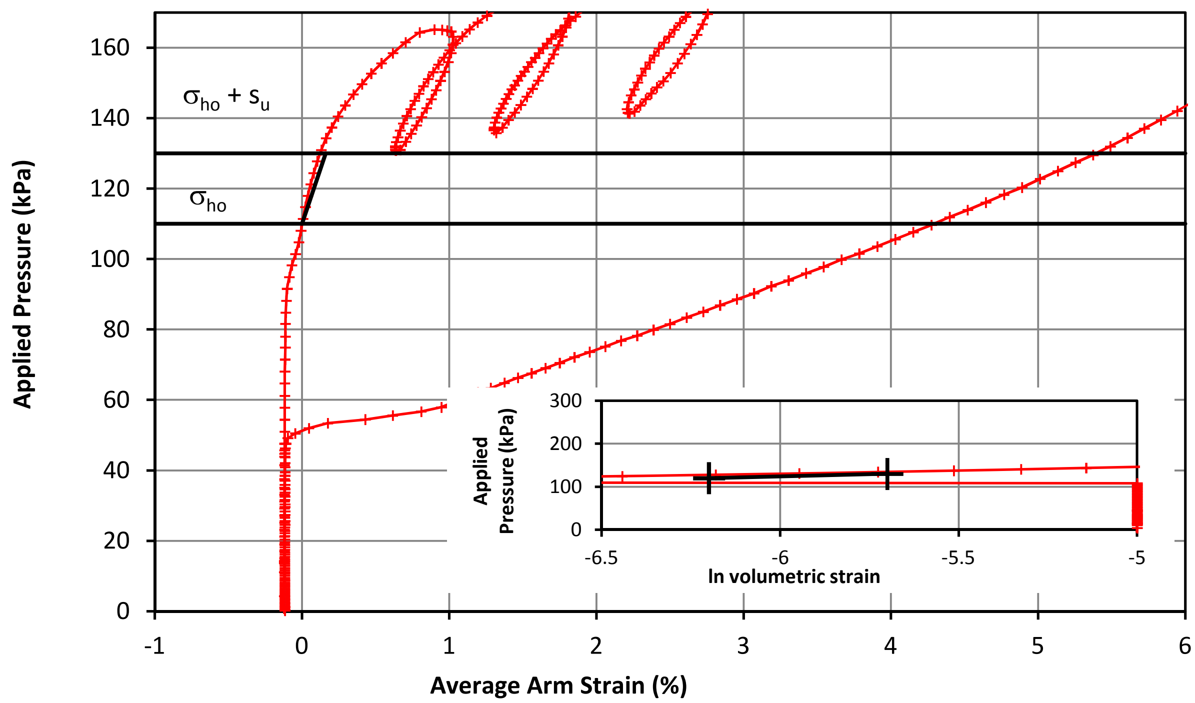
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	4
Borehole	ONSP01	Test Depth (m)	8.00



Initial Modulus	Shear Modulus	6.3 MPa



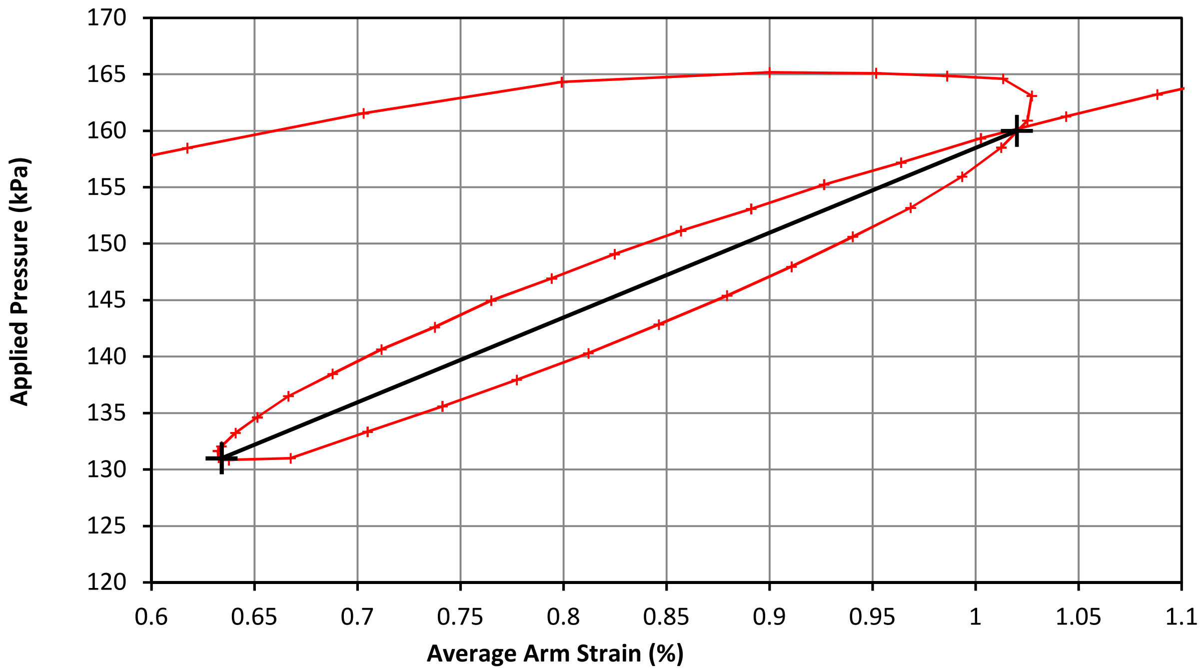
Marsland & Randolph	In situ horizontal stress	110 kPa
	Undrained Strength	20 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T04 - 03
Client	NGI		
Project No.	P1170112		

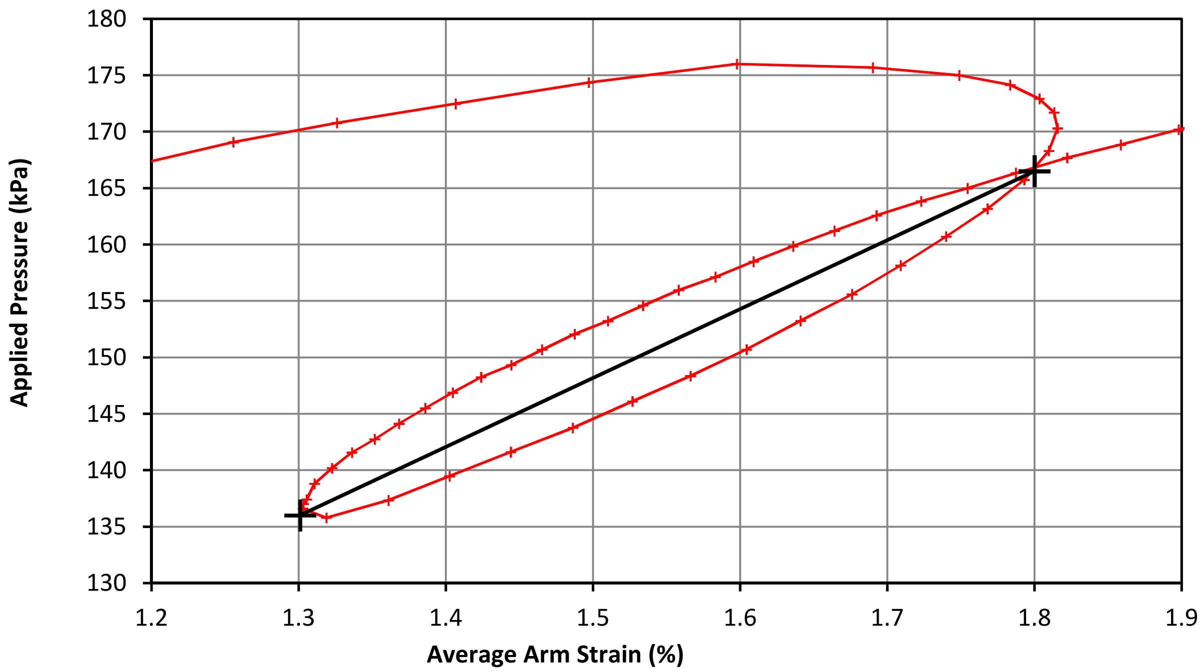
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	4
Borehole	ONSP01	Test Depth (m)	8.00



Loop 1	Shear Modulus	3.8 MPa
	Cavity Strain Range	0.386 %



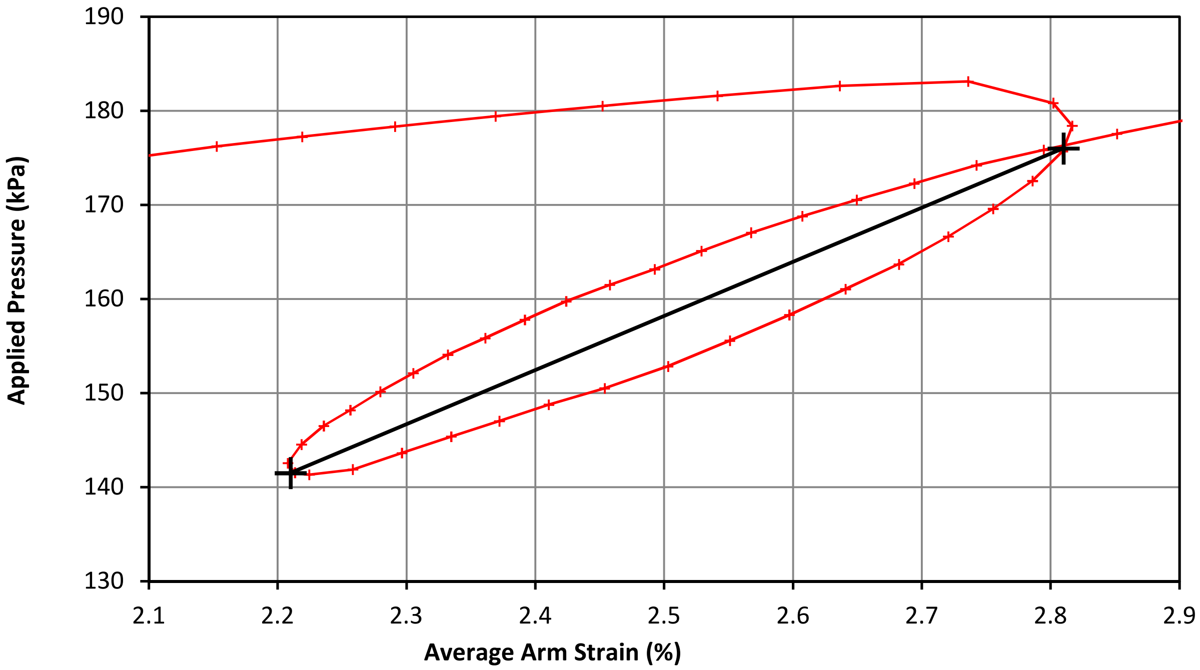
Loop 2	Shear Modulus	3.1 MPa
	Cavity Strain Range	0.499 %

Project	NGI - Onsøy Site	Figure No.	ONSP01 T04 - 04
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	4
Borehole	ONSP01	**Test Depth (m)**	8.00



Loop 3	Shear Modulus	3.0	MPa
	Cavity Strain Range	0.600	%

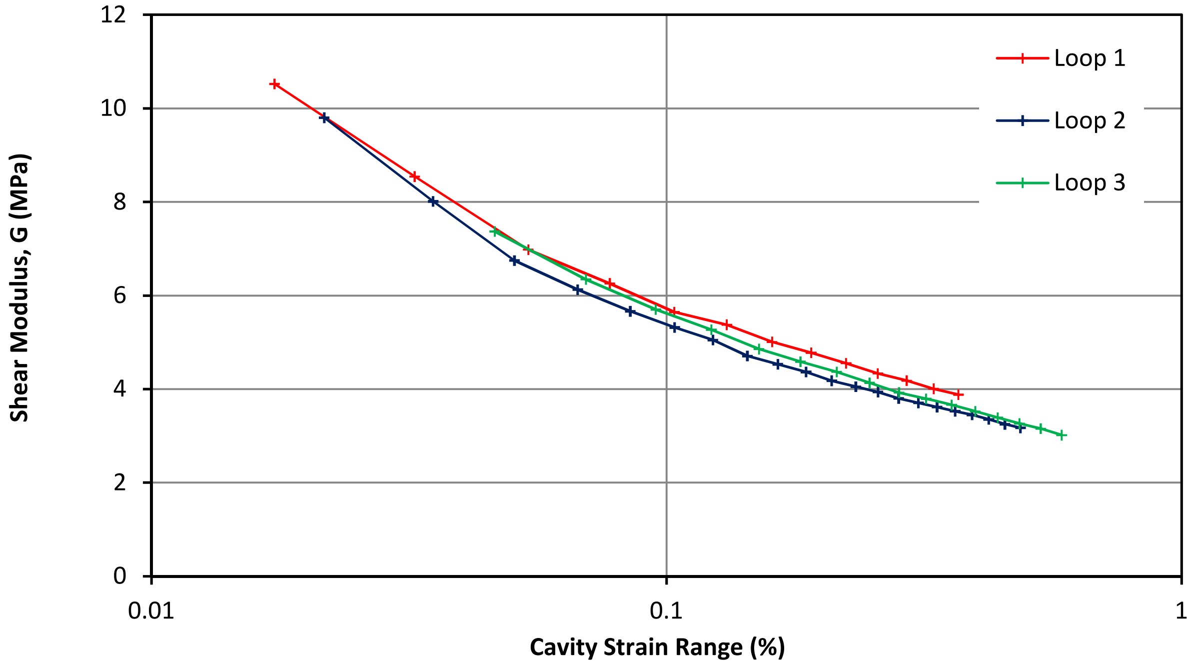
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T04 - 05**
Client	NGI		
Project No.	P1170112		

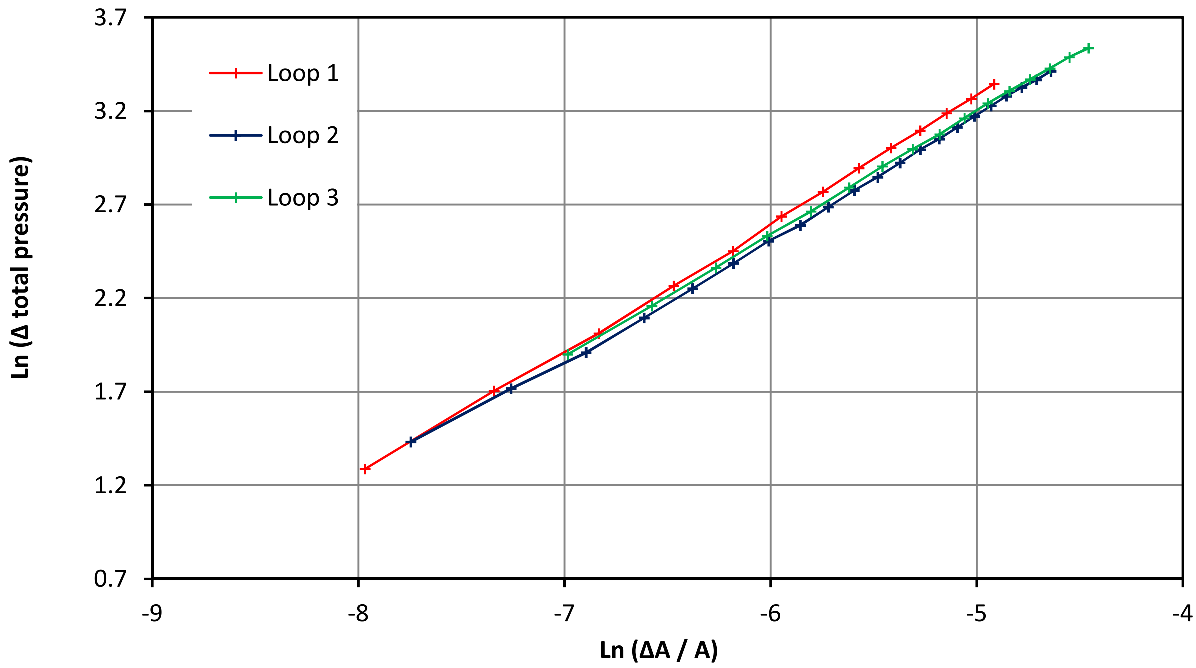
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	4
Borehole	ONSP01	**Test Depth (m)**	8.00





Loop 1		Loop 2		Loop 3	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.678	0.786 (MPa)	0.652	0.619 (MPa)	0.655	0.646 (MPa)

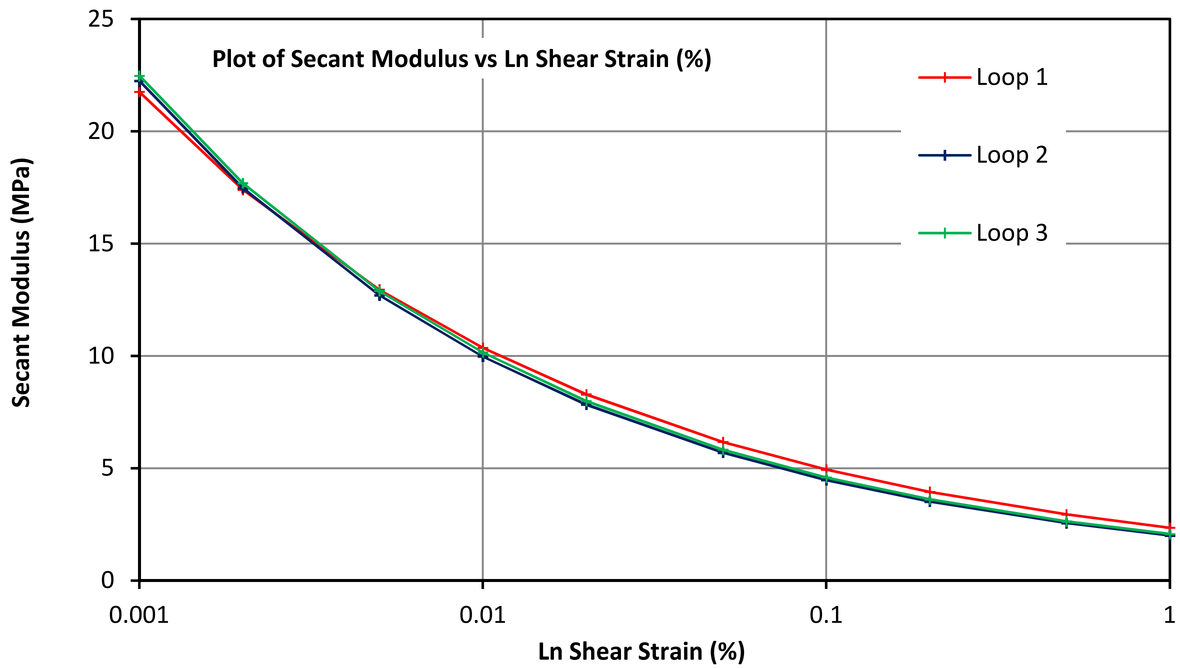
Project	NGI - Onsøy Site	**Figure No.**	ONSP01 T04 - 06
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	Test No.	4
Borehole	ONSP01	Test Depth (m)	8.00

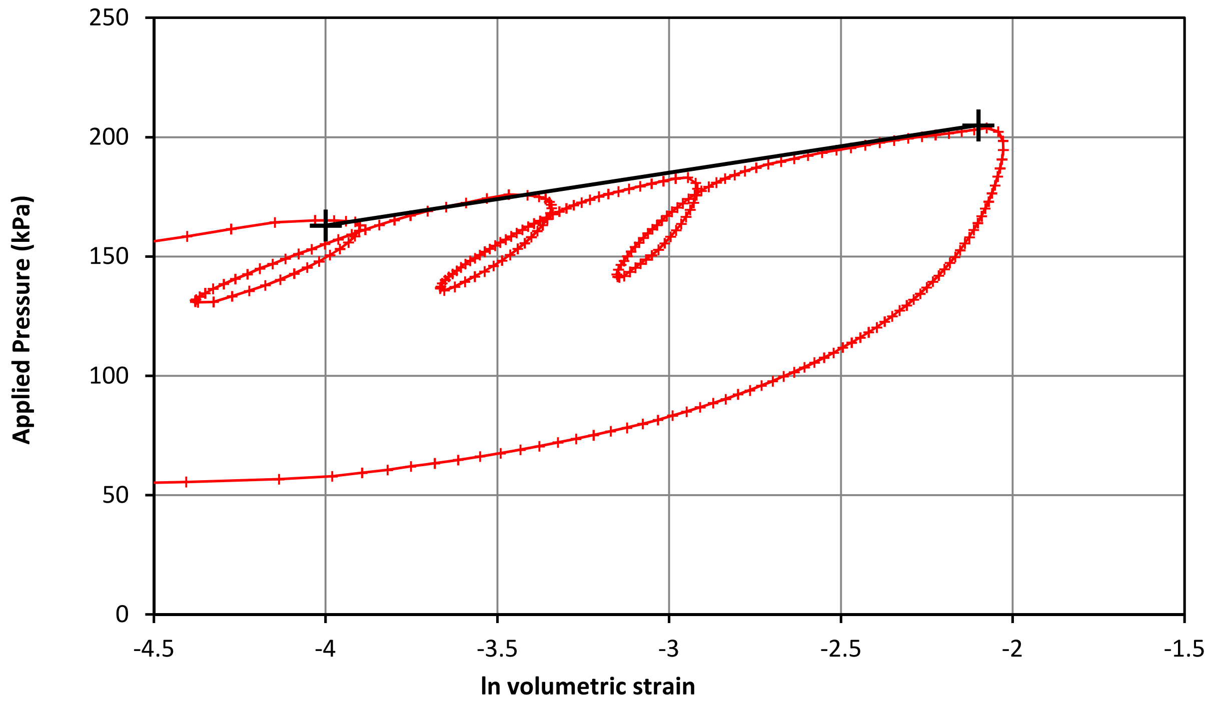


Shear Strain	Loop 1	Loop 2	Loop 3
0.001%	**22**	**22**	**22**
0.002%	17	17	18
0.005%	13	13	13
0.010%	**10**	**10**	**10**
0.020%	8	8	8
0.050%	6	6	6
0.100%	**5**	**4**	**5**
0.200%	4	4	4
0.500%	3	3	3
1.000%	**2**	**2**	**2**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T04 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

Test Date	21/09/2017	Test No.	4
Borehole	ONSP01	Test Depth (m)	8.00



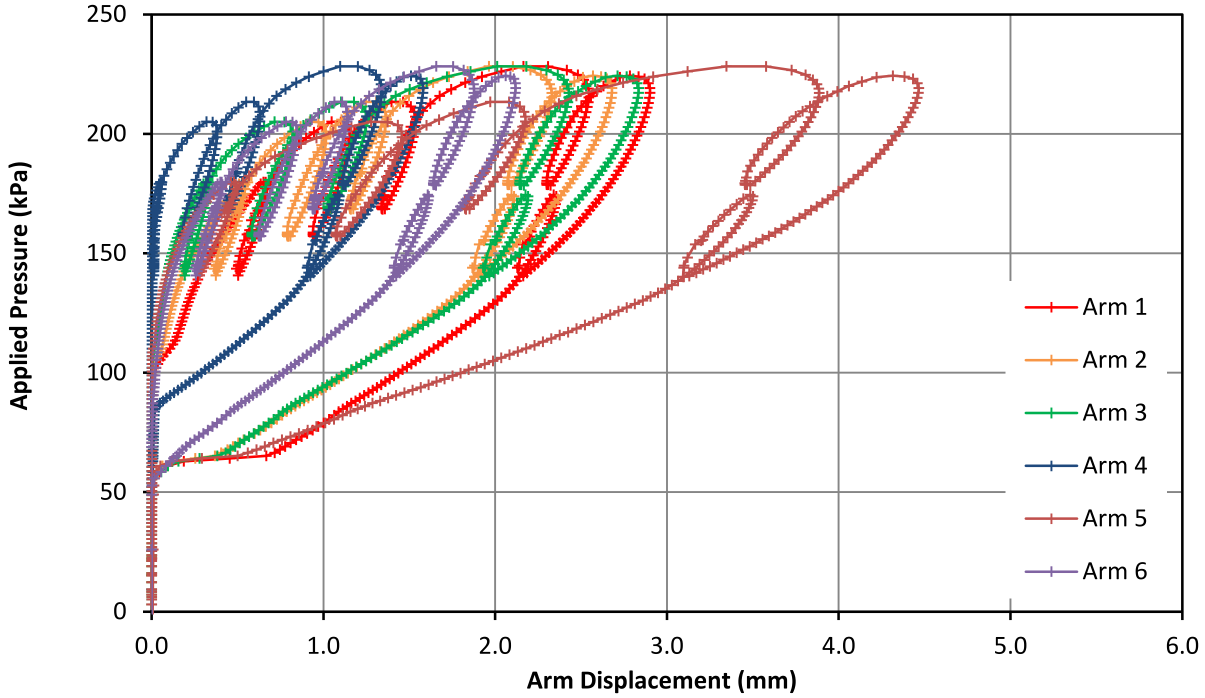
Strength	Undrained Shear	22	kPa
	Limit Pressure	251	kPa

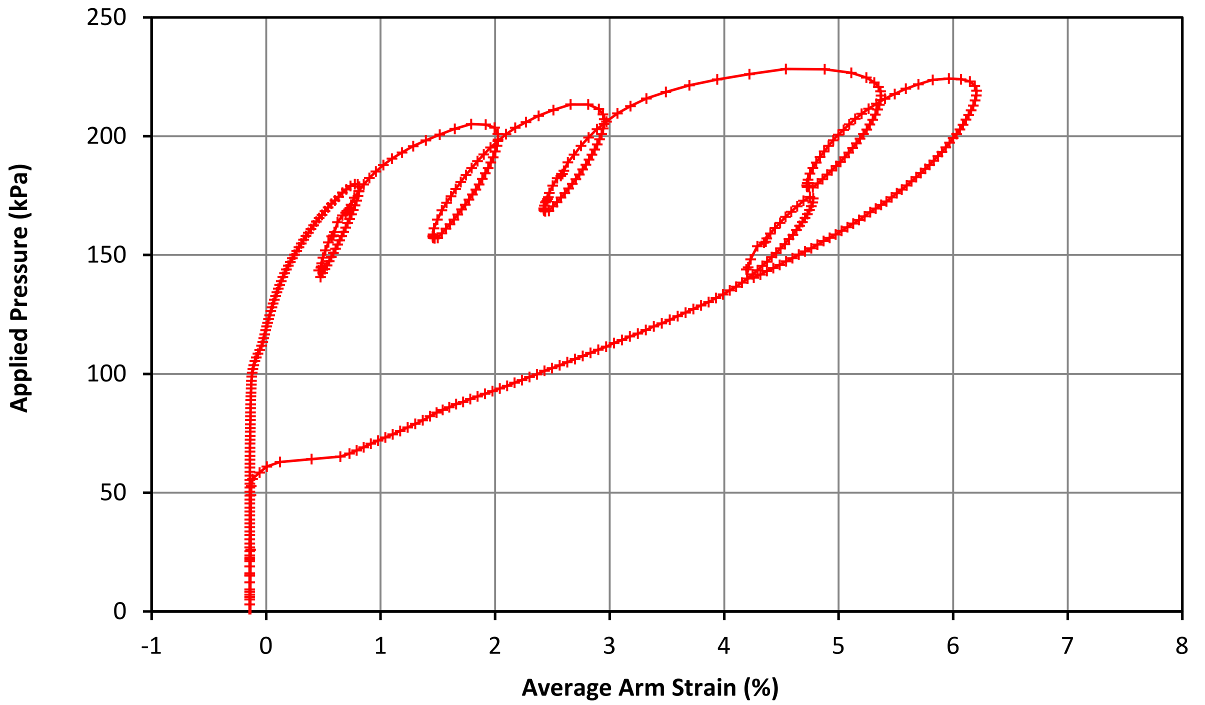
Project	NGI - Onsøy Site	Figure No.	ONSP01 T04 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	5
Borehole	ONSP01	Test Depth (m)	9.10





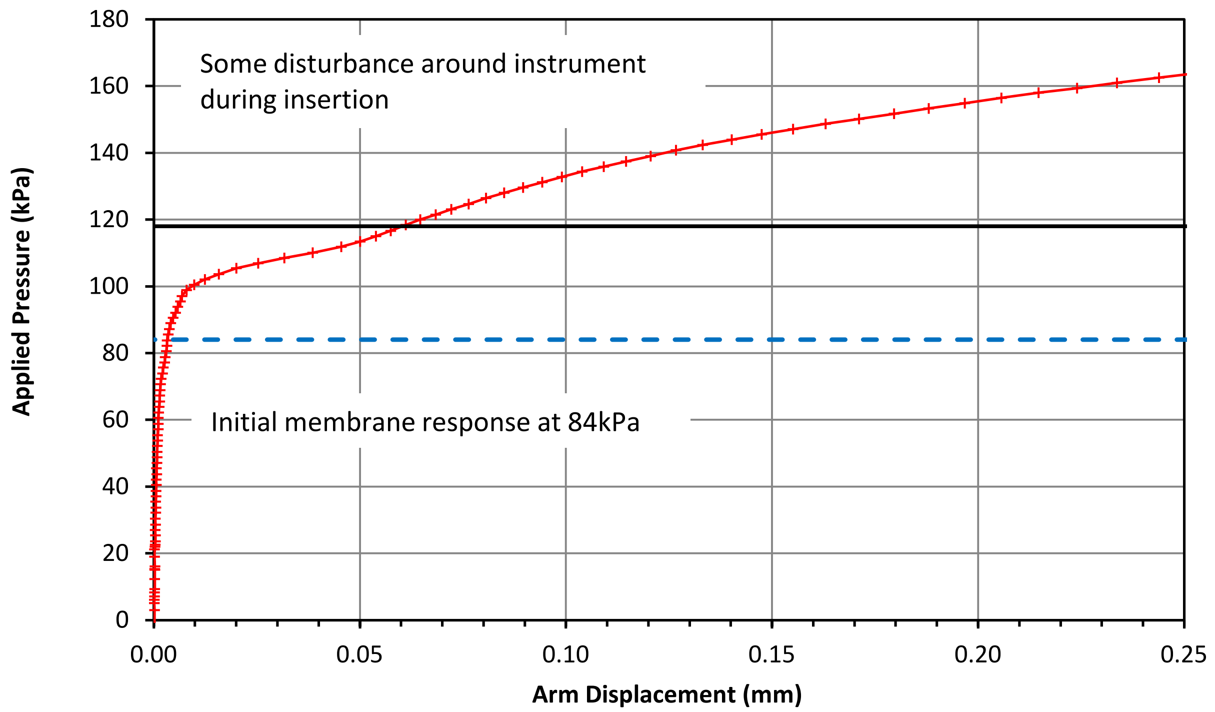
Comments

Project	NGI - Onsøy Site	Figure No.	ONSP01 T05 - 01
Client	NGI		
Project No.	P1170112		

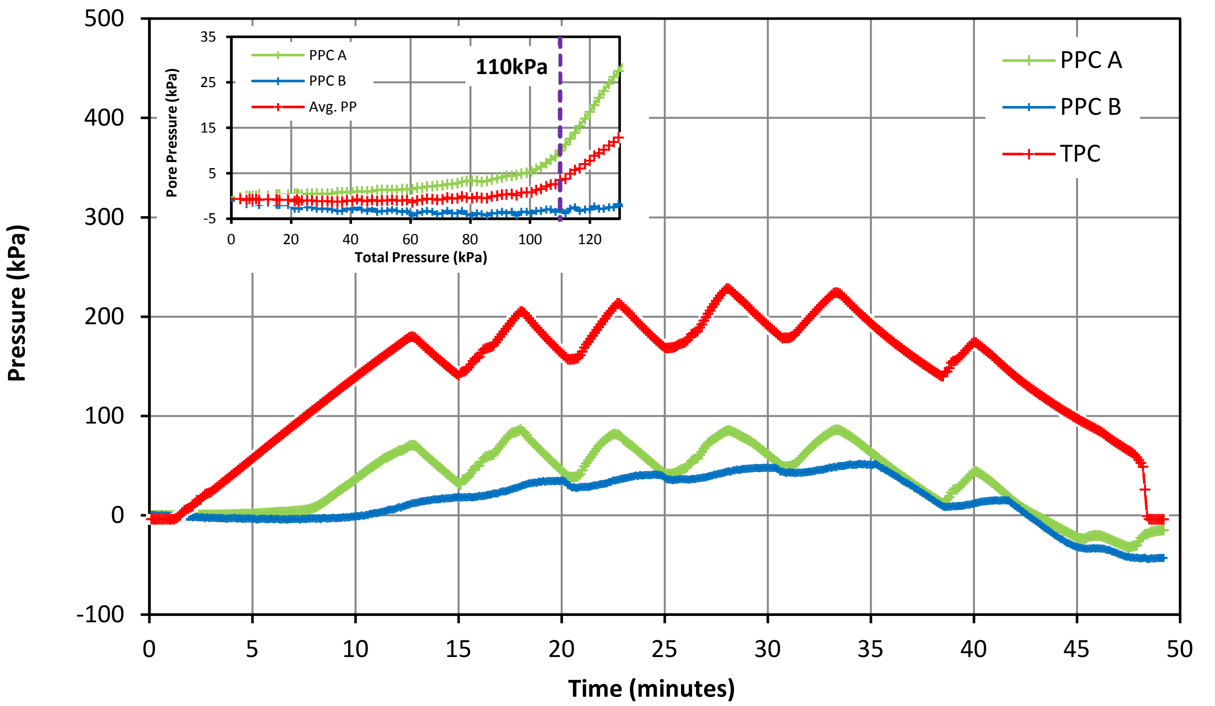
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	5
Borehole	ONSP01	Test Depth (m)	9.10



Lift Off Stress (Po)	118 kPa

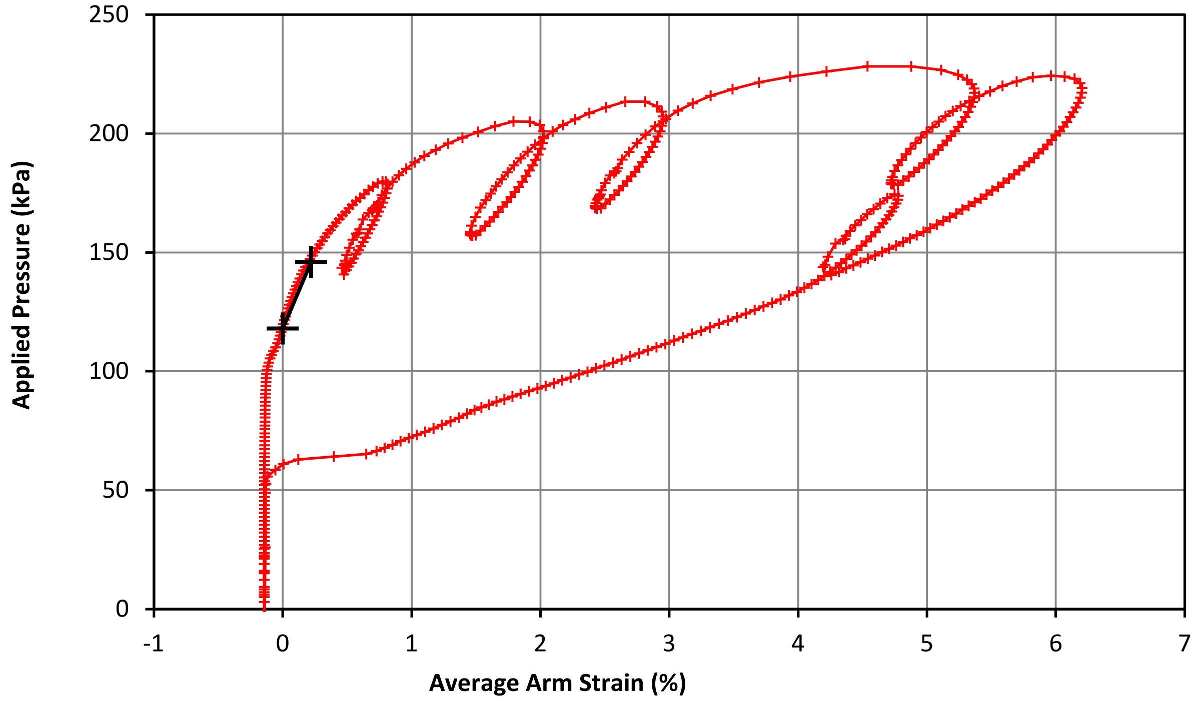


Project	NGI - Onsøy Site	Figure No.	ONSP01 T05 - 02
Client	NGI		
Project No.	P1170112		

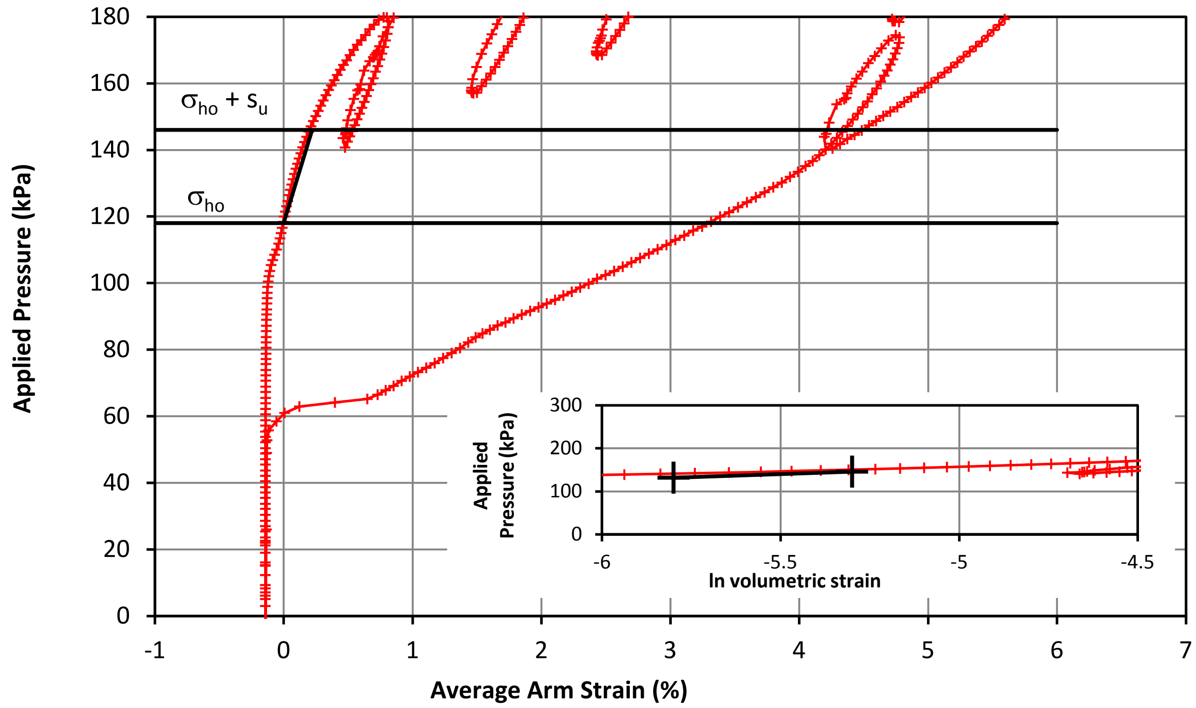
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	5
Borehole	ONSP01	**Test Depth (m)**	9.10



Initial Modulus	Shear Modulus	6.4 MPa



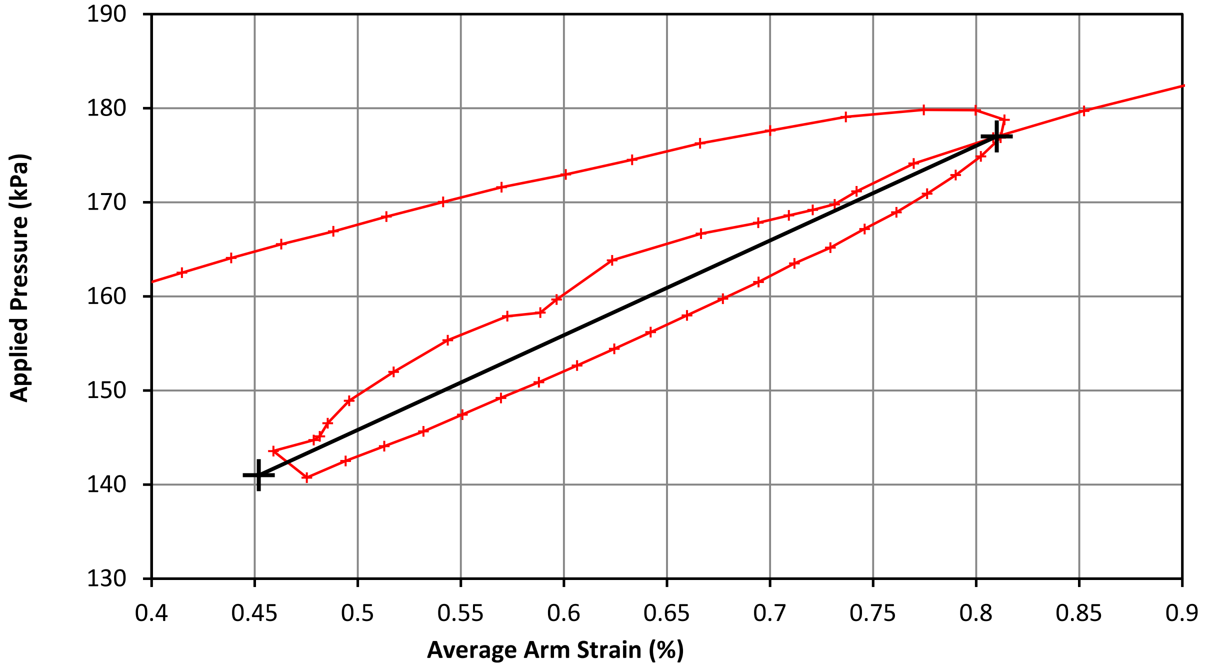
Marsland & Randolph	In situ horizontal stress	118 kPa
	Undrained Strength	28 kPa

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T05 - 03**
Client	NGI		
Project No.	P1170112		

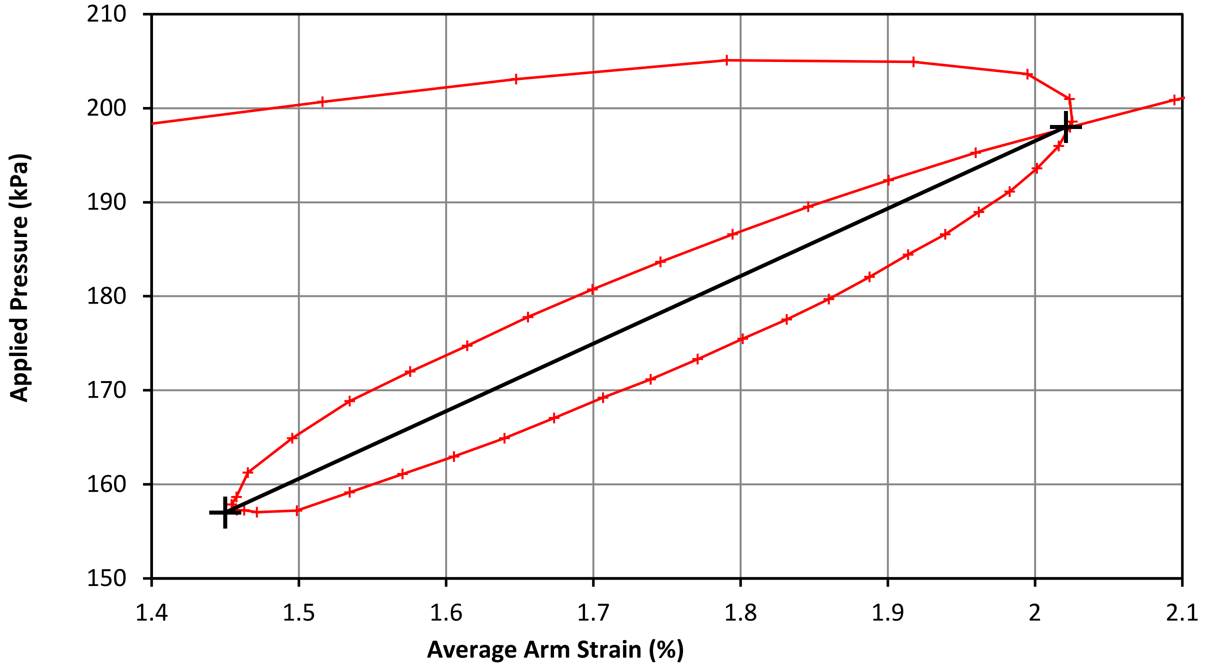
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	5
Borehole	ONSP01	**Test Depth (m)**	9.10



Loop 1	Shear Modulus	5.1	MPa
	Cavity Strain Range	0.358	%

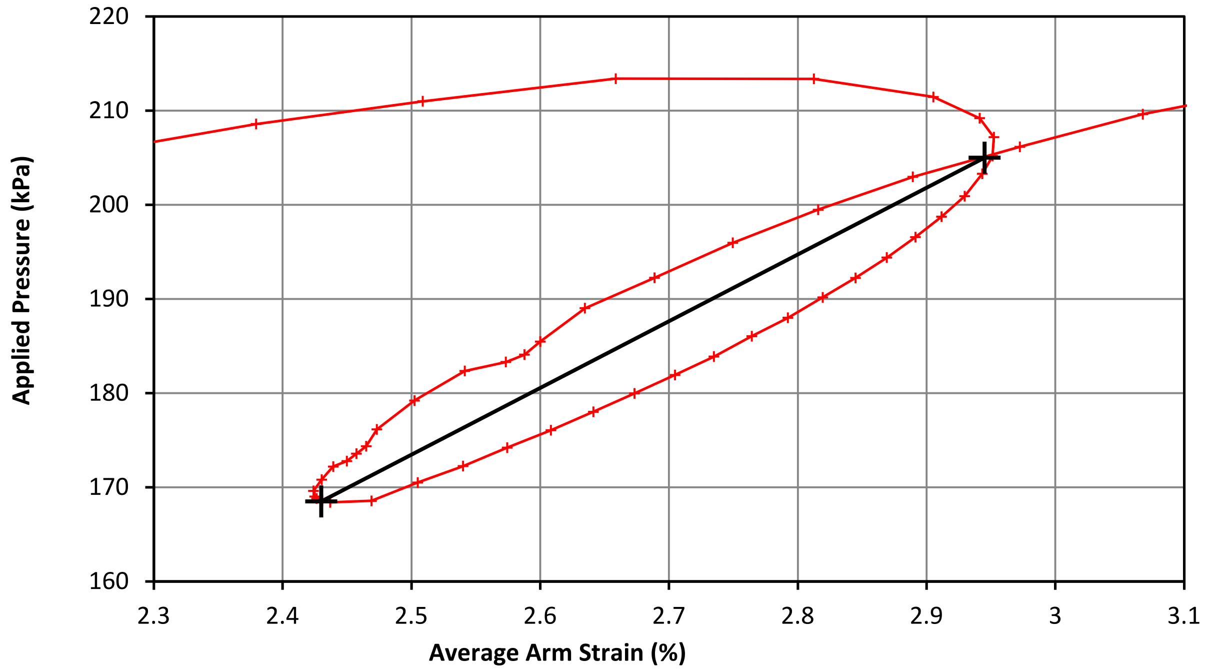


Loop 2	Shear Modulus	3.7	MPa
	Cavity Strain Range	0.571	%

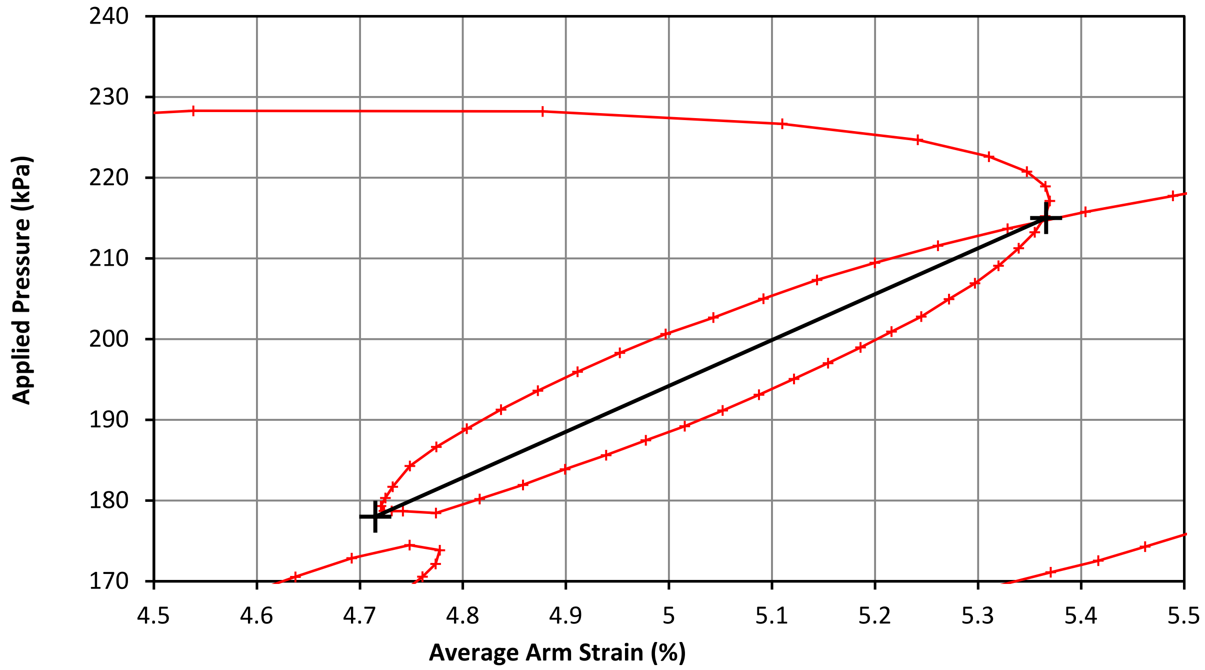
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T05 - 04**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	21/09/2017	**Test No.**	5
Borehole	ONSP01	**Test Depth (m)**	9.10



Loop 3	Shear Modulus	3.6 MPa
	Cavity Strain Range	0.515 %



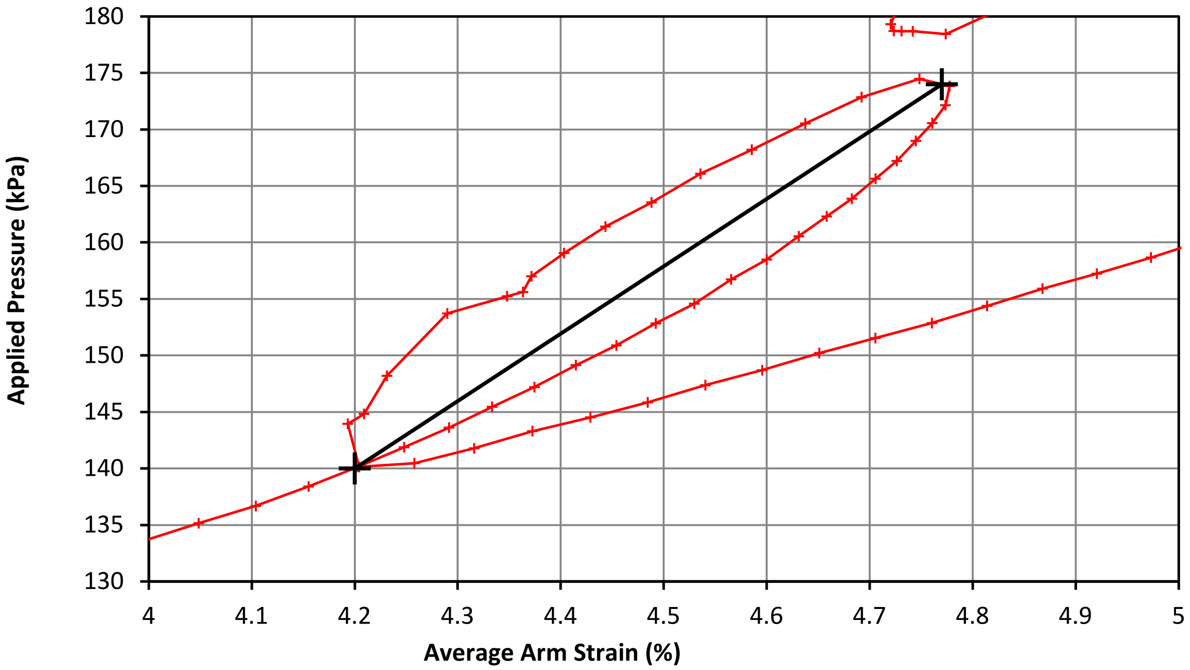
Loop 4	Shear Modulus	3.0 MPa
	Cavity Strain Range	0.651 %

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T05 - 05**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	5
Borehole	ONSP01	**Test Depth (m)**	9.10



Loop 5	Shear Modulus	3.1 MPa
	Cavity Strain Range	0.57 %

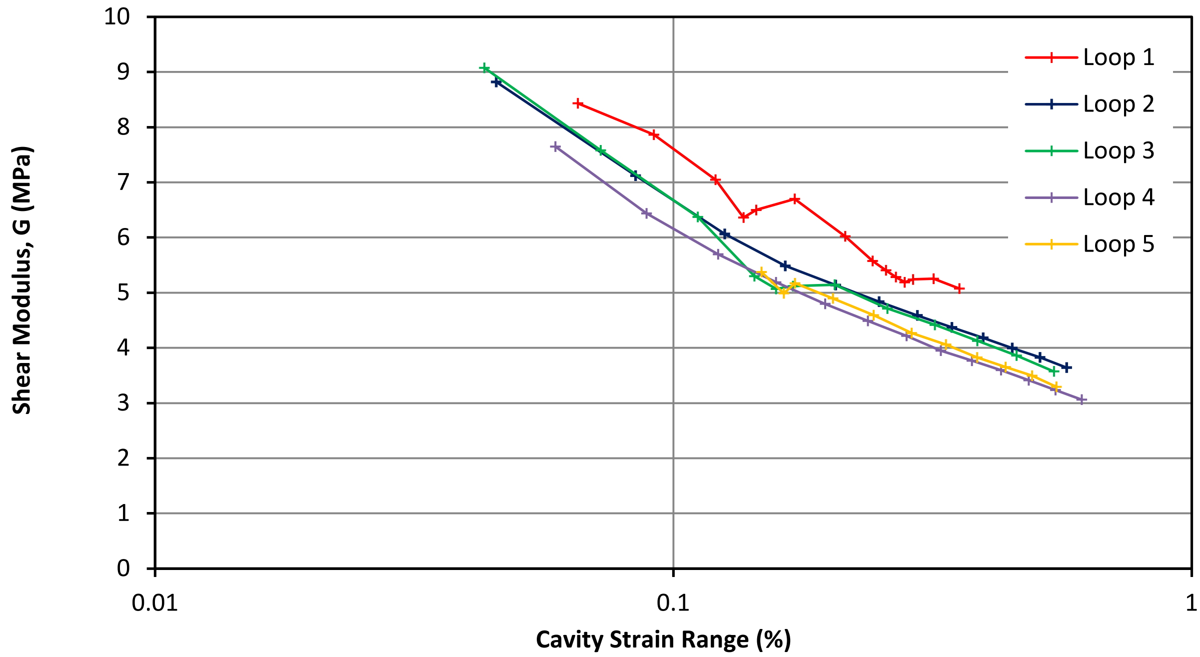
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T05 - 06**
Client	NGI		
Project No.	P1170112		

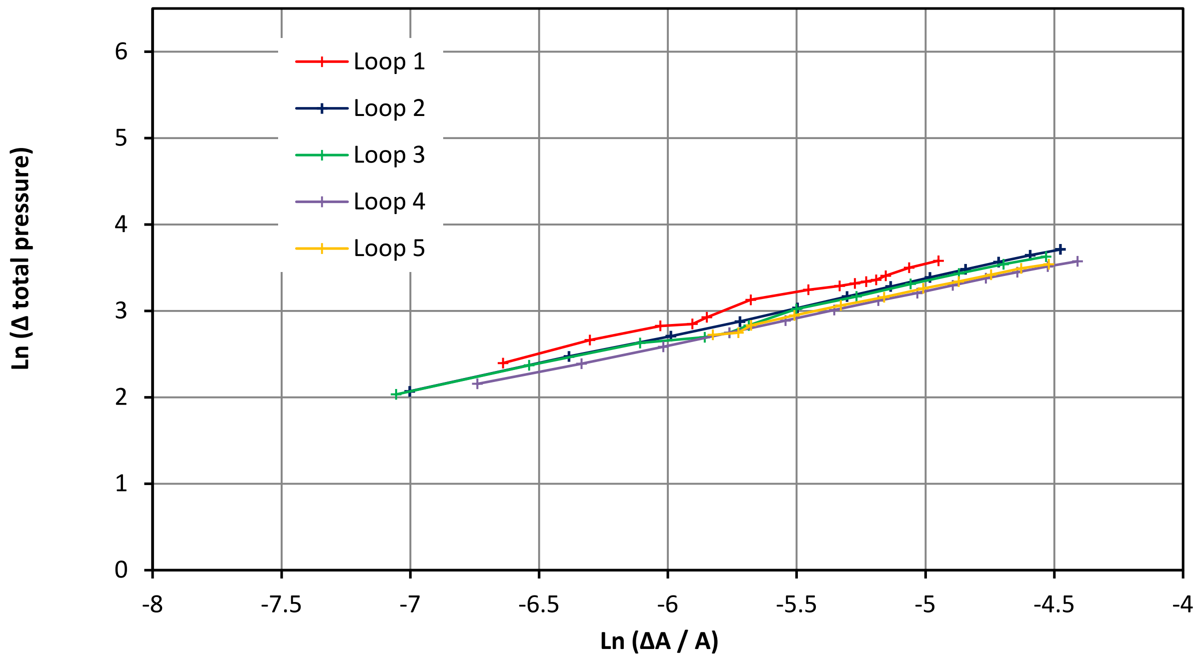
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	5
Borehole	ONSP01	**Test Depth (m)**	9.10





Loop 1		Loop 2		Loop 3		Loop 4		Loop 5	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.681	1.020 (MPa)	0.657	0.777 (MPa)	0.645	0.698 (MPa)	0.619	0.554 (MPa)	0.640	0.635 (MPa)

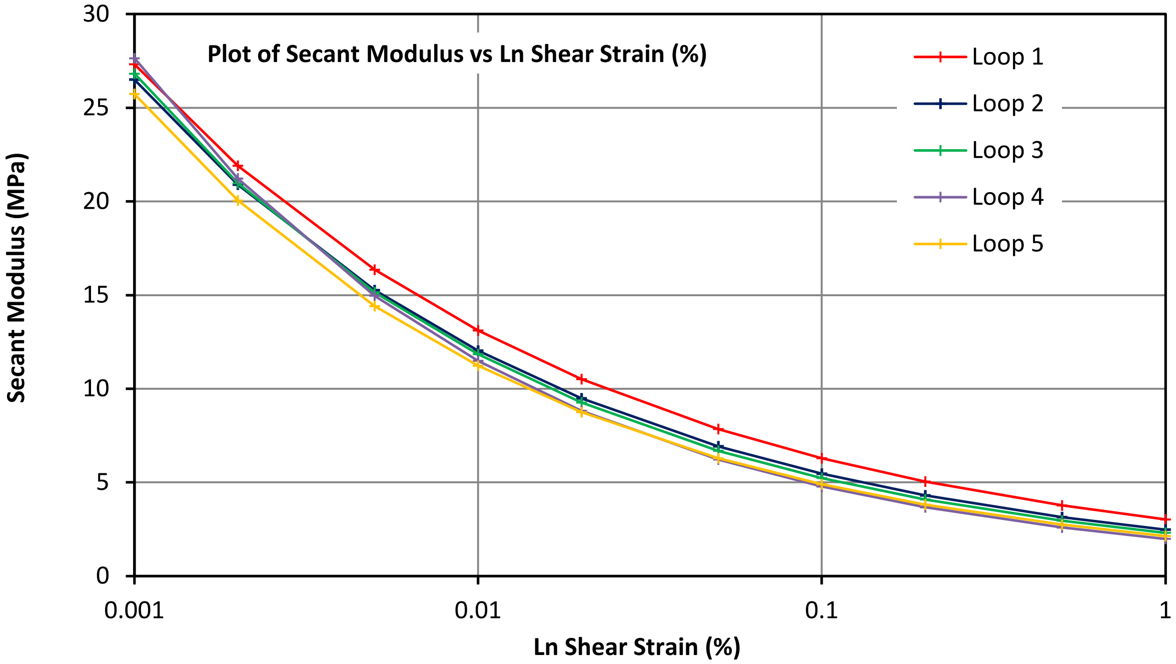
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T05 - 07**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	Test No.	5
Borehole	ONSP01	Test Depth (m)	9.10



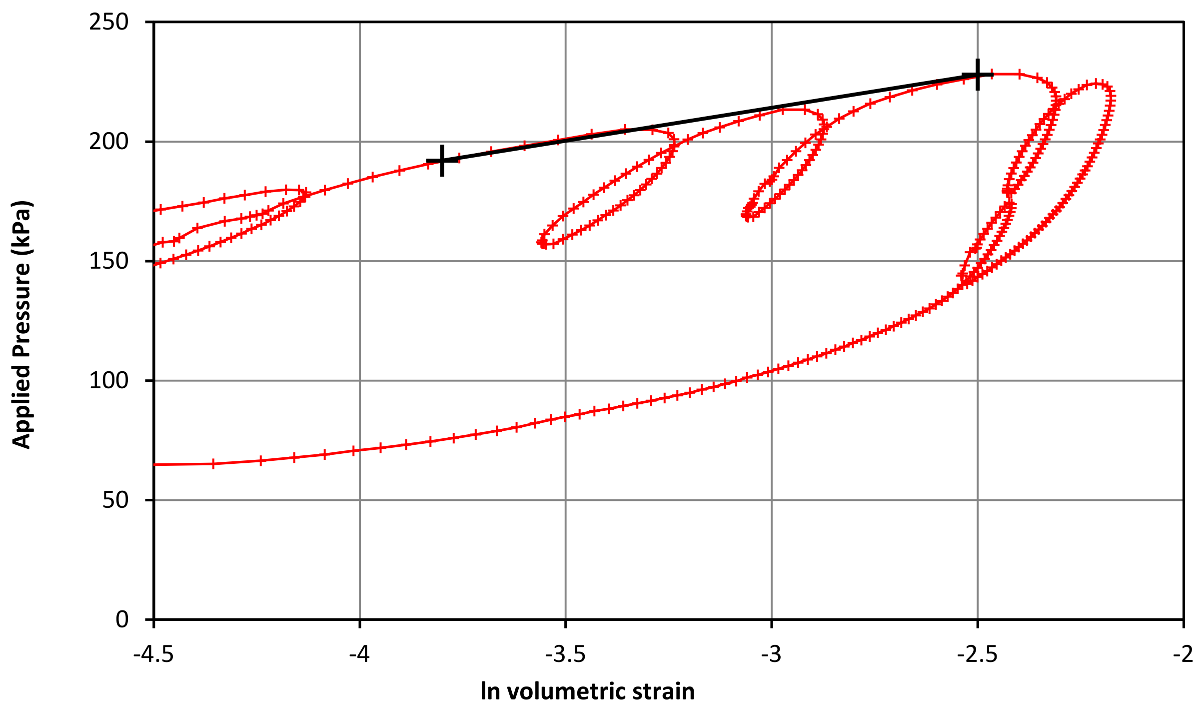
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5
0.001%	**27**	**27**	**27**	**28**	**26**
0.002%	22	21	21	21	20
0.005%	16	15	15	15	14
0.010%	**13**	**12**	**12**	**11**	**11**
0.020%	11	9	9	9	9
0.050%	8	7	7	6	6
0.100%	**6**	**5**	**5**	**5**	**5**
0.200%	5	4	4	4	4
0.500%	4	3	3	3	3
1.000%	**3**	**2**	**2**	**2**	**2**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T05 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	5
Borehole	ONSP01	Test Depth (m)	9.10



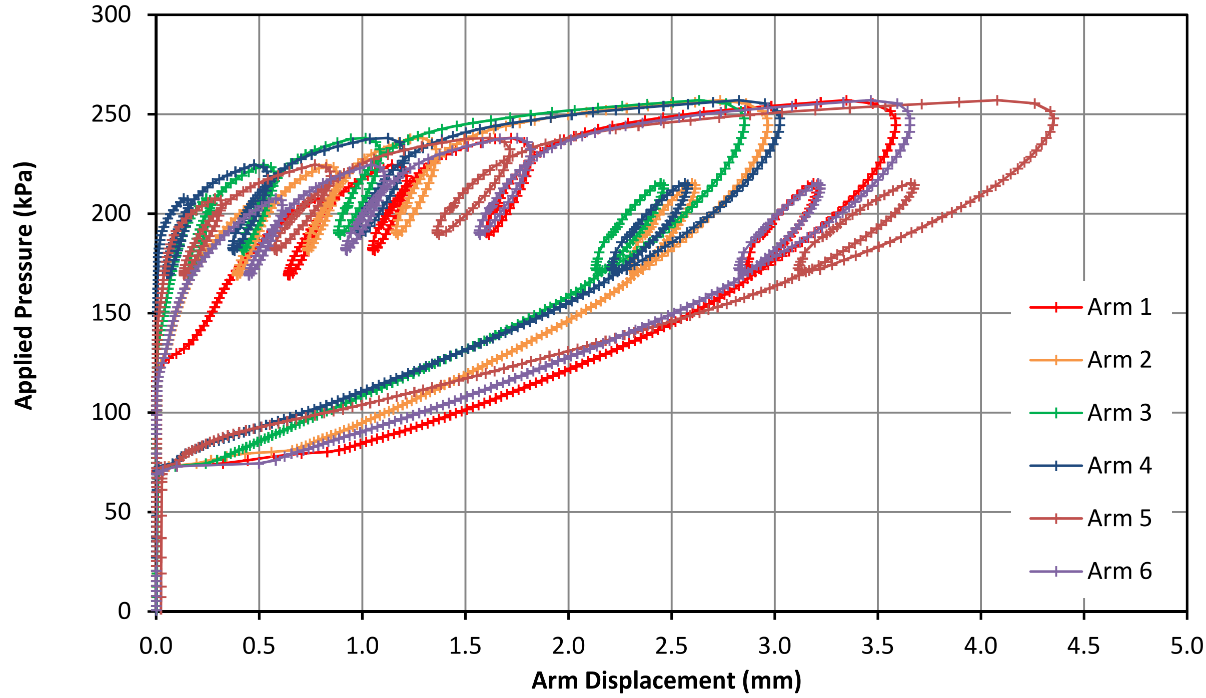
Strength	Undrained Shear	28 kPa
	Limit Pressure	297 kPa

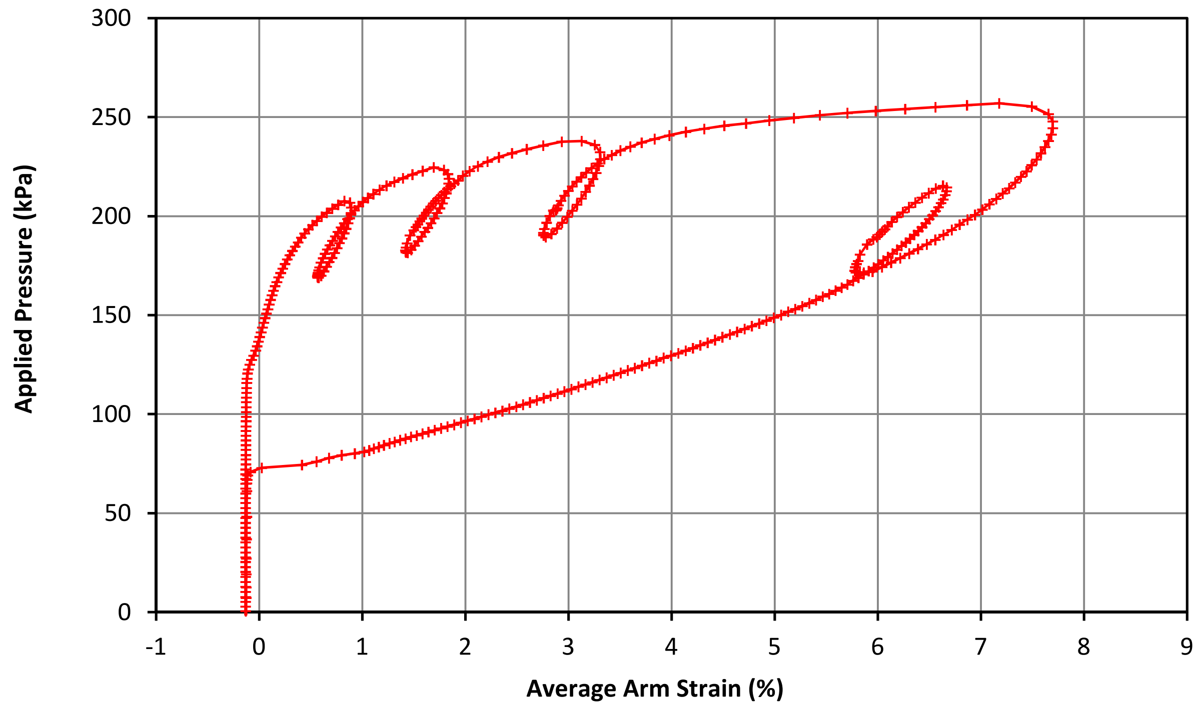
Project	NGI - Onsøy Site	Figure No.	ONSP01 T05 - 09
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	6
Borehole	ONSP01	**Test Depth (m)**	10.20





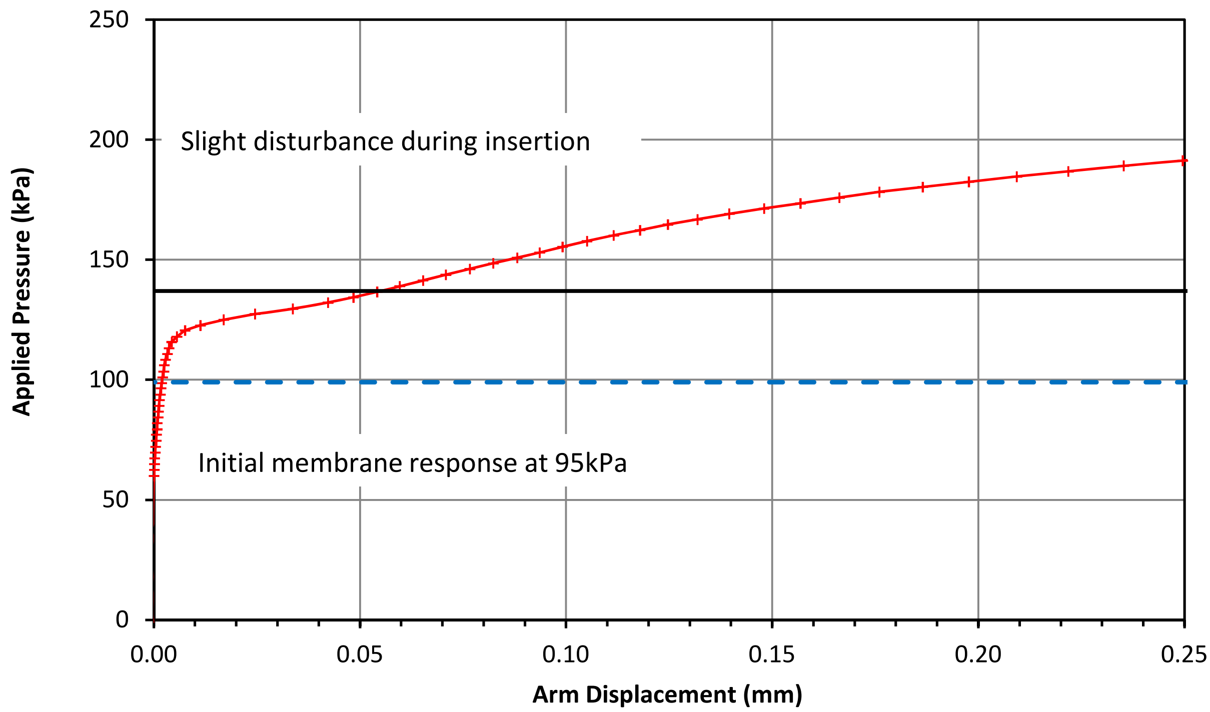
Comments

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T06 - 01**
Client	NGI		
Project No.	P1170112		

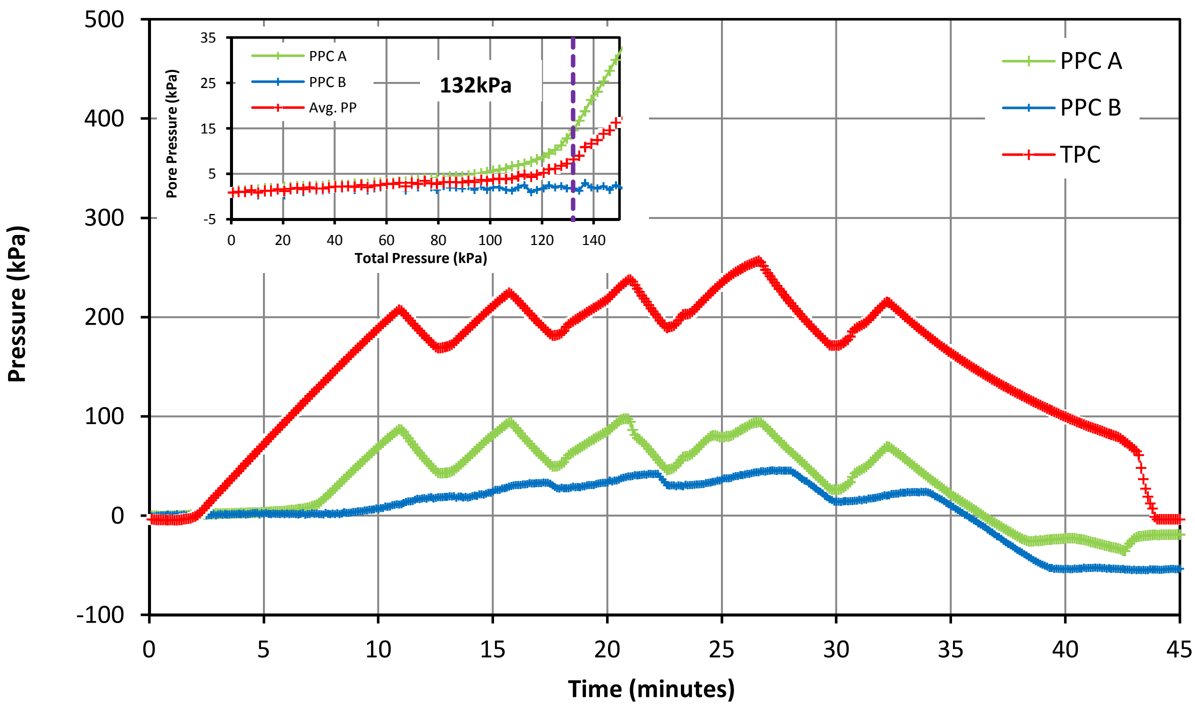
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	Test No.	6
Borehole	ONSP01	Test Depth (m)	10.20



Lift Off Stress (Po)	137 kPa

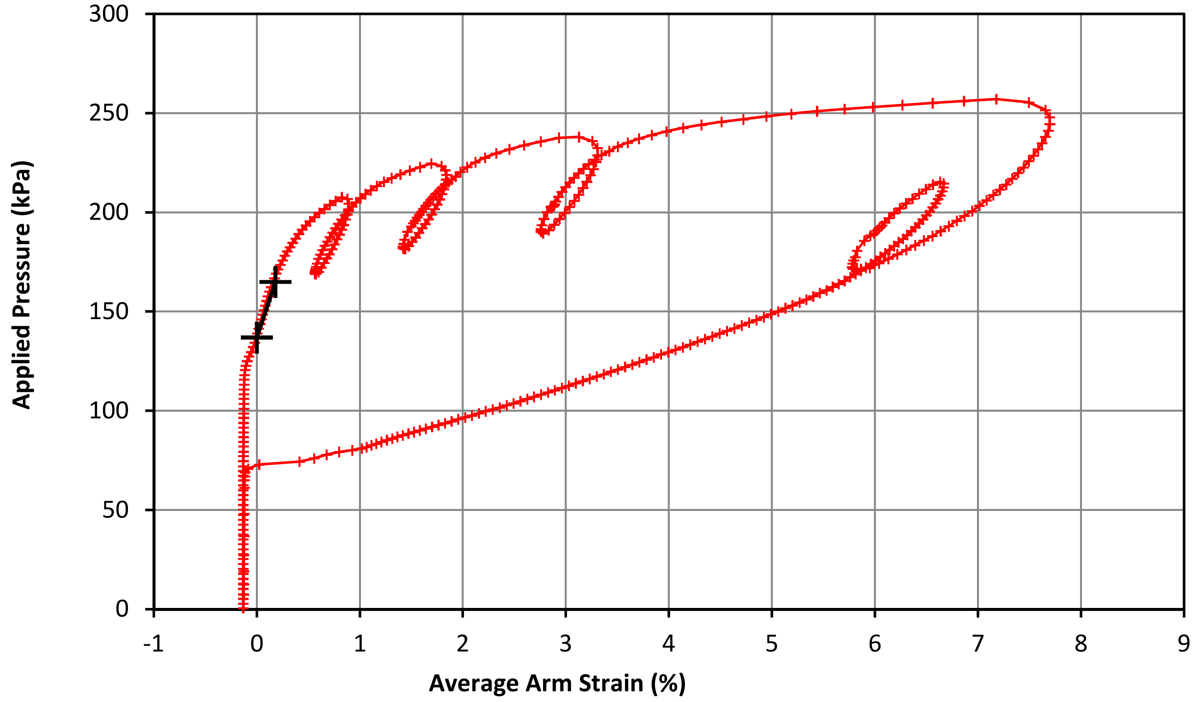


Project	NGI - Onsøy Site	Figure No.	ONSP01 T06 - 02
Client	NGI		
Project No.	P1170112		

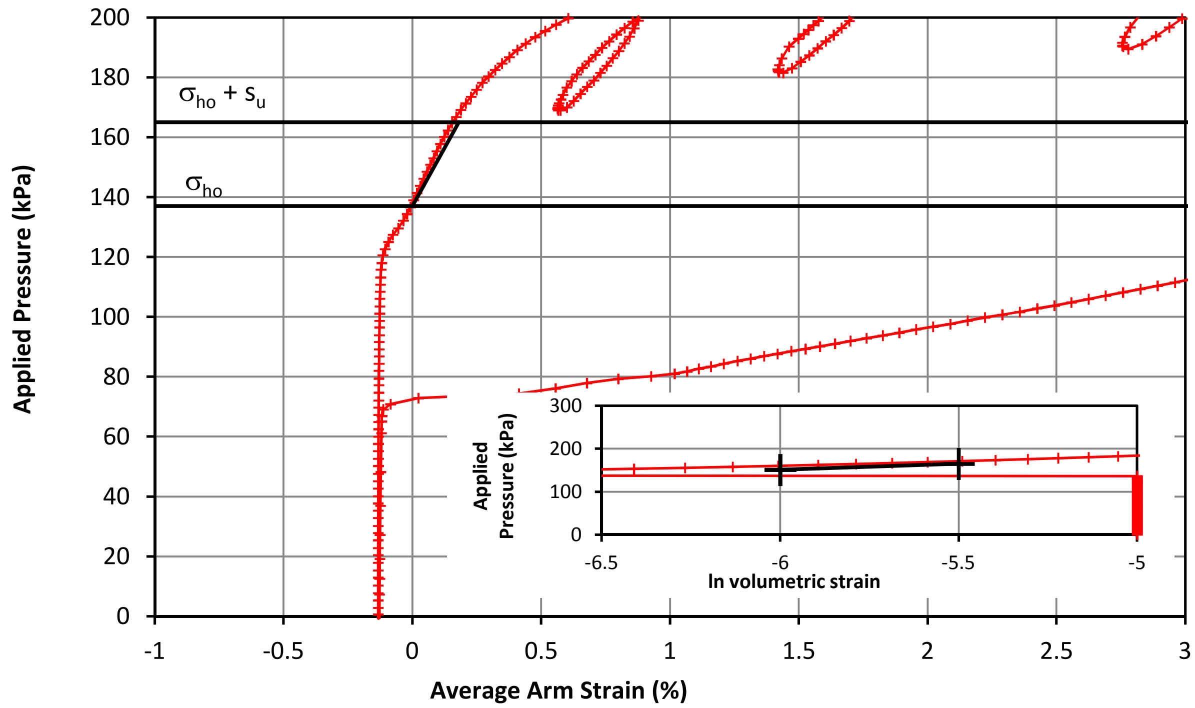
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	6
Borehole	ONSP01	Test Depth (m)	10.20



Initial Modulus	Shear Modulus	7.8 MPa



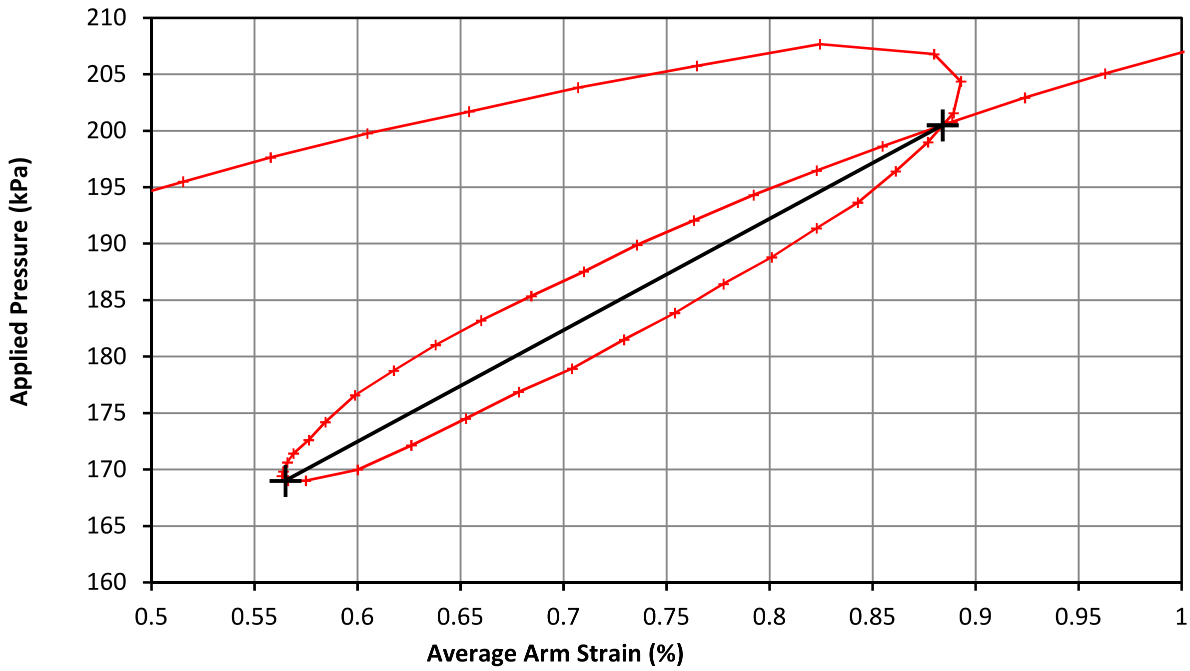
Marsland & Randolph	In situ horizontal stress	137 kPa
	Undrained Strength	28 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T06 - 03
Client	NGI		
Project No.	P1170112		

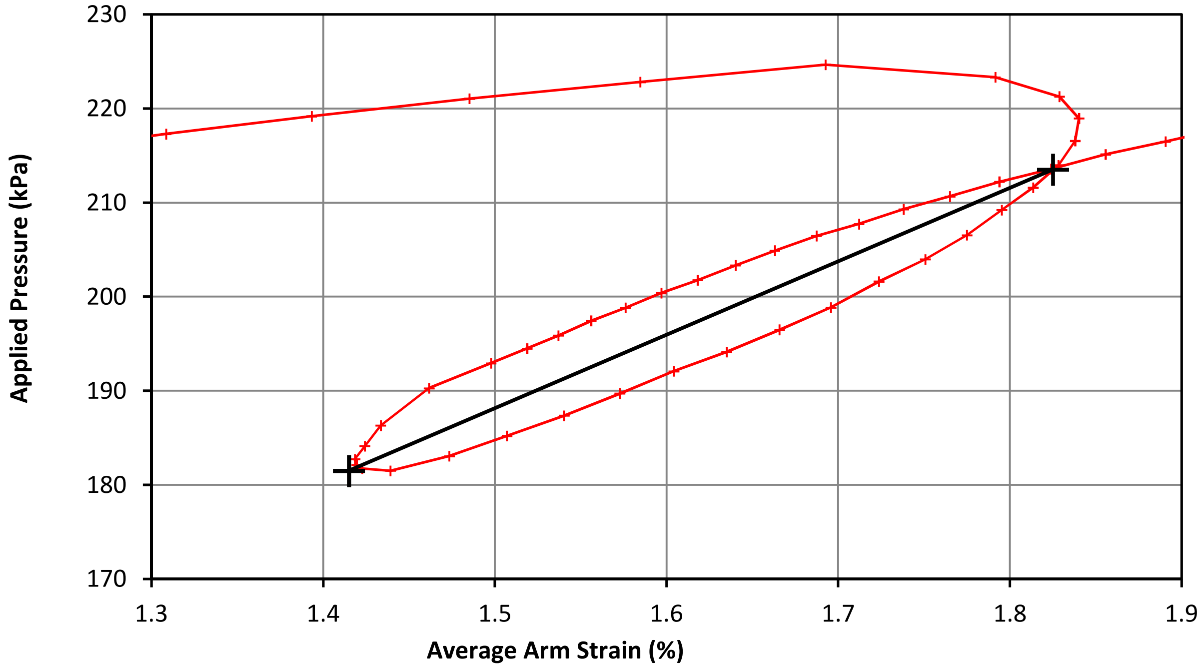
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	6
Borehole	ONSP01	**Test Depth (m)**	10.20



Loop 1	Shear Modulus	5.0	MPa
	Cavity Strain Range	0.319	%



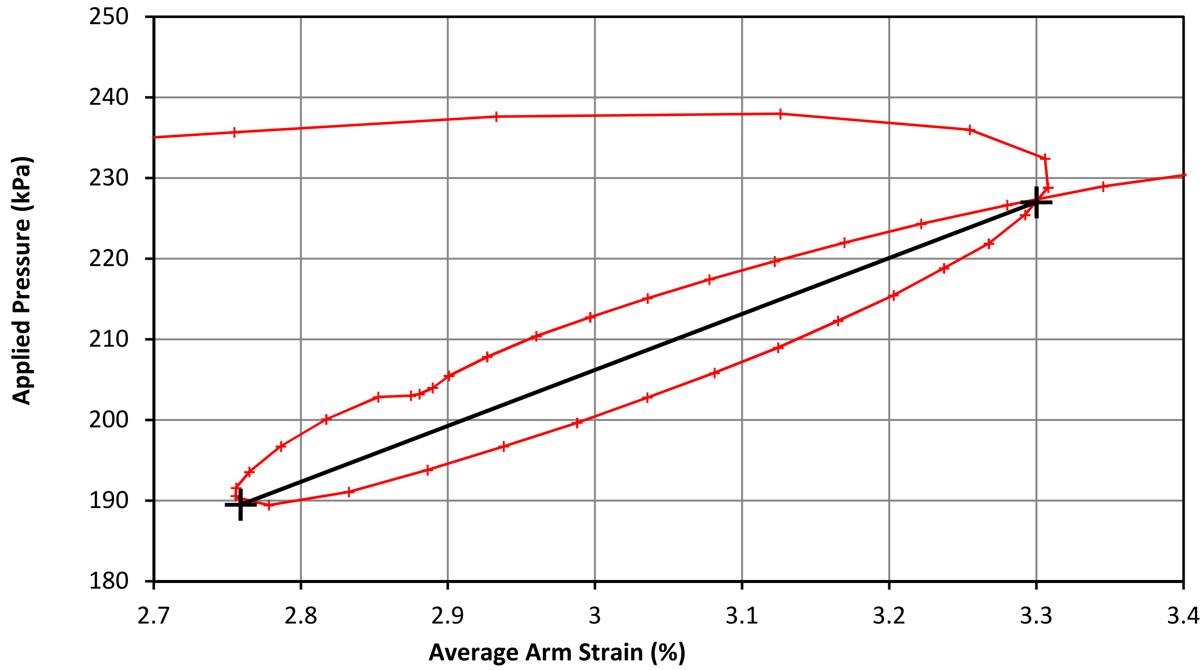
Loop 2	Shear Modulus	4.0	MPa
	Cavity Strain Range	0.410	%

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T06 - 04**
Client	NGI		
Project No.	P1170112		

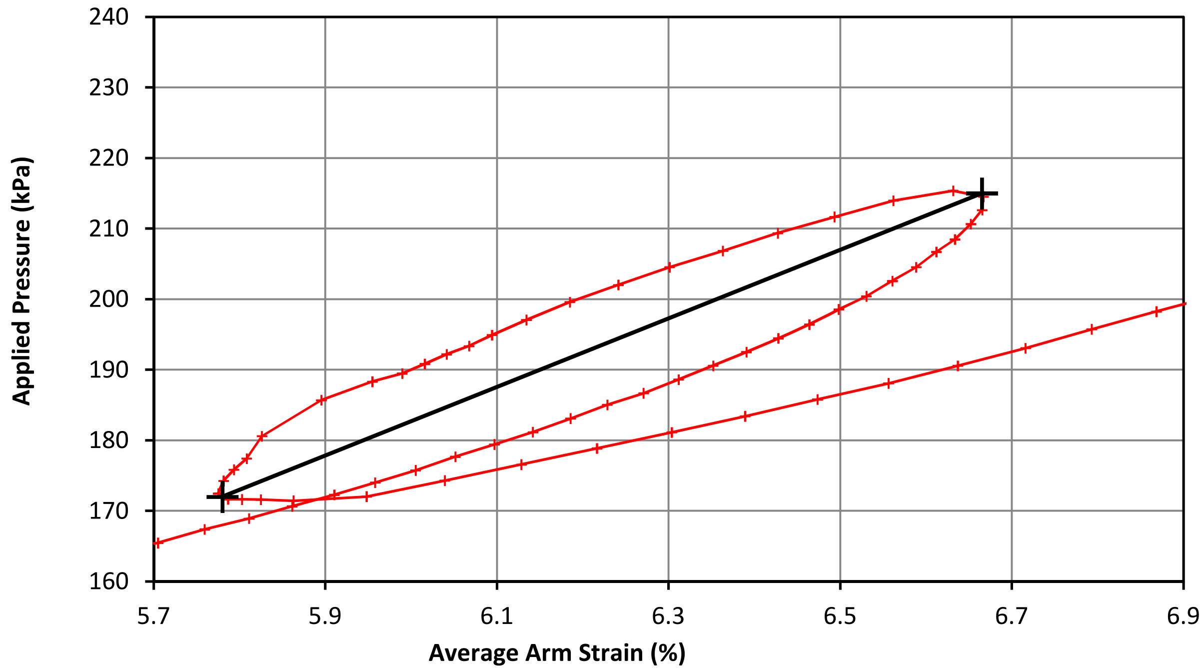
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	6
Borehole	ONSP01	**Test Depth (m)**	10.20



Loop 3	Shear Modulus	3.6	MPa
	Cavity Strain Range	0.541	%



Loop 4	Shear Modulus	2.6	MPa
	Cavity Strain Range	0.885	%

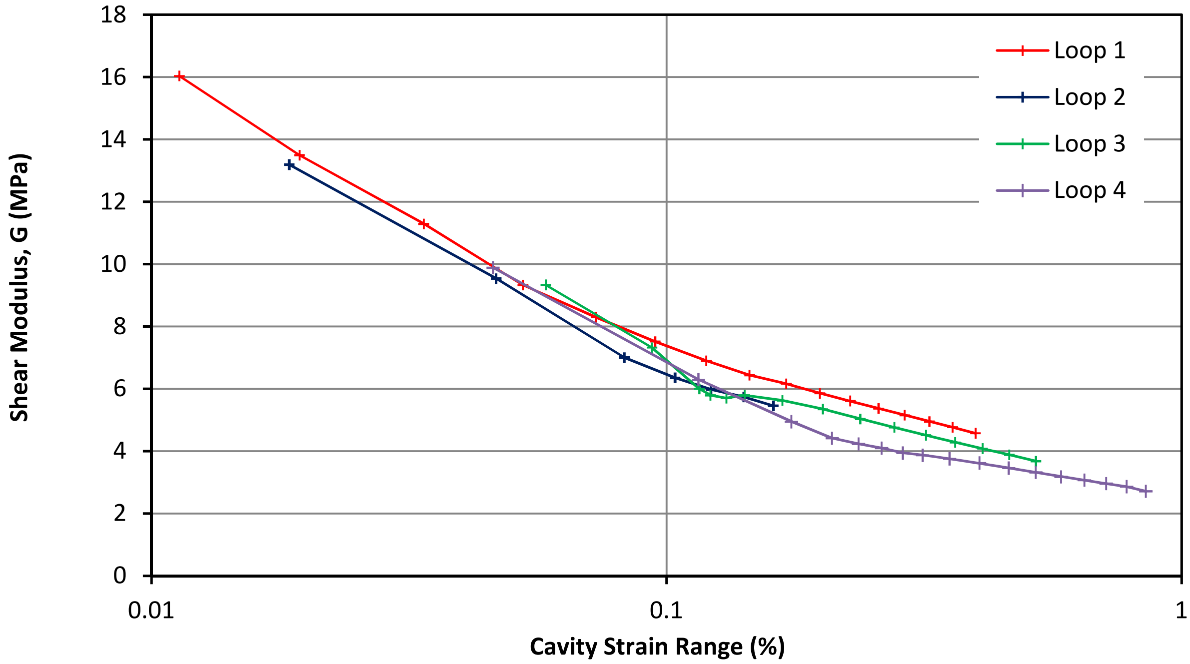
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T06 - 05**
Client	NGI		
Project No.	P1170112		

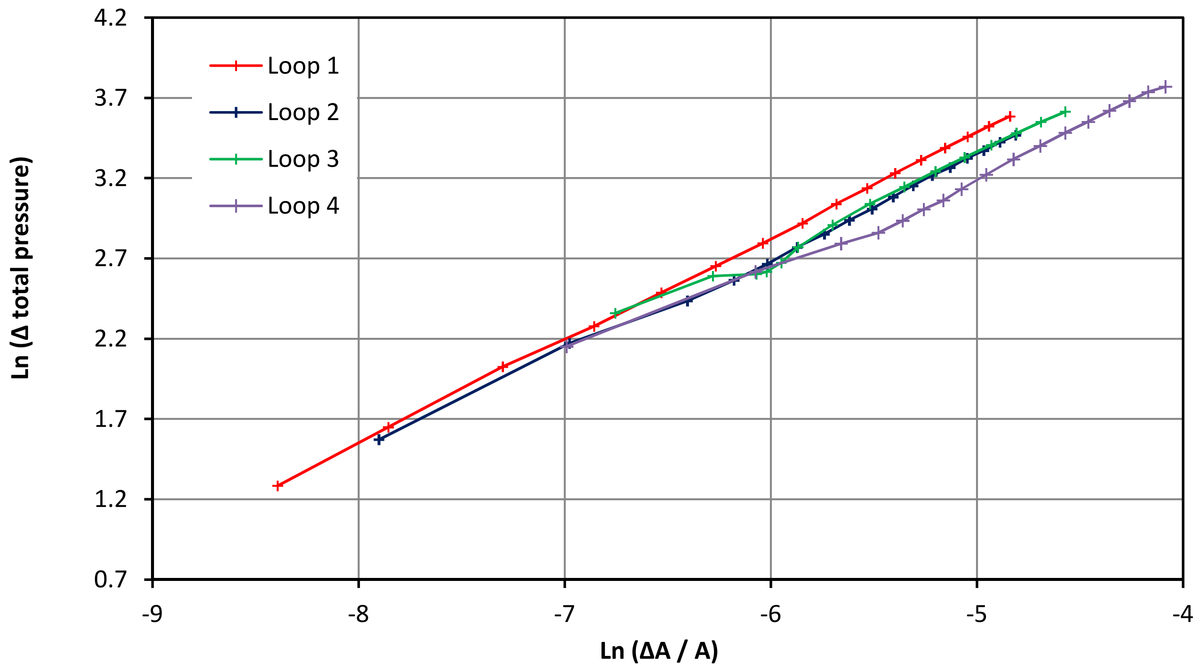
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	**Test No.**	6
Borehole	ONSP01	**Test Depth (m)**	10.20





Loop 1		**Loop 2**		**Loop 3**		**Loop 4**	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.645	0.818 (MPa)	0.617	0.614 (MPa)	0.627	0.653 (MPa)	0.583	0.459 (MPa)

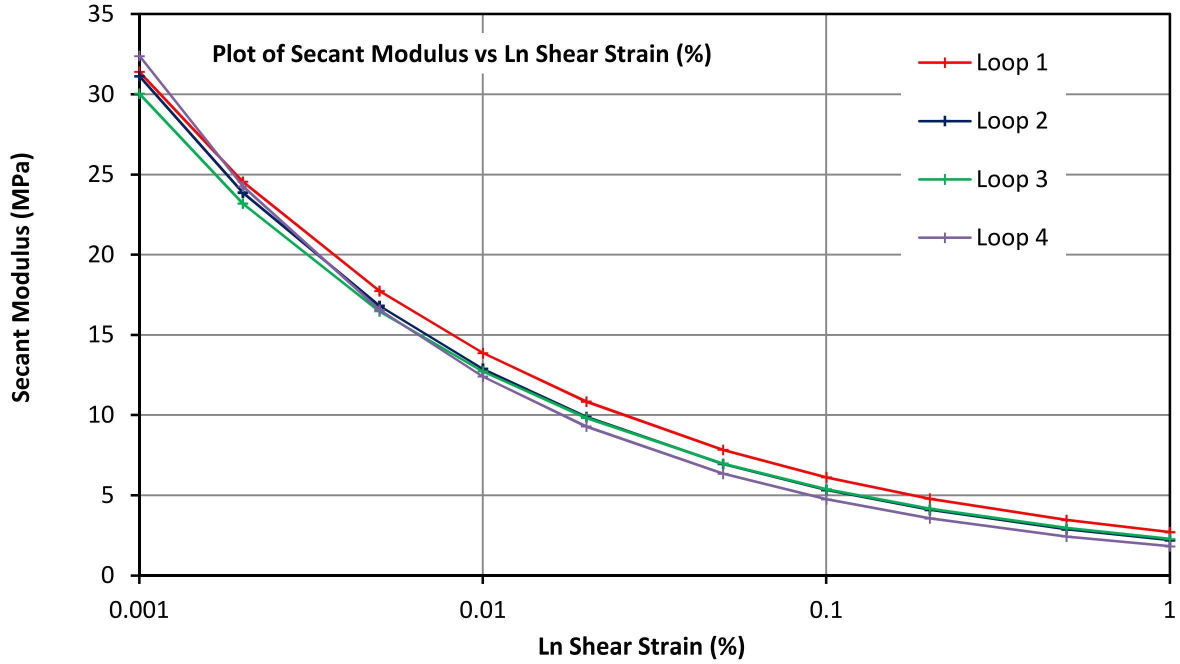
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T06 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	21/09/2017	Test No.	6
Borehole	ONSP01	Test Depth (m)	10.20



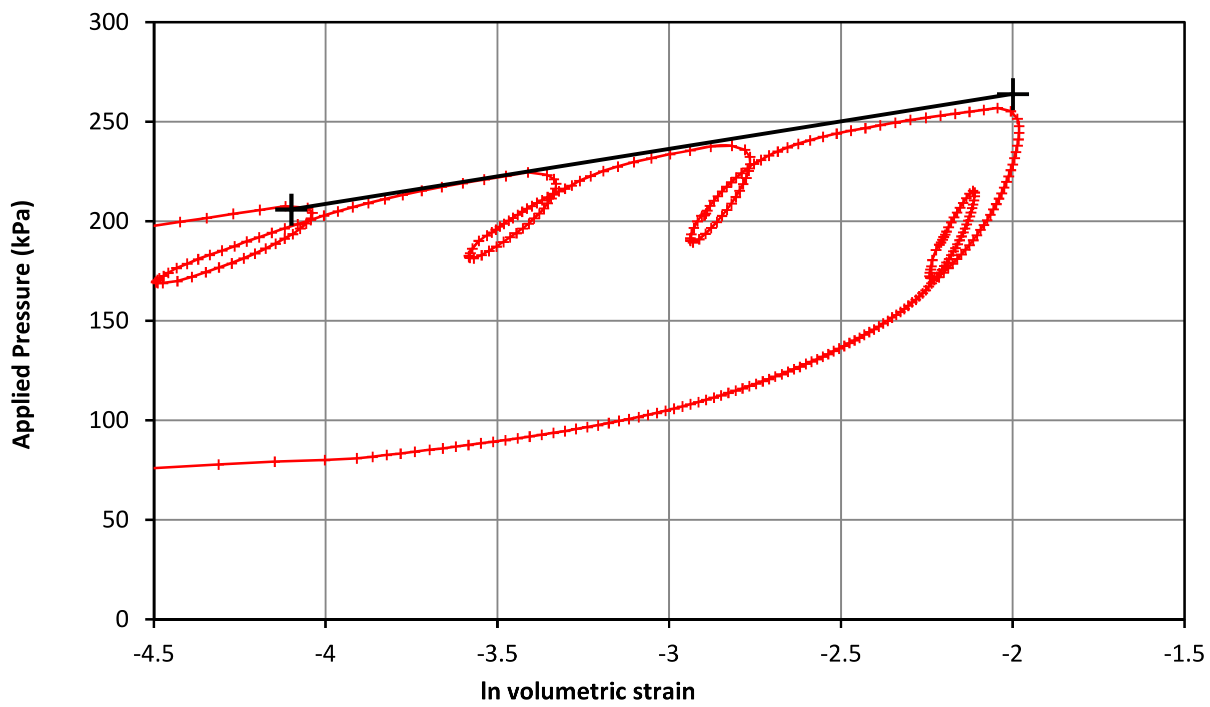
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4
0.001%	**31**	**31**	**30**	**32**
0.002%	25	24	23	24
0.005%	18	17	16	17
0.010%	**14**	**13**	**13**	**12**
0.020%	11	10	10	9
0.050%	8	7	7	6
0.100%	**6**	**5**	**5**	**5**
0.200%	5	4	4	4
0.500%	3	3	3	2
1.000%	**3**	**2**	**2**	**2**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T06 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU
SITE INVESTIGATION

Test Date	21/09/2017	Test No.	6
Borehole	ONSP01	Test Depth (m)	10.20

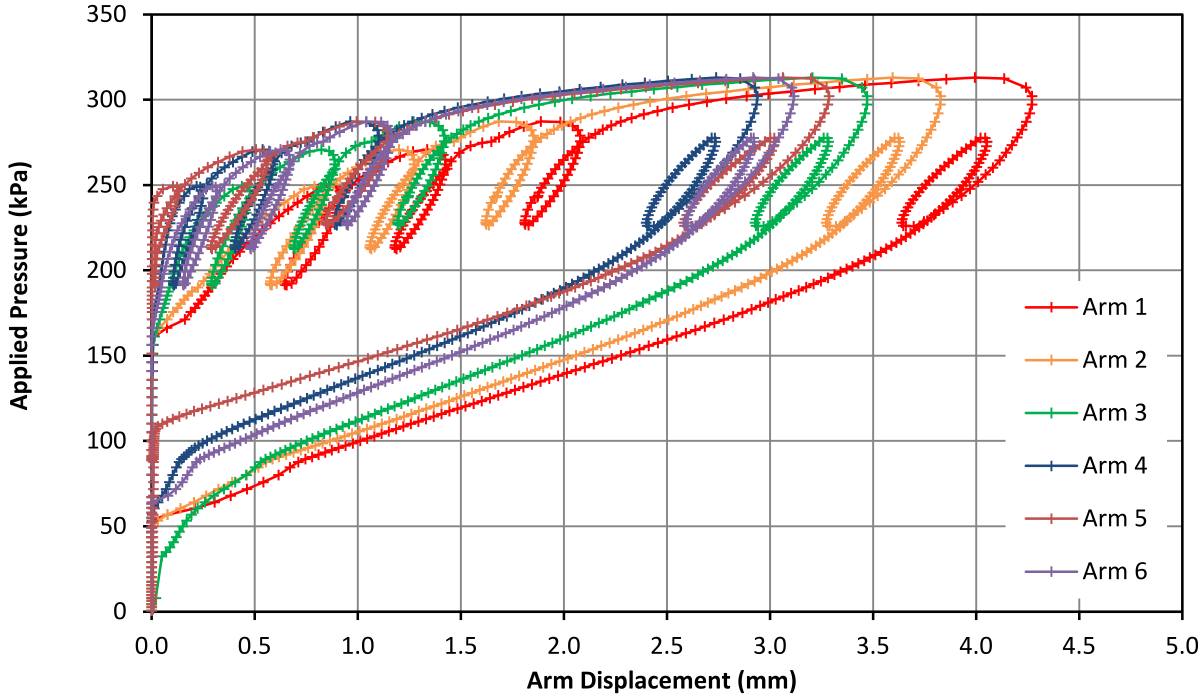


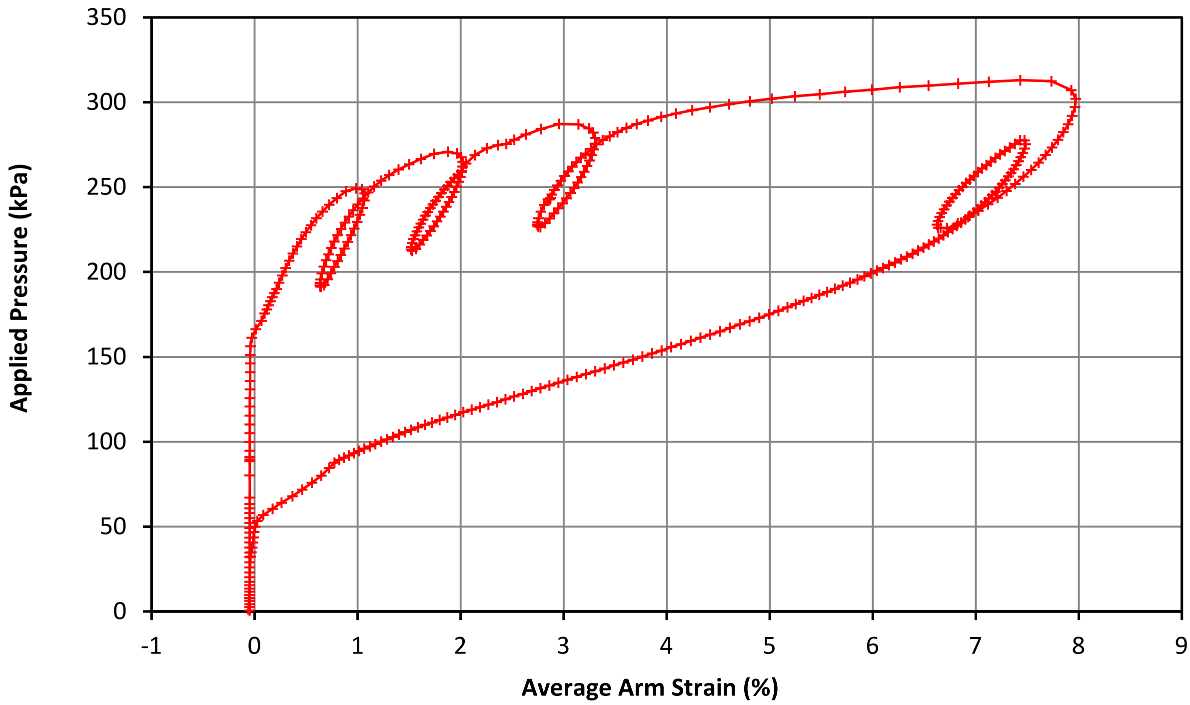
Strength	Undrained Shear	28	kPa
	Limit Pressure	319	kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T06 - 08
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	22/09/2017	**Test No.**	7
Borehole	ONSP01	**Test Depth (m)**	12.10



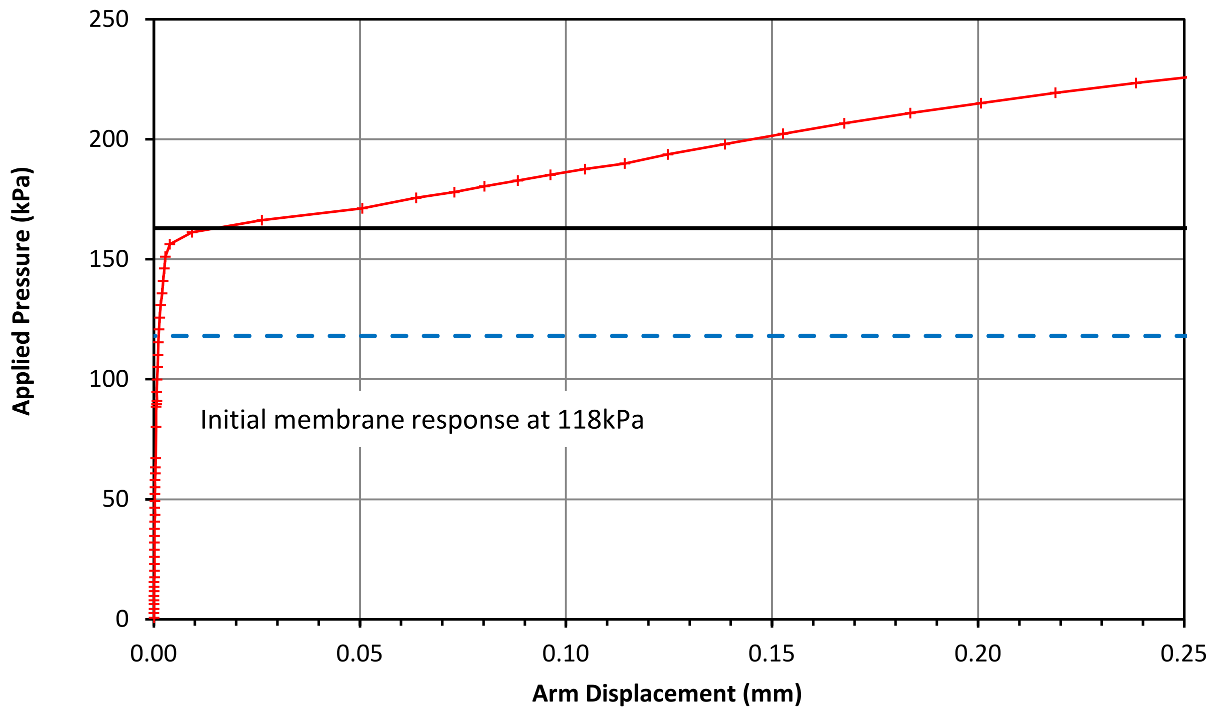


Comments

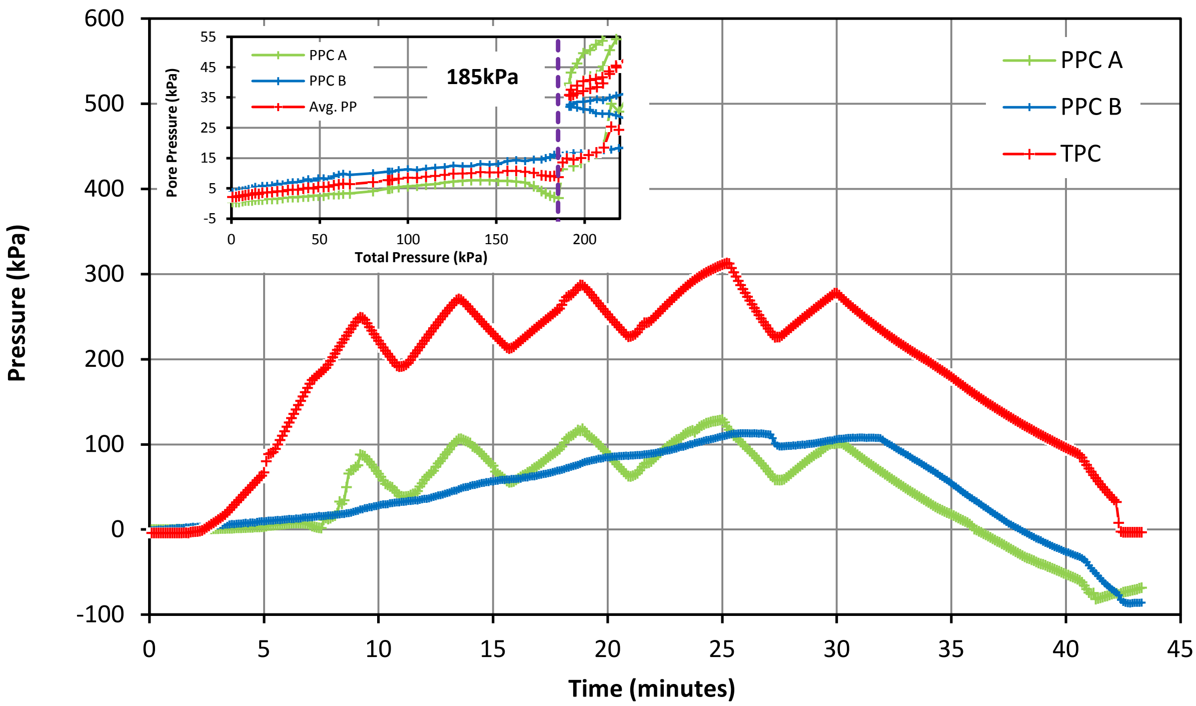
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T07 - 01**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Lift Off Stress & Pore Pressure Record

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10



Lift Off Stress (Po)	163 kPa

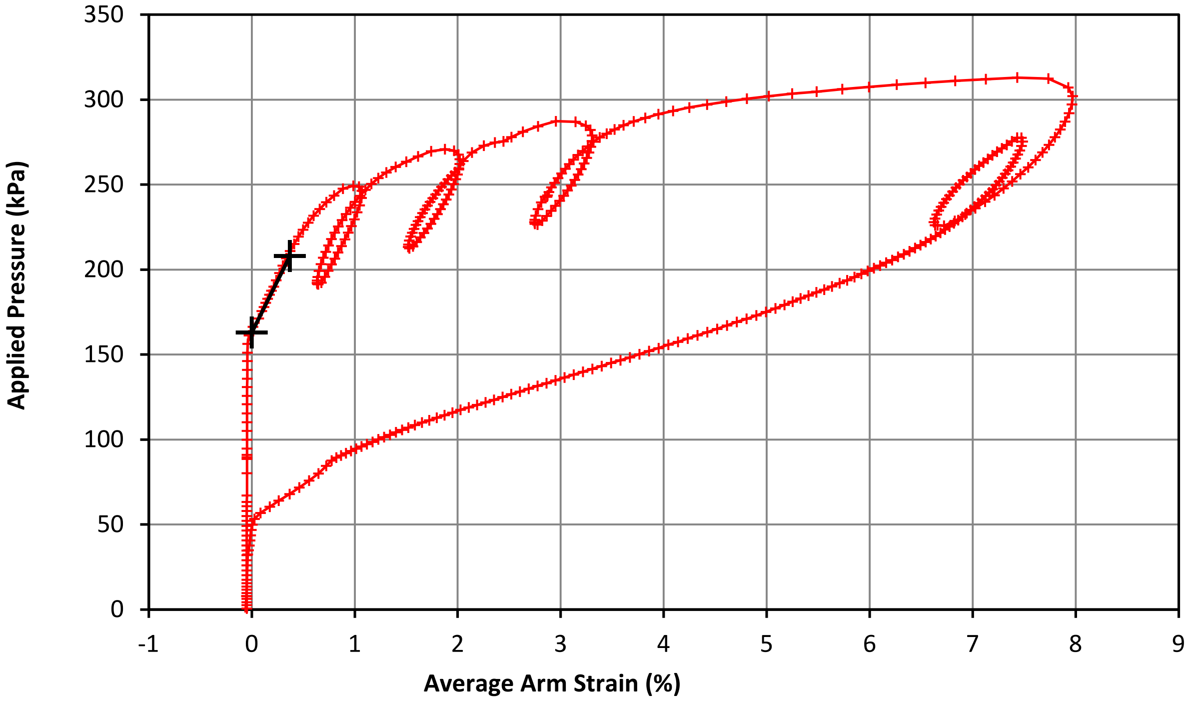


Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 02
Client	NGI		
Project No.	P1170112		

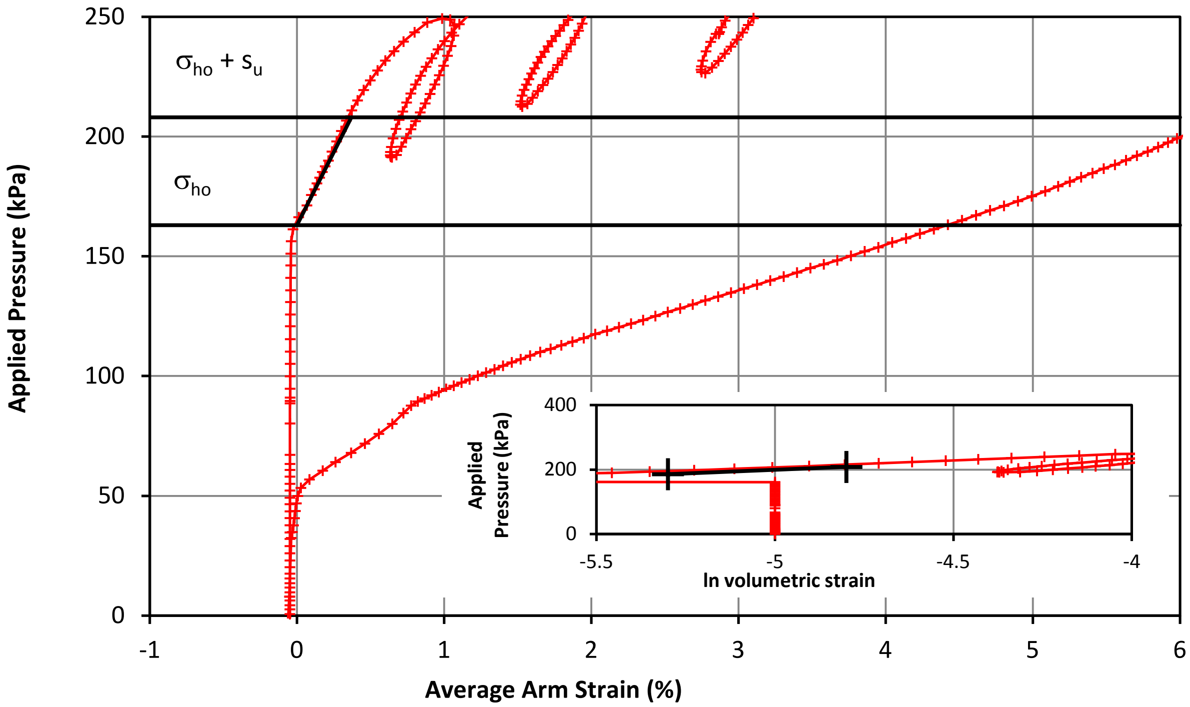
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10



Initial Modulus	Shear Modulus	6.1 MPa



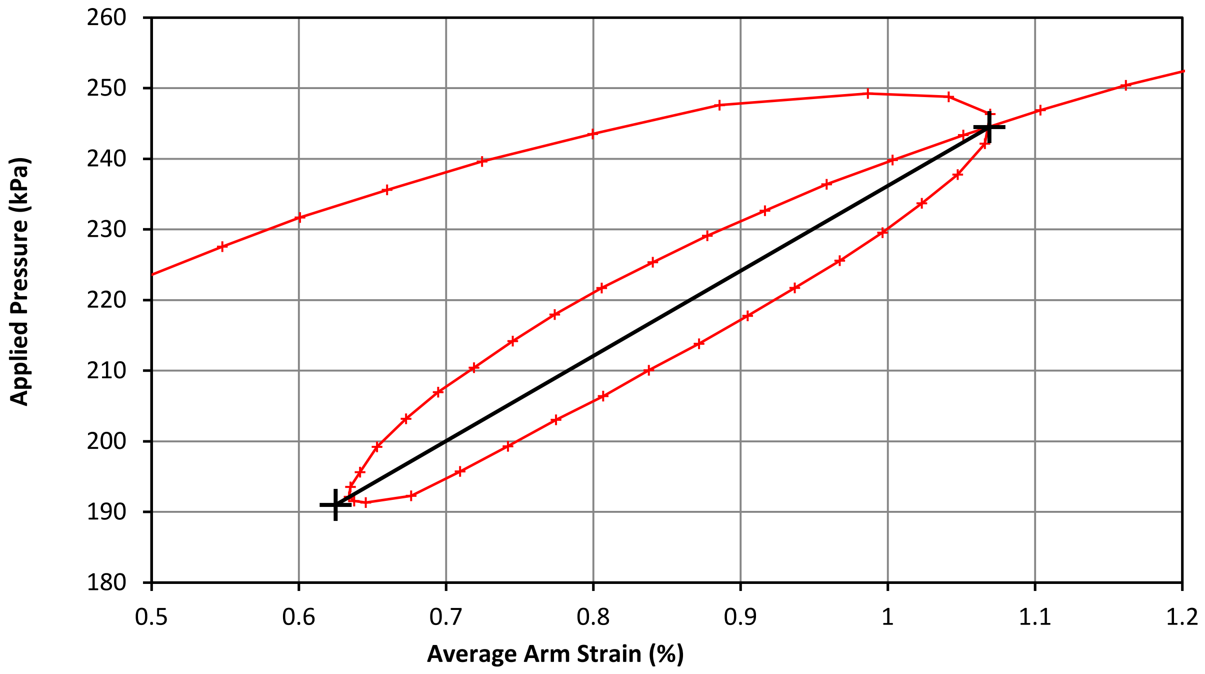
Marsland & Randolph	In situ horizontal stress	163 kPa
	Undrained Strength	45 kPa

Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 03
Client	NGI		
Project No.	P1170112		

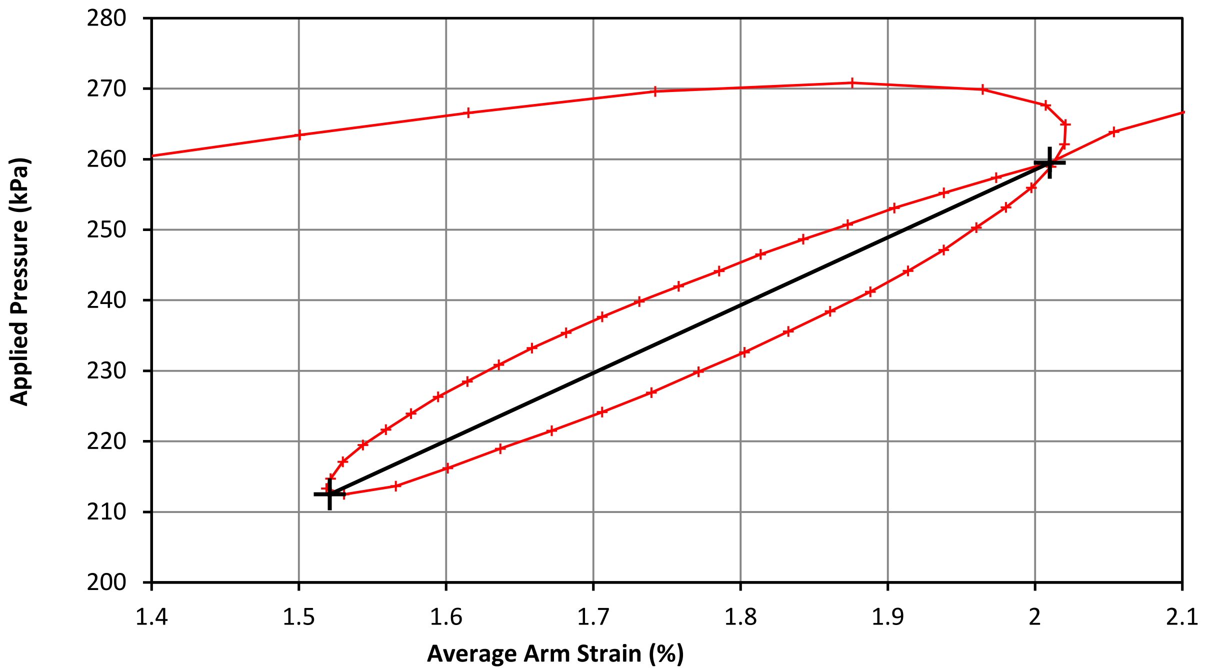
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10



Loop 1	Shear Modulus	6.1 MPa
	Cavity Strain Range	0.444 %



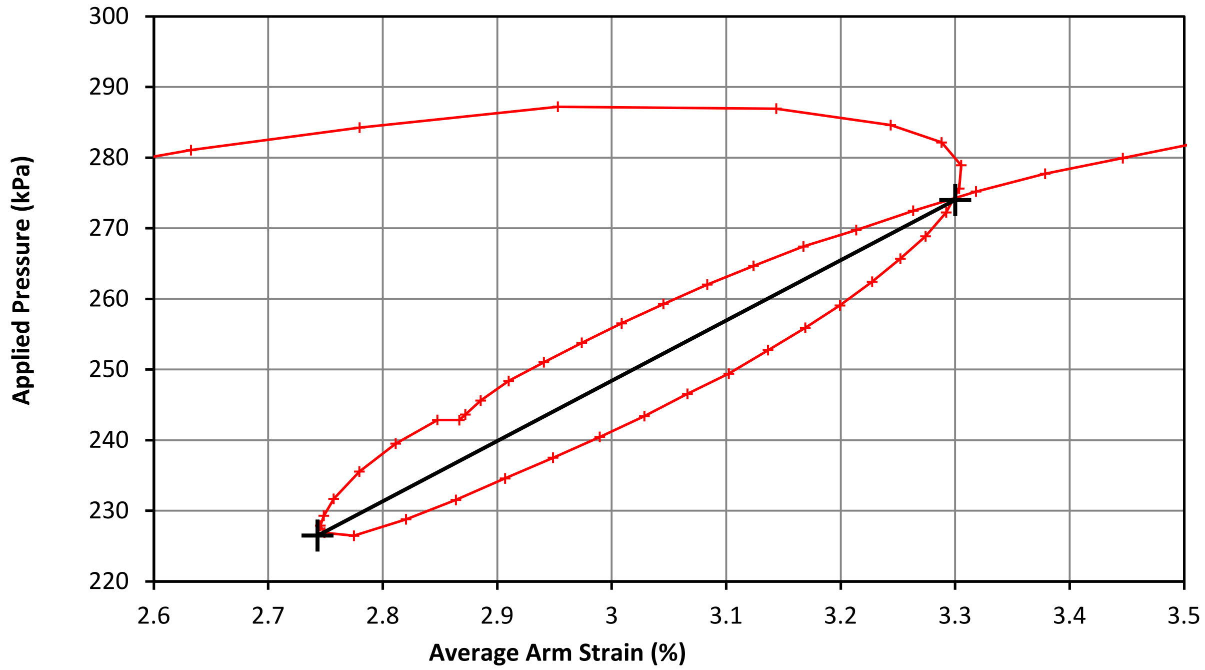
Loop 2	Shear Modulus	4.9 MPa
	Cavity Strain Range	0.489 %

Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 04
Client	NGI		
Project No.	P1170112		

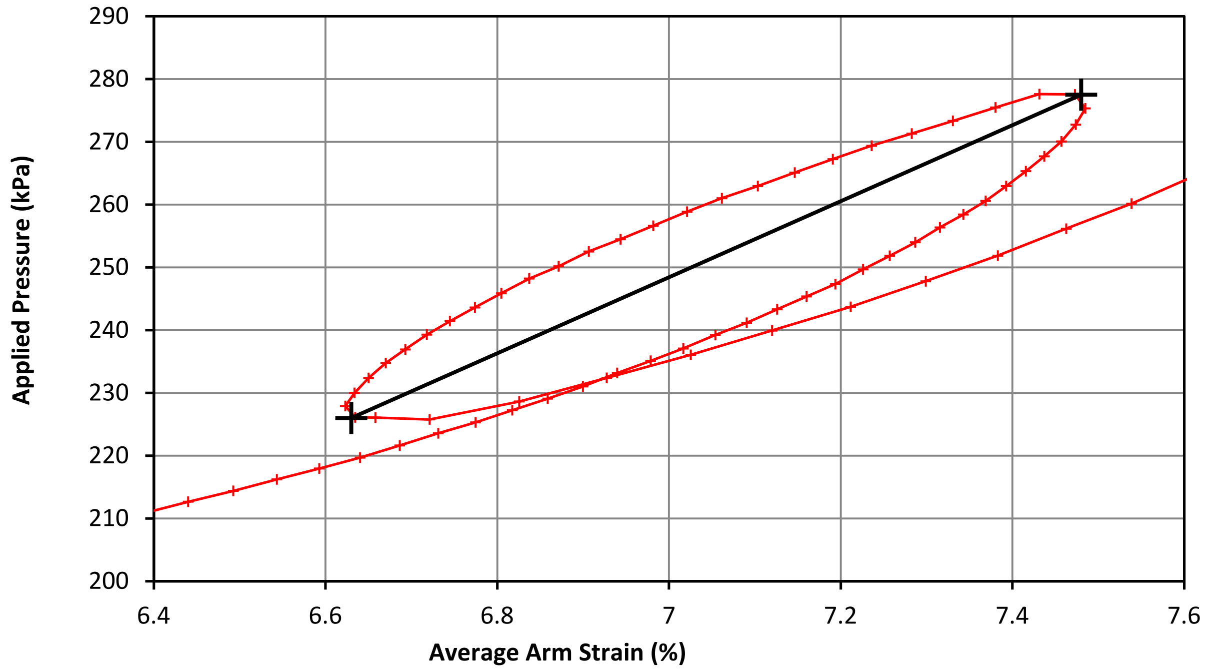
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10



Loop 3	Shear Modulus	4.4 MPa
	Cavity Strain Range	0.557 %



Loop 4	Shear Modulus	3.3 MPa
	Cavity Strain Range	0.850 %

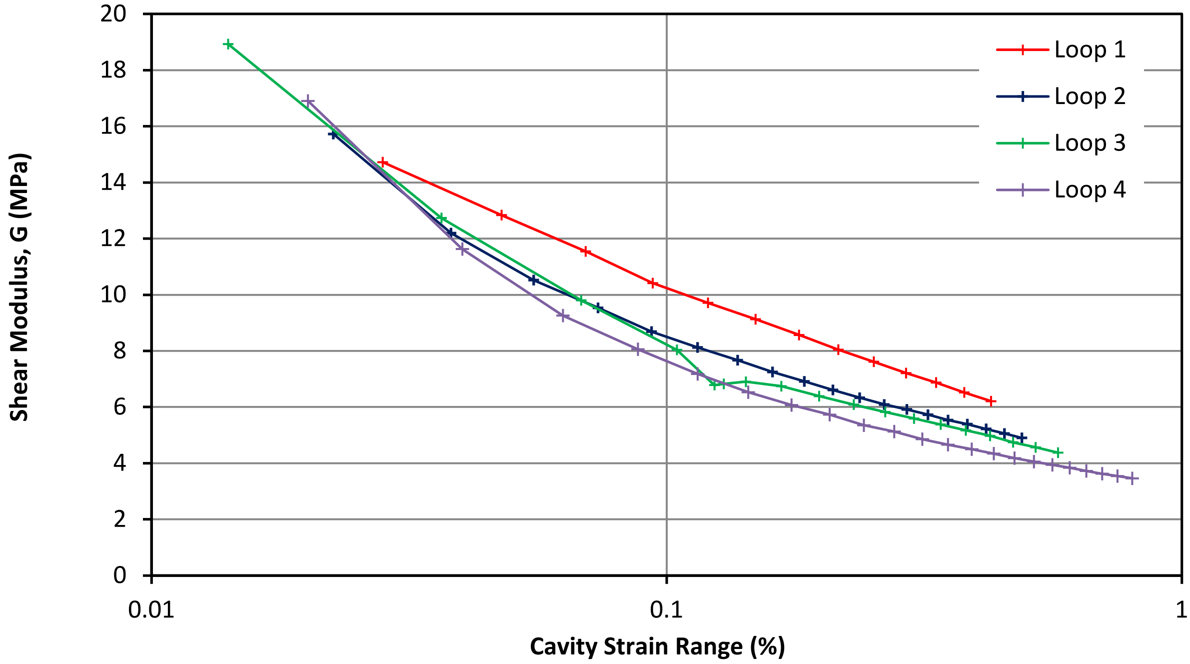
Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 05
Client	NGI		
Project No.	P1170112		

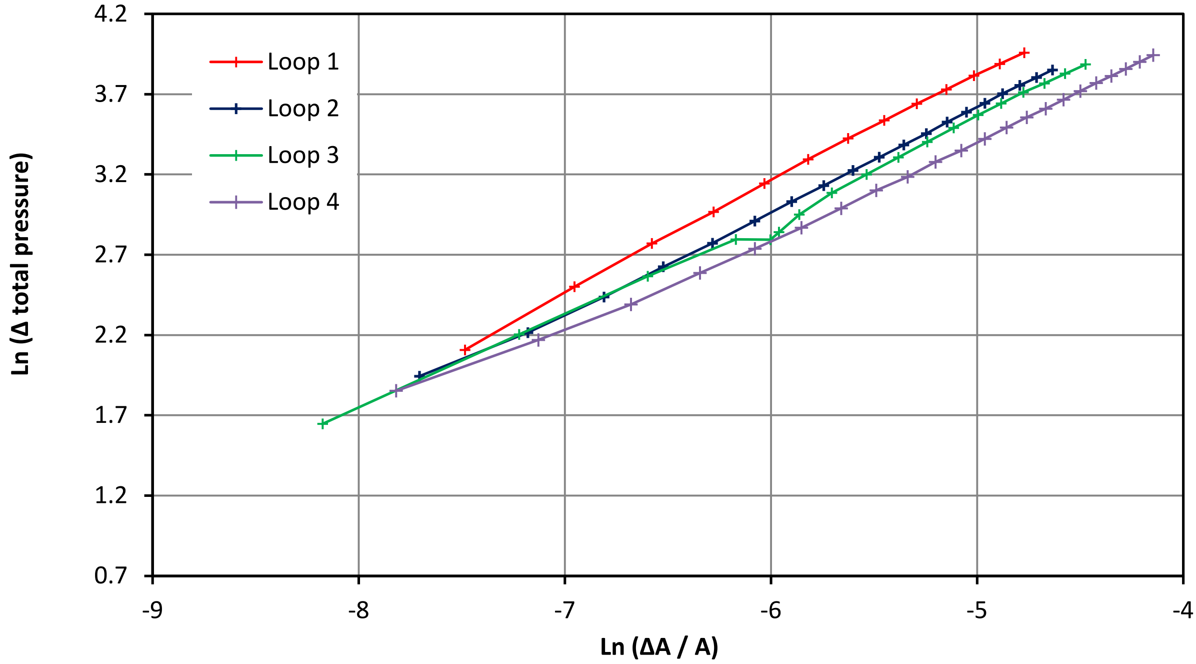
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10





Loop 1		Loop 2		Loop 3		Loop 4	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.681	1.680 (MPa)	0.638	0.900 (MPa)	0.619	0.761 (MPa)	0.589	0.575 (MPa)

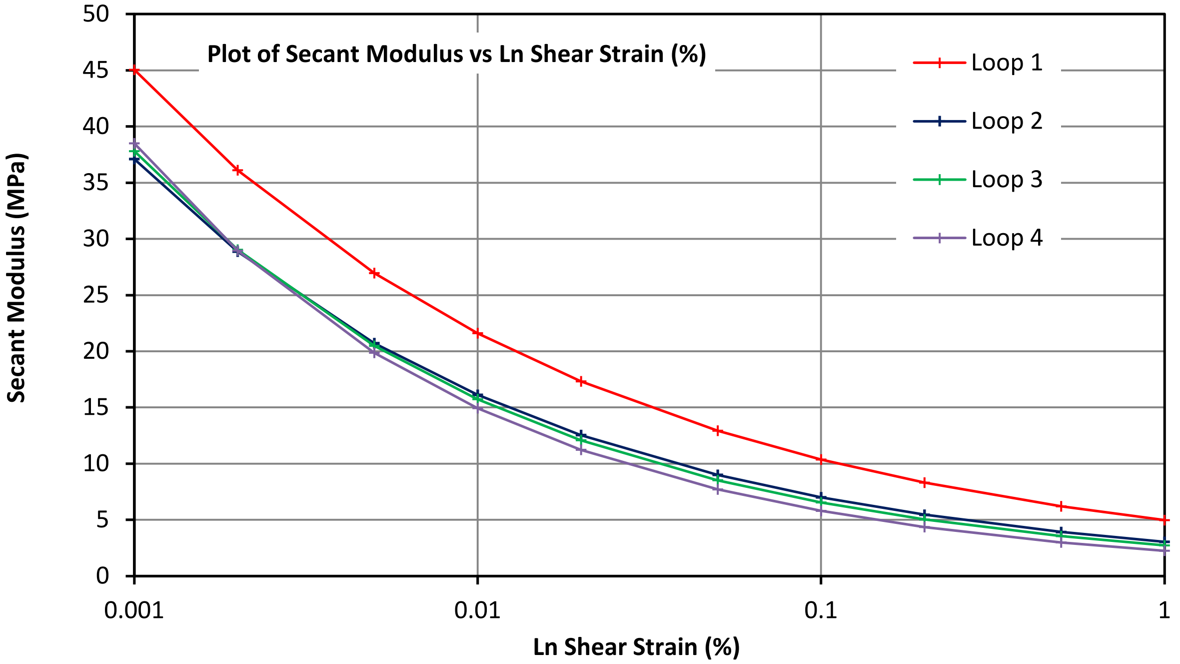
Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 06
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU
SITE INVESTIGATION

Test Date	22/09/2017	Test No.	7
Borehole	ONSP01	Test Depth (m)	12.10



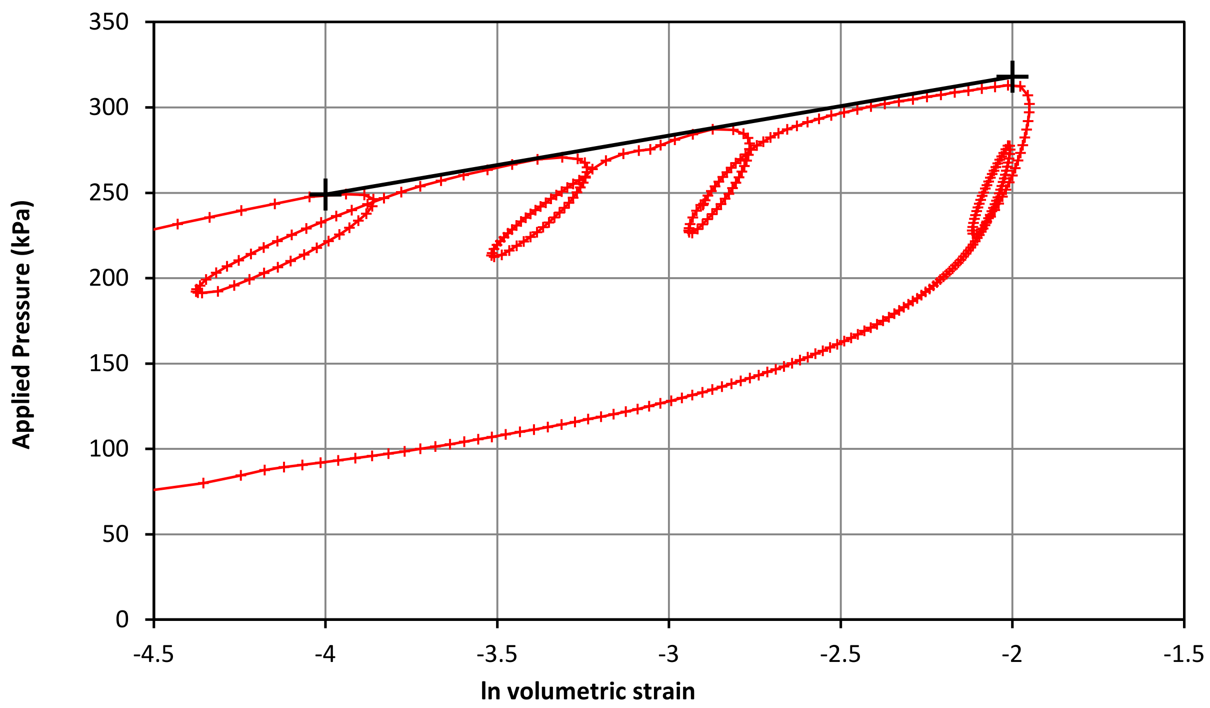
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4
0.001%	**45**	**37**	**38**	**39**
0.002%	36	29	29	29
0.005%	27	21	20	20
0.010%	**22**	**16**	**16**	**15**
0.020%	17	13	12	11
0.050%	13	9	9	8
0.100%	**10**	**7**	**7**	**6**
0.200%	8	5	5	4
0.500%	6	4	4	3
1.000%	**5**	**3**	**3**	**2**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T07 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU
SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	7
Borehole	ONSP01	**Test Depth (m)**	12.10

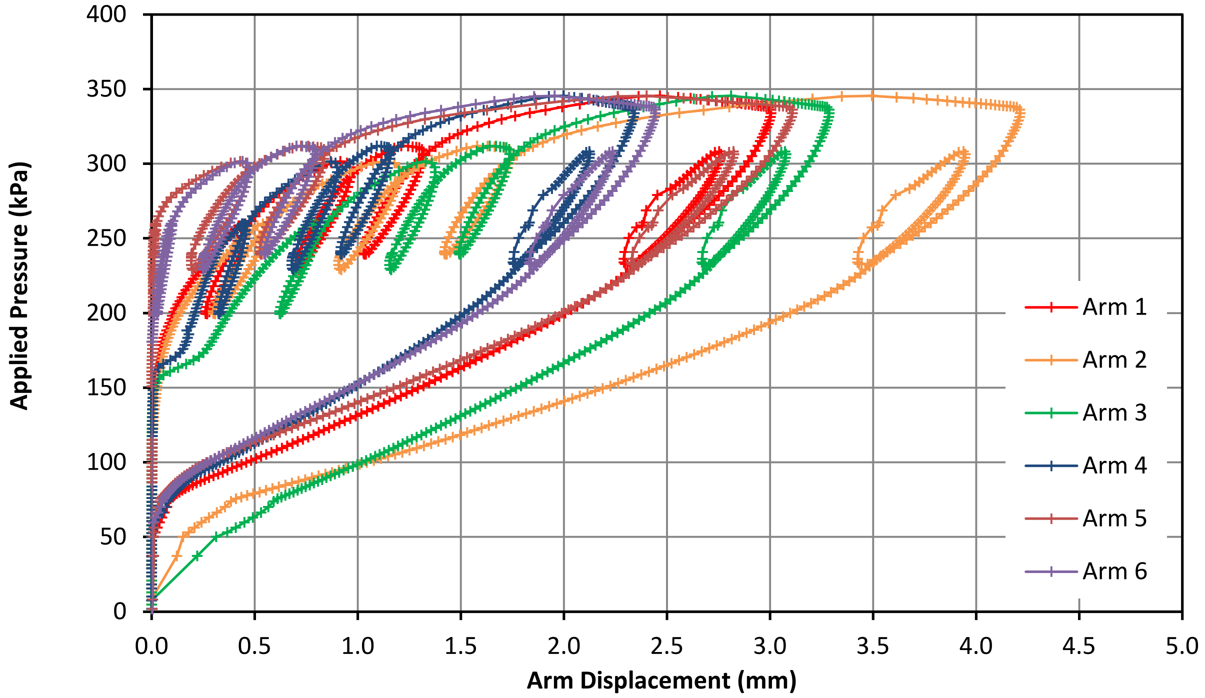


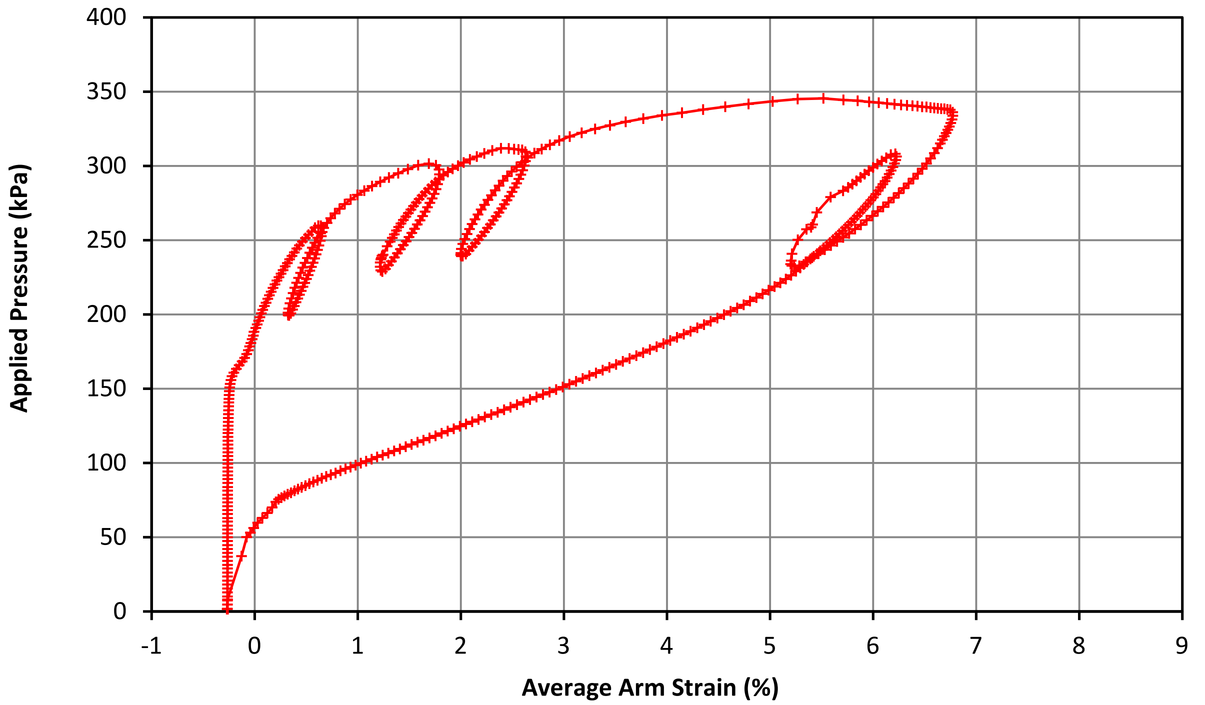
Strength	Undrained Shear	35	kPa
	Limit Pressure	387	kPa

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T07 - 08**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

Test Date	22/09/2017	Test No.	8
Borehole	ONSP01	Test Depth (m)	14.00





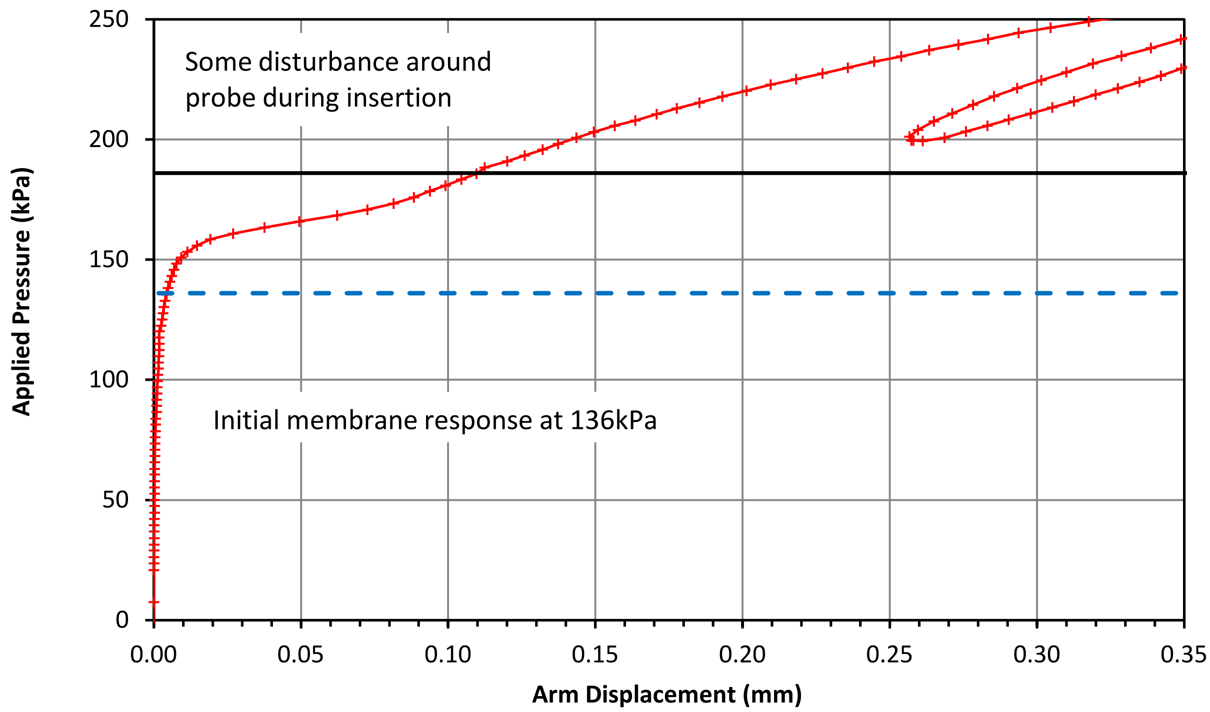
Comments

Project	NGI - Onsøy Site	Figure No.	ONSP01 T08 - 01
Client	NGI		
Project No.	P1170112		

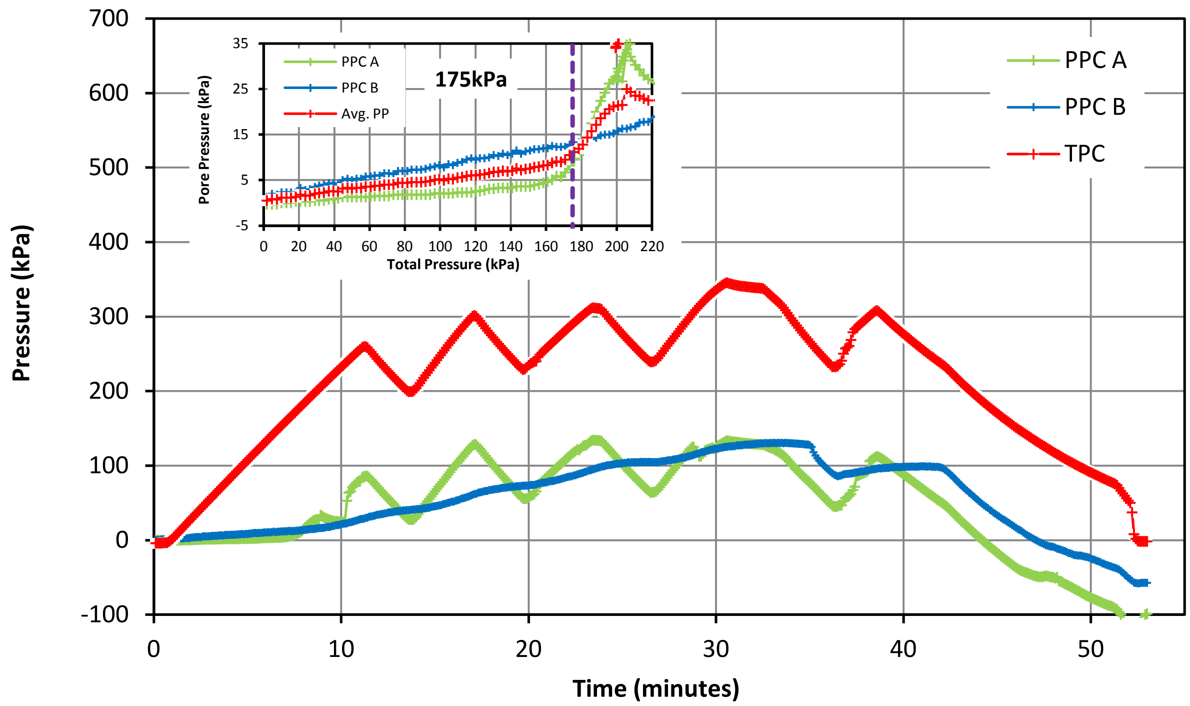
Pressuremeter Test - Lift Off Stress & Pore Pressure Record

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	8
Borehole	ONSP01	**Test Depth (m)**	14.00



Lift Off Stress (Po)	186 kPa

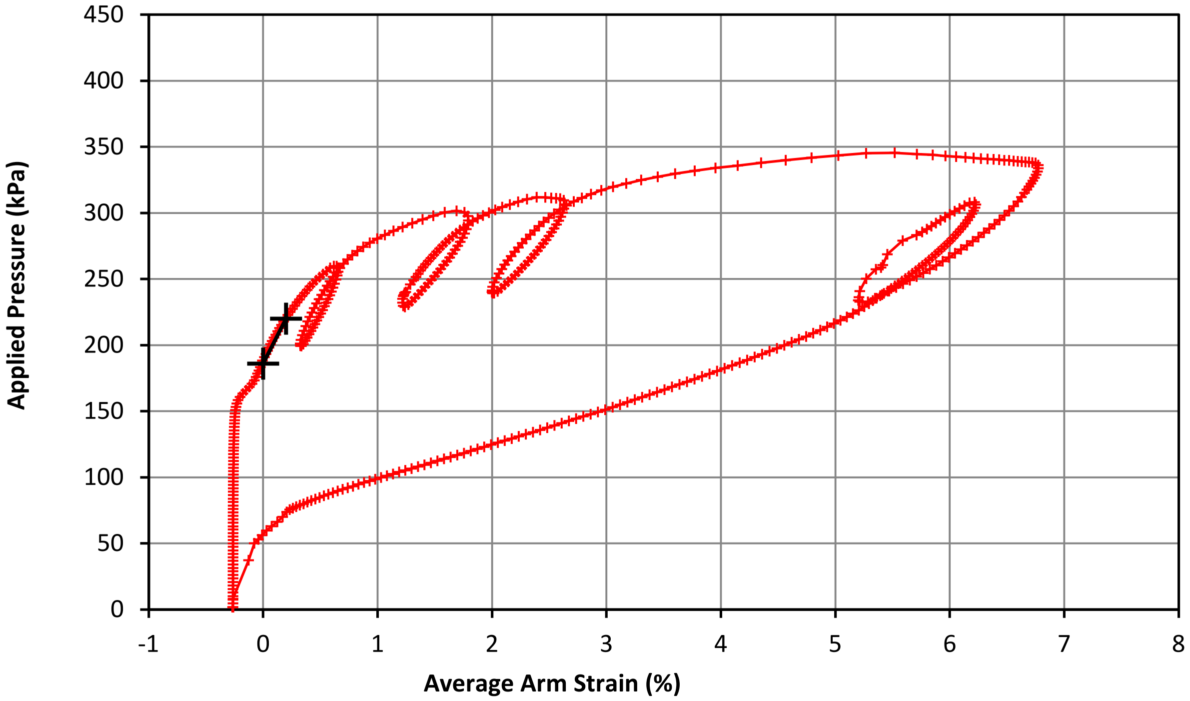


Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T08 - 02**
Client	NGI		
Project No.	P1170112		

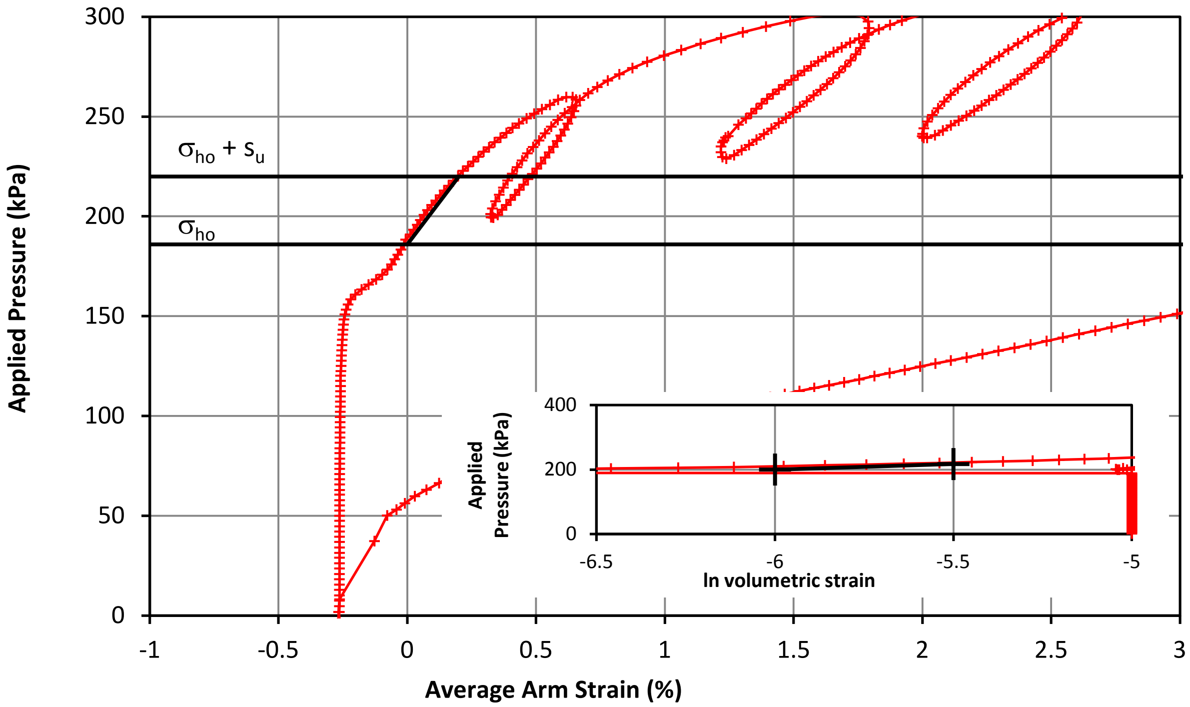
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	8
Borehole	ONSP01	**Test Depth (m)**	14.00



Initial Modulus	Shear Modulus	8.5 MPa



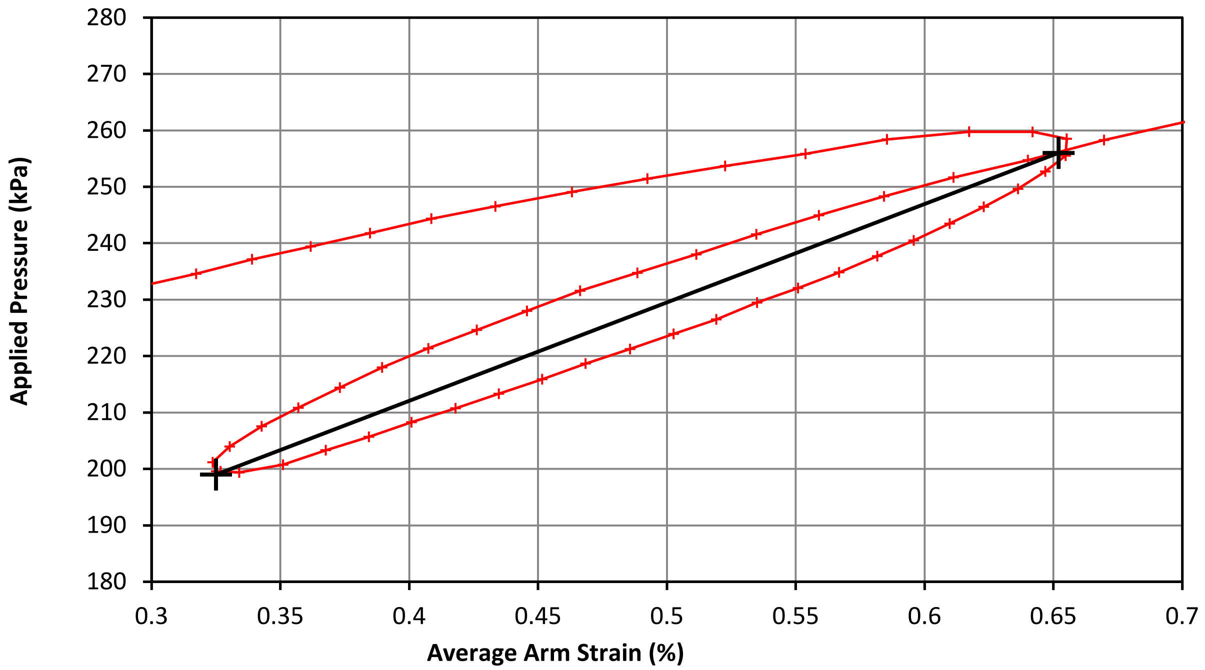
Marsland & Randolph	In situ horizontal stress	186 kPa
	Undrained Strength	34 kPa

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T08 - 03**
Client	NGI		
Project No.	P1170112		

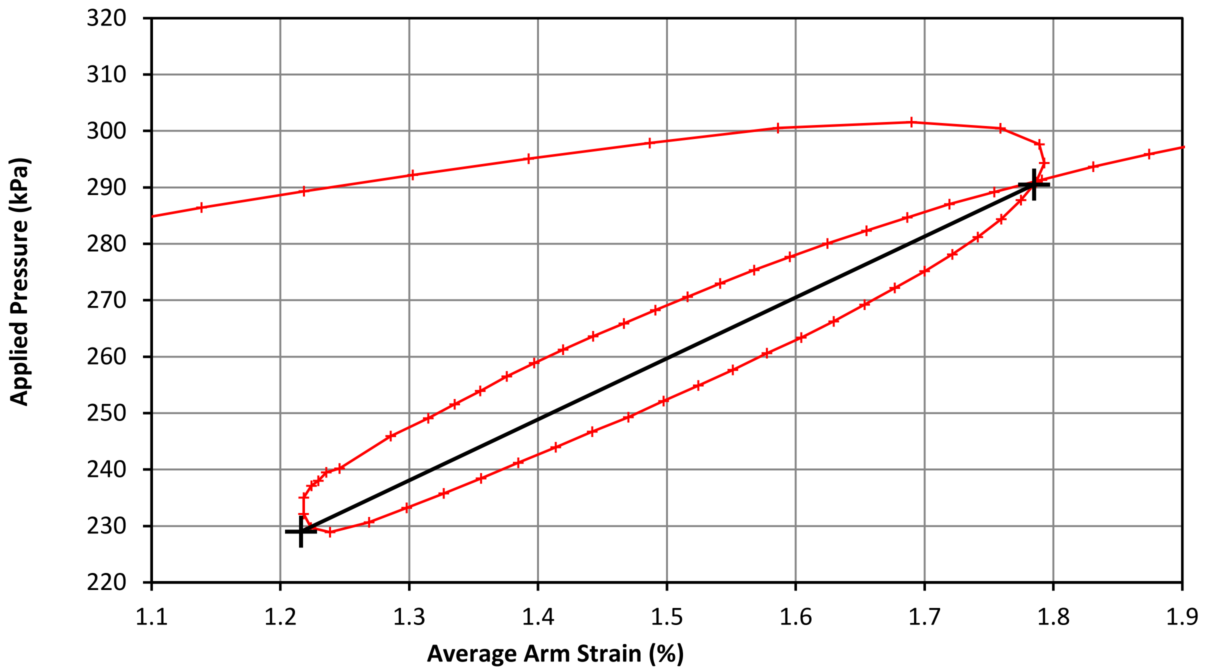
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	8
Borehole	ONSP01	**Test Depth (m)**	14.00



Loop 1	Shear Modulus	8.8 MPa
	Cavity Strain Range	0.327 %



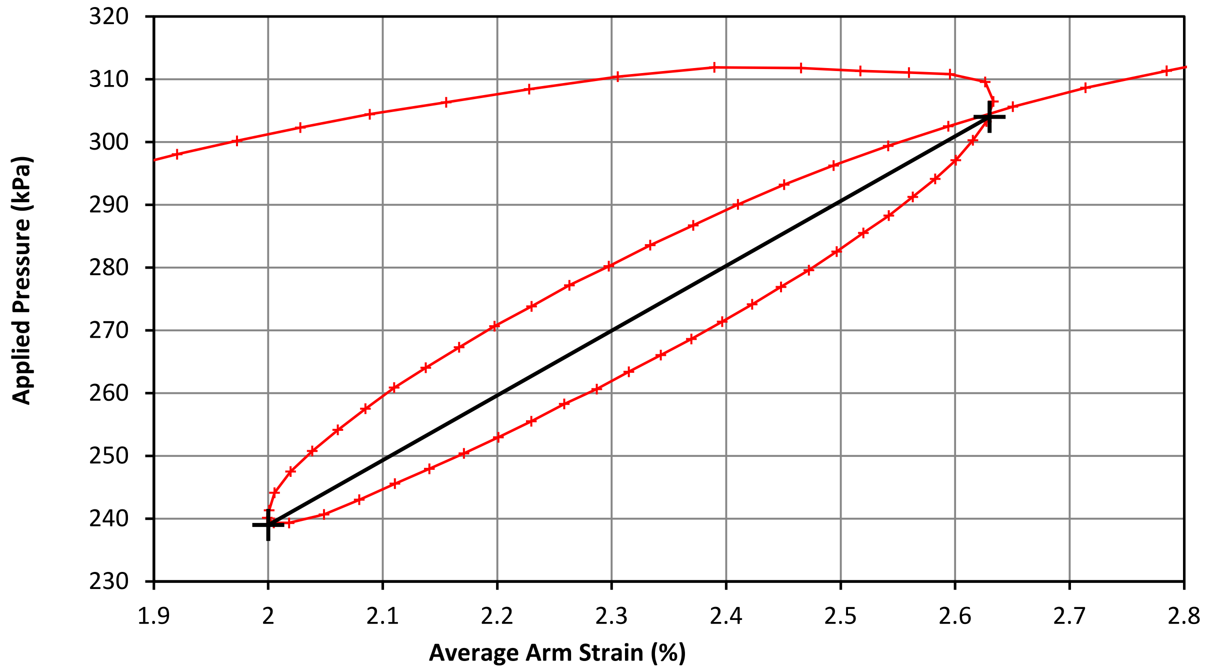
Loop 2	Shear Modulus	5.5 MPa
	Cavity Strain Range	0.569 %

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T08 - 04**
Client	NGI		
Project No.	P1170112		

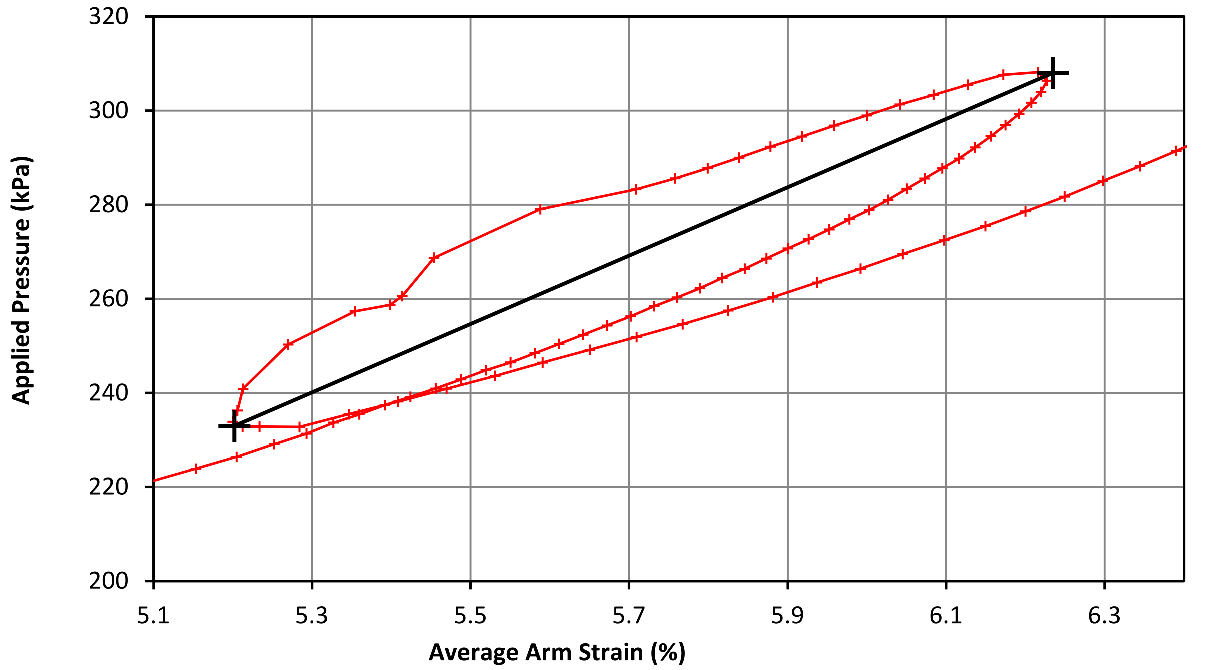
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	8
Borehole	ONSP01	Test Depth (m)	14.00



Loop 3	Shear Modulus	5.3 MPa
	Cavity Strain Range	0.630 %



Loop 4	Shear Modulus	3.9 MPa
	Cavity Strain Range	1.033 %

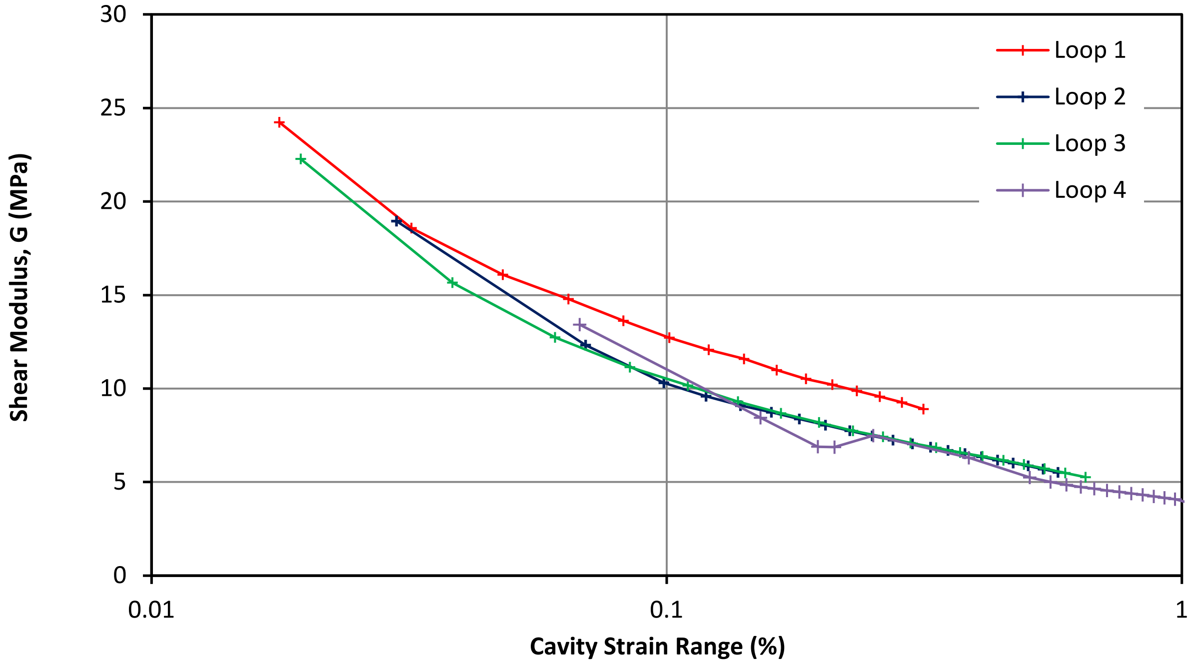
Project	NGI - Onsøy Site	Figure No.	ONSP01 T08 - 05
Client	NGI		
Project No.	P1170112		

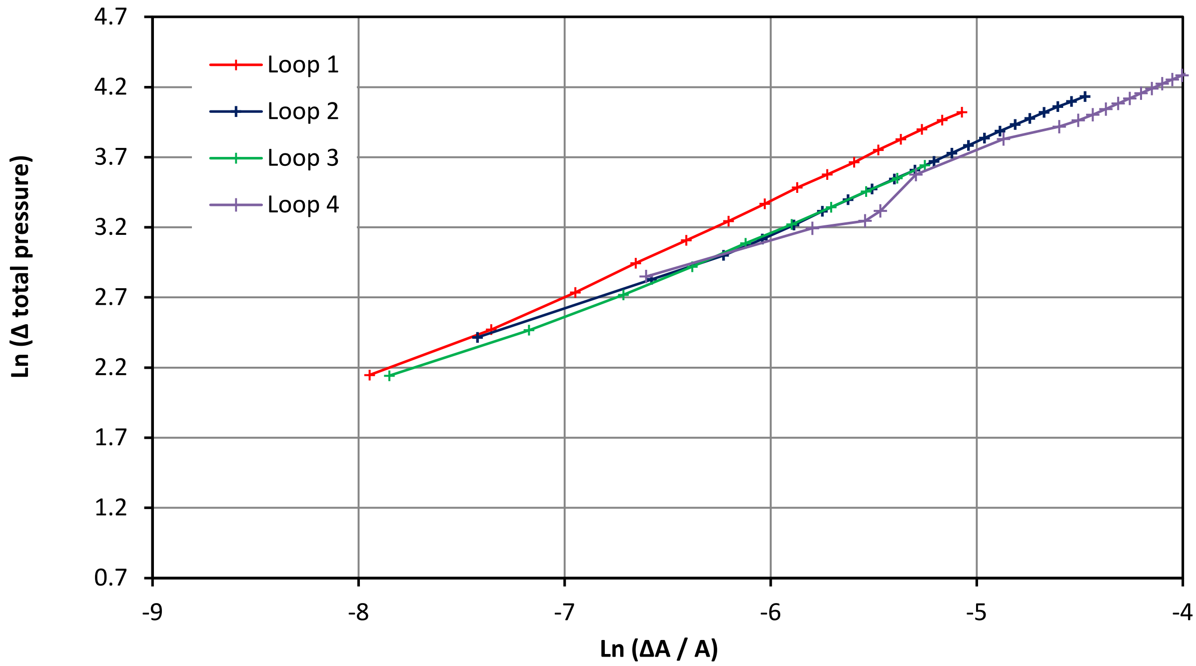
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	8
Borehole	ONSP01	**Test Depth (m)**	14.00





Loop 1		Loop 2		Loop 3		Loop 4	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.668	1.645 (MPa)	0.612	0.956 (MPa)	0.611	0.949 (MPa)	0.584	0.740 (MPa)

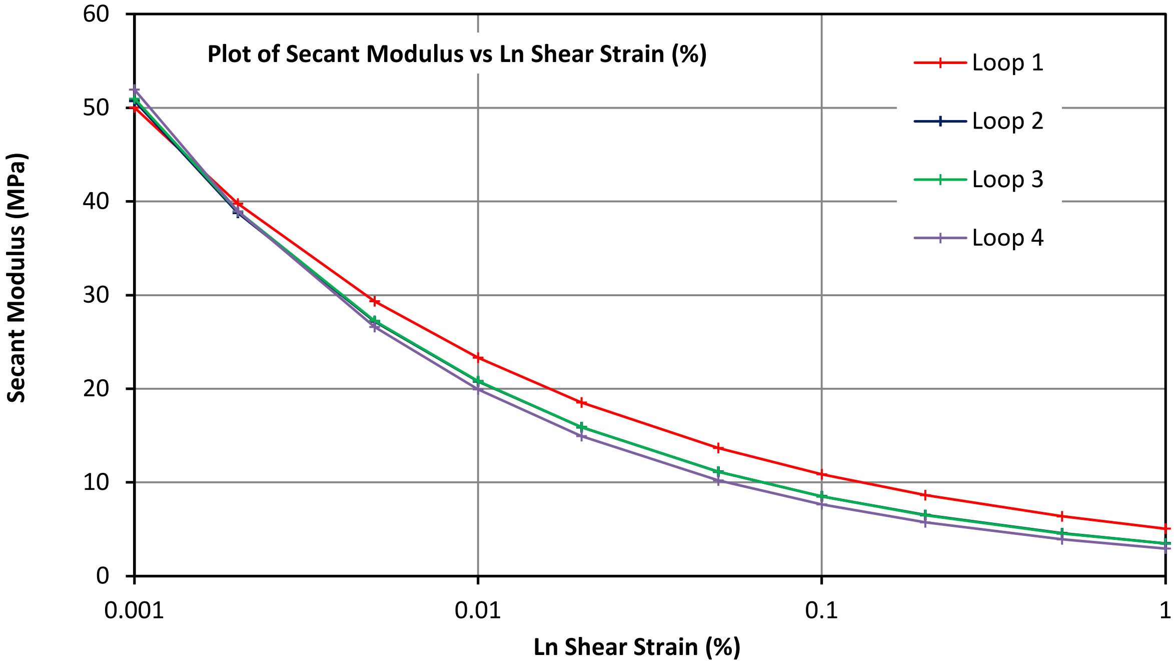
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T08 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	8
Borehole	ONSP01	Test Depth (m)	14.00



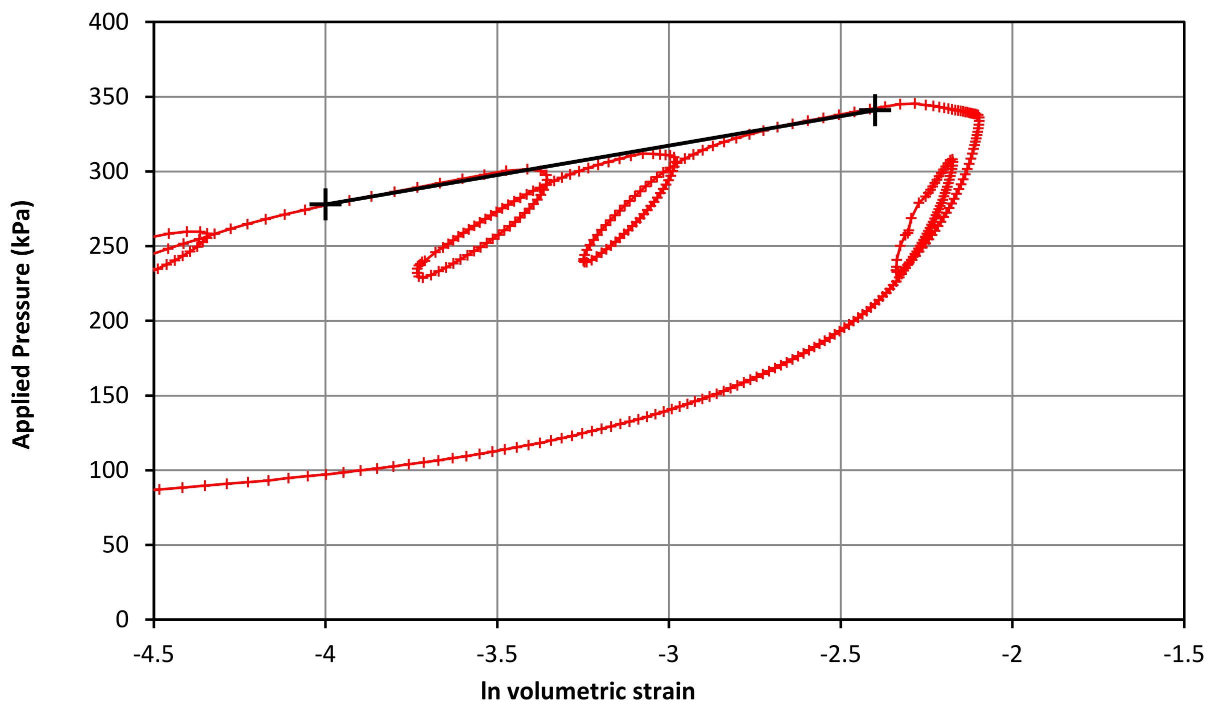
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4
0.001%	**50**	**51**	**51**	**52**
0.002%	40	39	39	39
0.005%	29	27	27	27
0.010%	**23**	**21**	**21**	**20**
0.020%	19	16	16	15
0.050%	14	11	11	10
0.100%	**11**	**9**	**9**	**8**
0.200%	9	7	6	6
0.500%	6	5	5	4
1.000%	**5**	**3**	**3**	**3**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T08 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	8
Borehole	ONSP01	**Test Depth (m)**	14.00



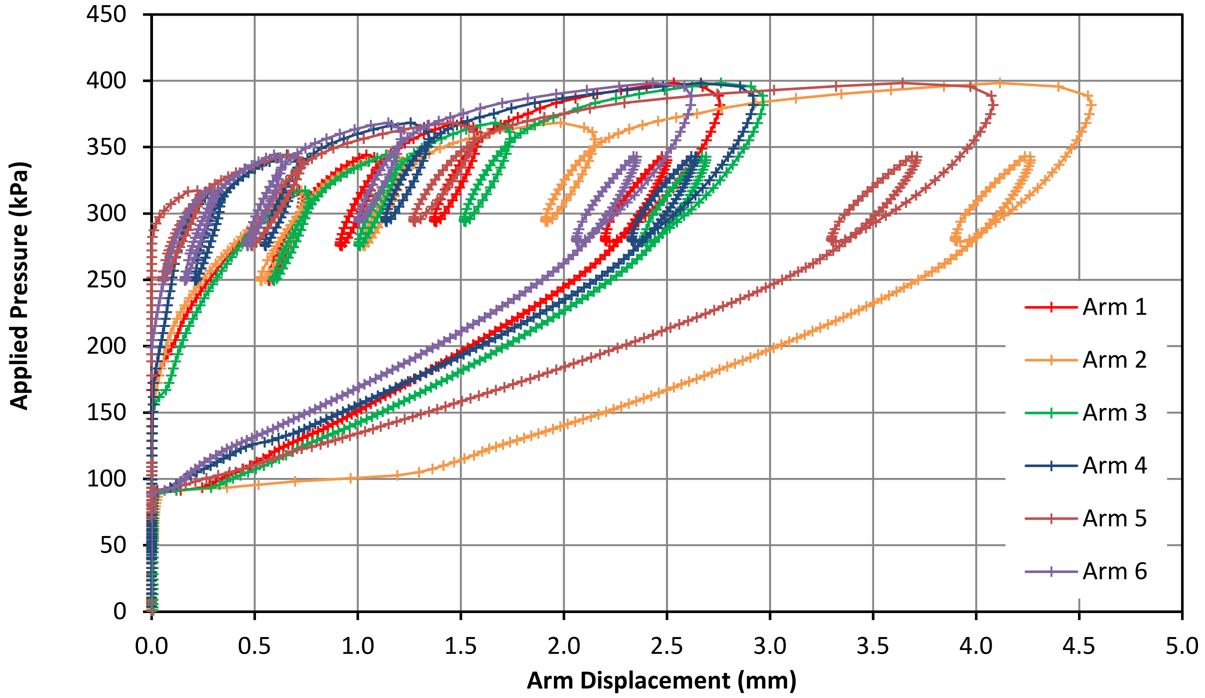
Strength	Undrained Shear	39	kPa
	Limit Pressure	436	kPa

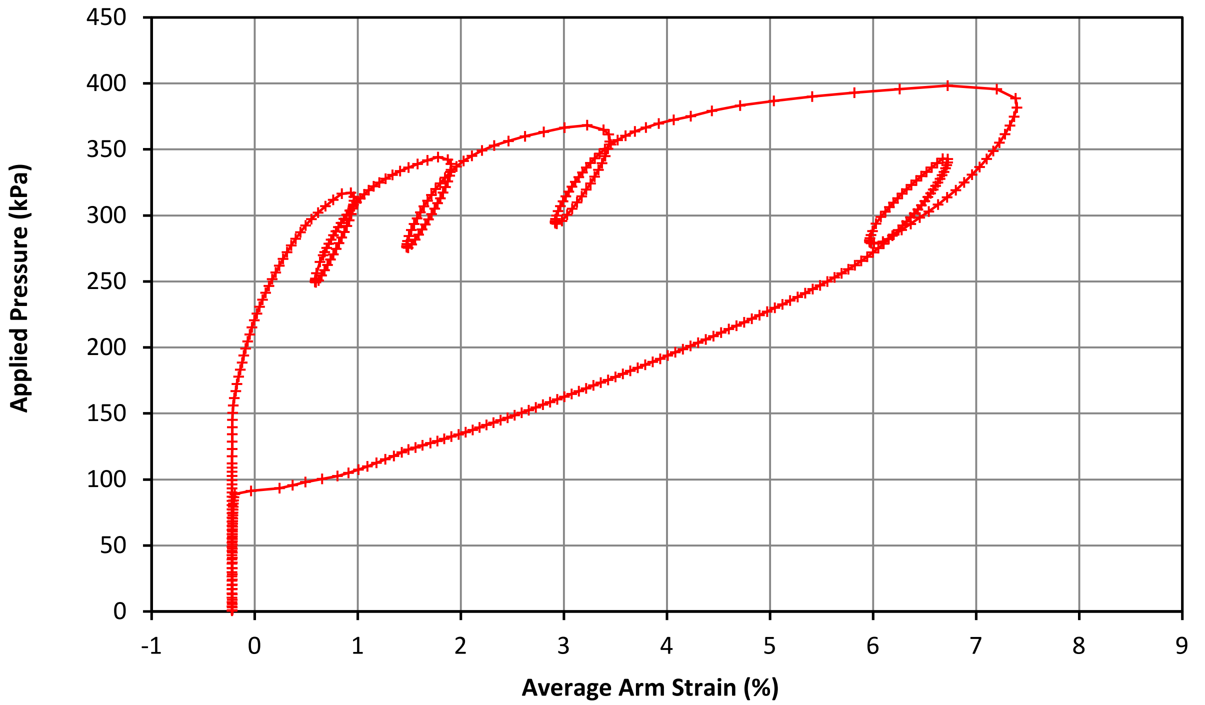
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T08 - 08**
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Overview

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	9
Borehole	ONSP01	Test Depth (m)	16.30



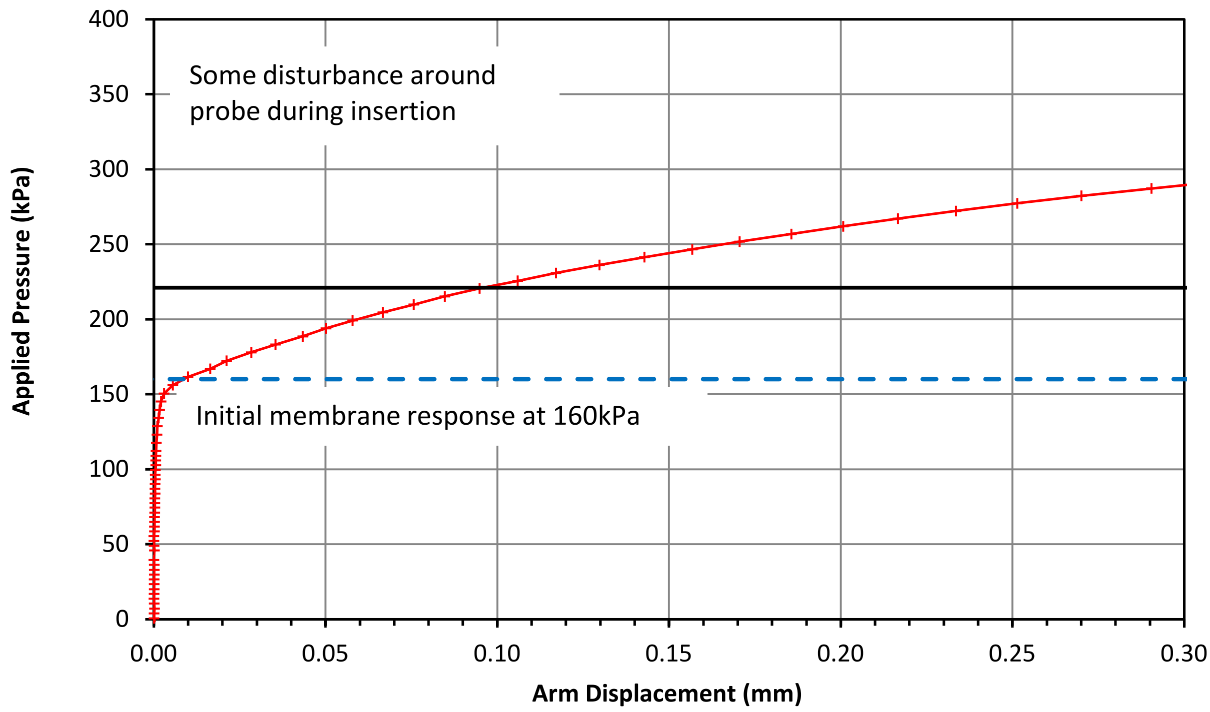


Comments

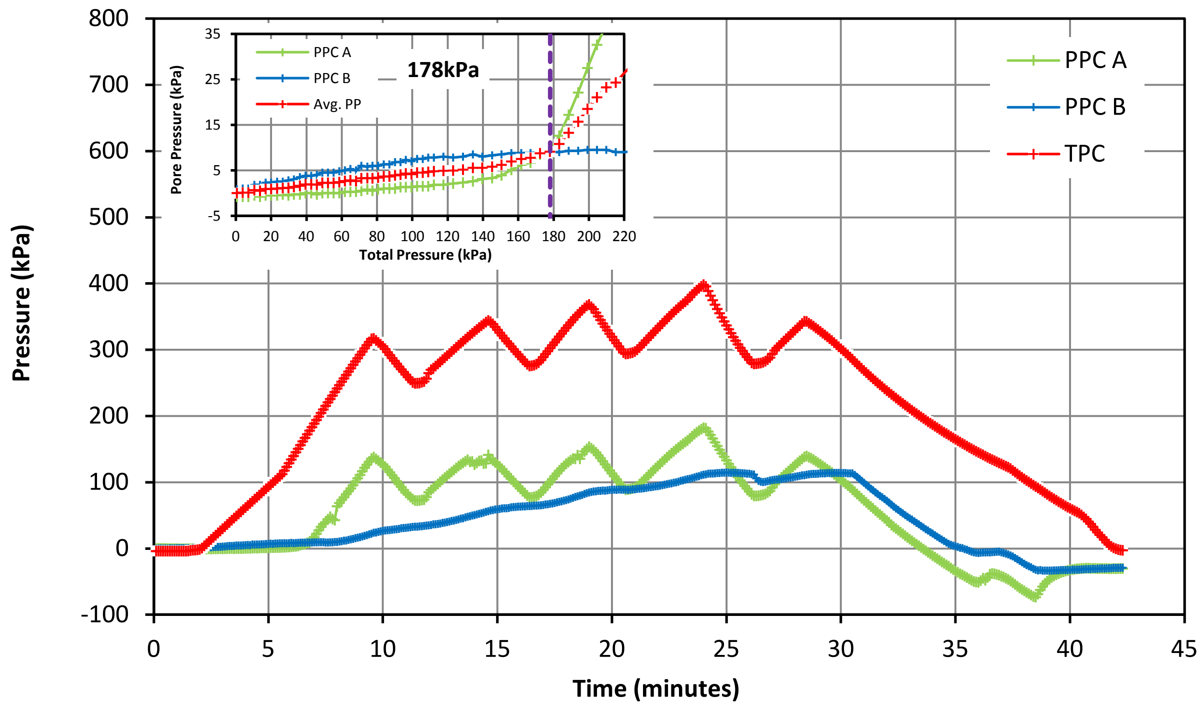
Project	NGI - Onsøy Site	Figure No.	ONSP01 T09 - 01
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Lift Off Stress & Pore Pressure Record

Test Date	22/09/2017	Test No.	9
Borehole	ONSP01	Test Depth (m)	16.30



Lift Off Stress (Po)	221 kPa

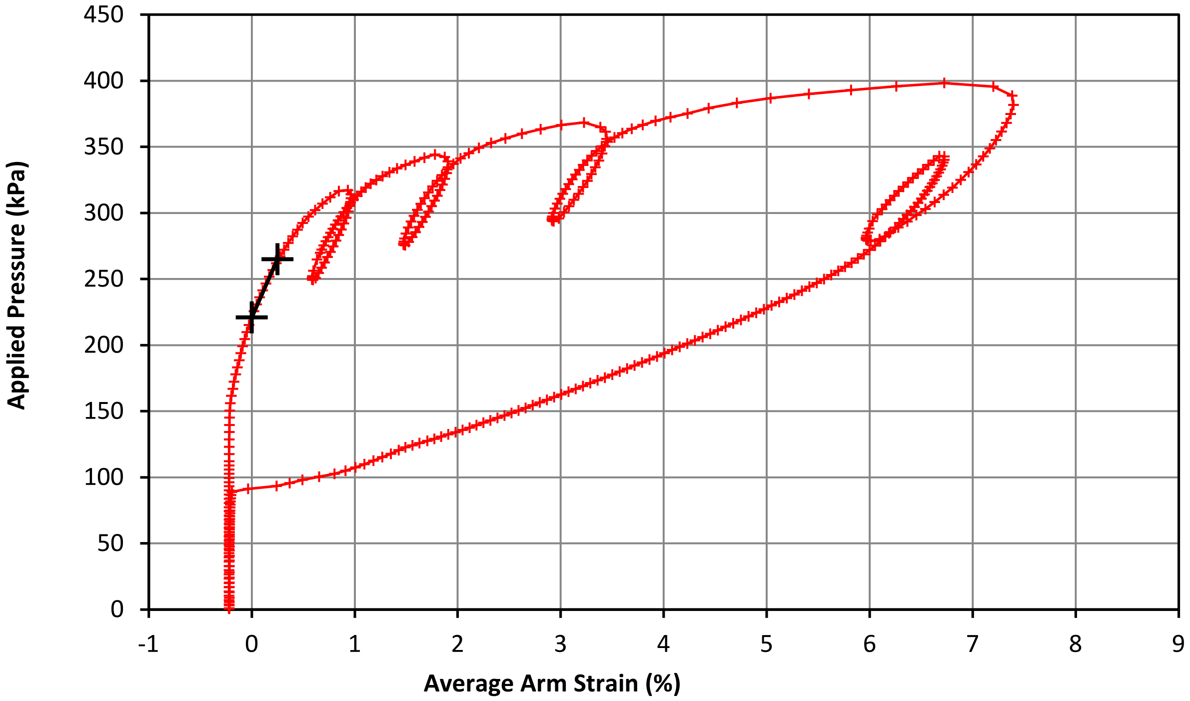


Project	NGI - Onsøy Site	Figure No.	ONSP01 T09 - 02
Client	NGI		
Project No.	P1170112		

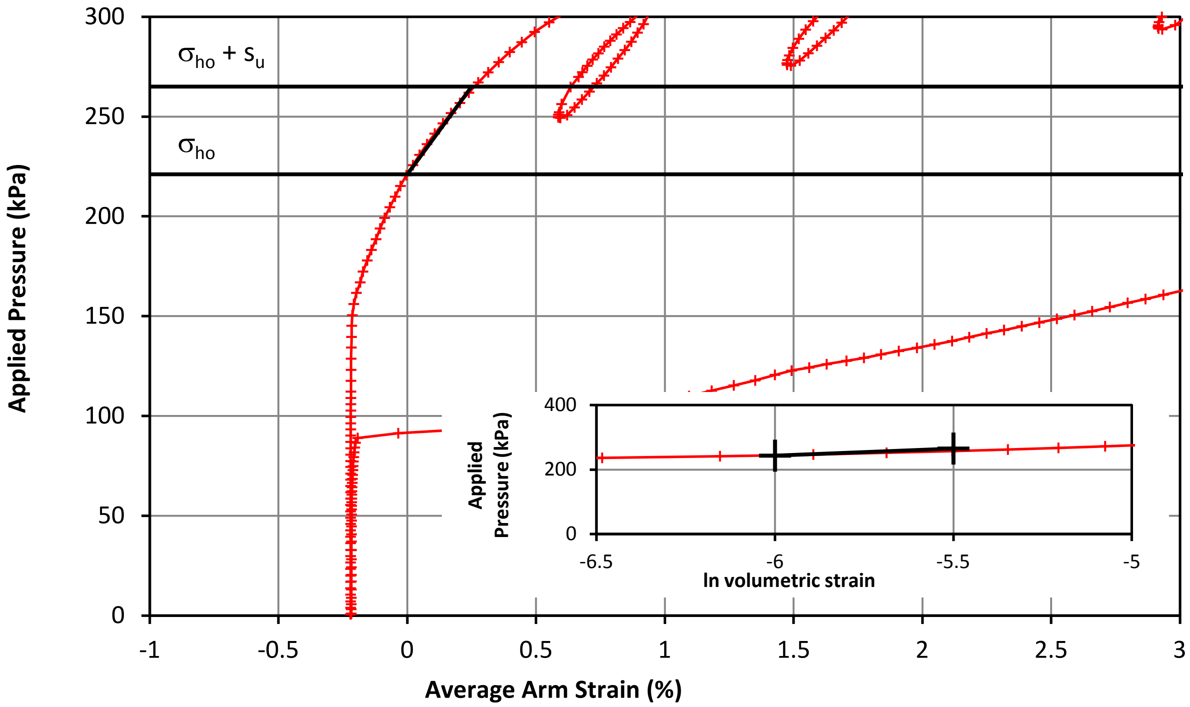
Pressuremeter Test Initial Modulus & In Situ Horizontal Stress

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	Test No.	9
Borehole	ONSP01	Test Depth (m)	16.30



Initial Modulus	Shear Modulus	8.8 MPa

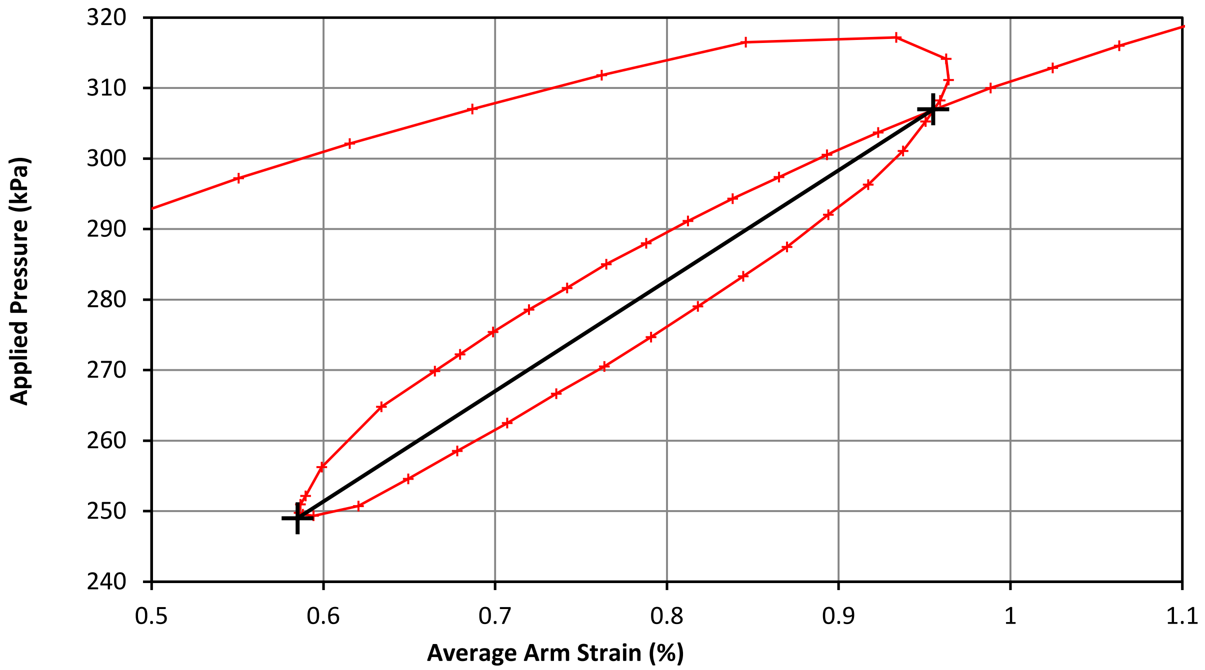


Marsland & Randolph	In situ horizontal stress	221 kPa
	Undrained Strength	44 kPa

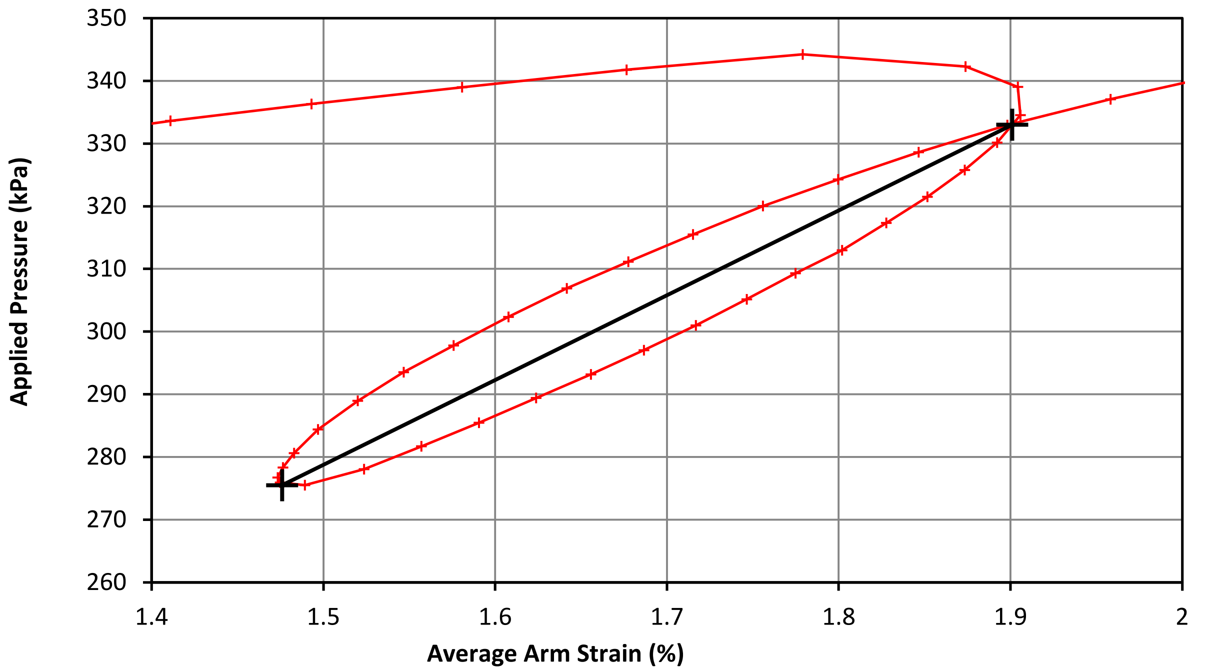
Project	NGI - Onsøy Site	Figure No.	ONSP01 T09 - 03
Client	NGI		
Project No.	P1170112		

Pressuremeter Test Unload Reload Loop

Test Date	22/09/2017	Test No.	9
Borehole	ONSP01	Test Depth (m)	16.30



Loop 1	Shear Modulus	7.9 MPa
	Cavity Strain Range	0.370 %



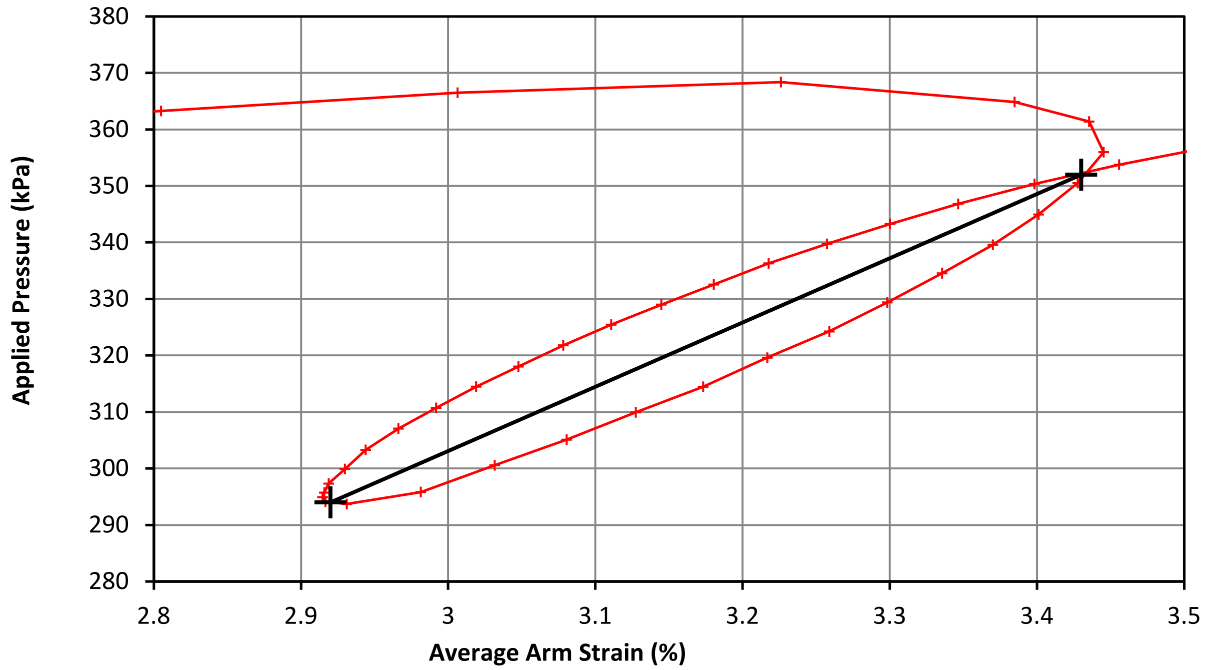
Loop 2	Shear Modulus	6.9 MPa
	Cavity Strain Range	0.425 %

Project	NGI - Onsøy Site	Figure No.	ONSP01 T09 - 04
Client	NGI		
Project No.	P1170112		

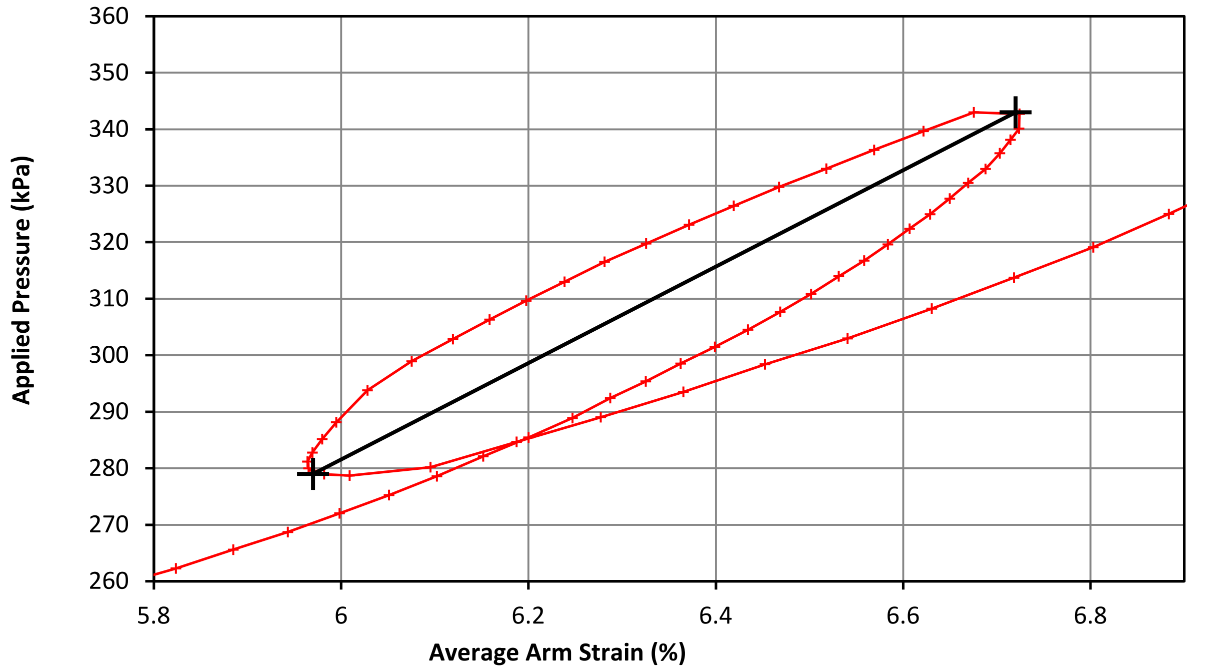
Pressuremeter Test Unload Reload Loop

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	9
Borehole	ONSP01	**Test Depth (m)**	16.30



Loop 3	Shear Modulus	5.9	MPa
	Cavity Strain Range	0.510	%



Loop 4	Shear Modulus	4.6	MPa
	Cavity Strain Range	0.750	%

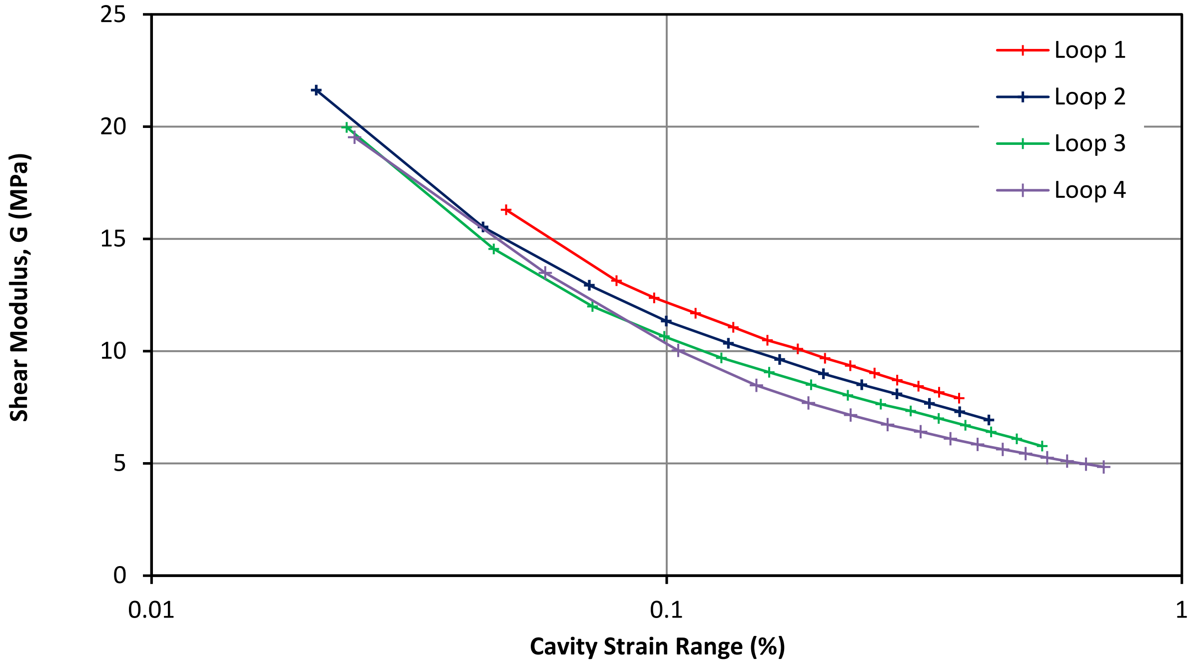
Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T09 - 05**
Client	NGI		
Project No.	P1170112		

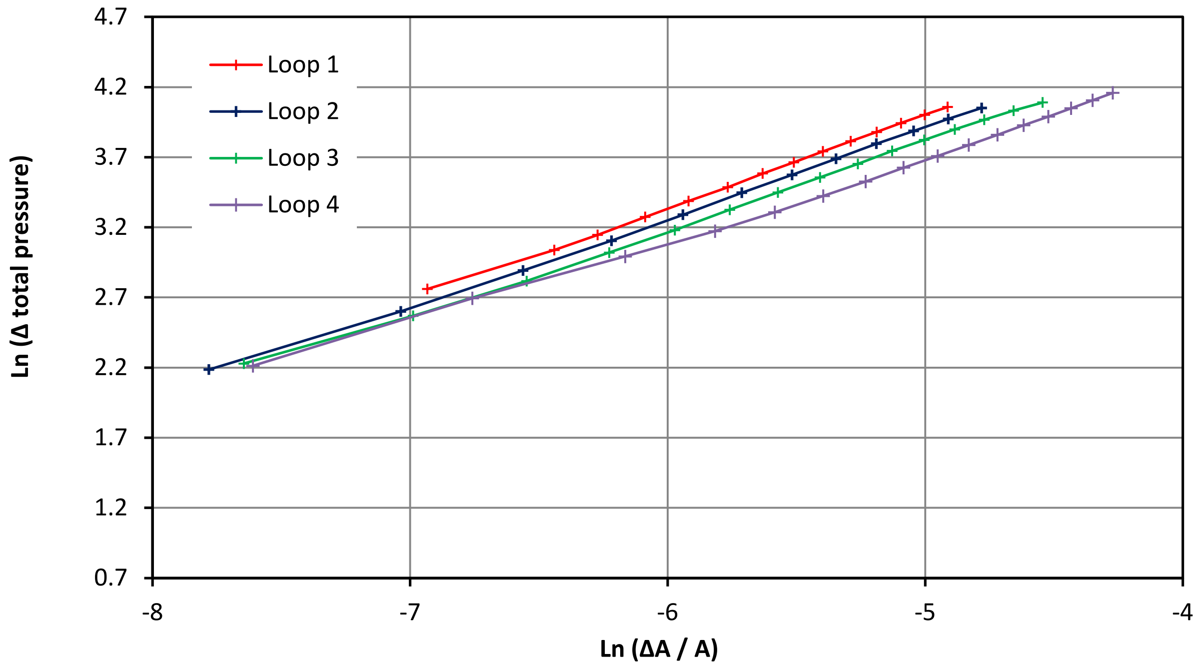
Pressuremeter Analysis

Small Strain Stiffness and Bolton and Whittle (1999)

IN SITU
SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	9
Borehole	ONSP01	**Test Depth (m)**	16.30





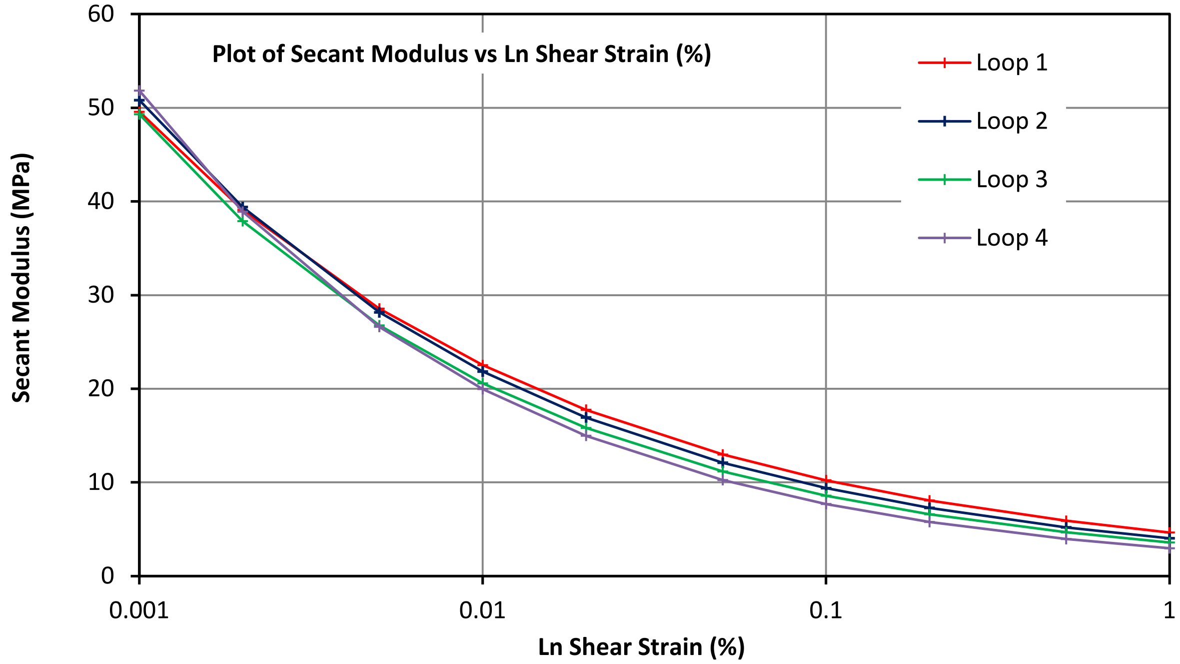
Loop 1		Loop 2		Loop 3		Loop 4	
Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept	Gradient(β)	Intercept
0.657	1.458 (MPa)	0.633	1.176 (MPa)	0.620	1.004 (MPa)	0.586	0.750 (MPa)

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T09 - 06**
Client	NGI		
Project No.	P1170112		

Pressuremeter Analysis

Secant Modulus - Shear Strain (%)

Test Date	22/09/2017	Test No.	9
Borehole	ONSP01	Test Depth (m)	16.30



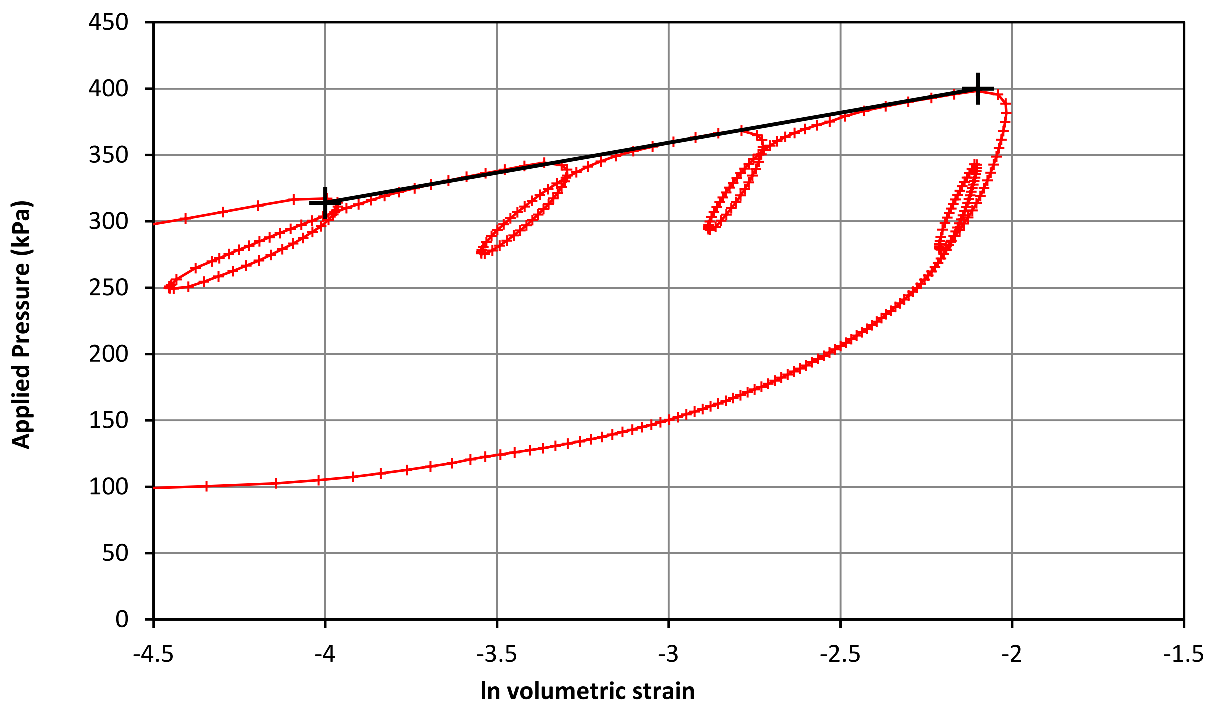
Shear Strain	Loop 1	Loop 2	Loop 3	Loop 4
0.001%	**50**	**51**	**49**	**52**
0.002%	39	39	38	39
0.005%	29	28	27	27
0.010%	**23**	**22**	**21**	**20**
0.020%	18	17	16	15
0.050%	13	12	11	10
0.100%	**10**	**9**	**9**	**8**
0.200%	8	7	7	6
0.500%	6	5	5	4
1.000%	**5**	**4**	**4**	**3**

Project	NGI - Onsøy Site	Figure No.	ONSP01 T09 - 07
Client	NGI		
Project No.	P1170112		

Pressuremeter Test - Strength

IN SITU SITE INVESTIGATION

Test Date	22/09/2017	**Test No.**	9
Borehole	ONSP01	**Test Depth (m)**	16.30



Strength	Undrained Shear	45	kPa
	Limit Pressure	495	kPa

Project	NGI - Onsøy Site	**Figure No.**	**ONSP01 T09 - 08**
Client	NGI		
Project No.	P1170112		

APPENDIX B

Calibrations

Description	Date of Calibration
SBP - Beatrice (pre contract)	08/09/2017
SBP Membrane Calibration	15/09/2017

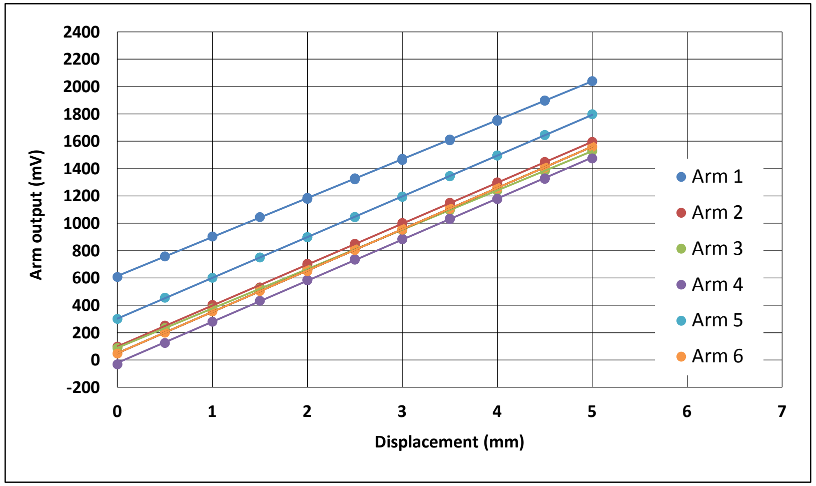
SBP ISSI

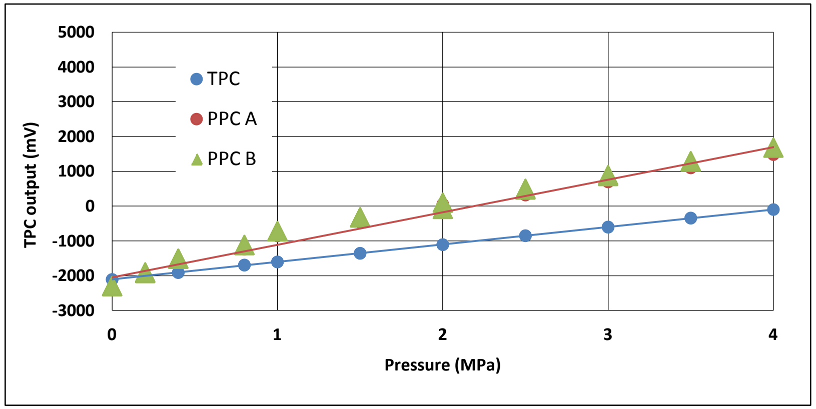
Beatrice - SBP01

IN SITU SITE INVESTIGATION

Arms	08/09/2017					
Displacement	Arm 1	Arm 2	Arm 3	Arm 4	Arm 5	Arm 6
mm	mV	mV	mV	mV	mV	mV
0	607.1	97.8	87.5	-31.7	300.3	47.1
0.5	757.7	251.4	233.7	124.4	455.5	199.9
1	903.2	402.9	376.6	280.1	601.4	354.7
1.5	1045.4	530.8	522.1	433.0	750.0	504.4
2	1186.2	703.9	667.1	587.2	899.2	656.7
2.5	1328.7	849.9	813.0	738.8	1046.6	809.7
3	1471.6	1001.9	955.4	886.1	1195.8	959.7
3.5	1612.7	1150.0	1099.9	1033.7	1345.7	1109.3
4	1755.1	1299.3	1242.8	1179.4	1496.5	1260.3
4.5	1898.2	1448.7	1382.5	1328.2	1645.9	1410.0
5	2039.8	1595.5	1528.6	1474.4	1797.6	1559.5
4.5	1896.5	1443.7	1381.2	1324.9	1645.1	1406.4
4	1749.0	1293.3	1238.5	1176.8	1495.2	1254.9
3.5	1607.2	1142.6	1094.7	1029.4	1343.6	1106.2
3	1463.0	993.5	948.9	883.0	1193.1	953.4
2.5	1321.6	843.8	807.1	733.8	1044.4	804.2
2	1178.6	694.7	662.1	582.6	897.4	649.9
1.5	1035.8	546.3	518.2	429.8	749.1	497.8
1	895.8	395.8	374.4	275.4	600.7	347.6
0.5	753.6	246.0	230.6	121.9	452.9	195.8
0	608.6	94.1	86.6	-33.9	305.8	45.1
Slope (mV/mm)	285.6	299.9	288.1	301.3	298.1	302.7
Zero (mV)	611.292	96.721	88.031	-24.123	302.596	47.526

Pressure Cells	08/09/2017		
Pressure	TPC	PPC A	PPC B
MPa	mV	mV	mV
0.0	-2111.0	-2394.4	-2300.9
0.2	-2011.9	-2001.0	-1903.2
0.4	-1912.0	-1616.2	-1511.5
0.8	-1699.3	-1231.0	-1116.1
1.0	-1602.6	-846.4	-718.9
1.5	-1360.1	-464.4	-326.0
2.0	-1110.2	-70.0	-80.0
2.5	-848.3	316.0	477.0
3.0	-608.8	693.0	866.0
3.5	-348.7	1097.0	1280.0
4.0	-99.2	1480.0	1682.0
3.5	-340.6	1106.5	1292.0
3.0	-598.1	717.0	892.0
2.5	-854.4	335.0	500.1
2.0	-1105.7	56.6	99.6
1.5	-1353.5	-464.5	-320.2
1.0	-1607.3	-858.0	-726.0
0.8	-1691.9	-1239.0	-1120.0
0.4	-1910.5	-1619.0	-1510.0
0.2	-2009.5	-2022.5	-1925.0
0.0	-2108.1	-2388.8	-2297.3
Slope (mV/MPa)	502.8	935.4	958.5
Zero (mV)	-2108.9	-2049.1	-1960.2



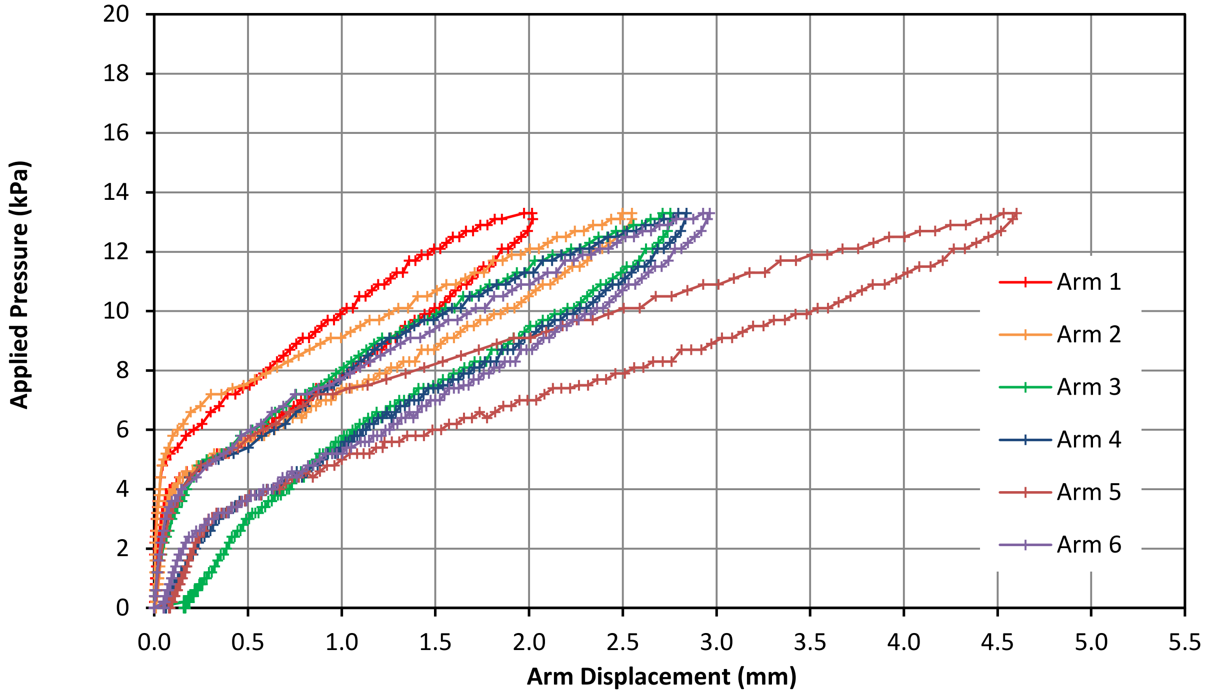


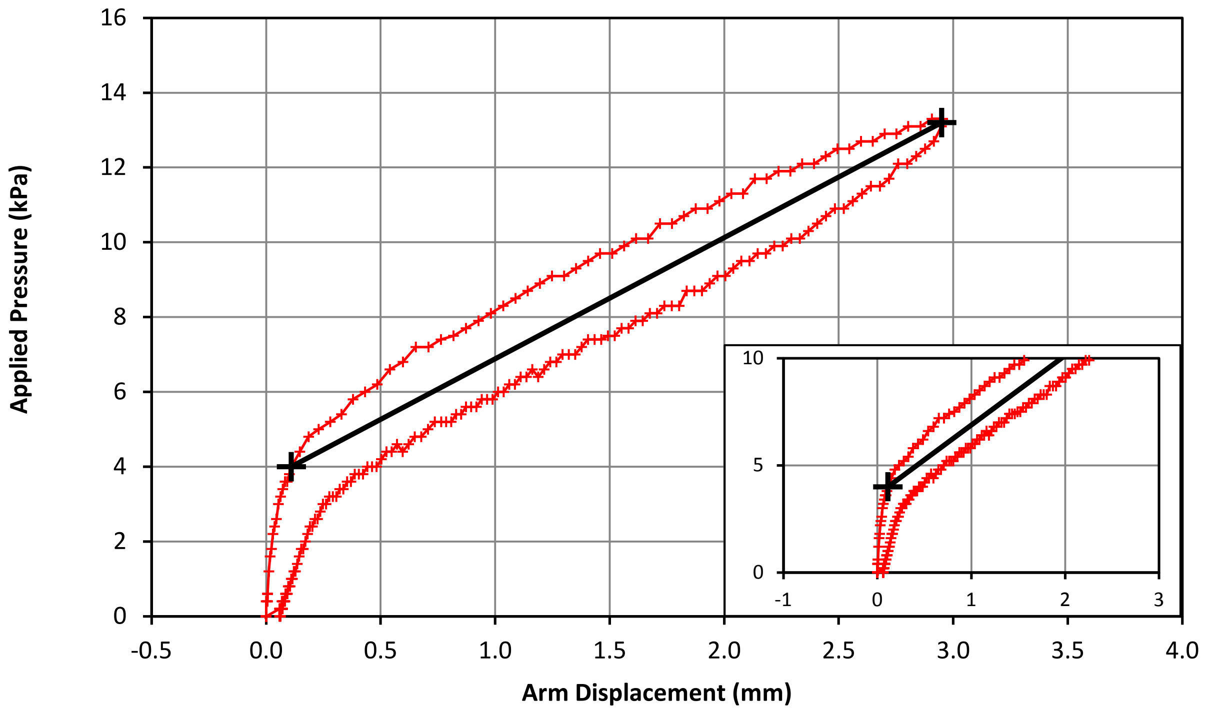
Calibrated by:	Dave Lewins
Calibrated at:	Rensihaw, Sheffield
Checked by:	Rob Cooke
Date:	08/09/2017

Membrane Calibration Beatrice (SBP01)

IN SITU SITE INVESTIGATION

Calibration Date	15/09/2017
Borehole	HALP01



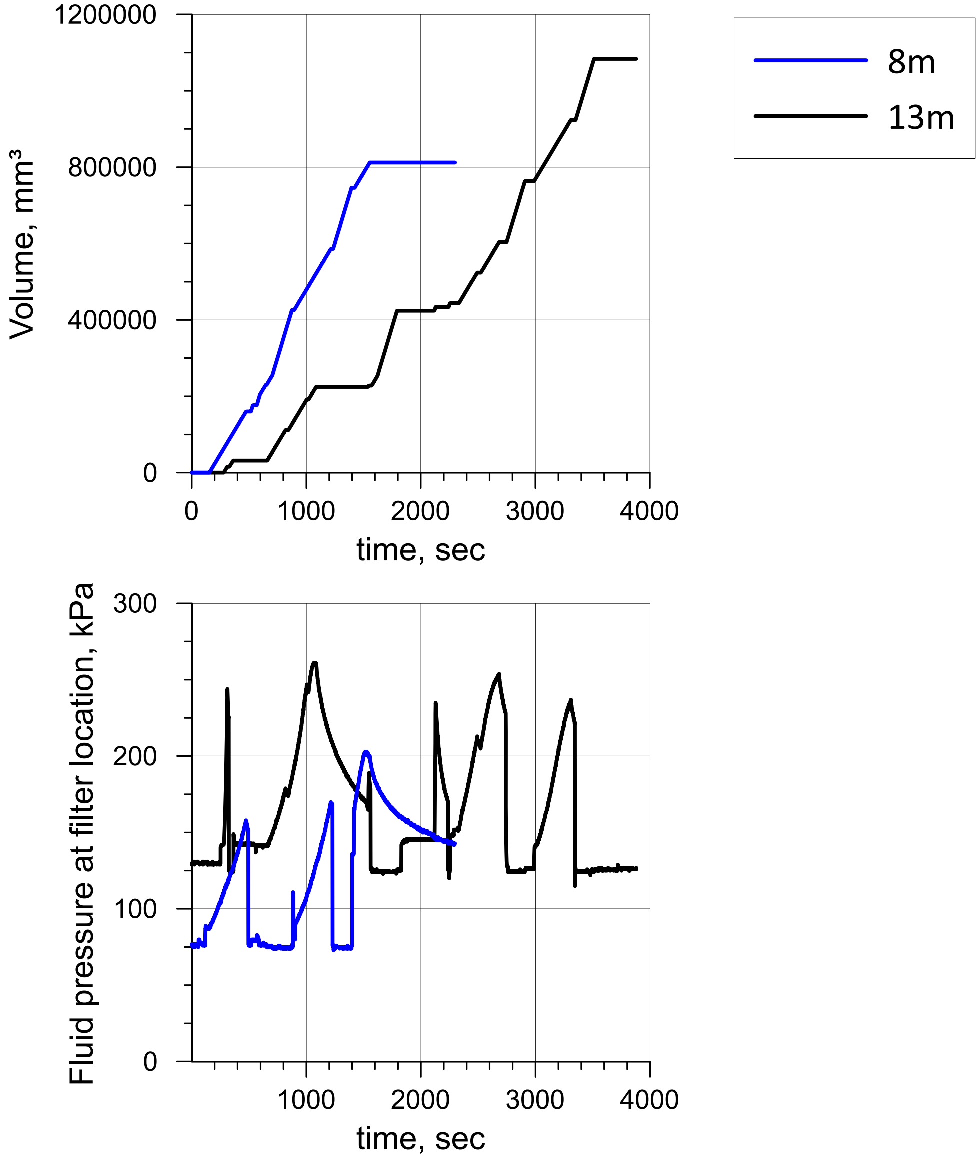


Arm Lift Off	4.0 kPa
Slope	3.2 kPa/mm

Project	NGI - Halden Site	**Figure No.**	**HALP01 M01**
Client	NGI		
Project No.	P1170112		

Appendix K

HYDRAULIC STRESS FRACTURE TESTING



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Hydraulic stress fracture test HALH01

Depths 8 m & 13 m

Document No. 20160154-04-R	
Figure No. 01	
Date 2018-14-09	Drawn by APP

NGTS

C:\Users\app\Desktop\HALH01.grf

Appendix L

SAMPLE LIST FROM BOREHOLES

Overview of samples taken and status after sampling

Borhull	Sample	Status by 12.09.2018
HALB01 Ø72mm	1 to 6 (bag)	Not tested
	7	Tested
	8	Sent to UMass, USA
	9	Sent to UMass, USA
	10	Tested
	11	Sent to UMass, USA
	12	Tested
	13	Tested
	14	Sent to UMass, USA
HALB02 Ø54mm	all	All sent to NGU
HALB03 Ø54mm	1	Sent to NTNU - Trondheim
	2	Sent to NTNU - Trondheim
	3	Tested
	4	Sent to NTNU - Trondheim
	5	Tested
	6	Tested
	7	Sent to UMass, USA
	8	Tested
	9	Tested by PhD student
	10	Sent to NTNU - Trondheim
	11	Sent to NTNU - Trondheim
	12	Tested
HALB04 Ø250 mm & Ø160 mm	7 bags	Not tested
	1	Not tested
	2	Sent to NTNU - Trondheim
	3	Tested
	4	Sent to NTNU - Trondheim
	5	Tested
	6	Tested
	5,5	Tested
	7	Sent to UMass, USA
	8	Tested
	9	Tested (frost heave test)
	10	Tested
	11	Tested by PhD student
	12	Tested
	1_mini	Sent to NTNU - Trondheim
	2_mini	Tested
	3_mini	Sent to NTNU - Trondheim
	13	Tested
	14	Sent to NTNU - Trondheim
	15	Sent to NTNU - Trondheim
HALB05 GPS	1	Tested
	2	Tested
HALB06 GPS	1	Tested by PhD student
	2	Tested
	3	Tested
	4	Tested by PhD student
	5	Tested

GROUP	SAMP
HEADING	Sample list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_ENG	NGI
LOCA_ID	HALB01
SAMP_TYPE	BH72
Full description	72 mm sample borehole (no liner)
SAMP_DATE	2015-10-19 2015-10-20
LOCA_DRIL	HAK/TAV
Temperature	~18 degrees

Reach bedrock NO

Depth to bedrock if reached m

ISO Field classification

YES

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lal	DREM_REM
0.4	0.5	1		Next day	
0.9	1.0	2		Next day	Silt m/...
1.4	1.5	3		Next day	
1.9	2.0	4		Next day	
2.4	2.5	5		Next day	
2.9	3.0	6		Next day	
3.0	3.8	7		Next day	Silt 5 cm bunn
4.0	4.8	8		Next day	silt
5.0	5.8	9		Next day	clayey silt
6.0	6.8	10		Next day	clayey silt
7.0	7.8	11		Next day	clayey silt
8.0	8.8	12		Next day	
10.0	10.9	13		Next day	
12.0	12.8	14		Next day	

National GeoTest Sites (NGTS)

Description

Sample list

HALB01

BH72

Document No.	20160154-04-R
Figure No.	1
Date	27.03.2018
Drawn by	RCa

NGTS

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB05-Samplelist.xlsx]Samplelist

GROUP	SAMP
HEADING	Sample list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_ENG	NGI
LOCA_ID	HALB02
SAMP_TYPE	BH54C
Full description	54 mm composite sample borehole (with liner)
SAMP_DATE	2015-10-19 2015-10-20
LOCA_DRIL	Hakon
Temperature	~18 degrees

Reach bedrock NO

Depth to bedrock if reached m

ISO Field classification

YES

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lak	DREM_REM
3	3.8	T11		Next day	Sylinder 3.0-3.8m
3.8	3.9			Next day	Bag
3.9	4.7	T16		Next day	
x				Next day	x
4.8	5.6	C84		Next day	
5.6	5.7			Next day	Bag
5.7	6.6	F110		Next day	
x				Next day	x
6.6	7.4	T12		Next day	
7.4	7.5			Next day	Bag
7.5	8.3	153		Next day	x
x				Next day	
8.4	9.2	2080		Next day	
x				Next day	
9.3	10.1	T4		Next day	
10.1	10.2			Next day	
10.2	11	I.		Next day	
11	11.1			Next day	
11.1	11.9	80		Next day	
11.9	12			Next day	
12	12.8	X1		Next day	
12.8	12.9			Next day	
12.9	13.7	766		Next day	
13.7	13.8			Next day	
13.8	14.6	X4		Next day	
x				Next day	
14.7	15.5	X5		Next day	
x				Next day	
15.6	16.4	X6		Next day	
16.4	16.5			Next day	

National GeoTest Sites (NGTS)

Description

Sample list

HALB02

BH54C

Document No. 20160154-04-R

Figure No. 1

Date 27.03.2018

Drawn by RCa

NGTS

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB03-Samplelist.xlsx]Samplelist

GROUP	SAMP		
HEADING	Sample list		
PROJ_ID	20160154		
PROJ_NAME	National GeoTest Sites (NGTS)		
PROJ_LOC	Halden (HAL)		
PROJ_CLNT	NGTS		
PROJ_CONT	NGI		
PROJ_ENG	NGI	Reach bedrock	NO
LOCA_ID	HALB03	Depth to bedrock if reached	m
SAMP_TYPE	BH54C		
Full description	54 mm composite sample borehole (with liner)		
SAMP_DATE	2016-06-06		
LOCA_DRIL	PKK/MaA		
Temperature	~18 degrees	ISO Field classification	
		YES	

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lal	DREM_REM
					predrilling
3	3.8	1	Silt	Next day	
4	4.8	2	Silt	Next day	
5	5.8	3	Silt some clay	Next day	
6	6.8	4	Silt	Next day	
7	7.8	5	Silt	Next day	
8	8.8	6	Silt clayey	Next day	
9	9.8	7	Silt clayey	Next day	
10	10.8	8	Silt clayey	Next day	
11	11.8	9	Silt clayey	Next day	
12	12.8	10	Silt clayey	Next day	
13	13.8	11	Silt clayey	Next day	
14	14.8	12	Silt clayey	Next day	

National GeoTest Sites (NGTS)

Description

Sample list

HALB03

BH54C

Document No. 20160154-04-R

Figure No. 1

Date 27.03.2018

Drawn by RCa

NGTS

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB01-Samplelist.xlsx]Samplelist

GROUP	SAMP
HEADING	Sample list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_ENG	NGI
LOCA_ID	HALB04
SAMP_TYPE	BHSB
Full description	Sherbrooke block sample borehole (large)
SAMP_DATE	2016-06-13 2016-06-21
LOCA_DRIL	MaA/PKK
Temperature	~18 degrees

ISO Field classification: YES

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lal	DREM_REM
					predrilling
3.1	3.45	x		Next day	Dårlig kvalitet - kastet
3.45	3.7	1		Next day	ok minus. Manglet deler av prøven, silt
3.7	4.05	x		Next day	Dårlig - kastet
4.05	4.4	x		Next day	Mislykket 1. kniv som ikke løste ut
4.4	4.75	x		Next day	Mislykket 1. kniv som ikke løste ut
4.75	5.15	2		Next day	ok minus. Silt, noe leire
5.15	5.5	3		Next day	ok. Silt leire
5.5	5.85	x		Next day	ok. Kastet. Silt, leire
5.85	6.1	4		Next day	ok. Silt, leire
6.1	6.55	x		Next day	Kastet. Silt, leire
6.55	6.9	x		Next day	Kastet. Silt, leire
6.9	7.25	5		Next day	Silt/leire
7.25	7.6	x		Next day	Kastet. Silt, leire
7.6	7.9	x		Next day	Måtte ha 3 forsøk får vi fikk utløst kniven
7.9	8.25	6		Next day	Silt/leire
8.25	8.6	5,5		Next day	Block
8.6	8.95	*		Next day	Dårlig kvalitet, pose
8.95	9.3	*		Next day	Kniv løste ikke ut. 2 forsøk, pose
9.3	9.65	7		Next day	Leire, silt
9.65	10	*		Next day	Pose
10	10.35	8		Next day	Block
10.35	10.7	*		Next day	Pose
10.7	10.7	x		Next day	Mistet, 2 kniver løste ut, men ingen prøve
11.05	11.4	9		Next day	Prøven er komprimert pga forrige som var mis
11.4	11.75	10		Next day	Block
11.75	12.1	*		Next day	Pose
12.1	12.45	11		Next day	Block
12.45	12.8	12		Next day	Block
13	13.1	1_mini		Next day	Kniver løste ikke ut. 2 forsøk

National GeoTest Sites (NGTS)

Description

Sample list

HALB04

BHSB

Document No. 20160154-04-R

Figure No. 1

Date 27.03.2018

Drawn by RCa

NGTS

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB04-Samplelist.xlsx]Samplelist (2)

GROUP	SAMP
HEADING	Sample list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_ENG	NGI
LOCA_ID	HALB04
SAMP_TYPE	BHSB
Full description	Sherbrooke block sample borehole (large)
SAMP_DATE	2016-06-13 2016-06-21
LOCA_DRIL	PKK/MaA
Temperature	~18 degrees

Reach bedrock NO

Depth to bedrock if reached m

ISO Field classification

YES

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in l	DREM_REM
13.1	13.4	*		Next day	Dårlig kvalitet (ødelagt pose)
13.4	13.75	2_mini		Next day	Bare 1 kniv løste ut, kast og redusert krakk
13.75	14.1	3_mini		Next day	OK. Knivene hadde ikke løst helt ut
14.1					Fortsettelse. Vanlig blokk
					Valgte å prøve og "skylle" gjennom
					området mini blokk var blitt kjørt
14.1	14.45	*		Next day	Dårlig kvalitet. Pose
14.45	14.8	13		Next day	Block
14.8	15.15	14		Next day	Block
15.15	15.2	15		Next day	Block

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National GeoTest Sites (NGTS)

Description

Sample list

HALB04

BHSB

Document No.
20160154-04-R

Figure No.
2

Date
14/04/2018

Drawn by
RCa

NGTS

GROUP	SAMP		
HEADING	Sample list		
PROJ_ID	20160154		
PROJ_NAME	National GeoTest Sites (NGTS)		
PROJ_LOC	Halden (HAL)		
PROJ_CLNT	NGTS		
PROJ_CONT	NGI		
PROJ_ENG	NGI	Reach bedrock	NO
LOCA_ID	HALB05	Depth to bedrock if reached	m
SAMP_TYPE	BHGPS		
Full description	Gel push Static penetration		
SAMP_DATE	2017-09-12 2017-09-13		
LOCA_DRIL	PKK/HSA		
Temperature	~18 degrees	ISO Field classification	
		YES	

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lal	DREM_REM
9.2	10.0	1		Next day	Silt
12.3	13.3	2		Next day	Silt

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB05-Samplelist.xlsx]Samplelist

National GeoTest Sites (NGTS)

Description

Sample list

HALB05

BHGPS

Document No.	
20160154-04-R	
Figure No. 1	
Date 27.03.2018	Drawn by RCa

NGTS

GROUP	SAMP
HEADING	Sample list
PROJ_ID	20160154
PROJ_NAME	National GeoTest Sites (NGTS)
PROJ_LOC	Halden (HAL)
PROJ_CLNT	NGTS
PROJ_CONT	NGI
PROJ_ENG	NGI
LOCA_ID	HALB06
SAMP_TYPE	BHGPS
Full description	Gel push Static penetration
SAMP_DATE	2018-05-08 2018-05-09
LOCA_DRIL	MH/PKK/AHG
Temperature	~23 degrees

Reach bedrock NO

Depth to bedrock if reached m

ISO Field classification

NO

SAMP_TOP	SAMP_BASE	SAMP_REF	SAMP_CLASS	Samples in lal	DREM_REM
6,0	6,8	1		Next day	Mistet en god del
7,9	8,9	2		Next day	ok
9,4	10,4	3		Same day	ok
10,8	11,8	4		Same day	ok
12,4	13,4	5		Same day	ok

National GeoTest Sites (NGTS)

Description

Sample list

HALB06

BHGPS

Document No. 20160154-04-R

Figure No. 1

Date 22.05.2018

Drawn by APP

NGTS

P:\2016\01\20160154\Fieldwork\Halden\BH\[HALB06-Samplelist-må oppdateres.xlsx]Samplelist

Appendix M

CLASSIFICATION TEST RESULTS

Table 1: Summary of classification test results: NGTS- Halden Research Site

Boring No.	Tube ID	Depth	Water content	Soil unit weight		Unit weight of solid part.	INDEX STRENGTH			PLASTICITY DATA			GRAIN SIZE DISTRIBUTION			COMMENTS
							Fall cone		Sensitivity (FC)	Plastic limit	Liquid limit	Plast.Index	clay	clay+silt	clay+silt +sand	
			w	γ (meas.)	γ (wc)	γ_s	s_u	$s_{u,rem}$	S_t	w_P	w_L	I_p	< 2 µm	< 0.063 mm	< 2 mm	
		m	%	kN/m^3	kN/m^3	kN/m^3	kPa	kPa	-	%	%	%	%	%	%	
HALB01	7-A-1	3,05	34,6		18,40					24,5	32,1	7,6	4,41	32	100	F. D. NGI
HALB01		3,40	30,1		18,97											
HALB01		3,43					24	2	10,0							
HALB01		3,45								0,0	-	-	3,12	15	100	F. D. NGI
HALB01		3,70					27	2	15,0							
HALB01	7-A-3	3,77								24,5	31,5	7,0	7,64	37	100	F. D. NGI
HALB01		3,78	28,5		19,20											
HALB01		4,04	29,2		19,10											
HALB01	8-A-1	4,05								22,3	30,7	8,4				
HALB01	8-A-2	4,37				26,35	33	4,4	7,5	24,7	32,0	7,3	8,76	39	100	F. D. NGI
HALB01		4,37	26,2		19,52									40	100	Hydrometer Multiconsult
HALB01		4,39	25,9		19,58											
HALB01		4,43											3,90	80	100	Hydrometer Unicone
HALB01	8-B-2	4,47	34,1	18,96	18,44											Oedo specimen
HALB01	8-B-3	4,65	34,5	18,50	18,39											Oedo specimen
HALB01	8-A-3	4,77								24,5	37,3	12,8	10,50	71	100	F. D. NGI
HALB01		4,79	30,0		18,97											
HALB03	3	5,10					24	2	10,4							
HALB03	3	5,18											10,00	81	100	Hydrometer Geolabs
HALB03	3	5,24											13,78	79	100	F. D. NGI
HALB03	3	5,24											2,00	67	100	Hydrometer Multiconsult
HALB03	3	5,24								0,0	-	-	7,50	57	100	Hydrometer NGI
HALB04	3	5,27					85	28	3,0				7,40	72	100	Hydrometer NGI
HALB04	3-1B-1	5,27	30,5	19,45	18,87											Oedo specimen
HALB04	3	5,28	31,9	18,93	18,74											
HALB04	3	5,28											7,50	75	100	Hydrometer Geolabs
HALB04	3-A-1	5,28	31,9	18,93	18,68											Triaxial specimen
HALB01		5,30	26,6	18,96	19,48								11,22	75	100	F. D. NGI
HALB01	9-A-1	5,30	29,6	18,96	18,99											Triaxial specimen
HALB01	9-A-2	5,30	30,5	18,95	18,87											Triaxial specimen
HALB03	3	5,32	30,0	19,41	18,99											
HALB03	3-A-1	5,32	30,0	19,41	18,93											Triaxial specimen
HALB01	9	5,36				26,26				25,5	35,8	10,3	11,19	77	100	F. D. NGI
HALB03	3-A-1	5,42	29,0	19,62	19,07											Oedo specimen
HALB01		5,79	28,6		19,18											
HALB01		6,05	33,5		18,53											
HALB01	10-A-3	6,30								24,6	34,5	9,9	11,40	78	100	F. D. NGI
HALB01		6,37					36	2	15,7							
HALB01		6,38	30,4		18,94											
HALB01	10-A-3	6,77								24,2	35,0	10,8	12,81	81	100	F. D. NGI
HALB01		6,79	27,3		19,37											
HALB04	5	7,03								25,3	33,4	8,1	13,28	80	100	F. D. NGI
HALB04	5	7,03					113						7,00	86	100	Hydrometer NGI
HALB04	5	7,03											6,50	90	100	Hydrometer Geolabs
HALB04	5-0-1	7,03	28,6	18,63	19,22											DSS specimen
HALB04	5-0-2	7,03	28,6	18,80	19,22											DSS specimen

Table 1: Summary of classification test results: NGTS- Halden Research Site

Boring No.	Tube ID	Depth	Water content	Soil unit weight		Unit weight of solid part.	INDEX STRENGTH			PLASTICITY DATA			GRAIN SIZE DISTRIBUTION			COMMENTS
							Fall cone		Sensitivity (FC)	Plastic limit	Liquid limit	Plast.Index	clay	clay+silt	clay+silt +sand	
			w	γ (meas.)	γ (wc)	γ_s	s_u	$s_{u,rem}$	S_t	w_P	w_L	I_p	< 2 μm	< 0.063 mm	< 2 mm	
		m	%	kN/m³	kN/m³	kN/m³	kPa	kPa	-	%	%	%	%	%	%	
HALB04	5--1	7,03	28,5	19,31	19,23											Oedo specimen
HALB04	5-A-1	7,03	29,9	19,41	19,03											Oedo specimen
HALB01		7,05	29,8		19,02											
HALB01		7,10					28	2,6	10,8							
HALB01	11-A-2	7,37				26,48	35	2	15,2	23,6	34,5	10,9	15,71	81	100	F. D. NGI
HALB01		7,39	29,3		19,08											
HALB01		7,50	29,0	19,22	19,13											
HALB01	11-B-1	7,50	29,0	19,22	19,16											DSS specimen
HALB03	5-A-1	7,50	29,3	19,26	19,12											Oedo specimen
HALB01		7,55	29,5	19,00	19,06								8,40	86	100	Hydrometer Unicone
HALB01	11-B-2	7,55	29,5	19,00	19,09											DSS specimen
HALB03	5	7,57	29,4	18,55	19,07											
HALB03	5-0-1	7,57	29,4	18,55	19,10											DSS specimen
HALB01	11-C-1	7,60	23,2	18,99	20,07											Triaxial specimen
HALB03	5	7,63											8,50	89	100	Hydrometer Geolabs
HALB03	5	7,75											16,90	82	100	F. D. NGI
HALB03	5	7,75											7,20	83	100	Hydrometer NGI
HALB01	11-A-3	7,77								23,0	32,1	9,1	17,41	84	100	F. D. NGI
HALB01		7,79	27,6		19,33											
HALB06	3	8,00	30,8		18,91											
HALB04	6	8,02					84	18	4,7	23,8	33,7	9,9				
HALB06	3	8,02					4	2	2,0							
HALB04	6-A-1	8,02	27,1	19,18	19,38											Triaxial specimen
HALB04	6-A-2	8,02	28,0	19,33	19,25											Triaxial specimen
HALB04	6-1	8,02	27,2	19,87	19,42											Oedo specimen
HALB01		8,04					39	2	16,3							
HALB01		8,05	29,5		19,06											
HALB06	3	8,05											9,67	72	100	Hydrometer NGI
HALB06	3	8,05											12,00	75	100	F. D. NGI
HALB06	3	8,10								23,0	29,0	6,0				
HALB04	6-2	8,17	29,0	19,52	19,16											Oedo specimen
HALB03	6-B-1	8,28	27,5	19,74	19,38											Oedo specimen
HALB04	5.5-C	8,30								23,3	33,3	10,0	8,03	82	100	F. D. NGI
HALB04	5.5	8,30					113	53	2,1				9,00	87	100	Hydrometer NGI
HALB04	5.5	8,30											11,00	92	100	Hydrometer Geolabs
HALB04	5.5-C	8,30								23,3	33,3	10,0				
HALB06	3-A-1	8,32	30,7	19,65	18,93											Triaxial specimen
HALB01		8,36					40	2	16,7							
HALB04	5.5	8,36	30,1	19,15	18,98											
HALB04	5.5-A-1	8,36	30,1	19,15	18,96											Triaxial specimen
HALB01	12-A-1	8,37								23,3	31,5	8,2	17,25	85	100	F. D. NGI
HALB01		8,38	29,3		19,09											
HALB03	6	8,38											17,52	86	100	F. D. NGI
HALB03	6	8,38											4,80	80	100	Hydrometer Multiconsult
HALB04	5.5-C-1	8,40	28,8	19,46	19,19											Oedo specimen
HALB04	5.5-C-2	8,42	28,2	19,56	19,28											Oedo specimen
HALB01		8,43											7,20	83	100	Hydrometer Unicone

Table 1: Summary of classification test results: NGTS- Halden Research Site

Boring No.	Tube ID	Depth	Water content	Soil unit weight		Unit weight of solid part.	INDEX STRENGTH			PLASTICITY DATA			GRAIN SIZE DISTRIBUTION			COMMENTS
							Fall cone		Sensitivity (FC)	Plastic limit	Liquid limit	Plast.Index	clay	clay+silt	clay+silt +sand	
			w	γ (meas.)	γ (wc)	γ_s	s_u	$s_{u,rem}$	S_t	w_P	w_L	I_p	< 2 μm	< 0.063 mm	< 2 mm	
		m	%	kN/m³	kN/m³	kN/m³	kPa	kPa	-	%	%	%	%	%	%	
HALB03	6	8,43											9,50	99	100	Hydrometer Geolabs
HALB03	6	8,46	28,3	18,79	19,23					22,4	31,4	9,0				Triaxial specimen
HALB06	3-B-1	8,47	29,5	19,67	19,09											Triaxial specimen
HALB01		8,60	28,6	19,07	19,18											
HALB01	12-B-4	8,60	28,6	19,07	19,16											Triaxial specimen
HALB03	6	8,65					37	3	13,2							
HALB06	3-C-1	8,65	28,7	19,01	19,20											Triaxial specimen
HALB06	3	8,72	28,7		19,20		30	3	12,0							
HALB04	5.5	8,78														
HALB05	1-B-1	9,35	28,5	20,05	19,23											Oedo specimen
HALB05	1-A-1	9,45	30,4	18,70	18,91											Triaxial specimen
HALB06	4	9,52					8	2	5,0							
HALB06	4	9,53	31,4		18,83											
HALB05	1-2	9,57	30,0	19,39	19,02											Oedo specimen
HALB05	1-B-1	9,60	30,2	19,25	18,94											Triaxial specimen
HALB05	1	9,70					39	4	10,5				9,30	88	100	Hydrometer NGI
HALB05	1	9,70											23,50	77	100	F. D. NGI
HALB06	4	9,81											16,40	81	100	F. D. NGI
HALB06	4	9,82											10,17	81	100	Hydrometer NGI
HALB04	-	9,82														Bag sample
HALB06	4-A-1	9,93	29,4	19,70	19,10											Triaxial specimen
HALB01		10,04					36	2	21,2							
HALB01		10,05	28,0		19,28											
HALB03	8	10,05											10,00	93	100	Hydrometer Geolabs
HALB03	8	10,07								23,3	32,4	9,2	13,52	89	100	F. D. NGI
HALB04	8-0-1	10,07	25,7	19,14	19,48											DSS specimen
HALB04	8-0-2	10,07	24,6	19,10	19,66											DSS specimen
HALB04	8-A-1	10,07	26,1	20,04	19,42											Oedo specimen
HALB06	4-B-1	10,08	28,1	19,74	19,13											Oedo specimen
HALB03	8	10,17								22,4	28,4	6,0				
HALB03	8	10,25	27,8	18,88	19,30											
HALB03	8-0-1	10,25	27,8	18,88	19,17											DSS specimen
HALB03	8	10,30											17,60	86	100	F. D. NGI
HALB03	8	10,30											10,50	84	100	Hydrometer NGI
HALB03	8	10,33	27,7	19,71	19,31											
HALB03	8-F-1	10,33	27,7	19,71	19,19											Oedo specimen
HALB01		10,36					43	1,9	22,6				13,29	88	100	F. D. NGI
HALB01	13-A-2	10,37								22,0	30,4	8,4				
HALB01		10,37	28,1		19,13								5,00	80	100	Hydrometer Multiconsult
HALB01		10,50	29,1	19,00	19,11											
HALB01	13-B-1	10,50	29,1	19,00	18,99											DSS specimen
HALB04	-	10,53														Bag sample
HALB01		10,60											7,80	85	100	Hydrometer Unicone
HALB01		10,78	24,3		19,85											
HALB04	10	11,45											9,50	88	100	Hydrometer NGI
HALB04	10	11,45											9,20	90	100	Hydrometer NGI
HALB04	-	11,93														Bag sample

Table 1: Summary of classification test results: NGTS- Halden Research Site

Boring No.	Tube ID	Depth m	Water content w %	Soil unit weight γ (meas.) kN/m³	Soil unit weight γ (wc) kN/m³	Unit weight of solid part. γ_s kN/m³	INDEX STRENGTH Fall cone s_u kPa	INDEX STRENGTH Fall cone $s_{u,rem}$ kPa	INDEX STRENGTH Sensitivity (FC) S_t -	PLASTICITY DATA Plastic limit w_P %	PLASTICITY DATA Liquid limit w_L %	PLASTICITY DATA Plast.Index I_p %	GRAIN SIZE DISTRIBUTION clay < 2 μm %	GRAIN SIZE DISTRIBUTION clay+silt < 0.063 mm %	GRAIN SIZE DISTRIBUTION clay+silt +sand < 2 mm %	COMMENTS
HALB01		12,05	26,9		19,43											
HALB01		12,10					24	3	8,6							
HALB01	14-A-2	12,35				26,50				20,5	28,2	7,7	9,82	82	100	F. D. NGI
HALB01		12,35	24,3		19,70									70	100	Hydrometer Multiconsult
HALB06	6	12,37				26,10										
HALB01		12,38	26,3		19,53											
HALB04	12	12,45											10,88	88	100	12.45-12.8 m ISO Hyd
HALB04	12	12,45											9,00	88	100	12.45-12.8 m ASTM Hyd
HALB04	12	12,45											8,46	90	100	12.45-12.8 m F.D.
HALB04	12	12,45											10,00	88	100	12.45-12.8 m ISO Hyd
HALB01		12,50											6,80	83	100	Hydrometer Unicone
HALB05	2-A-1	12,50	30,3	19,56	18,83											Triaxial specimen
HALB06	2-D-1	12,50														Oedo specimen
HALB06	6	12,52					10	2	5,0							
HALB06	6	12,53	28,5	19,96	19,07											
HALB04	12	12,55					69	4	17,3							
HALB01	14-A-3	12,57								20,0	27,3	7,3				
HALB04	12	12,57					58	19	3,1				8,00	81	100	Hydrometer Geolabs
HALB04	12-A-1	12,58	26,6	19,12	19,46											Triaxial specimen
HALB05	2	12,60					30	1	21,4							
HALB01	14-B-1	12,60	22,6	19,55	20,11											Triaxial specimen
HALB04	12	12,62								22,8	29,3	6,5				
HALB01		12,70					31	2	13,5							
HALB05	2-D-1	12,71	29,4	19,87	18,95											Oedo specimen
HALB01		12,78	23,9		19,91											
HALB01		12,80											8,50	71	100	F. D. NGI
HALB06	6	12,82											14,10	80	100	F. D. NGI
HALB06	6	12,82											9,39	78	100	Hydrometer NGI
HALB06	6-B-1	12,95	27,9		19,16											Triaxial specimen
HALB06	6-C-1	13,07	26,6		19,92											Oedo specimen
HALB04	-	13,25														Bag sample
HALB04	2-mini	13,53								20,9	28,5	8,1	15,10	81	100	F. D. NGI
HALB04	2-mini	13,53											10,07	76	100	Hydrometer NGI
HALB04	2-mini	13,53											8,00	87	100	Hydrometer Geolabs
HALB04	2-A-1	13,55	25,2	19,77	19,67					21,0	27,8	6,7				Triaxial specimen
HALB04	-	14,28														Bag sample
HALB03	12-B-1	14,31	24,5	19,97												Oedo specimen
HALB03	12	14,42	23,4	20,01	19,98					19,8	26,2	6,5				Triaxial specimen
HALB03	12	14,47											13,47	77	100	F. D. NGI
HALB03	12	14,47											3,30	67	100	Hydrometer Multiconsult
HALB04	13	14,48	20,6	20,26	20,48											
HALB04	13	14,48	20,0	20,23	20,60											
HALB04	13-0-1	14,48	20,6	20,26	20,33											DSS specimen
HALB04	13-0-2	14,48	20,0	20,23	20,44											DSS specimen
HALB04	13-A-2	14,58								19,9	26,0	5,0	12,43	68	100	F. D. NGI
HALB03	12	14,60					44	4	11,3							
HALB04	13	14,60	23,2	20,08	20,02		67	18	3,7	20,5	25,5	5,0				

Table 1: Summary of classification test results: NGTS- Halden Research Site

Boring No.	Tube ID	Depth	Water content	Soil unit weight		Unit weight of solid part.	INDEX STRENGTH			PLASTICITY DATA			GRAIN SIZE DISTRIBUTION			COMMENTS
							Fall cone		Sensitivity (FC)	Plastic limit	Liquid limit	Plast.Index	clay	clay+silt	clay+silt +sand	
			w	γ (meas.)	γ (wc)	γ_s	s_u	$s_{u,rem}$	S_t	w_P	w_L	I_p	< 2 µm	< 0.063 mm	< 2 mm	
		m	%	kN/m^3	kN/m^3	kN/m^3	kPa	kPa	-	%	%	%	%	%	%	
HALB04	13	14,60					56	17	3,3							
HALB04	13	14,60											7,00	81	100	Hydrometer Geolabs
HALB04	13-A-1	14,60	23,2	20,08	20,00											Triaxial specimen
HALB04	13-A-2	14,60	22,2	20,69	20,05											Oedo specimen
HALB04	13-A-2	14,60	24,4	20,78	19,69											Oedo specimen
HALB04	13	14,85											8,39	73	100	Hydrometer NGI

CLIENT: NGI

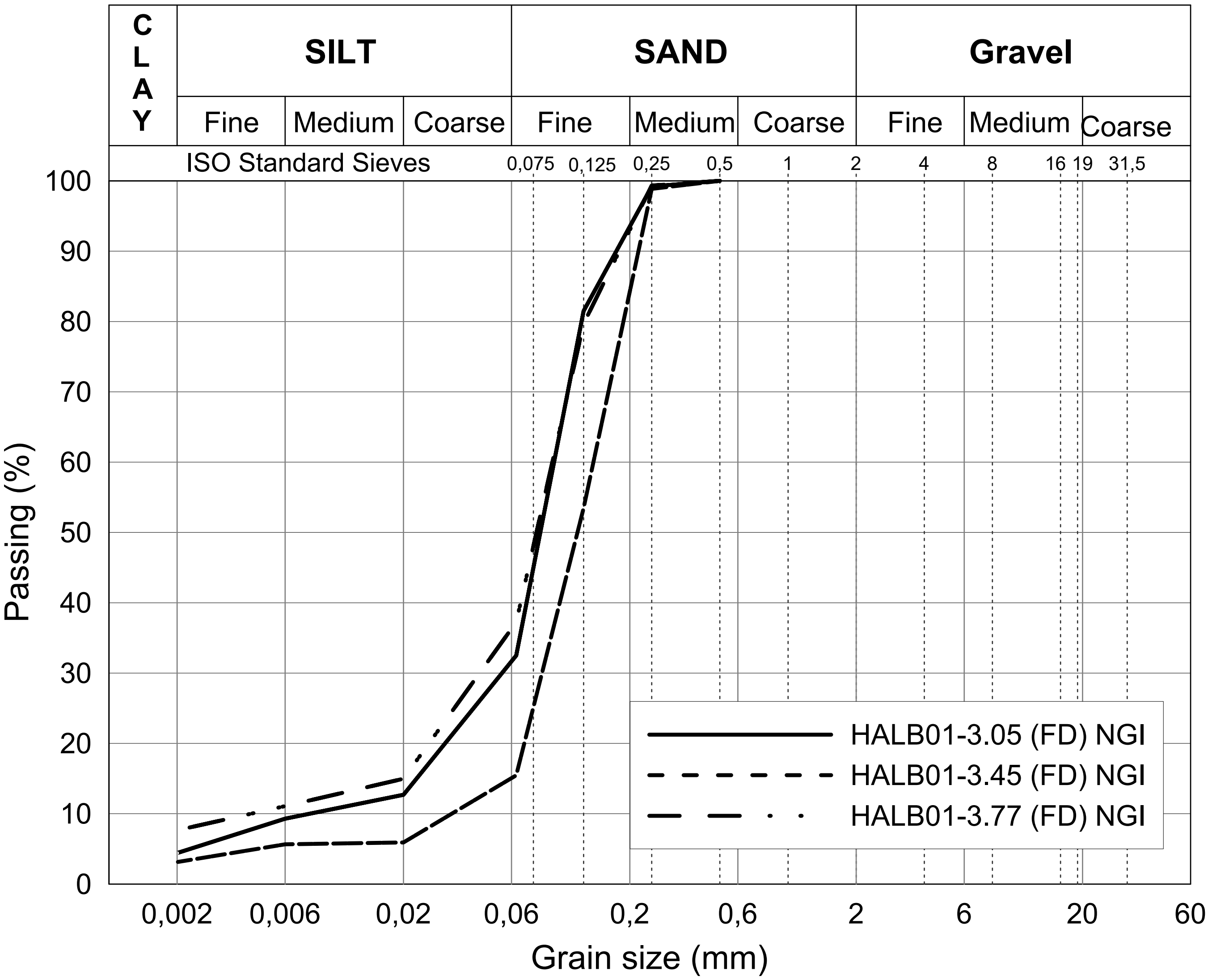
PROJECT: NGTS Halden

Document No.: 20160154-04-R
2018-09-06

Notes:
In case of I_p = 0, it represents a test failed to give the plastic limit due to low plasticity of the sample
[1] Classification using NGU (2011) guideline
[2] Vane test - Laboratory
[2] Vane test - Field

Table 2 Summary of salinity test results: NGTS- Halden Research Site

Boring No.	Part	Depth	Type	Soil -water ratio	Results	
					Conductivity	Conductivity as NaCl equivalents
-	-	m	-	-	μS/cm	g NaCL/l
HALB04	Bag	5.30	Conductivity	1:5	485	4.6
HALB04	Bag	7.03	Conductivity	1:5	422	4.1
HALB04	Bag	8.30	Conductivity	1:5	119	1.1
HALB04	Bag	8.60	Conductivity	1:5	287	2.4
HALB04	Bag	9.64	Conductivity	1:5	163.4	1.7
HALB04	Bag	10.35	Conductivity	1:5	133	1.2
HALB04	Bag	11.75	Conductivity	1:5	160	1.6
HALB04	Bag	13.10	Conductivity	1:5	158.5	1.4
HALB04	Bag	14.10	Conductivity	1:5	168.1	1.5



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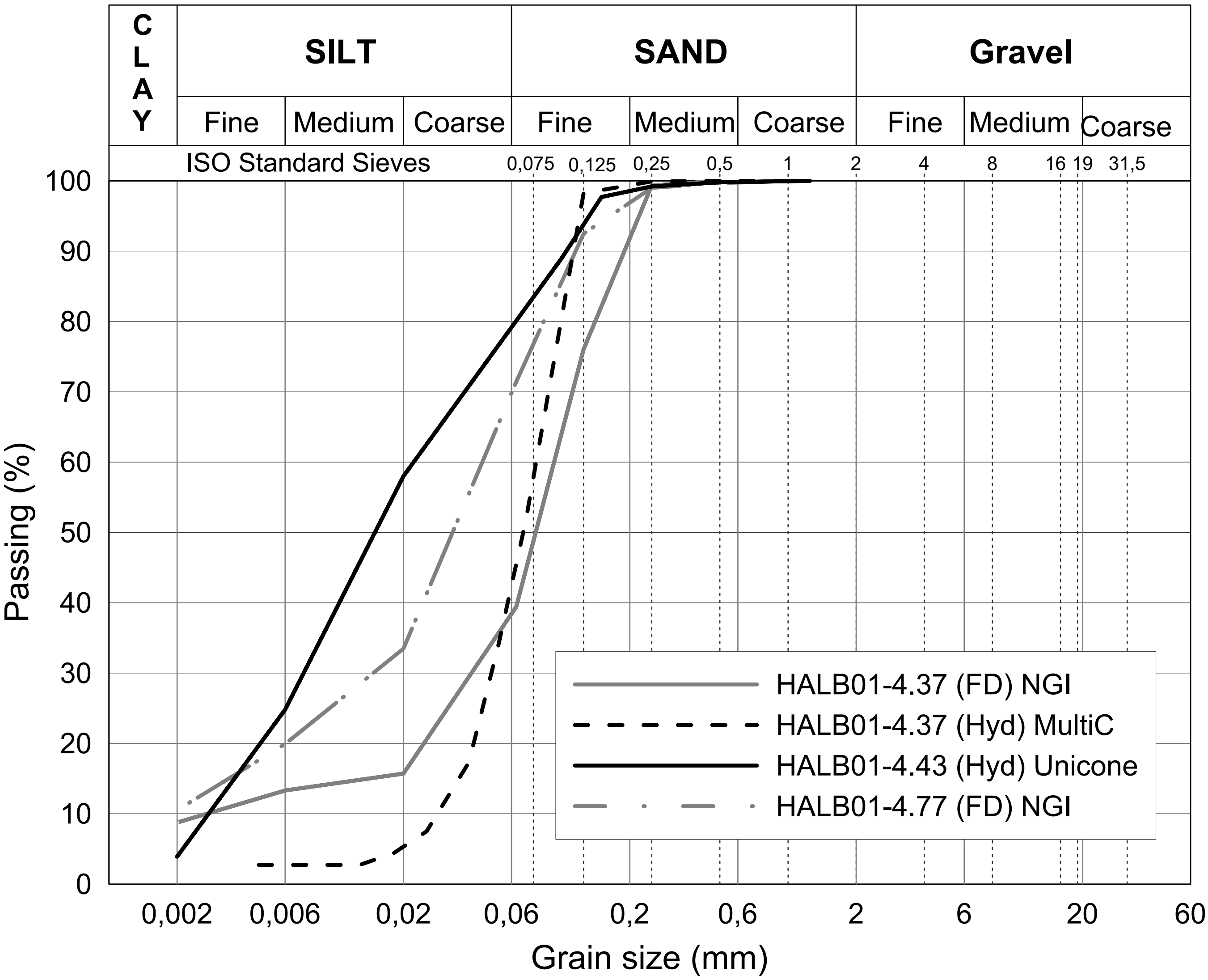
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Grain size distributions HAL 3m	Figure No. 20
	Date 2018-08-20 / Drawn by RCa/APP
	NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 4m	Figure No. 21	
	Date 2018-08-20	Drawn by RCa/APP
	NGTS	

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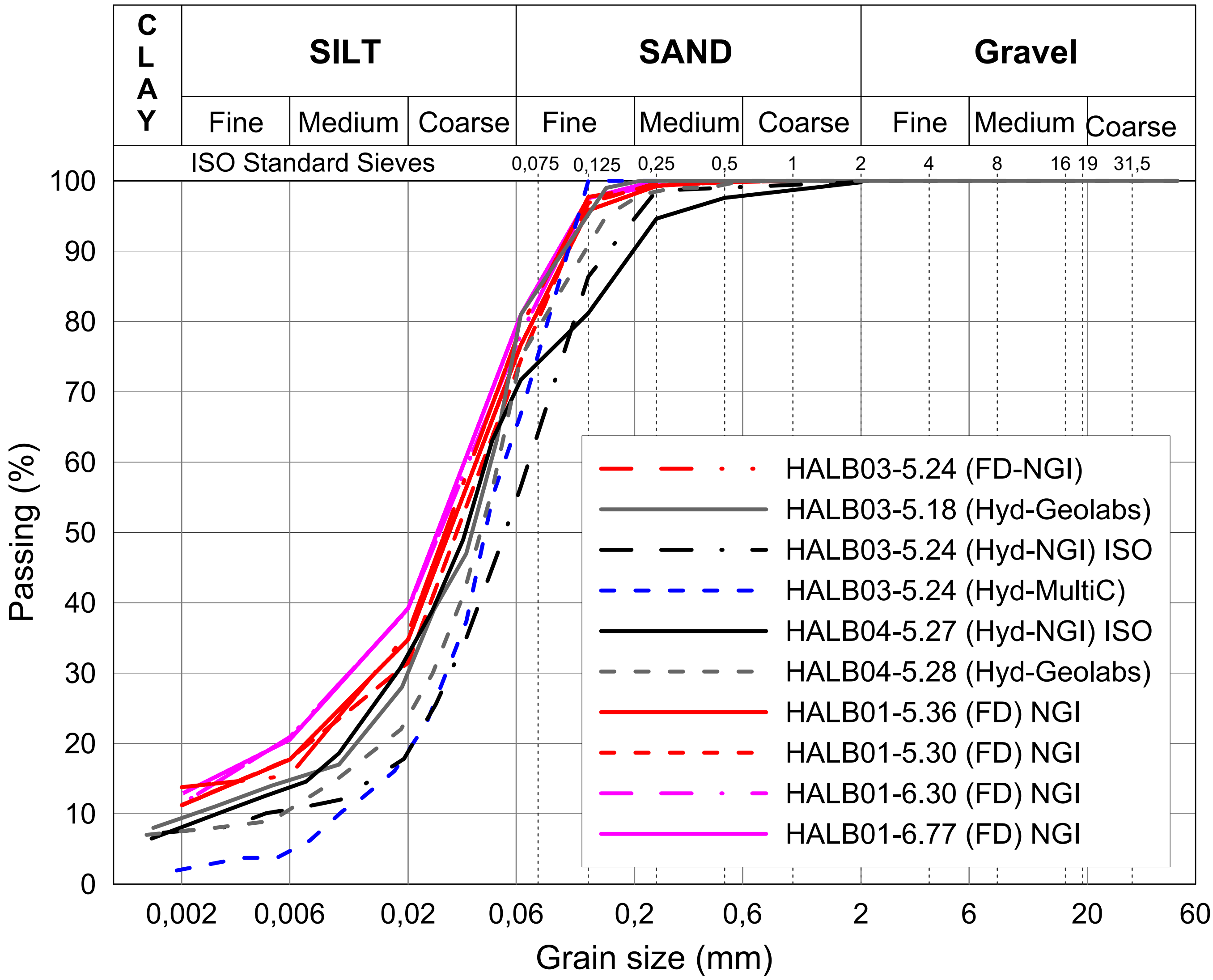

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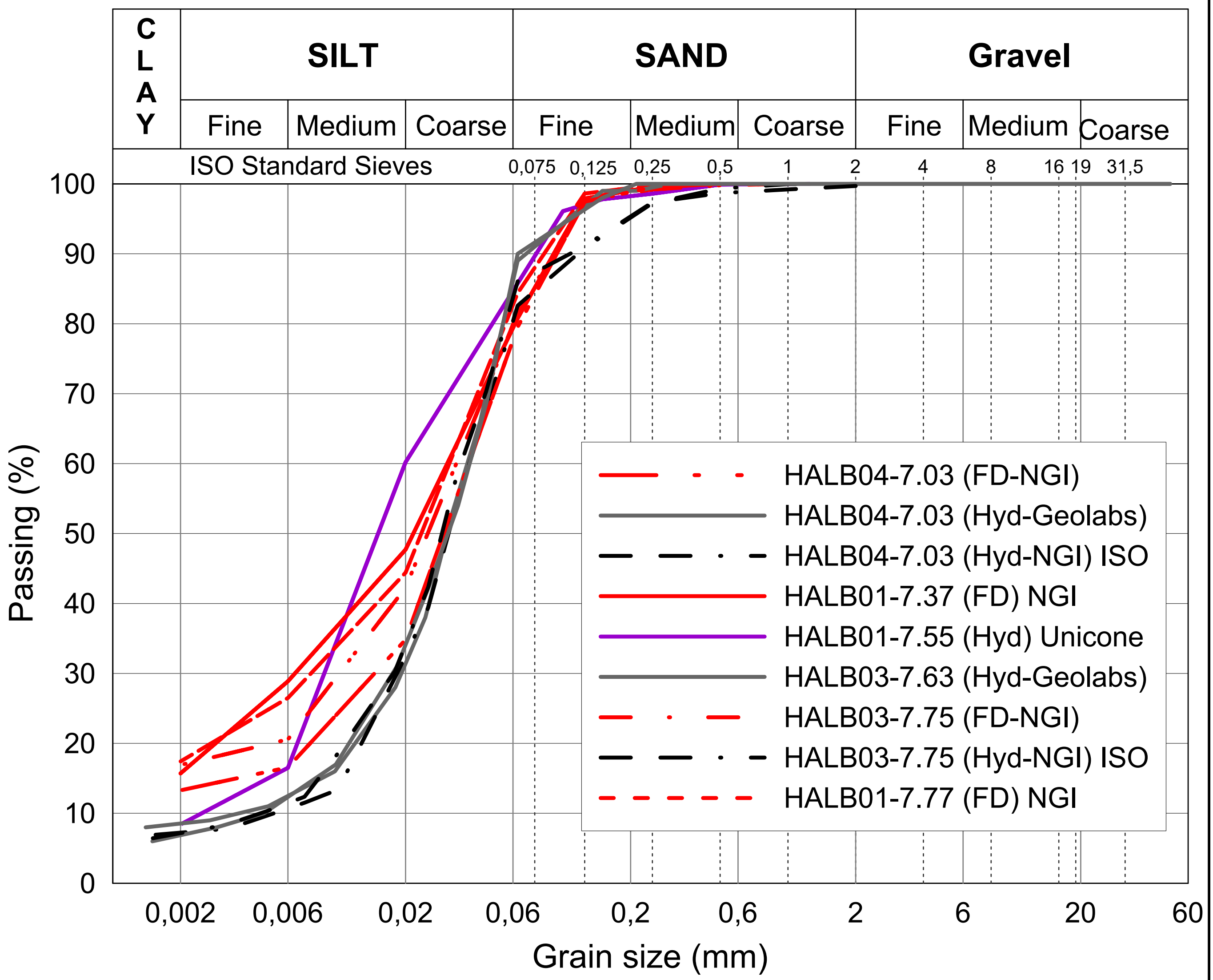
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Grain size distributions HAL 5-6m	Figure No. 22
	Date 2018-08-20 / Drawn by RCa/APP
	NGTS



Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Grain size distributions HAL 7m	Figure No. 23
	Date 2018-08-20 / Drawn by RCa/APP
	NGTS

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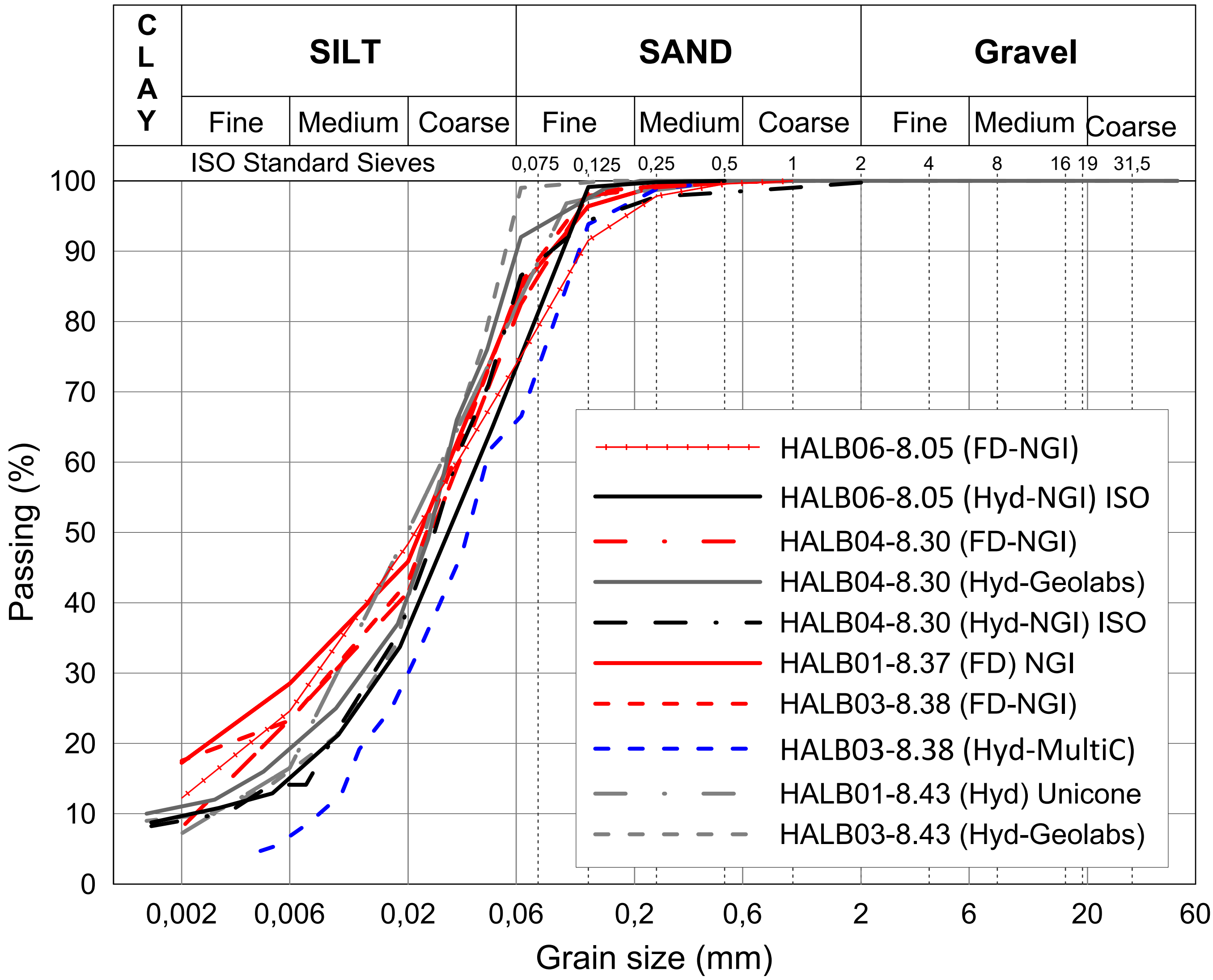

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 8m	Figure No. 24	
	Date 2018-08-20	Drawn by RCa/APP
	NGTS	

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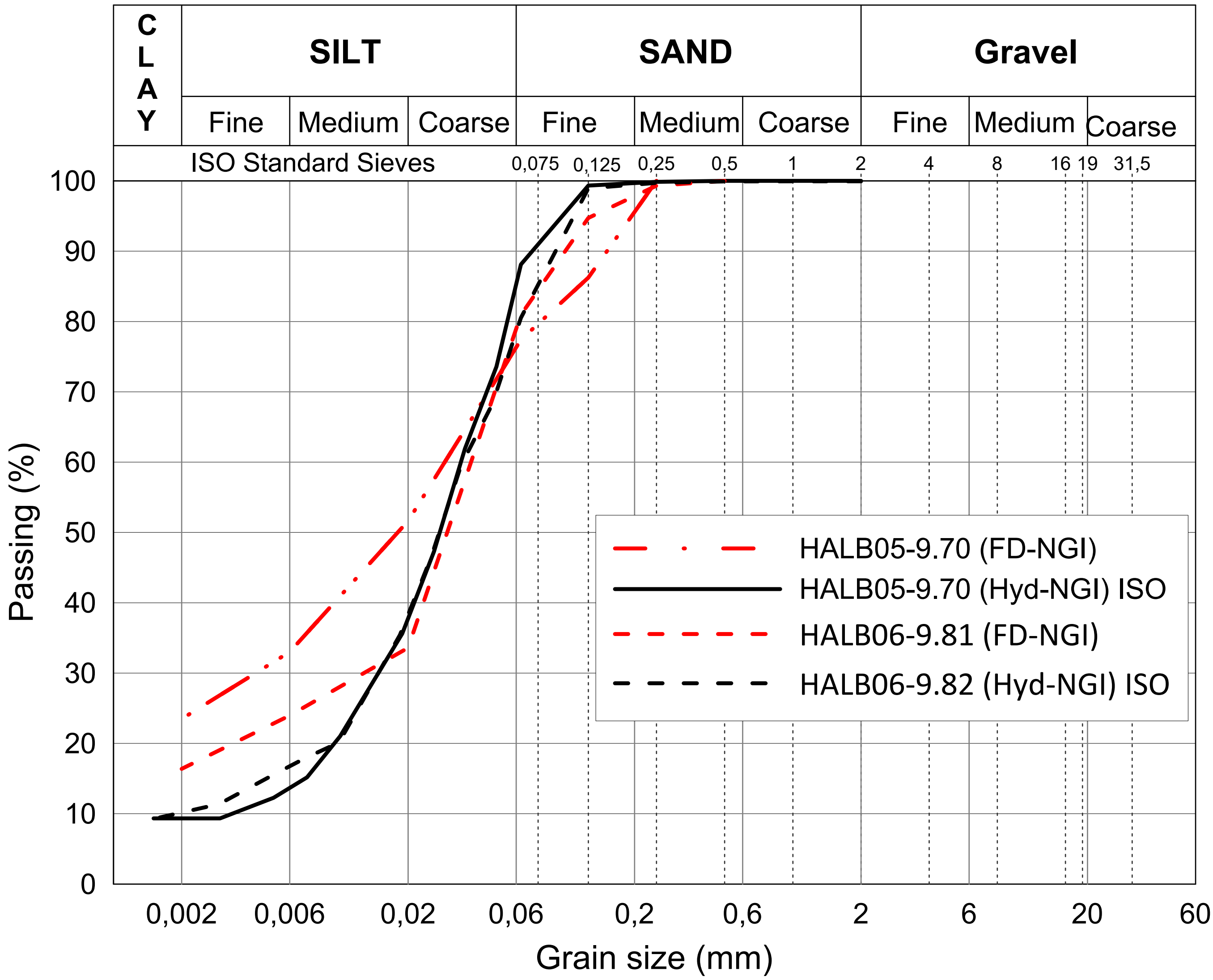
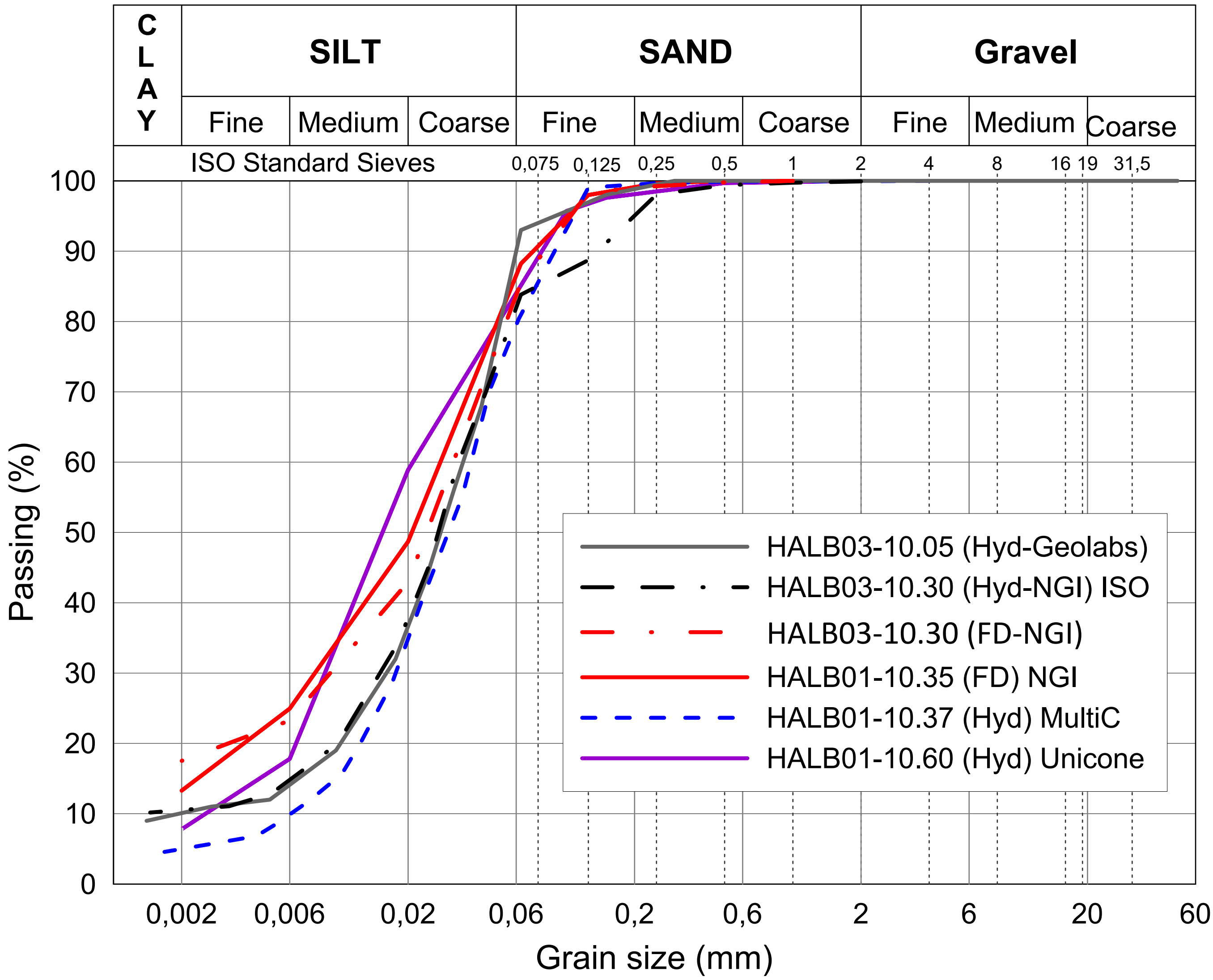


NGTS - Halden Research Site	Document No. 20160154-04-R
Grain size distributions HAL 9m	Figure No. 24
	Date 2018-08-20 / Drawn by RCa/APP
	NGTS



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NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 10m	Figure No. 25	
	Date 2018-08-20	Drawn by RCa/APP
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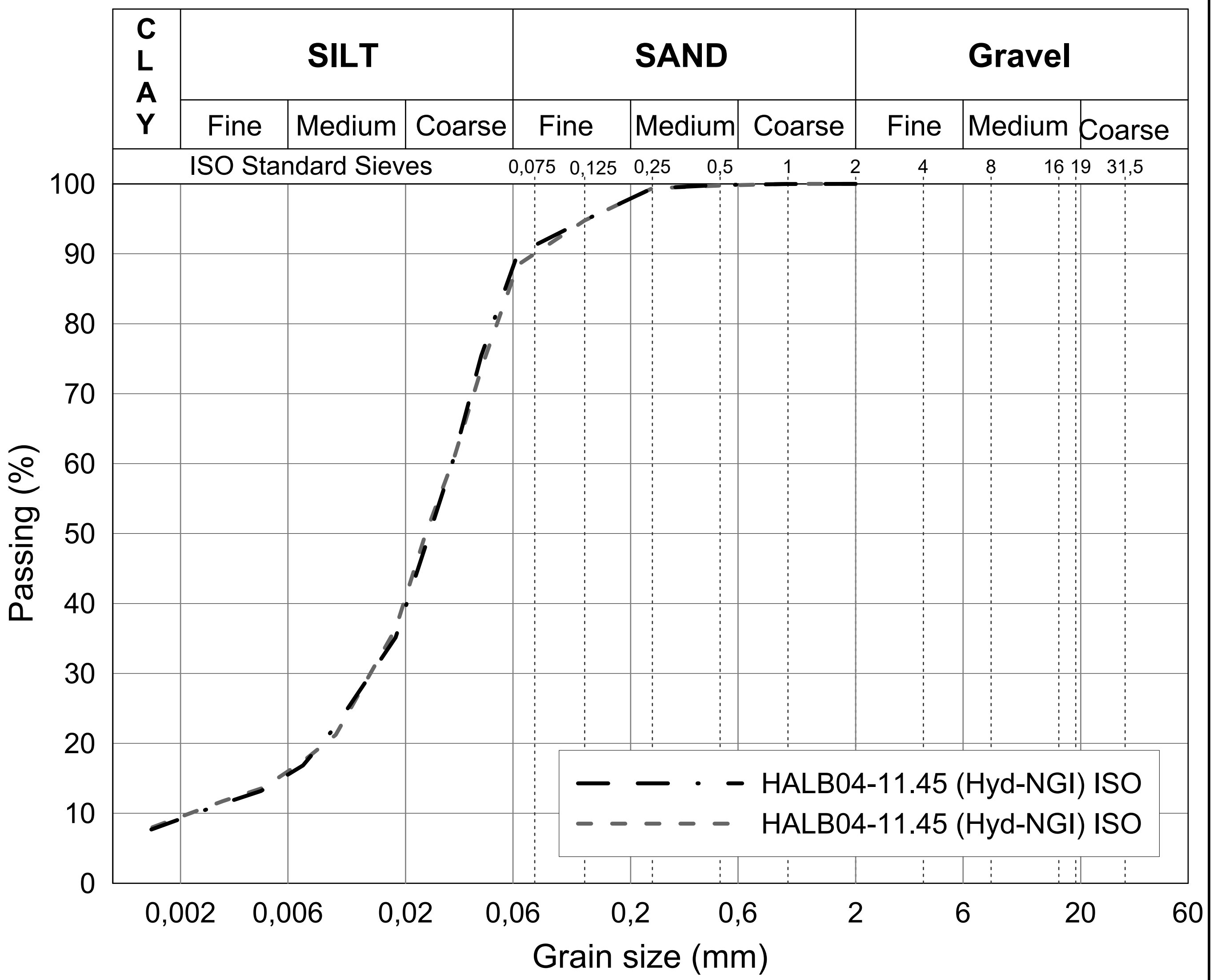

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 11m	Figure No. 26	
	Date 2018-04-06	Drawn by RCa
	NGTS	

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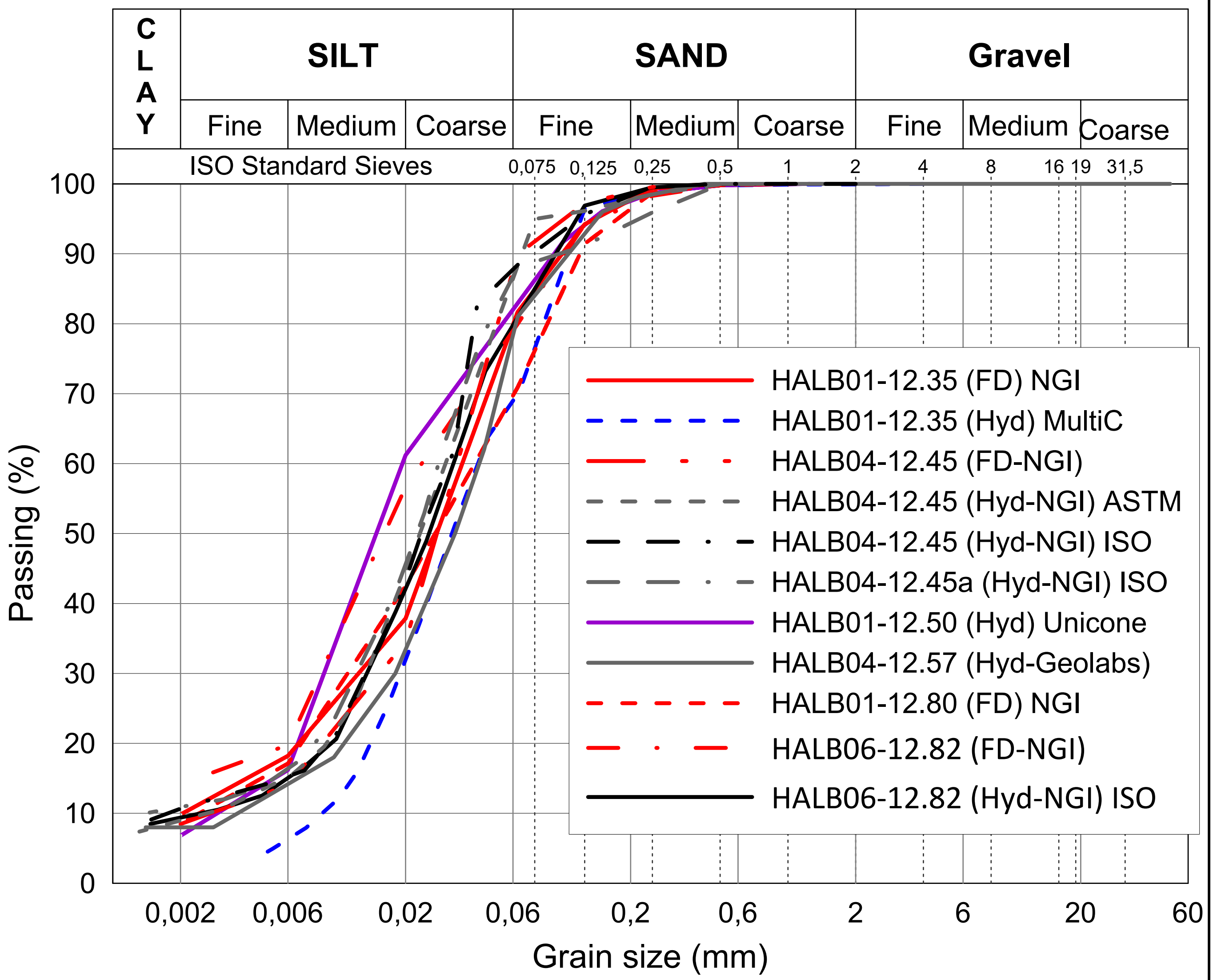

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Grain size distributions HAL 12m	Figure No. 27
	Date 2018-08-20 / Drawn by RCa/APP

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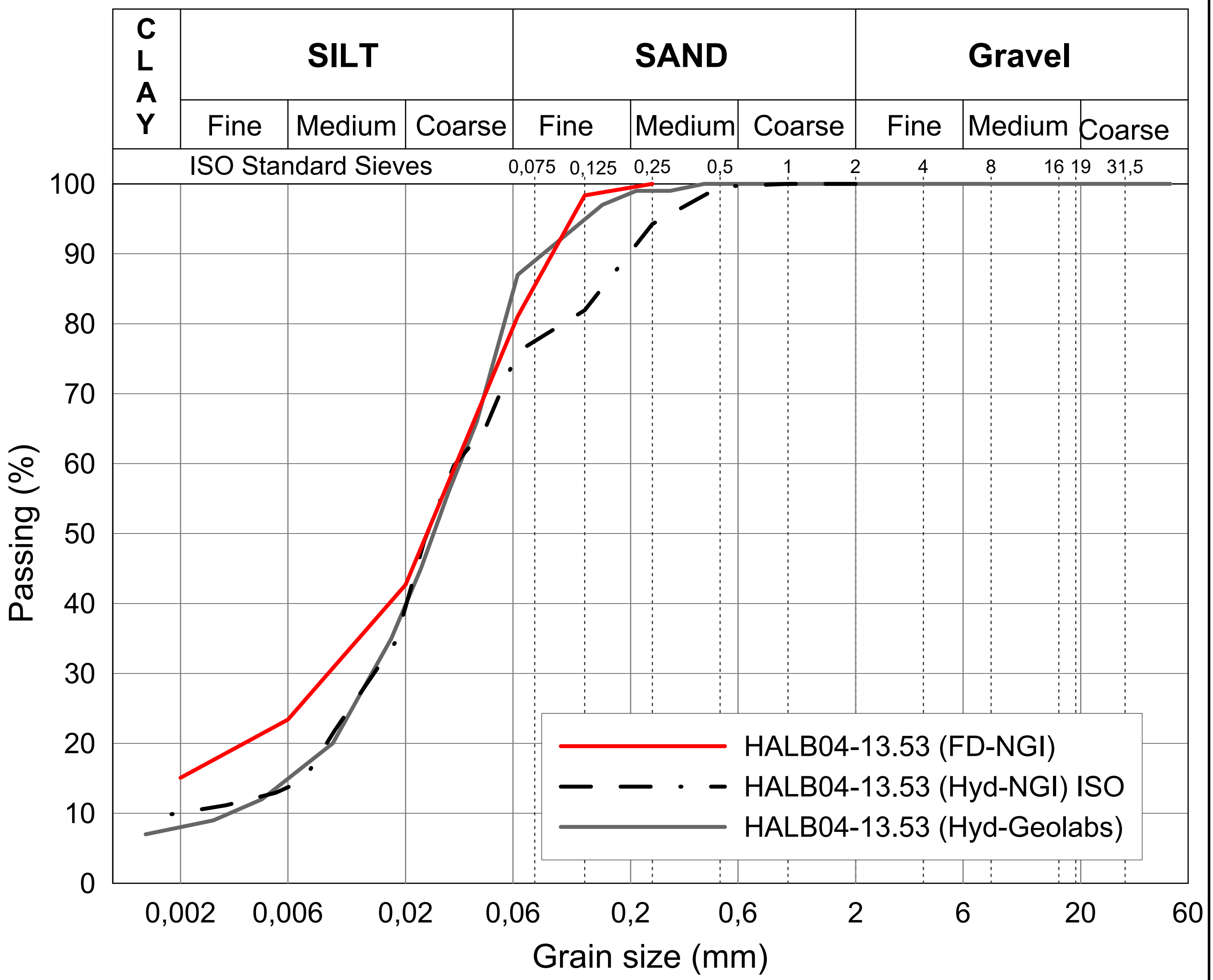

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 13m	Figure No. 28	
	Date 2018-08-20	Drawn by RCa/APP
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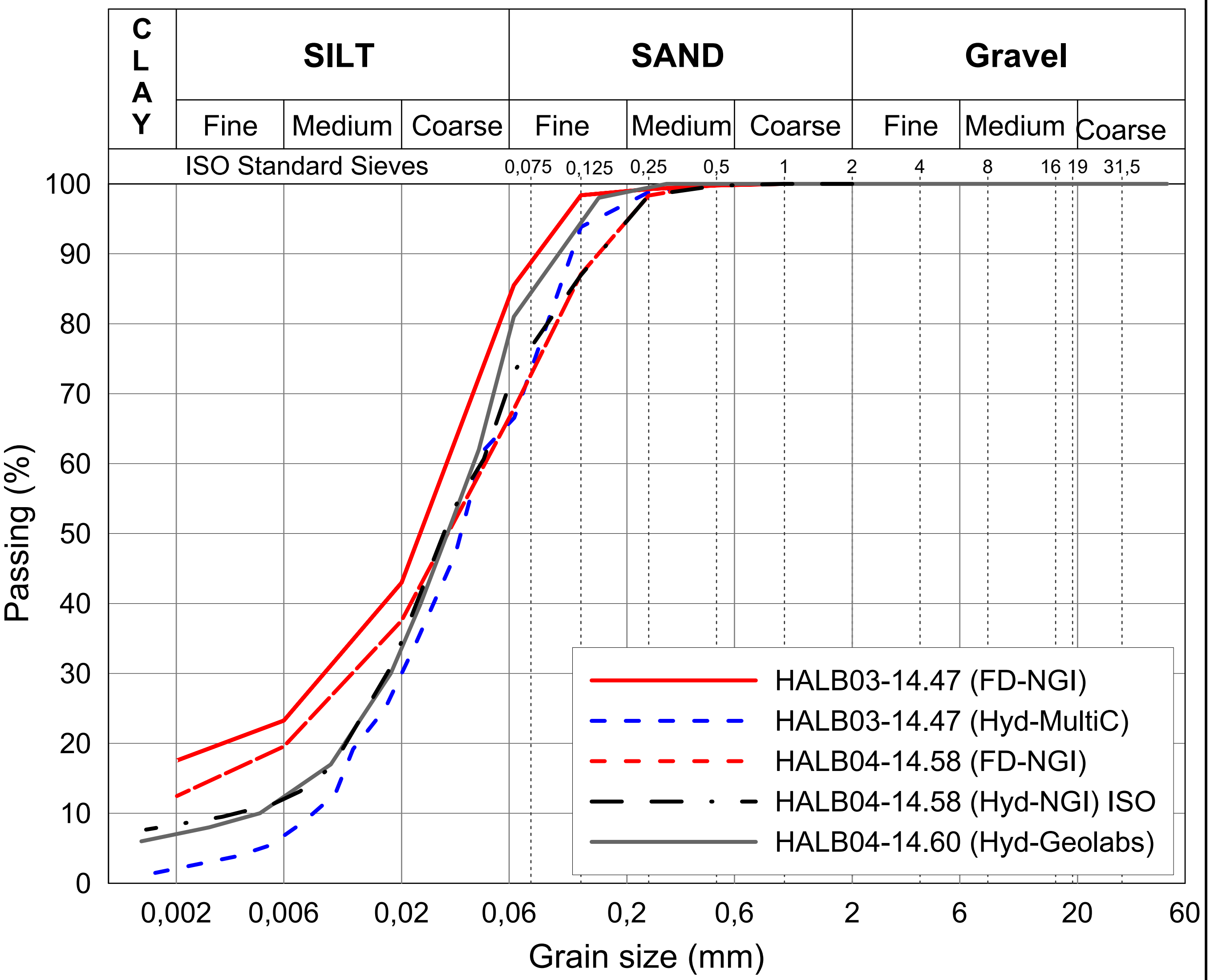

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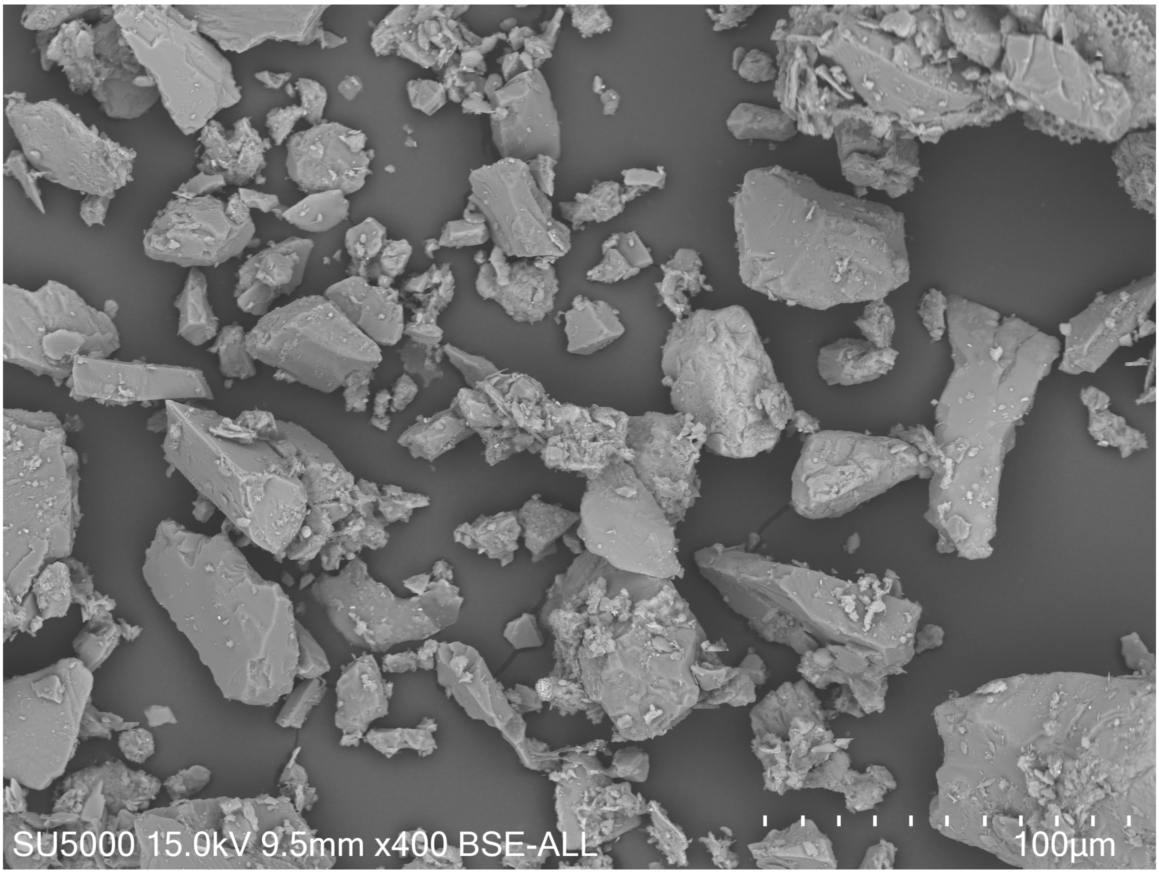
Date/Rev.: 2015-01-21/01

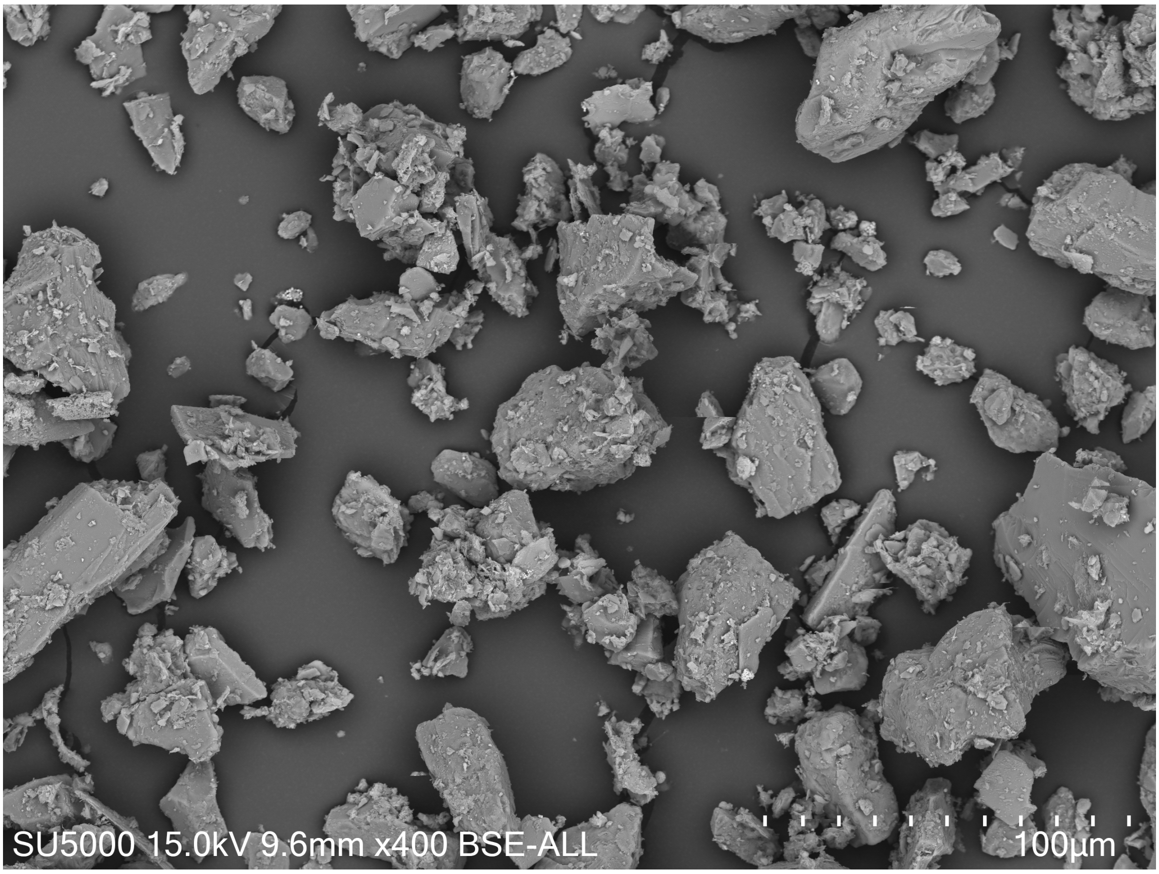
NGTS - Halden Research Site	Document No. 20160154-04-R	
Grain size distributions HAL 14m	Figure No. 29	
	Date 2018-08-20	Drawn by RCa/APP
	NGTS	



a)

b)

NGTS - Halden Research Site	Document No. 20160154-04-R
SEM images a) HALB01, 6.4 m depth. 400X magnification b) HALB01, 6.4 m depth. 1200X magnification	Figure No. 12 Date 2018-05-31 / Drawn by OyB



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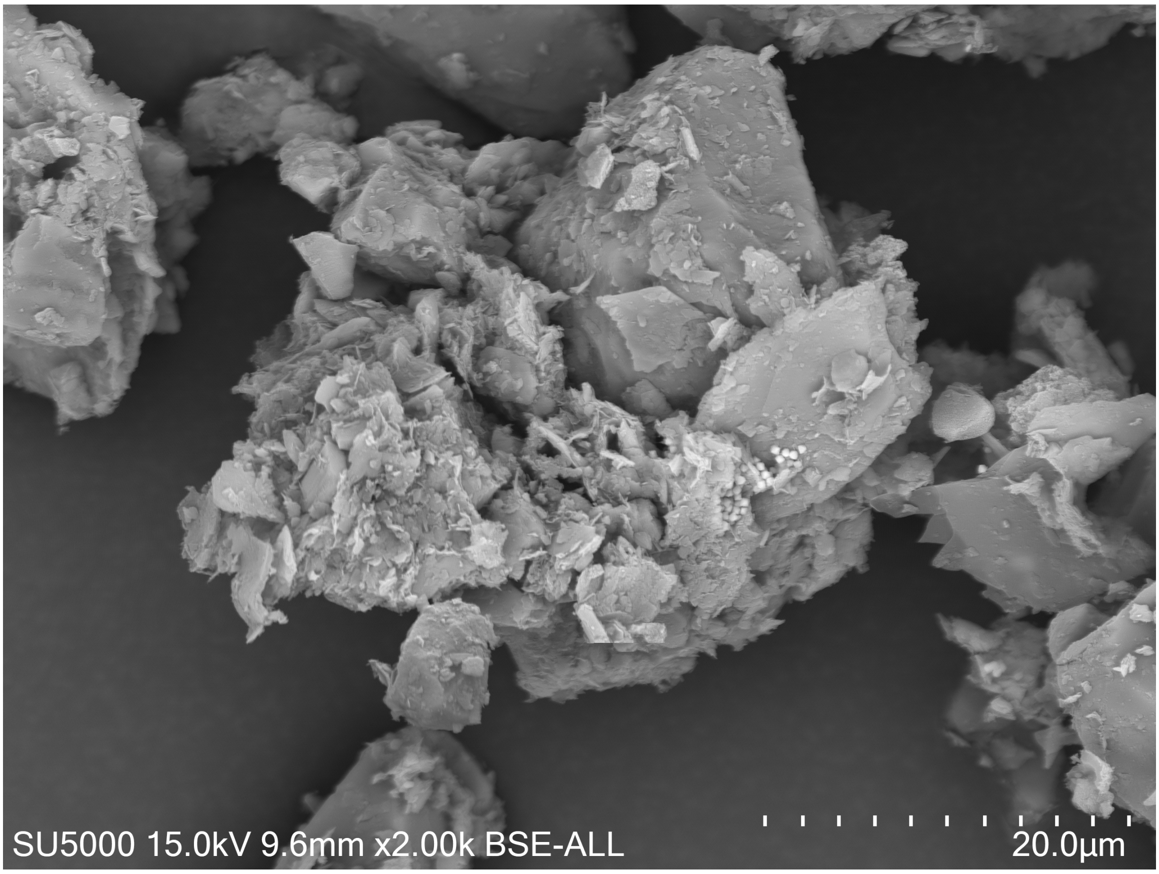

b)

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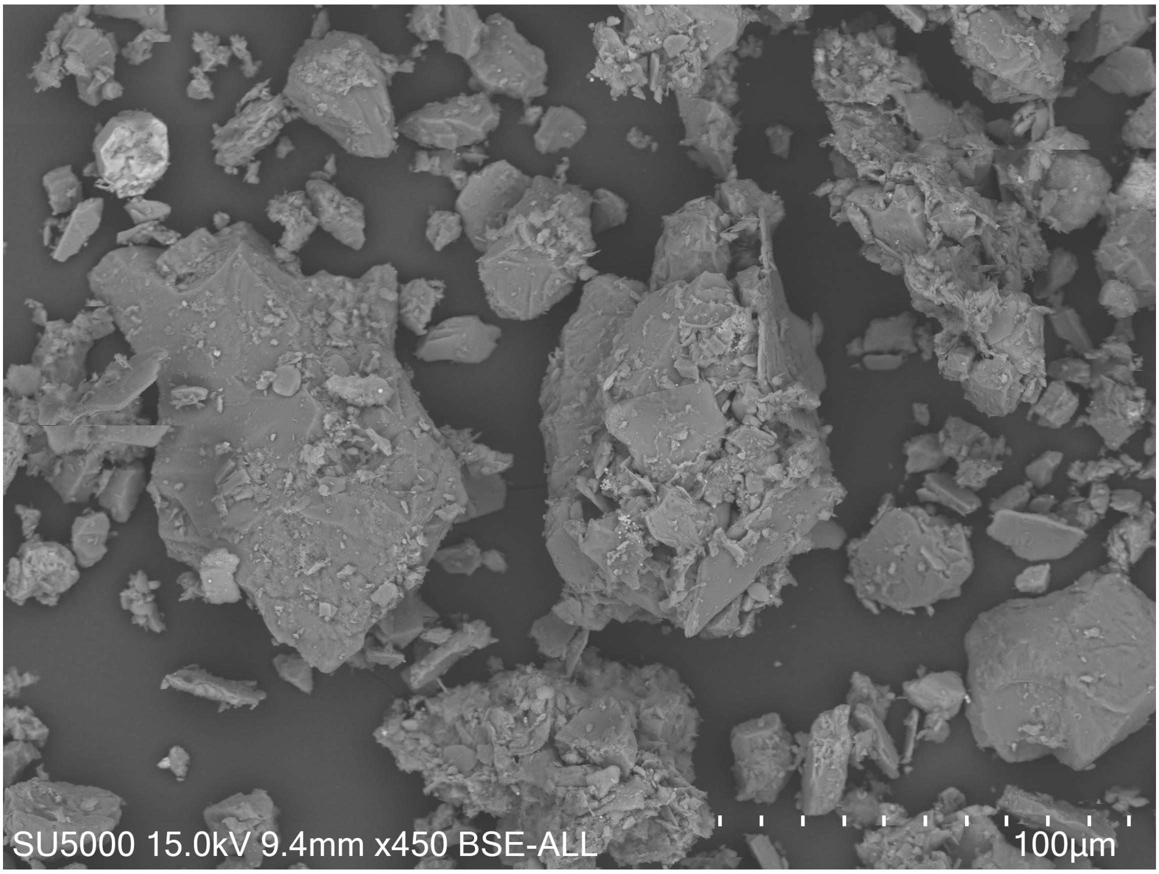
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
SEM images a) HALB01, 7.55 m depth. 400X magnification b) HALB01, 7.55 m depth. 2000X magnification	Figure No. 13 Date 2018-05-31 / Drawn by OyB NGI



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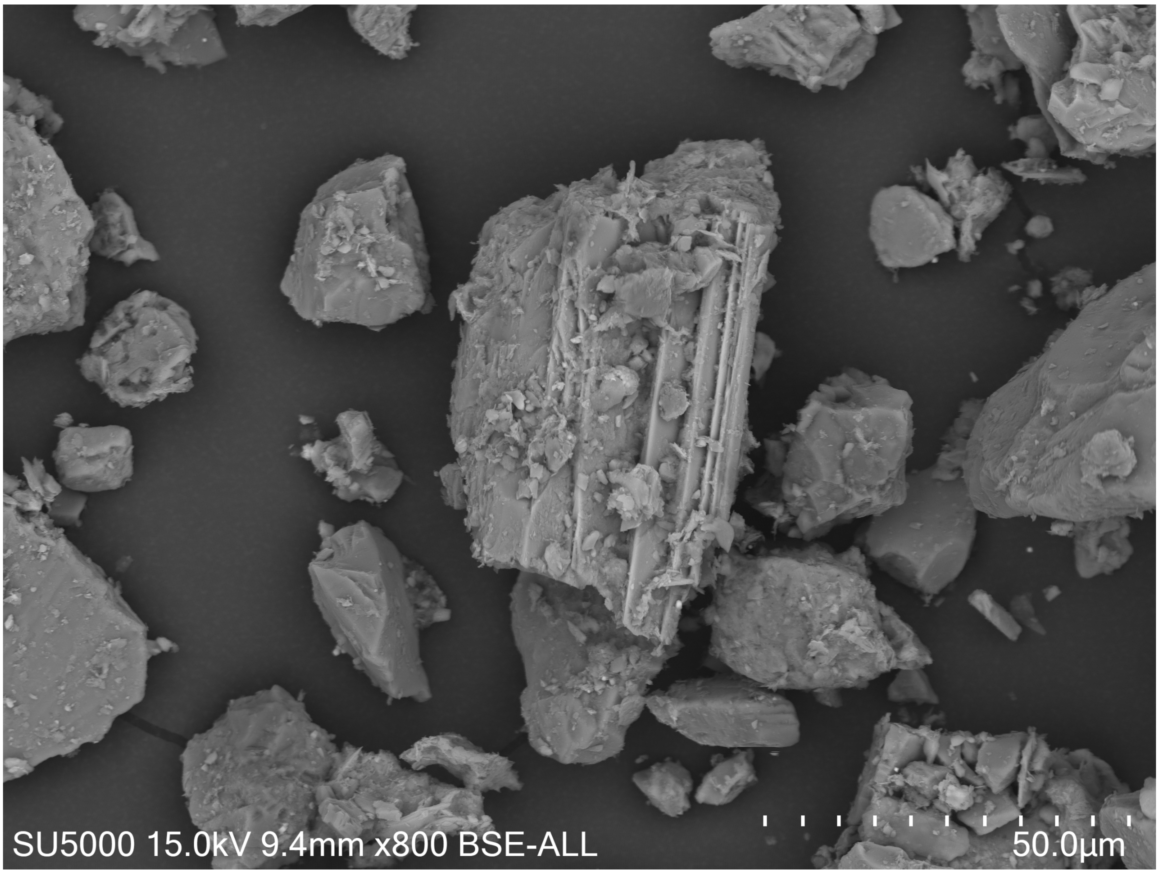

b)

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Document No.	20160154-04-R
Figure No.	14
Date	2018-05-31
Drawn by	OyB

SEM images
a) HALB01, 8.6 m depth. 450X magnification

b) HALB01, 8.6 m depth. 800X magnification

NGI

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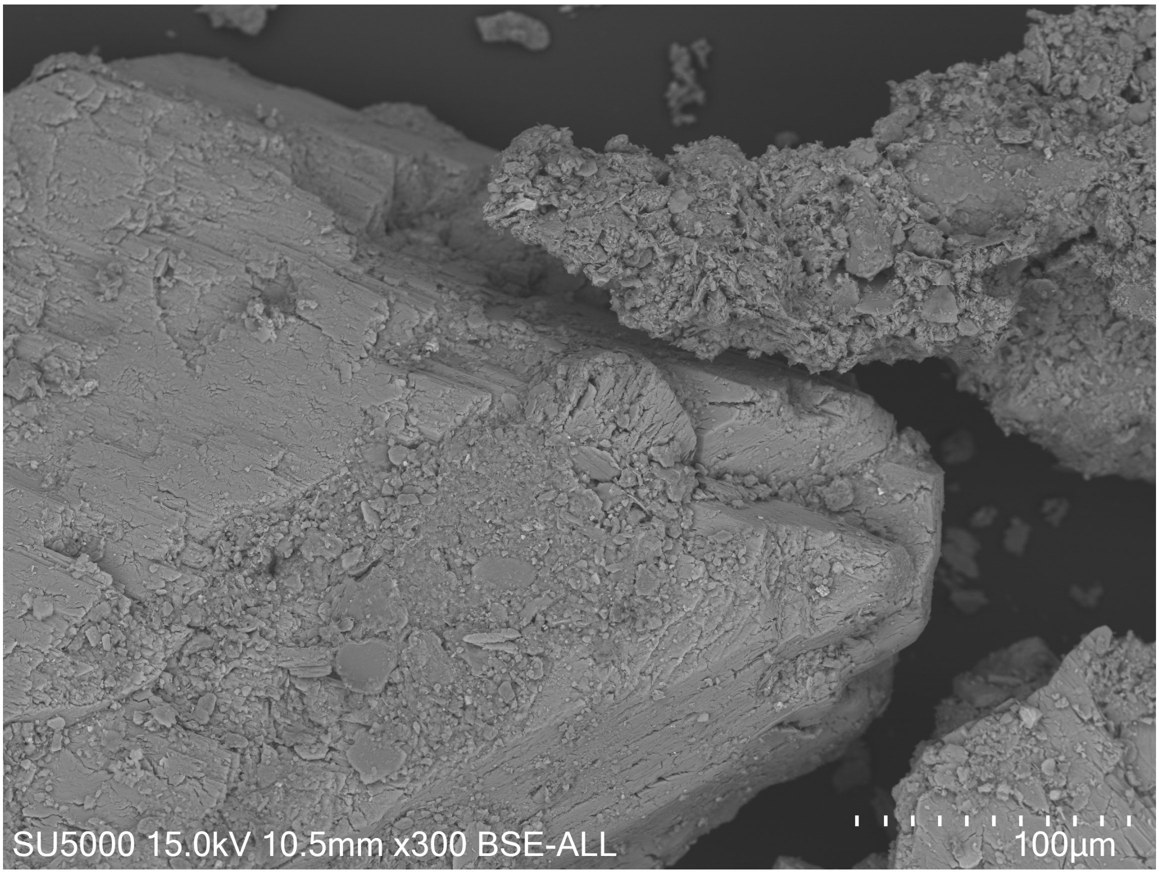

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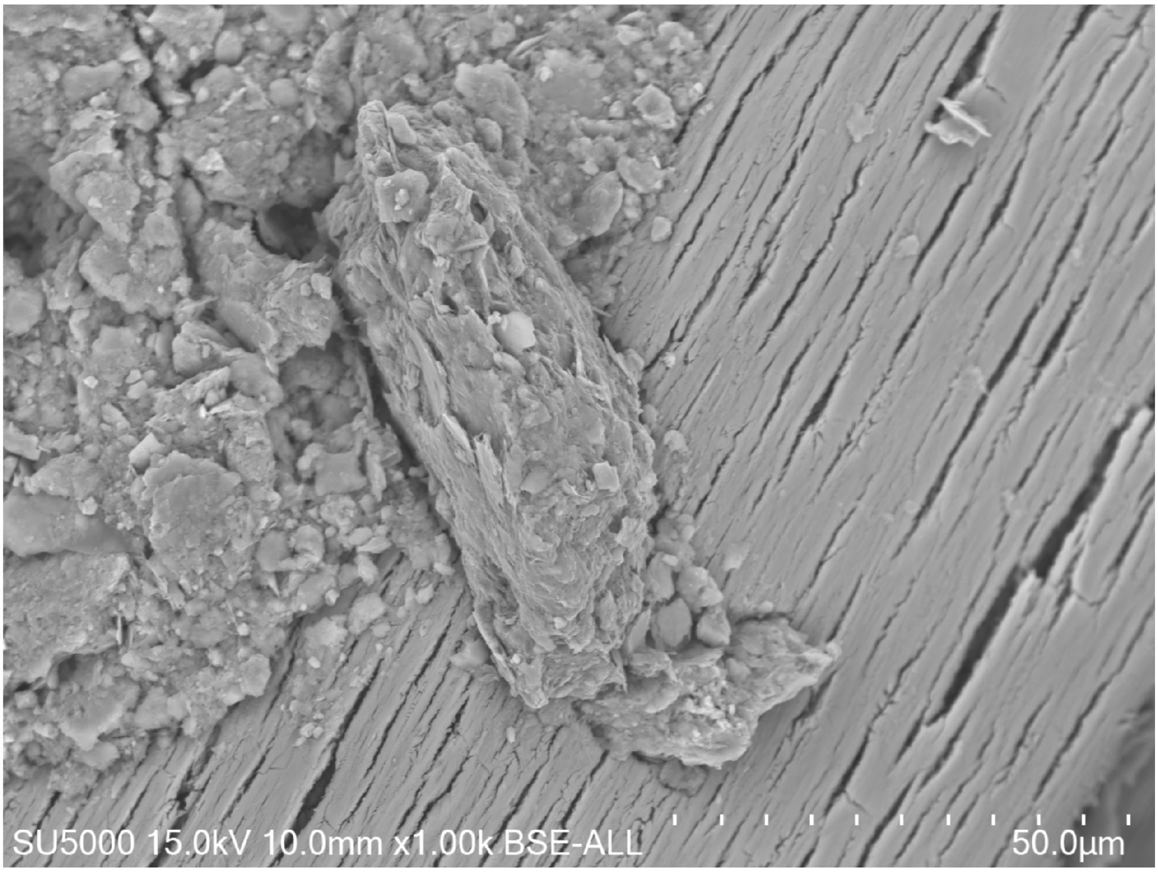

b)

Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site

Document No.
20160154-04-R

Figure No.
15

Date
2018-05-31

Drawn by
OyB

SEM images
a) HALB01, 15.3 m depth. 300X magnification

b) HALB01, 15.3 m depth. 1000X magnification

NGI

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Appendix N

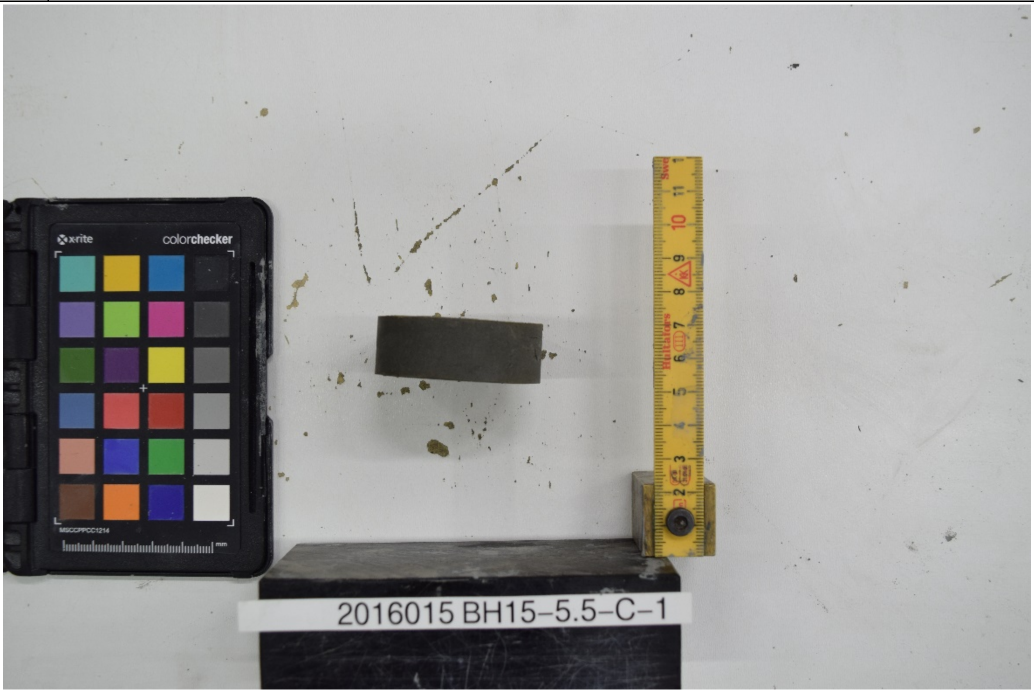
OEDOMETER TEST RESULTS

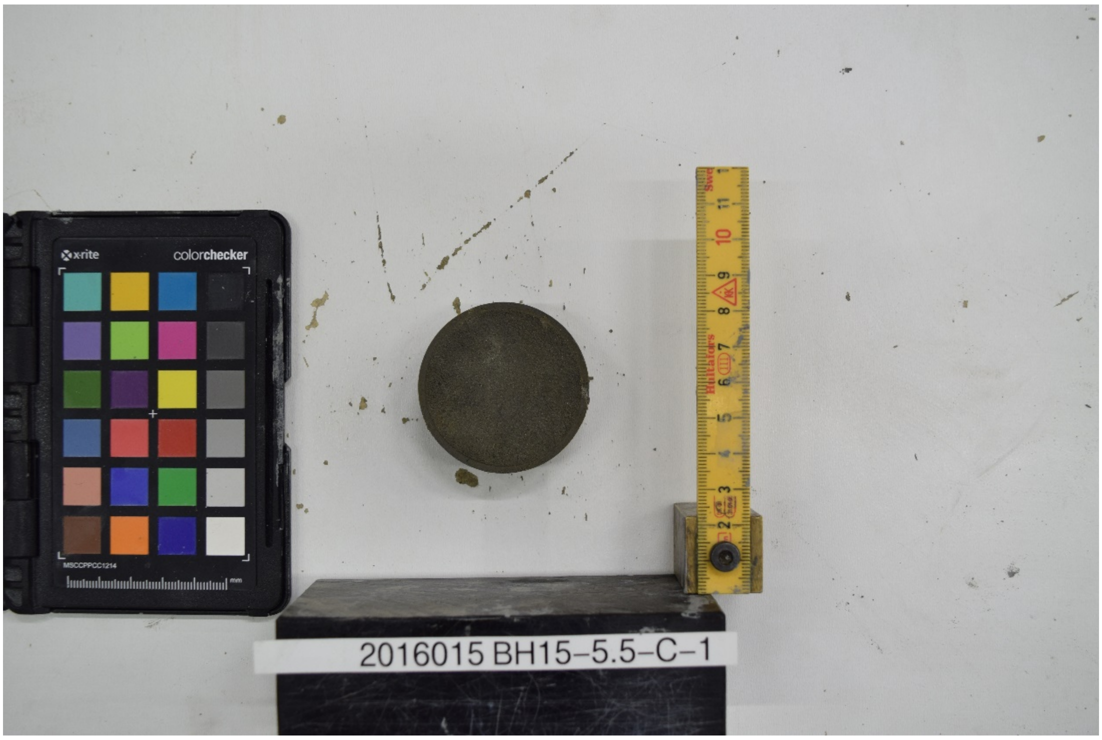
Test:	HALB03-8-F-1

Test:	HALB04-3-1B-1

Test:	HALB04-3-1B-1

Test:	HALB04-5.5-C-1





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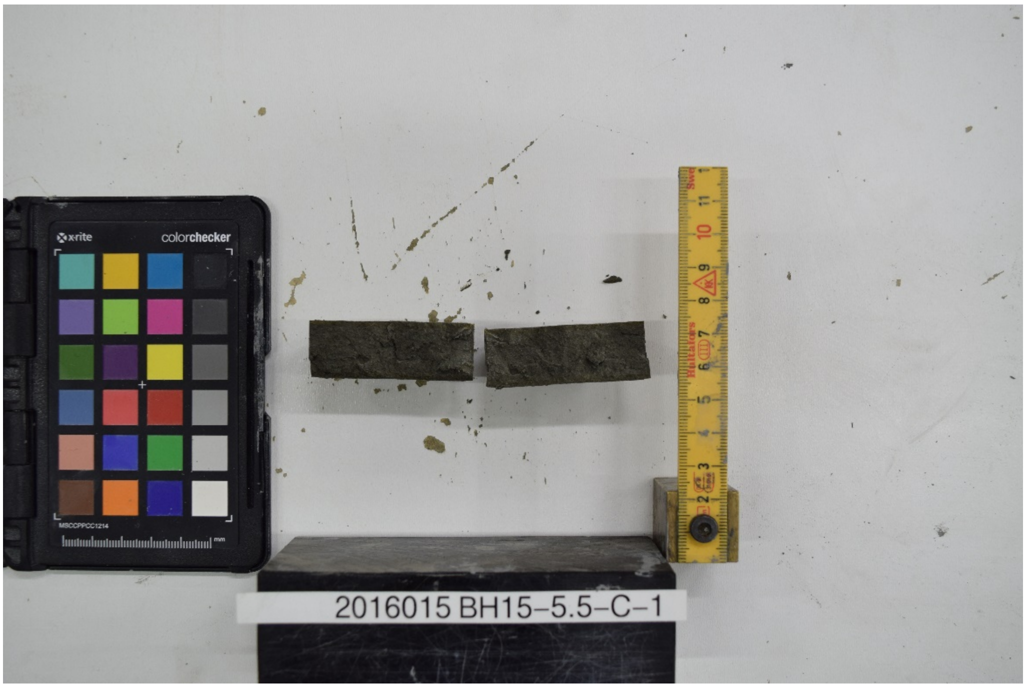
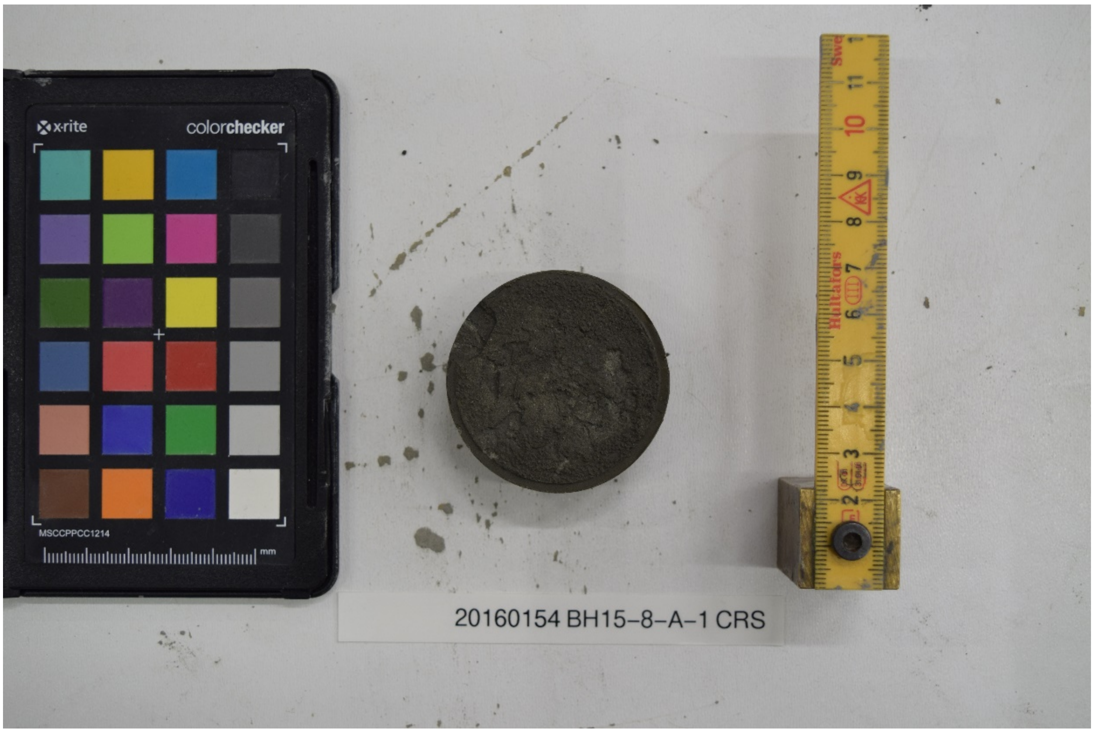


Test:	HALB04-8-A-1



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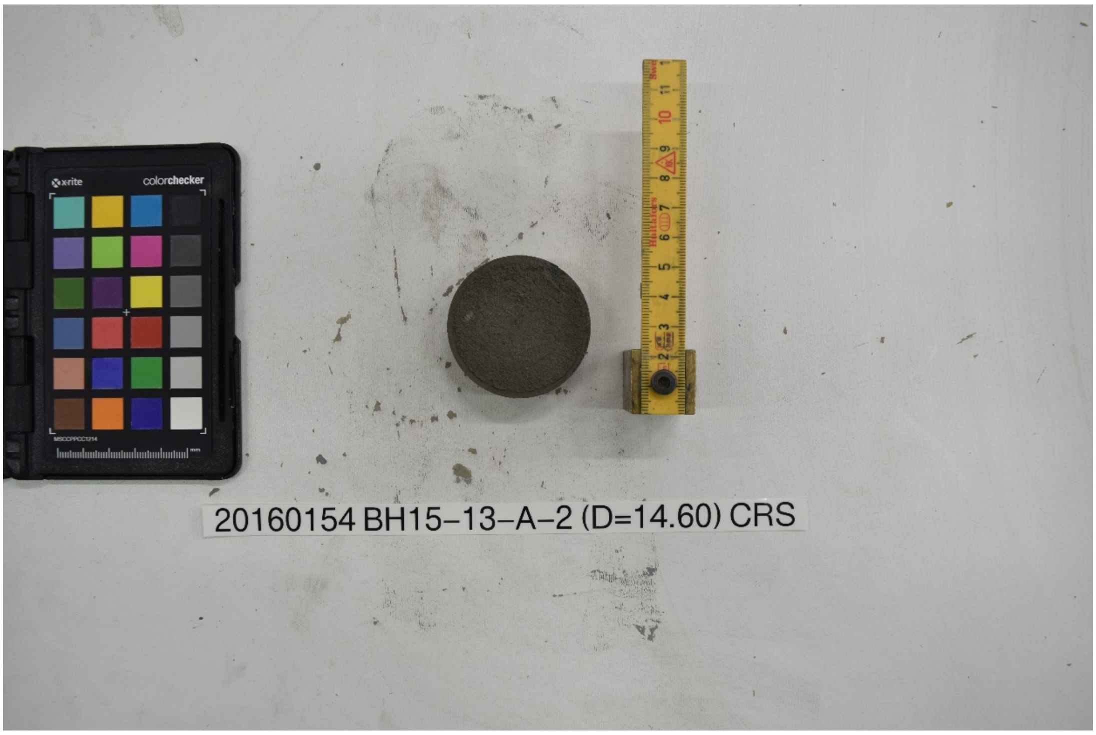
Test:	HALB04-13-A-2



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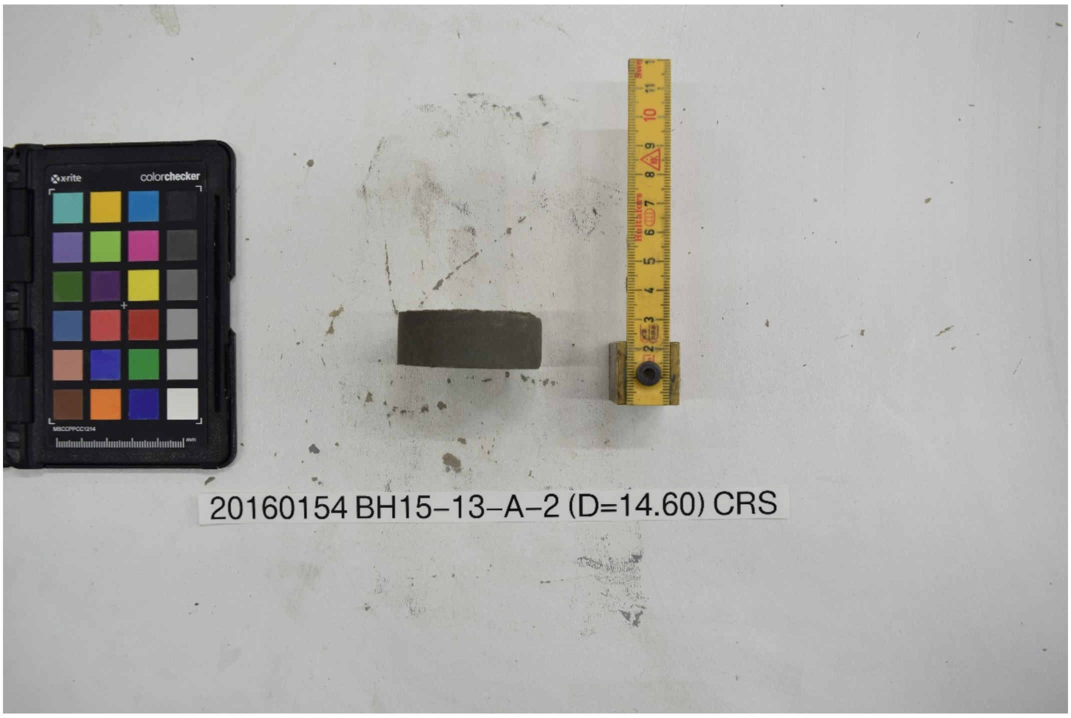
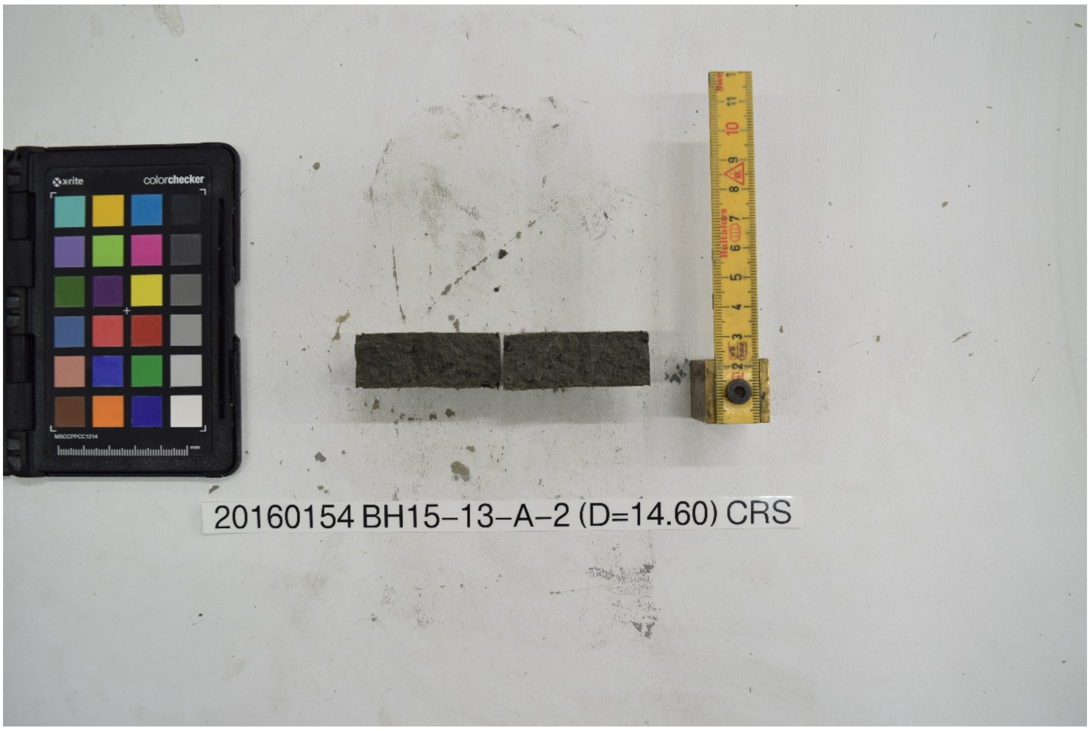
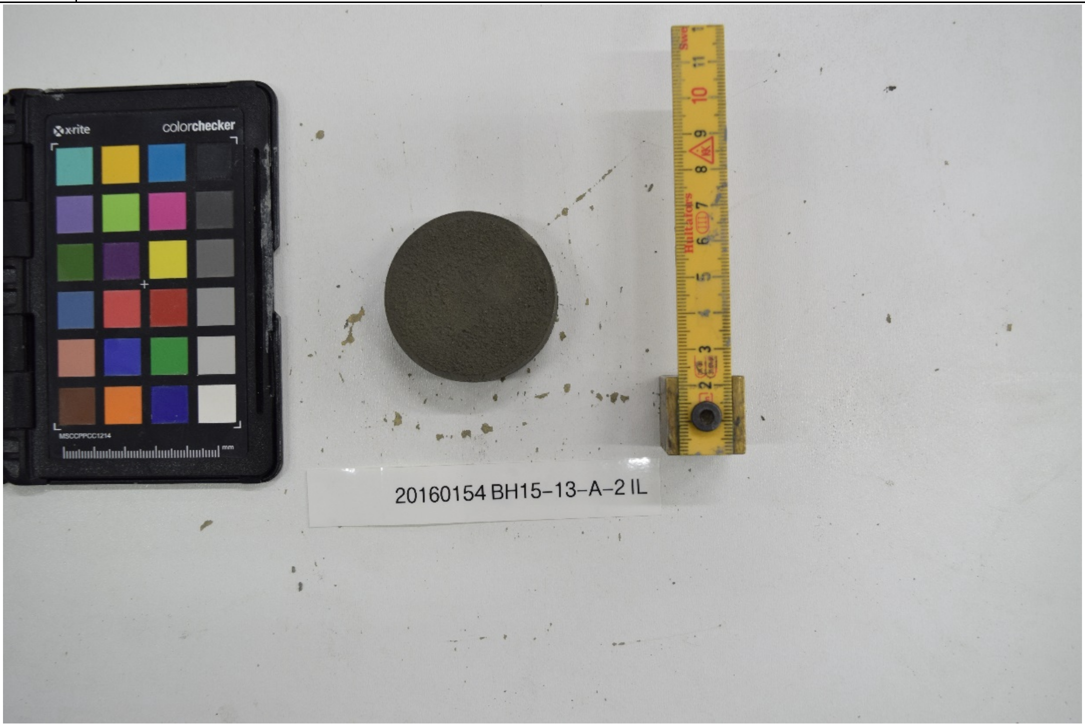
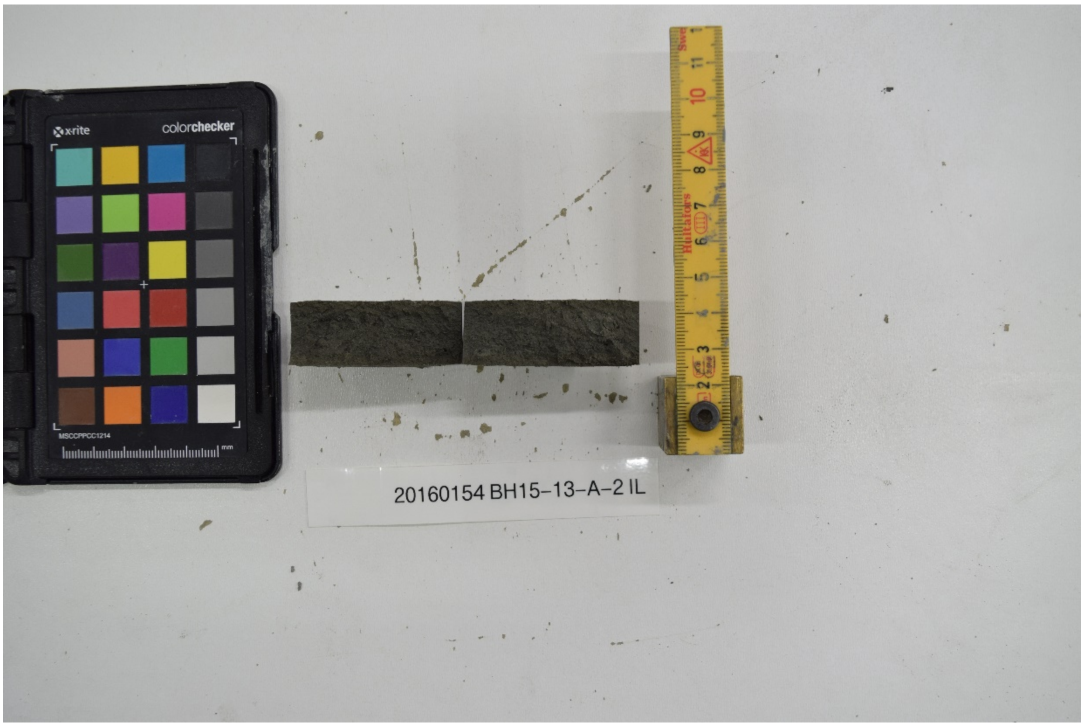




Test:	HALB04-5.5-C

Test:	HALB04-13-A-2





Test:	HALB04-6-2

Table 1: Summary of odeometer test results: NGTS- Halden Research Site

Boring No.	Tube part test	Depth (m)	Test type	Loading Rate %/hr or load increment	Sample area (cm^2)	INDEX PROPERTIES: Water content w_i (%)	I_p (%)	Clay cont. (%)	Fines cont. (%)	Unit weight (kN/m^3)	LOADING PROCEDURE: Estim. s_{v0}' (kPa)	Start unload, p_1' (kPa)	Start re-load, p_2' (kPa)	Start unload, p_3' (kPa)	Start re-load, p_4' (kPa)	DEFORMATION PARAMETERS: Loading M_0 (MPa)	Loading M_1 (MPa)	Loading M_2 (MPa)	Stress range (<) for m (kPa)	m (-)	p_r' (kPa)	COEFF. OF CONS. Loading c_{v0} (m2/s)	c_{v1} (m2/s)	c_{v2} (m2/s)	PERM. k 1) (m/s)	ESTIM. PRECONS. PRESSURE p_c' 2) (kPa)	p_c' 3) (kPa)	p_c' 4) (kPa)	p_c' 5) (kPa)	$\Delta V/V$ at p_0' (%)	COMMENTS	FIGURE REFERENCE
HALB01	8-B-2	4,47	CRSC	5,4	35	34,1	7,5	3,9	75,0	18,96	64	500	30	-	-	3,9	47	-	500	28	-75	5,5E-06	4,9E-05	-	1,5E-08	120	-	-	-	1,66	Permeability at p'o and unload loop. Clay 8.8 % NGI Falling Drop & Caly 4 % Hyd Unicone.	Fig. 01 - Fig. 04
HALB03	3-A-1	5,42	CRSC	5,4	20	29,0	-	7,5	57,0	19,62	65	7248	65	-	-	11,2	363	-	1000	68	-120	-	-	-	-	1200	-	-	-	0,34	Tube hit the floor before specimen was extruded. Permeability was not possible, flow too fast. SILT, soft. homogeneous, grey	Fig. 05 - Fig. 07
HALB03	5-A-1	7,50	CRSC	5,4	20	29,3	-	7,2	98,0	19,26	81	517	82	1 683	82	7,9	96	154	300	38	-110	1,2E-05	9,5E-05	1,1E-04	1,7E-08	300	-	-	-	1,10	SILT, medium hard, homogenous, dark grey	Fig. 08 - Fig. 11
HALB03	6-B-1	8,28	CRSC	5,4	20	27,5	9,0	9,5	99,0	19,74	94	2021	95	-	-	8,4	209	-	600	40	-110	1,5E-05	1,5E-04	-	2,0E-08	550	-	-	-	1,08	SILT, medium hard, homogenous, dark grey	Fig. 12 - Fig. 15
HALB03	8-F-1	10,33	CRSC	5,4	20	27,7	6,0	10,5	84,0	19,71	112	2000	113	-	-	11,8	200	-	1000	31	-300	1,4E-05	1,2E-04	-	1,3E-08	280	-	-	-	1,17	SILT, sandig clayey, grey	Fig. 16 - Fig. 19
HALB03	12-B-1	14,31	CRSC	5,4	20	24,5	6,5	8,4	73,0	19,97	158	3407	158	-	-	16,1	328	-	1000	54	-190	2,6E-05	2,9E-04	-	2,0E-08	400	-	-	-	1,63	SILT, medium hard, homogenous, grey	Fig. 20 - Fig. 23
HALB04	3-1B-1	5,27	CRSC	5,4	20	30,5	6,7	7,4	75,0	19,45	65	978	66	-	-	5,2	104	-	1000	29	-200	7,8E-06	7,9E-05	-	1,8E-08	300	-	-	-	1,24	SILT; some organic rests, homogenous, dark grey	Fig. 24 - Fig. 27
HALB04	5--1	7,03	CRSC	5,4	20	28,5	8,1	7,5	90,0	19,31	81	450	82	1 420	82	7,0	83	144	400	38	-88	3,0E-05	2,4E-04	2,9E-04	5,1E-08	350	-	-	-	1,20	SILT; medium hard, homogeneous, grey	Fig. 28 - Fig. 31
HALB04	6-2	8,17	CRSC	5,4	50	29,0	10,0	8,0	82,0	19,52	92	94	400	1 175	-	9,3	39	90	420	42	-45	2,1E-05	5,6E-05	1,1E-04	2,7E-08	300	-	-	-	1,87	Mounted horizontally. SILT; medium hard, homogeneous, grey	Fig. 60 - Fig. 62
HALB04	5.5-C-1	8,40	CRSC	5,4	20	28,8	10,0	11,0	82,0	19,46	94	1174	98	-	-	7,5	140	-	1000	28	-170	1,1E-05	1,1E-04	-	1,7E-08	290	-	-	-	1,49	SILT, fissured, grey, black spots	Fig. 32 - Fig. 35
HALB04	8-A-1	10,07	CRSC	5,4	20	26,1	9,2	10,5	84,0	20,04	112	1487	202	-	-	9,5	162	-	1000	29	-270	6,9E-06	5,2E-05	-	9,3E-09	230	-	-	-	1,83	SILT, hard, homogenous, dark grey	Fig. 36 - Fig. 39
HALB04	13-A-2	14,60	CRSC	5,4	20	22,2	5,0	7,0	81,0	20,69	158	1015	158	4 563	158	16,7	188	396	300	54	-190	1,3E-05	9,8E-05	1,4E-04	9,8E-09	410	-	-	-	1,55	SILT, hard, single shell fragments, homogenous, grey	Fig. 40 - Fig. 43
HALB05	1-B-1	9,35	CRSC	5,4	20	28,5	-	9,3	88,1	20,05	106	1099	111	-	-	9,1	160	-	400	54	-40	5,5E-06	6,6E-05	-	7,8E-09	190	-	-	-	2,99	SILT; medium hard, homogeneous, grey	Fig. 44 - Fig. 47
HALB05	2-D-1	12,71	CRSC	5,4	20	29,4	6,5	8,0	81,0	19,87	136	881	136	-	-	7,3	142	-	700	37	-190	6,5E-06	8,0E-05	-	1,2E-08	120	-	-	-	3,01	-	Fig. 48 - Fig. 51
HALB06	6-C-1	13,07	CRSC	5,4	20	26,6	8,1	9,4	78,0	19,92	142	1748	142	-	-	11,4	218	-	550	46	-100	1,2E-05	1,2E-04	-	1,4E-08	230	-	-	-	2,88	SILT: medium strength, homogenoues, dark grey	Fig. 69 - Fig. 71
HALB01	8-B-3	4,65	IL	30 min	35	34,5	7,3	3,9	75,0	18,50	64	500	30	-	-	6,0	58	-	500	35	-100	-	-	-	4,7E-08	200	-	-	-	1,75	-	Fig. 52 - Fig. 53
HALB04	5-A-1	7,03	IL	30 min	20	29,9	8,1	7,0	90,0	19,41	81	647	49	-	-	6,1	103	-	650	36	-121	8,3E-06	-	-	3,8E-08	210	-	-	-	1,60	SILT; medium hard, homogeneous, grey	Fig. 54 - Fig. 55
HALB04	6-1	8,02	IL	24 h	20	27,2	10,0	9,0	70,0	19,87	92	731	93	-	-	7,1	139	-	600	41	-150	8,3E-06	-	-	1,7E-08	330	-	-	-	1,79	SILT, medium to high, homogenous, grey	Fig. 63 - Fig. 64
HALB04	5.5-C-2	8,42	IL	30 min	20	28,2	10,0	9,0	82,0	19,56	94	765	93	-	-	9,2	133	-	800	43	-46	8,6E-06	1,2E-04	-	9,3E-09	310	-	-	-	1,78	IL -measured cv not reliable, instead calculated cv from k and Mo.	Fig. 56 - Fig. 57
HALB04	13-A-2	14,60	IL	30 min	20	24,4	5,0	7,0	81,0	20,78	158	1265	157	-	-	11,0	231	-	1000	75	-32	9,4E-07		-	1,0E-08	-	-	-	-	3,10	30 min increments, IL - greater deformation in IL compared to CRS	Fig. 58 - Fig. 59
HALB05	1-2	9,57	IL	24 h	20	30,0	6,0	9,3	77,0	19,39	107	917	98	-	-	7,0	138	-	700	28	-150	6,6E-06	-	-	1,2E-08	305	-	-	-	2,36	SILT; medium hard, homogeneous, grey	Fig. 65 - Fig. 66
HALB06	4-B-1	10,08	IL	24 h	20	28,1	9,2	10,2	81,0	19,74	107	932	98	-	-	8,7	145	-	700	34	-110	2,8E-06	-	-	1,5E-08	300	-	-	-	2,20	SILT, medium hard, homogenous, grey. 24 hour loading increments. 1 unloading/reloading loop	Fig. 67 - Fig. 68

CLIENT: NGI

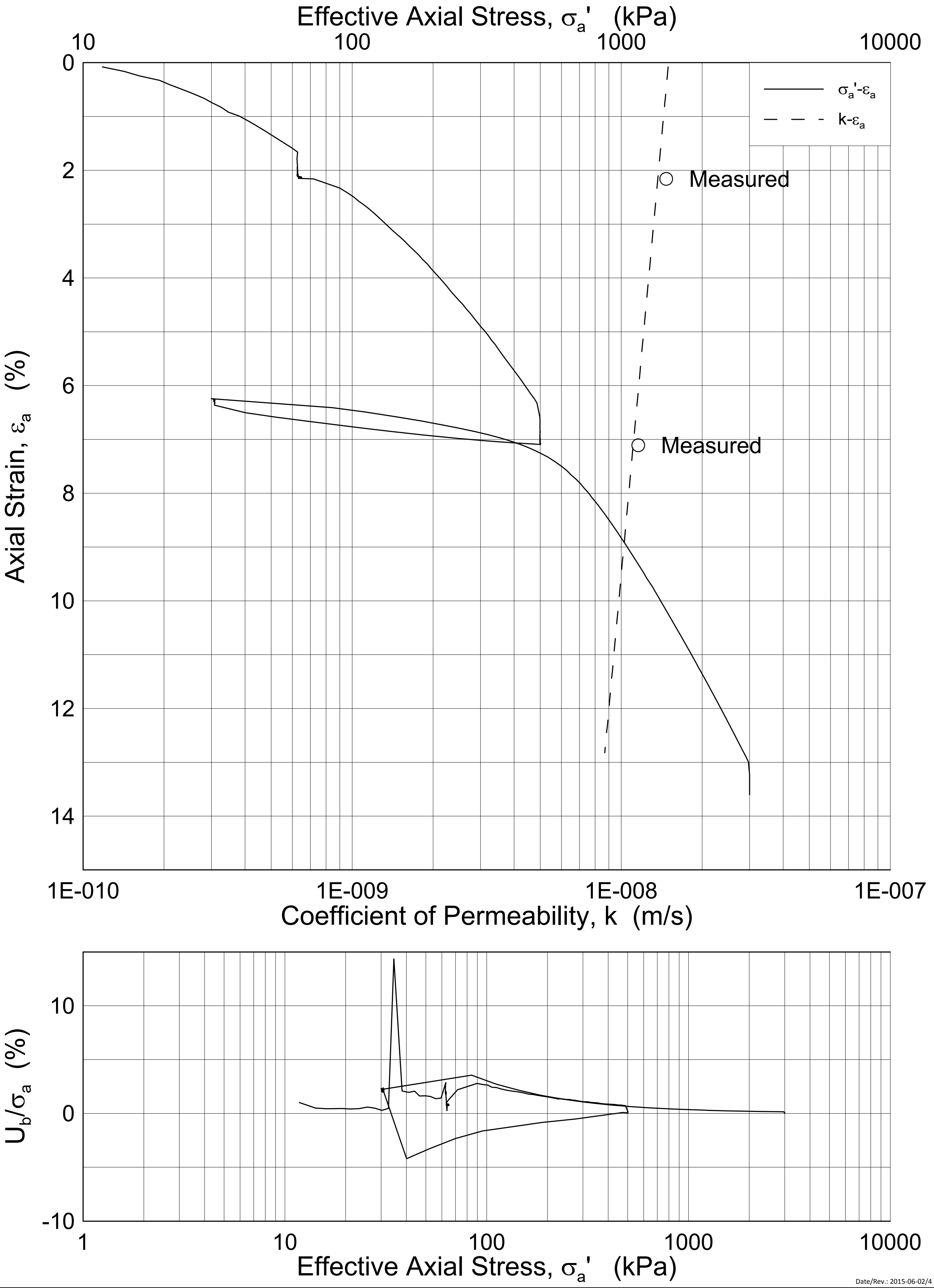
PROJECT: NGTS Halden

Document No.: 20160154-04-R

M_0,c_{v0} = at p_0' (tangent module)
M_1,c_{v1} = average from p_2' to p_1', reloading
M_2,c_{v2} = average from p_4' to p_3', reloading

NA = Not applicable
NAD = Not able to derive

1) k = coefficient of permeability at zero axial strain
2) Using the Casagrande interpretation
3) Using the Becker interpretation
4) Using empirical relationships between s_u, I_p, p_0' and p_c' where s_u is determined in triaxial compression tests (CAUc)
5) Using the Janbu interpretation
6) De/e_i, where $De = e_{vol}(1+e_i)$ and $e_i = 2.69 * w_i$
7) 1 - very good to excellent, 2 - good to fair, 3 - poor, 4 - very poor (Ref. Lunne et al. 1998) marine clay



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Date/Rev.: 2015-06-02/4

NGTS - Halden Research Site	Document No. 20160154-04-R	
Oedometer test (CRSC)	Figure No. 01	
	Date 2018-04-06	Drawn by / Checked FP / GS

Boring: HALB01 | Tube: 8 | Part: B | Test: 2

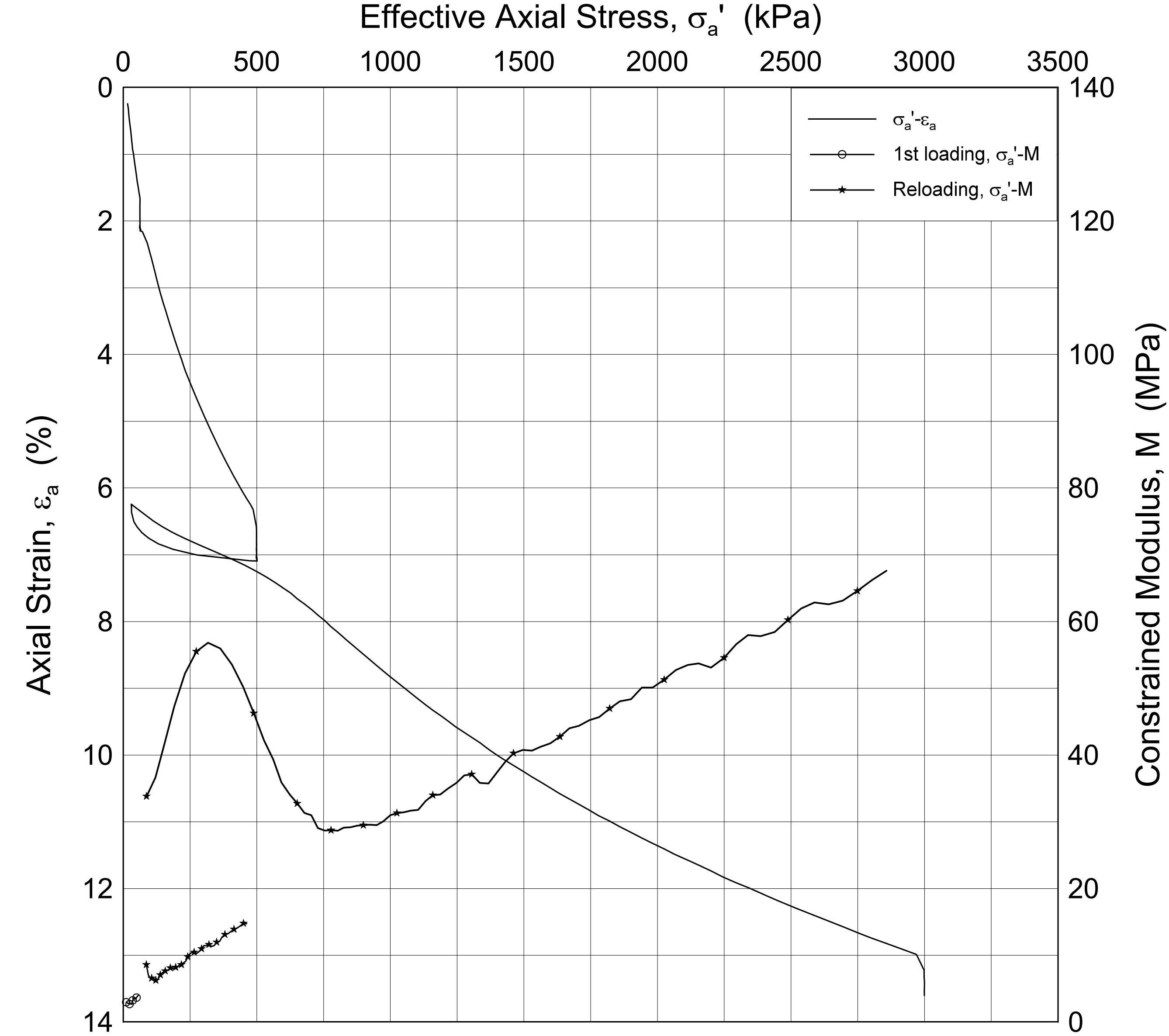
Depth = 4.47 m

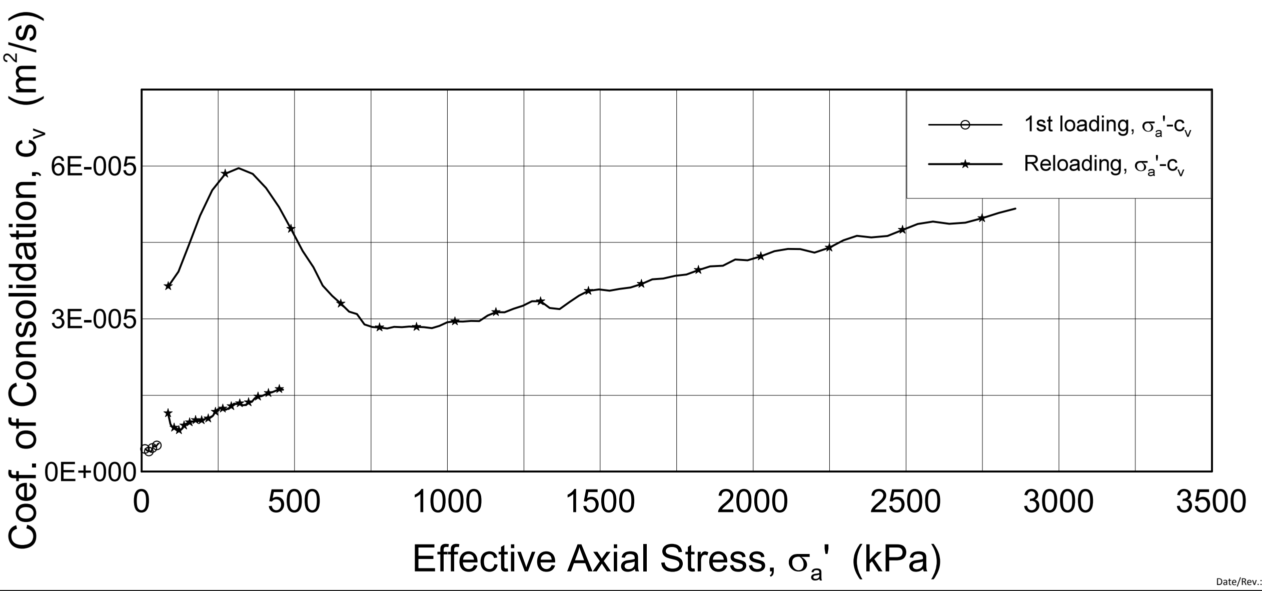
p_0' = 64 kPa

w_i = 34.1 %

γ_i = 18.96 kN/m³

NGTS





Date/Rev.: 2015-06-02/4

NGTS - Halden Research Site

Oedometer test (CRSC)

				Depth	=	4.47	m
Boring:	HALB01	Tube:	8	p_0'	=	64	kPa
		Part:	B	w_i	=	34.1	%
		Test:	2	γ_i	=	18.96	kN/m³

Document No.
20160154-04-R

Figure No.
02

Date
2018-04-06

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FP/GS

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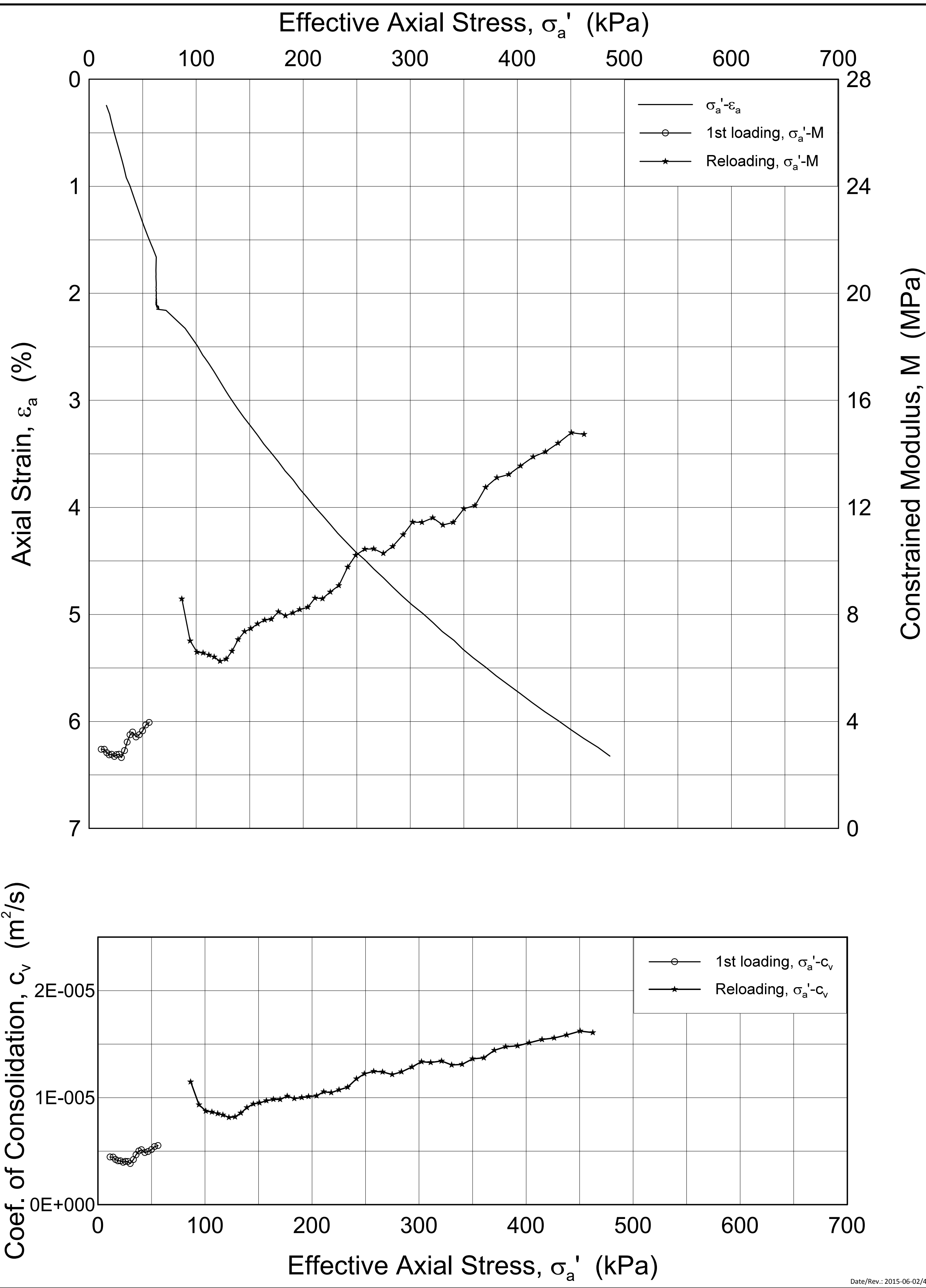

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Document No. 20160154-04-R

Figure No. 03

Date 2018-04-06

Drawn by / Checked FP/GS

Oedometer test (CRSC)

Boring: HALB01	Tube:	8	Depth	=	4.47	m
			p_0'	=	64	kPa
	Part:	B	w_i	=	34.1	%
	Test:	2	γ_i	=	18.96	kN/m³

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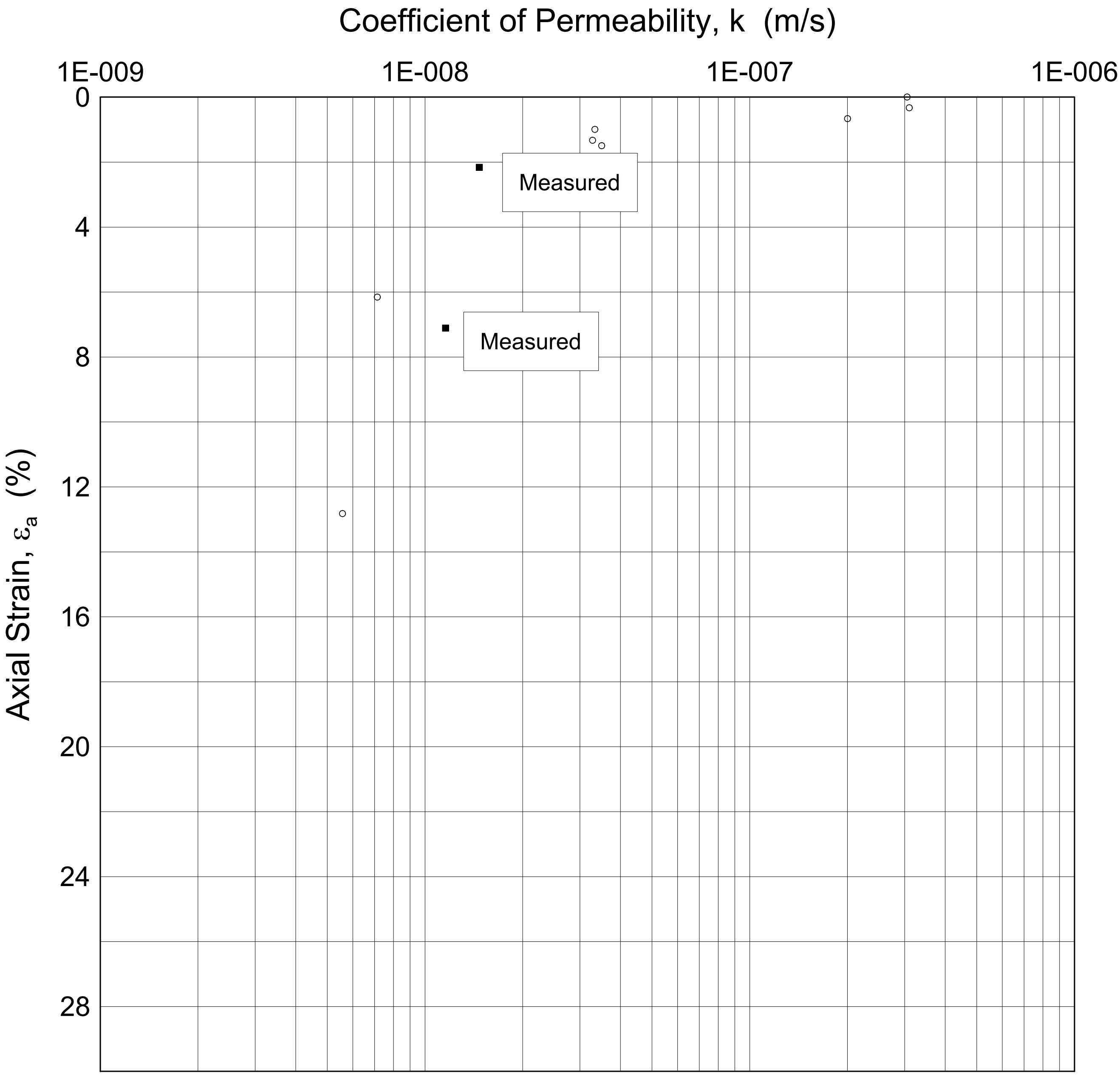

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NGTS - Halden Research Site		Document No. 20160154-04-R
Oedometer test (CRSC)		Figure No. 04
		Date 2018-04-06 / Drawn by / Checked FI / GS

Boring: HALB01 — Tube: 8 — Part: B — Test: 2

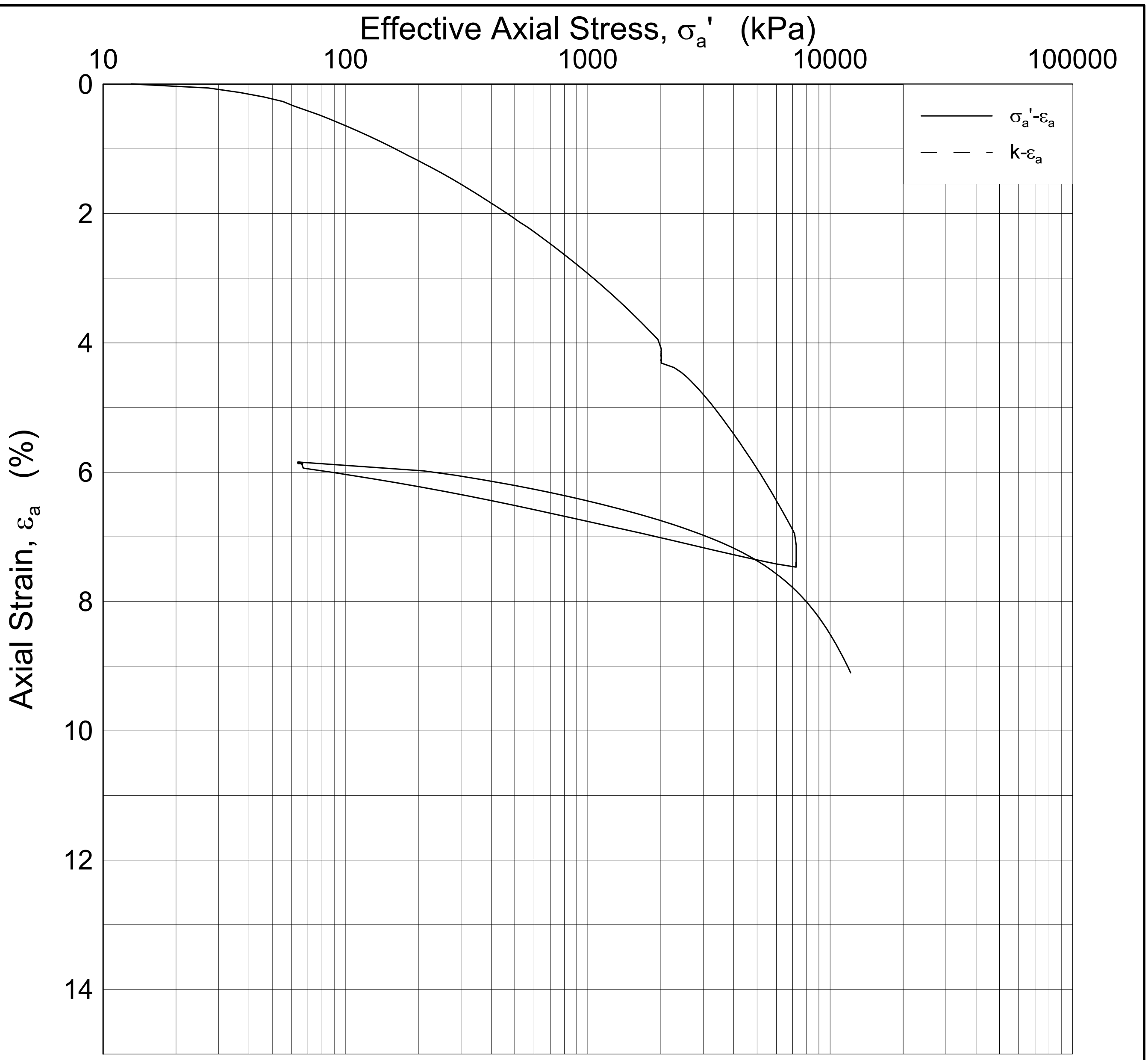
Depth = 4.47 m

p_0' = 64 kPa

w_i = 34.1 %

γ_i = 18.96 kN/m³

NGTS



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Document No. 20160154-04-R

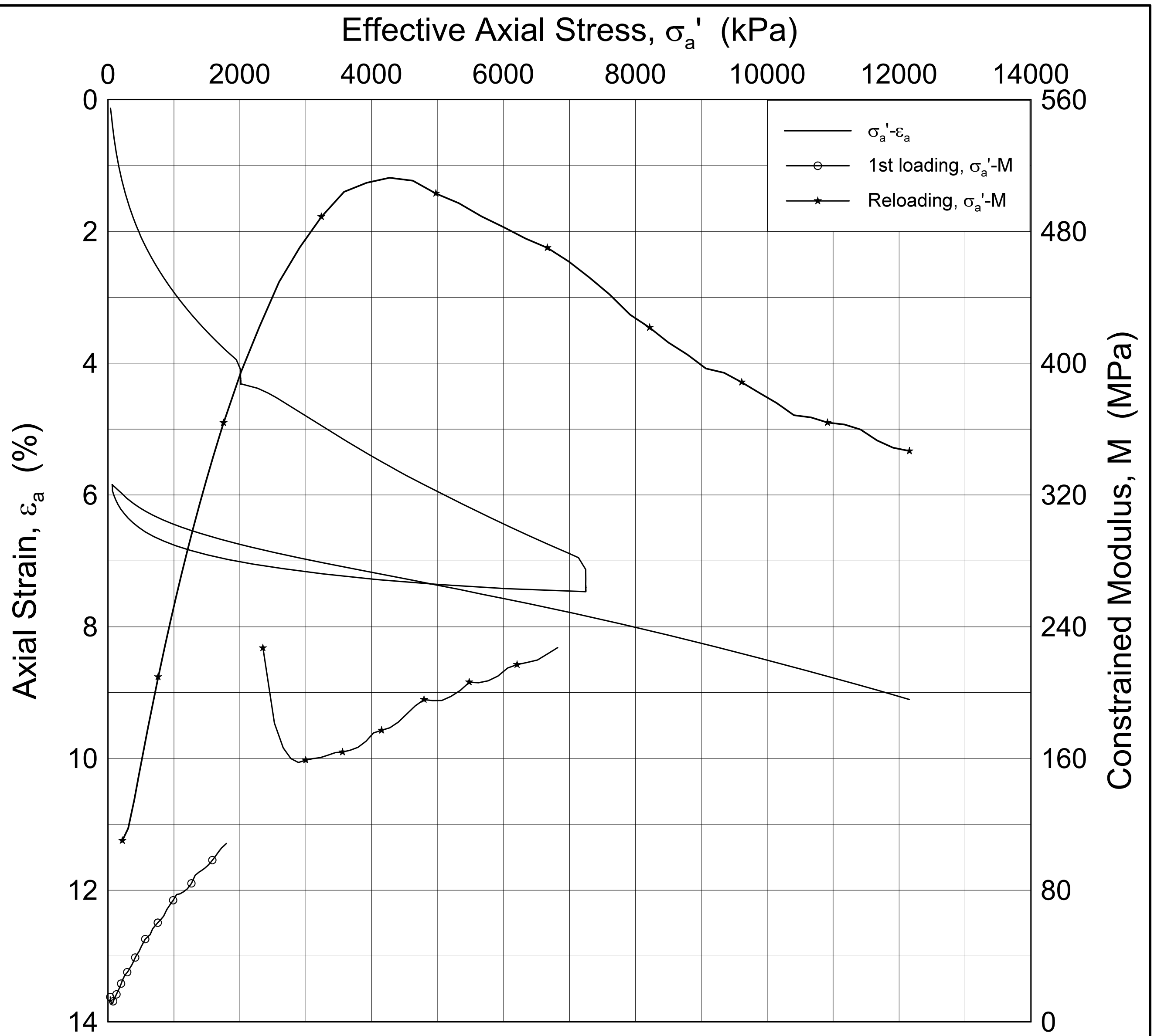
Figure No. 05

Oedometer test (CRSC)

Boring:	HALB03	Tube:	3	Depth	=	5.42	m
		Part:	A	p_0'	=	65.0	kPa
		Test:	1	w_i	=	29.0	%
				γ_i	=	19.62	kN/m³

Date	Drawn by / Checked
2018-04-06	FI/GS

NGTS

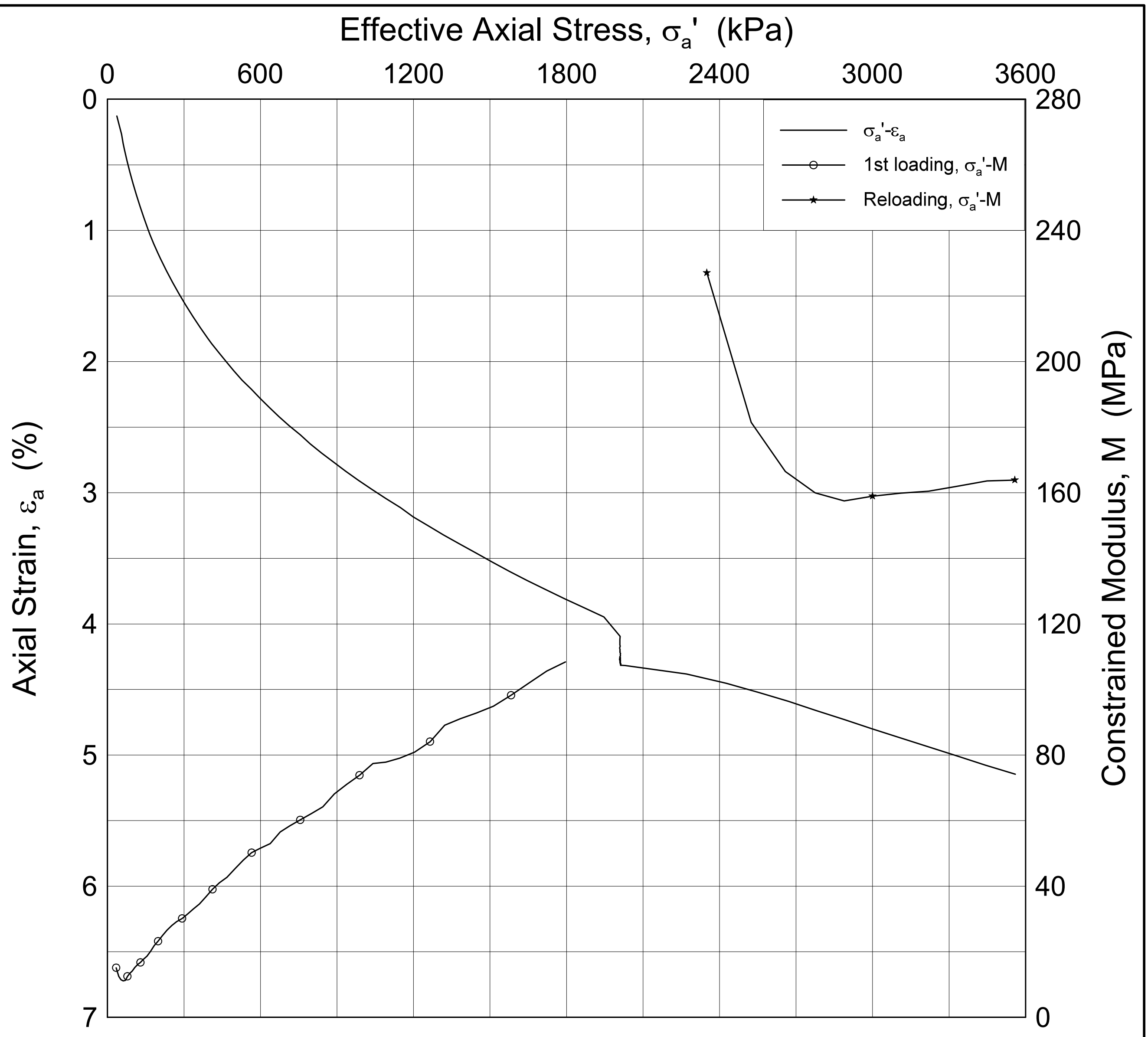


NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 06
	Date 2018-04-06 — Drawn by / Checked FI/GS

Boring: HALB03 | Tube: 3 | Part: A | Test: 1

Depth = 5.42 m
p_0' = 65.0 kPa
w_i = 29.0 %
γ_i = 19.62 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

Boring: HALB03 Tube: 3 Part: A Test: 1

Depth = 5.42 m

p_0' = 65.0 kPa

w_i = 29.0 %

γ_i = 19.62 kN/m³

Document No. 20160154-04-R

Figure No. 07

Date 2018-04-06

Drawn by / Checked FI/GS

NGTS

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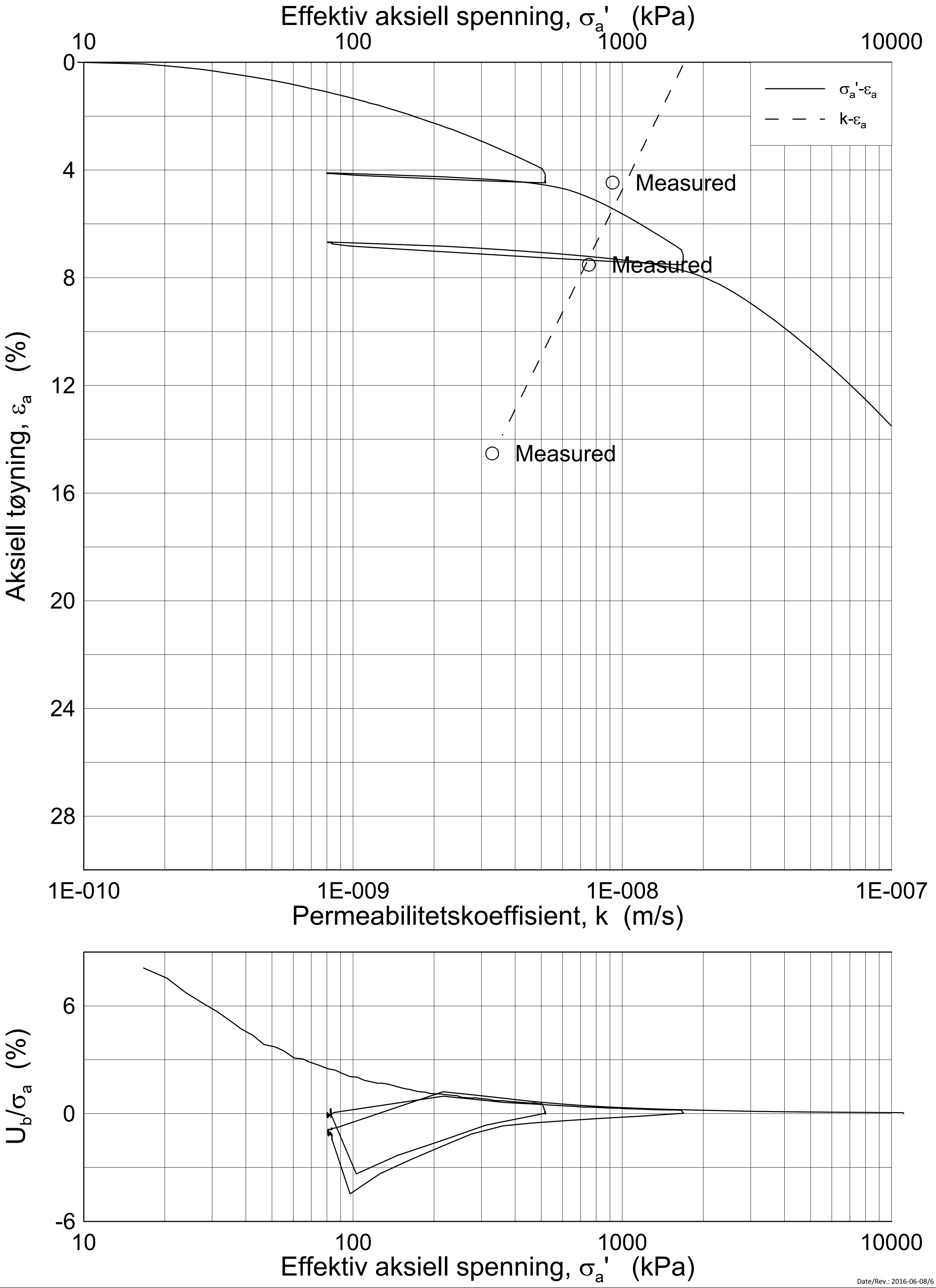

Date/Rev.: 2016-06-08/6

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NGTS - Halden Research Site	Dokument nr. 20160154-04-R	
	Figur nr. 08	
	Dato 2018-04-06	Tegnet av / Kontr. JRO/GS

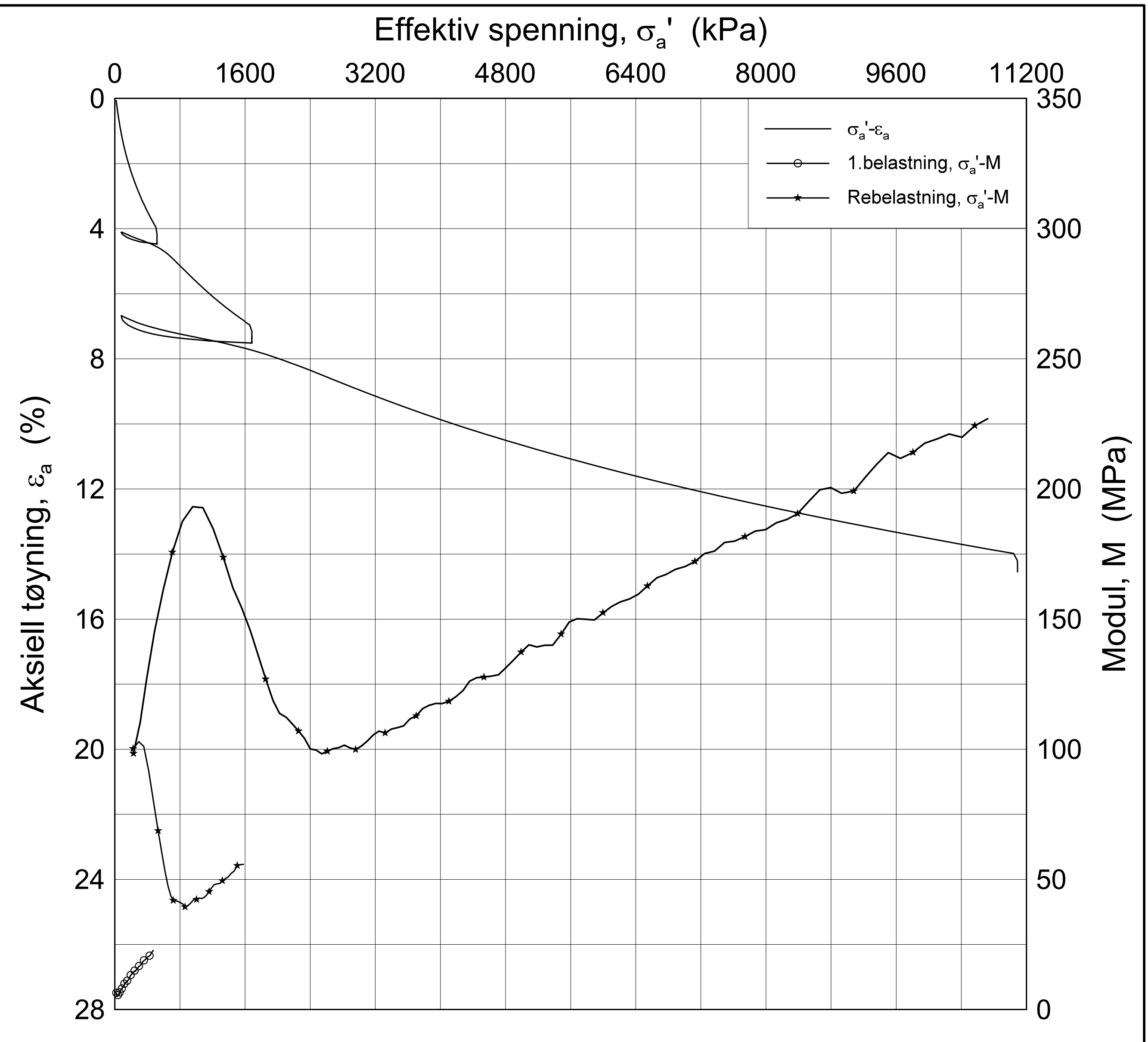
Ødometer test (CRSC)

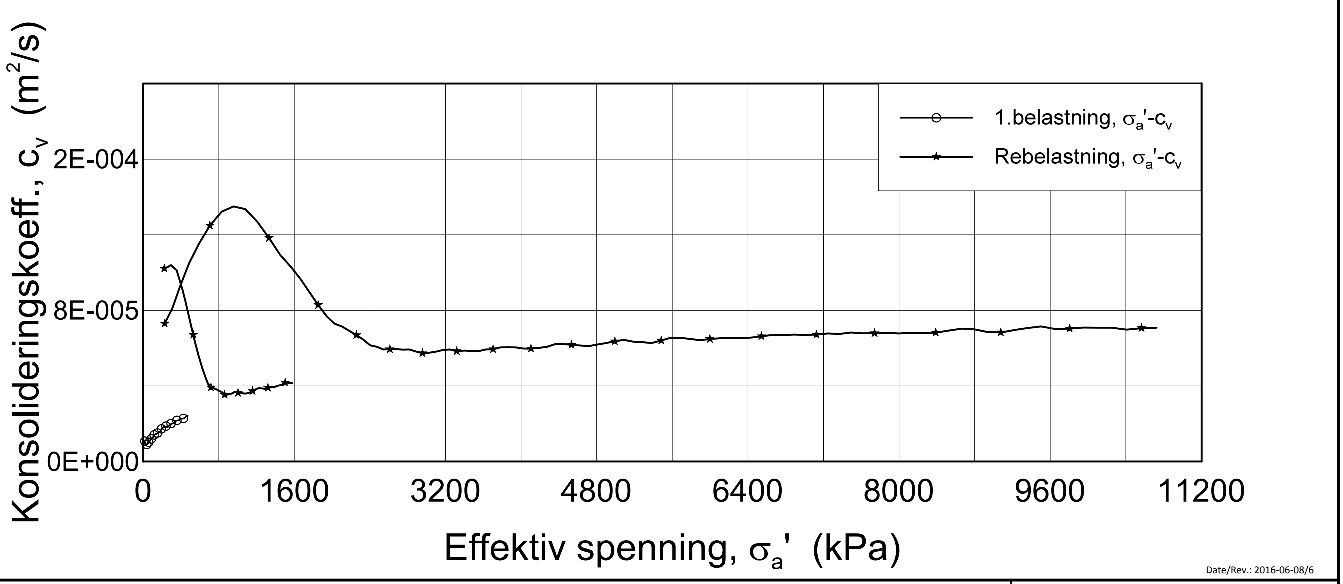
Borhull: HALB03

Sylinder: 5
Del: A
Test: 1

Dybde = 7.0-7.8m
p_0' = 81.0 kPa
w_i = 29.3 %
γ_i = 19.26 kN/m³

NGTS





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Date/Rev.: 2016-06-08/6

NGTS - Halden Research Site

Ødometer test (CRSC)

Borhull: HALB03

Sylinder: 5

Del: A

Test: 1

Dybde = 7.0-7.8m

p_0' = 81.0 kPa

w_i = 29.3 %

γ_i = 19.26 kN/m³

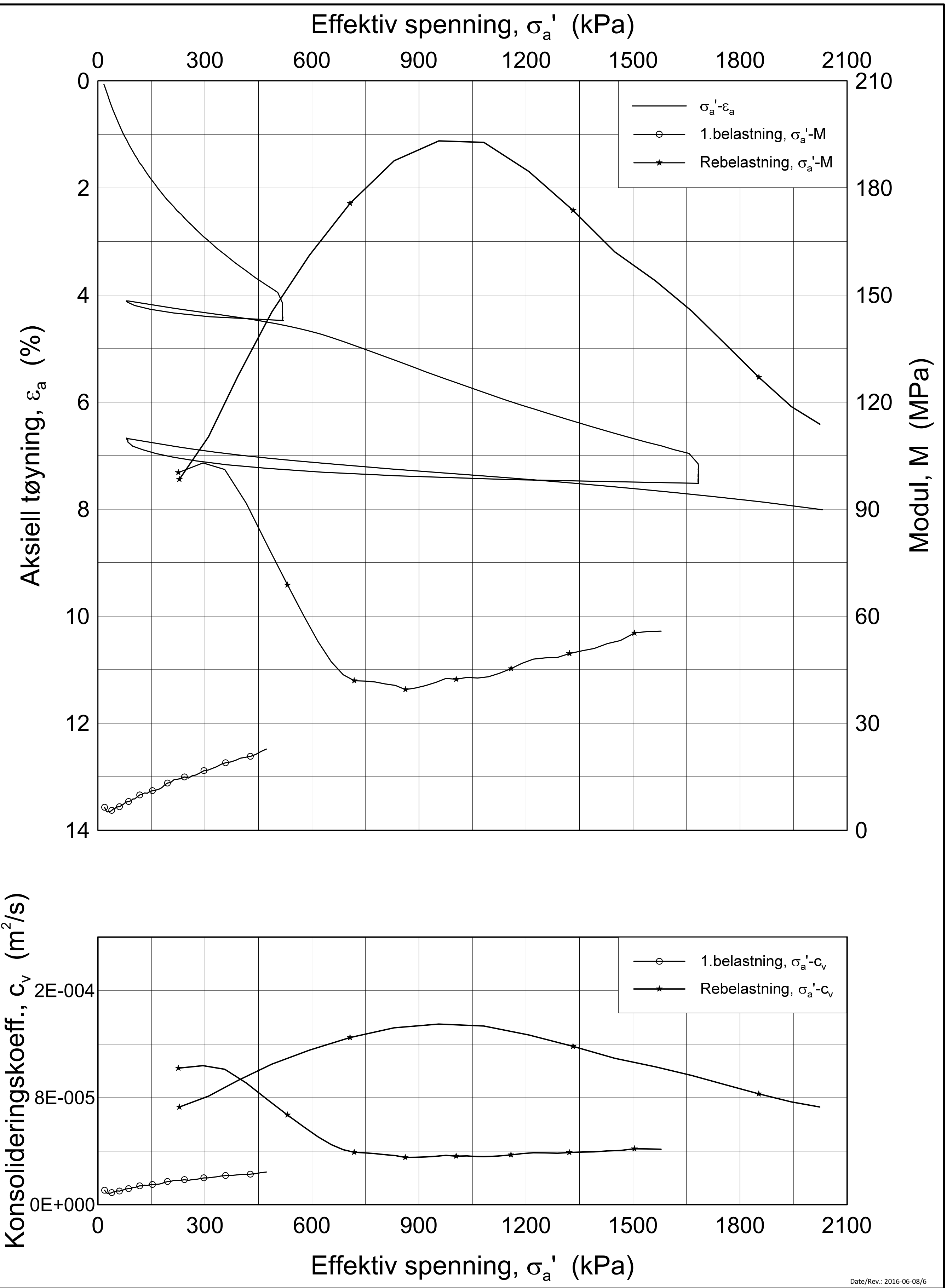
Dokument nr. 20160154-04-R

Figur nr. 09

Dato 2018-04-06

Tegnet av / Kontr. JRO/GS

NGTS



Date/Rev.: 2016-06-08/6

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Ødometer test (CRSC)

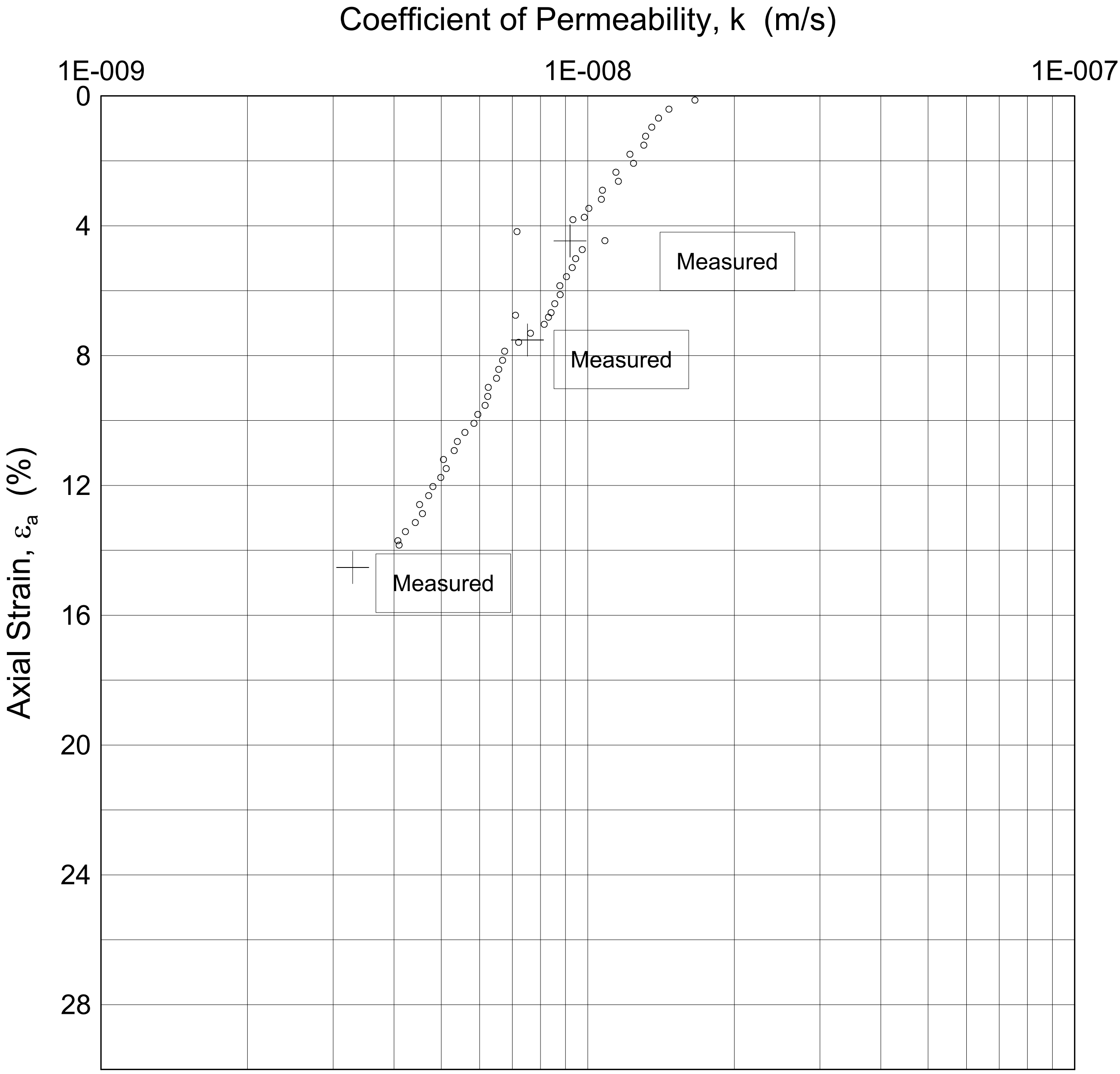
Borhull: HALB03

Sylinder: 5
Del: A
Test: 1

Dybde = 7.0-7.8m
p_0' = 81.0 kPa
w_i = 29.3 %
γ_i = 19.26 kN/m³

Dokument nr.: 20160154-04-R
Figur nr.: 10
Dato: 2018-04-06
Tegnet av / Kontr.: JRO/GS

NGTS



NGTS - Halden Research Site

Oedometer test (CRSC)

Boring: HALB03	Tube:	5	Depth	=	7.0-7.8m	
	Part:	A	p_0'		81.0	kPa
	Test:	1	w_i	=	29.3	%
			γ_i	=	19.26	kN/m³

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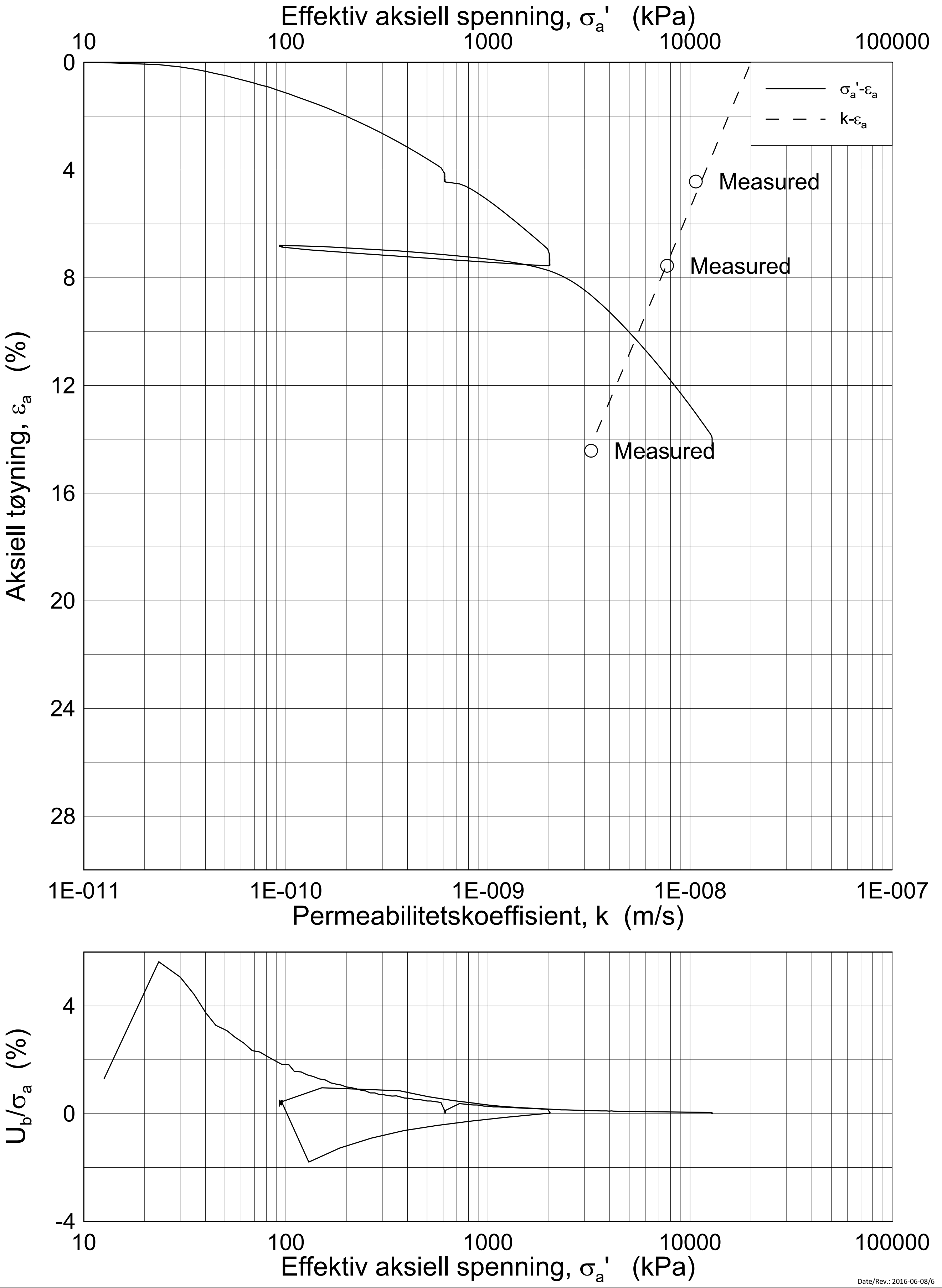
Figure No. 11	
Date 2018-04-06	Drawn by / Checked JRO/GS

NGTS



Date/Rev.: 2016-06-08/6

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Dokument nr.
20160154-04-R

Figur nr.
12

Ødometer test (CRSC)

Dato	Tegnet av / Kontr.
2018-04-06	JRO/GS

Borhull: HALB03

Sylinder: 6
Del: B
Test: 1

Dybde = 8.28 m
p_0' = 94.0 kPa
w_i = 27.5 %
γ_i = 19.74 kN/m³

NGTS

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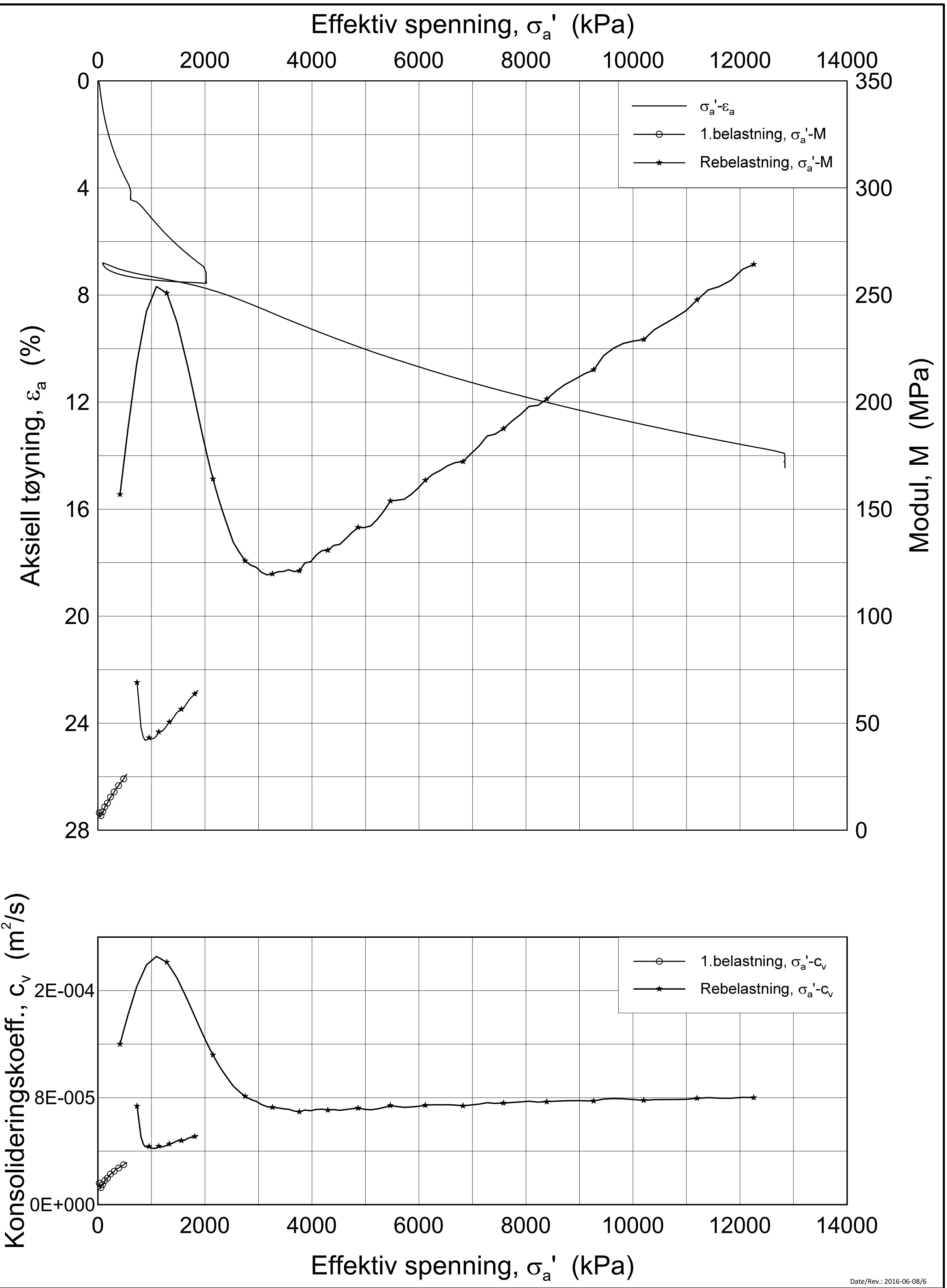

Date/Rev.: 2016-06-08/6

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NGTS - Halden Research Site	Dokument nr. 20160154-04-R
Ødometer test (CRSC)	Figur nr. 13
	Dato 2018-04-06 / Tegnet av / Kontr. JRO/GS

Borhull: HALB03

Sylinder: 6

Del: B

Test: 1

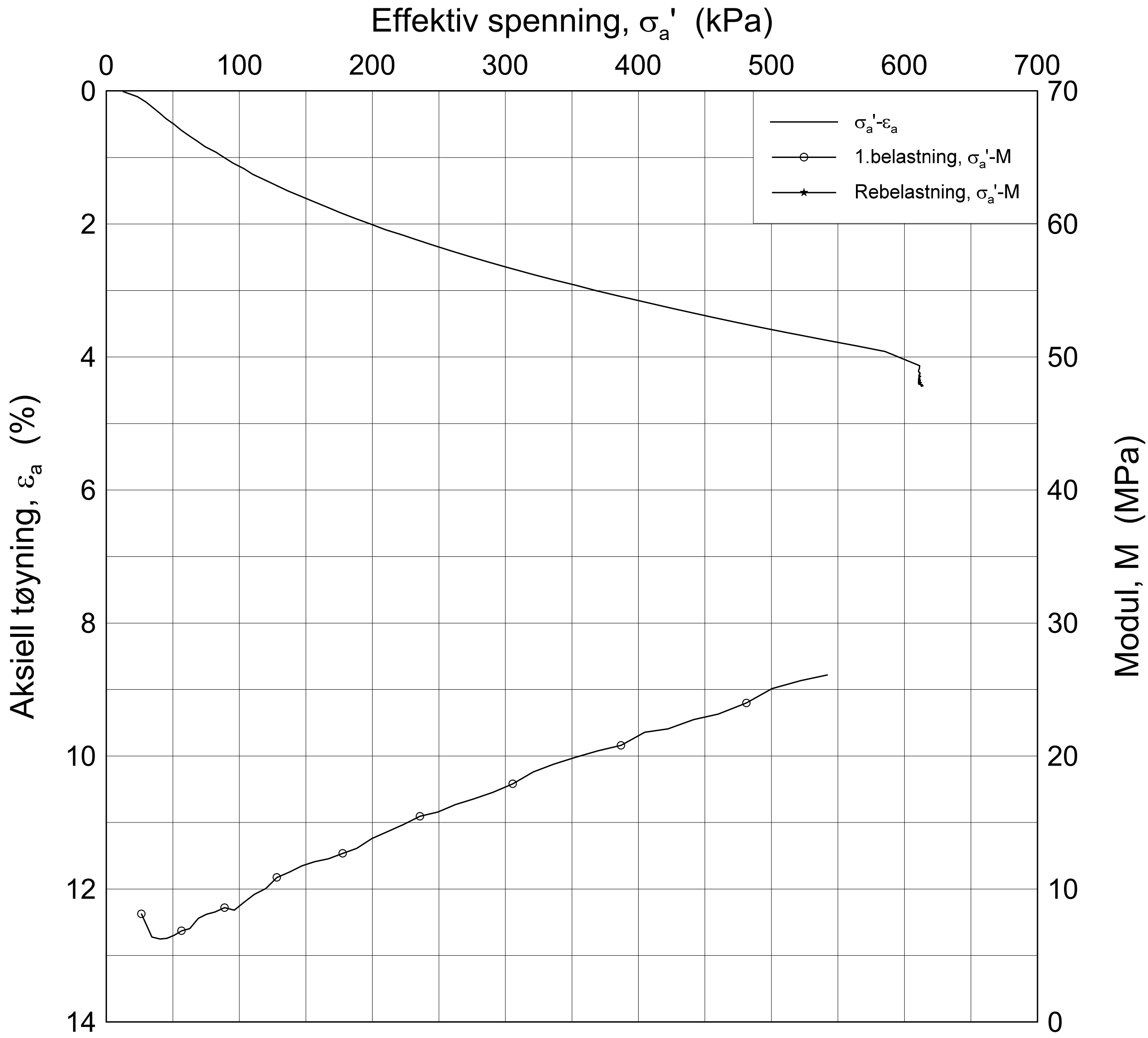
Dybde = 8.28 m

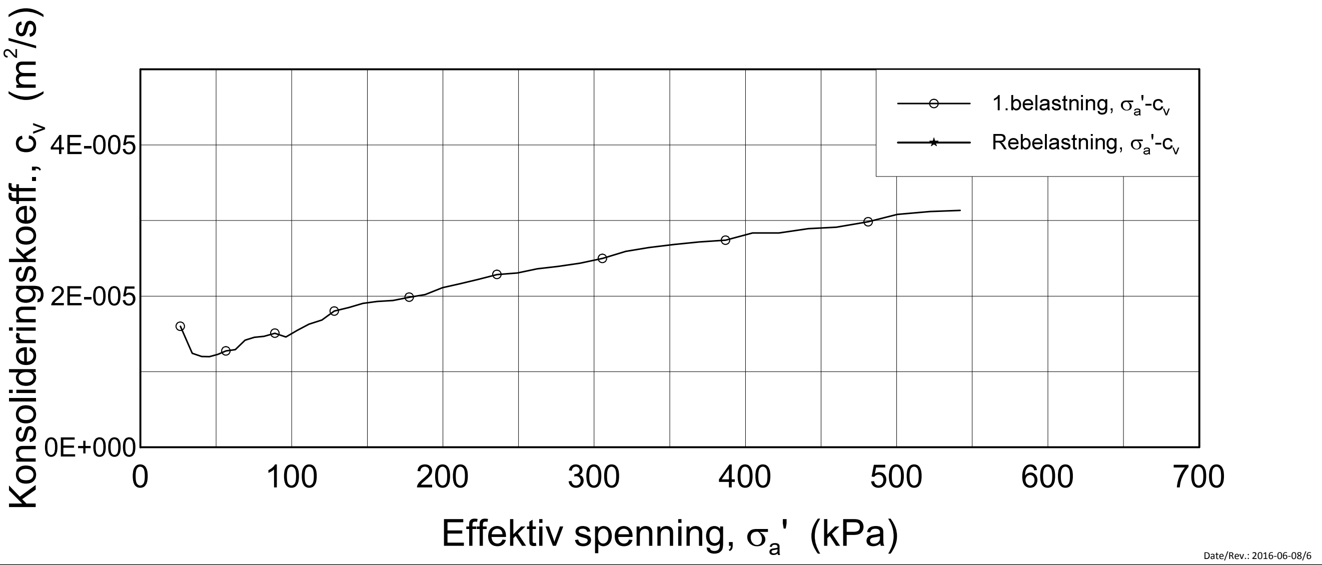
p_0' = 94.0 kPa

w_i = 27.5 %

γ_i = 19.74 kN/m³

NGTS





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Date/Rev.: 2016-06-08/6

NGTS - Halden Research Site

Ødometer test (CRSC)

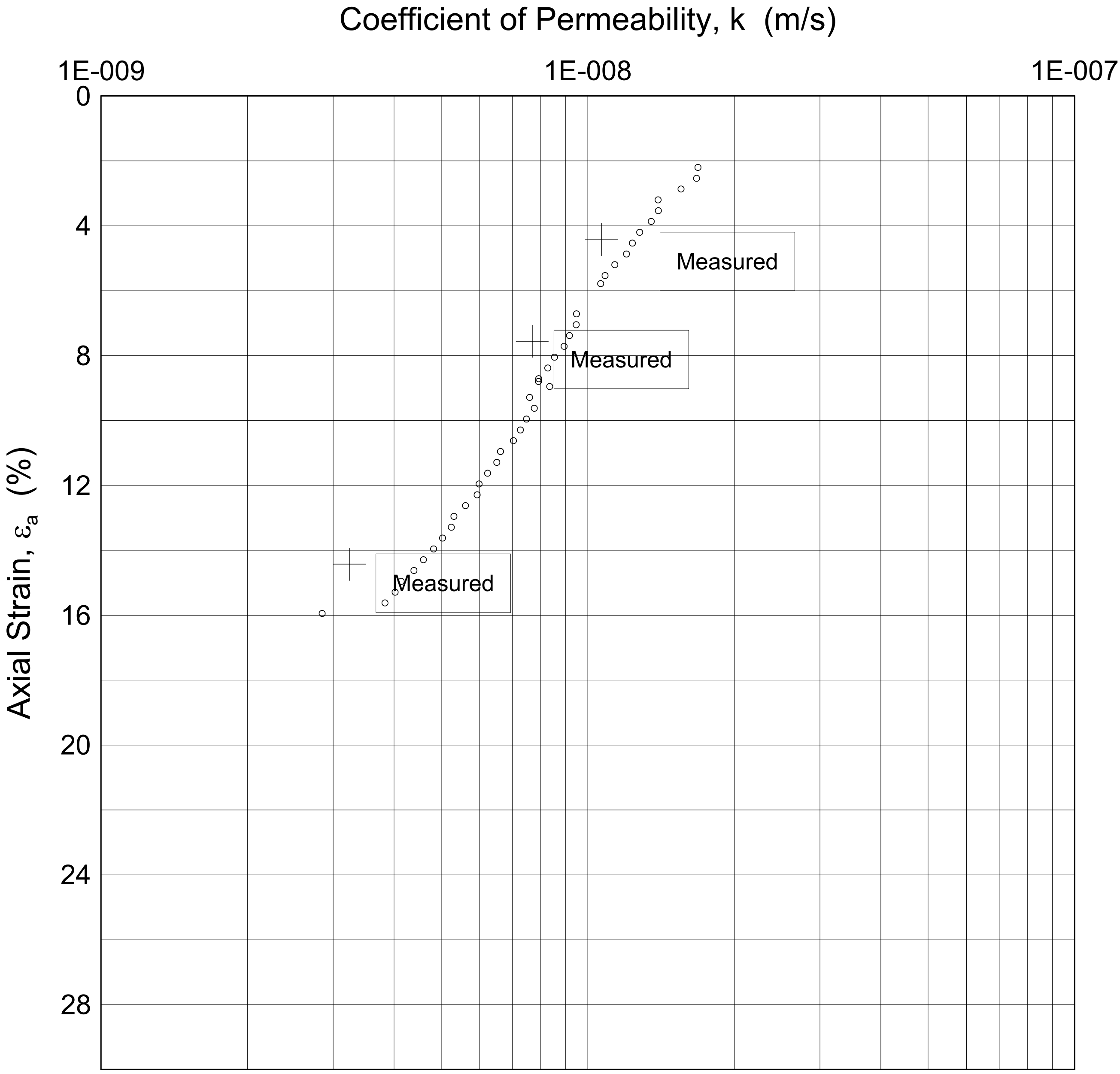
Borhull: HALB03

Sylinder: 6
Del: B
Test: 1

Dybde = 8.28 m
p_0' = 94.0 kPa
w_i = 27.5 %
γ_i = 19.74 kN/m³

Dokument nr. 20160154-04-R
Figur nr. 14
Dato 2018-04-06
Tegnet av / Kontr. JRO/GS

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

				Depth	=	8.28	m	
Boring:	HALB03	Tube:	6	p_0'	=	94.0	kPa	
		Part:	B	w_i	=	27.5	%	
		Test:	1	γ_i	=	19.74	kN/m^3	

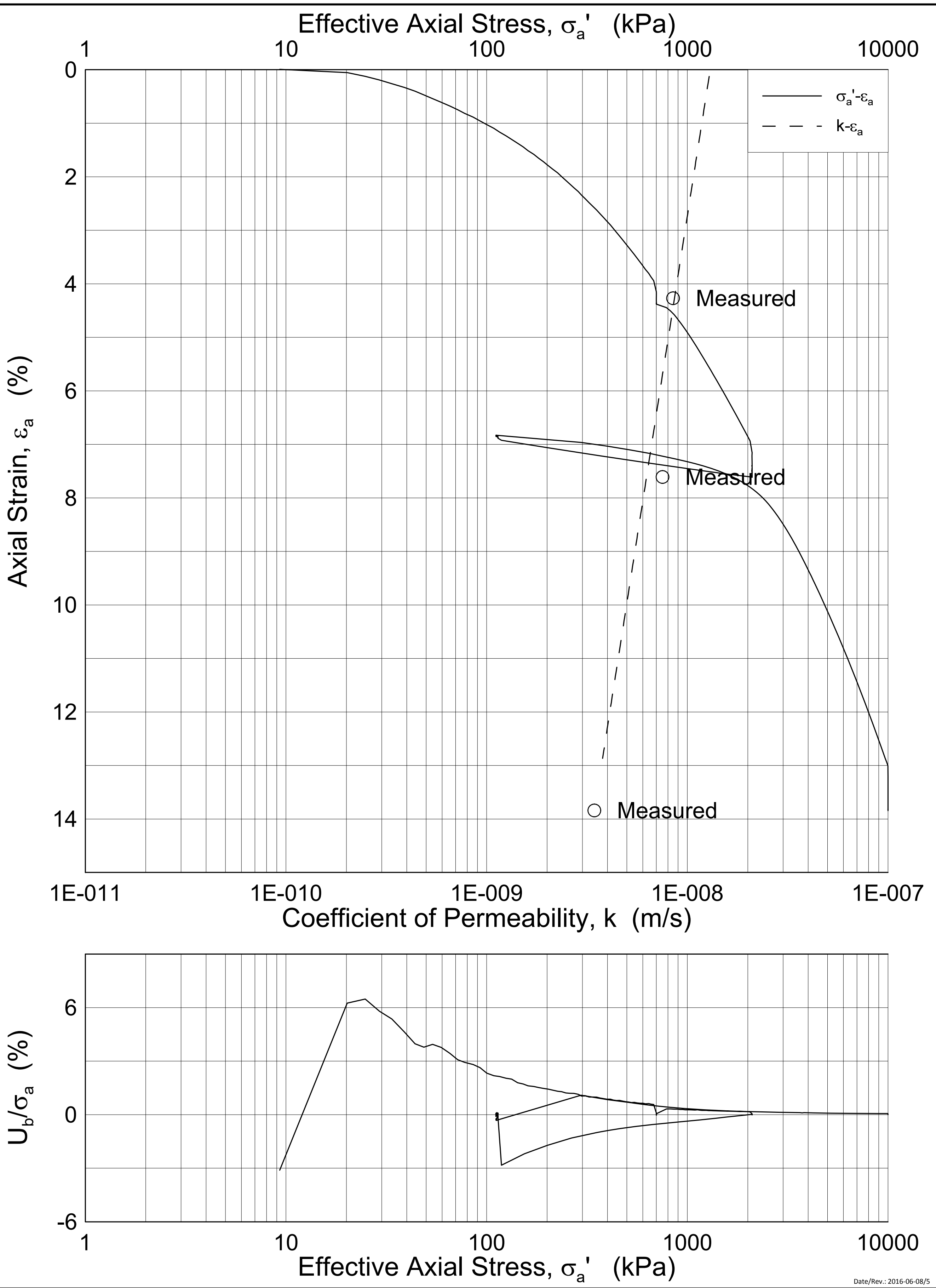
Document No. 20160154-04-R

Figure No. 15

Date 2018-04-06

Drawn by / Checked JRO/GS

NGTS



Date/Rev.: 2016-06-08/5

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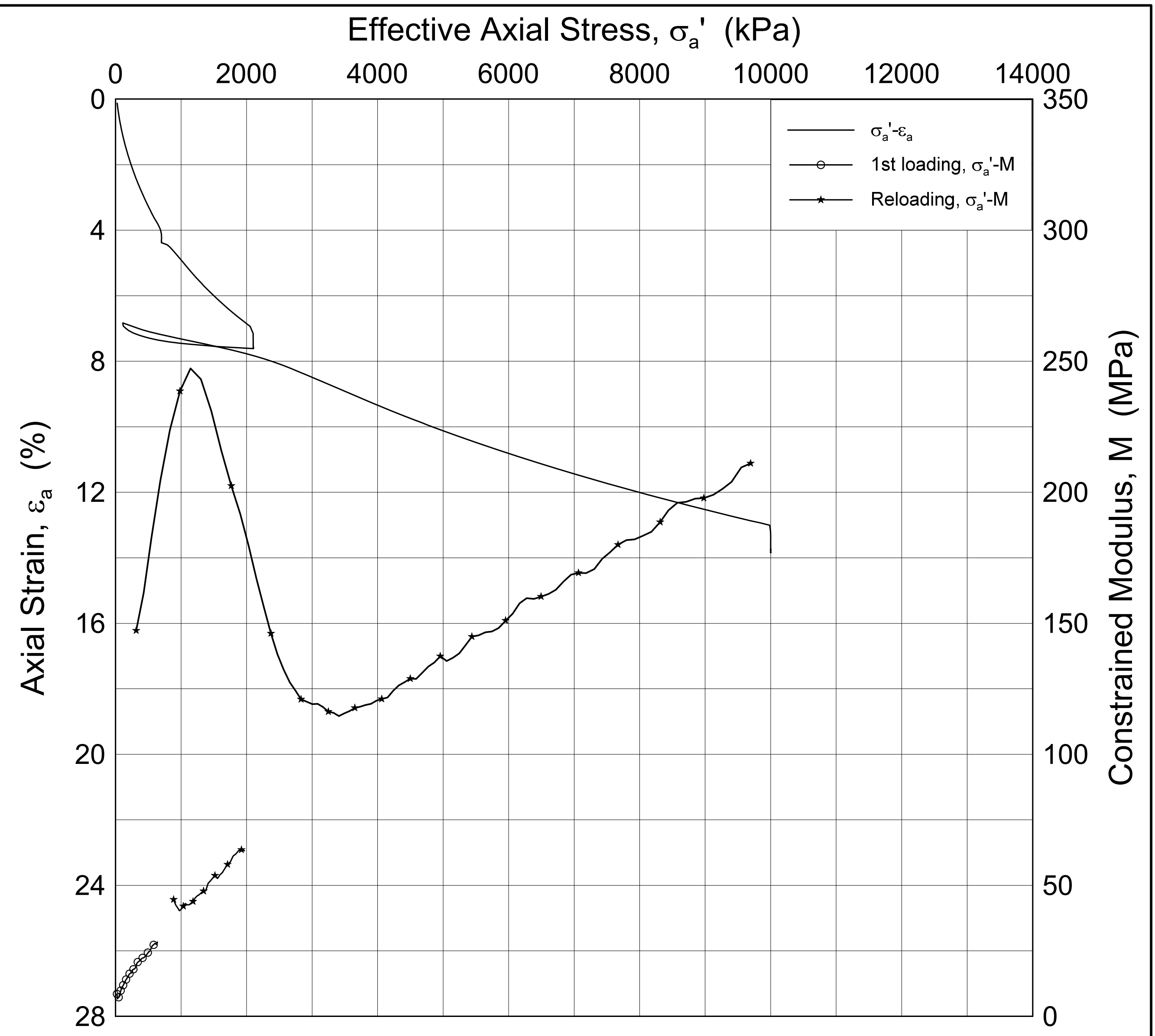
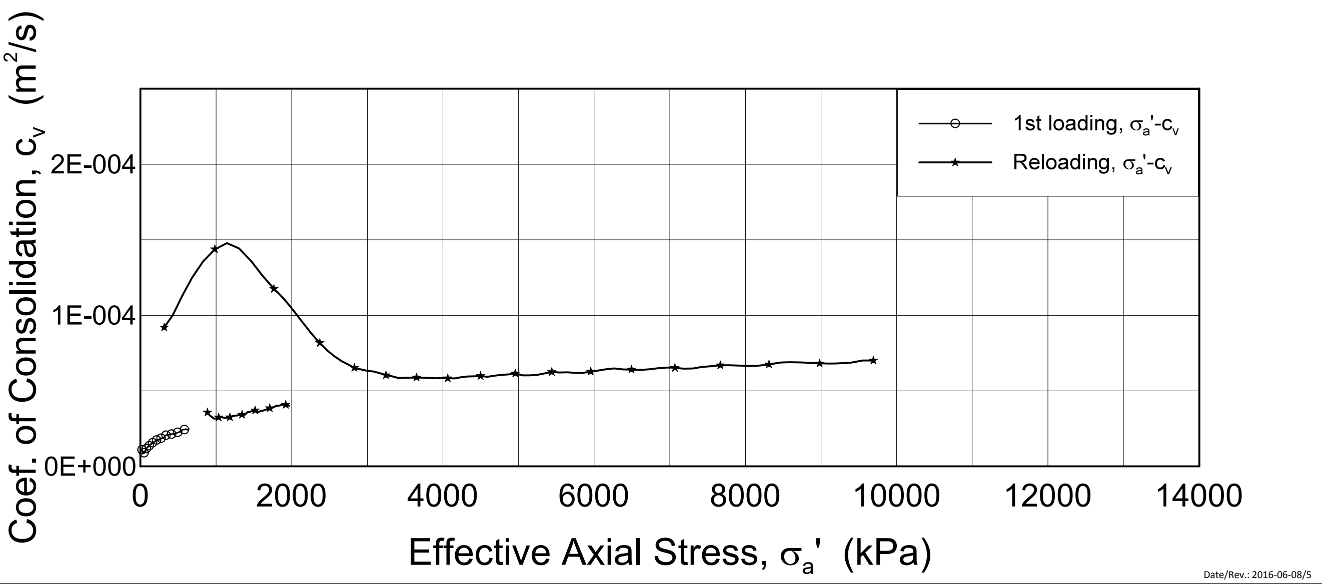
NGTS - Halden Research Site	Document No. 20160154-04-R
	Figure No. 16
Oedometer test (CRSC)	Date 2018-04-06 / Drawn by / Checked FI /GS

Boring: HALB03 | Tube: 8 | Part: F | Test: 1

Depth = 10.33 m
p_0' = 112.0 kPa
w_i = 27.7 %
γ_i = 19.71 kN/m³

NGTS





Date/Rev.: 2016-06-08/5

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Document No. 20160154-04-R

Figure No. 17

Oedometer test (CRSC)

Date 2018-04-06 | Drawn by / Checked FI /GS

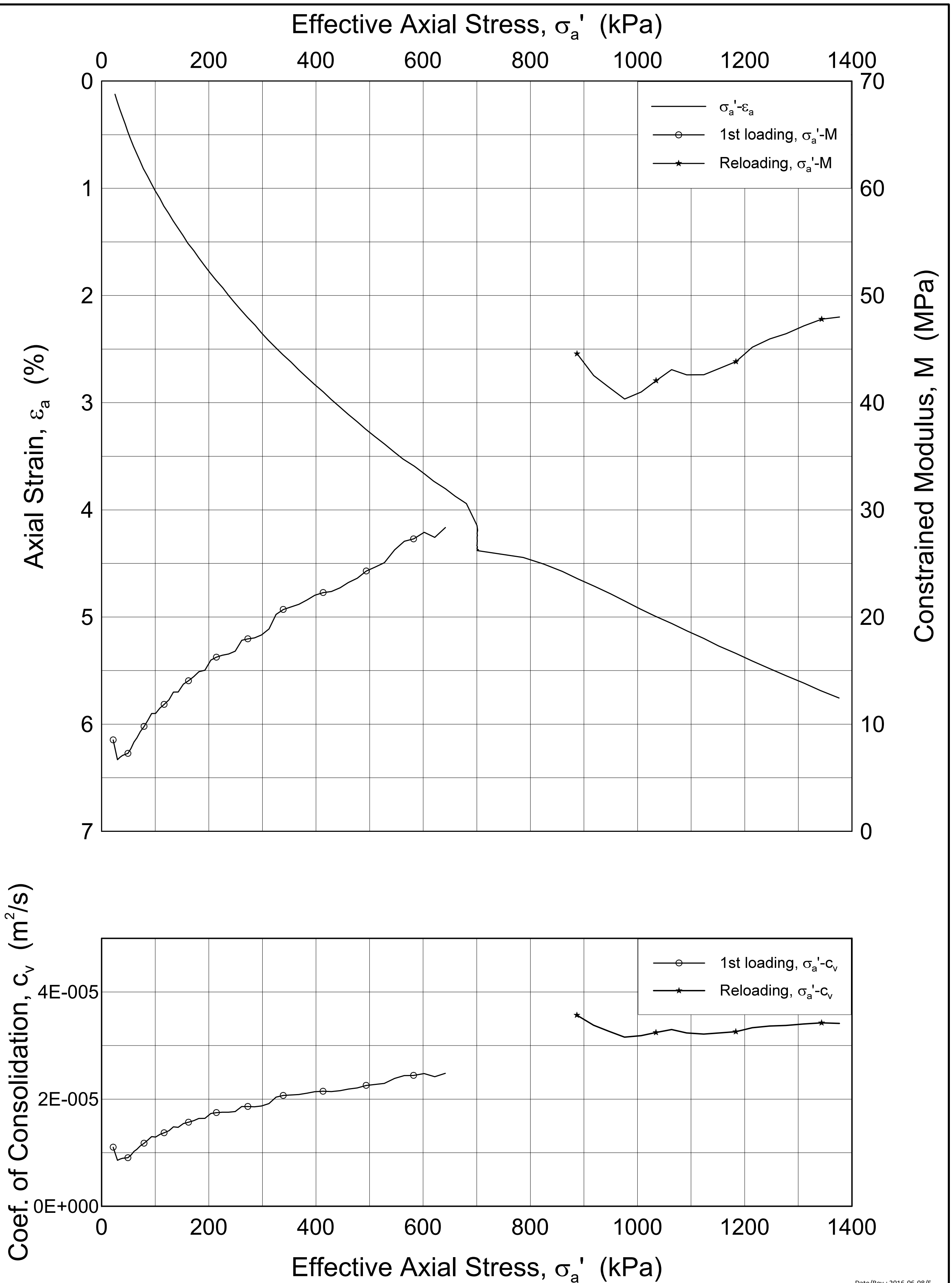
Depth = 10.33 m

Boring: HALB03 | Tube: 8 | p_0' = 112.0 kPa

Part: F | w_i = 27.7 %

Test: 1 | γ_i = 19.71 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

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Figure No. 18

Oedometer test (CRSC)

Date 2018-04-06

Drawn by / Checked FI /GS

Boring: HALB03

Tube: 8
Part: F
Test: 1

Depth = 10.33 m
p_0' = 112.0 kPa
w_i = 27.7 %
γ_i = 19.71 kN/m³

NGTS

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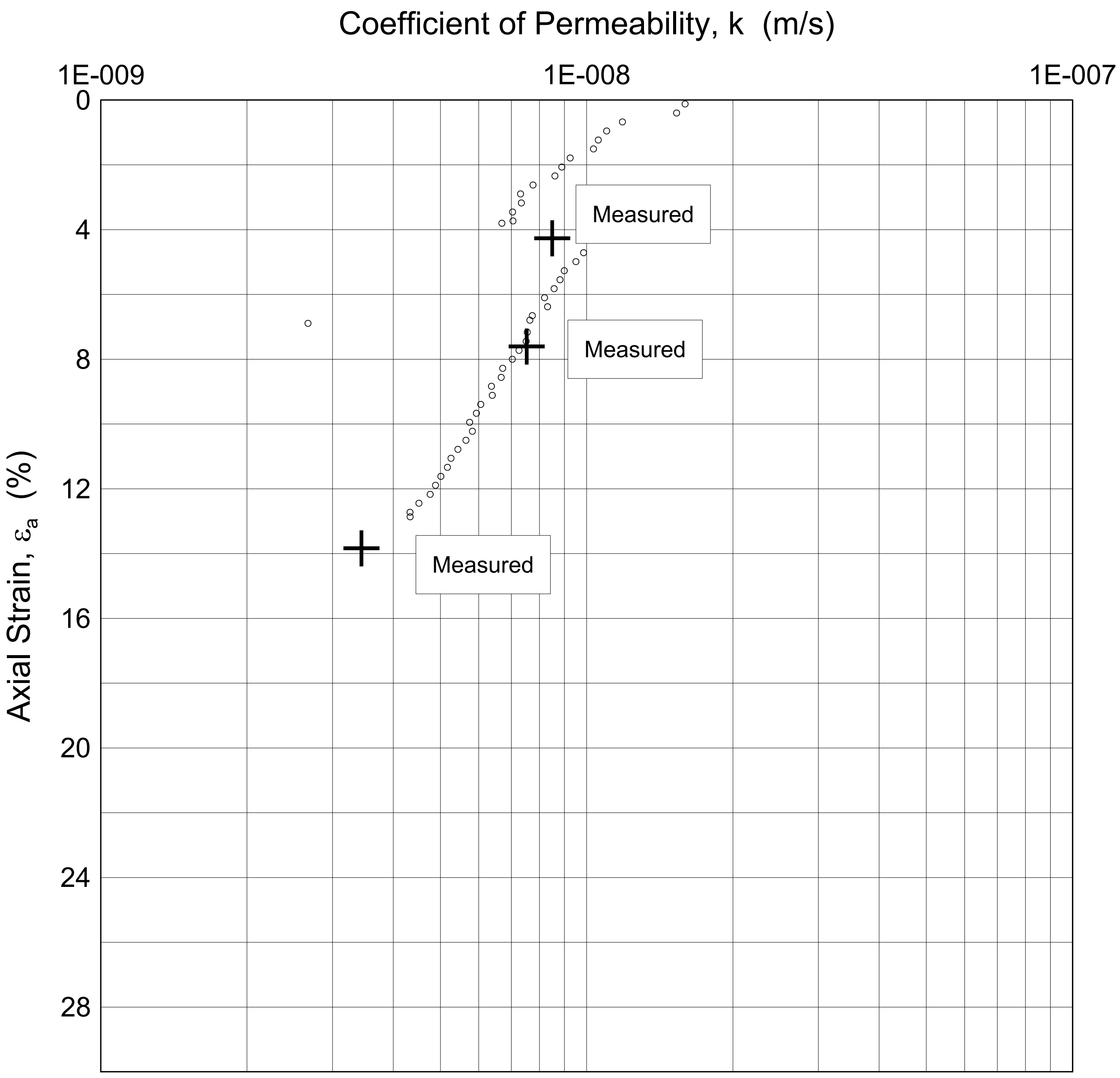

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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 19

Oedometer test (CRSC)

Date	Drawn by / Checked
2018-04-06	FI /GS

Boring: HALB03

Tube: 8

Part: F

Test: 1

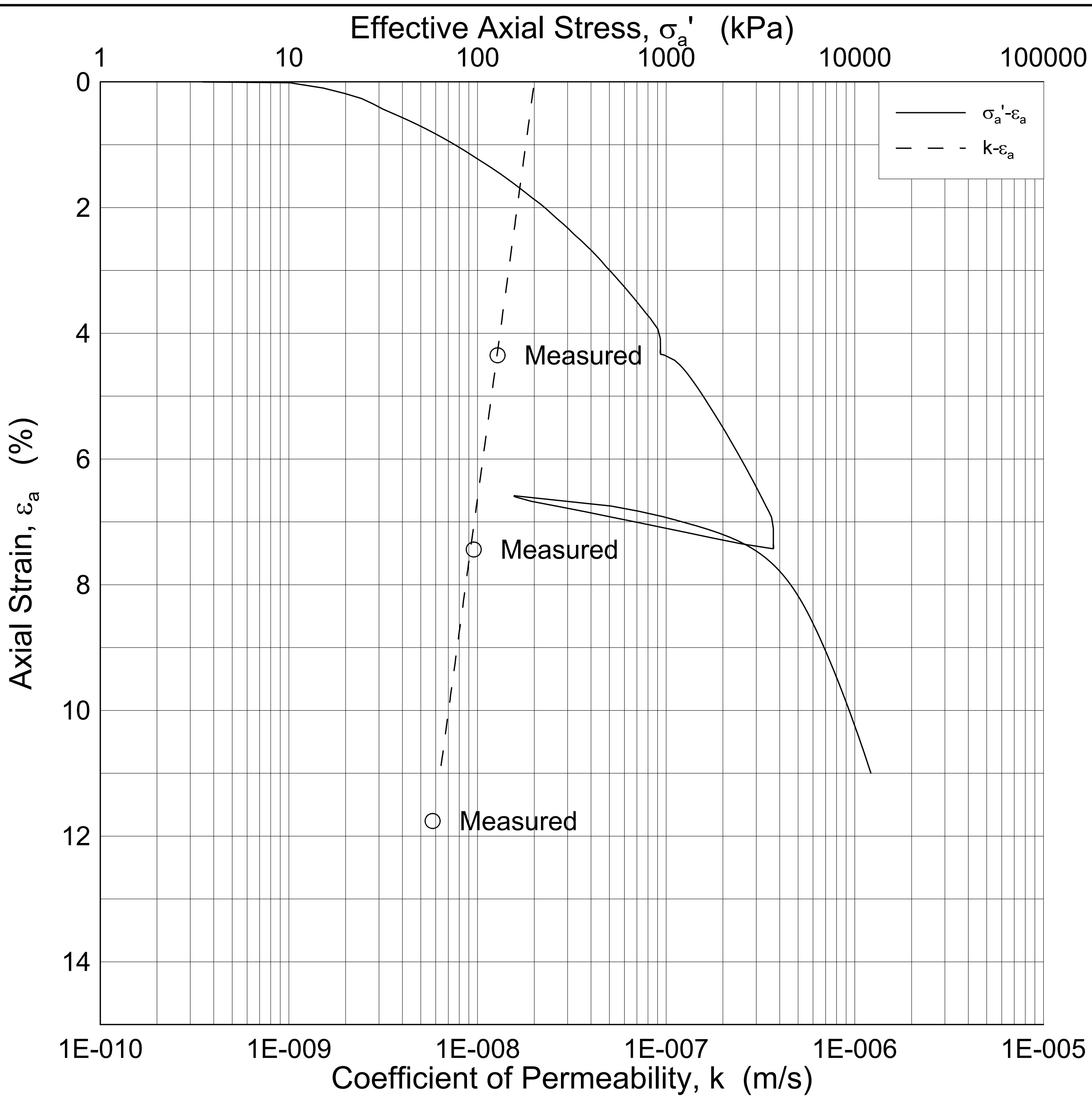
Depth = 10.33 m

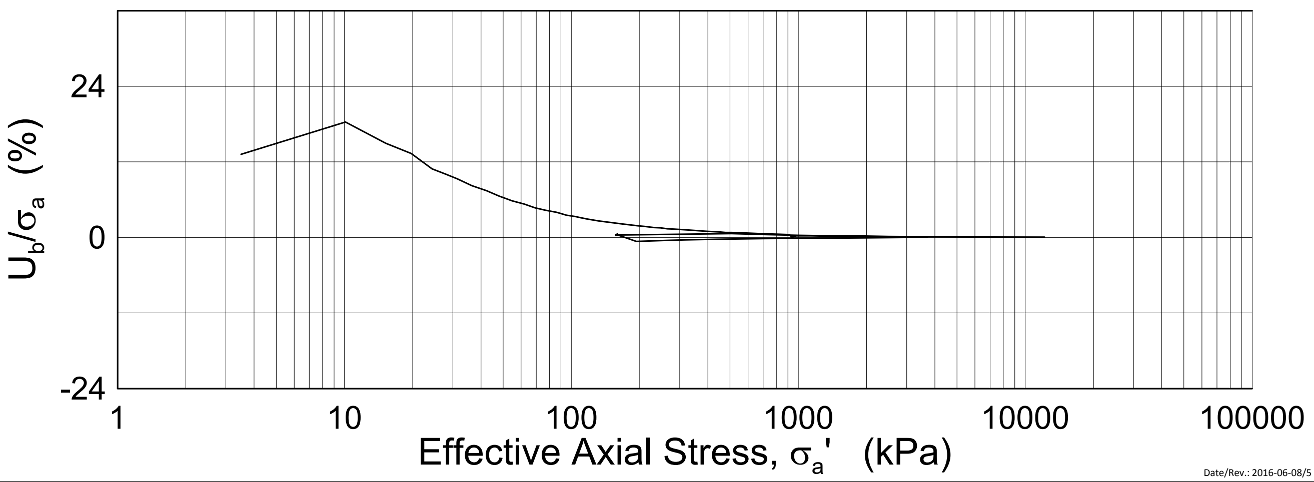
p_0' = 112.0 kPa

w_i = 27.7 %

γ_i = 19.71 kN/m³

NGTS





Date/Rev.: 2016-06-08/5

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Oedometer test (CRSC)

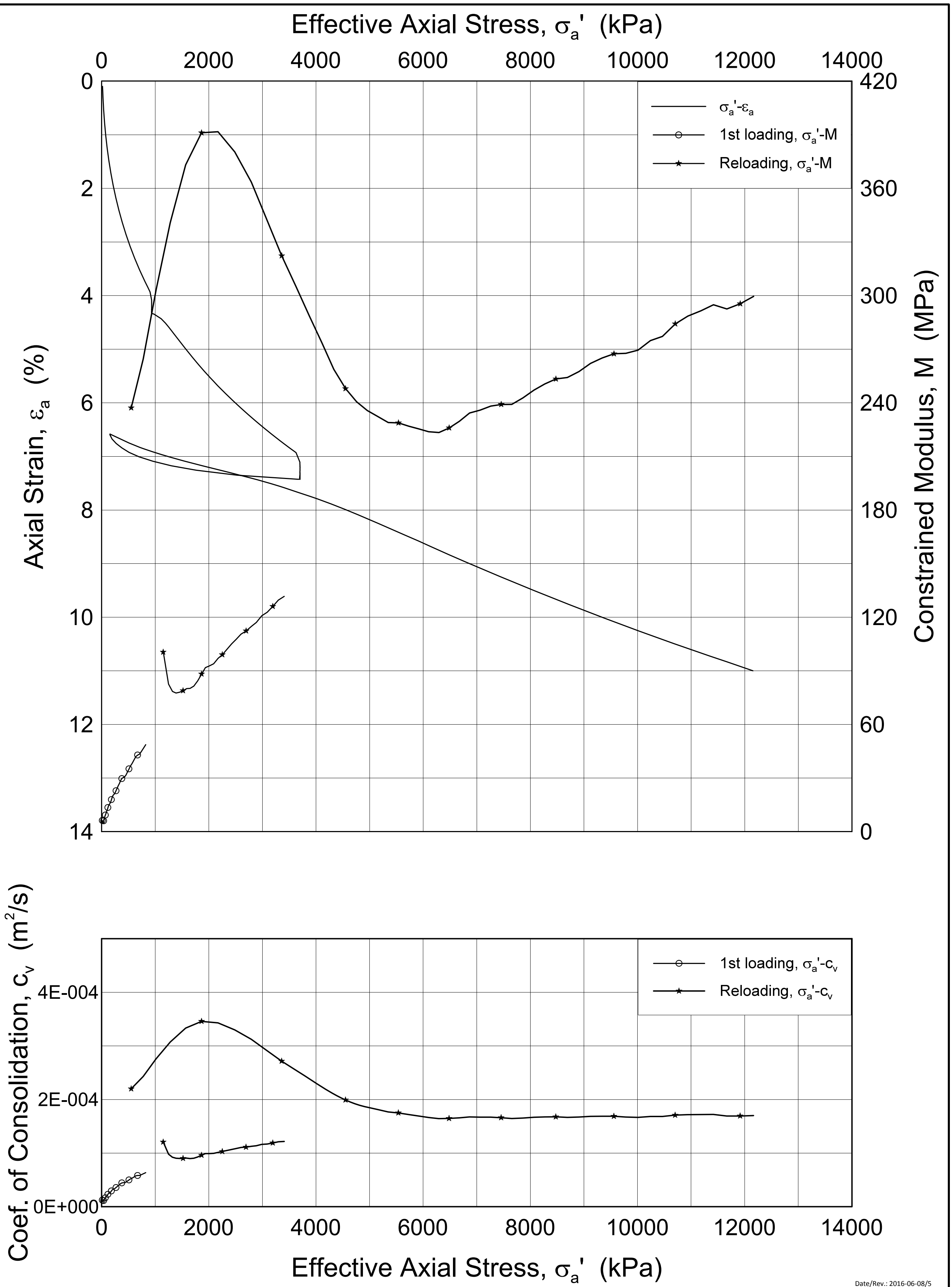
				Depth	=	14.31	m
Boring:	HALB03	Tube:	12	p_0'	=	158.0	kPa
		Part:	B	w_i	=	24.5	%
		Test:	1	γ_i	=	19.97	kN/m³

Document No. 20160154-04-R

Figure No. 20

Date	Drawn by / Checked
2018-04-06	FI/GS

NGTS



Date/Rev.: 2016-06-08/5

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Figure No. 21

Oedometer test (CRSC)

Date 2018-04-06

Drawn by / Checked FI /GS

Boring:	HALB03	Tube:	12	Depth	=	14.31	m
		Part:	B	p_0'	=	158.0	kPa
		Test:	1	w_i	=	24.5	%
				γ_i	=	19.97	kN/m^3

NGTS

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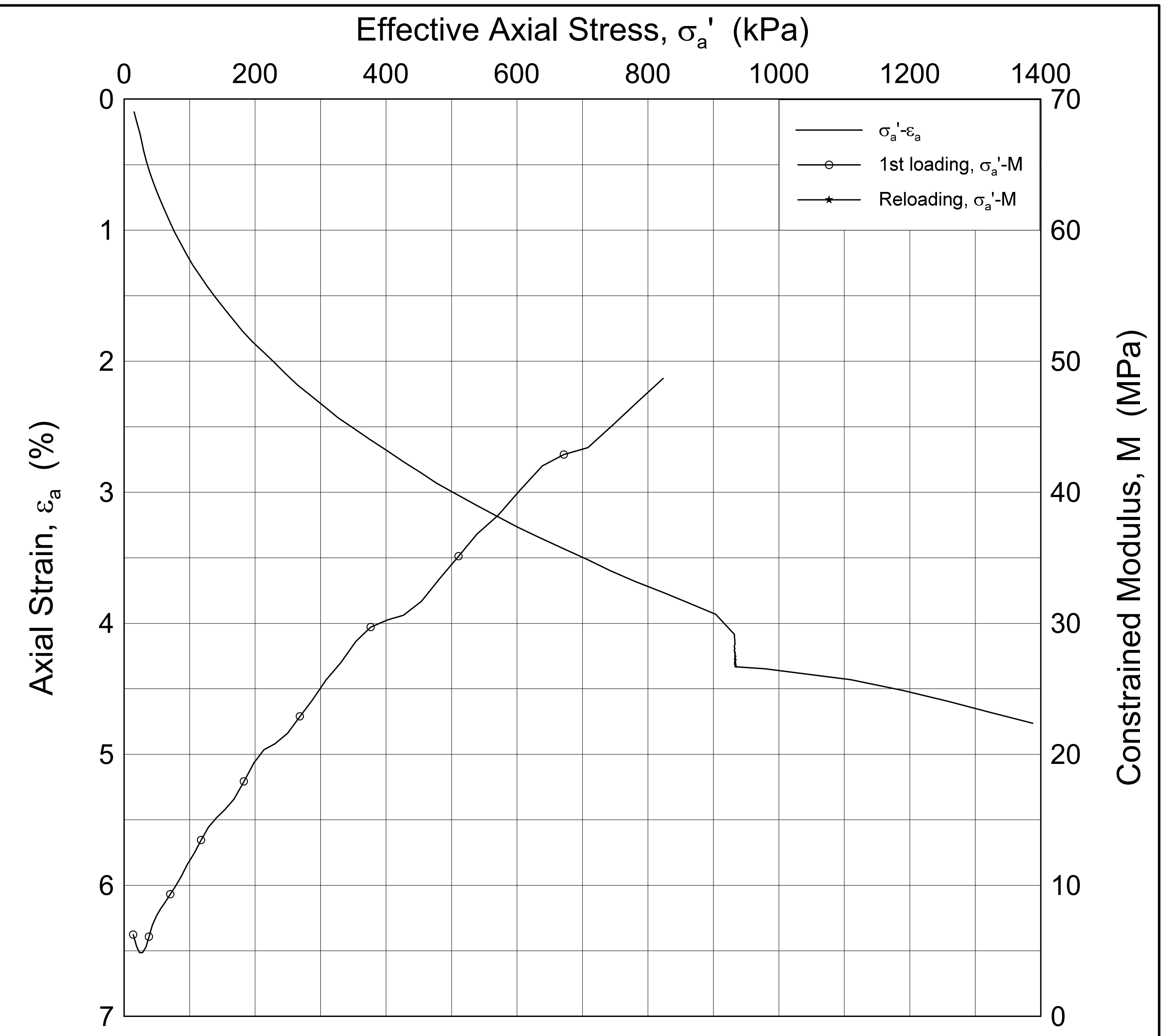

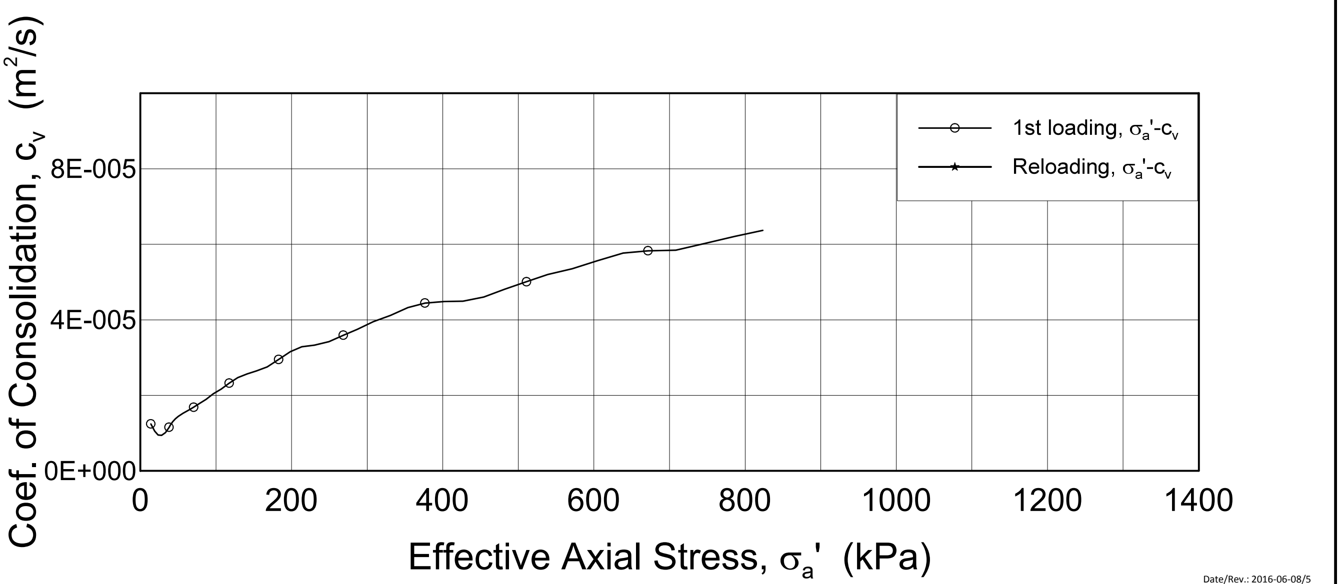

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Figure No. 22

Date 2018-04-06

Drawn by / Checked FI /GS

Oedometer test (CRSC)

Boring: HALB03

Tube: 12

Part: B

Test: 1

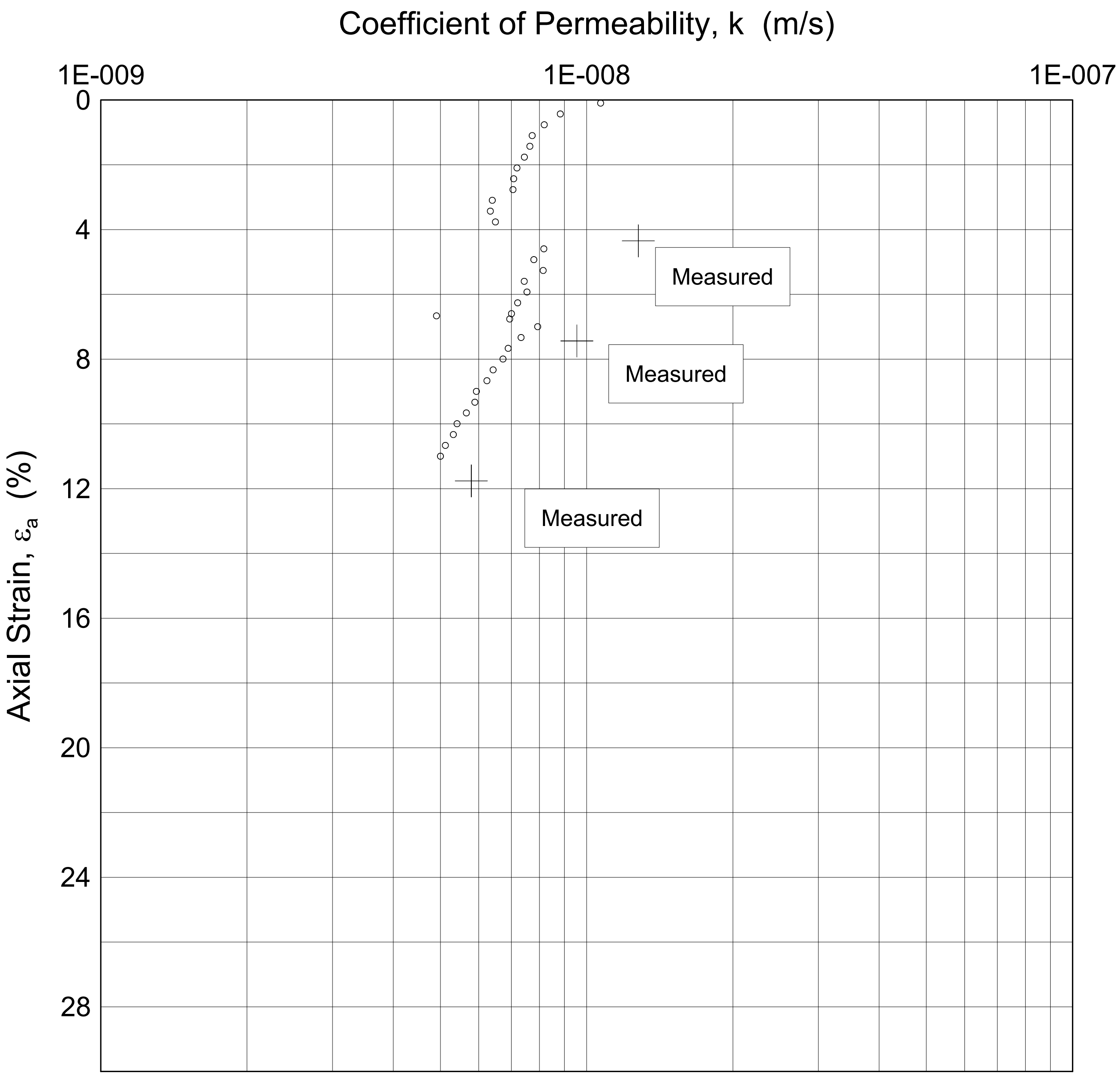
Depth = 14.31 m

p_0' = 158.0 kPa

w_i = 24.5 %

γ_i = 19.97 kN/m³

NGTS



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NGTS - Halden Research Site

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Figure No. 23

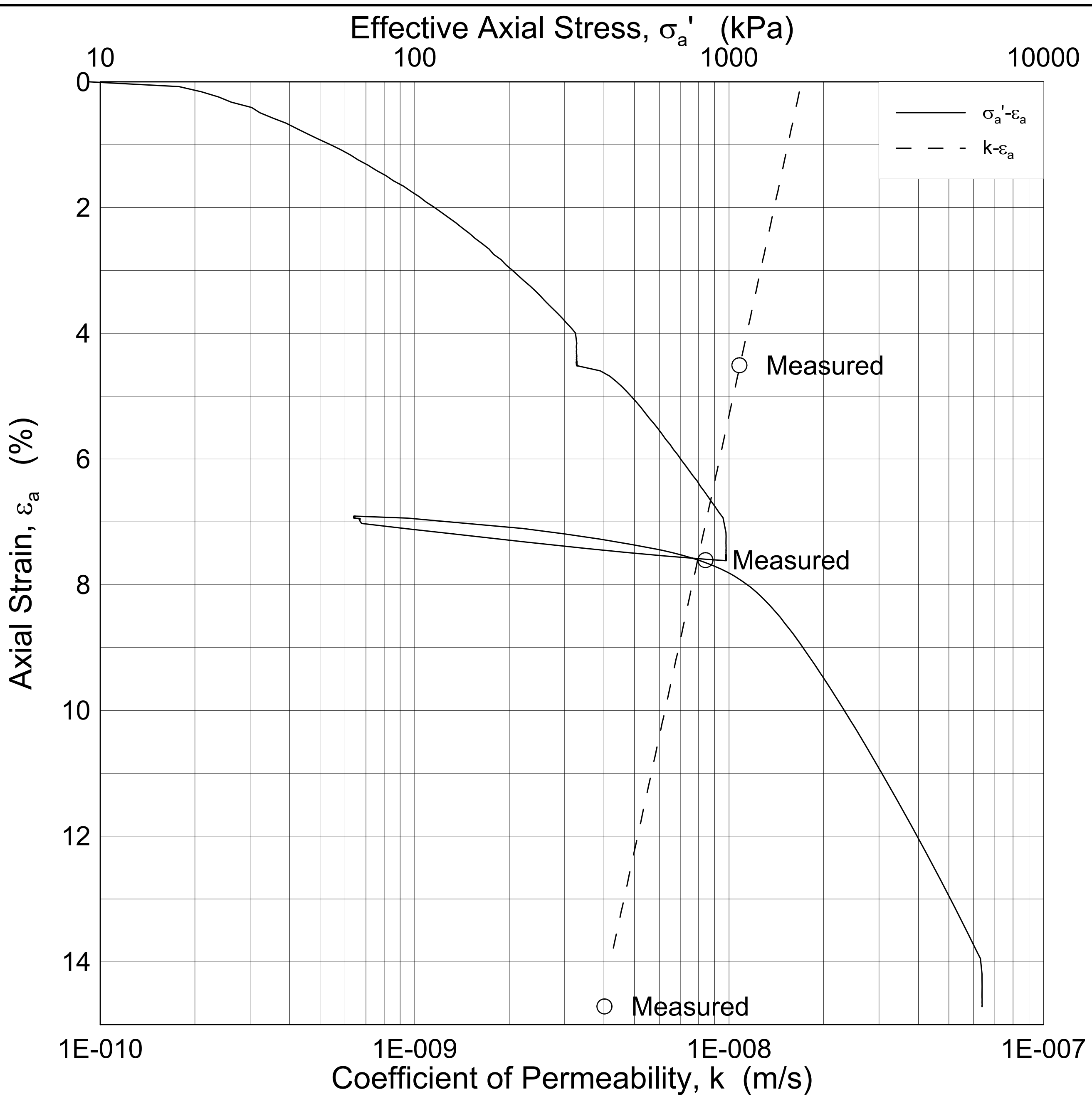
Date 2018-04-06

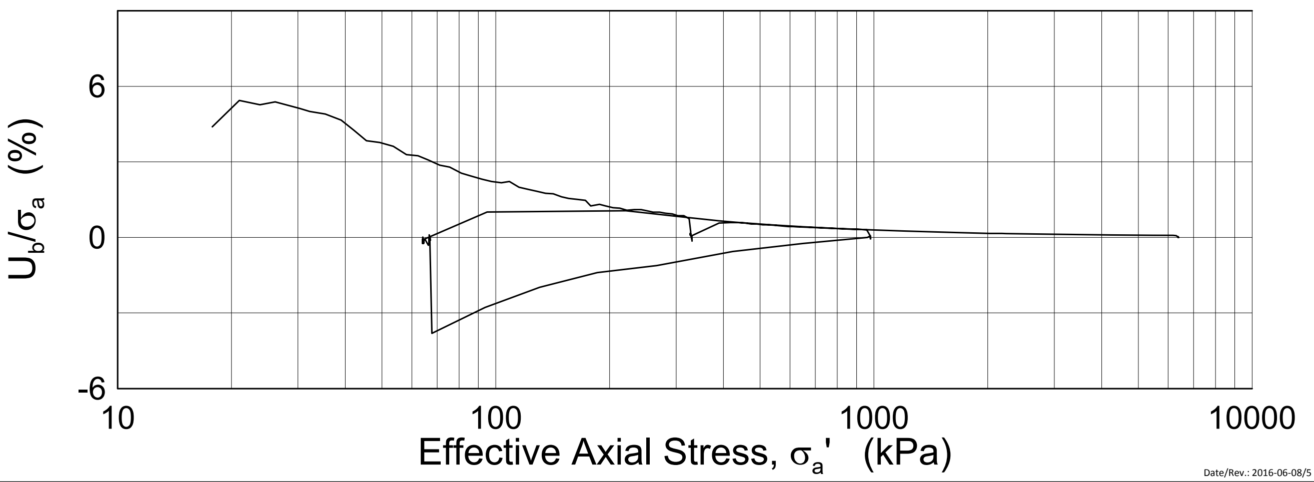
Drawn by / Checked FI /GS

Oedometer test (CRSC)

Boring: HALB03	Tube:	12	Depth	=	14.31	m
	Part:	B	p_0'	=	158.0	kPa
	Test:	1	w_i	=	24.5	%
			γ_i	=	19.97	kN/m³

NGTS





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NGTS - Halden Research Site

Oedometer test (CRSC)

Boring:	HALB04	Tube:	3	Depth	=	5.27	m
				p_0'	=	65.0	kPa
		Part:	1B	w_i	=	30.5	%
		Test:	1	γ_i	=	19.45	kN/m³

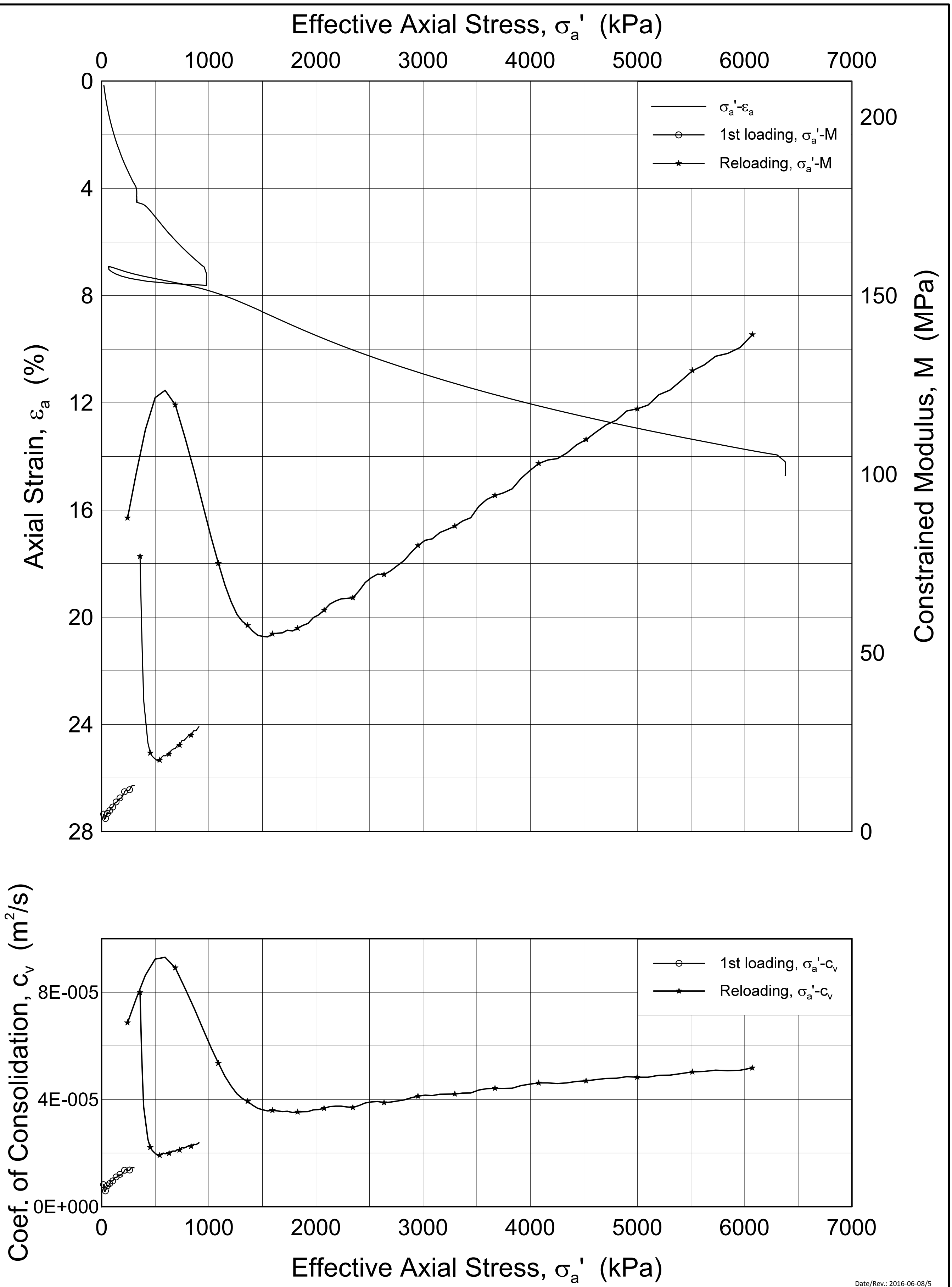
Document No. 20160154-04-R

Figure No. 24

Date 2018-04-06

Drawn by / Checked FI /GS

NGTS



Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 25

Oedometer test (CRSC)

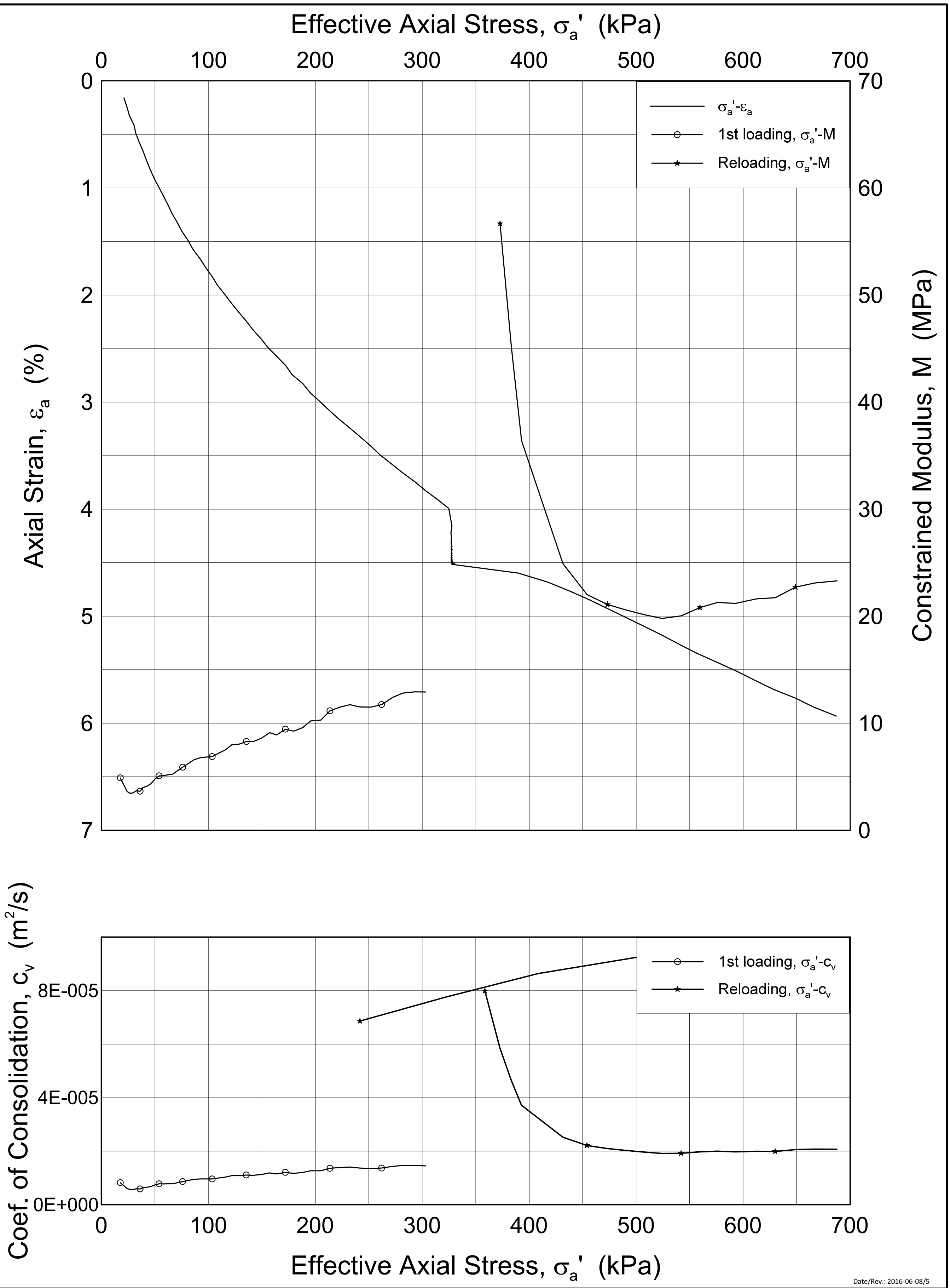
Date 2018-04-06

Drawn by / Checked FI /GS

Boring: HALB04

Tube:	3	Depth	=	5.27	m
Part:	1B	p_0'	=	65.0	kPa
Test:	1	w_i	=	30.5	%
		γ_i	=	19.45	kN/m^3

NGTS



NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 26

Oedometer test (CRSC)

Date 2018-04-06

Drawn by / Checked FI /GS

Boring: HALB04

Tube: 3

Part: 1B

Test: 1

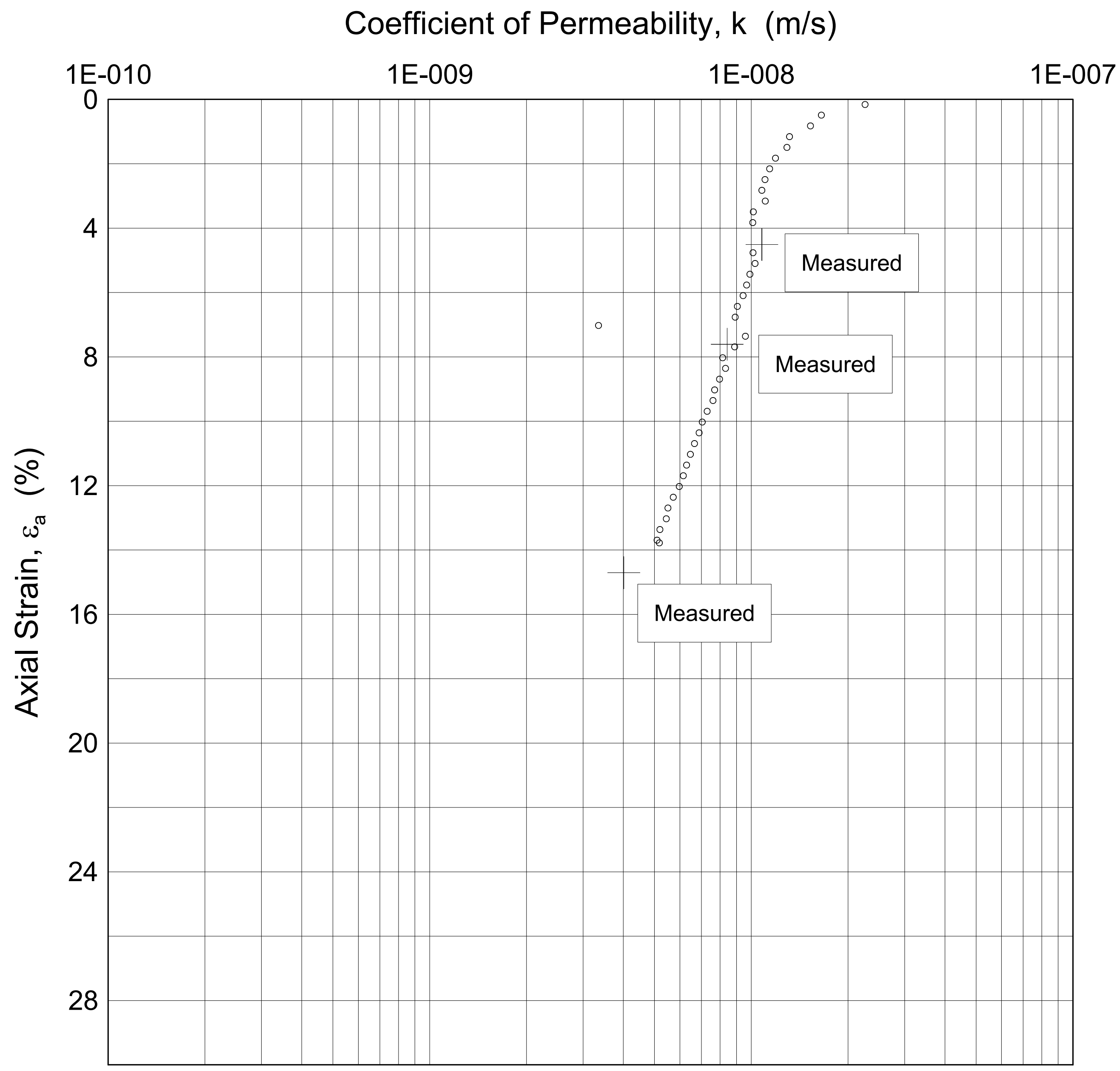
Depth = 5.27 m

p_0' = 65.0 kPa

w_i = 30.5 %

γ_i = 19.45 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 27

Oedometer test (CRSC)

Date 2018-04-06

Drawn by / Checked FI /GS

Boring: HALB04

Tube: 3

Part: 1B

Test: 1

Depth = 5.27 m

p_0' = 65.0 kPa

w_i = 30.5 %

γ_i = 19.45 kN/m³

NGTS

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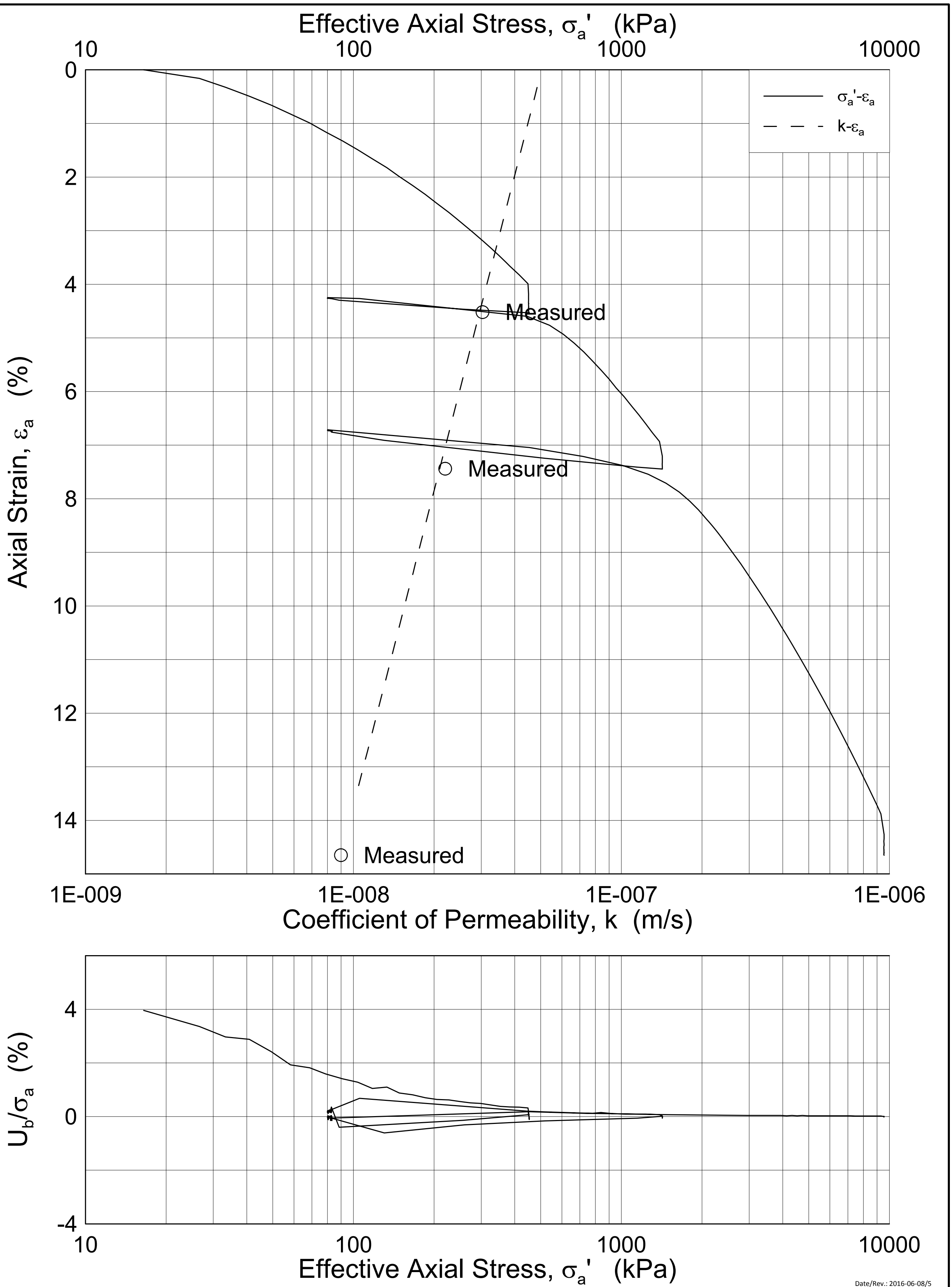

Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site	Document No. 20160154-04-R
	Figure No. 28
Oedometer test (CRSC)	Date 2018-04-06 / Drawn by / Checked FI/GS

Boring: HALB04

Tube: 5

Part: A

Test: 1

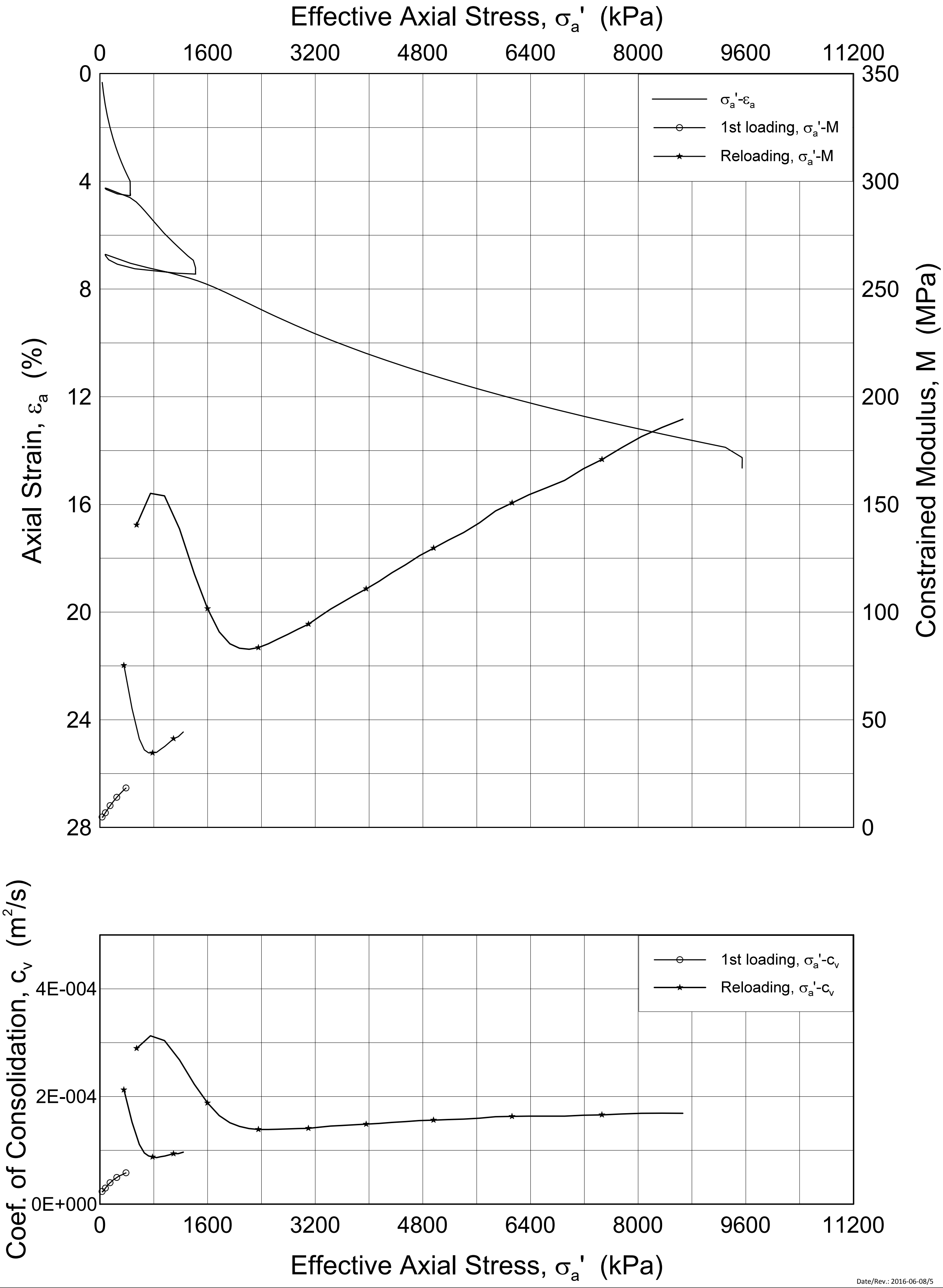
Depth = 7.03 m

p_0' = 81.0 kPa

w_i = 28.5 %

γ_i = 19.31 kN/m³

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

				Depth	=	7.03	m
Boring:	HALB04	Tube:	5	p_0'	=	81.0	kPa
		Part:	A	w_i	=	28.5	%
		Test:	1	γ_i	=	19.31	kN/m^3

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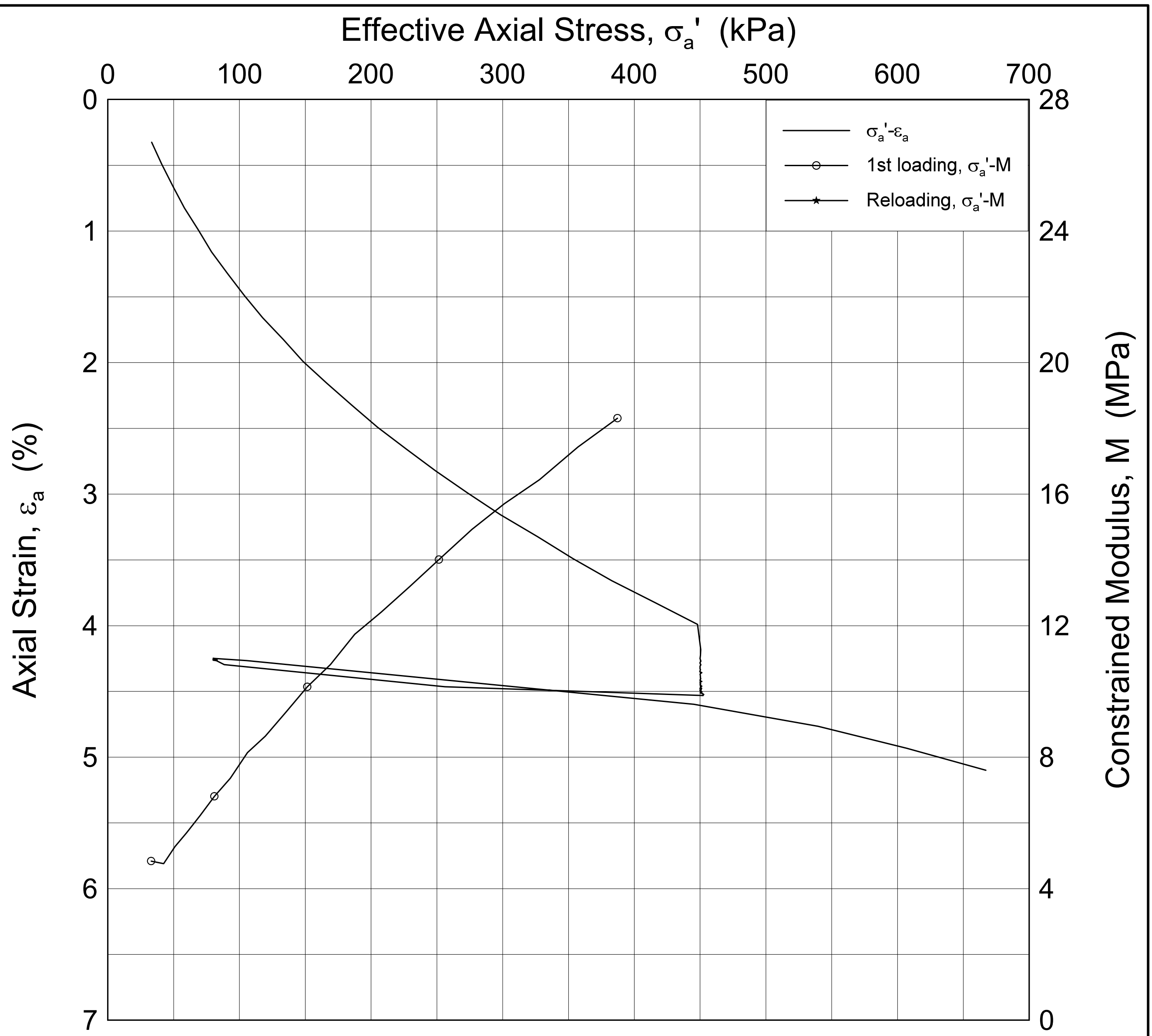
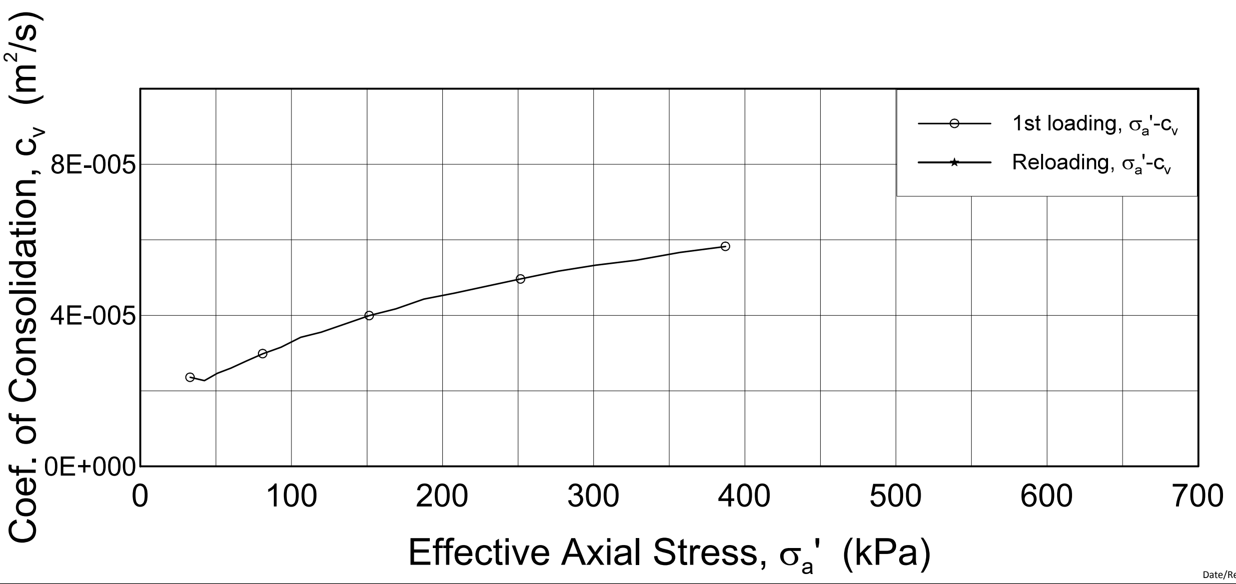
Figure No.
29

Date
2018-04-06

Drawn by / Checked
FI/GS

NGTS





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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

					Depth	=	7.03	m
Boring:	HALB04	Tube:	5		p_0'	=	81.0	kPa
		Part:	A		w_i	=	28.5	%
		Test:	1		γ_i	=	19.31	kN/m³

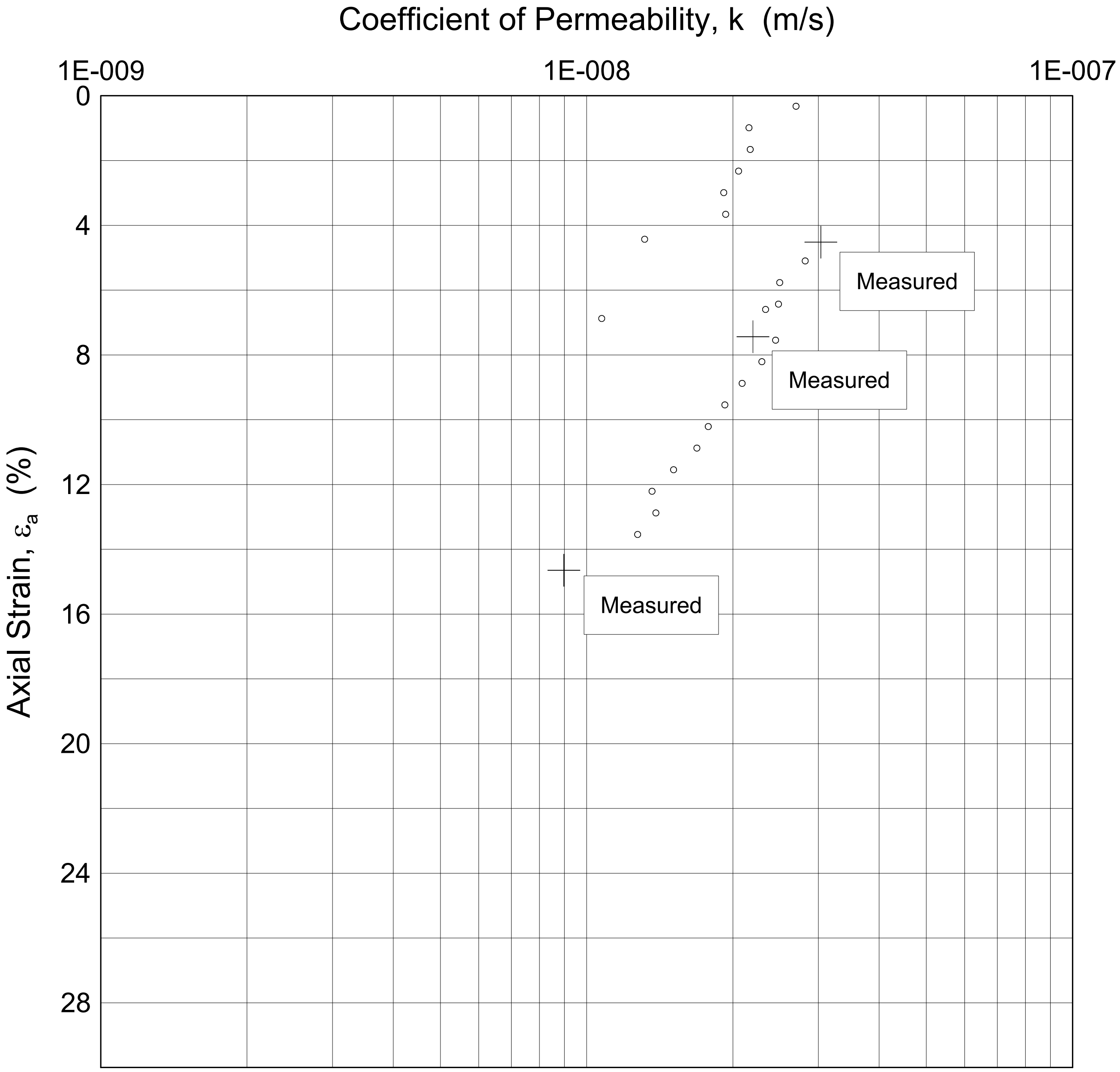
Document No. 20160154-04-R

Figure No. 30

Date 2018-04-06

Drawn by / Checked FI/GS

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 31

Date 2018-04-06

Drawn by / Checked FI/GS

Oedometer test (CRSC)

Boring: HALB04 | Tube: 5 | Part: A | Test: 1

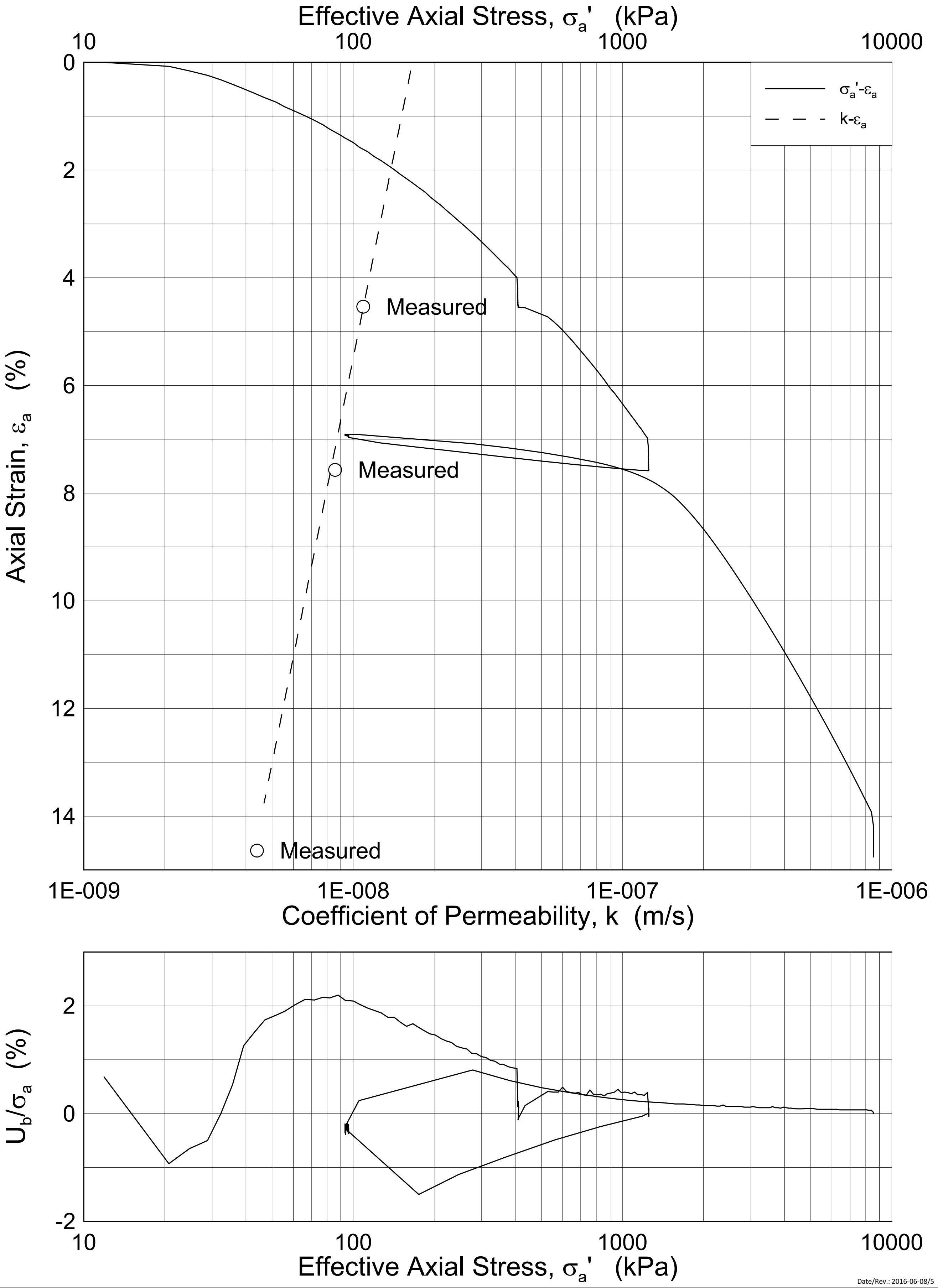
Depth = 7.03 m

p_0' = 81.0 kPa

w_i = 28.5 %

γ_i = 19.31 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 32

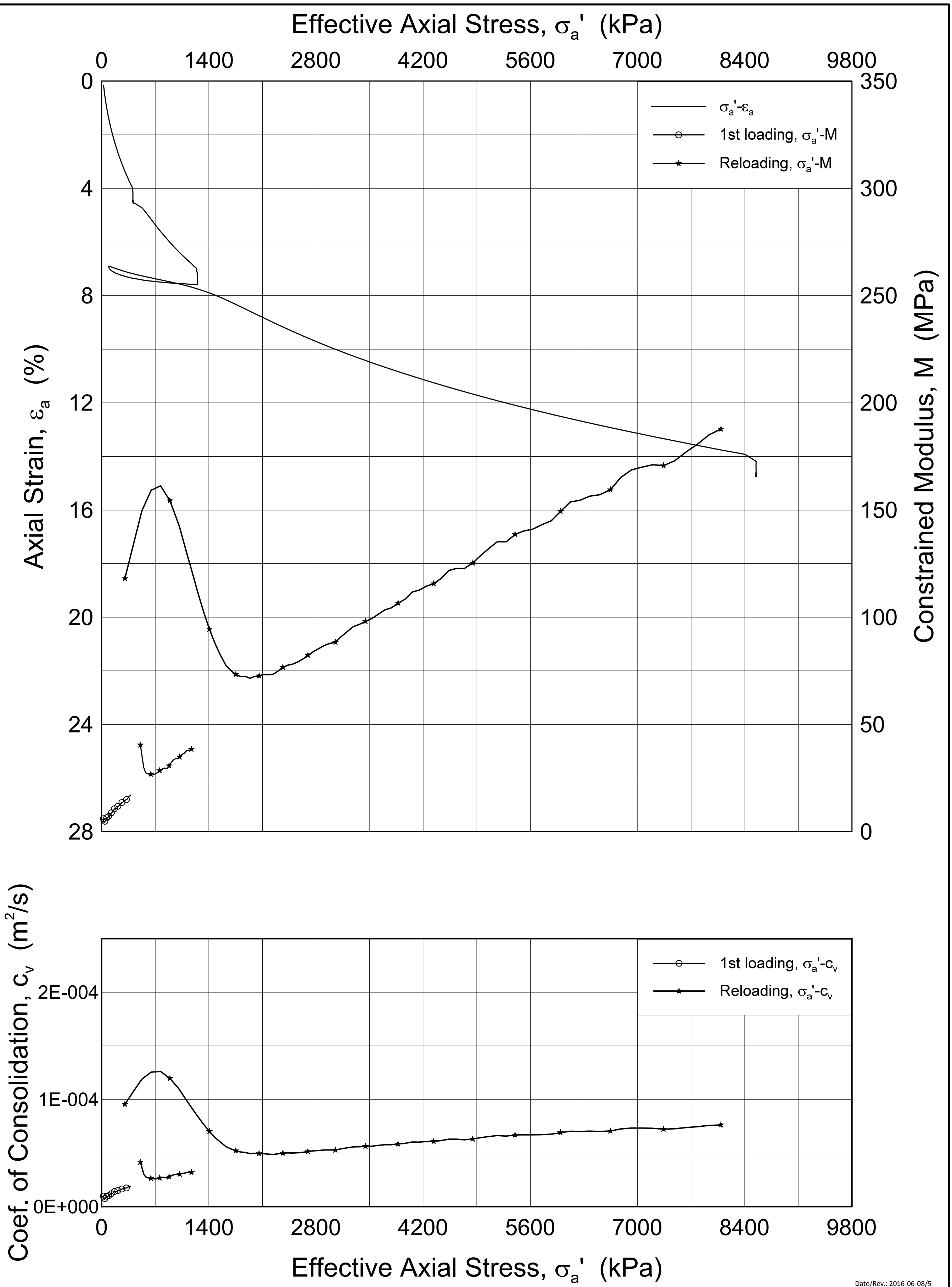
Date 2018-04-06

Drawn by / Checked FI /GS

Oedometer test (CRSC)

				Depth	=	8.4	m
Boring:	HALB04	Tube:	5.5	p_0'	=	94.0	kPa
		Part:	C	w_i	=	28.8	%
		Test:	1	γ_i	=	19.46	kN/m³

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 33

Oedometer test (CRSC)

Date 2018-04-06

Drawn by / Checked FI /GS

Boring: HALB04 | Tube: 5.5 | Part: C | Test: 1

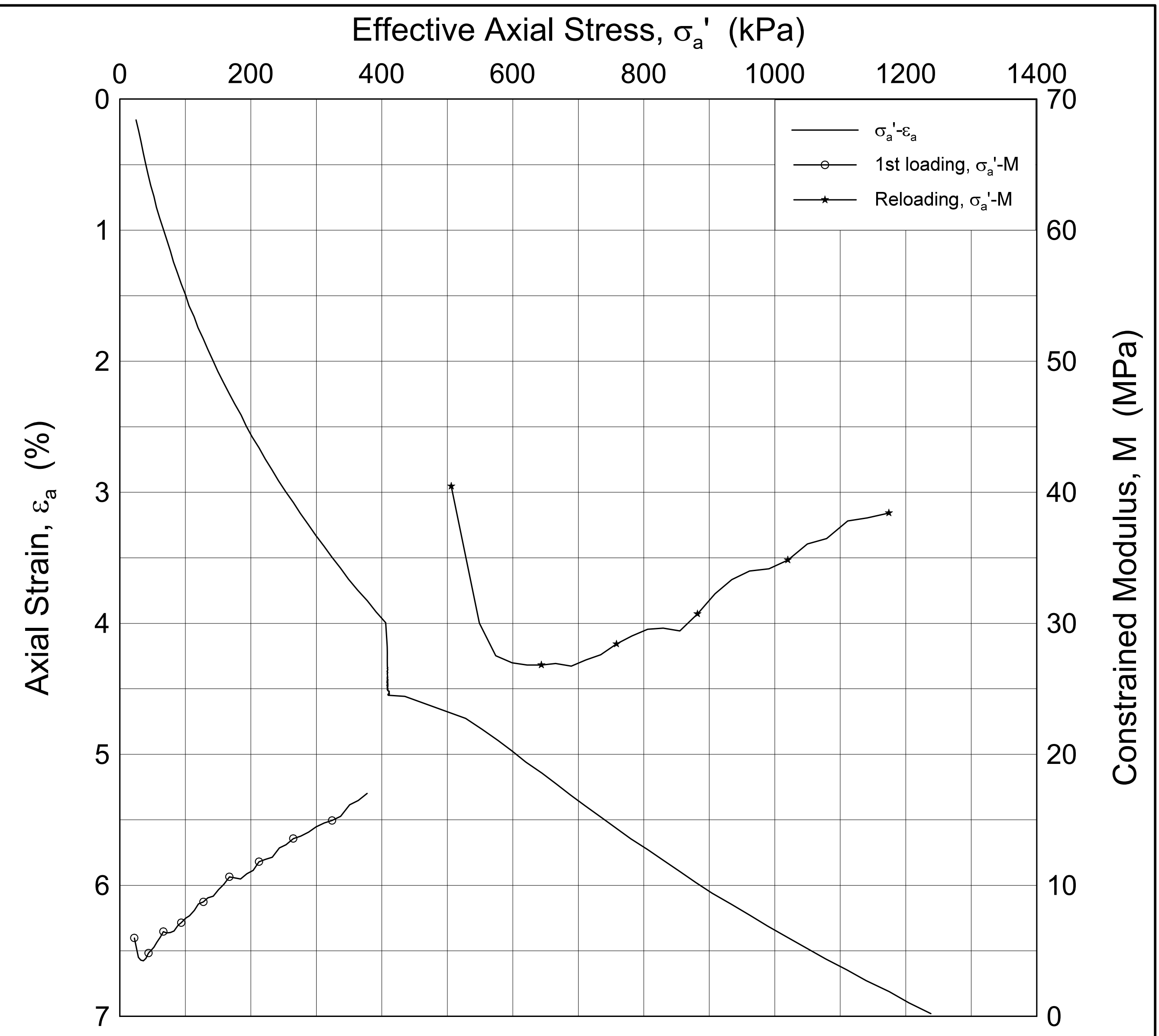
Depth = 8.4 m

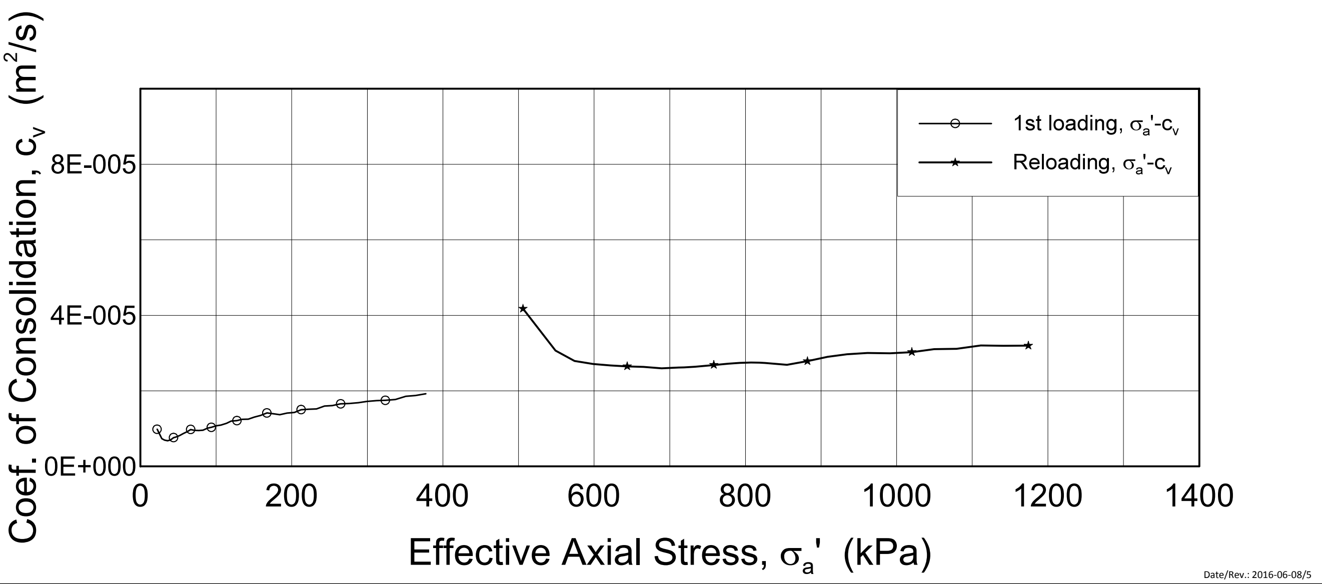
p_0' = 94.0 kPa

w_i = 28.8 %

γ_i = 19.46 kN/m³

NGTS





Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

Boring: HALB04	Tube:	5.5	Depth	=	8.4	m
	Part:	C	p_0'	=	94.0	kPa
	Test:	1	w_i	=	28.8	%
			γ_i	=	19.46	kN/m^3

Document No. 20160154-04-R

Figure No. 34

Date 2018-04-06

Drawn by / Checked FI /GS

NGTS

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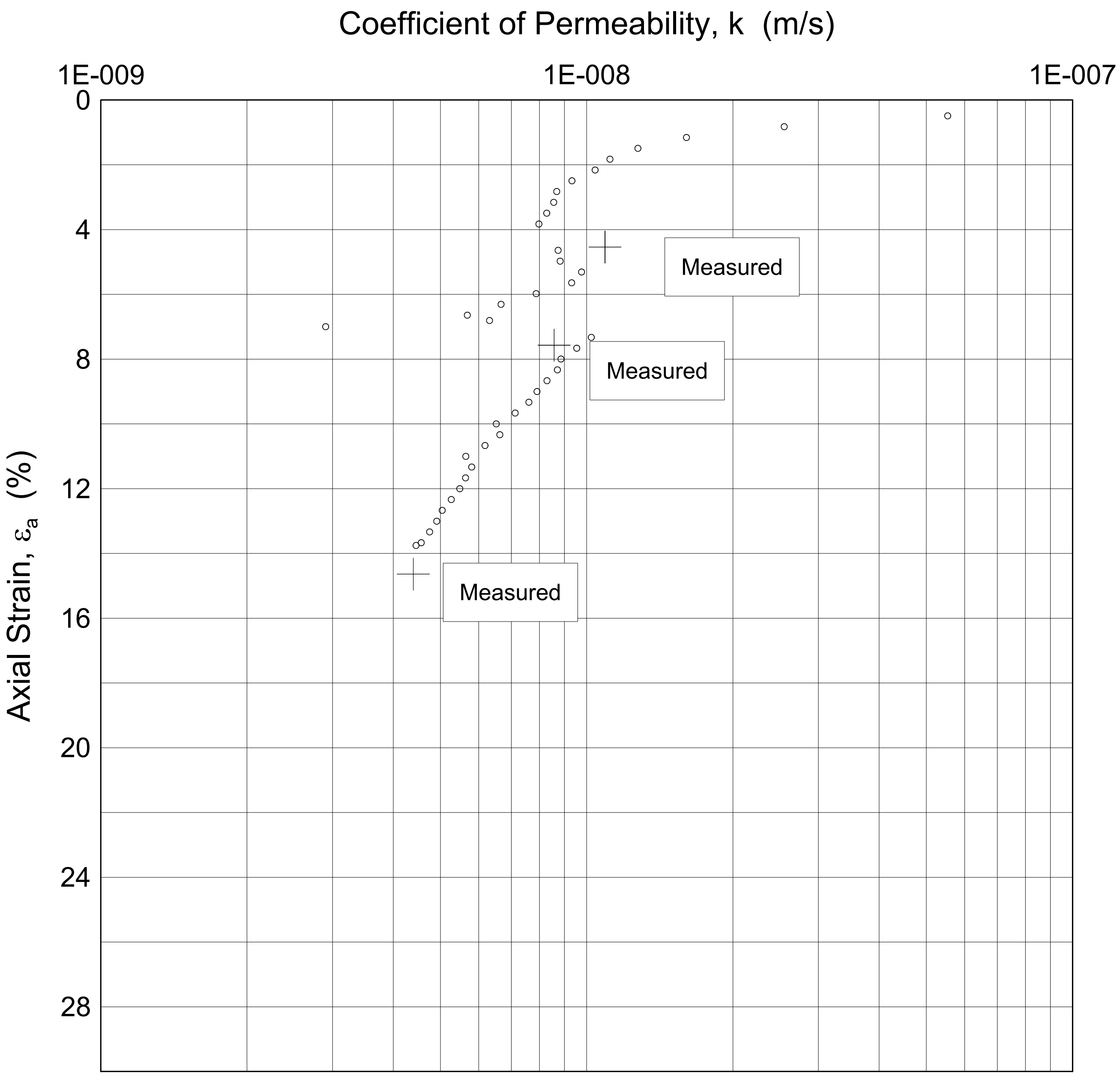

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NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 35

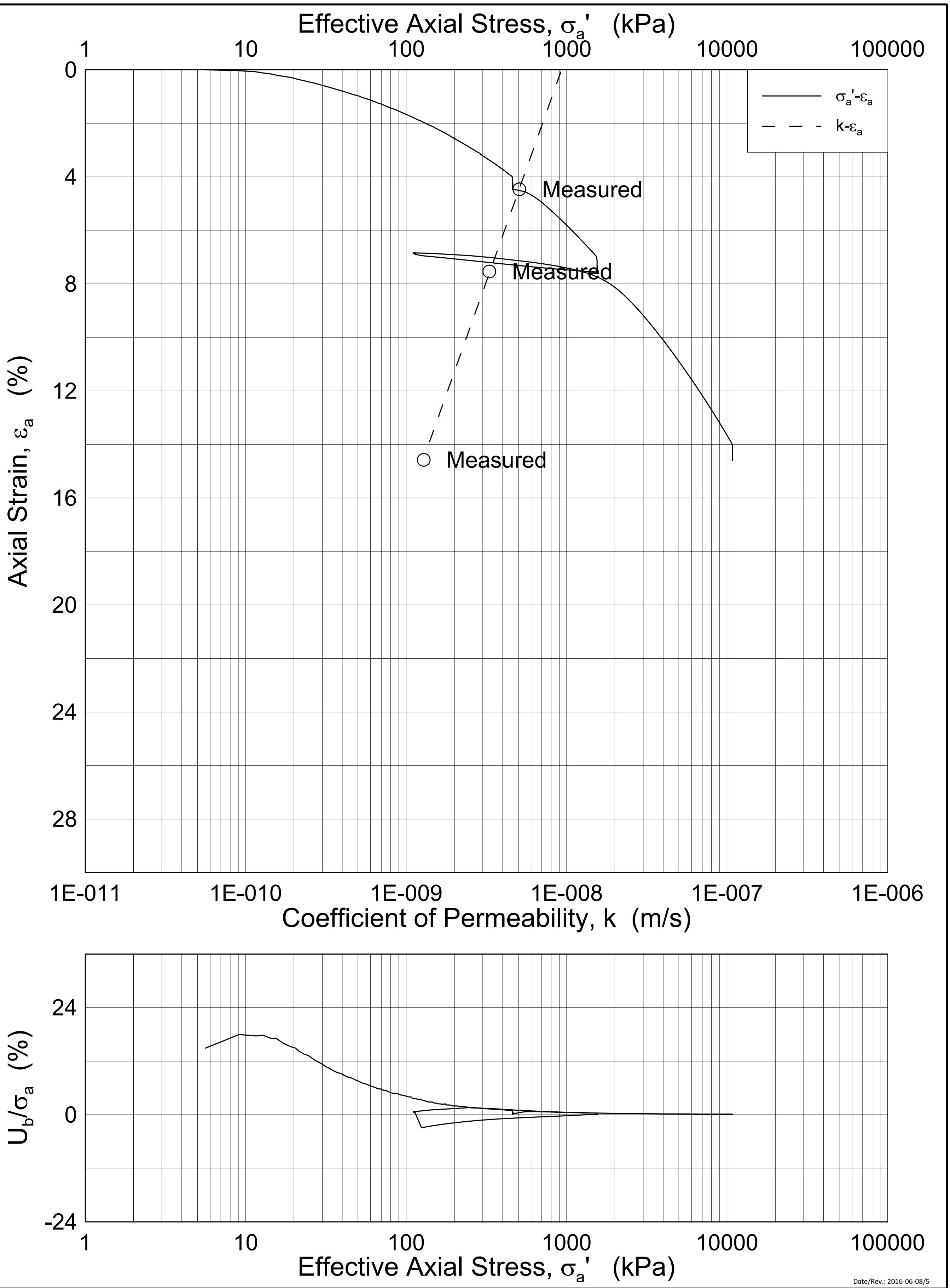
Date 2018-04-06

Drawn by / Checked FI /GS

Oedometer test (CRSC)

				Depth	=	8.4	m
Boring:	HALB04	Tube:	5.5	p_0'	=	94.0	kPa
		Part:	C	w_i	=	28.8	%
		Test:	1	γ_i	=	19.46	kN/m^3

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 36
	Date 2018-04-06 / Drawn by / Checked FI /GS

Boring: HALB04

Tube: 8

Part: A

Test: 1

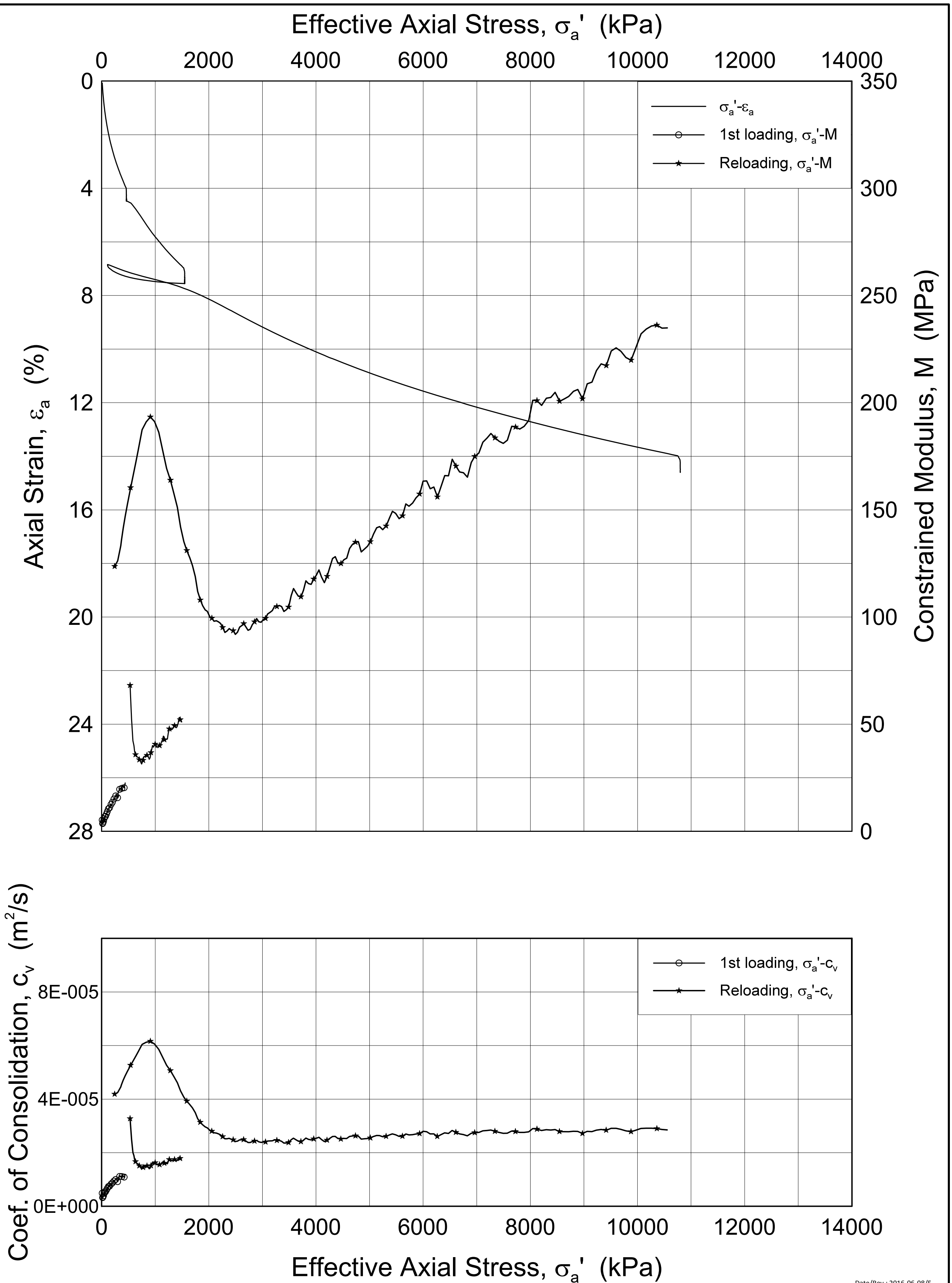
Depth = 10.0-10.35 m

p_0' = 112.0 kPa

w_i = 26.1 %

γ_i = 20.04 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 37
	Date 2018-04-06 / Drawn by / Checked FI /GS

Boring: HALB04

Tube: 8
Part: A
Test: 1

Depth = 10.0-10.35 m
p_0' = 112.0 kPa
w_i = 26.1 %
γ_i = 20.04 kN/m³

NGTS

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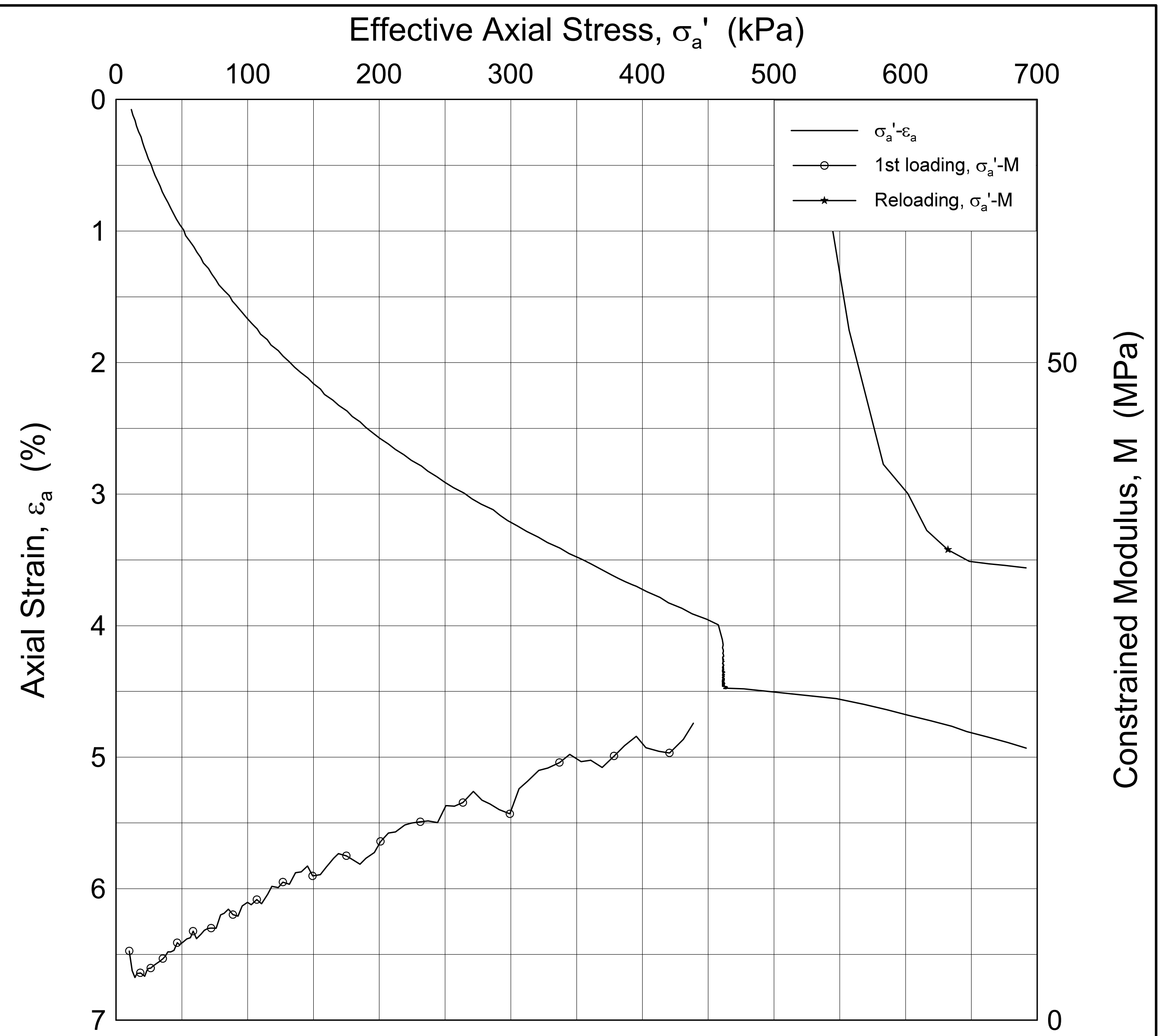

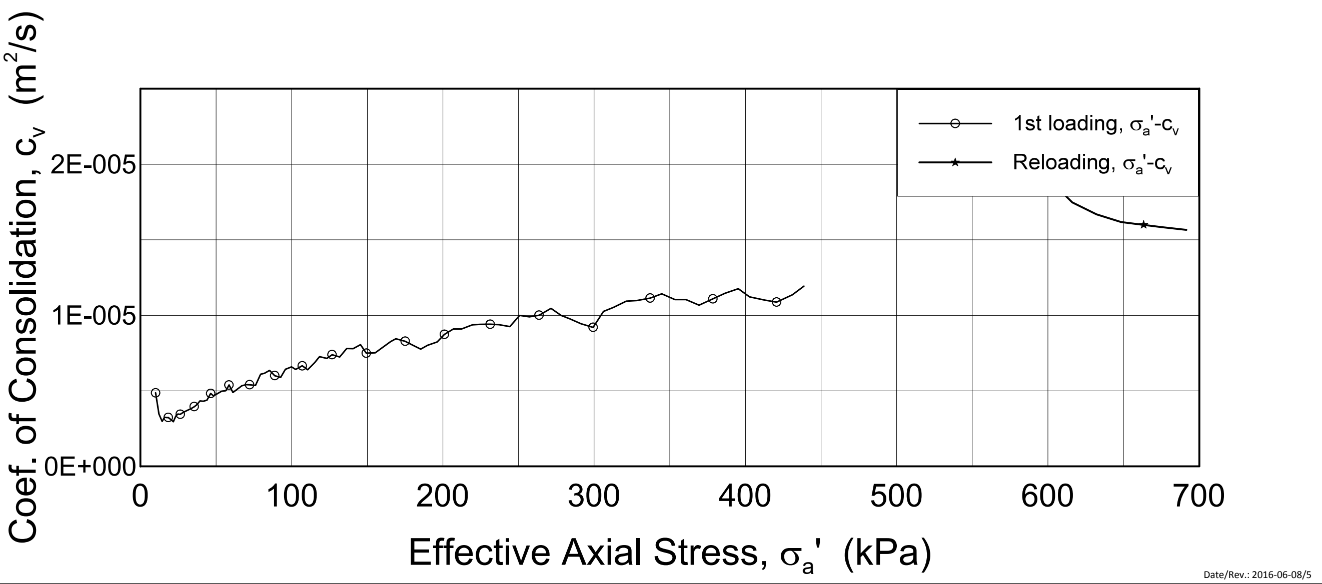

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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 38
	Date 2018-04-06 — Drawn by / Checked FI /GS

Boring: HALB04 — Tube: 8 — Part: A — Test: 1

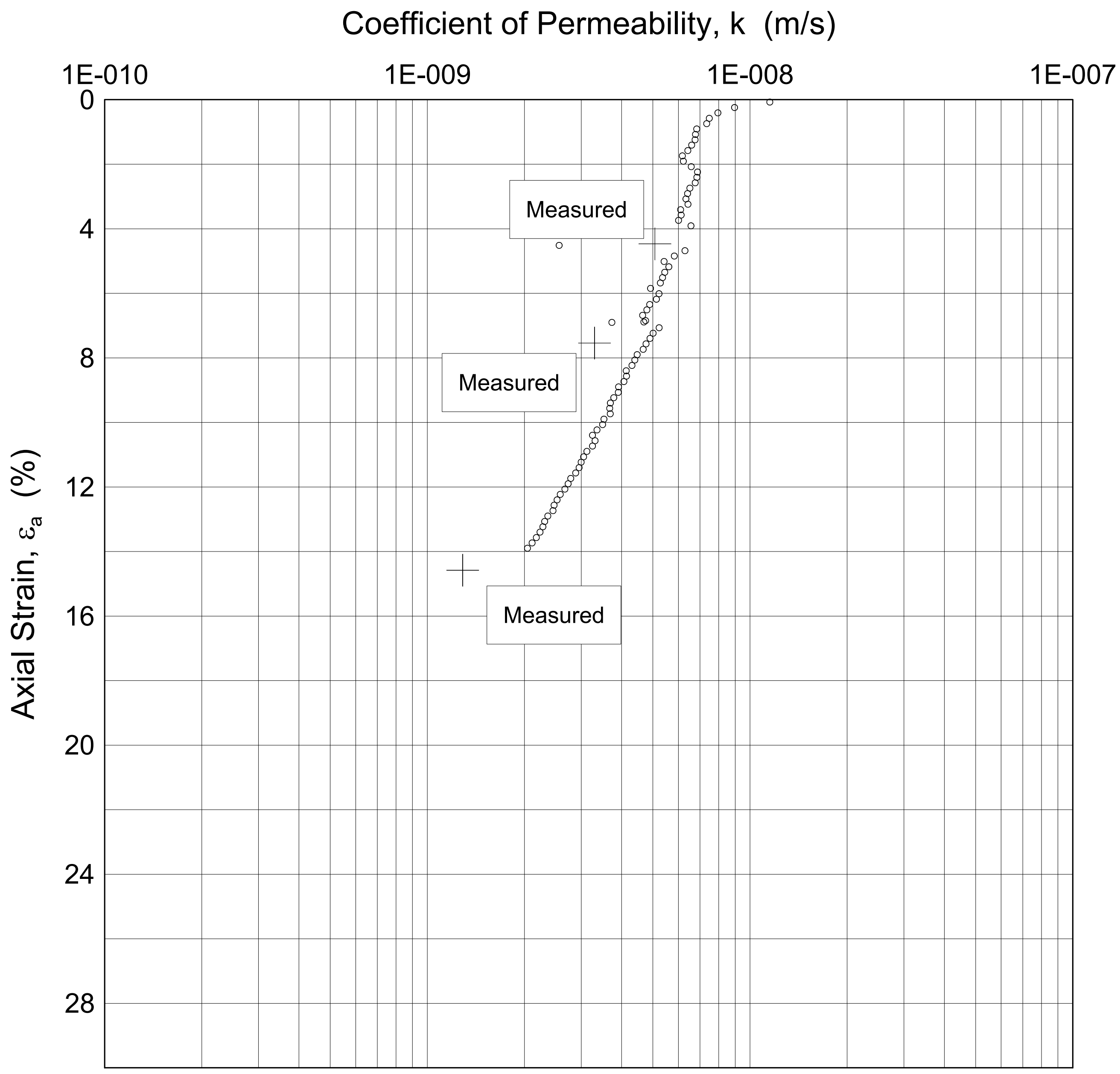
Depth = 10.0-10.35 m

p_0' = 112.0 kPa

w_i = 26.1 %

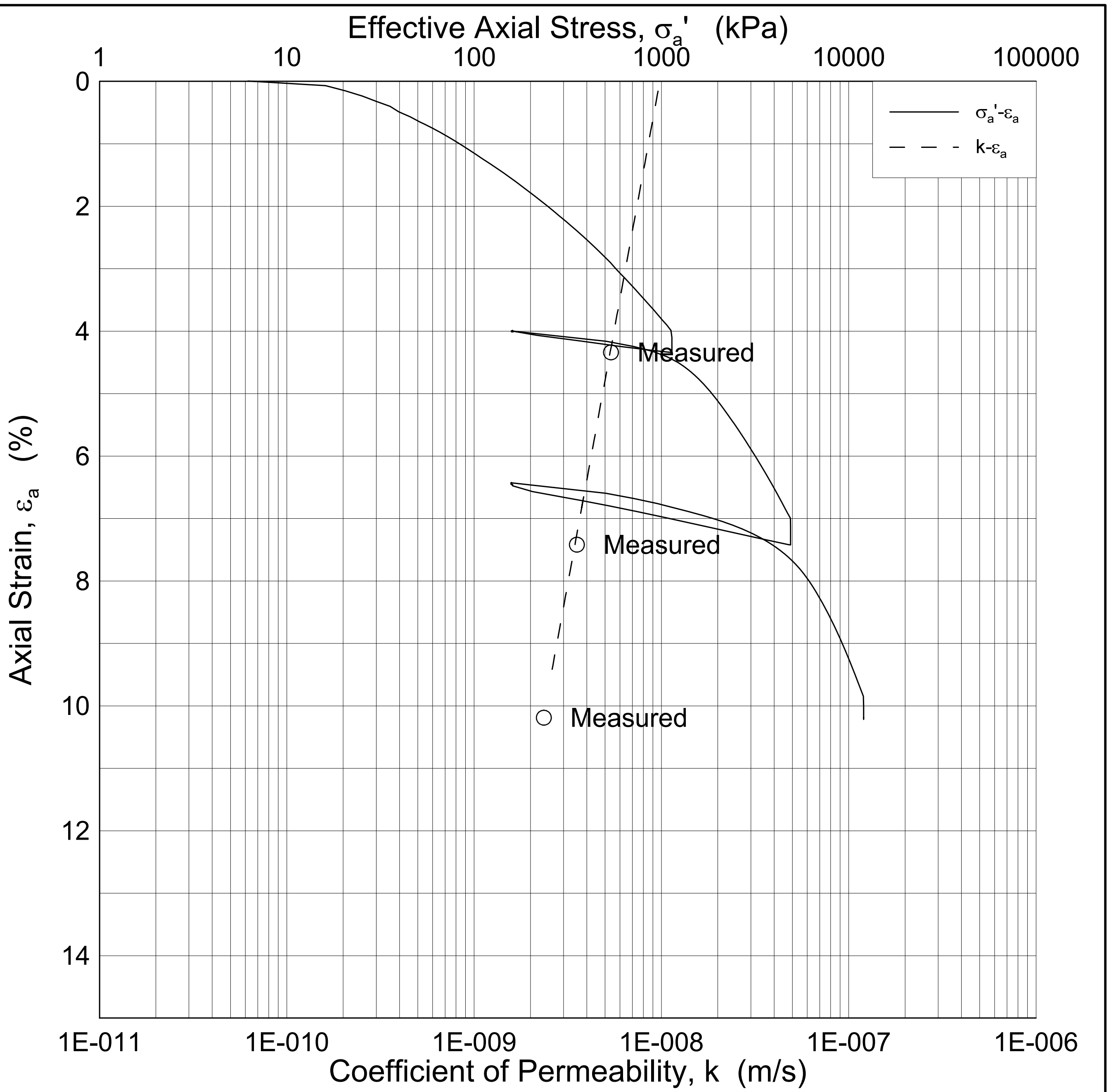
γ_i = 20.04 kN/m³

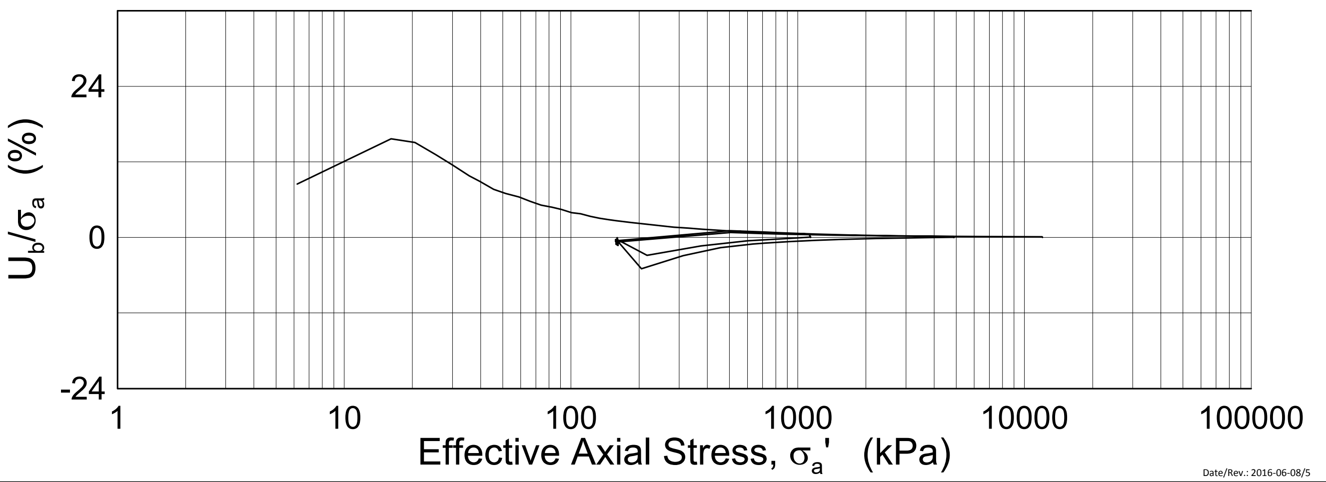
NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 39
Boring: HALB04 · Tube: 8 · Part: A · Test: 1	Date 2018-04-06 · Drawn by / Checked FI /GS
Depth = 10.0-10.35 m; p_0' = 112.0 kPa; w_i = 26.1 %; γ_i = 20.04 kN/m³	NGTS





Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site

Oedometer test (CRSC)

Boring: HALB04

Tube: 13

Part: A

Test: 2

Depth = 14.6 m

p_0' = 158.0 kPa

w_i = 22.2 %

γ_i = 20.69 kN/m³

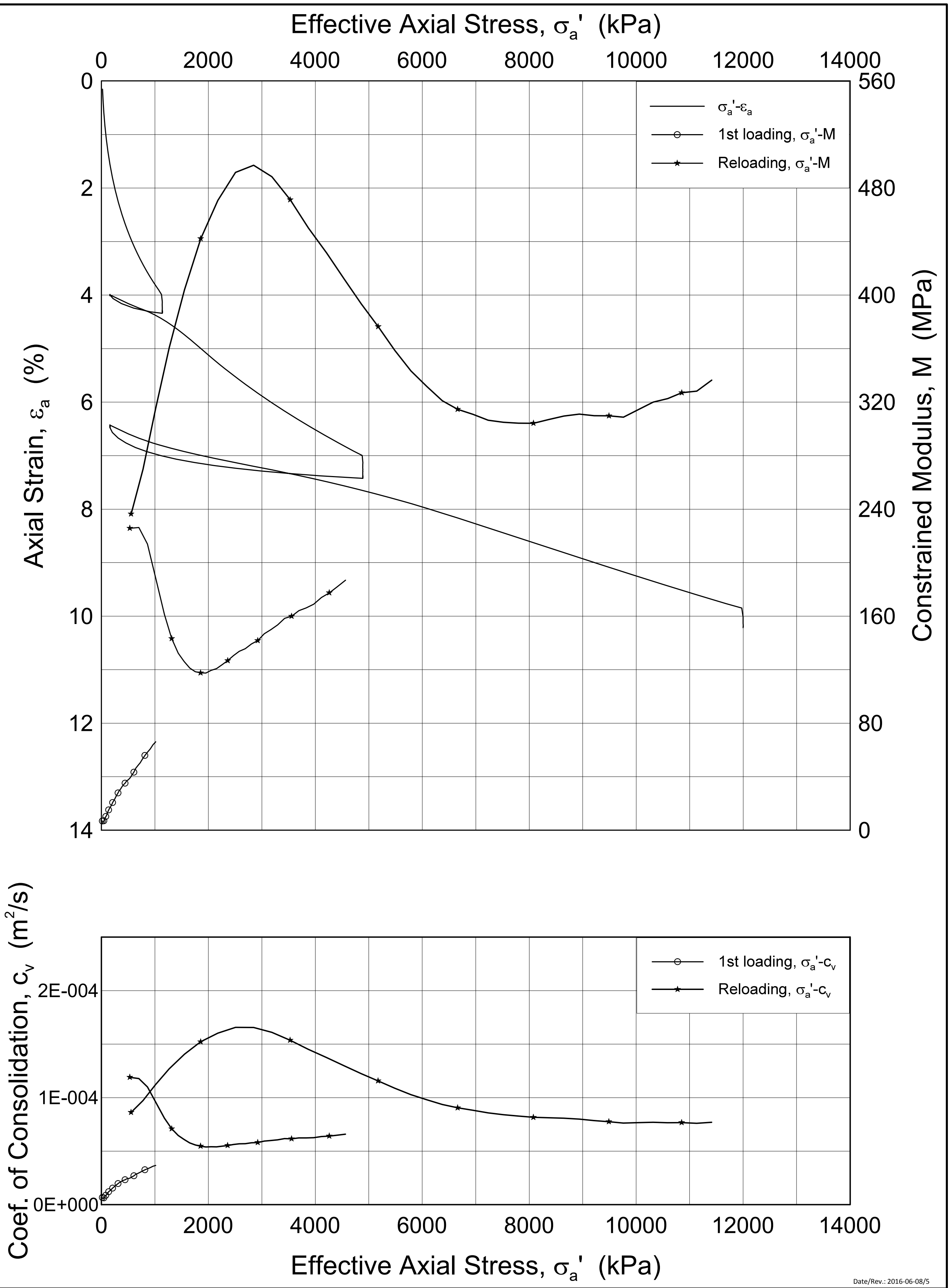
Document No. 20160154-04-R

Figure No. 40

Date 2018-04-06

Drawn by / Checked FI /GS

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 41

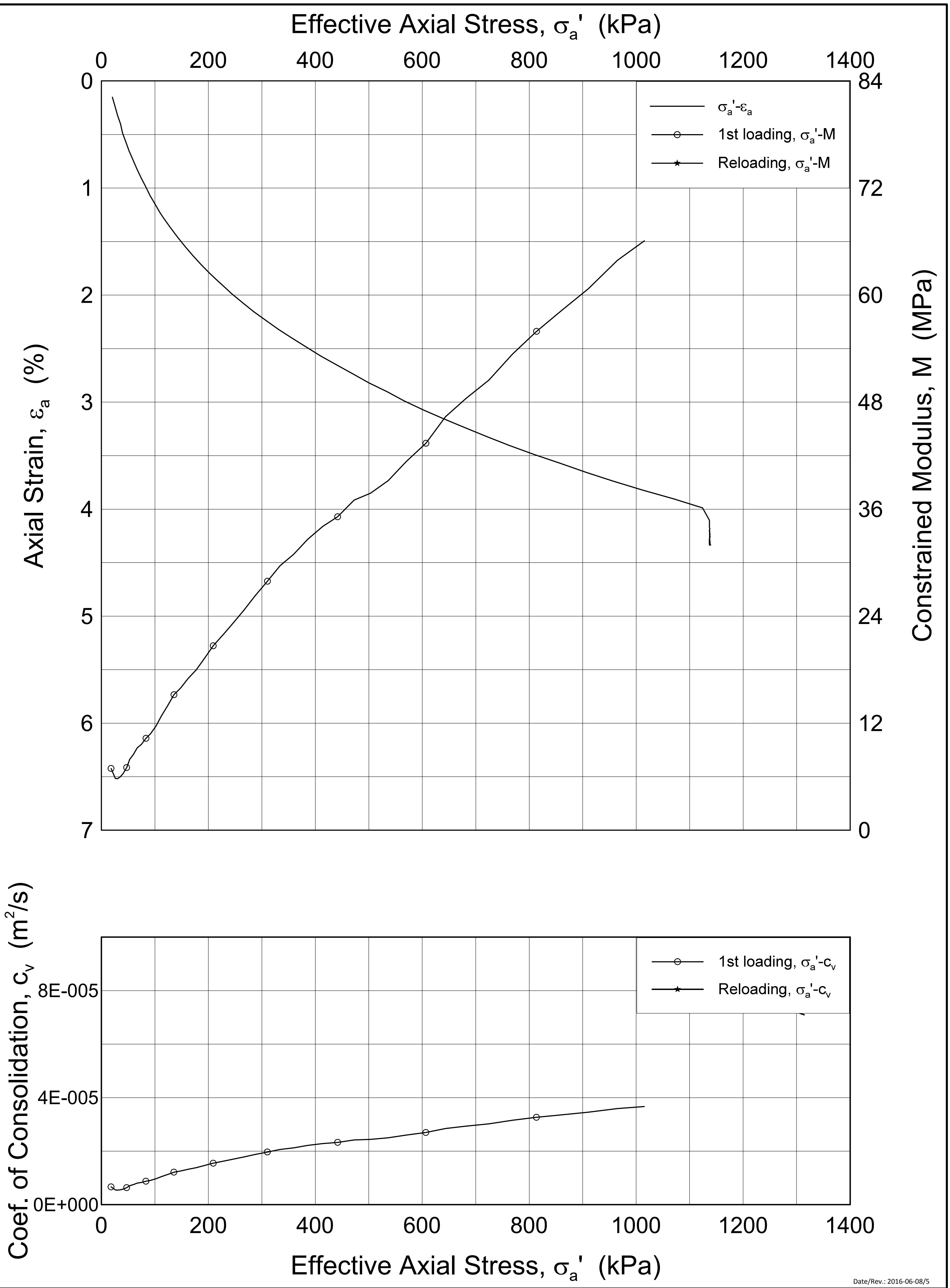
Date 2018-04-06

Drawn by / Checked FI/GS

Oedometer test (CRSC)

				Depth	=	14.6	m
Boring:	HALB04	Tube:	13	p_0'	=	158.0	kPa
		Part:	A	w_i	=	22.2	%
		Test:	2	γ_i	=	20.69	kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

Boring:	HALB04	Tube:	13	p_0'	=	158.0	kPa
		Part:	A	w_i	=	22.2	%
		Test:	2	γ_i	=	20.69	kN/m³

Depth = 14.6 m

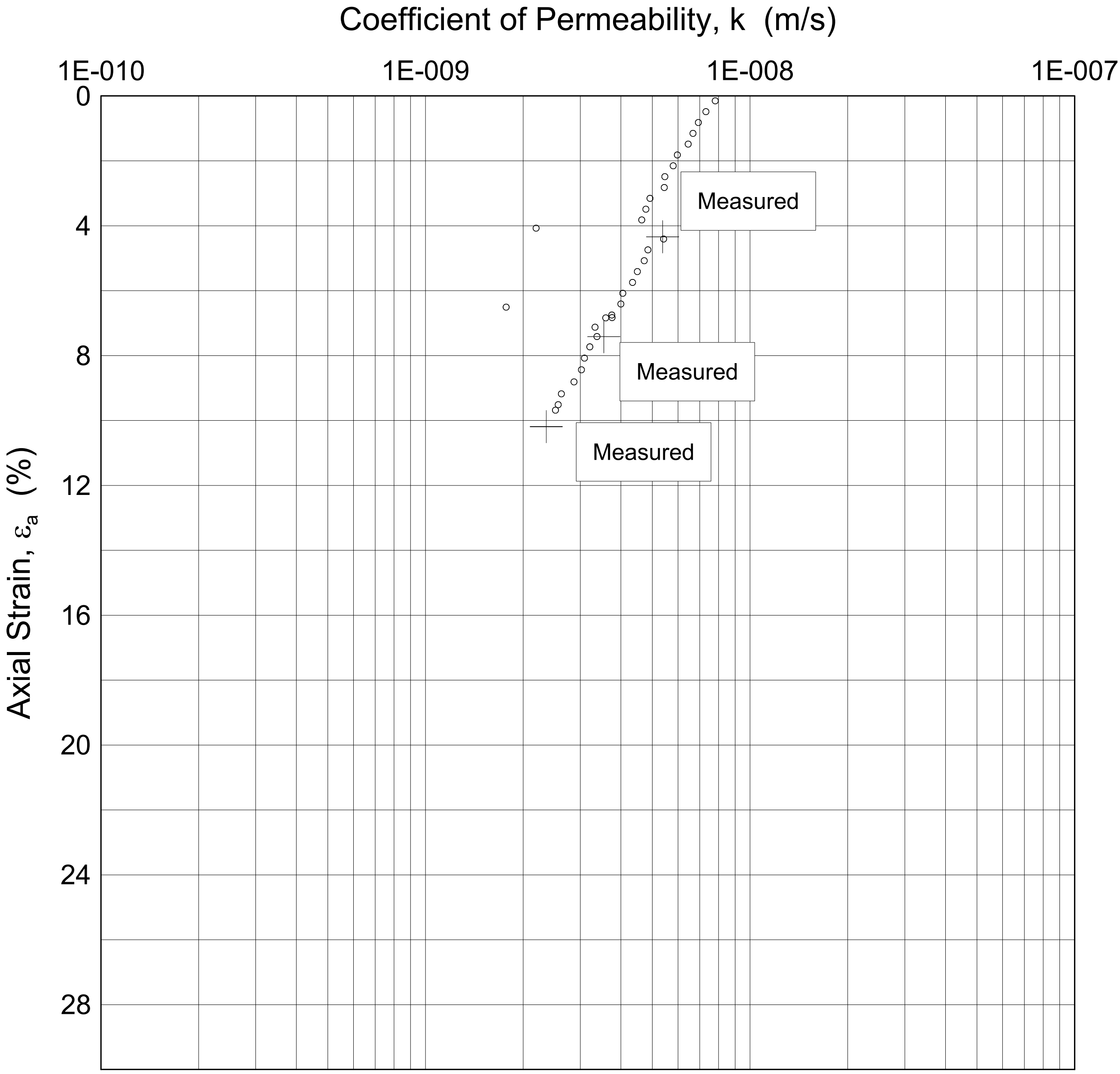
Document No. 20160154-04-R

Figure No. 42

Date 2018-04-06

Drawn by / Checked FI /GS

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Document No. 20160154-04-R

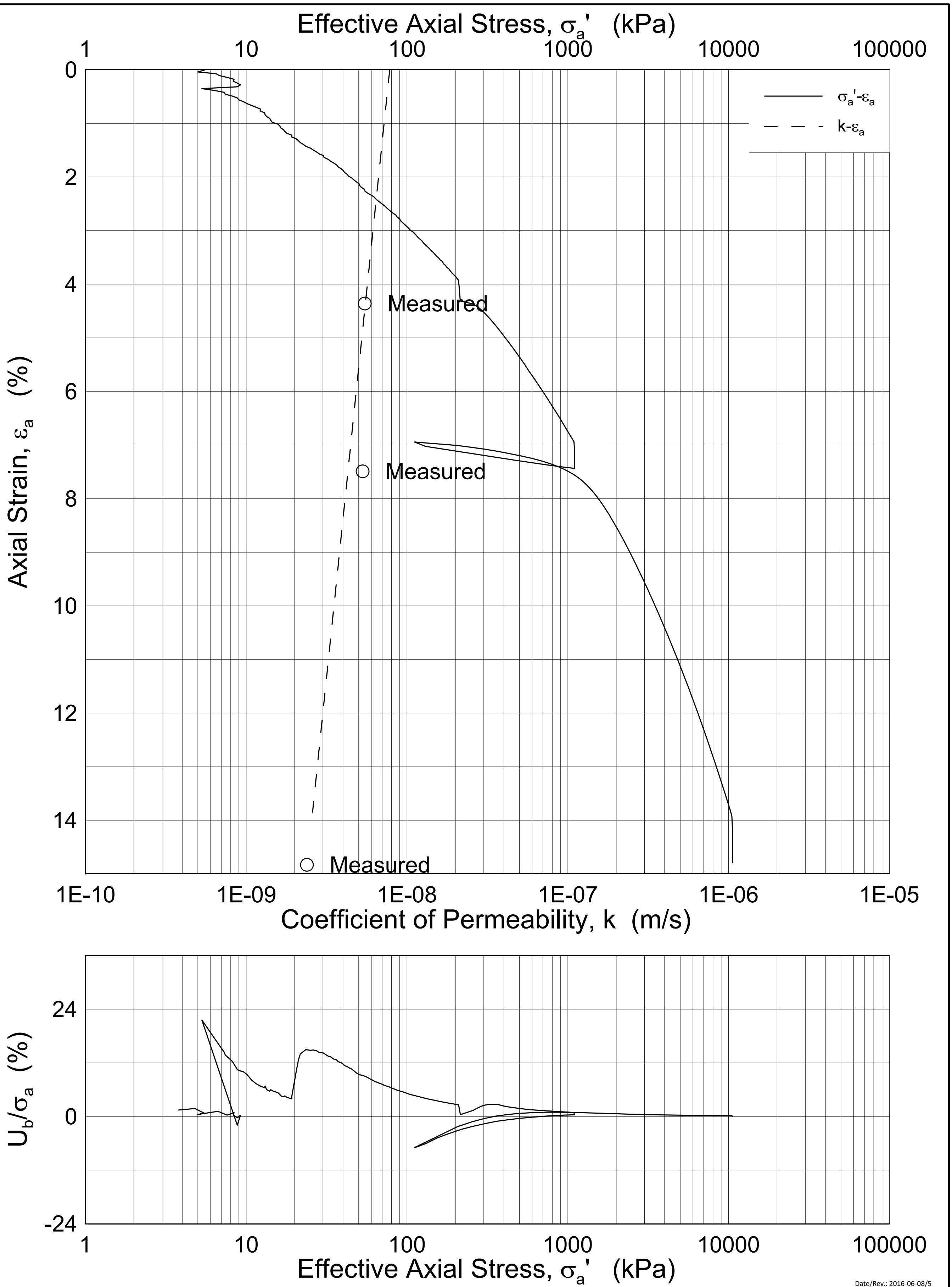
Figure No. 43

Date 2018-04-06

Drawn by / Checked FI/GS

Oedometer test (CRSC)

				Depth	=	14.6	m
Boring:	HALB04	Tube:	13	p_0'	=	158.0	kPa
		Part:	A	w_i	=	22.2	%
		Test:	2	γ_i	=	20.69	kN/m^3



Date/Rev.: 2016-06-08/5

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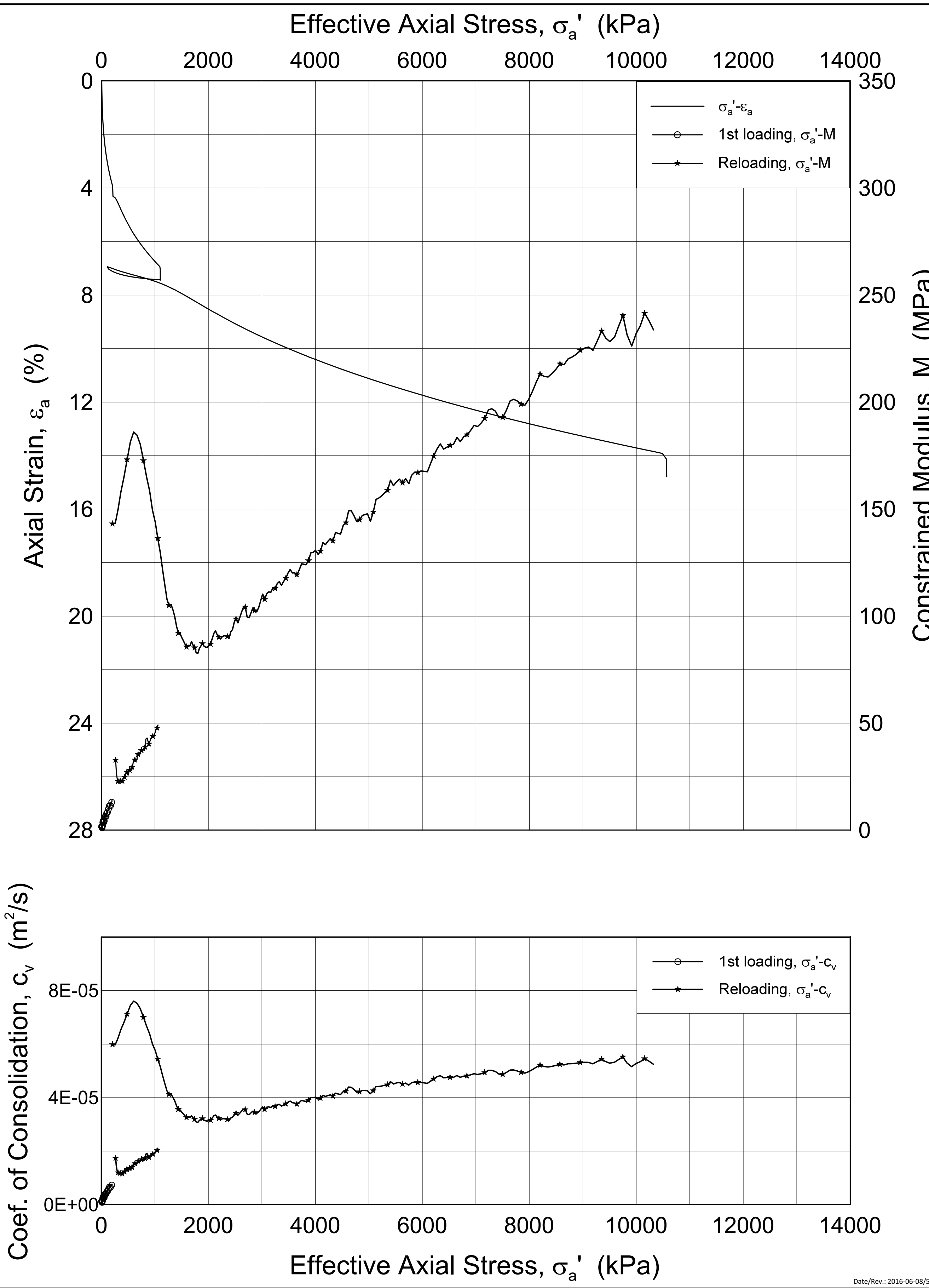
NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 44
	Date 2018-06-05 / Drawn by / Checked FI/GS

Boring: HALB05 Tube: 1 Part: B Test: 1

Depth = 9.35 m
p_0' = 106.7 kPa
w_i = 28.5 %
γ_i = 20.05 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 45
	Date 2018-06-05 / Drawn by / Checked FI/GS

Boring: HALB05 Tube: 1 Part: B Test: 1

Depth = 9.35 m

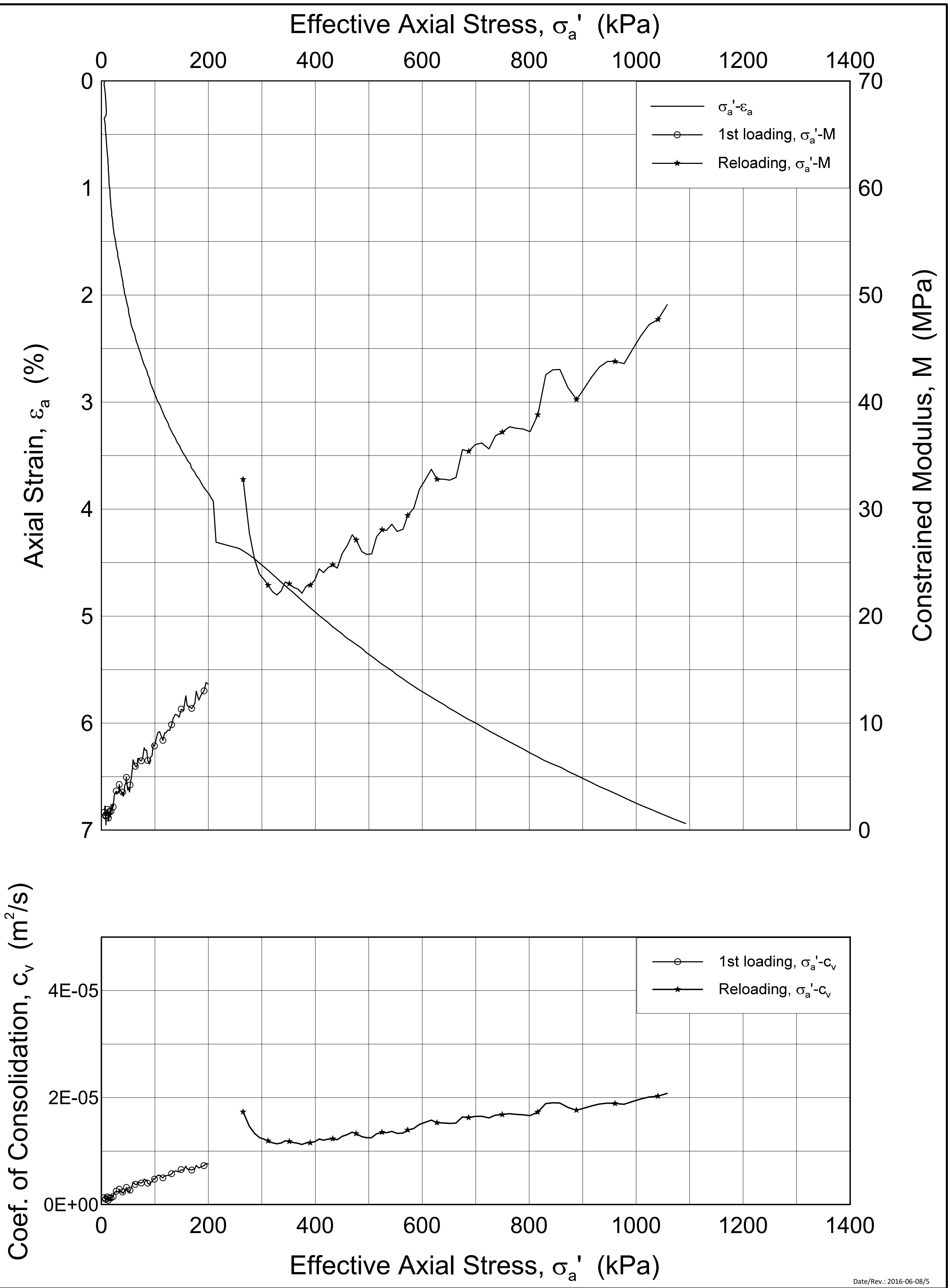
p_0' = 106.7 kPa

w_i = 28.5 %

γ_i = 20.05 kN/m³

NGTS

P:\2016\01\20160154\Lab\Halden\CRS\HALB05\HALB05-1-B-1 Lin (CRS4163).grf



Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site	Document No. 20160154-04-R	
	Figure No. 46	
Oedometer test (CRSC)	Date 2018-06-05	Drawn by / Checked FI/GS

Boring: HALB05 Tube: 1 Part: B Test: 1

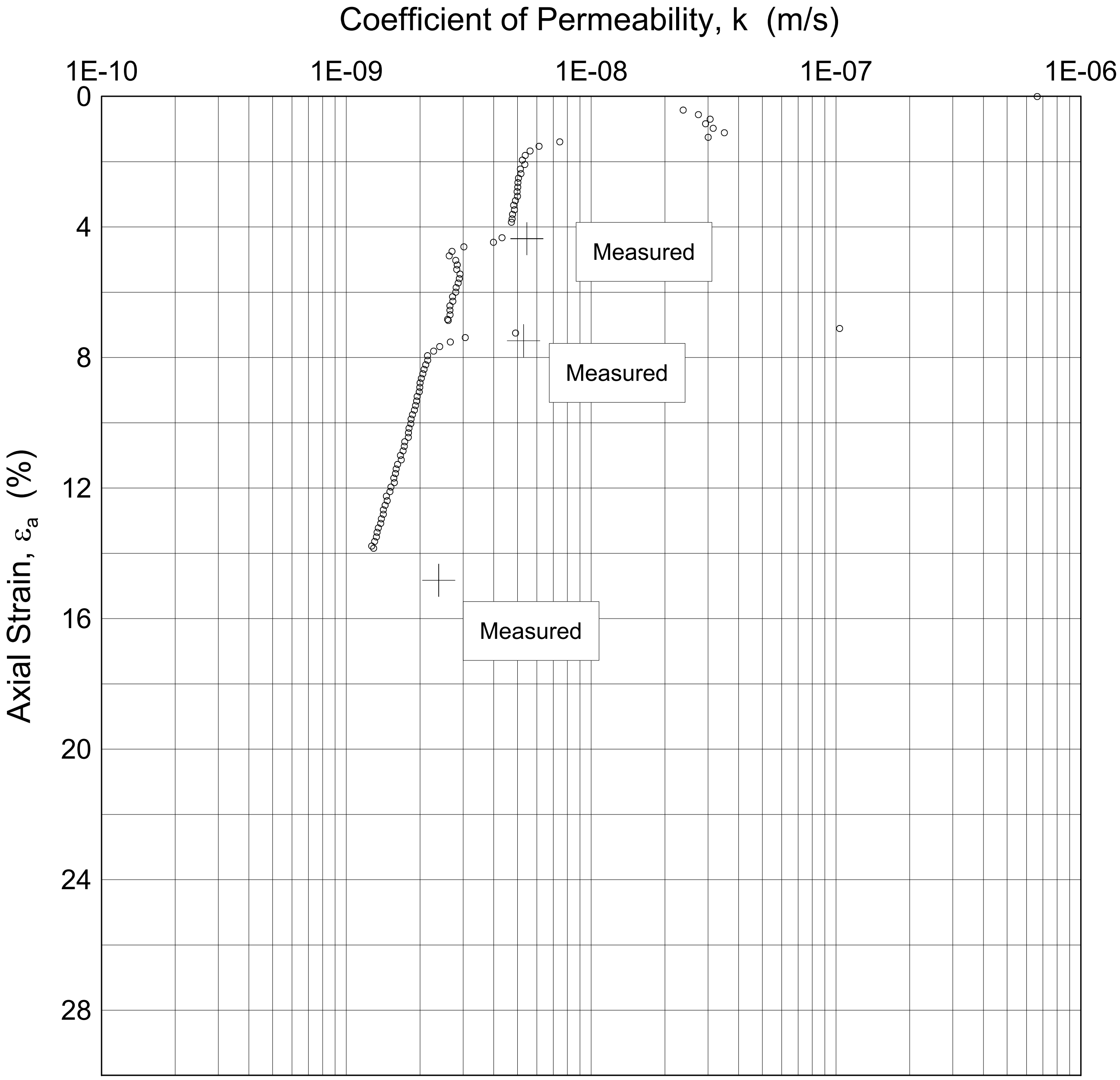
Depth = 9.35 m

p_0' = 106.7 kPa

w_i = 28.5 %

γ_i = 20.05 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site		Document No. 20160154-04-R
Oedometer test (CRSC)		Figure No. 47
Boring: HALB05	Depth = 9.35 m	Date 2018-06-05
Tube: 1	p_0' = 106.7 kPa	Drawn by / Checked FI/GS
Part: B	w_i = 28.5 %	NGTS
Test: 1	γ_i = 20.05 kN/m³	

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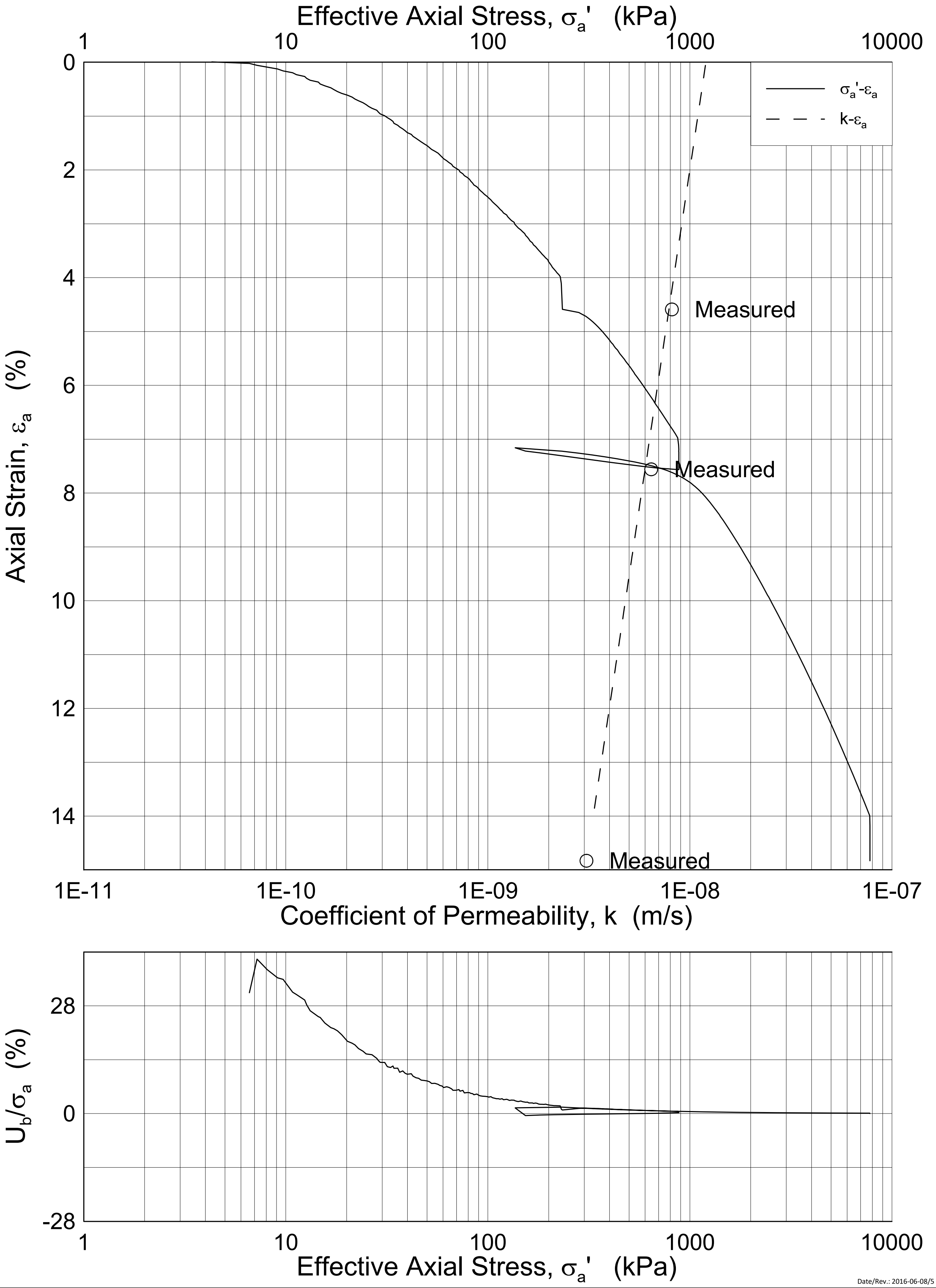

Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (CRSC)	Figure No. 48
	Date 2018-06-05 / Drawn by / Checked FI/GS

Boring: HALB05

Tube: 2

Part: D

Test: 1

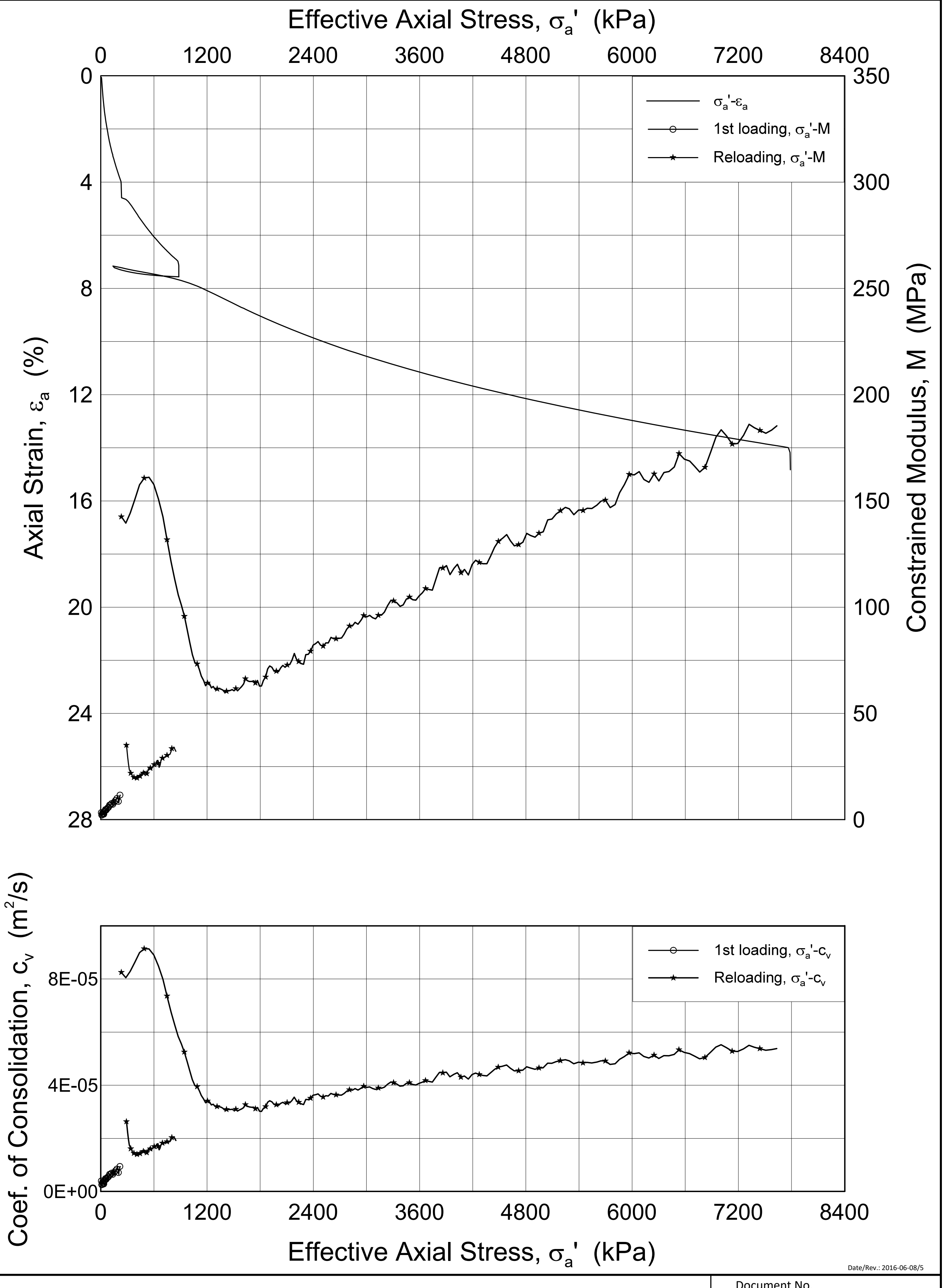
Depth = 12.71 m

p_0' = 136.5 kPa

w_i = 29.4 %

γ_i = 19.87 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

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NGTS - Halden Research Site

Oedometer test (CRSC)

Boring: HALB05	Tube: 2	Depth = 12.71 m
		p_0' = 136.5 kPa
	Part: D	w_i = 29.4 %
	Test: 1	γ_i = 19.87 kN/m³

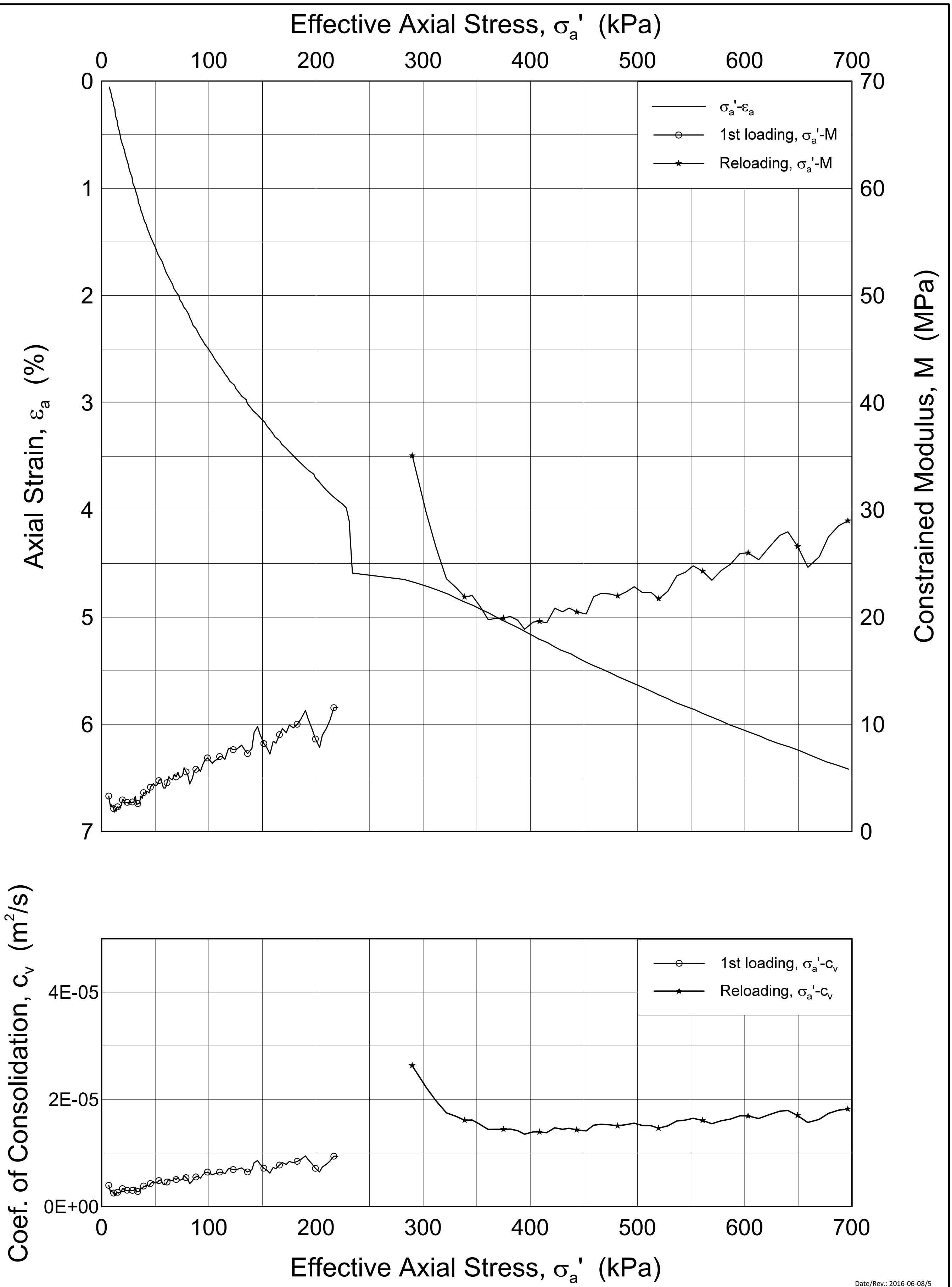
Document No. 20160154-04-R

Figure No. 49

Date 2018-06-05

Drawn by / Checked FI/GS

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (CRSC)

Boring:	HALB05	Tube:	2	Depth	= 12.71 m
		Part:	D	p_0'	= 136.5 kPa
		Test:	1	w_i	= 29.4 %
				γ_i	= 19.87 kN/m³

Document No. 20160154-04-R

Figure No. 50

Date 2018-06-05

Drawn by / Checked FI/GS

NGTS

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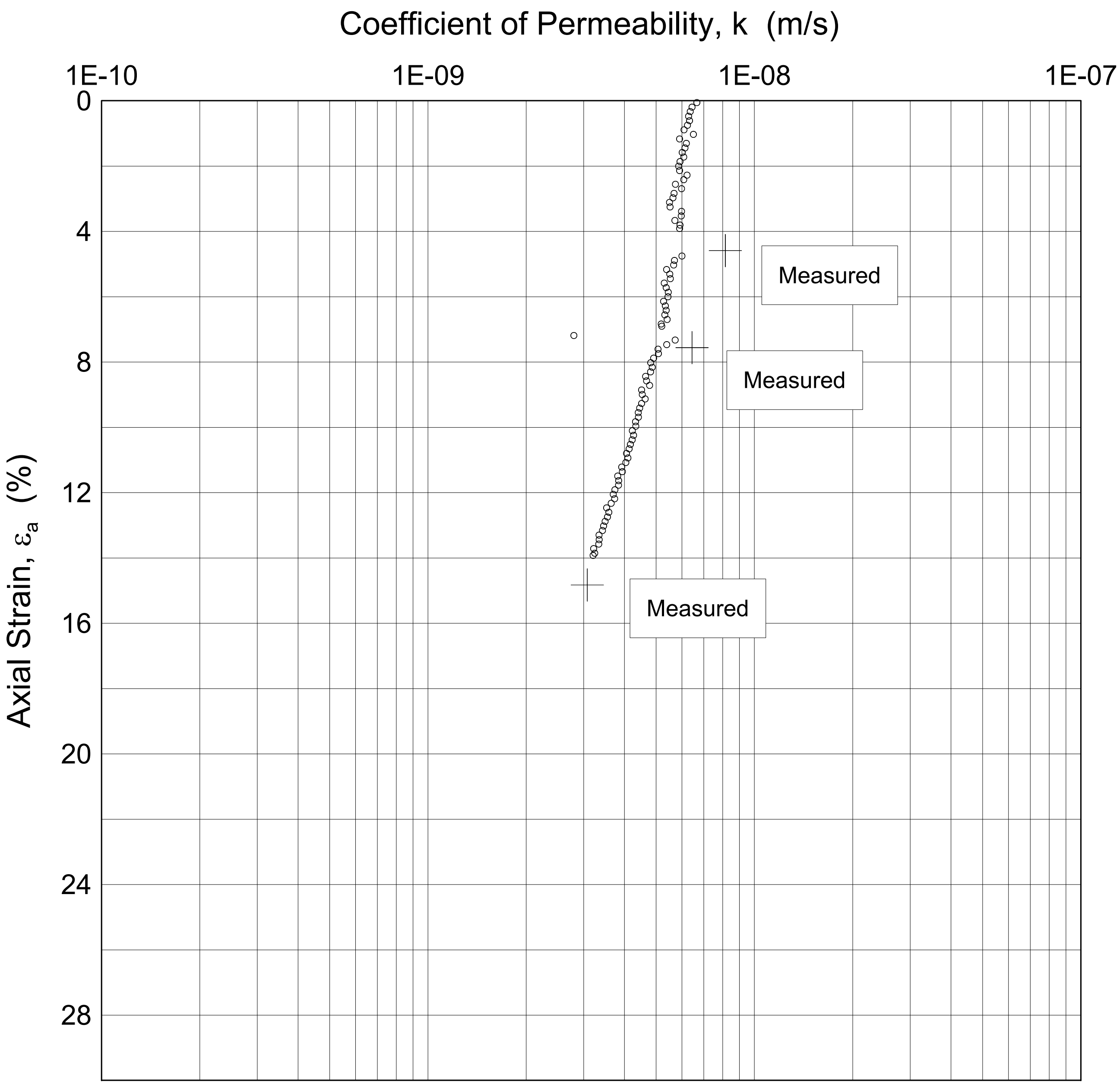

Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site	Document No. 20160154-04-R	
Oedometer test (CRSC)	Figure No. 51	
Boring: HALB05 · Tube: 2 · Part: D · Test: 1	Date 2018-06-05	Drawn by / Checked FI/GS

Depth = 12.71 m

p_0' = 136.5 kPa

w_i = 29.4 %

γ_i = 19.87 kN/m³

NGTS

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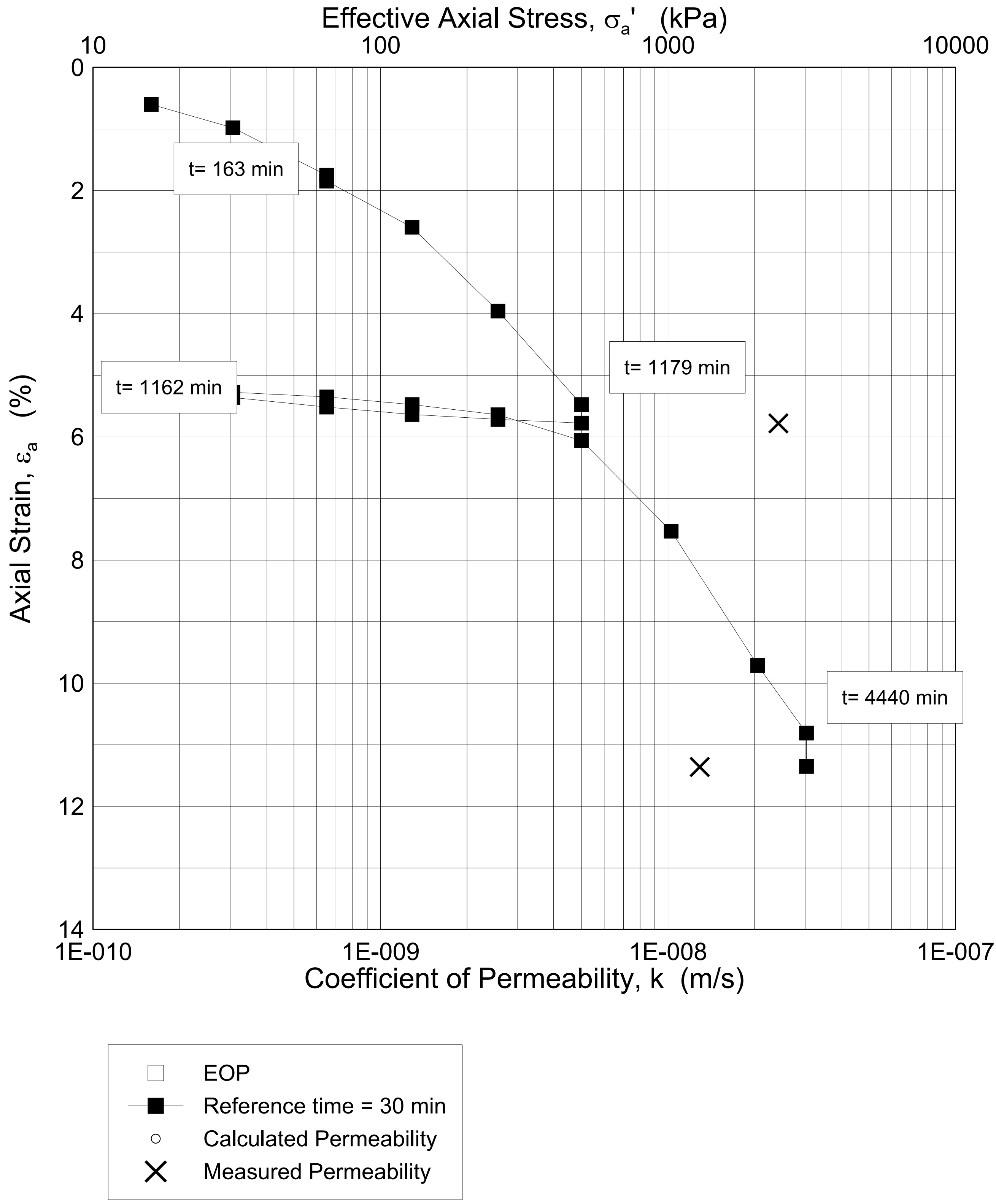

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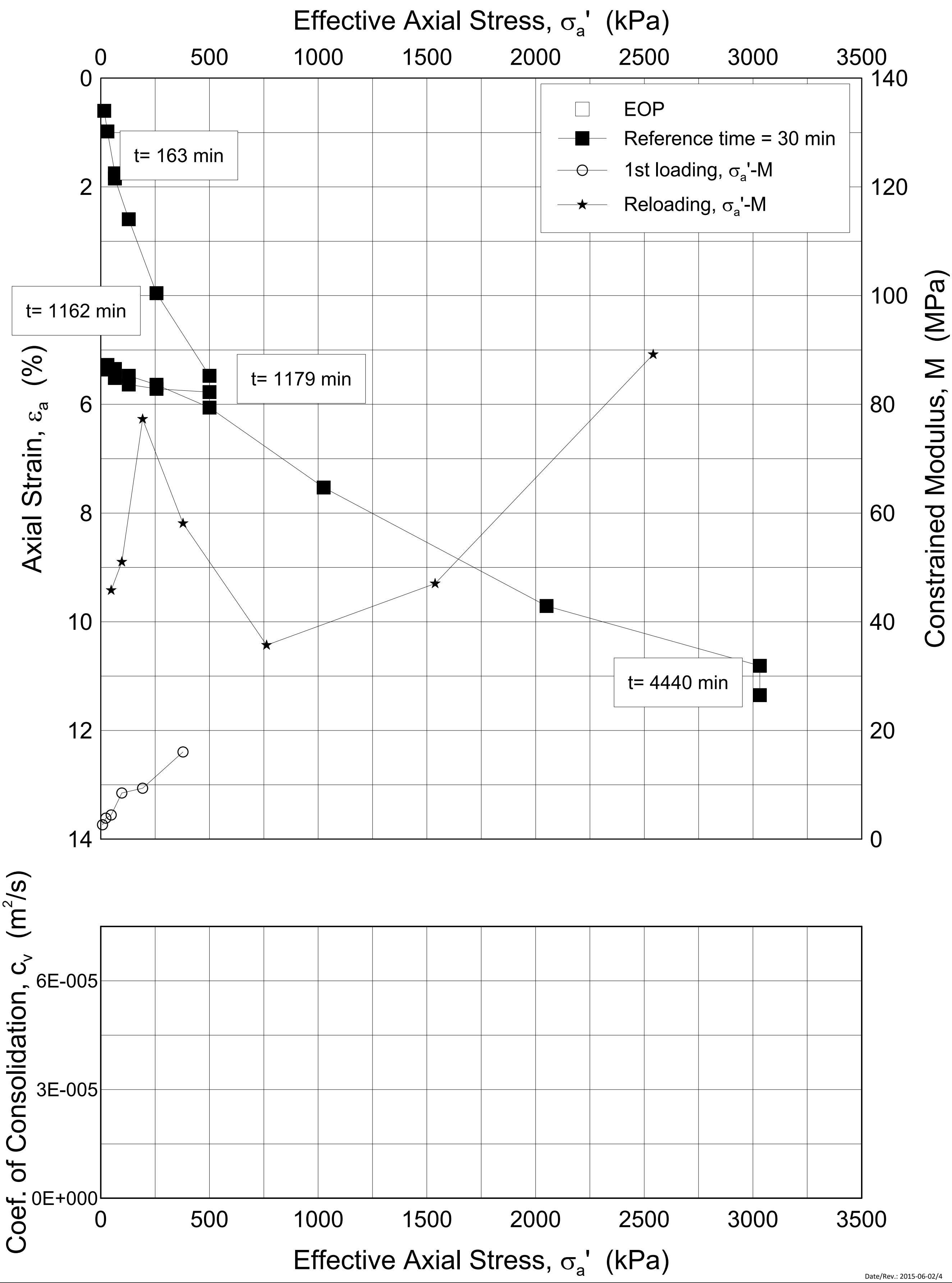
Date/Rev.: 2015-06-02/4

NGTS - Halden Research Site	Document No. 20160154-04-R
Oedometer test (IL)	Figure No. 52
Boring: HALB01 Tube: 8 Part: B Test: 3	Date 2018-04-10 Drawn by / Checked FP / GS
Depth = 4.65 m; p_0' = 64 kPa; w_i = 34.5 %	NGTS



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Date/Rev.: 2015-06-02/4

NGTS - Halden Research Site

Oedometer test (IL)

Boring: HALB01	Tube:	8	Depth	= 4.65	m
	Part:	B	p_0'	= 64.0	kPa
	Test:	3	w_i	= 34.5	%

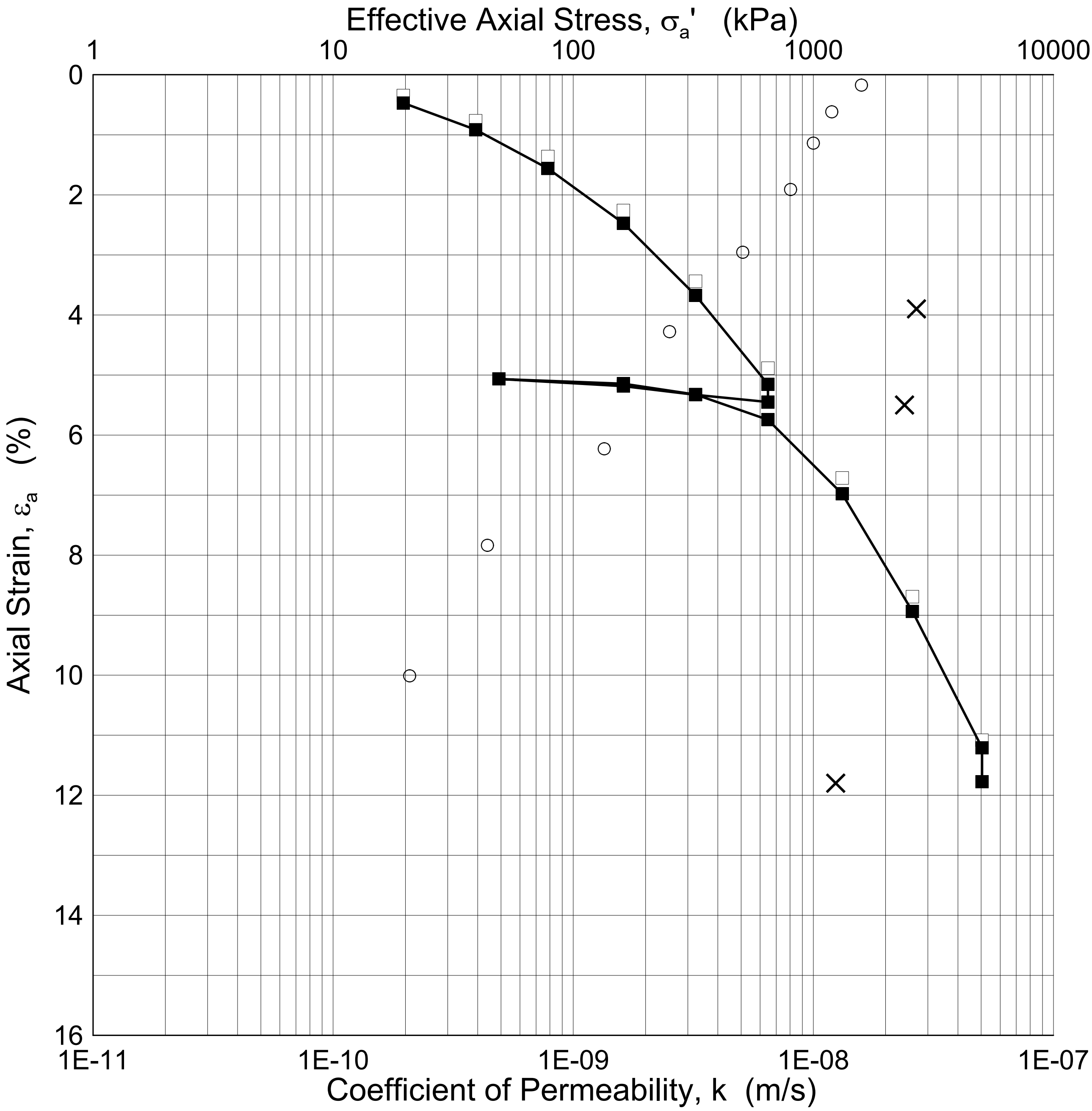
Document No. 20160154-04-R

Figure No. 53

Date 2018-04-10

Drawn by / Checked FP/GS

NGTS



○ Calculated k From time-compression curves

× Measured k

□ EOP

■ End of increment (ref. time 30 min.)

Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (IL)

Boring: HALB04	Tube:	5	Depth	=	7.03	m
			p_0'	=	81.0	kPa
	Part:	A	w_i	=	29.9	%
	Test:	1	γ_i	=	19.41	kN/m³

Document No. 20160154-04-R

Figure No. 54

Date 2018-06-05

Drawn by / Checked PCa / GS

NGTS

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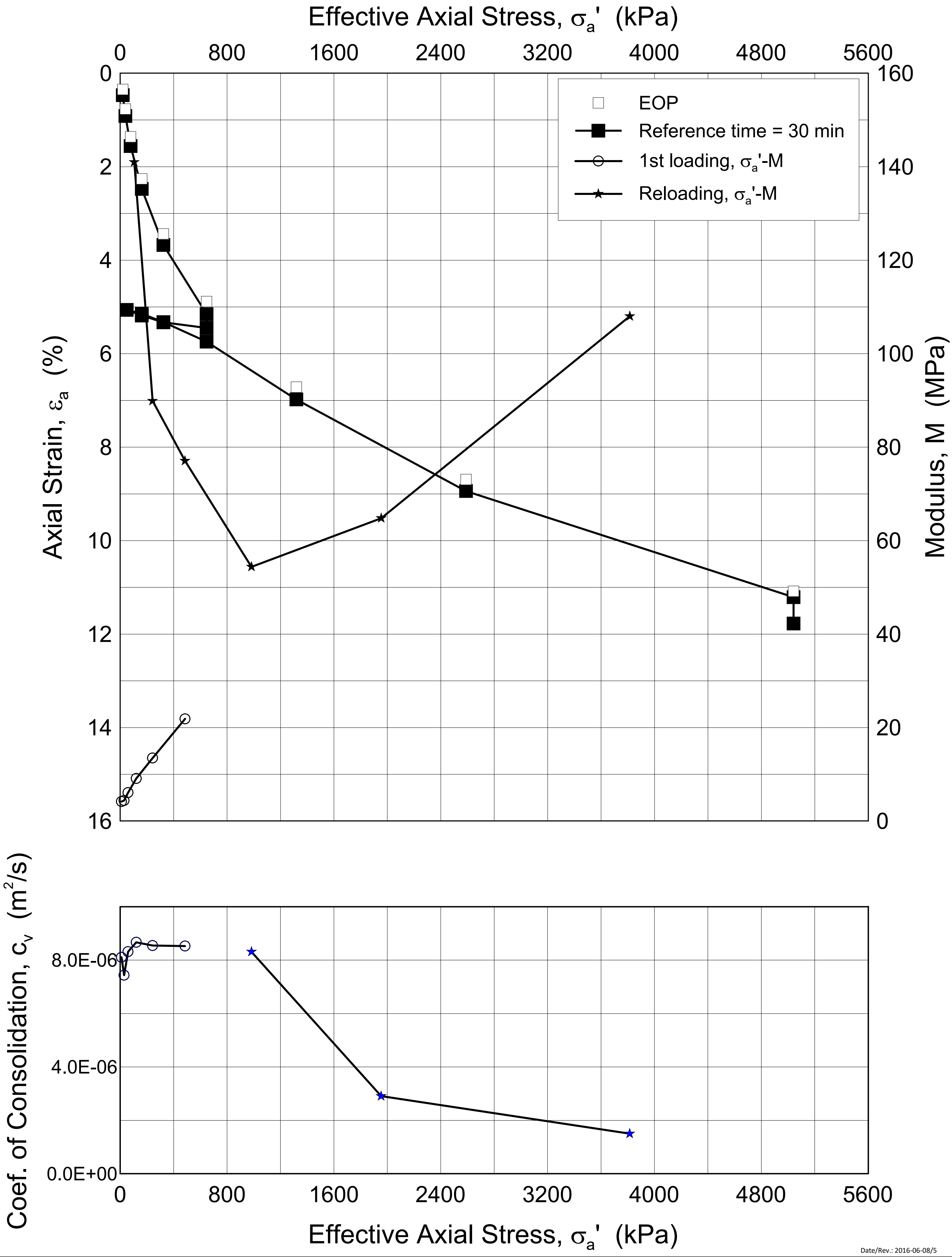

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NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 55

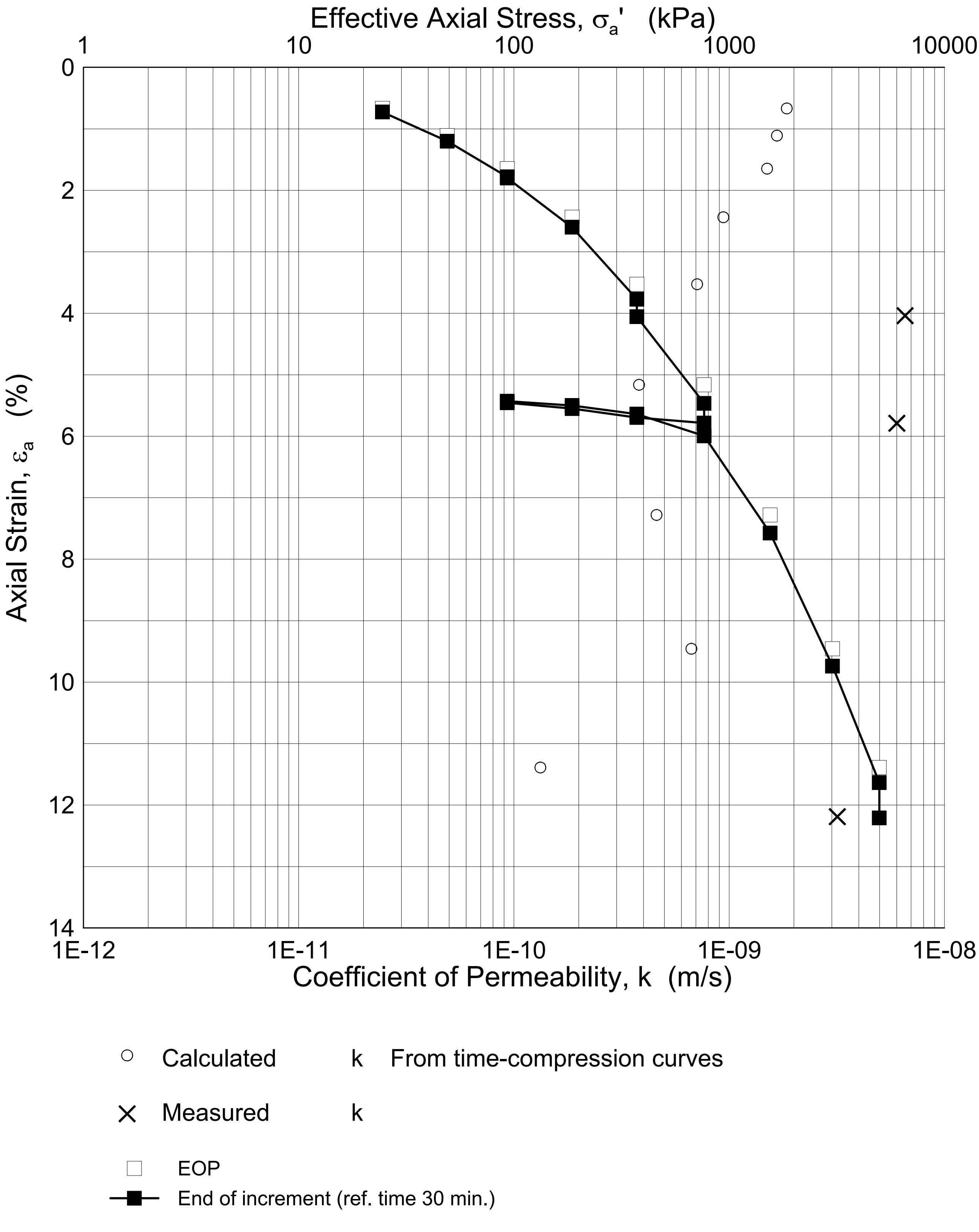
Date 2018-06-05

Drawn by / Checked PCa/ GS

Oedometer test (IL)

Boring: HALB04	Tube:	5	Depth	=	7.03	m
			p_0'	=	81.0	kPa
	Part:	A	w_i	=	29.9	%
	Test:	1	γ_i	=	19.41	kN/m³

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (IL)

Boring: HALB04	Tube:	5.5	Depth	=	8.42	m
	Part:	C	p_0'	=	94.0	kPa
	Test:	2	w_i	=	28.2	%
			γ_i	=	19.56	kN/m³

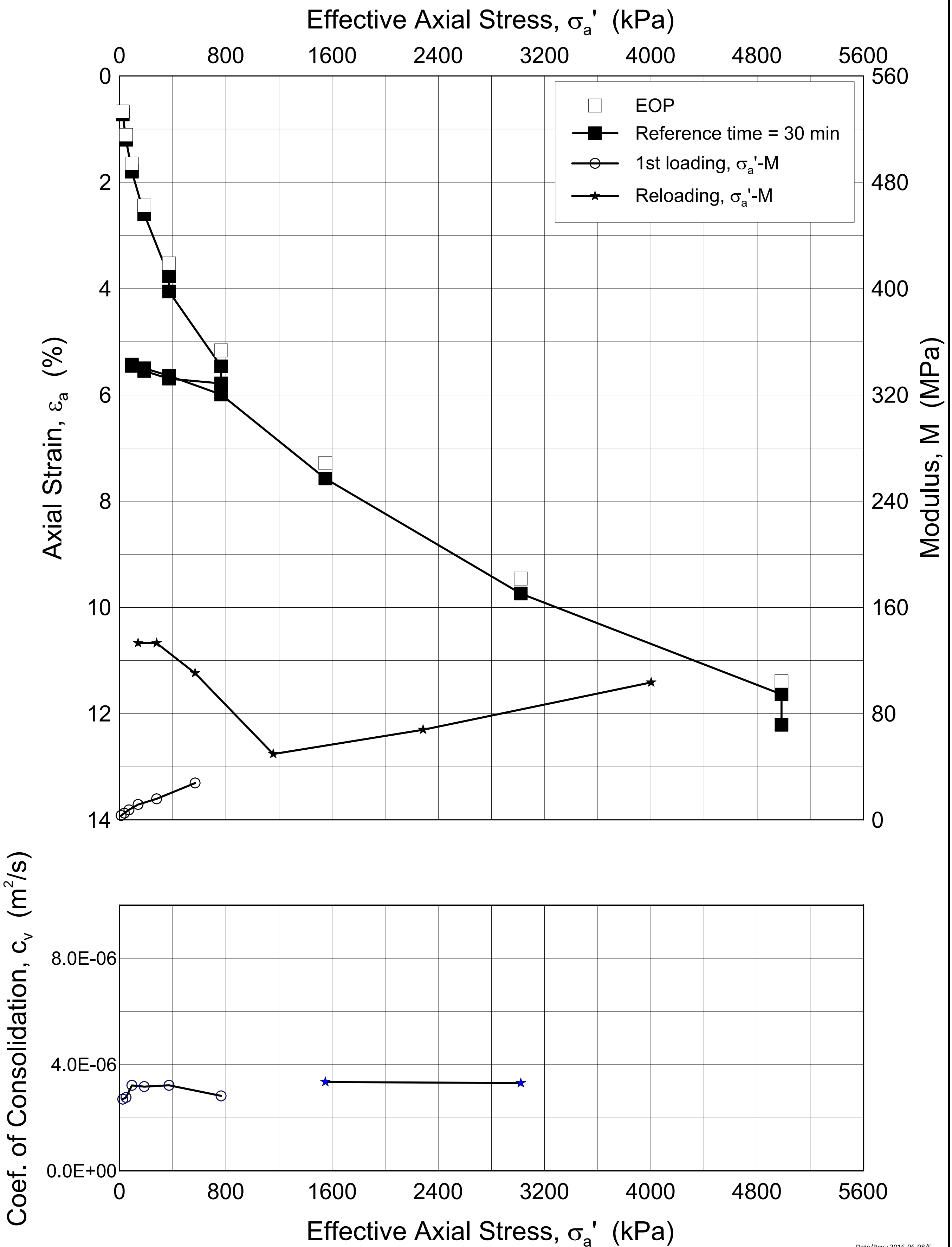
Document No. 20160154-04-R

Figure No. 56

Date 2018-06-05

Drawn by / Checked PCa / GS

NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site

Oedometer test (IL)

			Depth	=	8.42	m	
Boring: HALB04	Tube:	5.5	p_0'	=	94.0	kPa	
	Part:	C	w_i	=	28.2	%	
	Test:	2	γ_i	=	19.56	kN/m^3	

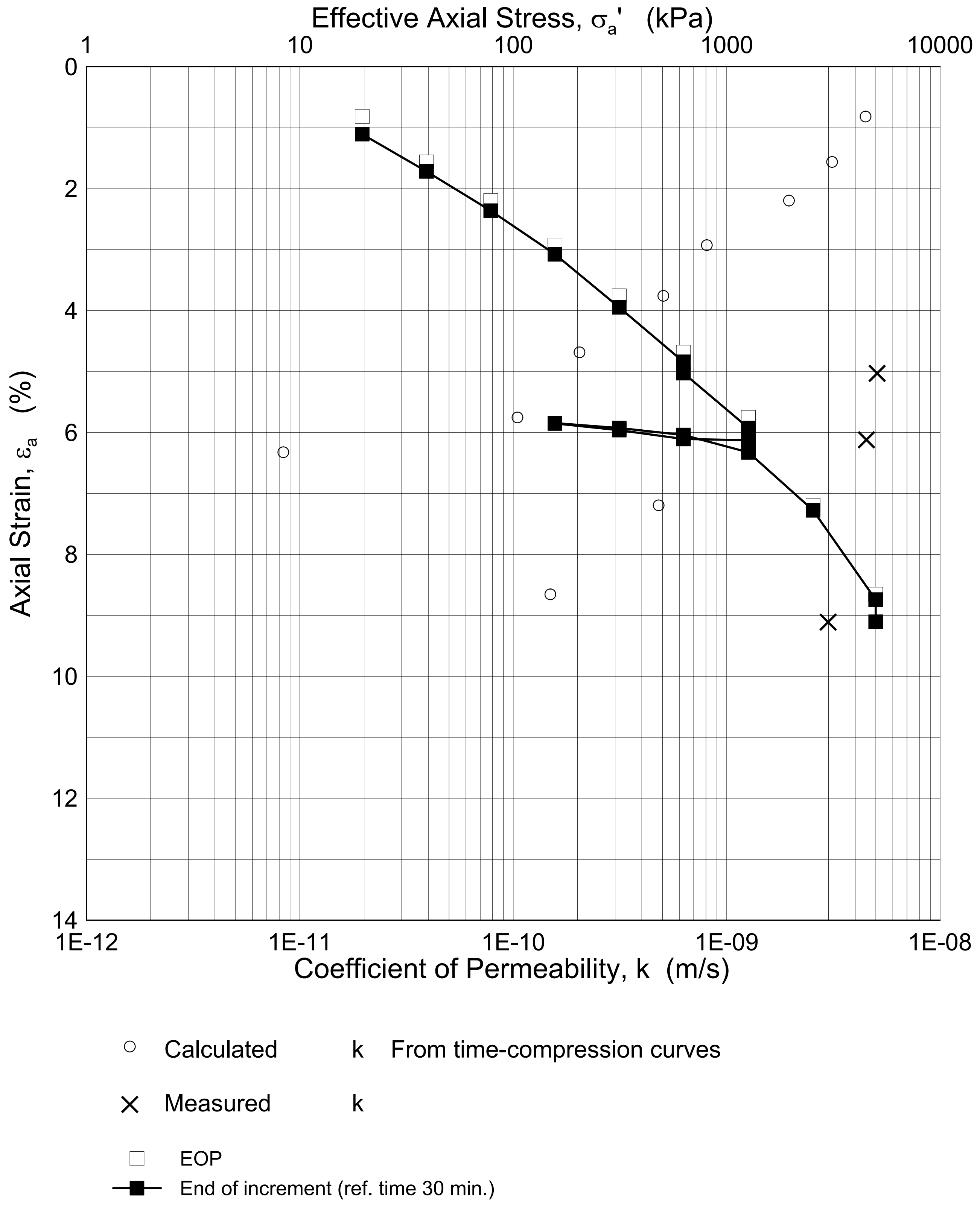
Document No. 20160154-04-R

Figure No. 57

Date 2018-06-05

Drawn by / Checked PCa/ GS

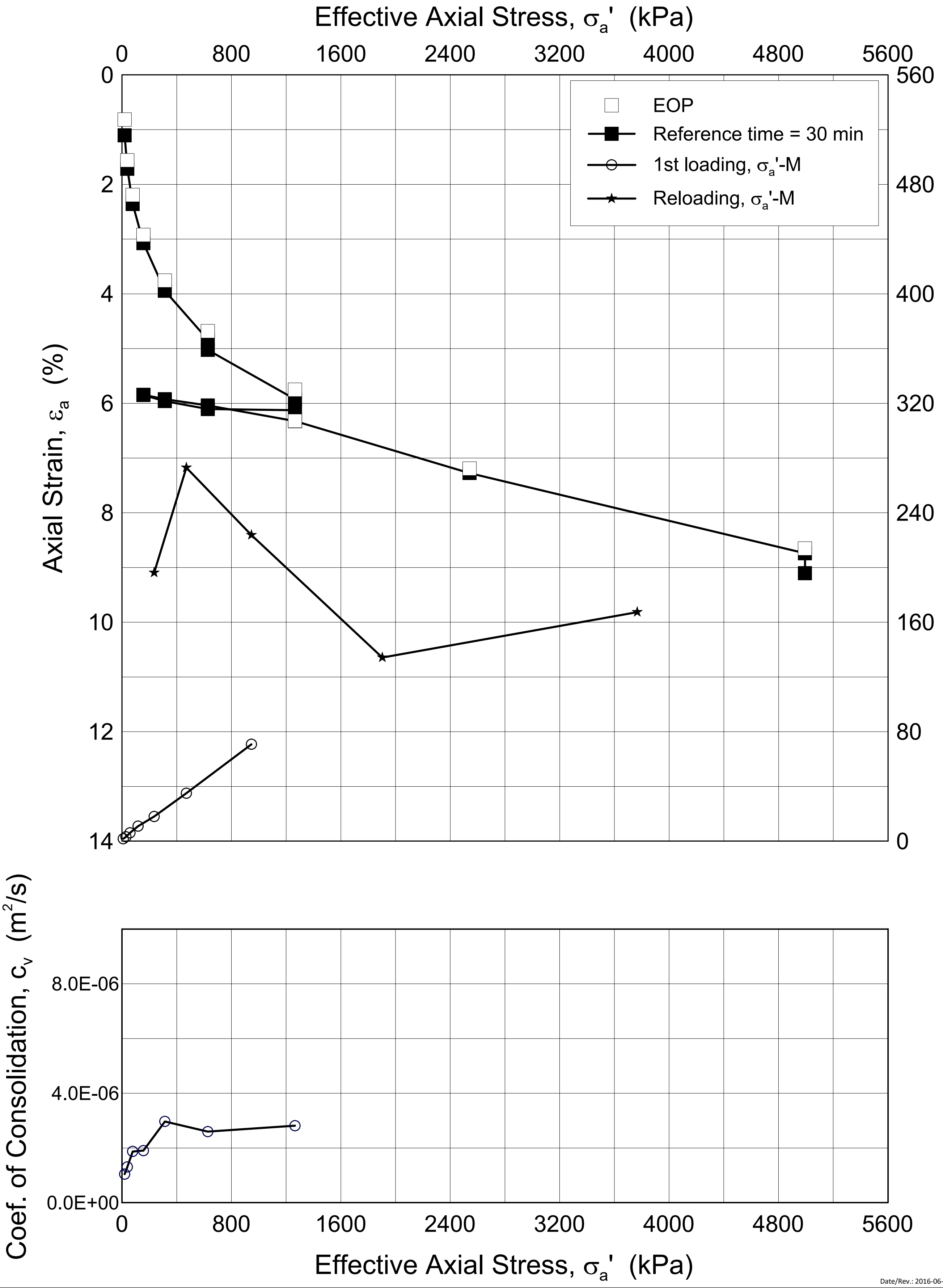
NGTS



P:\2016\01\20160154\Lab\Halden\IL\HALB04-13-A-2\IL_HALB04-13-A-2_LOG.grf

Date/Rev.: 2016-06-08/5

NGTS - Halden Research Site		Document No. 20160154-04-R
Oedometer test (IL)		Figure No. 58
Boring: HALB04	Depth = 14.6 m	Date 2018-06-05
Tube: 13	p_0' = 158.0 kPa	Drawn by / Checked MAS / GS
Part: A	w_i = 24.4 %	
Test: 2	γ_i = 20.78 kN/m³	NGTS



Date/Rev.: 2016-06-08/5

P:\2016\01\20160154\Lab\Halden\IL\HALB04-13-A-2\IL_HALB04-13-A-2_LIN.grf

NGTS - Halden Research Site

Oedometer test (IL)

Boring: HALB04

Tube: 13

Part: A

Test: 2

Depth = 14.6 m

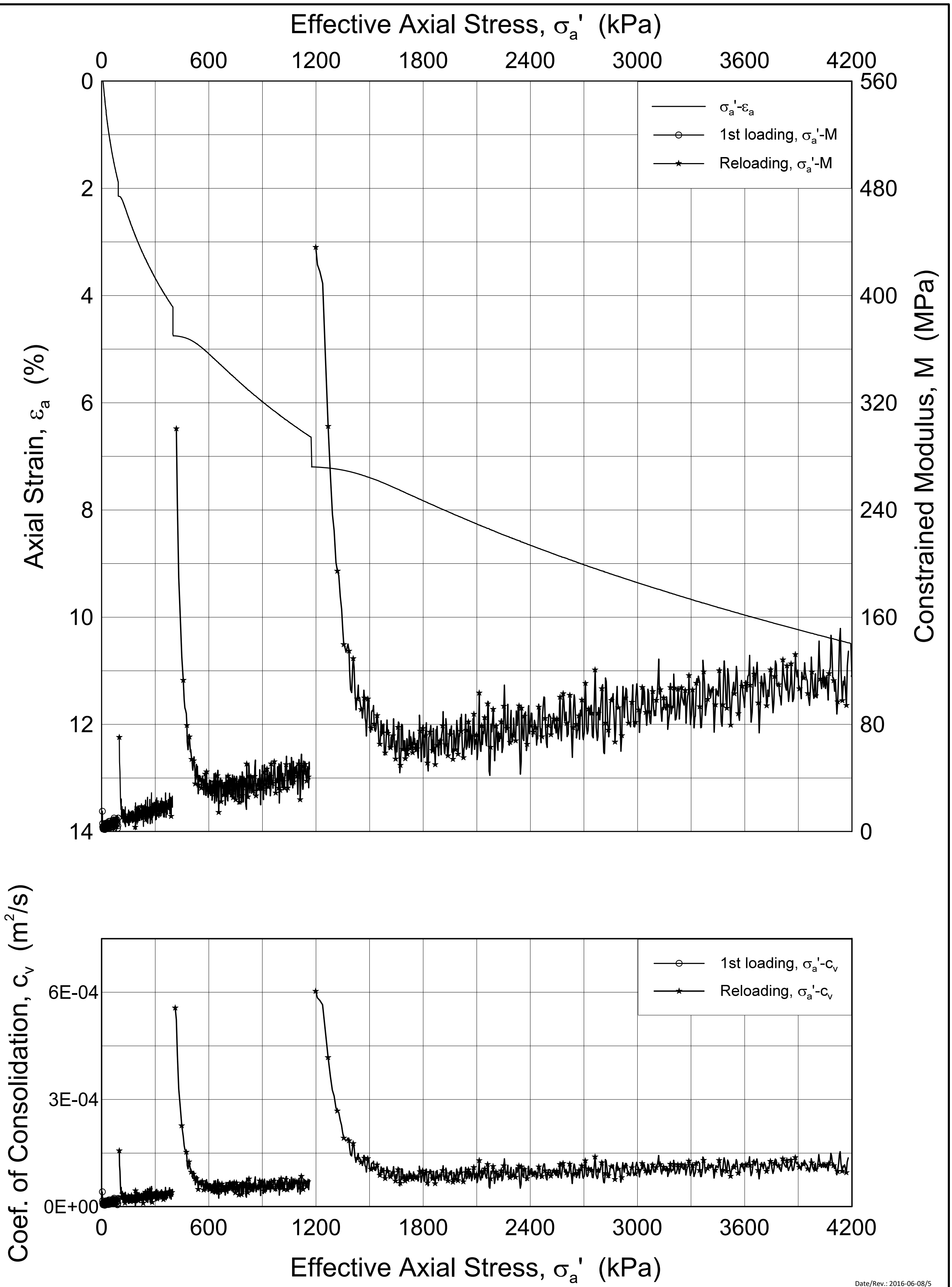
p_0' = 158.0 kPa

w_i = 24.4 %

γ_i = 20.78 kN/m³

Document No.	20160154-04-R
Figure No.	59
Date	2018-06-05
Drawn by / Checked	MAS / GS

NGTS



Date/Rev.: 2016-06-08/5

H:\LABDATA\2016\20160154\HAL-Halden\CRS\HALB04-6-2 lin (crs4280).grf

NGTS - Halden Silt Site

Document No. 20160154-01-R

Figure No. 60

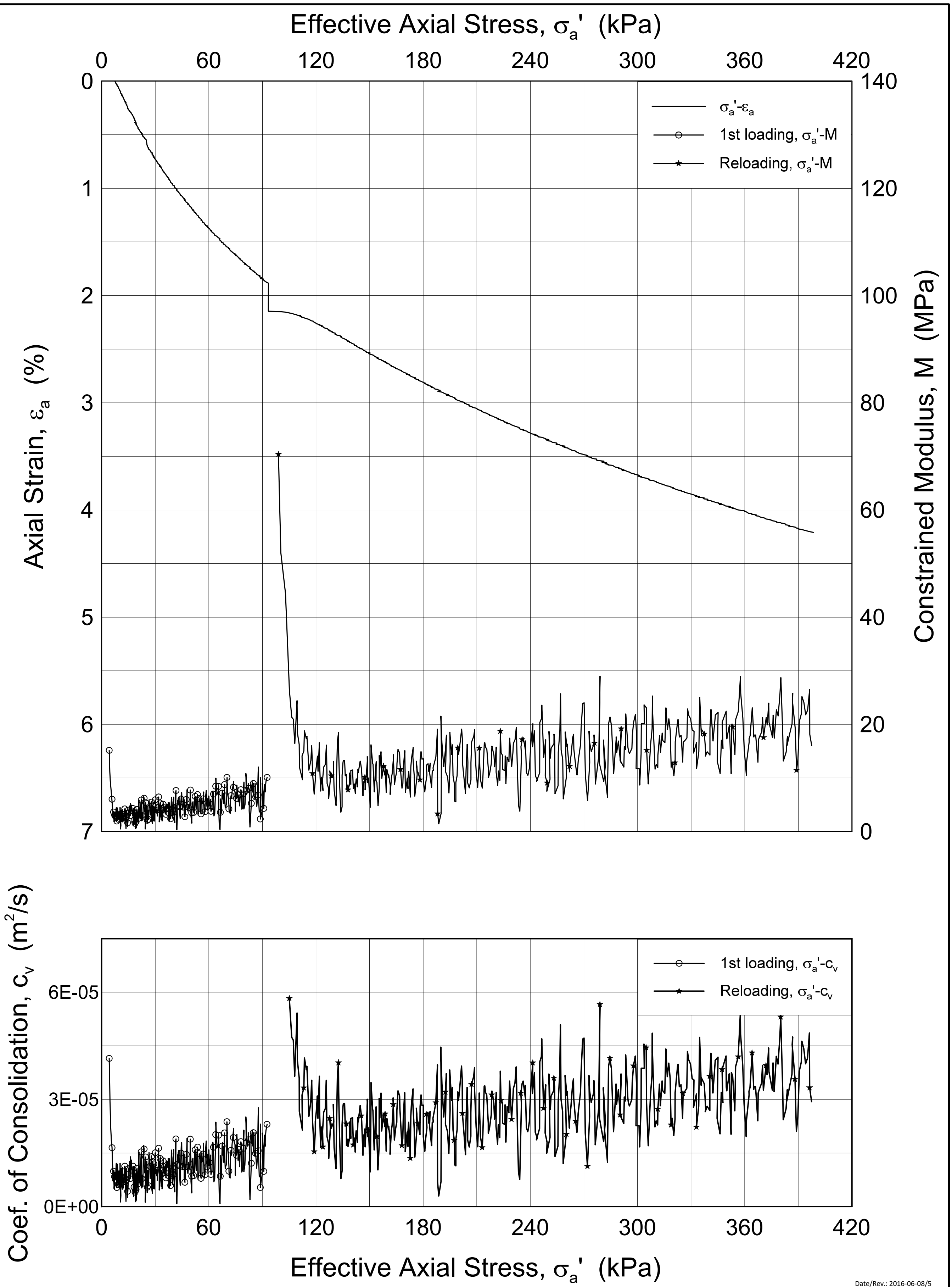
Date 2018-06-12

Drawn by / Checked FP/GS

Oedometer test (CRSC) Mounted horizontally.

				Depth	=	8.17	m
Boring:	HALB04	Tube:	6	p_0'	=	92.0	kPa
		Part:		w_i	=	29.0	%
		Test:	2	γ_i	=	19.52	kN/m³

NGTS



Date/Rev.: 2016-06-08/5

H:\LABDATA\2016\20160154\HAL-Halden\CRS\HALB04-6-2 lin-2 (crs4280).grf

NGTS - Halden Silt Site

Document No. 20160154-01-R

Figure No. 61

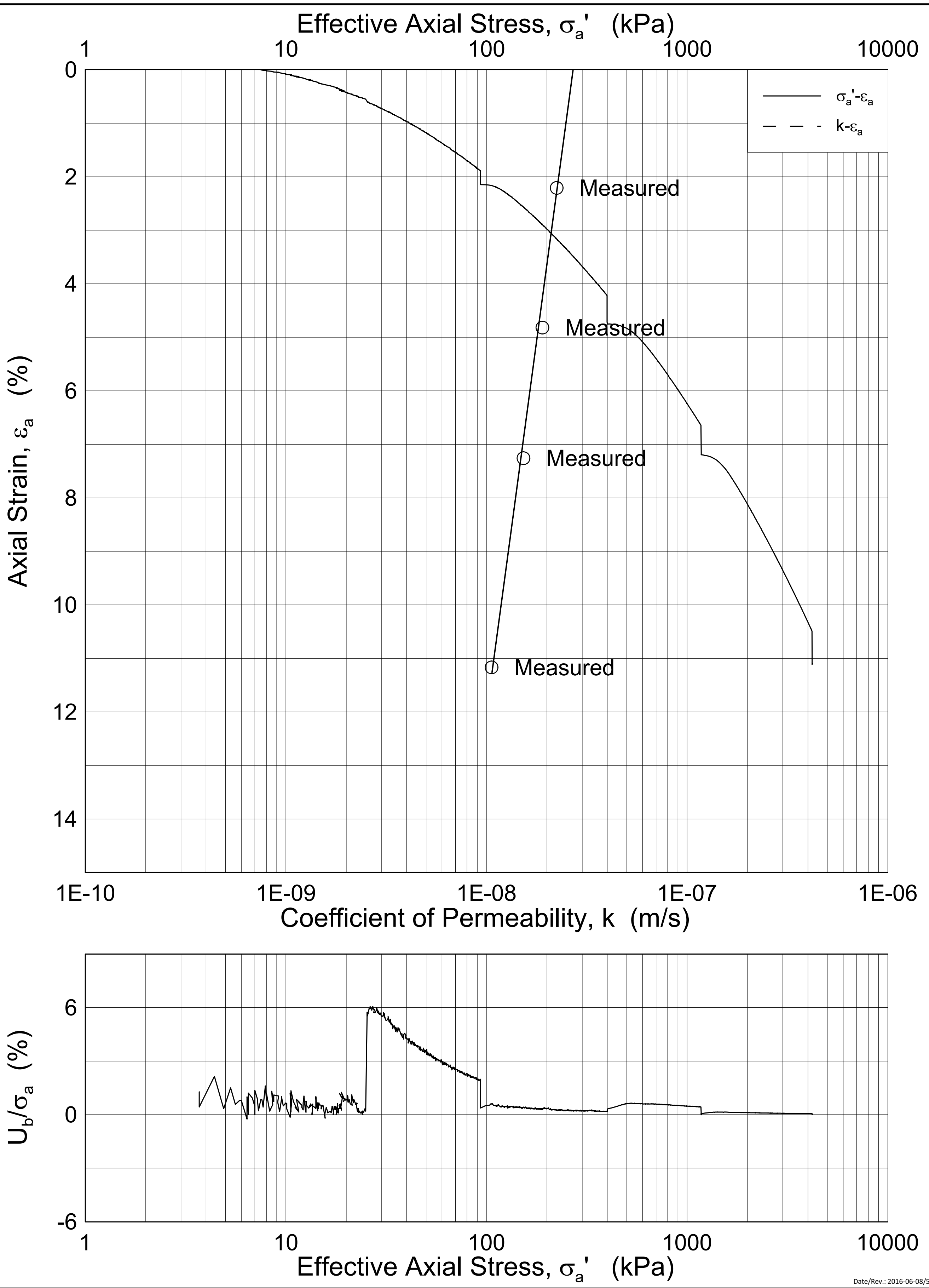
Date 2018-06-12

Drawn by / Checked FP/GS

Oedometer test (CRSC) Mounted horizontally.

Boring: HALB04	Tube:	6	Depth	=	8.17	m
			p_0'	=	92.0	kPa
	Part:		w_i	=	29.0	%
	Test:	2	γ_i	=	19.52	kN/m³

NGTS



Date/Rev.: 2016-06-08/5

H:\LABDATA\2016\20160154\HAL-Halden\CRS\HALB04-6-2 log (crs4280).grf

NGTS - Halden Silt Site

Oedometer test (CRSC) Mounted horizontally.

				Depth	=	8.17	m
Boring:	HALB04	Tube:	6	p_0'	=	92.0	kPa
		Part:		w_i	=	29.0	%
		Test:	2	γ_i	=	19.52	kN/m³

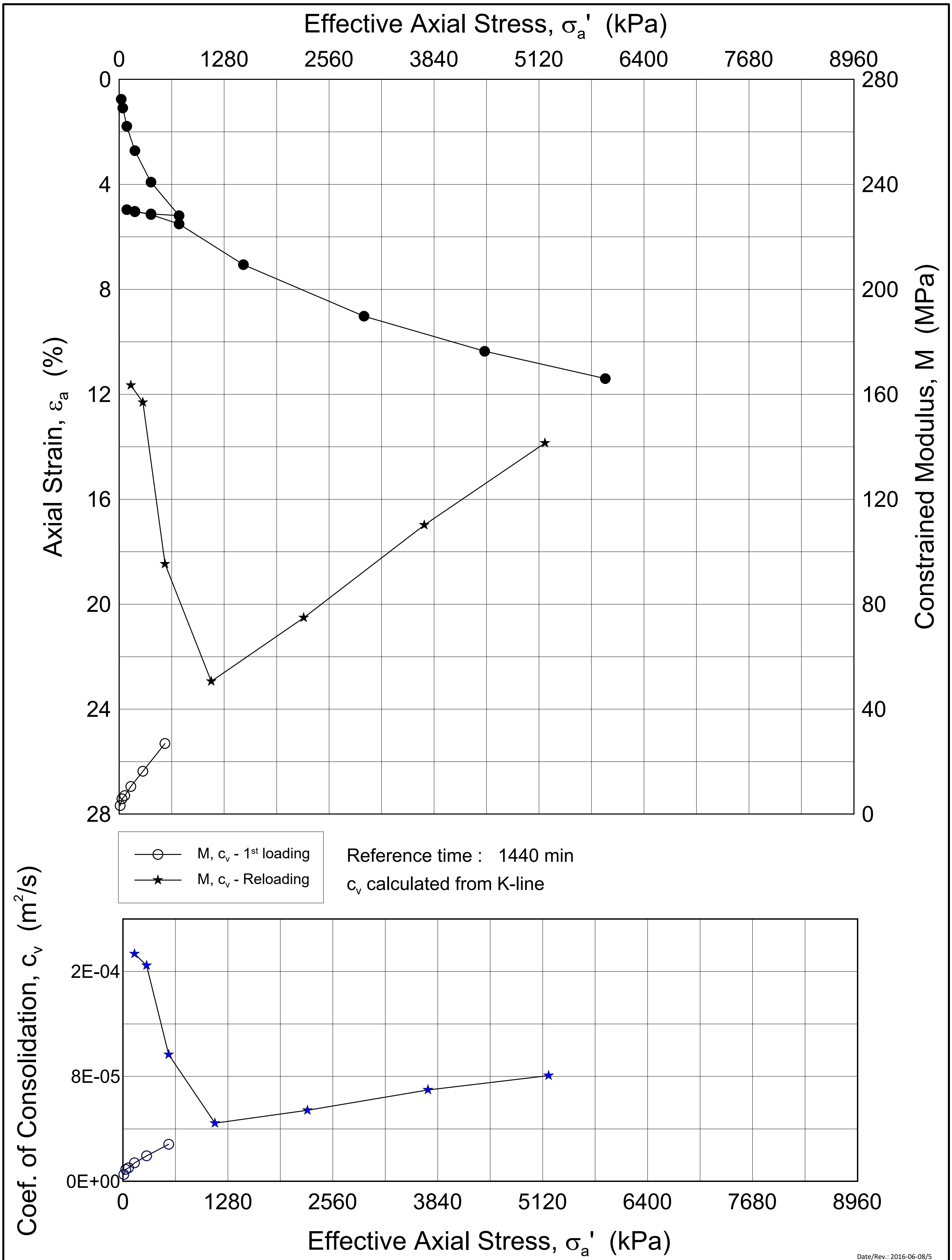
Document No. 20160154-01-R

Figure No. 62

Date 2018-06-12

Drawn by / Checked FP/GS

NGTS



Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site	Document No. 20160154-01-R
Oedometer test (IL)	Figure No. 63
	Date 2018-07-02
	Drawn by / Checked PCa / GS

Boring: HALB04 Tube: 6 Part: Test: 1

Depth = 8.02 m

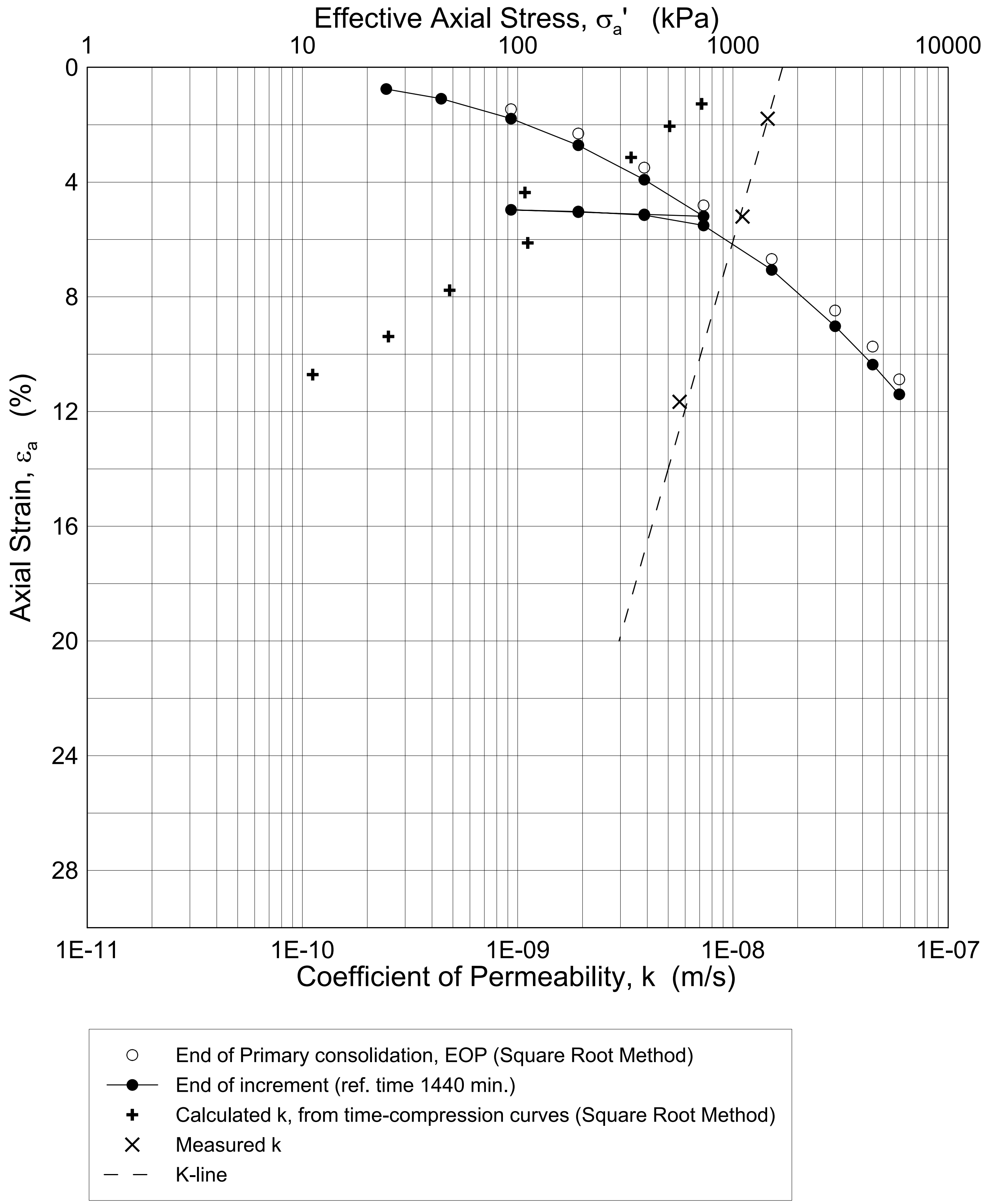
p_0' = 92.0 kPa

w_i = 27.2 %

γ_i = 19.87 kN/m³

NGTS

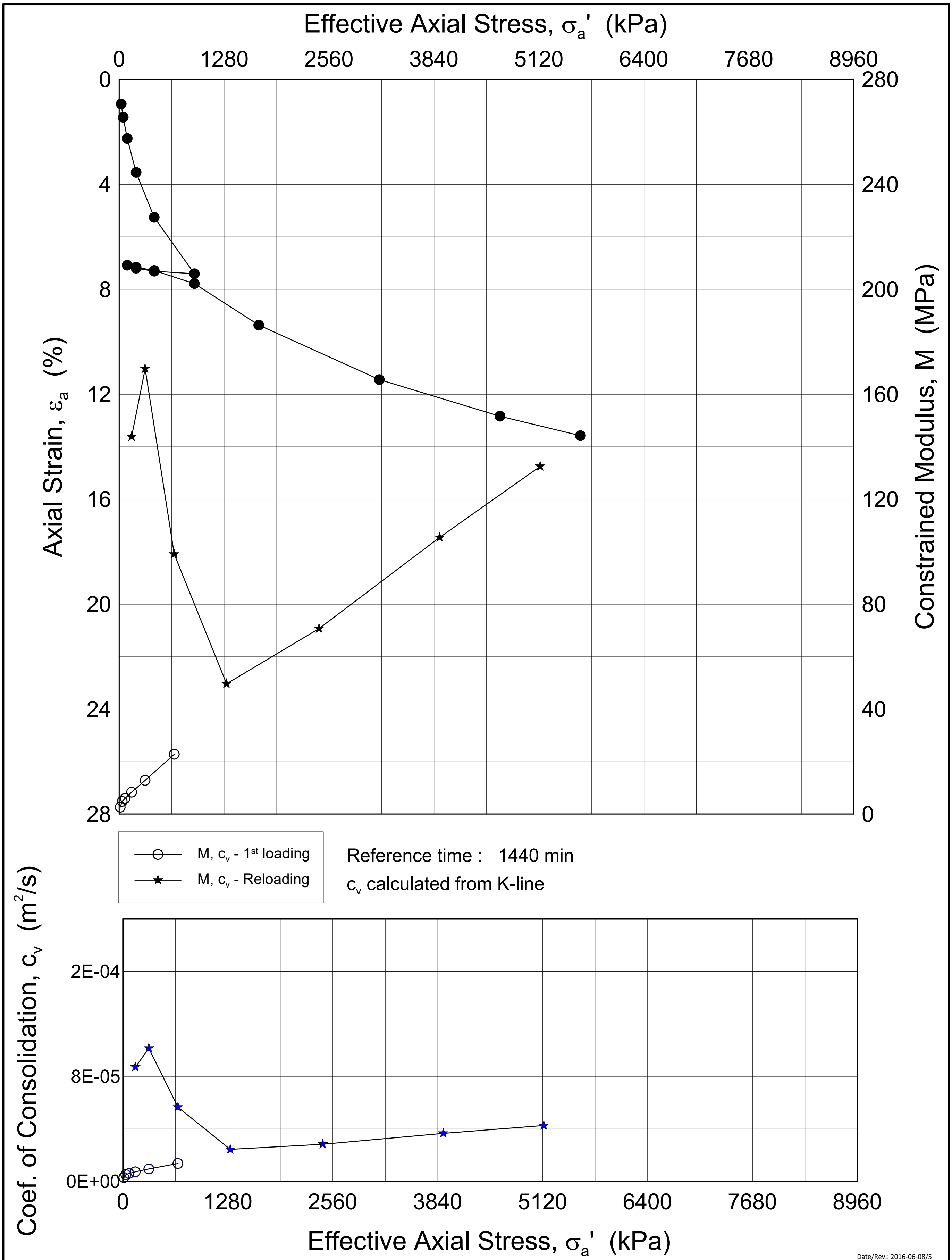
H:\LABDATA\2016\20160154\HAL-Halden\Oedom\IL\20160154-HALB04-Block6--\HALB04-6-1-data LIN.grf



H:\LABDATA\2016\20160154\HAL-Halden\Oedom\IL\20160154-HALB04-Block6--\HALB04-6-1-data LOG.grf

Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site		Document No. 20160154-01-R
Oedometer test (IL)		Figure No. 64
Boring: HALB04	Depth = 8.02 m	Date 2018-07-02
Tube: 6	p_0' = 92.0 kPa	Drawn by / Checked PCa / GS
Part:	w_i = 27.2 %	NGTS
Test: 1	γ_i = 19.87 kN/m³	



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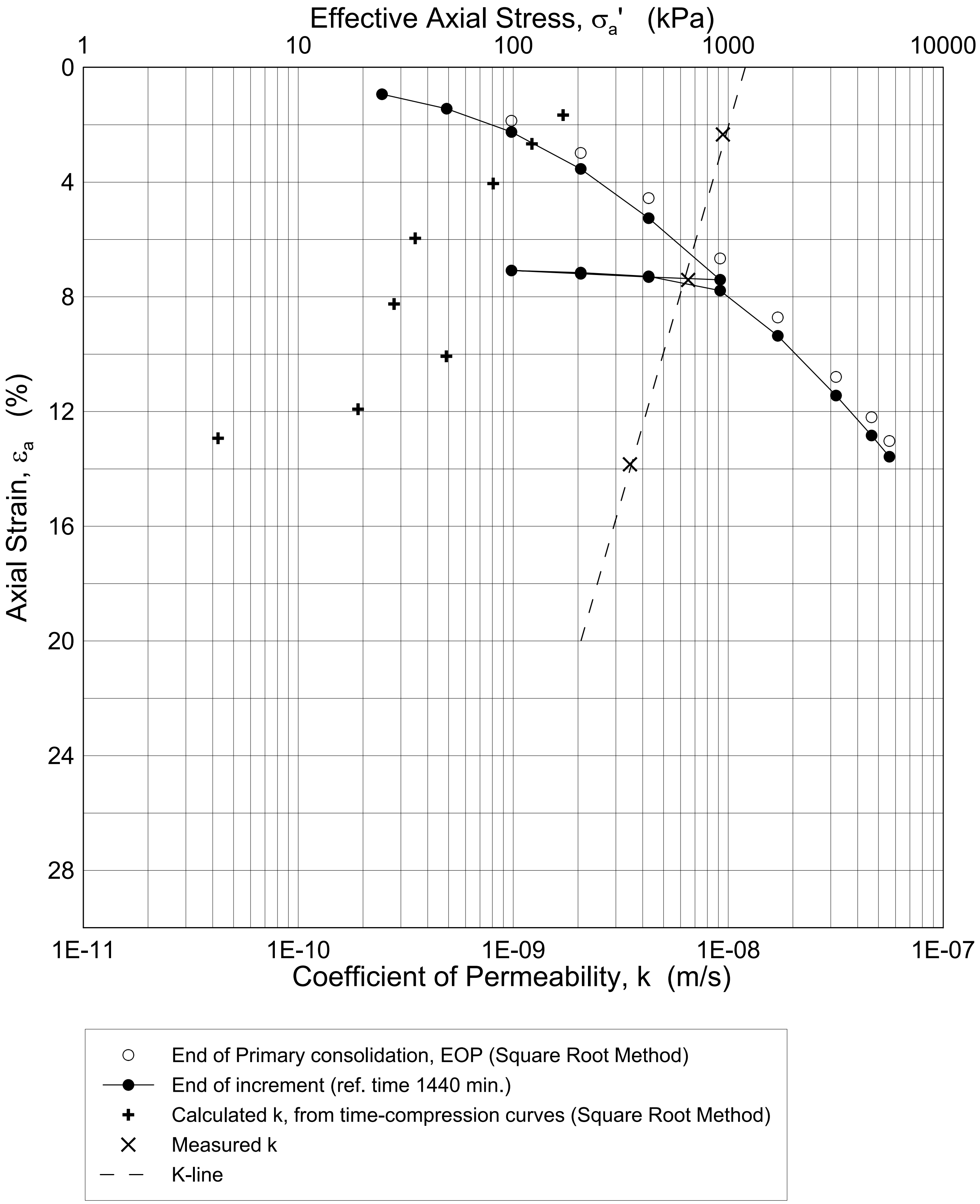
Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site	Document No. 20160154-04-R
Oedometer test (IL)	Figure No. 65
	Date 2018-07-02 / Drawn by / Checked PCa / GS

Boring: HALB05 Tube: 1 Part: Test: 2

Depth = 9.57 m
p_0' = 106.7 kPa
w_i = 30.0 %
γ_i = 19.39 kN/m³

NGTS



H:\LABDATA\2016\20160154\HAL-Halden\Oedom\IL\20160154-HALB05-1--2\HALB05-1-2-data LOG.grf

Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site

Oedometer test (IL)

Boring: HALB05 | Tube: 1 | Part: | Test: 2

Depth = 9.57 m

p_0' = 106.7 kPa

w_i = 30.0 %

γ_i = 19.39 kN/m³

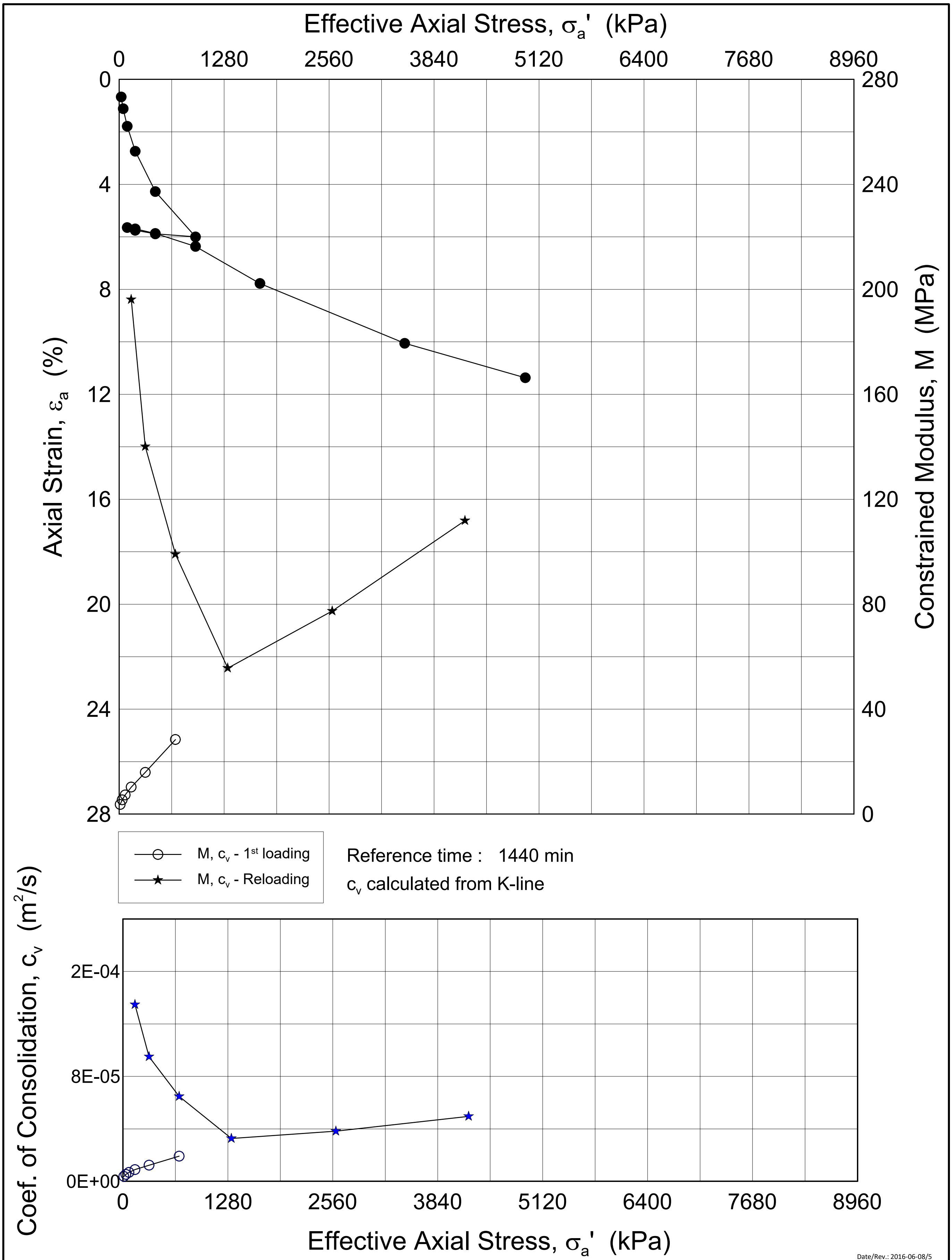
Document No. 20160154-04-R

Figure No. 66

Date 2018-07-02

Drawn by / Checked PCa / GS

NGTS



NGTS - Halden Silt Site

Oedometer test (IL)

Boring: HALB06	Tube:	4	Depth	=	10.08 m
	Part:	B	p_0'	=	107.0 kPa
	Test:	1	w_i	=	28.1 %
			γ_i	=	19.74 kN/m^3

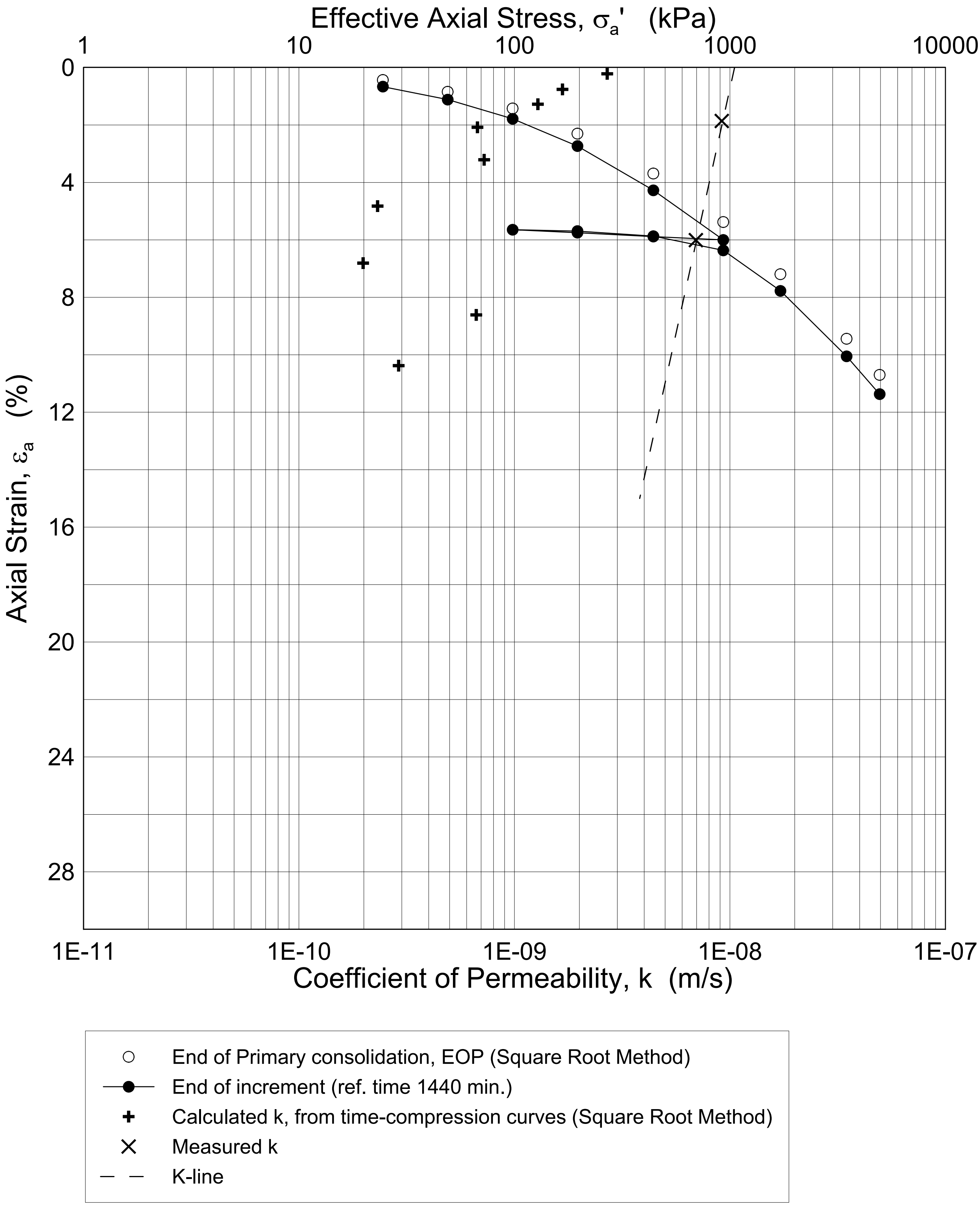
Document No. 20160154-01-R

Figure No. 67

Date 2018-08-01

Drawn by / Checked PCa / GS

NGTS



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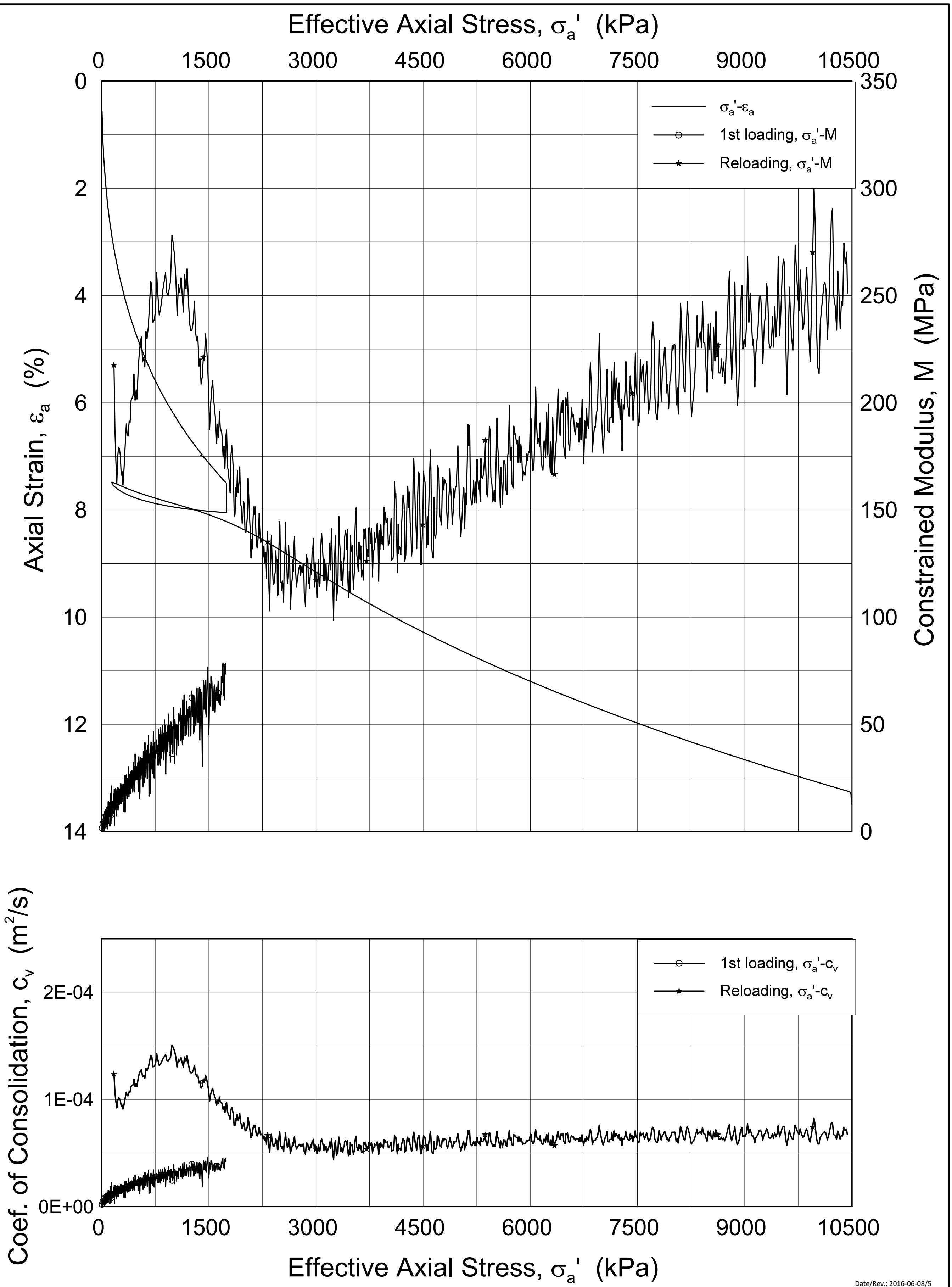
Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site		Document No. 20160154-01-R
Oedometer test (IL)		Figure No. 68
	Depth = 10.08 m	Date 2018-08-01
Boring: HALB06 Tube: 4	p_0' = 107.0 kPa	Drawn by / Checked PCa / GS
Part: B	w_i = 28.1 %	
Test: 1	γ_i = 19.74 kN/m³	NGTS



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Date/Rev.: 2016-06-08/5

NGTS - Halden Silt Site	Document No. 20160154-01-R
Oedometer test (CRSC)	Figure No. 69
	Date 2018-09-10 / Drawn by / Checked FP/GS

Boring: HALB06

Tube: 6

Part: C

Test: 1

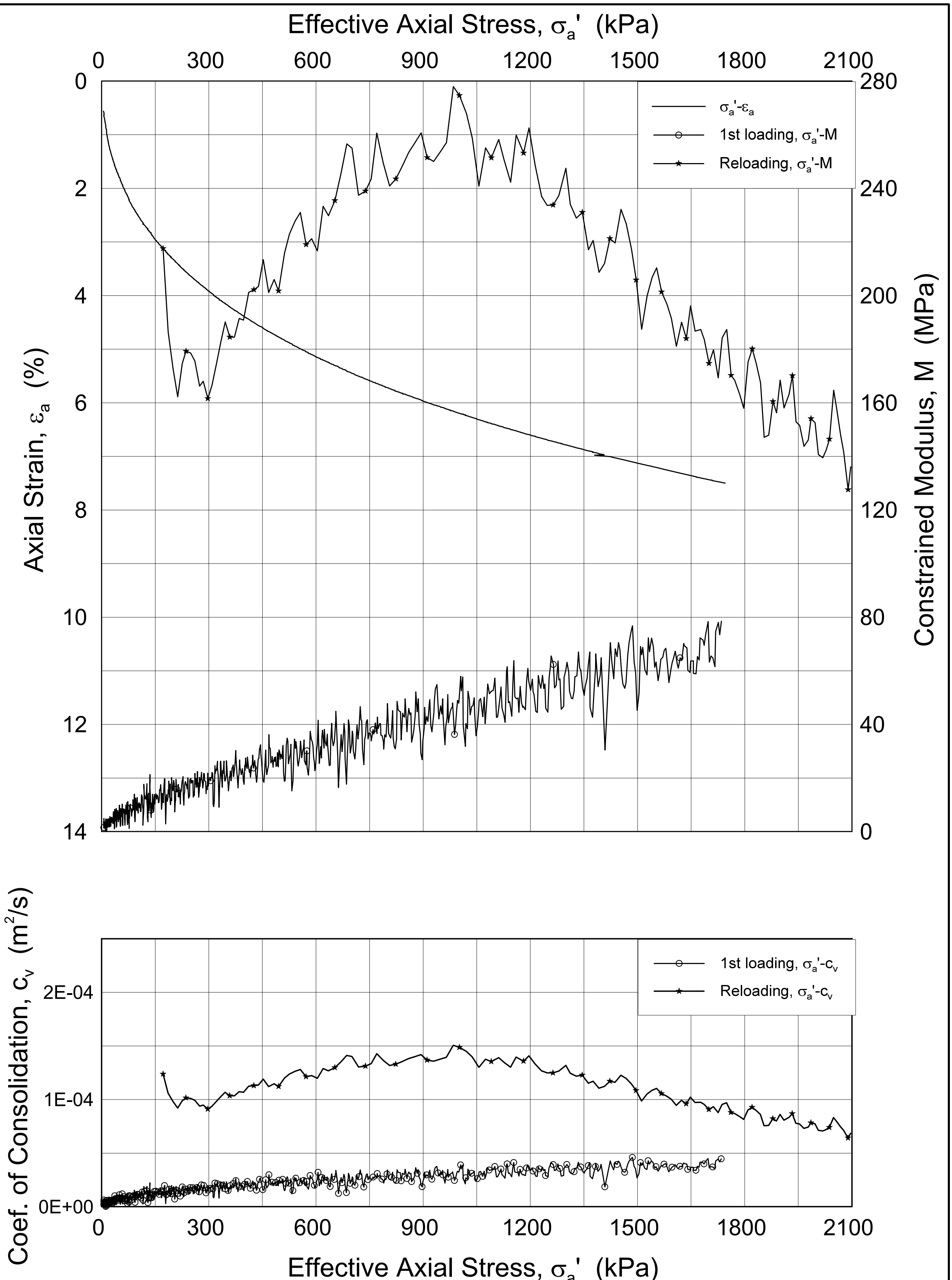
Depth = 13.07 m

p_0' = 141.5 kPa

w_i = 26.6 %

γ_i = 19.92 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

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NGTS - Halden Silt Site	Document No. 20160154-01-R
Oedometer test (CRSC)	Figure No. 70
	Date 2018-09-10 ; Drawn by / Checked FP/GS

Boring: HALB06 — Tube: 6 — Part: C — Test: 1

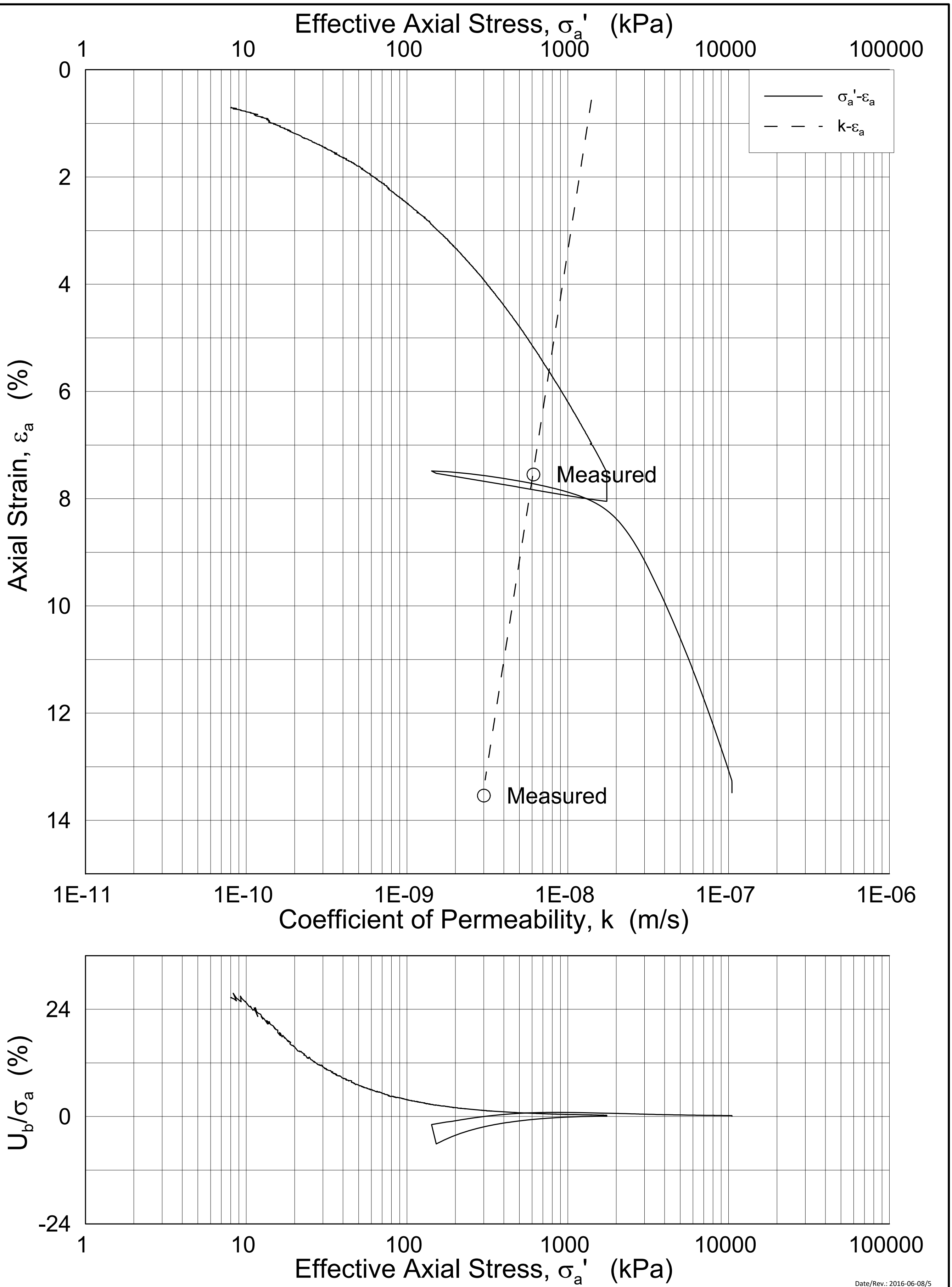
Depth = 13.07 m

p_0' = 141.5 kPa

w_i = 26.6 %

γ_i = 19.92 kN/m³

NGTS



Date/Rev.: 2016-06-08/5

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NGTS - Halden Silt Site

Oedometer test (CRSC)

				Depth	=	13.07	m
Boring:	HALB06	Tube:	6	p_0'	=	141.5	kPa
		Part:	C	w_i	=	26.6	%
		Test:	1	γ_i	=	19.92	kN/m³

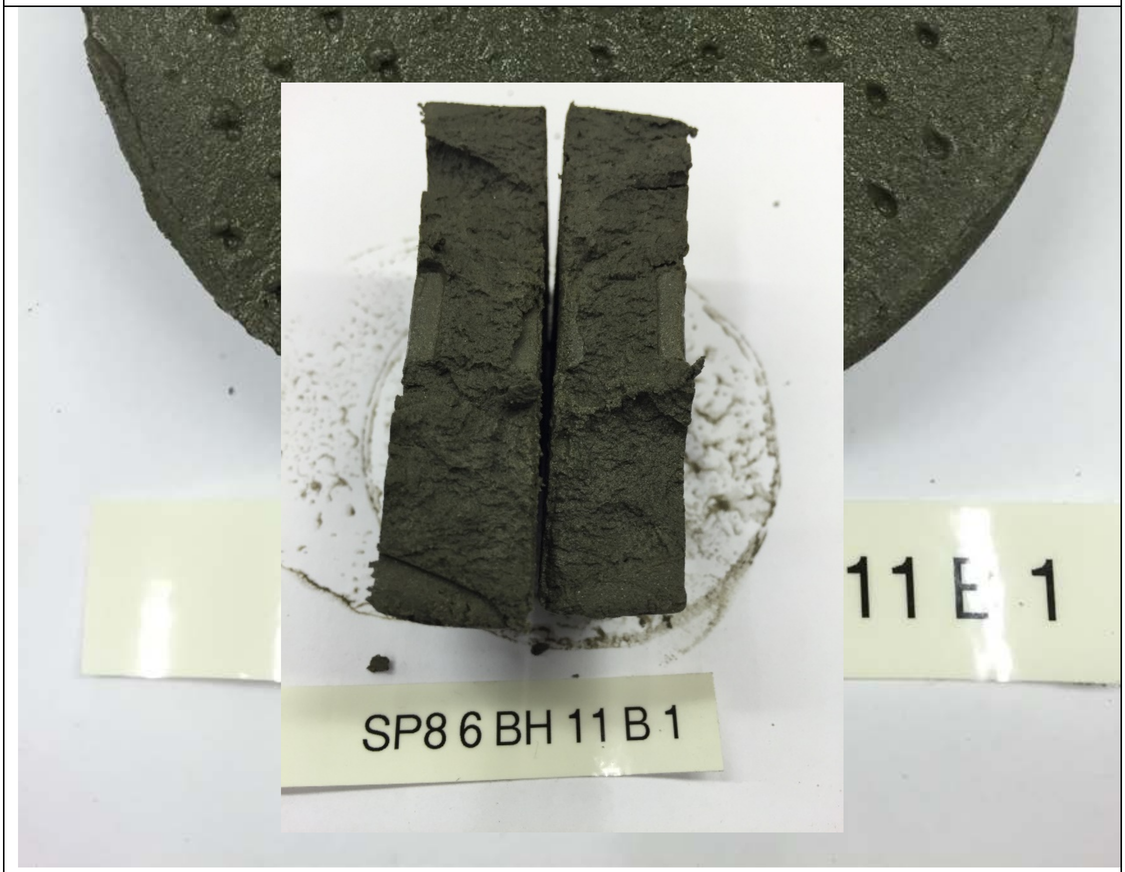
Document No. 20160154-01-R	
Figure No. 71	
Date 2018-09-10	Drawn by / Checked FP/GS

NGTS

Appendix O

DSS TEST RESULTS

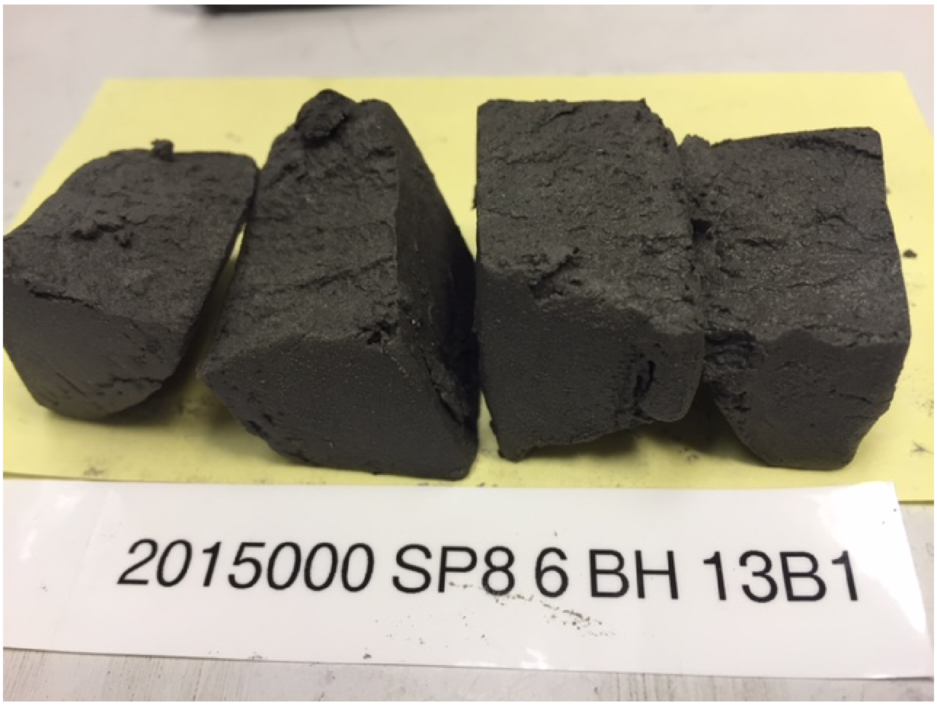
Test:	HALB01-11-B-1

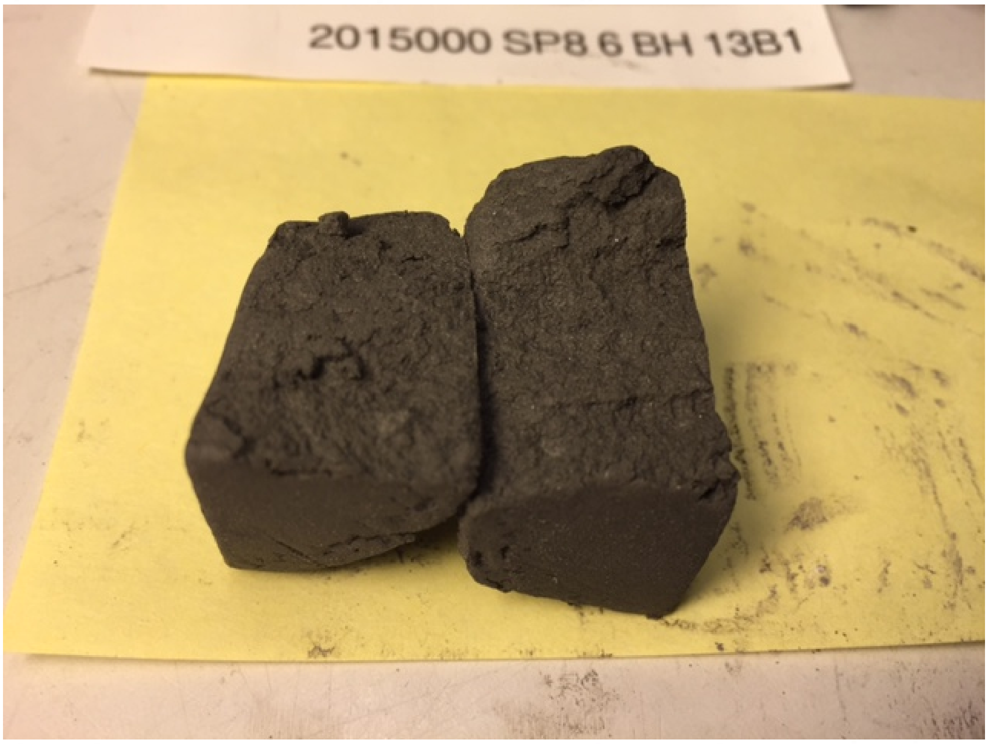


Test:	HALB01-11-B-1

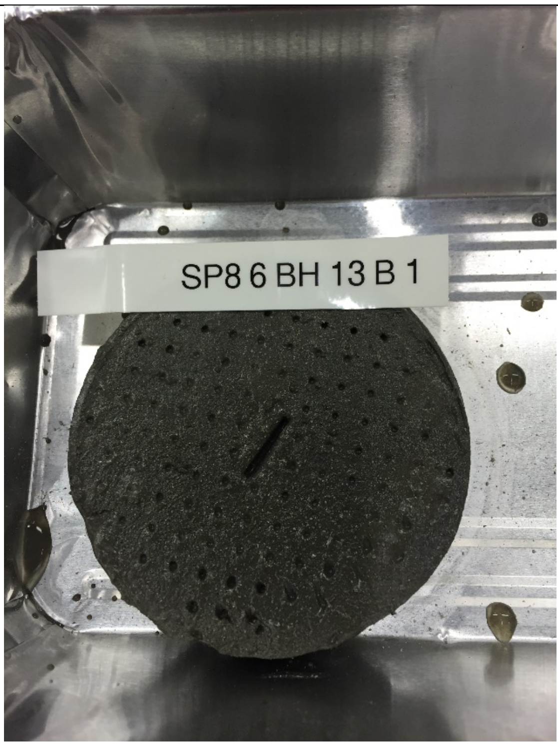
Test:	HALB0
	

Test:	HALB01-13-B-1





Test:	HALB01-13-B-1

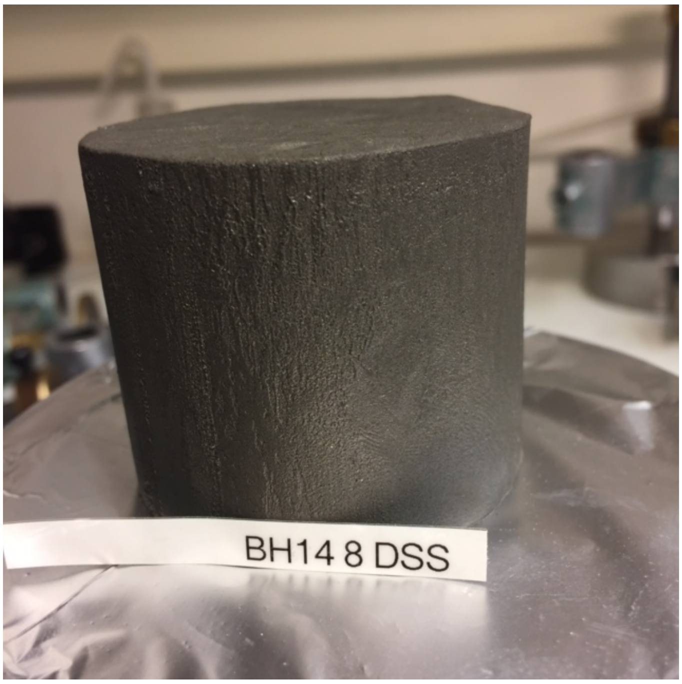


Test:	HALB01-13-B-1

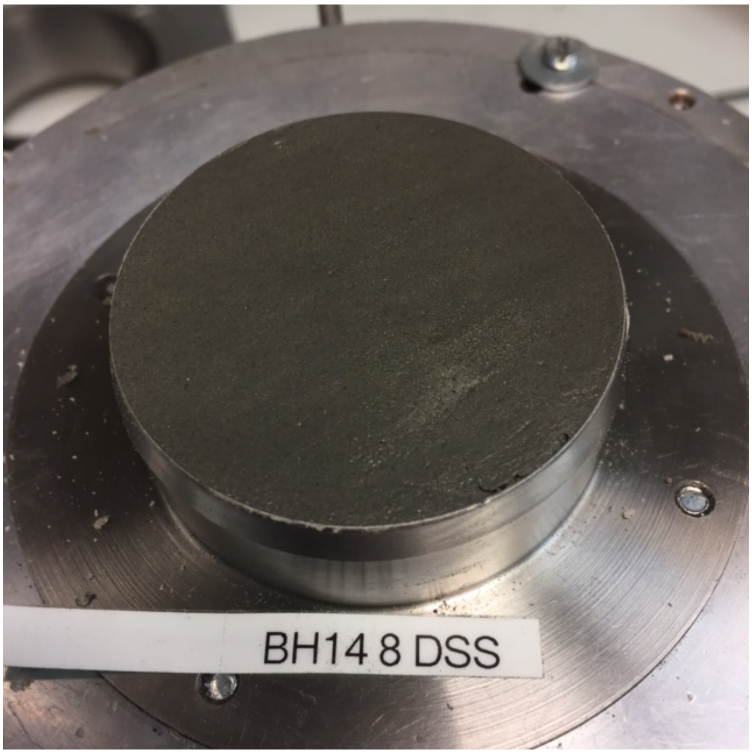
Test:	HALB03-5-0-1

Test:	HALB03-8-0-1

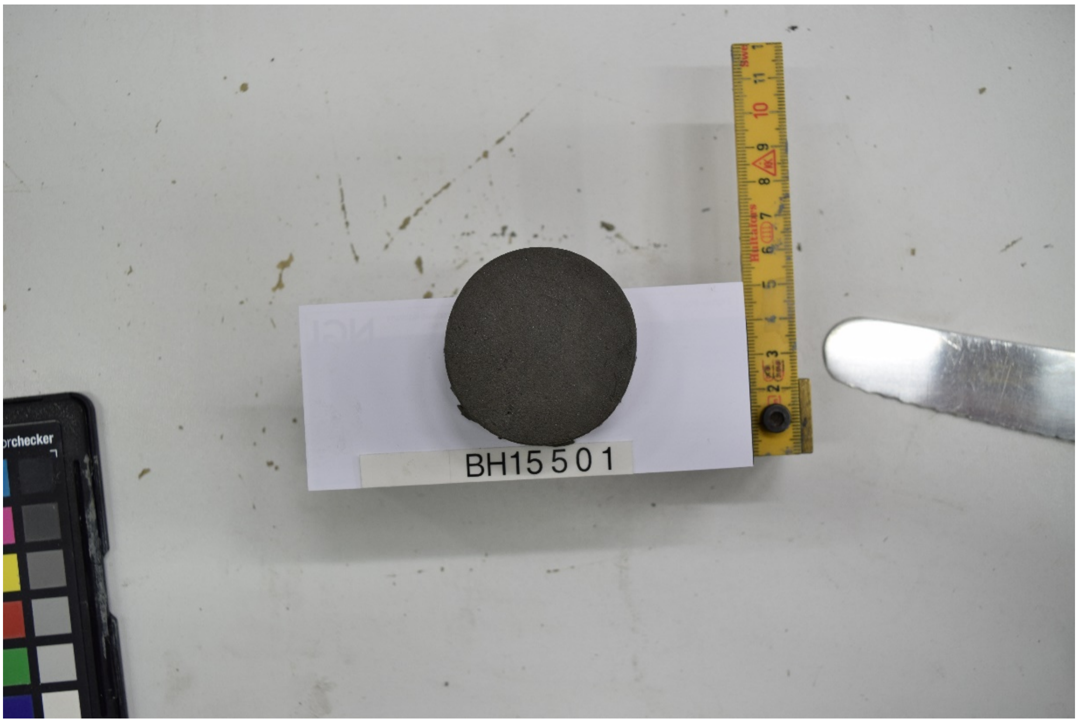
Test:	HALB03-8-0-1

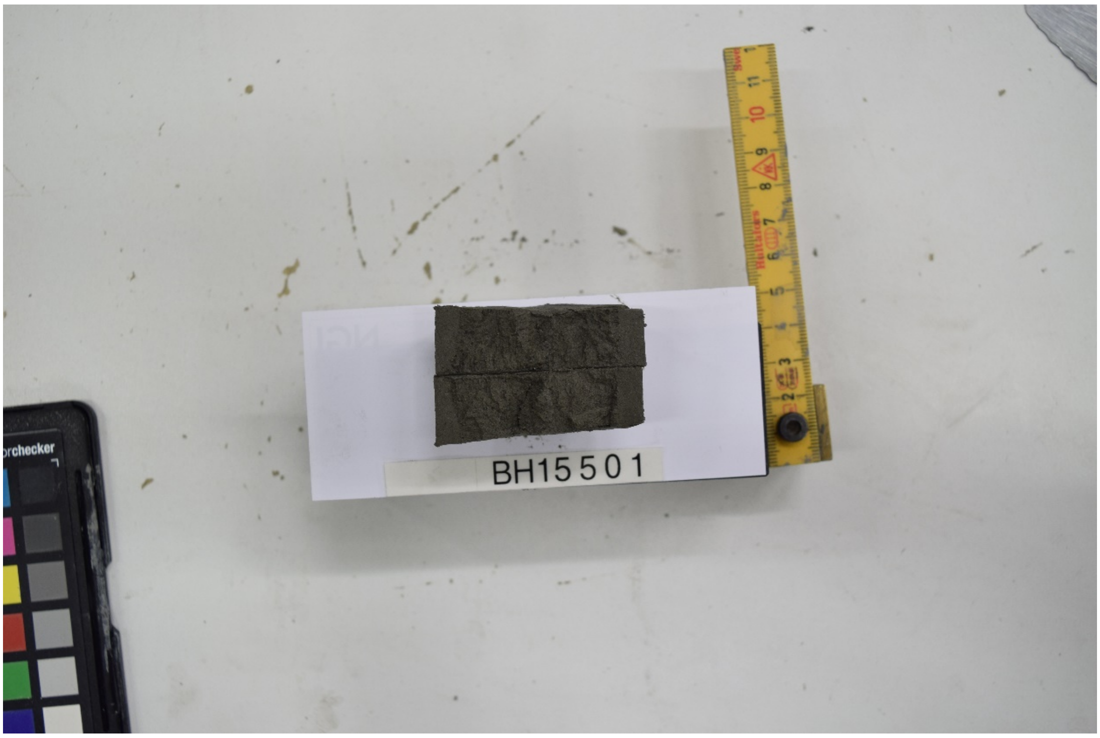


Test:	HALB03-8-0-1



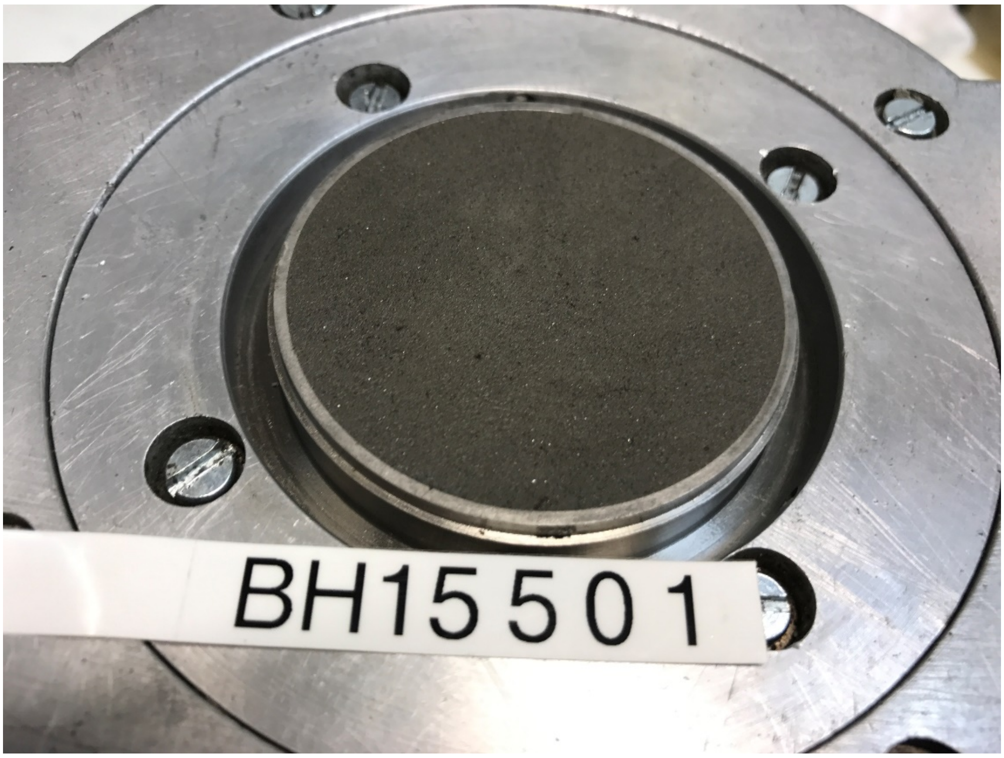
Test:	HALB04-5-0-1



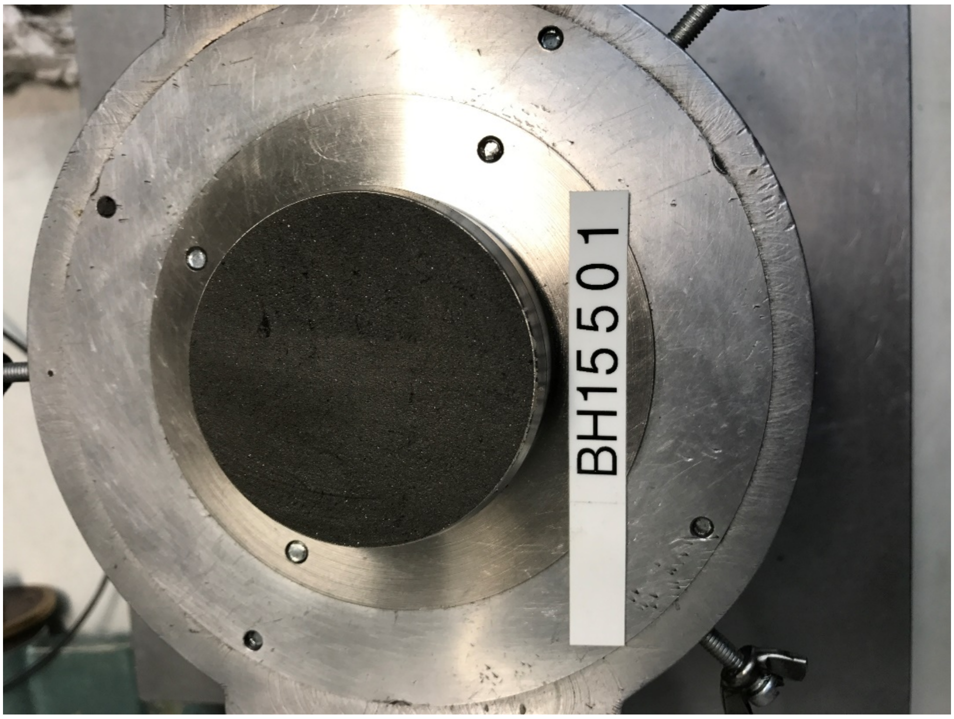


Test:	HALB04-5-0-1

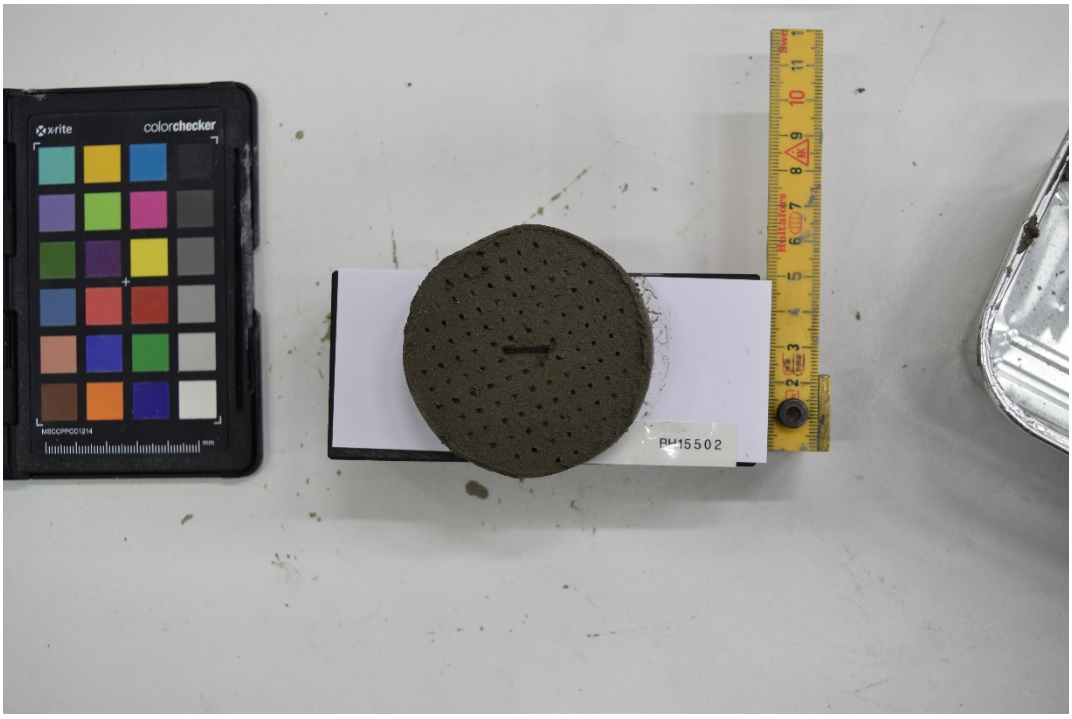
Test:	HALB04-5-0-1

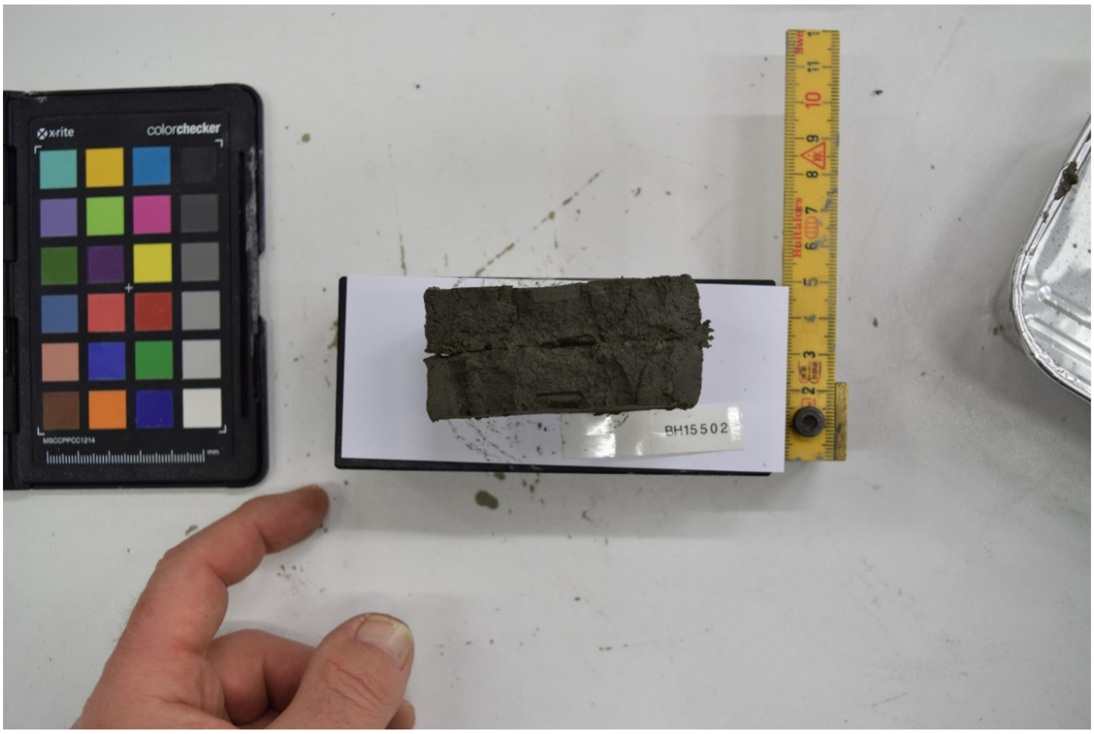


Test:	HALB04-5-0-1

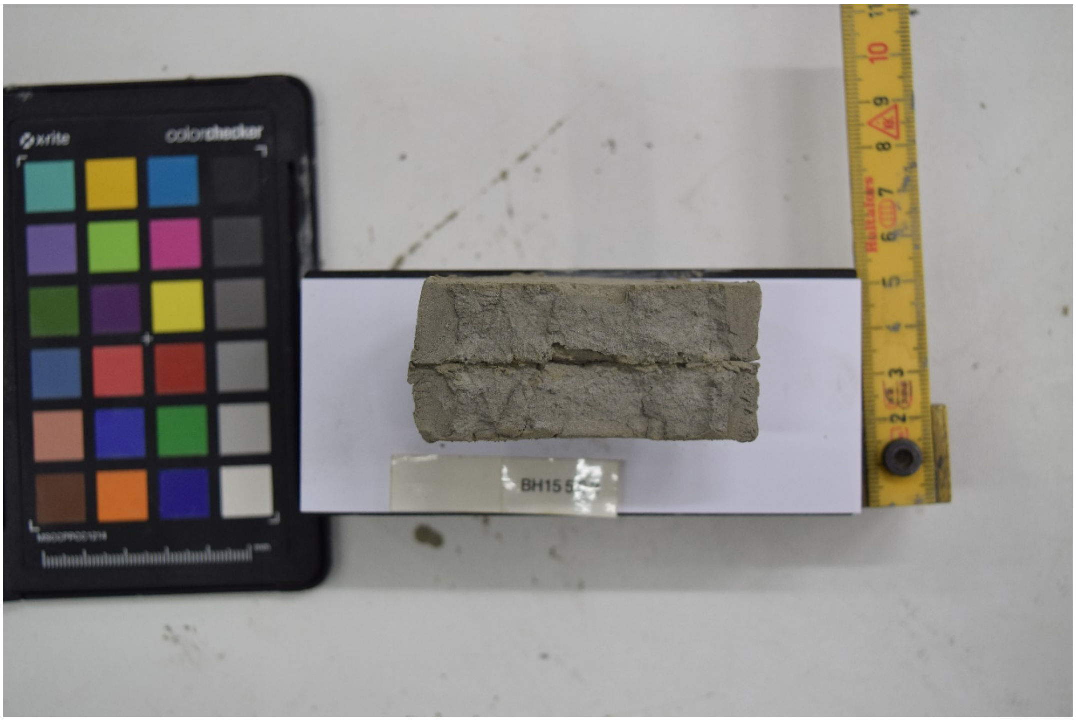


Test:	HALB04-5-0-2

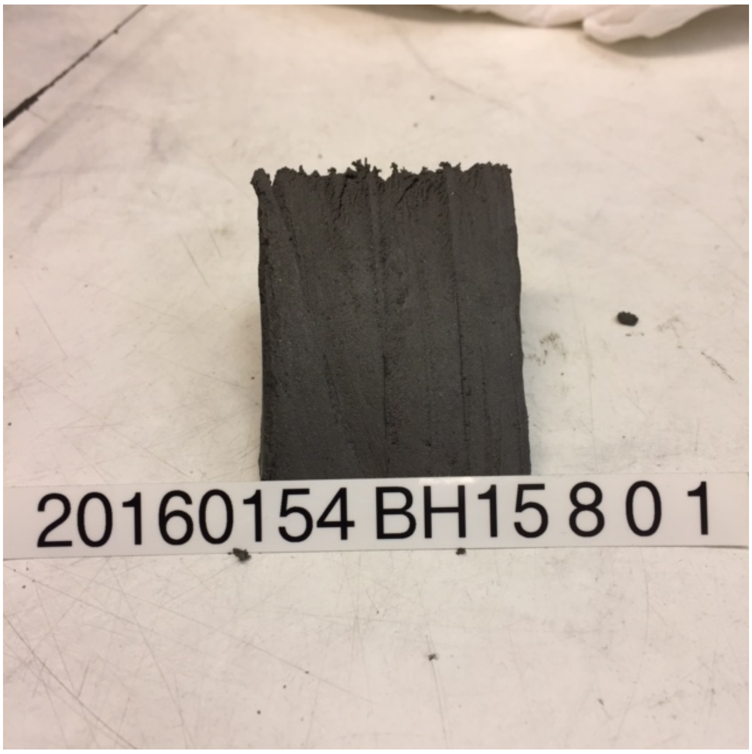




Test:	HALB04-5-0-2

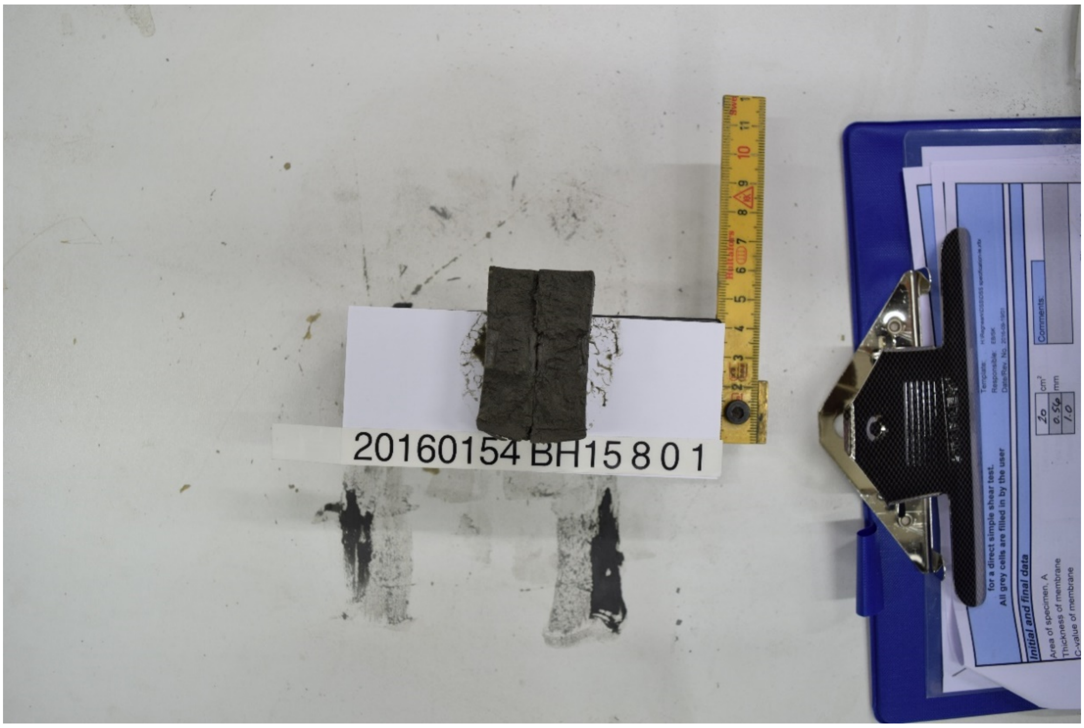


Test:	HALB04-8-0-1

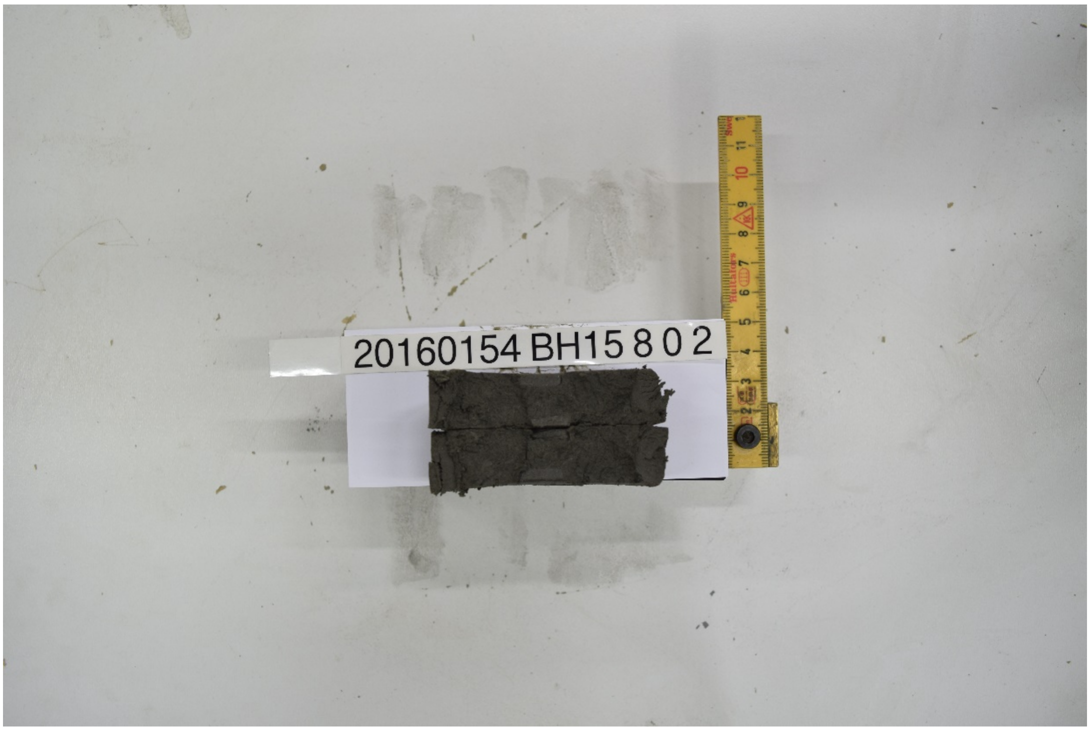


Test:	HALB04-8-0-1

Test:	HALB04-8-0-1

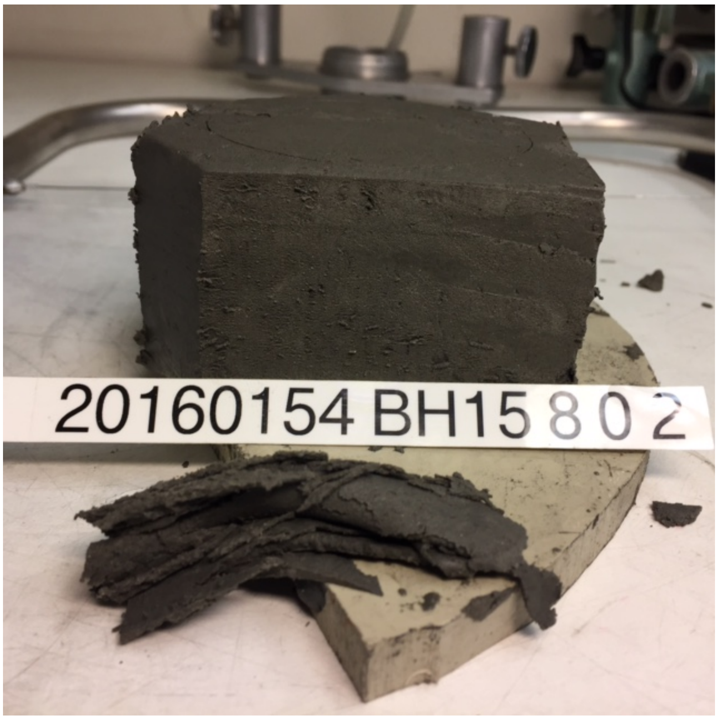


Test:	HALB04-8-0-2

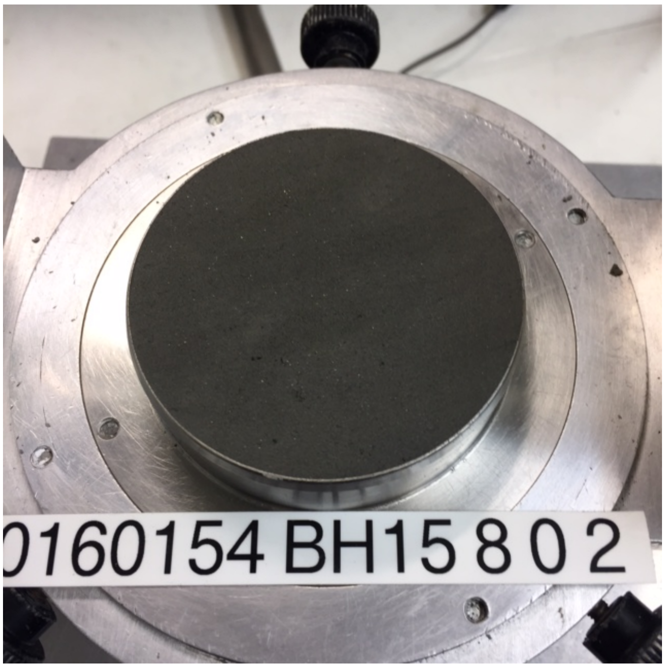


Test:	HALB04-8-0-2

Test:	HALB04-8-0-2

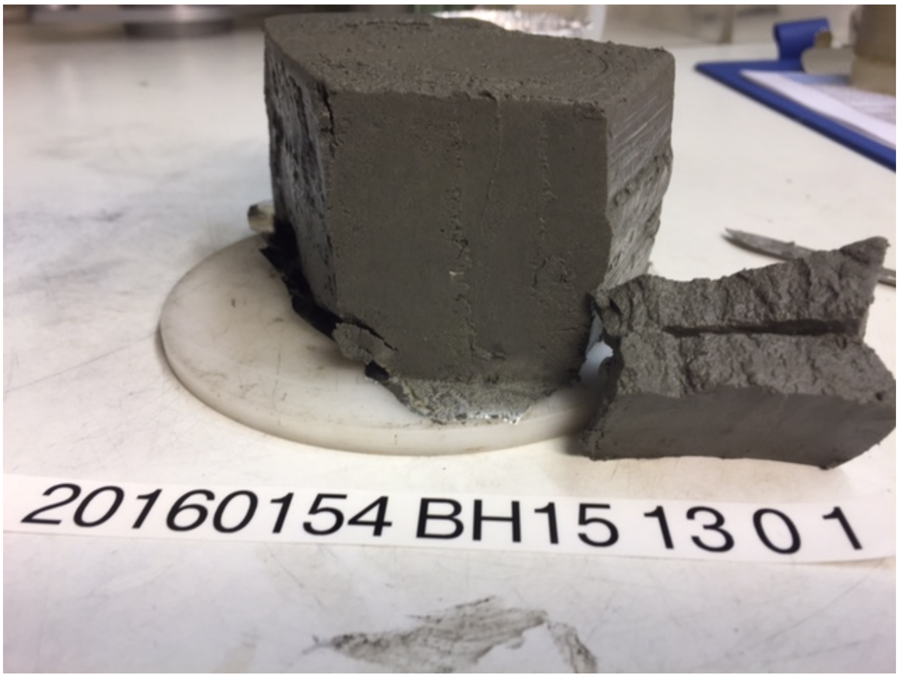


Test:	HALB04-8-0-2

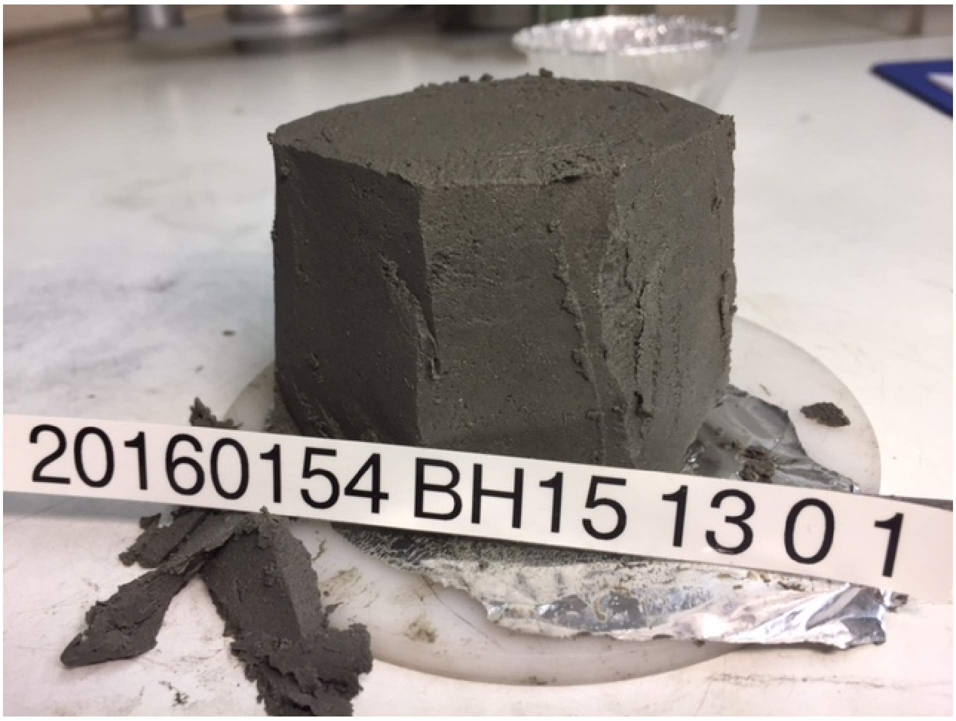


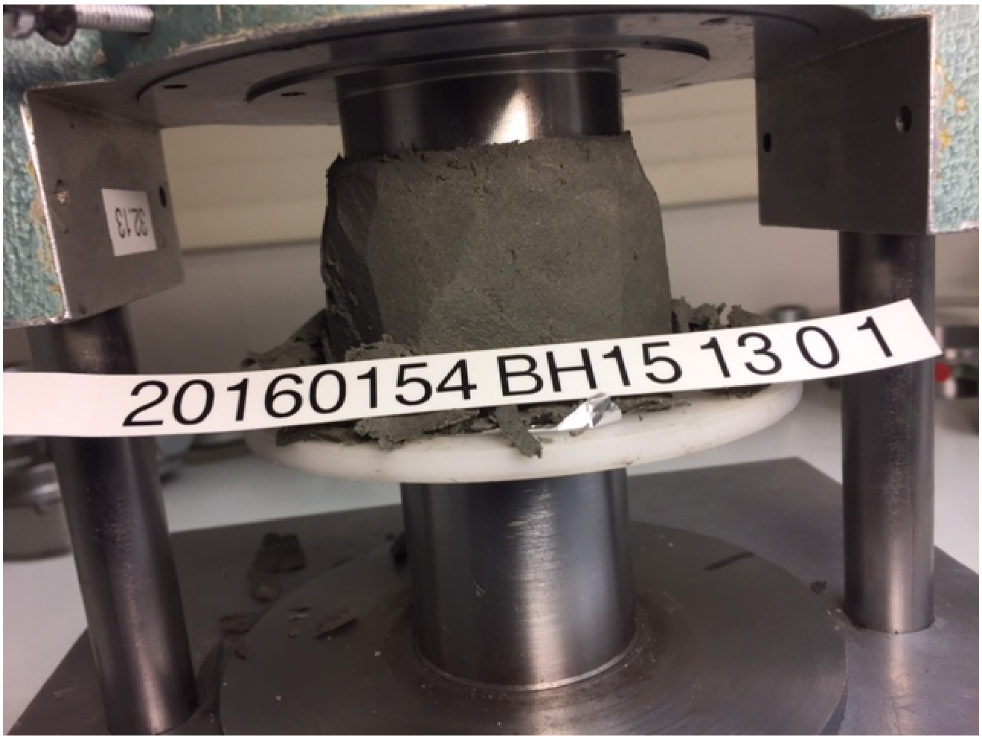
Test:	HALB04-13-0-1

Test:	HALB04-13-0-1

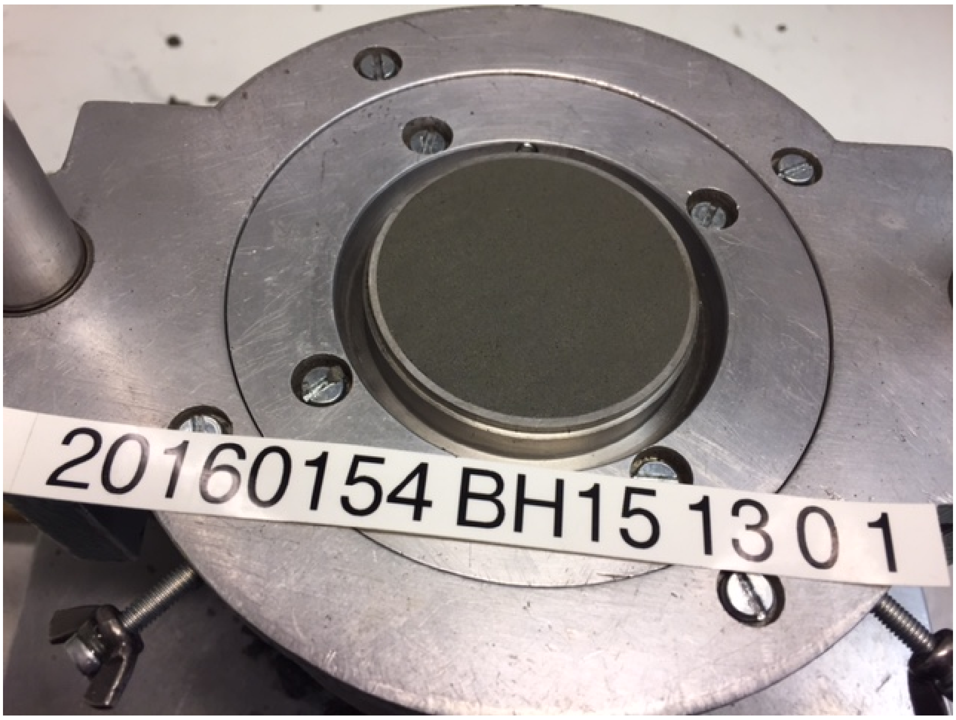


Test:	HALB04-13-0-1

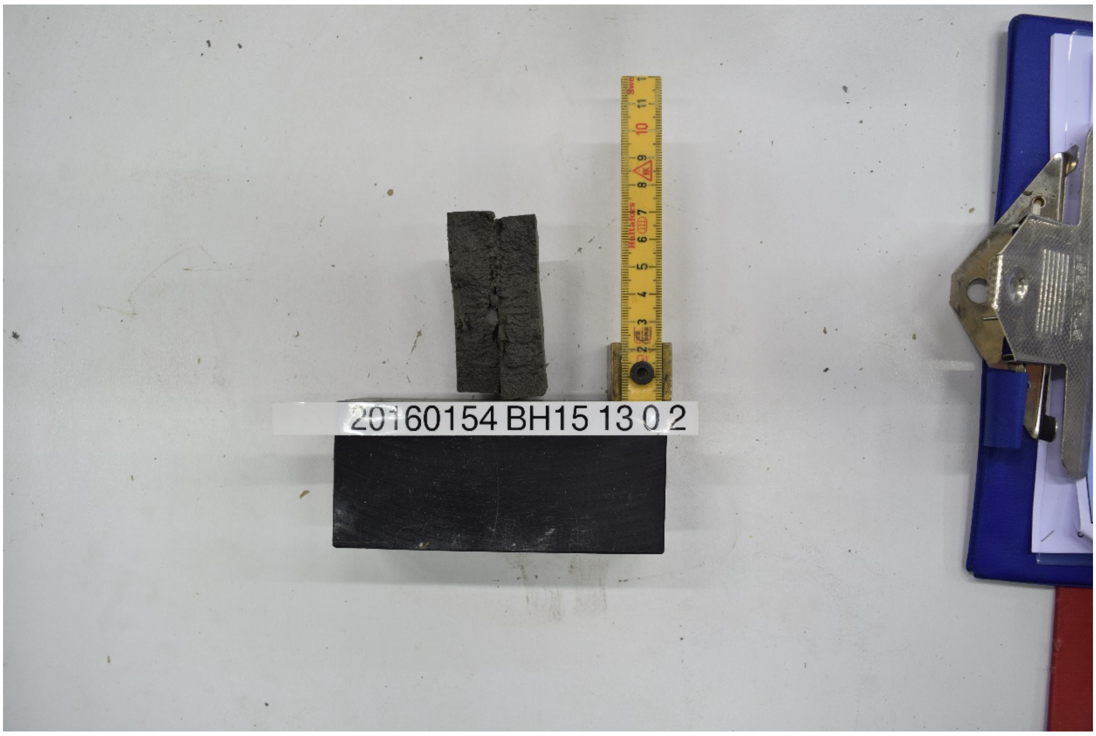




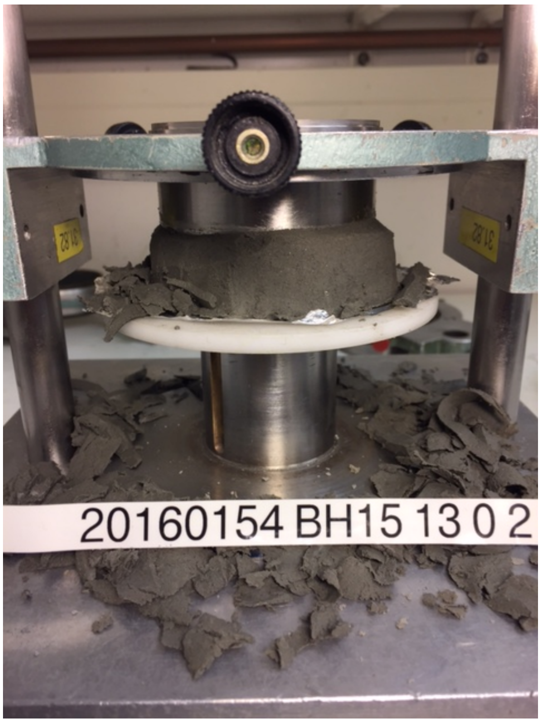
Test:	HALB04-13-0-1



Test:	HALB04-13-0-2



Test:	HALB04-13-0-2



Test:	HALB04-13-0-2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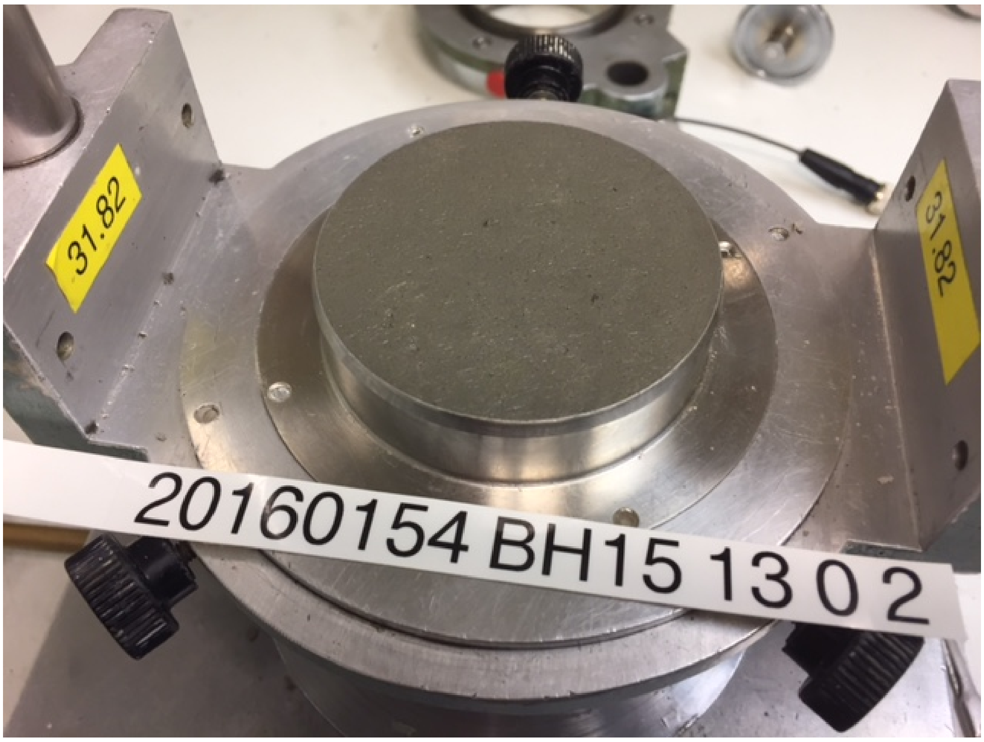

31.82
31.82
20160154 BH15 13 0 2

Table 1: Summary of undrained DSS tests: NGTS - Halden Research Site

Boring No.	Tube part test	Depth (m)	INDEX PROPERTIES: Water content w_i (%)	Water content w_f (%)	I_p (%)	Clay cont. (%)	Fines cont. (%)	Unit weight (kN/m^3)	Type of test 1)	Area (cm^2)	CONSOLIDATION: Estim. p_0' (kPa)	$\sigma'_{a\,max}$ (kPa)	$\sigma'_{a\,min} = \sigma'_{ac}$ (kPa)	ε_{ac} (%)	STATIC TESTING: s_{uD} (τ_f) (kPa)	U_f (kPa)	γ_f (%)	s_{uD}/σ'_{ac} (τ_f/σ_{ac}') (-)	COMMENTS	FIGURE REFERENCE
HALB01	11-B-1	7.50	29.0	26.3	9.1	8.4	86	19.22	DSS	35	105	105.0	105.0	1.28	29.5	40.9	2.4	0.28	With G_{max}. S shaped, dilation, su at umax	Fig. 01 - Fig. 02
HALB01	11-B-2	7.55	29.5	23.0	9.1	8.4	86	19.00	DSS-rem	35	105	105.0	105.0	6.11	27.1	50.1	3.5	0.26	With G_{max}. S shaped, dilation, su at umax	Fig. 03 - Fig. 04
HALB01	13-B-1	10.50	29.1	27.8	8.4	7.8	85	19.00	DSS	35	135	135.0	135.0	1.78	36.9	57.7	2.9	0.27	With G_{max}. S shaped, dilation, su at umax	Fig. 05 - Fig. 06
HALB03	5-0-1	7.57	29.4	25.6	8.1	8.5	89	18.55	DSS	20	105	105.0	105.0	1.89	34.3	34.4	2.0	0.33	With G_{max}. S shaped, dilation, su at umax	Fig. 07 - Fig. 08
HALB03	8-0-1	10.25	27.8	25.3	6.0	10.5	84	18.88	DSS	20	135	135.0	135.0	2.20	36.9	55.7	2.6	0.27	With G_{max}. S shaped, dilation, su at umax	Fig. 09 - Fig. 10
HALB04	5-0-1	7.03	28.6	26.4	8.1	7.0	86	18.63	DSS	20	105	105.1	105.1	1.46	36.3	31.1	1.8	0.35	With G_{max}. S shaped, dilation, su at umax	Fig. 11 - Fig. 12
HALB04	5-0-2	7.03	28.6	27.2	8.1	7.0	86	18.80	DSS	35	105	105.0	105.0	1.72	32.9	36.2	2.3	0.31	With G_{max}. S shaped, dilation, su at umax	Fig. 13 - Fig. 14
HALB04	8-0-1	10.07	25.7	24.1	9.2	10.5	84	19.14	DSS	20	135	135.0	135.0	1.70	38.8	48.9	1.5	0.29	With G_{max}. S shaped, dilation, su at umax	Fig. 15 - Fig. 16
HALB04	8-0-2	10.07	24.6	25.4	9.2	10.5	84	19.10	DSS	35	135	135.0	135.0	1.21	41.2	47.5	2.6	0.31	With G_{max}. S shaped, dilation, su at umax	Fig. 17 - Fig. 18
HALB04	13-0-1	14.48	20.6	19.6	5.0	7.0	81	20.26	DSS	20	158	158.1	158.1	1.12	39.2	65.1	1.6	0.25	With G_{max}. S shaped, dilation, su at umax	Fig. 19 - Fig. 20
HALB04	13-0-2	14.48	20.0	19.3	5.0	7.0	81	20.23	DSS	35	158	158.1	158.1	0.68	50.3	38.2	1.3	0.32	With G_{max}. S shaped, dilation, su at umax	Fig. 21 - Fig. 22

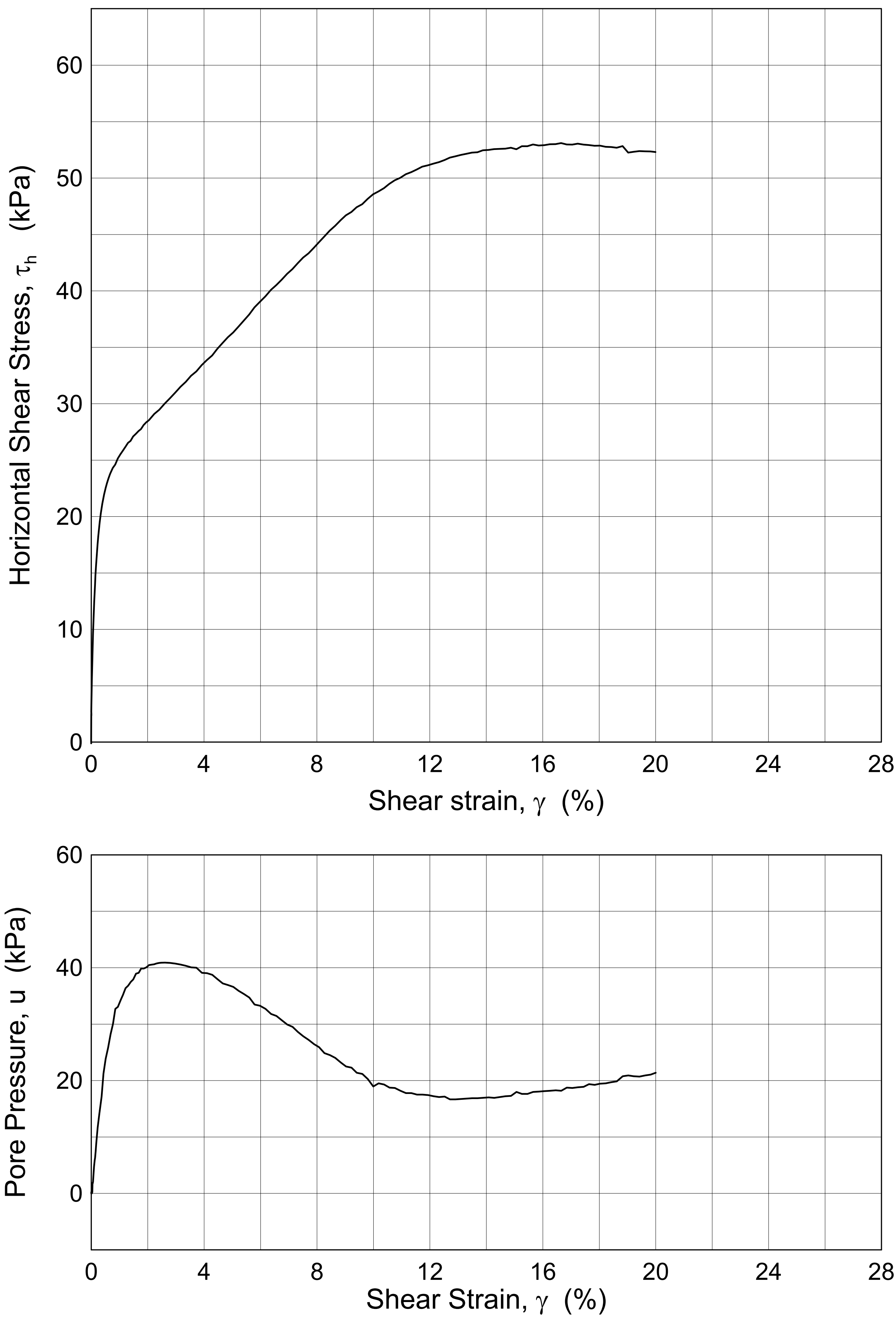
CLIENT: NGI

PROJECT: NGTS
Halden
2018-06-06

Document No.: 20160154-04-R

In case of I_p = 0, it represents a test failed to give the plas
due to low plasticity of the sample

LEGEND
1) DSS = Direct Simple Shear, static test
DSS-rec = Direct Simple Shear, static test (reconstituted specimen)
DSScy = Direct Simple Shear, cyclic test
2) At building in
3) End of consoldiation, before pre-shearing



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NGTS - Halden Research Site

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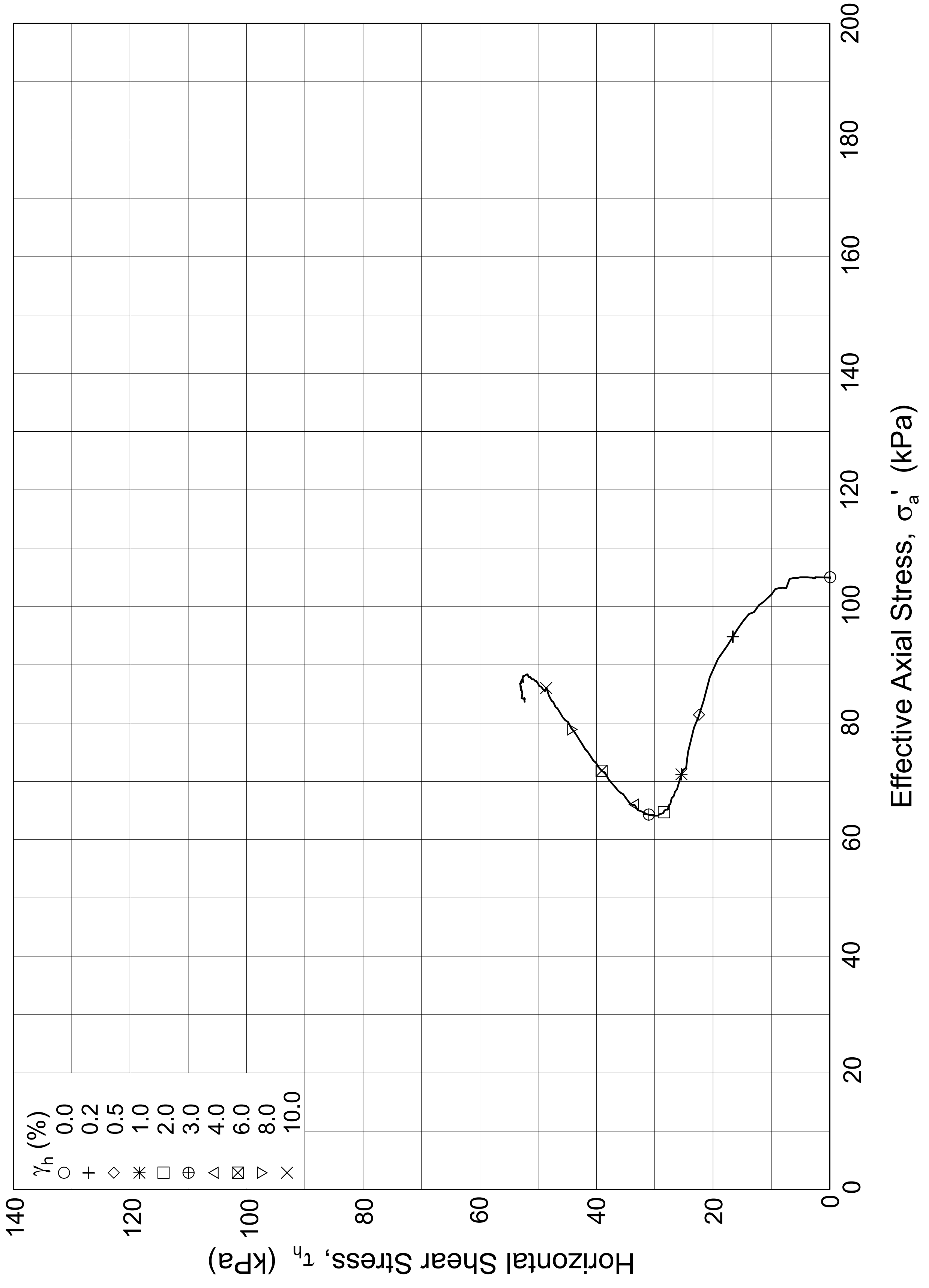
Direct Simple Shear Test

Figure No. 01

Boring:	**HALB01**	Depth	=	**7.50**	m	Consolidation stresses				Date 2018-04-05 / Drawn by/checked JLA / MAS
Tube:	**11**	p_o'	=	**105.0**	kPa	(kPa)	max.	min.	final	
Part:	**B**	w_i	=	**29.0**	%	σ_{ac}' =	105.0	-	**105.0**	NGTS
Test:	**1**	γ_i	=	**19.22**	kN/m^3	τ_c' =	-	-	**-**	



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NGTS - Halden Research Site									Document No. 20160154-04-R
Direct Simple Shear Test									Figure No. 02
Boring: **HALB01**	Depth	=	**7.50**	m	Consolidation stresses				Date 2018-04-05 / Drawn by/checked JLA / MAS
Tube: **11**	p_o'	=	**105.0**	kPa	(kPa)	max.	min.	final	
Part: **B**	w_i	=	**29.0**	%	σ_{ac}' =	105.0	-	**105.0**	NGTS
Test: **1**	γ_i	=	**19.22**	kN/m³	τ_c' =	-	-	**-**	

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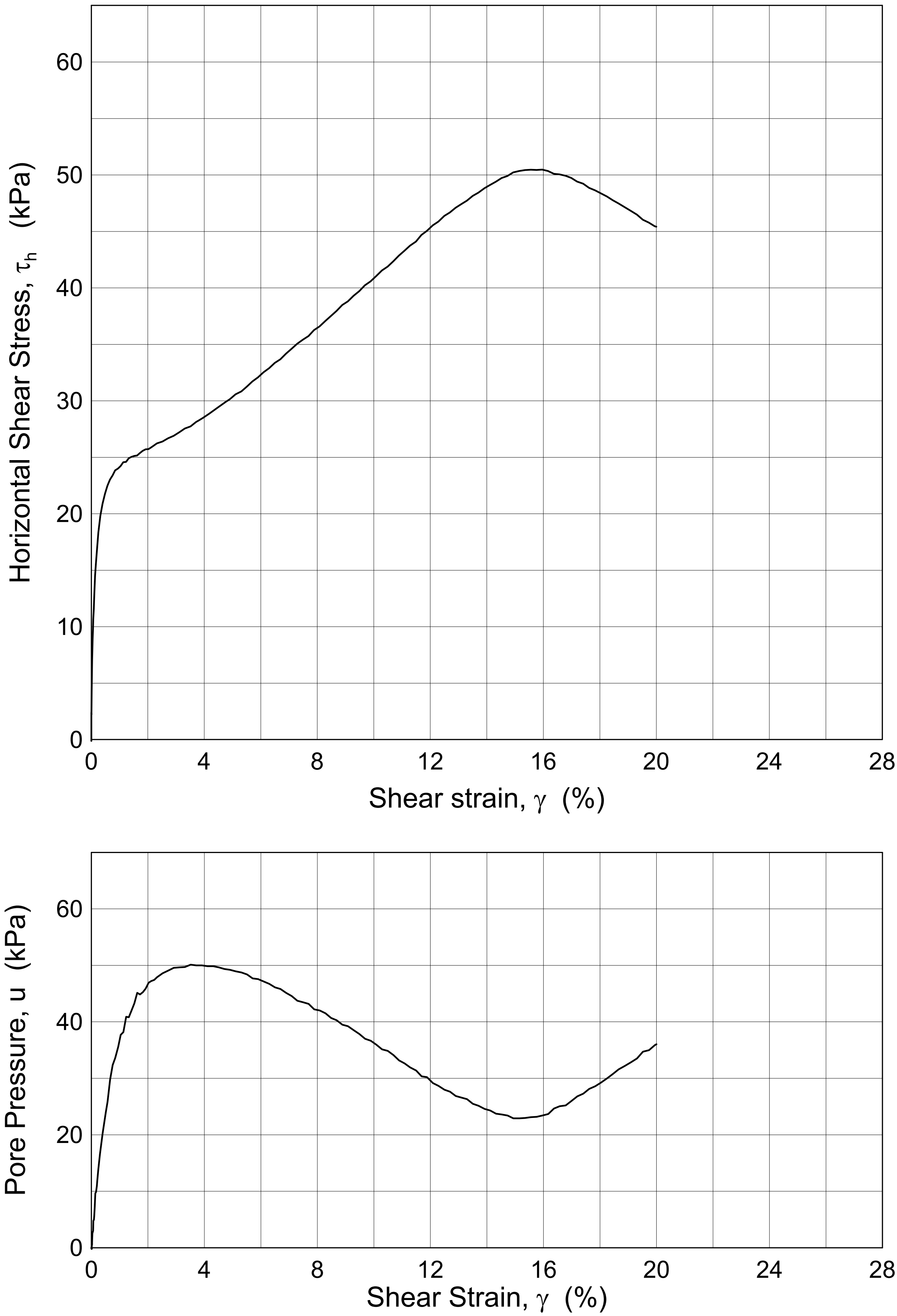

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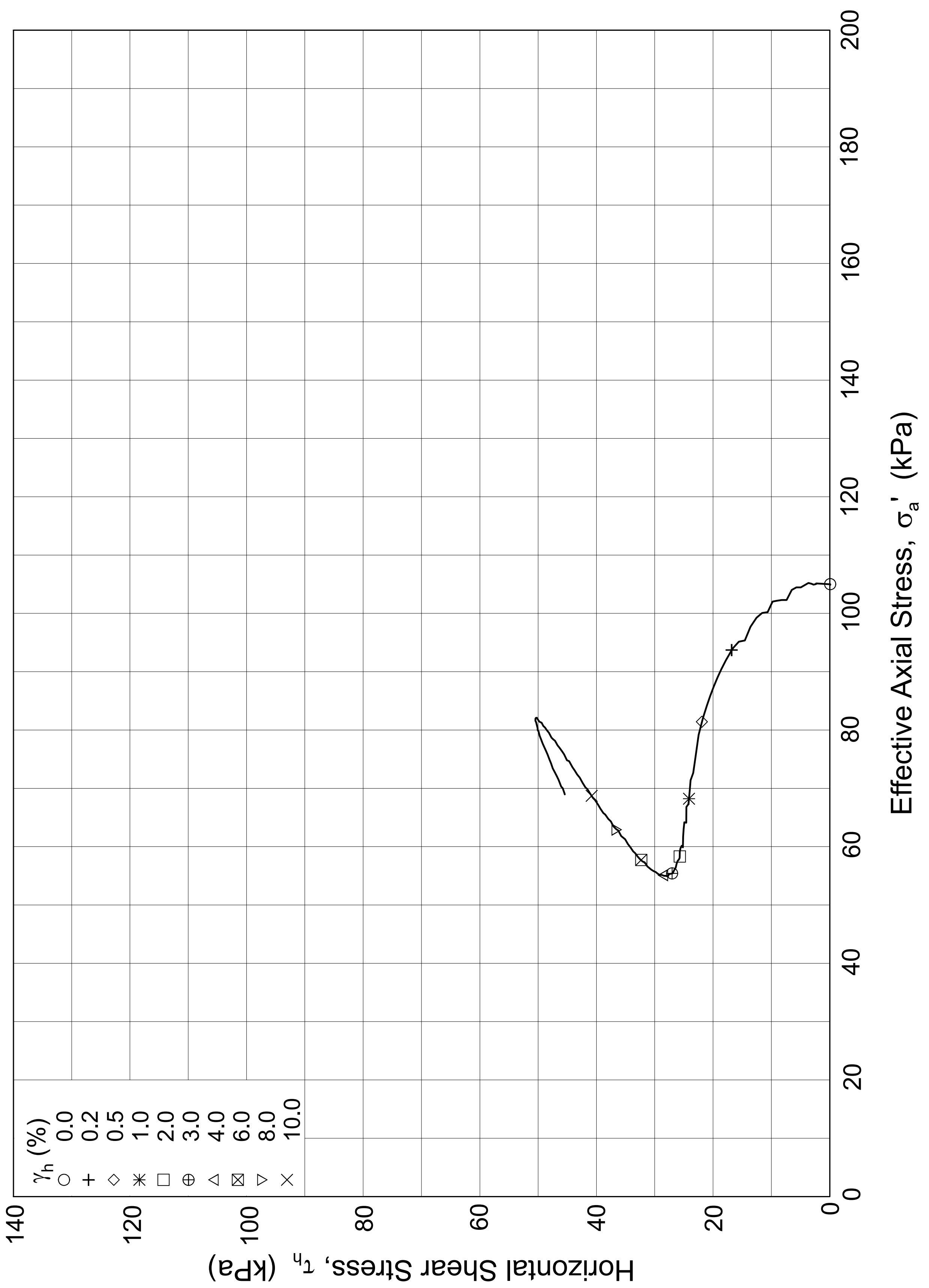
NGTS - Halden Research Site		Document No. 20160154-04-R
Direct Simple Shear Test		Figure No. 03
		Date 2018-04-05
		Drawn by/checked JLA / MAS

Boring: **HALB01**	Depth	=	**7.55**	m	Consolidation stresses			
Tube: **11**	p_o'	=	**90.0**	kPa	(kPa)	max.	min.	final
Part: **B**	w_i	=	**29.5**	%	σ_{ac}' =	105.0	-	**105.0**
Test: **2**	γ_i	=	**19.00**	kN/m^3	τ_c' =	-	-	**-**

NGTS



Date/Rev.: 2015-01-12/4

NGTS - Halden Research Site			Document No. 20160154-04-R
Direct Simple Shear Test			Figure No. 04
Boring: **HALB01**	Depth = **7.55** m	Consolidation stresses	Date 2018-04-05 / Drawn by/checked JLA / MAS
Tube: **11**	p_o' = **90.0** kPa	(kPa) max. min. final	NGTS
Part: **B**	w_i = **29.5** %	σ_{ac}' = 105.0 - **105.0**	
Test: **2**	γ_i = **19.00** kN/m³	τ_c' = - - **-**	

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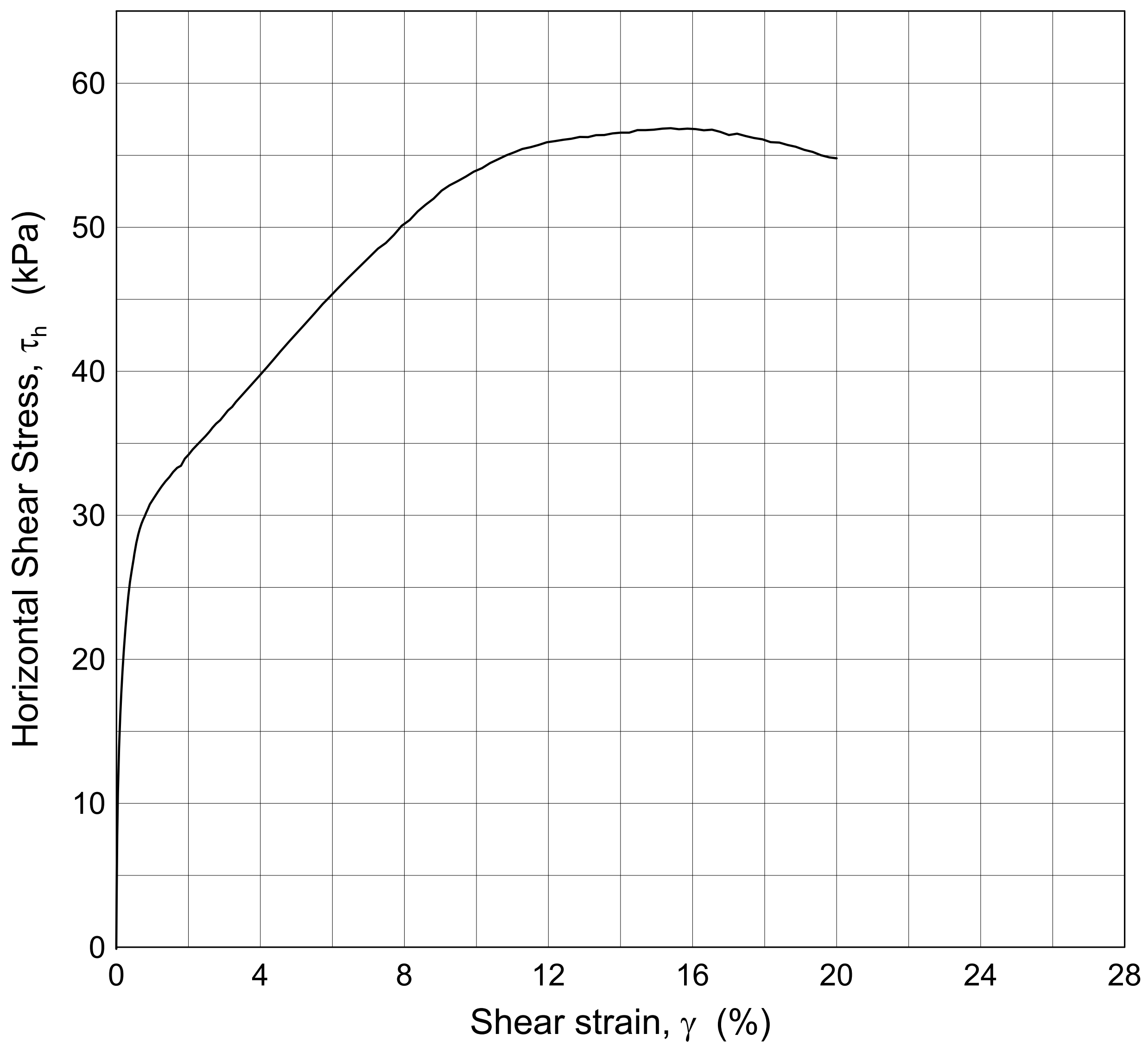

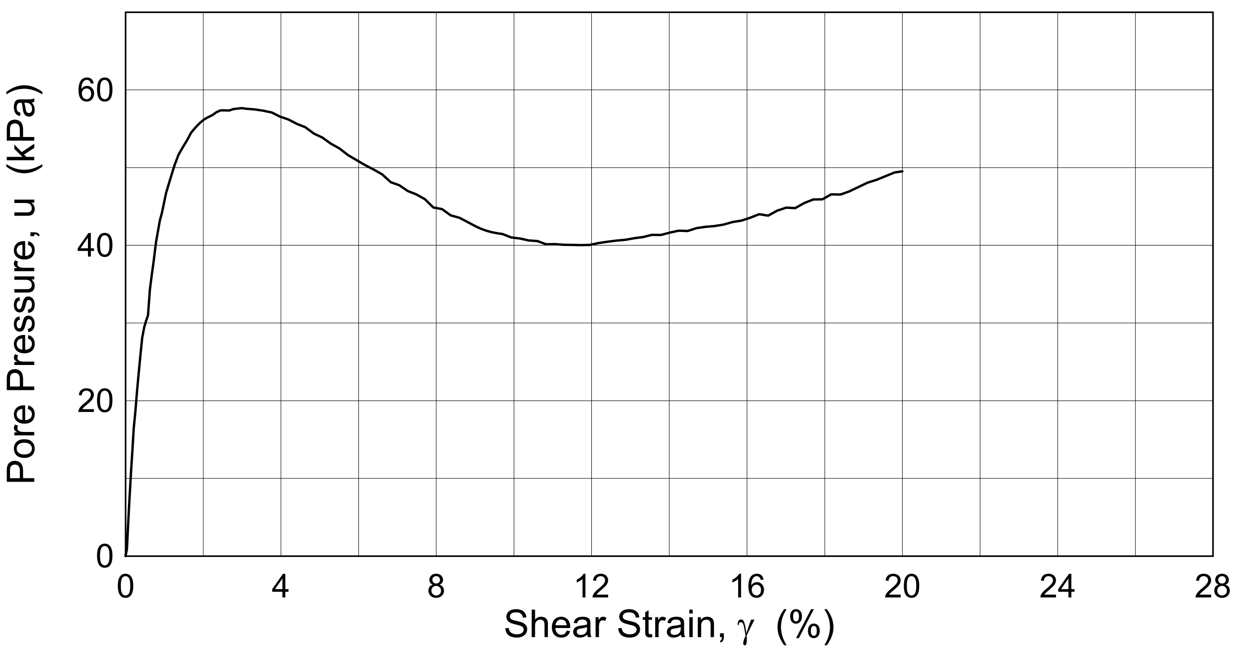

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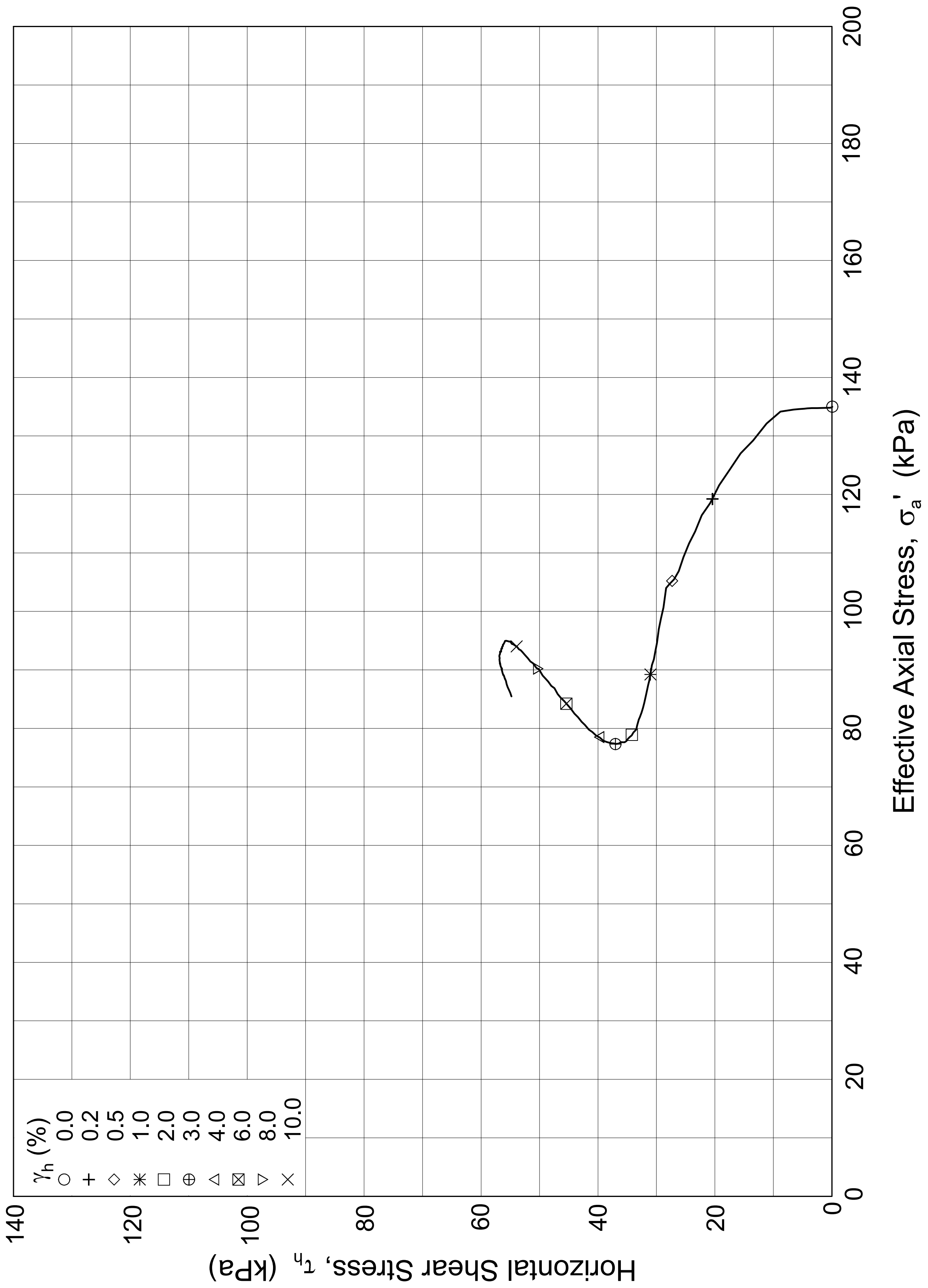
NGTS - Halden Research Site			Document No. 20160154-04-R
Direct Simple Shear Test			Figure No. 05
Boring: **HALB01**	Depth = **10.50** m	Consolidation stresses	Date 2018-04-05
Tube: **13**	p_o' = **135.0** kPa	(kPa) max. min. final	Drawn by/checked JLA / MAS
Part: **B**	w_i = **29.1** %	σ_{ac}' = 135.0 - **135.0**	NGTS
Test: **1**	γ_i = **19.0** kN/m³	τ_c' = - - **-**	



Date/Rev.: 2015-01-12/4

NGTS - Halden Research Site								Document No. 20160154-04-R
Direct Simple Shear Test								Figure No. 06
Boring: **HALB01**	Depth	=	**10.50**	m	Consolidation stresses			Date 2018-04-05 / Drawn by/checked JLA / MAS
Tube: **13**	p_o'	=	**135.0**	kPa	(kPa)	max. min.	final	
Part: **B**	w_i	=	**29.1**	%	σ_{ac}' =	135.0 -	**135.0**	NGTS
Test: **1**	γ_i	=	**19.0**	kN/m³	τ_c' =	- -	**-**	

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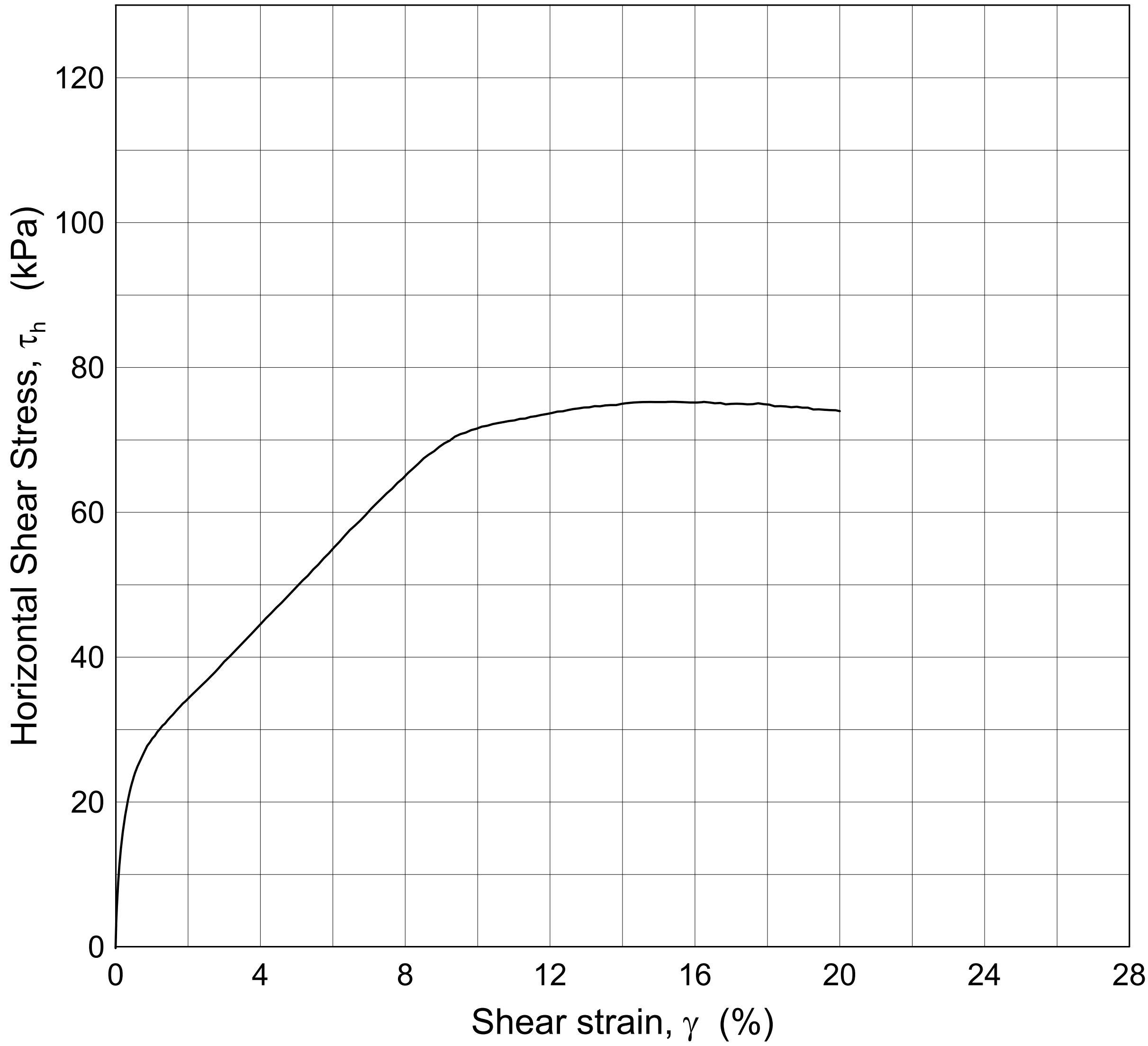

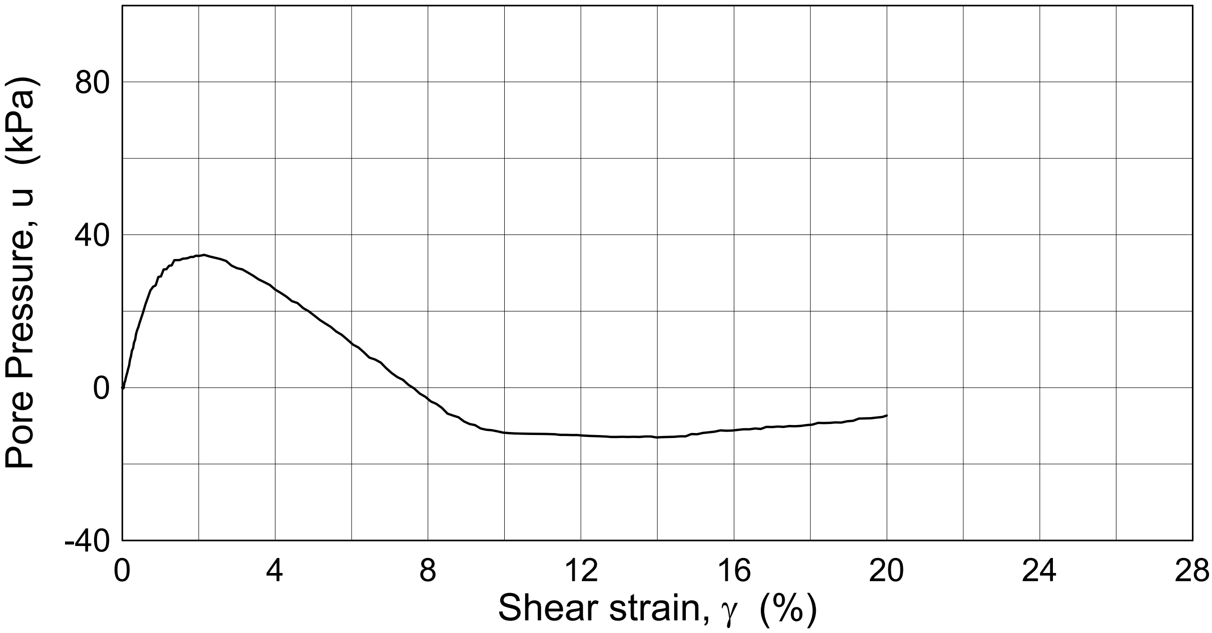

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NGTS - Halden Silt Site

Direct Simple Shear Test

Document No. 20160154

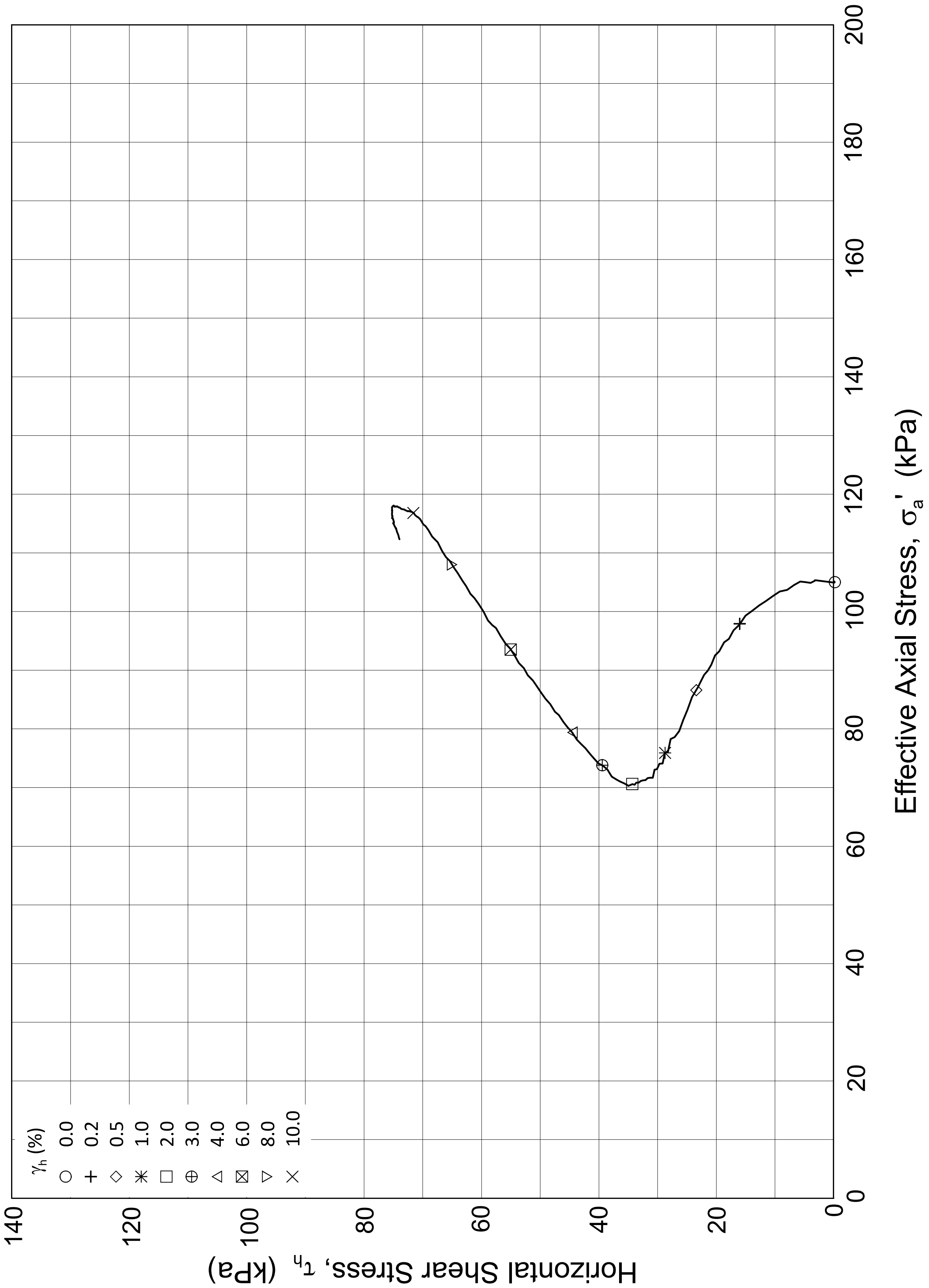
Figure No. 07

Date 2018-04-05

Drawn by / Checked JLA / MAS

Boring: **HALB03**	Depth = 7.57 m	Consolidation stresses	
Tube: 5	p_0' = 105.0 kPa	(kPa) max. min. final	
Part: 0	w_i = 29.4 %	σ_{ac}' = 105.0 105.0 **105.0**	
Test: 1	γ_i = 18.55 kN/m³	τ_c' = - - **-**	

NGTS



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NGTS - Halden Silt Site

Direct Simple Shear Test

Boring: **HALB03**	Depth = 7.57 m	Consolidation stresses
Tube: 5	p_0' = 105.0 kPa	(kPa) max. min. final
Part: 0	w_i = 29.4 %	σ_{ac}' = 105.0 105.0 **105.0**
Test: 1	γ_i = 18.55 kN/m³	τ_c' = - - **-**

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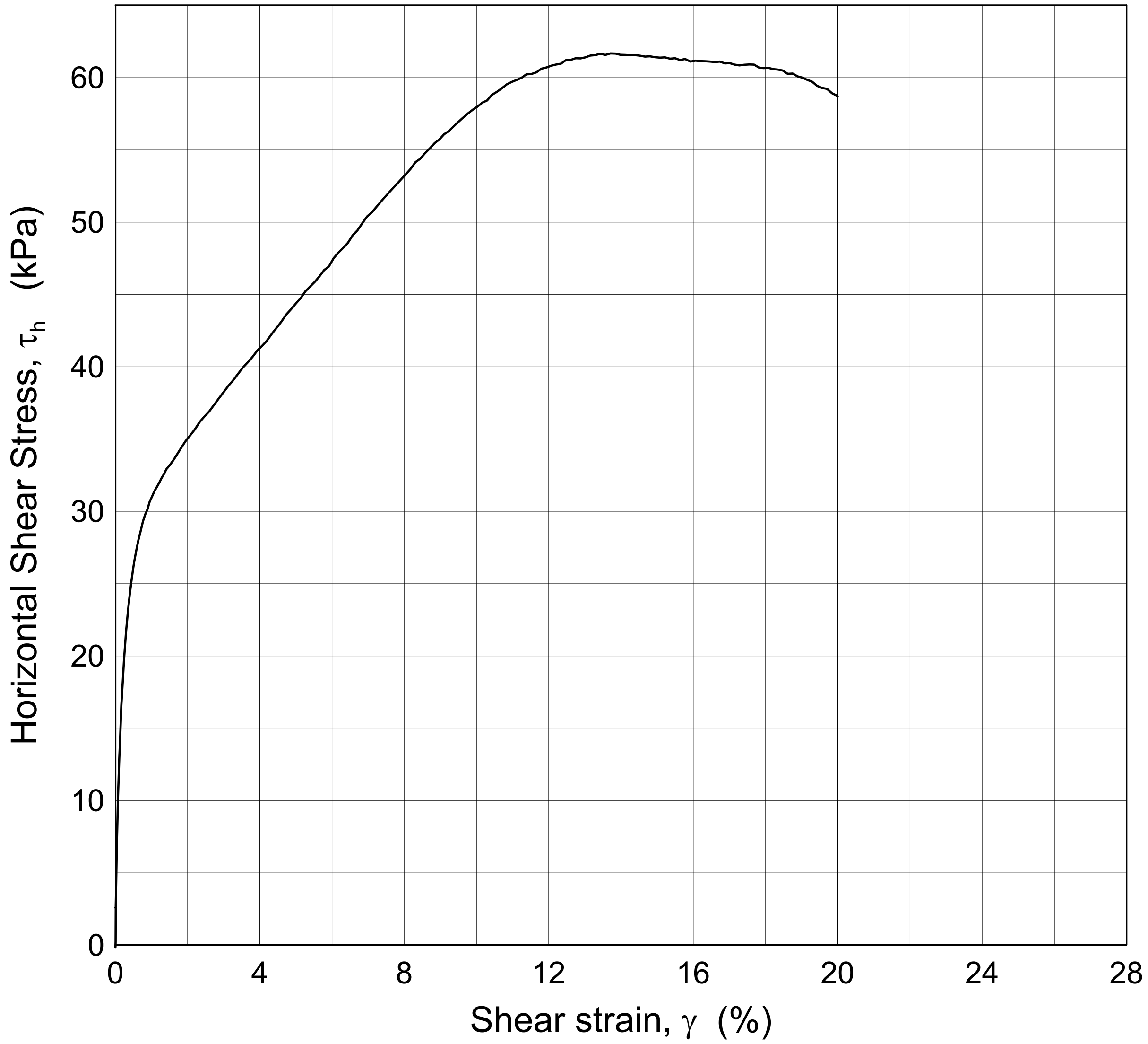
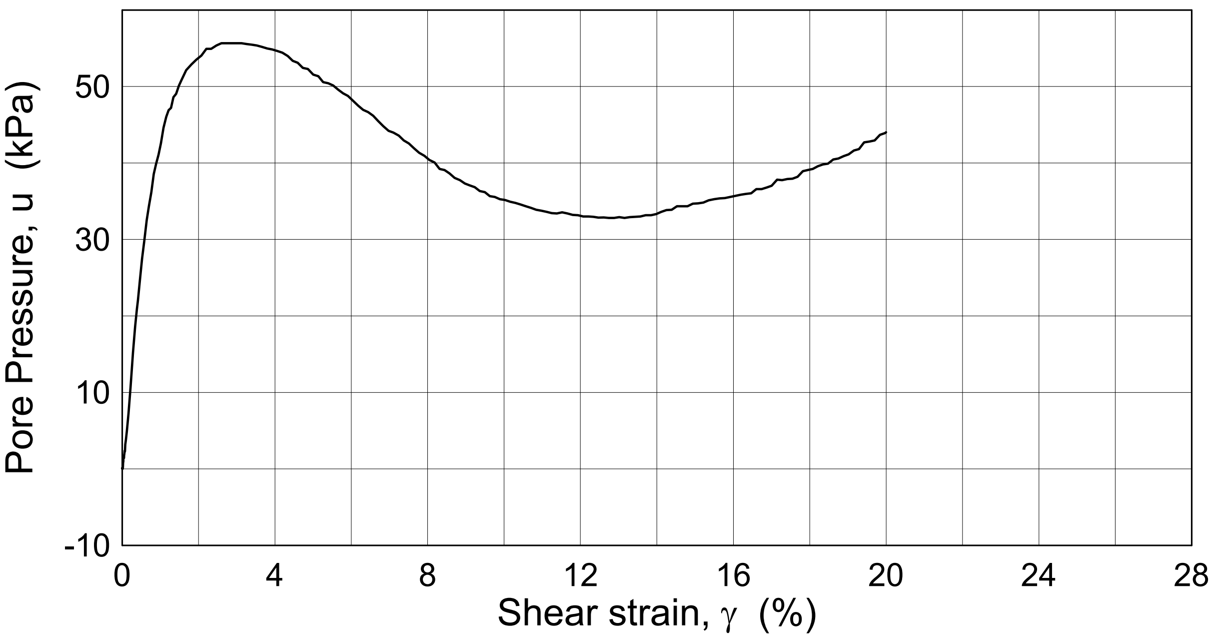
Figure No.	08
Date	2018-04-05
Drawn by / Checked	JLA / MAS

NGTS





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Direct Simple Shear Test

Figure No. 09

Boring: **HALB03**	Depth = 10.25 m	Consolidation stresses	Date 2018-04-05
Tube: 8	p_0' = 135.0 kPa	(kPa) max. min. final	Drawn by / Checked JLA / MAS
Part: 0	w_i = 27.8 %	σ_{ac}' = 135.0 135.0 **135.0**	NGTS
Test: 1	γ_i = 18.88 kN/m³	τ_c' = - - **-**	

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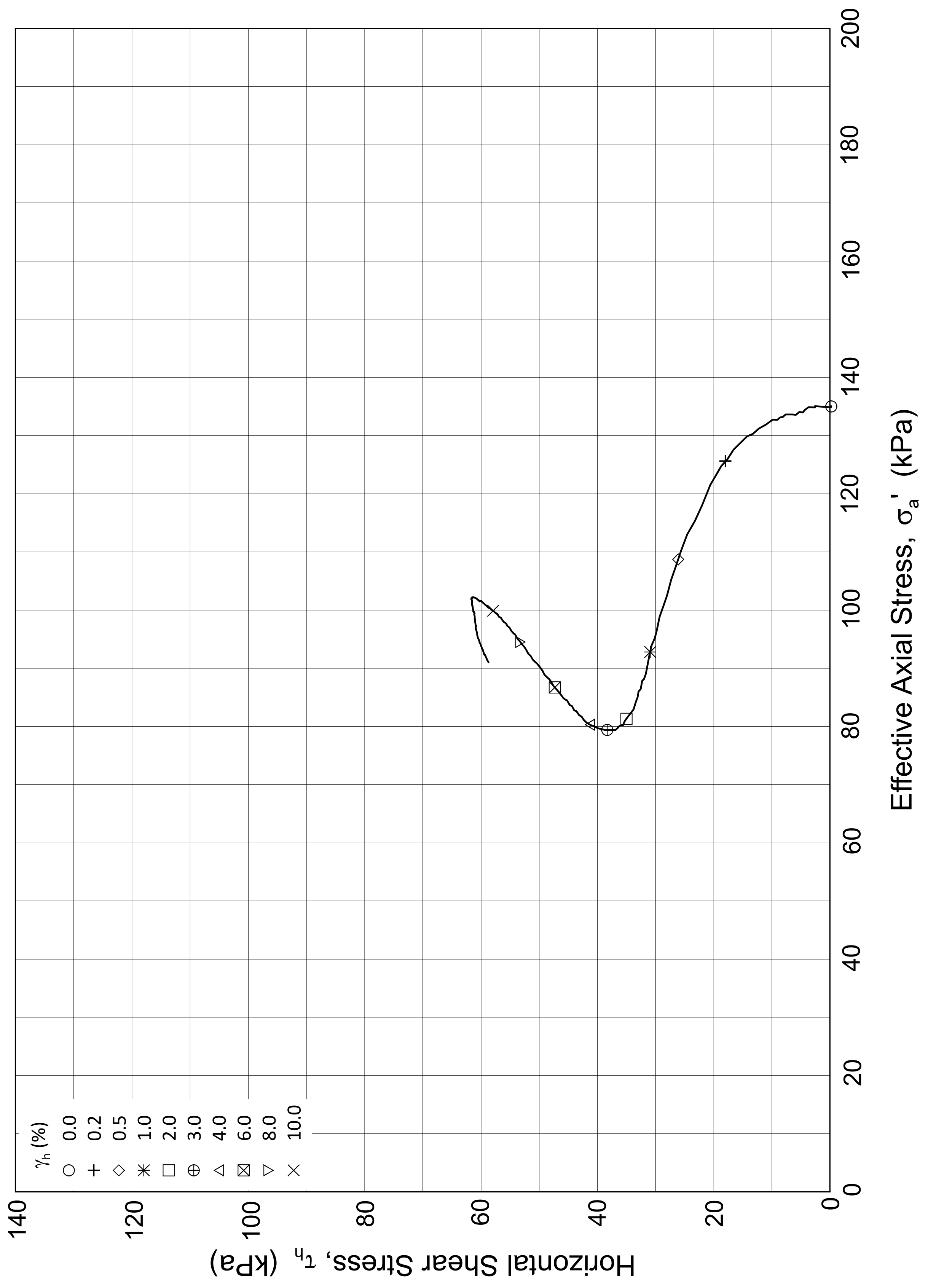

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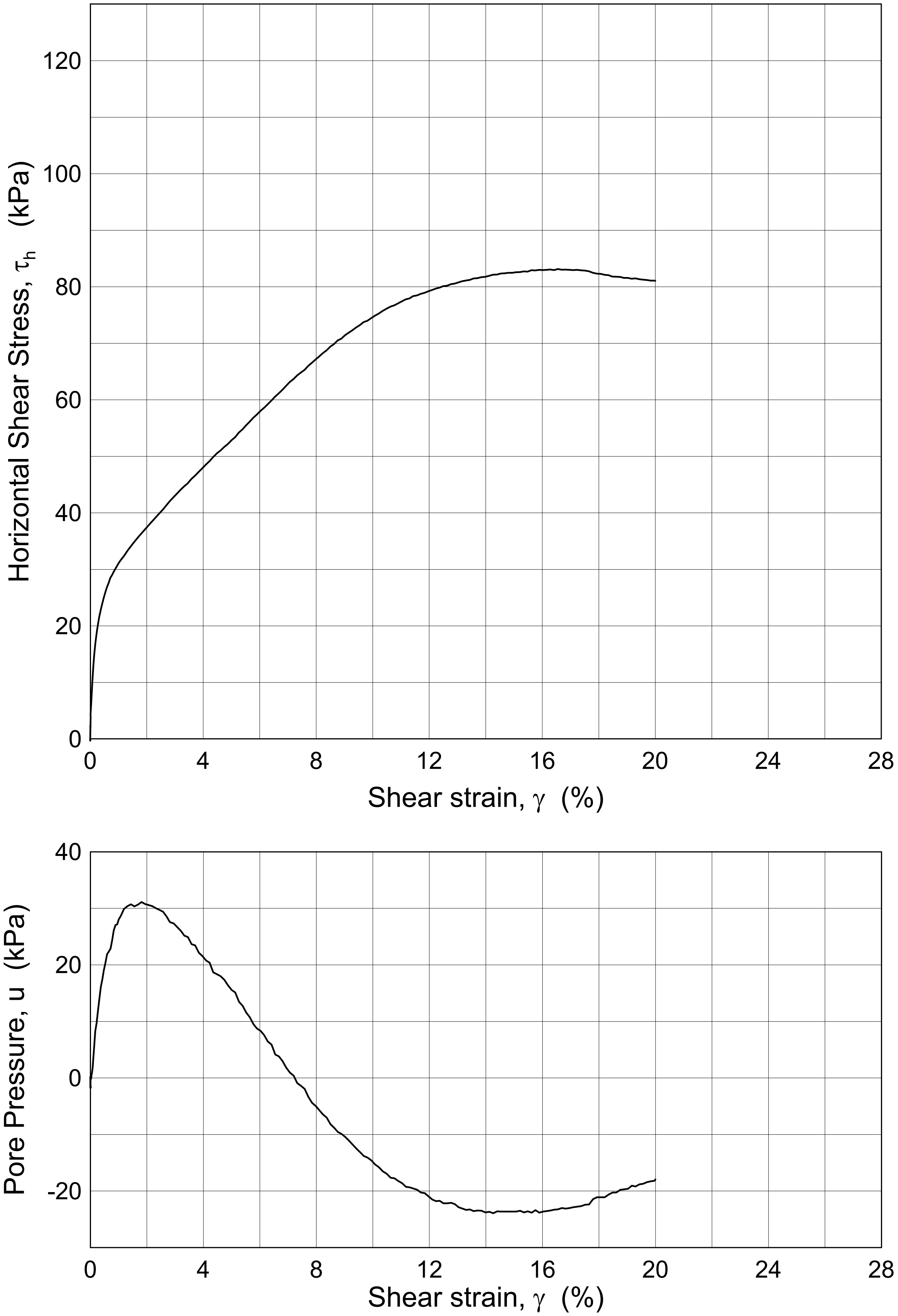
Date/Rev.: 2016-10-28/6

NGTS - Halden Research Site			Document No. 20160154-04-R
Direct Simple Shear Test			Figure No. 10
Boring: **HALB03**	Depth = 10.25 m	Consolidation stresses	Date 2018-04-05 / Drawn by / Checked JLA / MAS
Tube: 8	p_0' = 135.0 kPa	(kPa) max. min. final	NGTS
Part: 0	w_i = 27.8 %	σ_{ac}' = 135.0 135.0 **135.0**	
Test: 1	γ_i = 18.88 kN/m³	τ_c' = - - **-**	



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NGTS - Halden Silt Site

Direct Simple Shear Test

Document No. 20160154-04-R

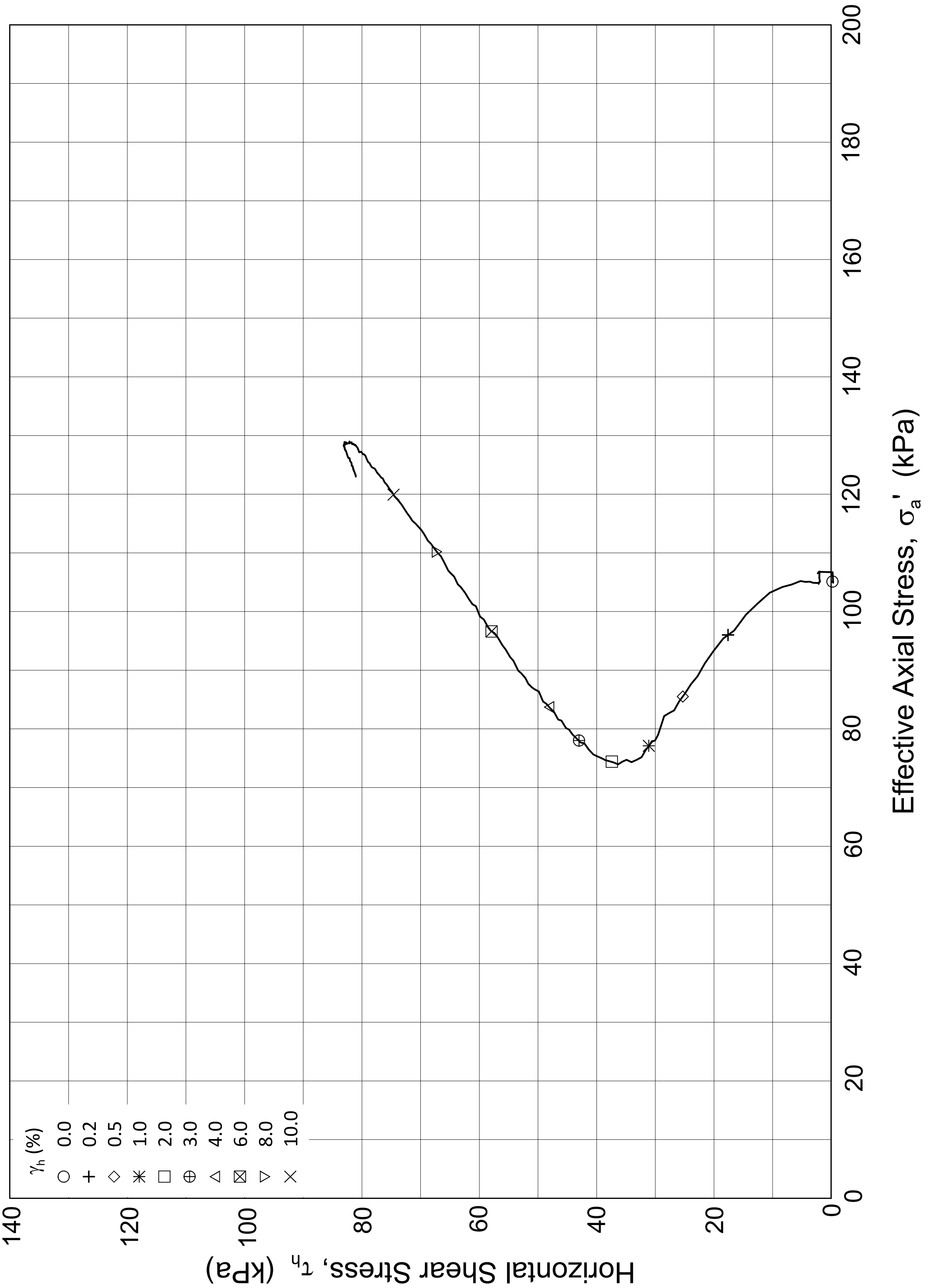
Figure No. 11

Date 2018-04-05

Drawn by / Checked JLA / MAS

Boring: HALB04	Depth = 7.03 m	Consolidation stresses	
Tube: 5	p_0' = 105.0 kPa	(kPa) max. min. final	
Part: 0	w_i = 28.6 %	σ_{ac}' = 105.1 105.1 **105.1**	
Test: 1	γ_i = 18.63 kN/m³	τ_c' = - - **-**	

NGTS



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NGTS - Halden Silt Site

Document No. 20160154-04-R

Direct Simple Shear Test

Figure No. 12

Boring: HALB04	Depth = 7.03 m	Consolidation stresses	Date 2018-04-05
Tube: 5	p_0' = 105.0 kPa	(kPa) max. min. final	Drawn by / Checked JLA / MAS
Part: 0	w_i = 28.6 %	σ_{ac}' = 105.1 105.1 **105.1**	
Test: 1	γ_i = 18.63 kN/m³	τ_c' = - - -	

NGTS

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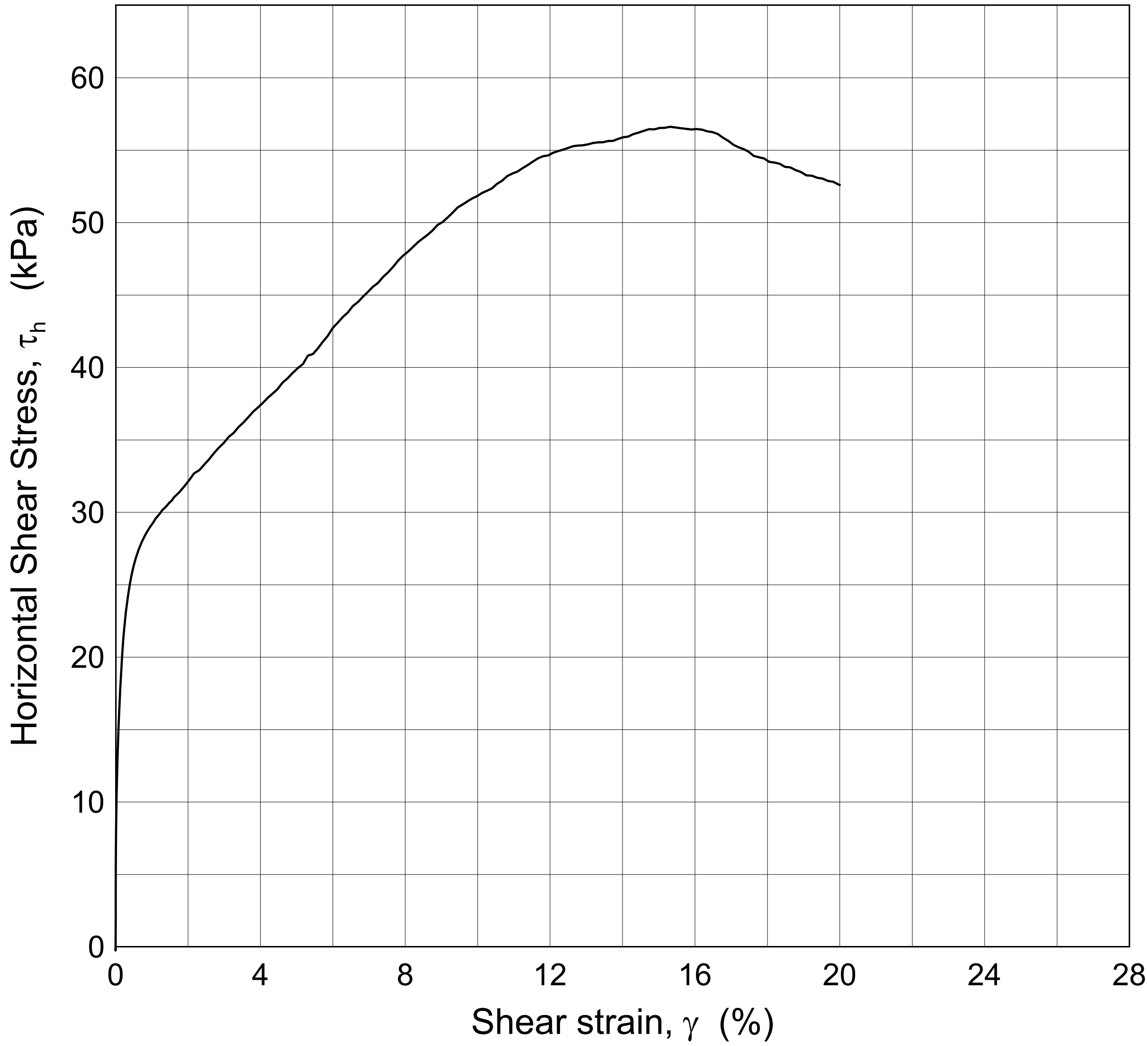

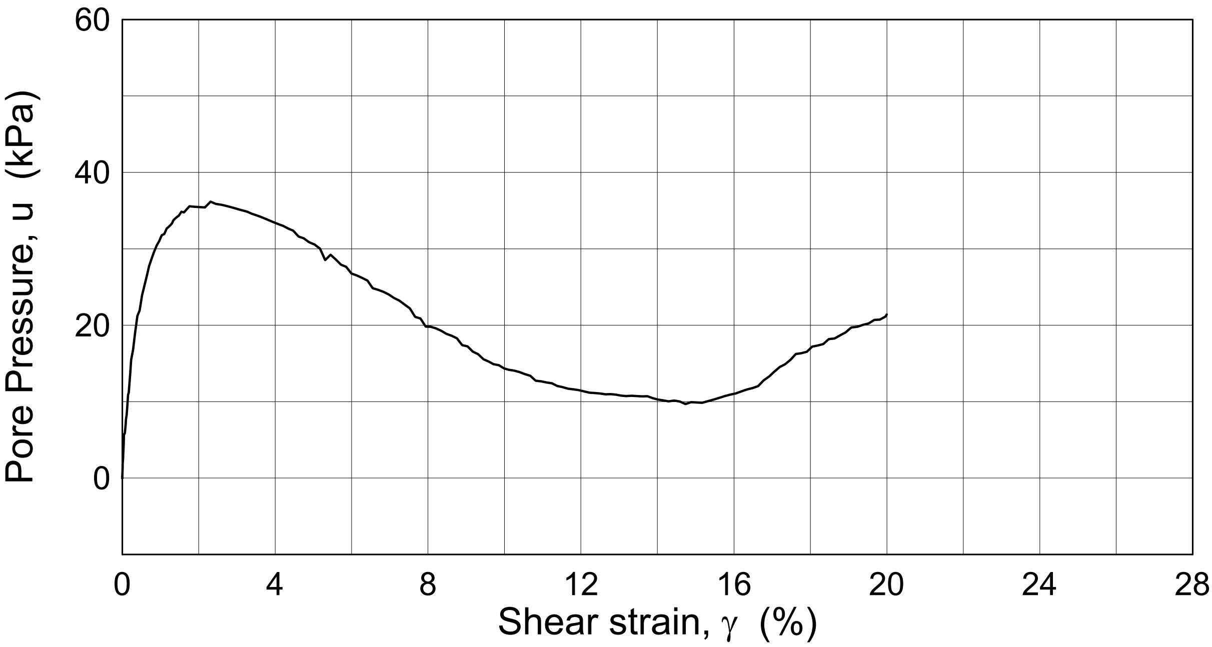

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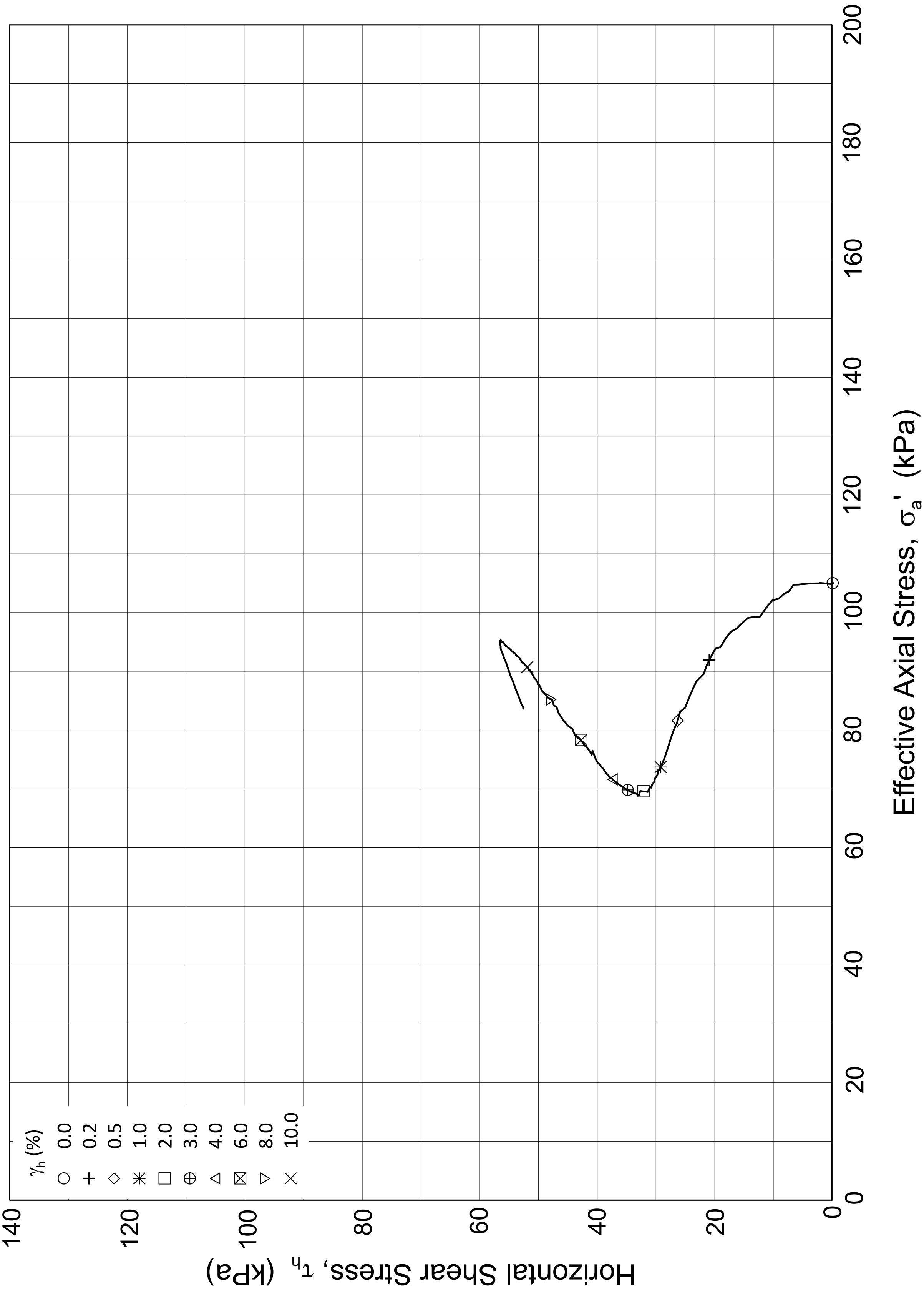
Date/Rev.: 2016-10-28/6

NGTS - Halden Silt Site			Document No. 20160154-04-R
Direct Simple Shear Test			Figure No. 13
Boring: HALB04	Depth = 7.03 m	Consolidation stresses	Date 2018-04-05; Drawn by / Checked JLA / MAS
Tube: 5	p_0' = 105.0 kPa	(kPa) max. min. final	NGTS
Part: 0	w_i = 28.6 %	σ_{ac}' = 105.0 105.0 **105.0**	
Test: 2	γ_i = 18.80 kN/m³	τ_c' = - - **-**	



Date/Rev.: 2016-10-28/6

NGTS - Halden Silt Site

Direct Simple Shear Test

Boring:	HALB04	Depth	=	7.03	m	Consolidation stresses			
Tube:	5	p_0'	=	105.0	kPa	(kPa)	max.	min.	final
Part:	0	w_i	=	28.6	%	σ_{ac}' =	105.0	105.0	**105.0**
Test:	2	γ_i	=	18.80	kN/m³	τ_c' =	-	-	**-**

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20160154-04-R

Figure No.
14

Date	Drawn by / Checked
2018-04-05	JLA / MAS

NGTS

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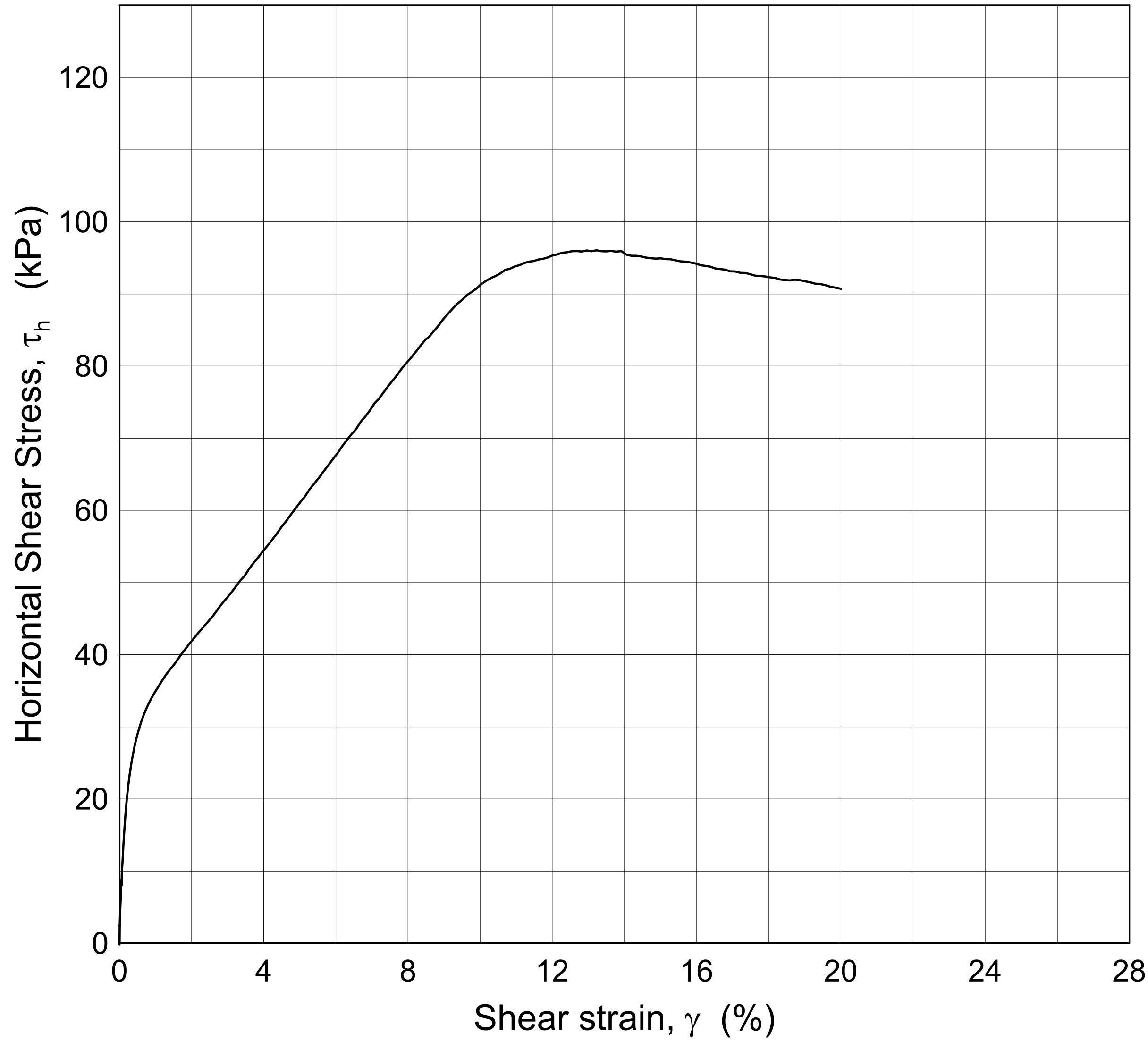

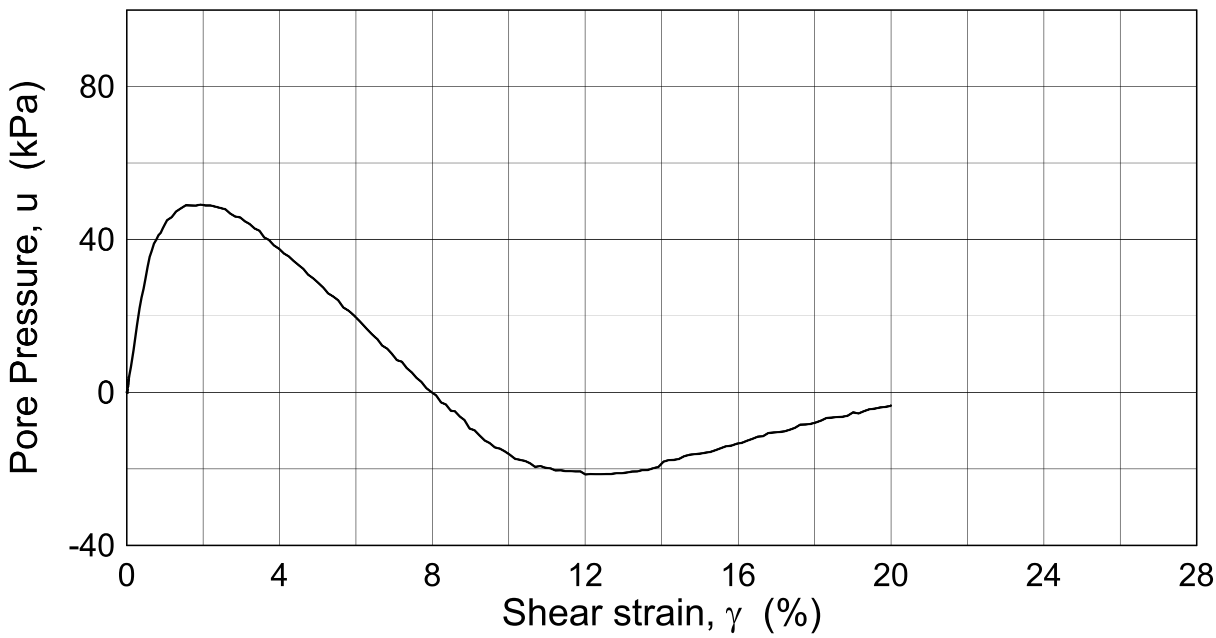

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Direct Simple Shear Test

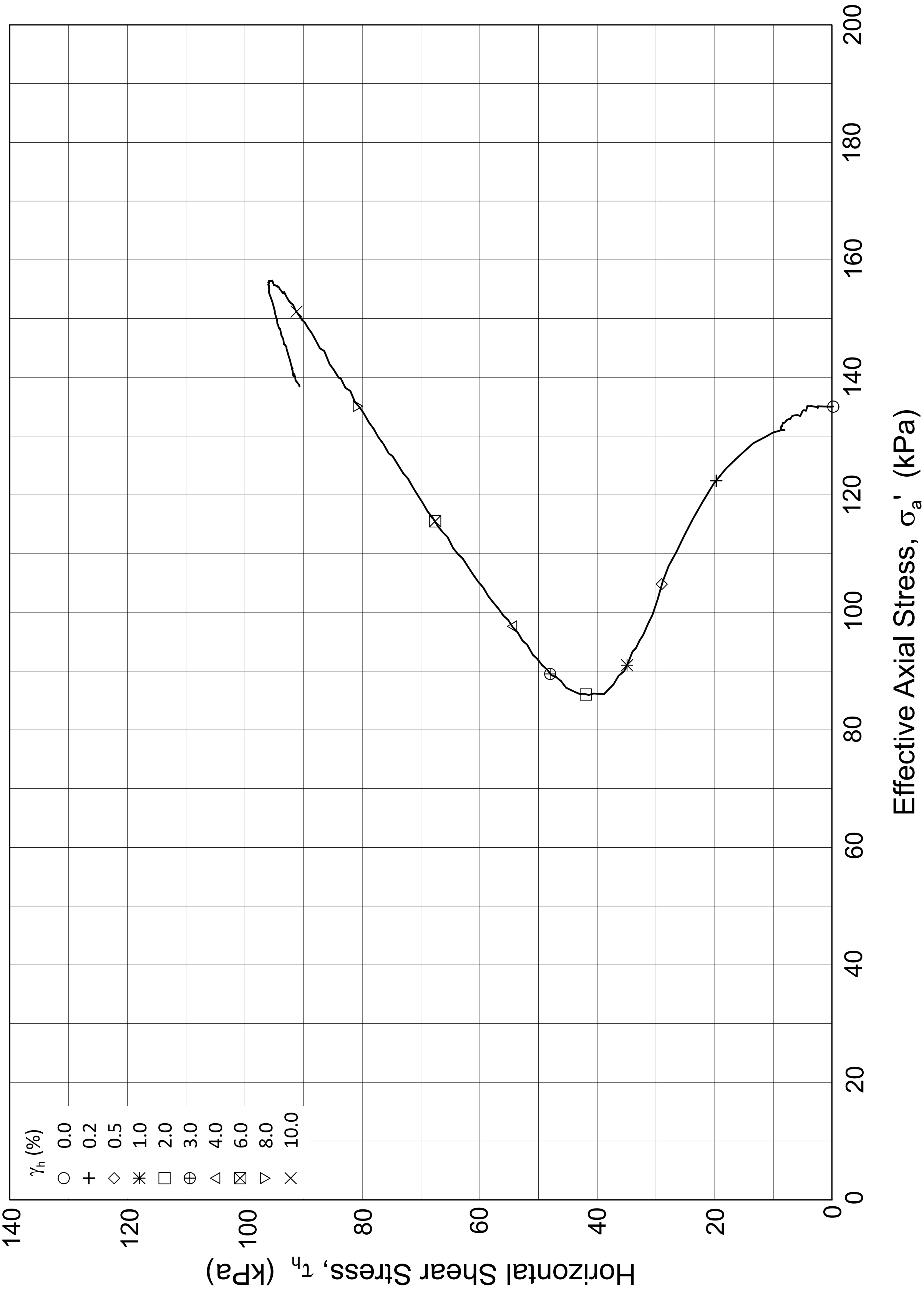
Figure No. 15

Boring: HALB04	Depth = 10.07 m	Consolidation stresses
Tube: 8	p_0' = 135.0 kPa	(kPa) max. min. final
Part: 0	w_i = 25.7 %	σ_{ac}' = 135.0 135.0 **135.0**
Test: 1	γ_i = 19.14 kN/m³	τ_c' = - - **-**

Date 2018-04-05

Drawn by / Checked JLA / MAS

NGTS



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NGTS - Halden Silt Site

Direct Simple Shear Test

Document No. 20160154-04-R

Figure No. 16

Date 2018-04-05

Drawn by / Checked JLA / MAS

Boring:	HALB04	Depth	= 10.07	m	Consolidation stresses			
Tube:	8	p_0'	= 135.0	kPa	(kPa)	max.	min.	final
Part:	0	w_i	= 25.7	%	σ_{ac}' =	135.0	135.0	**135.0**
Test:	1	γ_i	= 19.14	kN/m³	τ_c' =	-	-	**-**

NGTS

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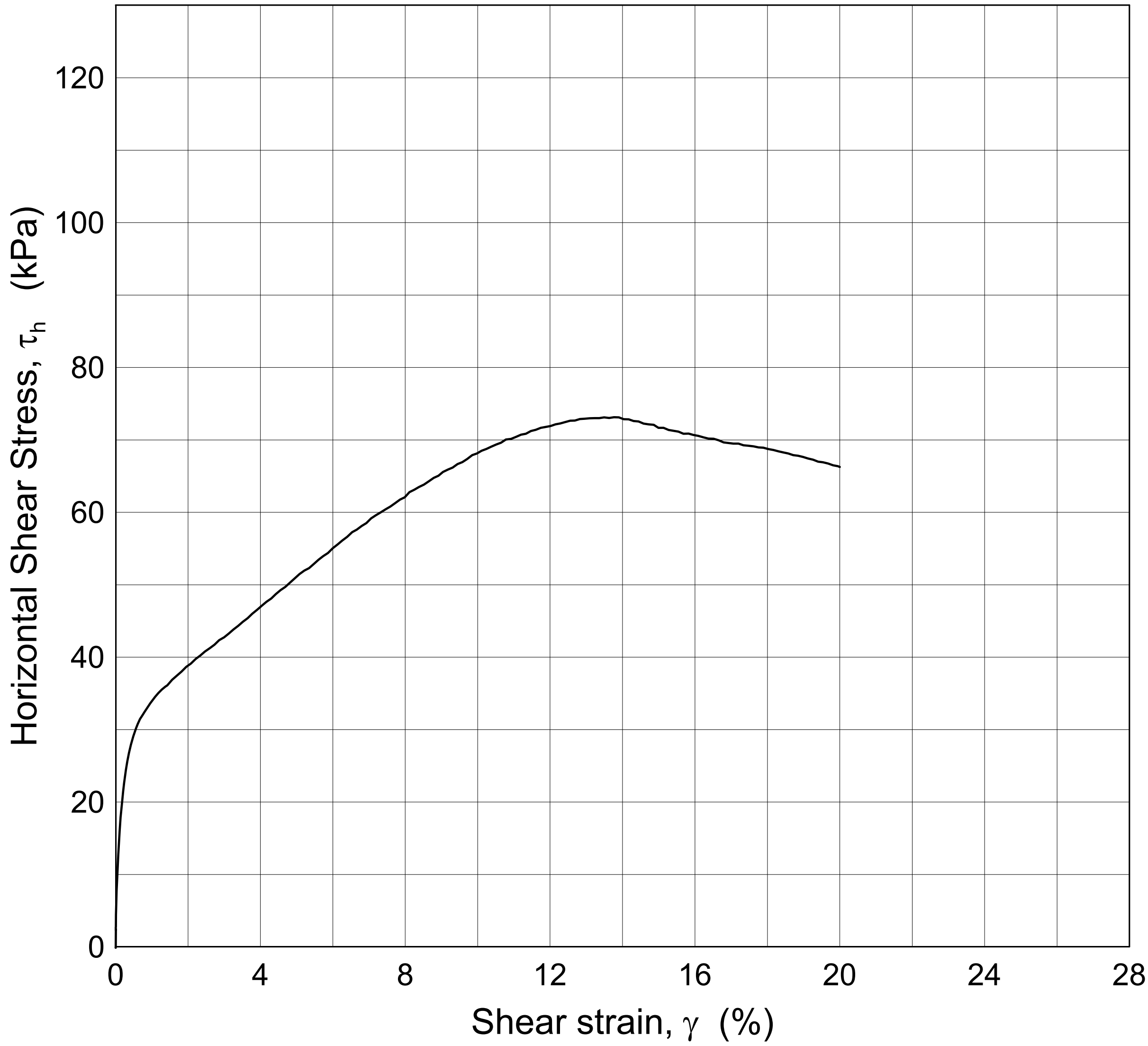

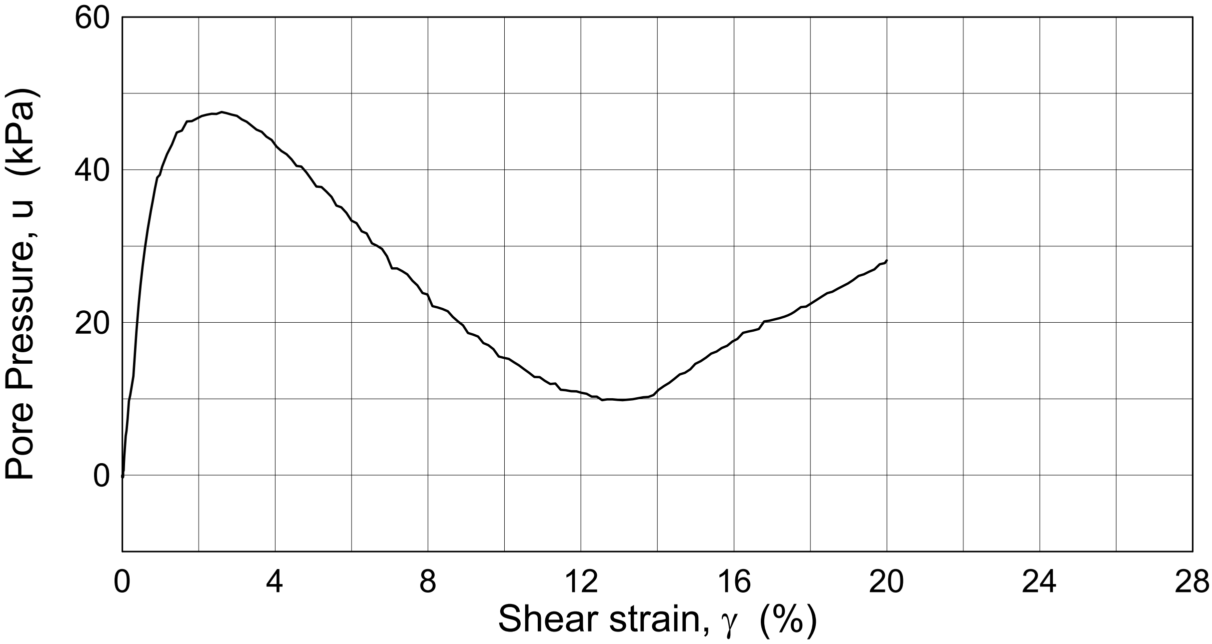

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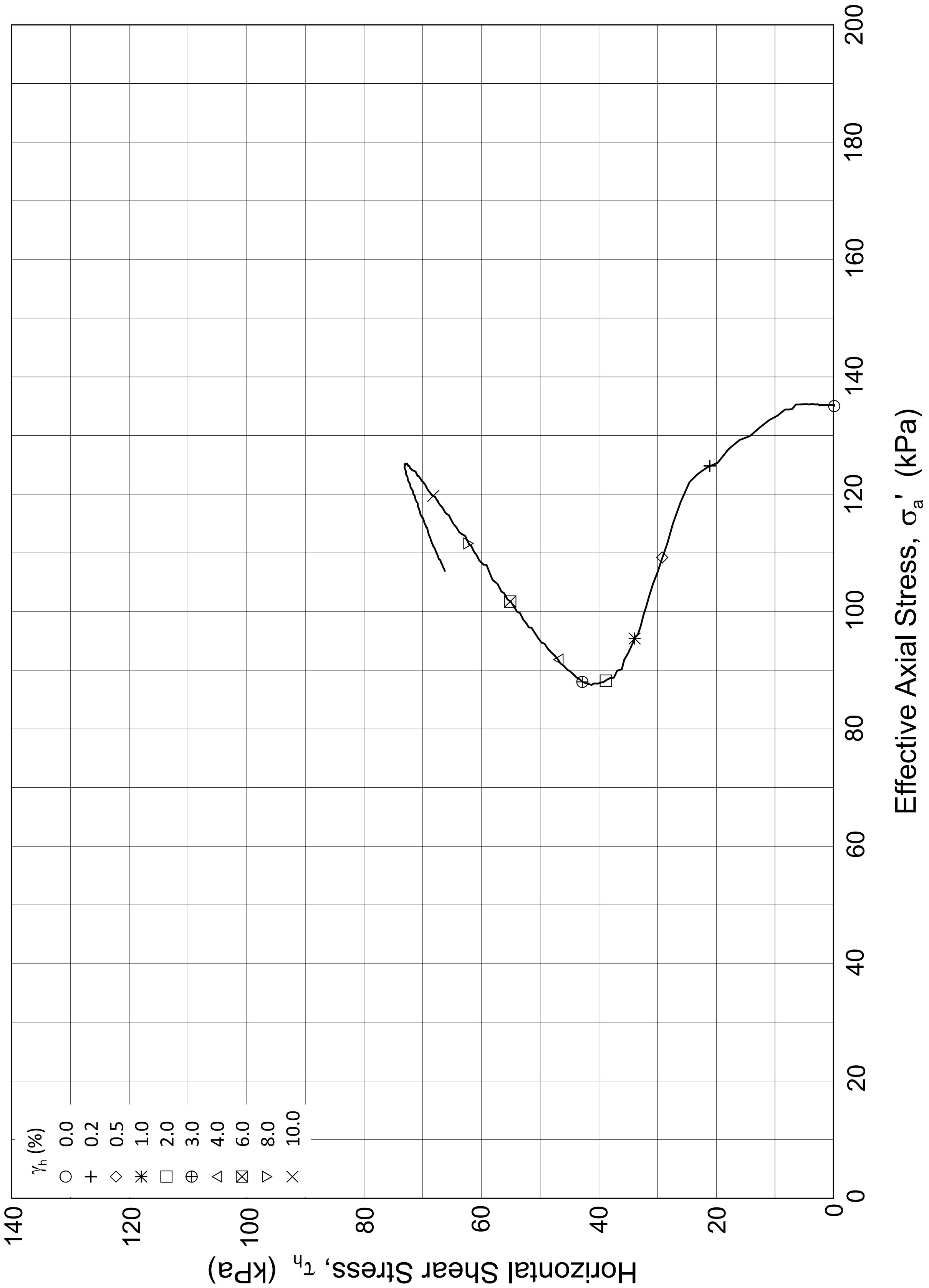
NGTS - Halden Silt Site			Document No. 20160154
Direct Simple Shear Test Gmax			Figure No. 17
Boring: BH15	Depth = 10.07 m	Consolidation stresses	Date 2018-04-05 / Drawn by / Checked JLA / MAS
Tube: 8	p_0' = 135.0 kPa	(kPa) max. min. final	NGTS
Part: 0	w_i = 24.6 %	σ_{ac}' = 135.0 135.0 **135.0**	
Test: 2	γ_i = 19.10 kN/m³	τ_c' = - - **-**	



Date/Rev.: 2016-10-28/6

NGTS - Halden Silt Site			Document No. 20160154
Direct Simple Shear Test Gmax			Figure No. 18
Boring: BH15	Depth = 10.07 m	Consolidation stresses	Date 2018-04-05 / Drawn by / Checked JLA / MAS
Tube: 8	p_0' = 135.0 kPa	(kPa) max. min. final	NGTS
Part: 0	w_i = 24.6 %	σ_{ac}' = 135.0 135.0 **135.0**	
Test: 2	γ_i = 19.10 kN/m³	τ_c' = - - **-**	

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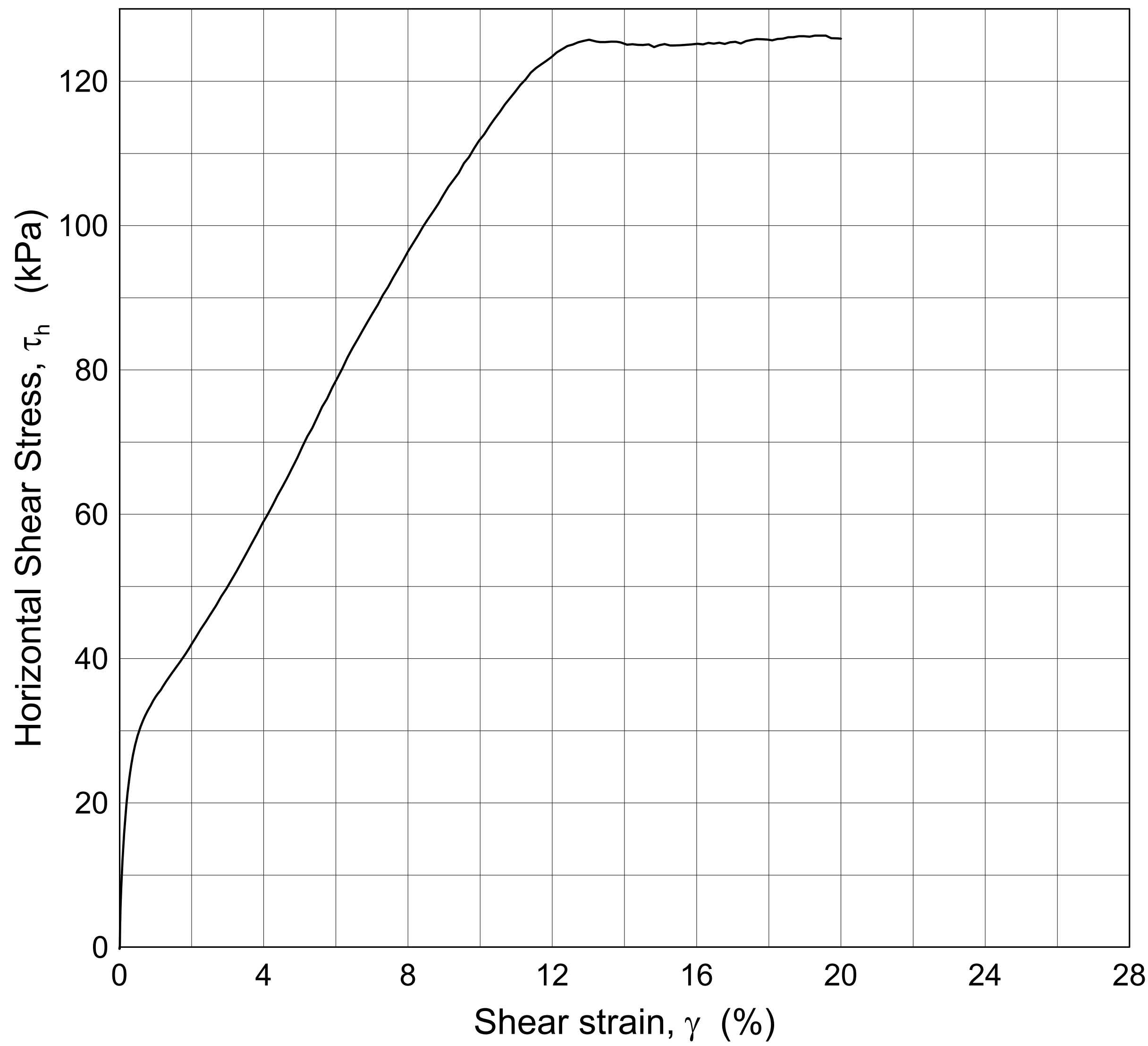

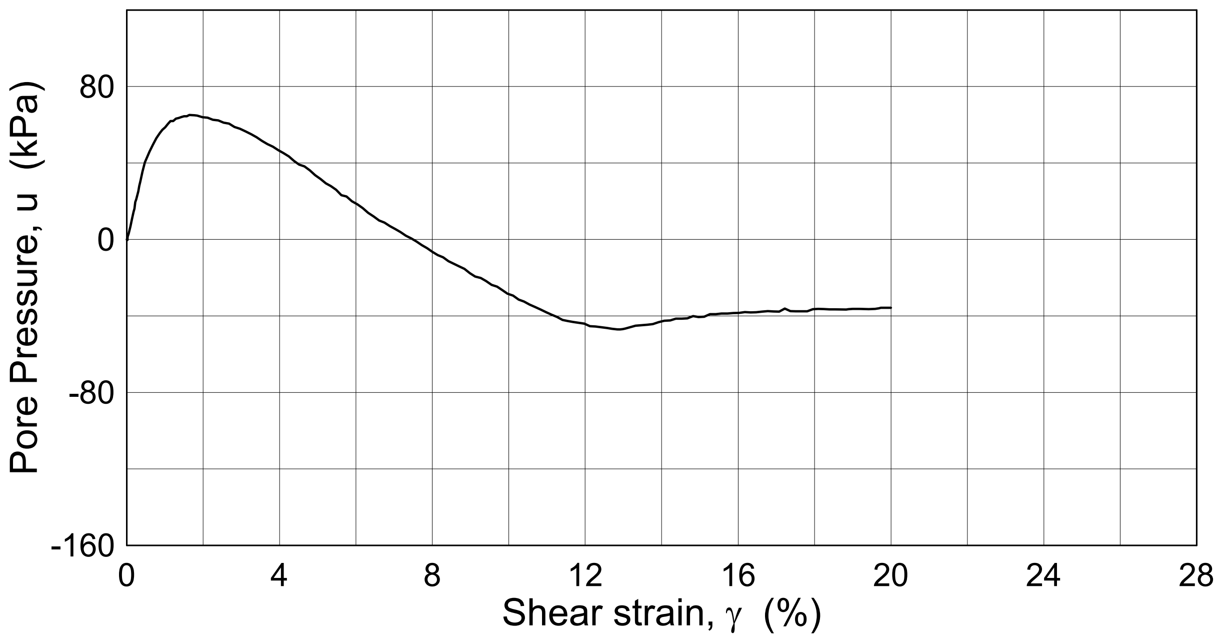

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Direct Simple Shear Test

Figure No. 19

Date 2018-04-05

Drawn by / Checked JLA/ MAS

Boring: BH15	Depth = 14.48 m	Consolidation stresses	
Tube: 13	p_0' = 158.0 kPa	(kPa) max. min. final	
Part: 0	w_i = 20.6 %	σ_{ac}' = 158.1 158.1 **158.1**	
Test: 1	γ_i = 20.26 kN/m³	τ_c' = - - **-**	

NGTS

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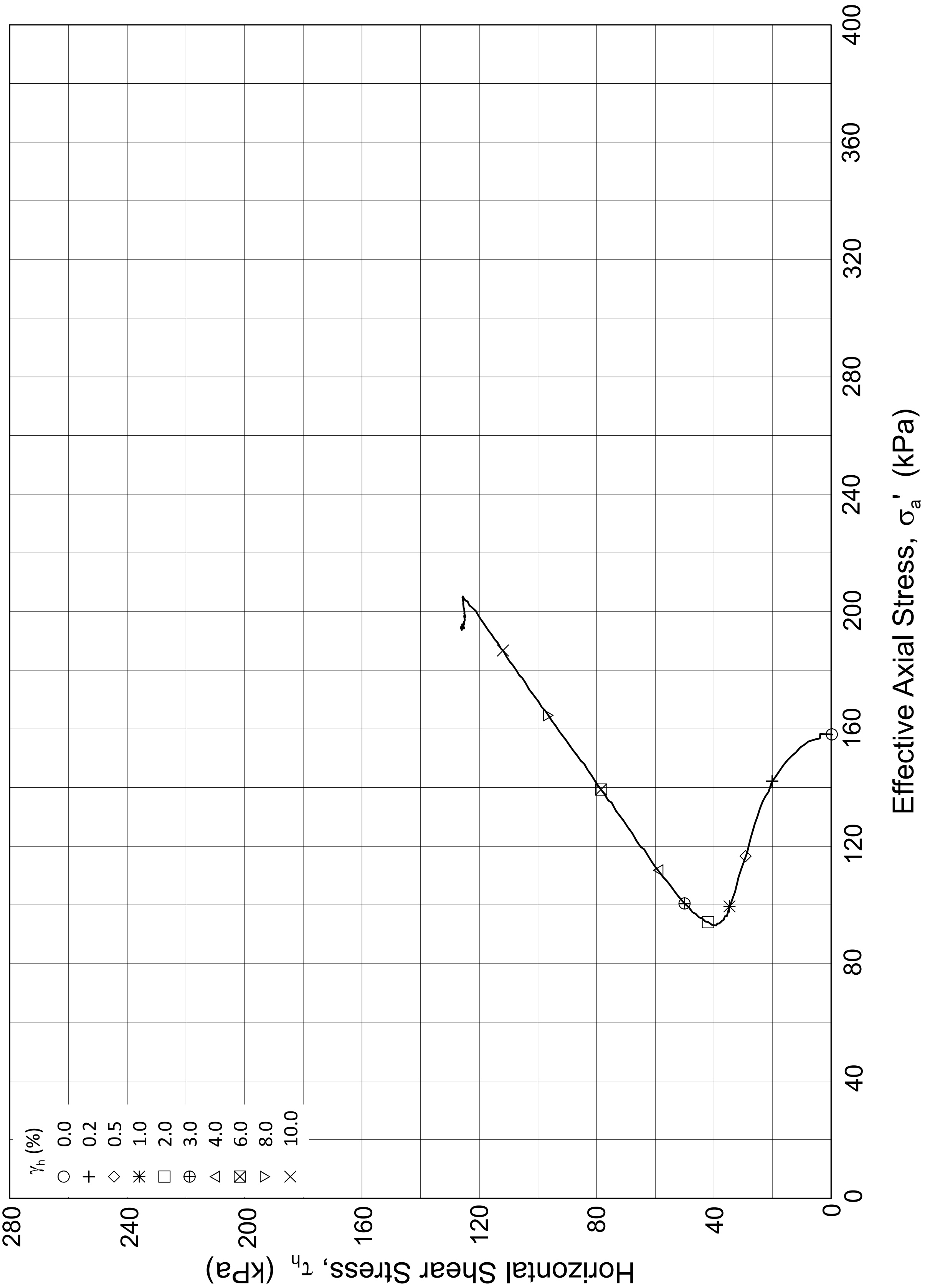

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NGTS - Halden Silt Site

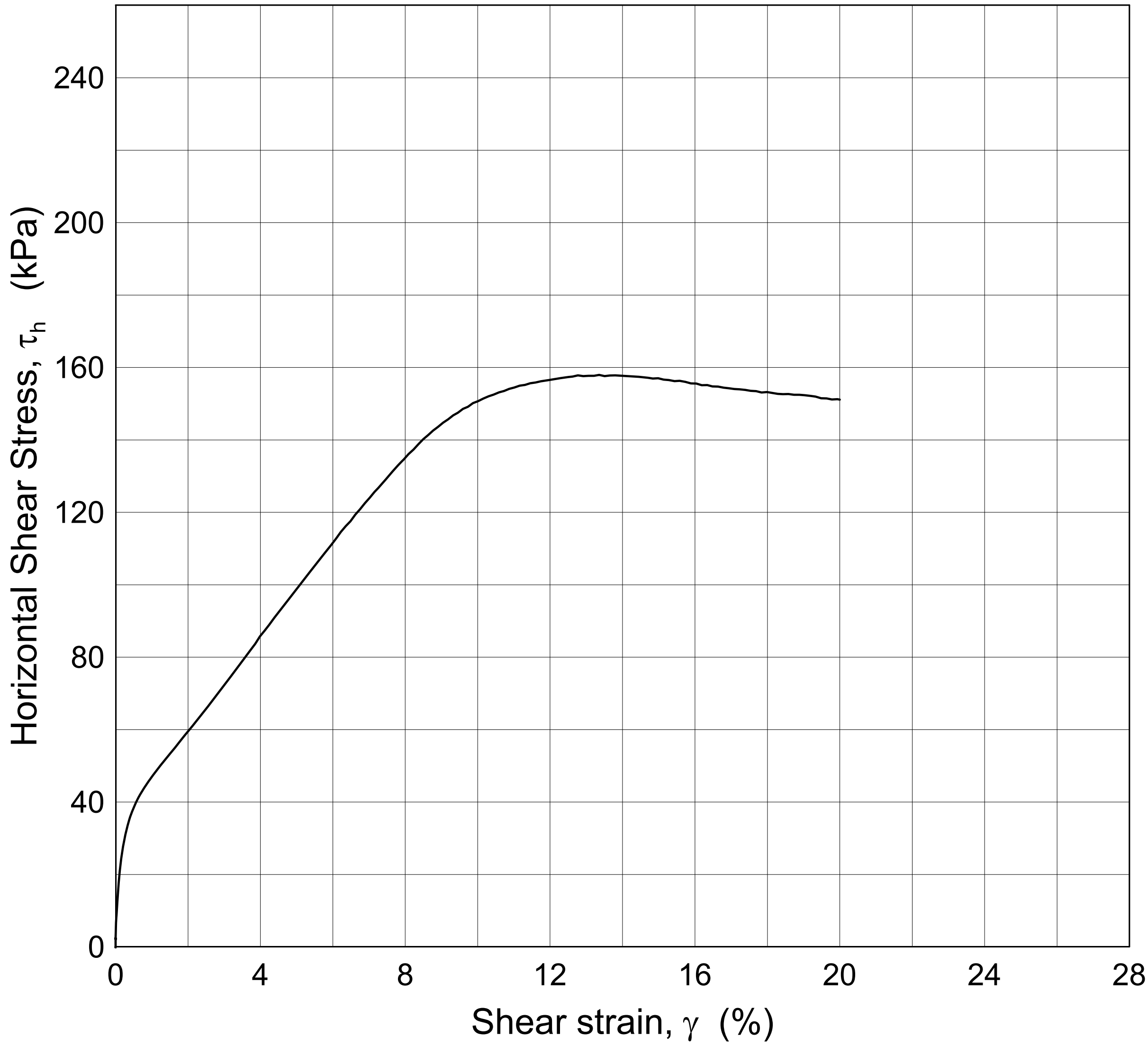
Document No. 20160154

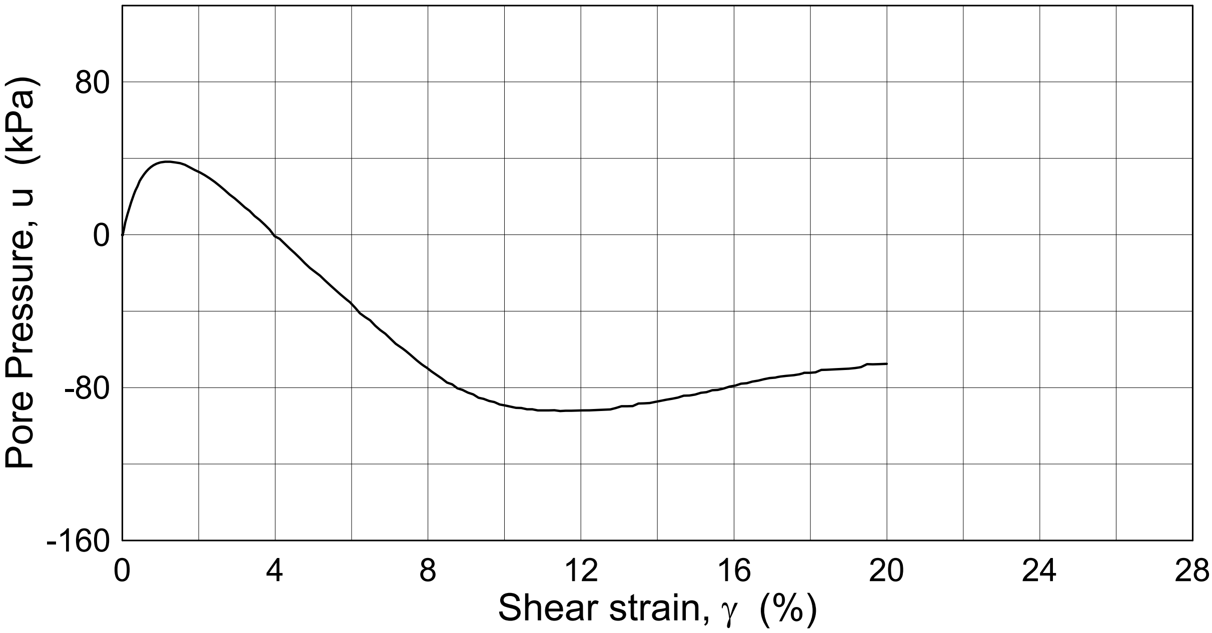
Direct Simple Shear Test

Figure No. 20

Boring:	BH15	Depth	=	14.48	m	Consolidation stresses				Date	Drawn by / Checked
Tube:	13	p_0'	=	158.0	kPa	(kPa)	max.	min.	final	2018-04-05	JLA/ MAS
Part:	0	w_i	=	20.6	%	σ_{ac}' =	158.1	158.1	**158.1**		
Test:	1	γ_i	=	20.26	kN/m^3	τ_c' =	-	-	-		

NGTS





Date/Rev.: 2016-10-28/6

NGTS - Halden Silt Site

Document No. 20160154

Direct Simple Shear Test

Figure No. 21

Boring: BH15	Depth = 14.48 m	Consolidation stresses				Date 2018-04-05	Drawn by / Checked JLA / MAS
Tube: 13	p_0' = 158.0 kPa	(kPa)	max.	min.	final		
Part: 0	w_i = 20.0 %	σ_{ac}' =	158.1	158.1	**158.1**		
Test: 2	γ_i = 20.32 kN/m^3	τ_c' =	-	-	**-**		

NGTS

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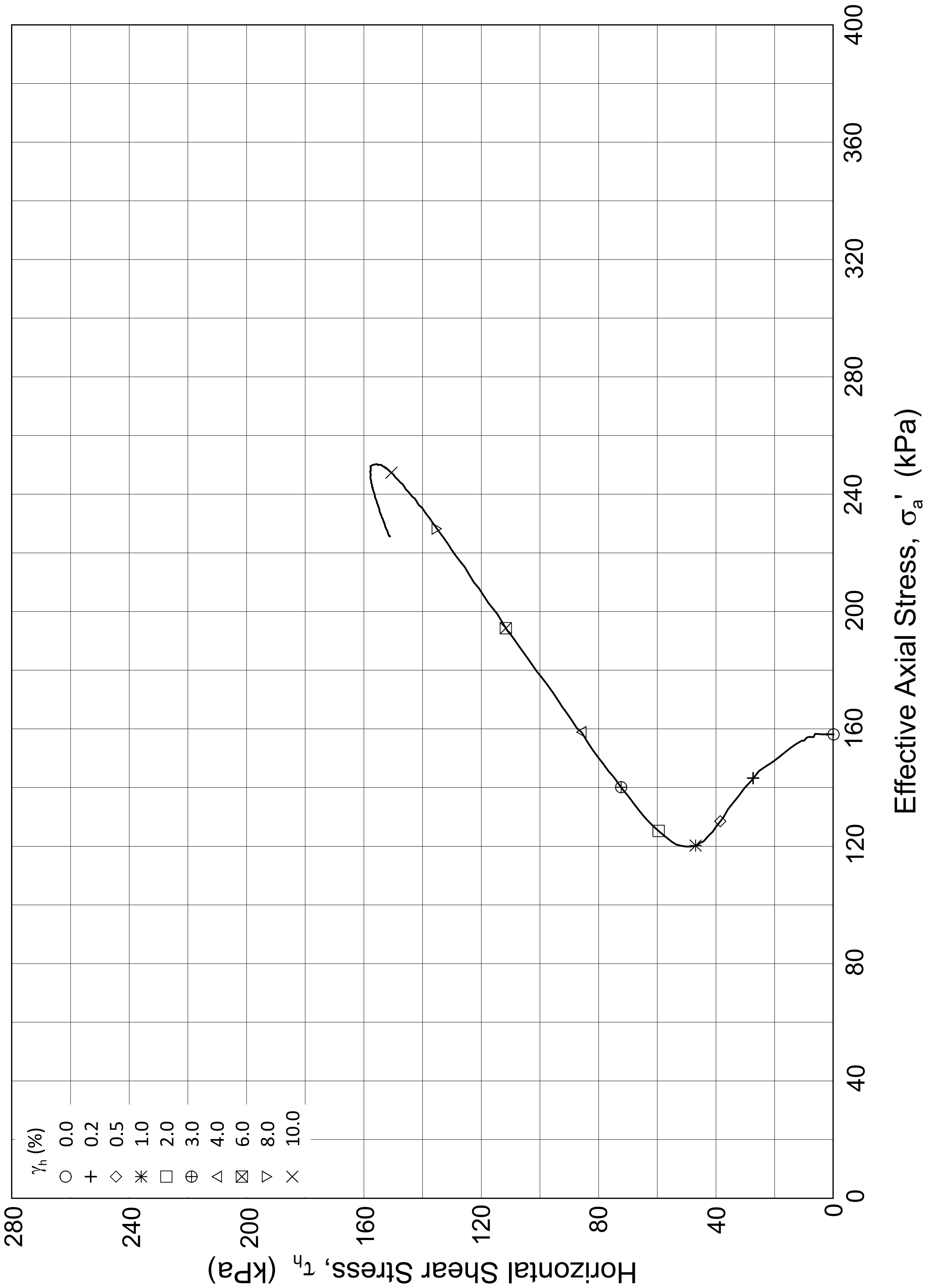

Date/Rev.: 2016-10-28/6

NGTS - Halden Silt Site			Document No. 20160154	
Direct Simple Shear Test			Figure No. 22	
Boring: BH15	Depth = 14.48 m	Consolidation stresses	Date 2018-04-05	Drawn by / Checked JLA / MAS
Tube: 13	p_0' = 158.0 kPa	(kPa) max. min. final	NGTS	
Part: 0	w_i = 20.0 %	σ_{ac}' = 158.1 158.1 **158.1**		
Test: 2	γ_i = 20.32 kN/m³	τ_c' = - - **-**		

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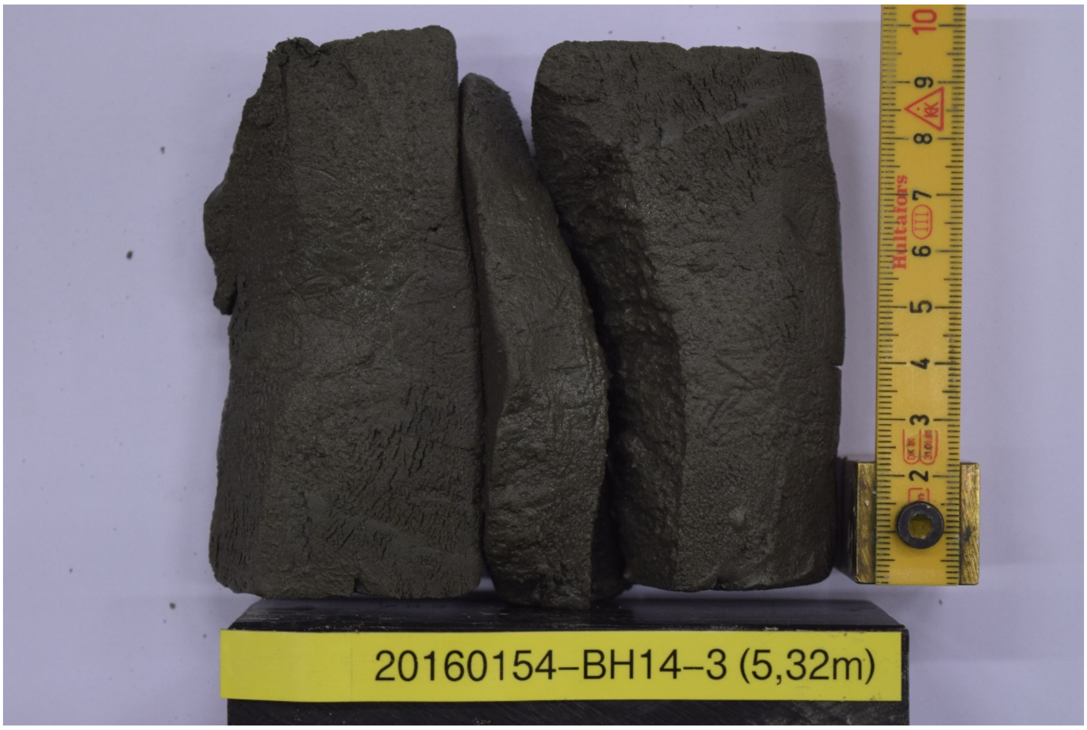
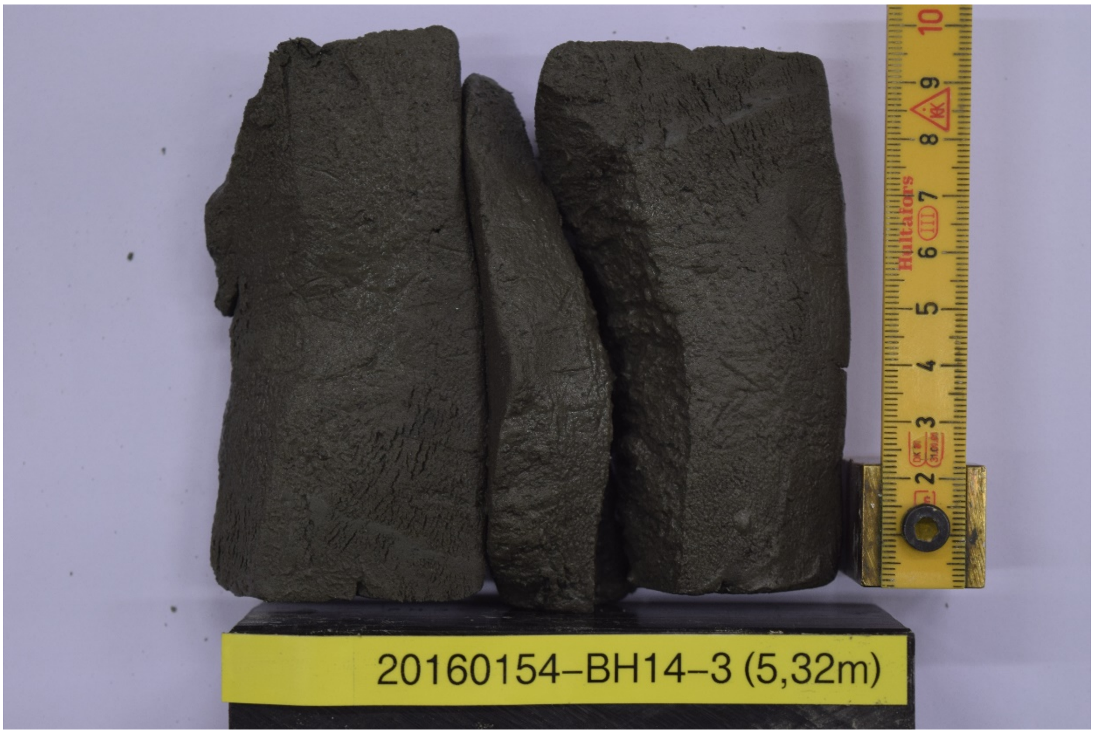
Appendix P

TRIAXIAL TEST RESULTS

Test:	HALB01-12-B-4
	
	

Test:	HALB03-14-B-3





Test:	HALB04-3-A-1

Test:	HALB04-3-A-1


x-rite
colorchecker
NGI 2018-03-16 14:14
HALB04 6 CAD 1

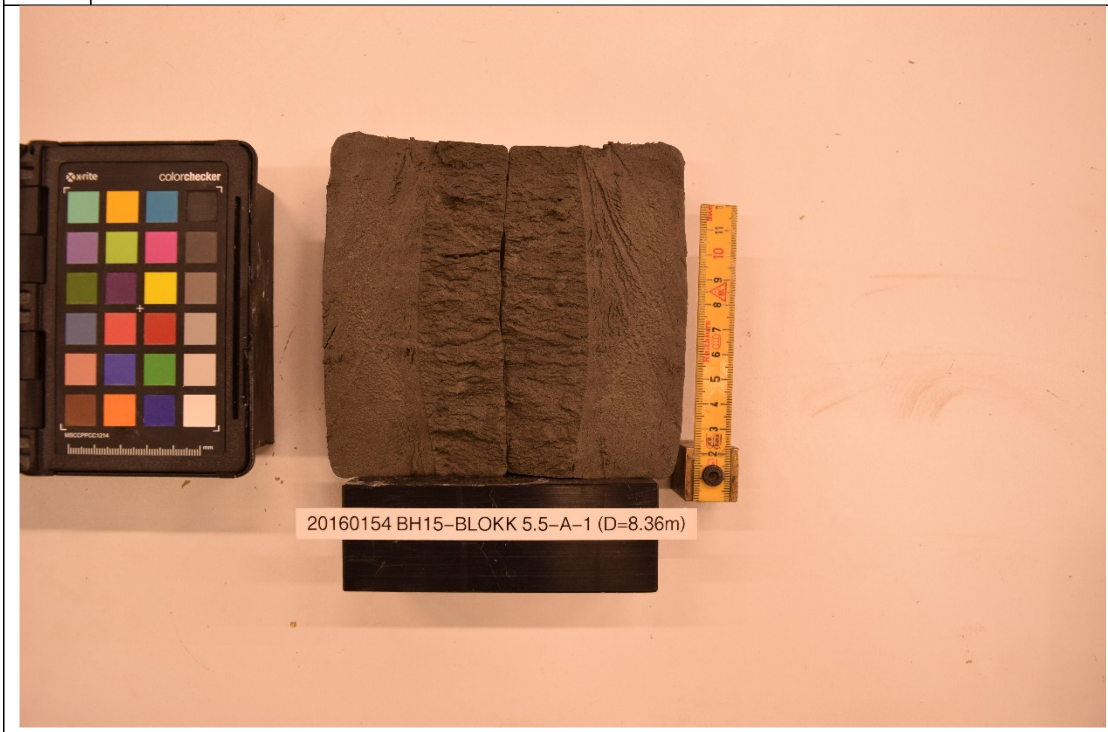
Test:	HALB04-6-A-1

Test:	HALB04-6-A-1

Test:	HALB04-6-A-2

Test:	HALB04-6-A-2

Test:	HALB04-5.5-A-1



Test:	HALB04-5.5-A-1

Test:	HALB04-13-A-1

Test:	HALB05-1-B-1

Test:	HALB06-3-A-1

Test:	HALB06-3-B-1

Test:	HALB06-3-C-1

Test:	HALB06-4-A-1

Test:	HALB06-6-B-1


x·rite
colorchecker
NGI 2018-07-04 16:36
20160154
HALB06 6 B 1-SPLIT


x·rite
colorchecker
MSCCPPCC1214
NGI 2018-07-04 16:35
20160154
HALB06 6 B 1

Table 1: Summary of triaxial tests: NGTS - Halden Research Site

Boring No.	Tube part test	Depth m	INDEX PROPERTIES: Water content w_i %	Water content w_c %	I_p %	Clay cont. %	Fines cont. %	Unit weight$_i$ kN/m^3	Type of test 1)	CONSOLIDATION: Estim. p_o' kPa	σ_a' max kPa	σ_r' max kPa	σ_a' final kPa	σ_r' final kPa	ε_{vol} %	ε_{ac} %	B %	UNDRAINED. STATIC TESTING: s_u 2) kPa	U_f kPa	ε_f %	s_u/σ'_{ac} -	DRAINED STATIC TESTING: τ_f kPa	ε_f %	ϕ' (a = 0) deg.	τ_f/σ'_{ac} -	Resistivity (100 Hz) ohm*m	Sample quality 4) -	Permeability k 5) m/s	Rate of strain %/hr	COMMENTS	FIGURE REFERENCE
HALB01	9-A-1	5,30	29,6	29,0	10,3	7,5	75,0	18,96	CAUC	77	-	-	76,9	38,5	0,86	0,71	99,2	32,0	10,5	1,2	0,42					-	N/A	-	1,4	S shaped, dilation, s_u at u_{max}	Fig. 1 - Fig. 2
HALB01	9-A-2	5,30	30,5	30,4	10,3	7,5	75,0	18,95	CAUCrec	77	-	-	77,0	38,5	0,16	0,11	98,8	41,1	9,1	0,4	0,53					-	N/A	-	1,4	Contraction, s_u at peak shear stress. Reconstituted sample	Fig. 3 - Fig. 4
HALB01	11-C-1	7,60	23,2	-	9,1	8,4	86,0	18,99	CAUC	88	-	-	89,0	44,9	0,19	0,50	92,5	42,2	9,5	0,5	0,47					-	N/A	-	-	Tested at UMass Amherst, Dried out from storage	Fig. 5 - Fig. 6
HALB01	12-B-4	8,60	28,6	28,0	8,2	7,2	83,0	19,07	CAUC	105	-	-	115,0	57,5	0,84	0,81	99,2	49,0	14,9	0,8	0,43					-	N/A	9,28E-09	1,4	S shaped, dilation, s_u at u_{max}	Fig. 7 - Fig. 8
HALB01	14-B-1	12,60	22,6	-	7,3	8,5	71,0	19,55	CAUC	137	-	-	139,7	71,8	0,40	0,75	95,5	62,0	14,8	0,6	0,44					-	N/A	-	-	Tested at UMass Amherst, (Dried out from storage?)	Fig. 9 - Fig. 10
HALB03	3-A-1	5,32	30,0	29,6	-	7,5	57,0	19,41	CAUC	72	-	-	72,3	36,3	0,56	0,77	98,9	31,8	8,3	0,7	0,44					-	N/A	8,36E-09	1,9	S shaped, dilation, s_u at u_{max}.	Fig. 11 - Fig. 12
HALB03	6-A-1	8,46	28,3	27,4	9,0	9,5	99,0	18,79	CAUC	105	-	-	104,9	53,0	1,33	1,02	99,4	44,7	15,2	1,0	0,43					-	N/A	8,35E-09	1,4	S shaped, dilation, s_u at u_{max}	Fig. 13 - Fig. 14
HALB06	3-A-1	8,32	30,7	29,7	9,0	9,5	99,0	19,65	CAUC	91	-	-	90,90	45,50	1,51	0,89	99,3	40,3	12,7	1,1	0,44					-	N/A	-	1,5	S shaped, dilation, s_u at u_{max}.	Fig. 15 - Fig. 16
HALB06	3-B-1	8,47	29,5	28,3	9,0	9,5	99,0	19,67	CADC	91	-	-	91,00	45,50	1,75	0,91	98,5					66,2	6,1	36,7	0,73	-	N/A	-	0,5		Fig. 17 - Fig. 18
HALB03	12-A-1	14,42	23,4	22,1	6,5	8,4	73,0	20,01	CAUC	159	-	-	160,4	79,4	2,25	0,85	99,0	71,6	17,9	0,8	0,45					-	N/A	6,50E-09	1,4	Greater tendancy for inmediate dilation, s_u at u_{max}	Fig. 19 - Fig. 20
HALB04	3-A-1	5,28	31,9	30,8	6,7	7,5	75,0	18,93	CAUC	77	-	-	76,9	38,5	1,63	0,90	99,4	33,9	12,0	1,0	0,44					-	N/A	1,28E-08	1,4	S shaped, dilation, s_u at u_{max}	Fig. 21 - Fig. 22
HALB04	6-A-1	8,02	27,1	25,4	10,0	8,0	82,0	19,18	CADC	91	-	-	90,8	45,5	2,64	0,57	95,1					80,1	5,91	39,5	0,88	16,6	N/A	1,17E-08	0,5	Resistivity+Gmax	Fig. 23 - Fig. 25
HALB04	6-A-2	8,02	28,0	27,6	10,0	8,0	82,0	19,33	CK_0UC	91			90,8	51,0	0,70	0,71	98,8	40,5	20,6	0,8	0,45					-	N/A	-	1,4	K_0 = 0.56, s_u at umax	Fig. 26 - Fig. 27
HALB06	3-C-1	8,65	28,7	28,0	9,0	9,5	99,0	19,10	CAUE	91			91,0	45,5	1,15	0,71	96,8	-11,7	7,2	-1,26	-0,13					25,2	N/A	5,24E-09	-1,4	Resistivity+Gmax. S shaped, dilation, s_u at umax	Fig. 28 - Fig. 29.1
HALB04	5.5-A-1	8,36	30,1	29,2	10,0	8,0	82,0	19,15	CAUC	105	-	-	105,0	52,4	1,30	0,81	99,2	45,2	13,8	1,1	0,43					-	N/A	1,11E-08	1,3	S shaped, dilation, s_u at u_{max}	Fig. 30 - Fig. 31
HALB04	12-A-1	12,58	26,6	25,9	6,5	8,0	81,0	19,12	CAUC	137	-	-	136,5	68,3	1,07	0,78	96,9	59,5	16,9	0,8	0,44					20,2	N/A	8,18E-09	1,4	Resistivity. S shaped, dilation, s_u at u_{max}	Fig. 32 - Fig. 34
HALB04	2-A-1	13,55	25,2	24,8	6,7	8,0	87,0	19,77	CAUC	148	-	-	147,3	73,8	0,64	0,93	98,0	64,7	17,9	0,8	0,44					-	N/A	8,15E-09	2,1	Mini Block sample. S shaped, dilation, s_u at u_{max}	Fig. 35 - Fig. 36
HALB04	13-A-1	14,60	23,2	21,7	5,0	7,0	81,0	20,08	CAUC	159	-	-	158,4	79,3	2,56	0,81	98,8	71,6	16,9	0,7	0,45					-	N/A	6,33E-09	1,4	S shaped, dilation, s_u at u_{max}	Fig. 37 - Fig. 38
HALB06	4-A-1	9,93	29,4	28,5	9,2	10,2	81,0	19,70	CAUC	107			107,0	53,5	1,42	0,97	98,9	44,0	16,6	1,0	0,41					-	N/A	-	1,5	S shaped, dilation, s_u at u_{max}	Fig. 39 - Fig. 40
HALB06	6-B-1	12,95	27,9	27,1	6,5	9,4	78,0	19,96	CADC	137	-	-	136,9	68,5	1,24	0,96	98,5					98,8	7,6	35,9	0,72	-	N/A	-	0,5		Fig. 41 - Fig. 42
HALB05	1-A-1	9,45	30,4	30,3	-	9,3	88,1	18,70	CAUC	107	-	-	106,4	53,4	0,23	0,63	97,6	46,9	11,0	0,8	0,44					23,7	N/A	1,31E-08	1,4	Resistivity. S shaped, dilation, s_u at u_{max}	Fig. 43 - Fig. 45
HALB05	1-B-1	9,60	30,2	26,7	-	9,3	88,1	19,25	CADC	107	-	-	106,7	53,4	5,21	0,93	99,2					80,0	7,6	36,8	0,75	-	N/A	-	0,5		Fig. 46 - Fig. 47
HALB05	2-A-1	12,50	30,3	28,6	6,5	8,0	81,0	19,56	CAUC	137	-	-	136,6	68,3	2,60	1,21	97,9	57,9	18,8	1,5	0,42					27,6	N/A	1,79E-08	1,5	Resistivity+Gmax+permeability. s_u at u_{max}	Fig. 48 - Fig. 50

CLIENT: NGI

PROJECT: NGTS
Halden

Document No.: 20160154-04-R
2018-09-12

LEGEND

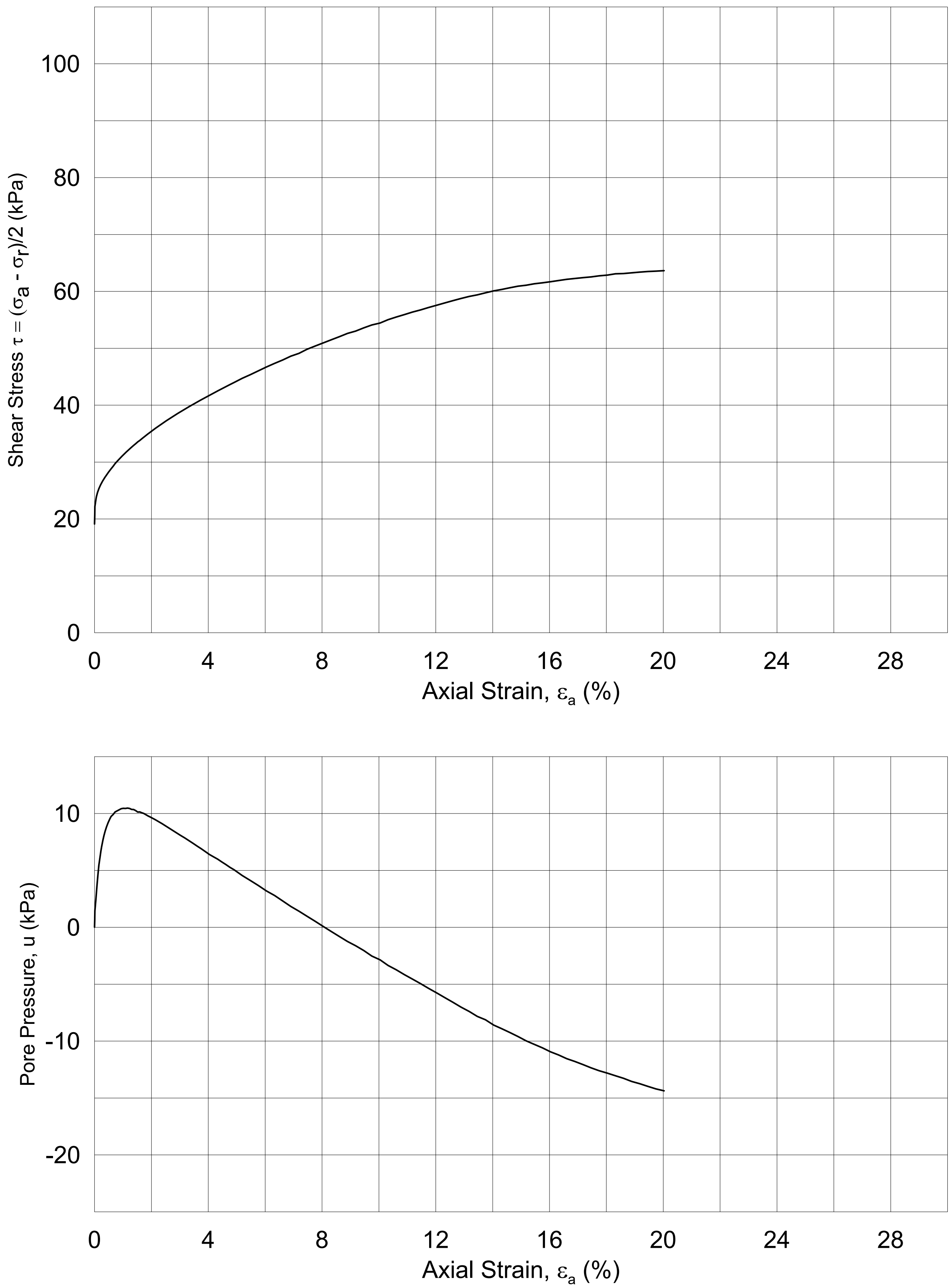
1) CAUC = Consolidated Anisotropic Undrained test in Compression
CAUE = Consolidated Anisotropic Undrained test in Extension
CAUcy = Consolidated Anisotropic Undrained cyclic test
CAUCrec= Reconstituted CAUC test
CADC = Consolidated Anisotropic Drained test in Compression

2) s_u at u_{max} if dilation or peak shear stress if contraction

3) $\Delta e/e_i$, where $\Delta e = \varepsilon_{vol}$ $(1+e_i)$ and e_i = 2.69 * w_i

4) New criteria to be determined later in the study

5) Constant head permeability test



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Document No. 20160154-04-R

Figure No. 01

Triaxial test: **CAUC**

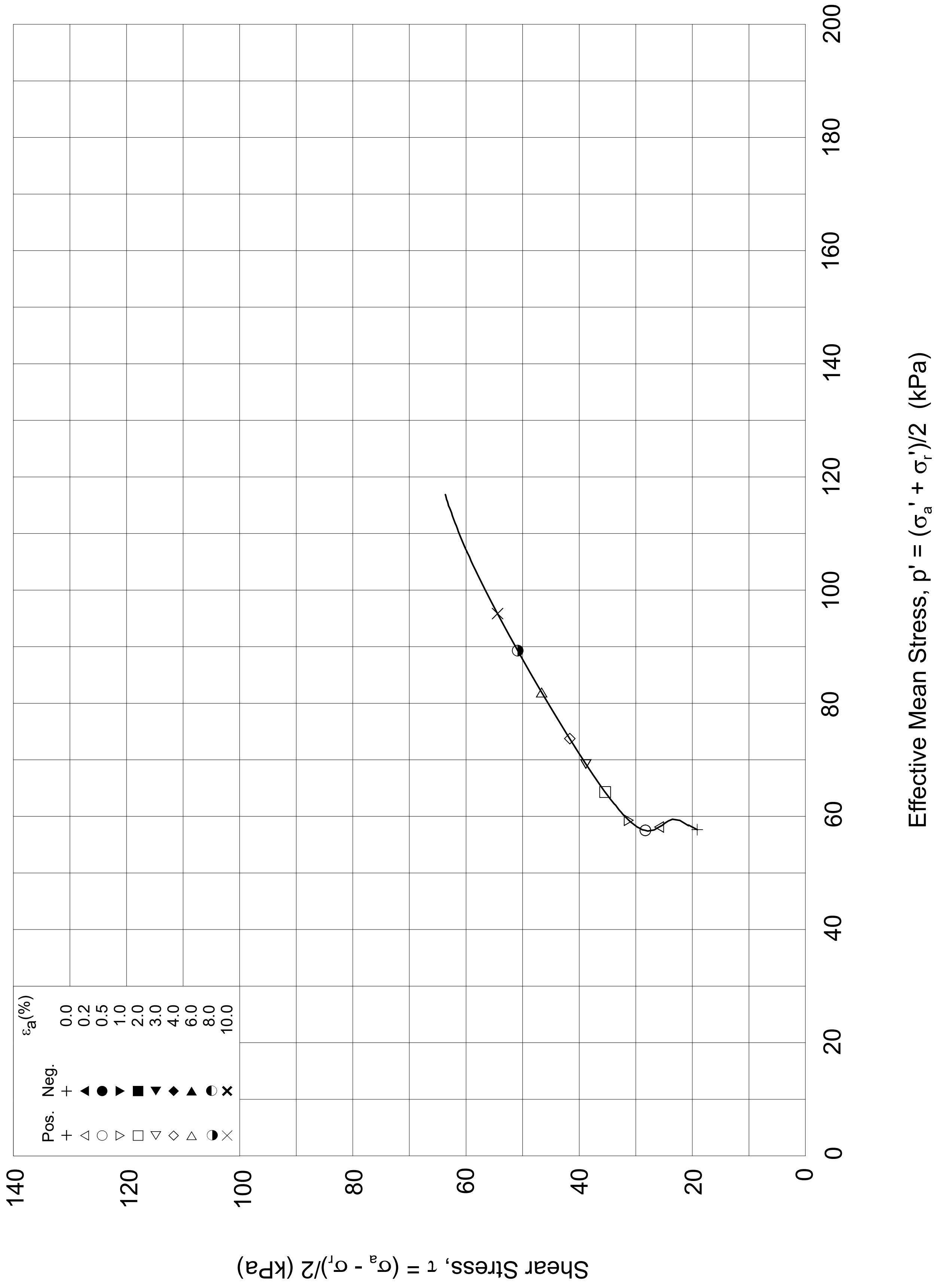
Boring:	**HALB01**	Depth =	**5.30**	m	Consolidation stresses				
Tube:	**9**	po' =	**77.0**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**29.6**	%	σ_{ac}' =	-	-	**76.9**	
Test:	**1**	w_c =	**29.0**	%	σ_{rc}' =	-	-	**38.5**	

Date 2018-03-22

Drawn by/checked MAS / GS

NGTS

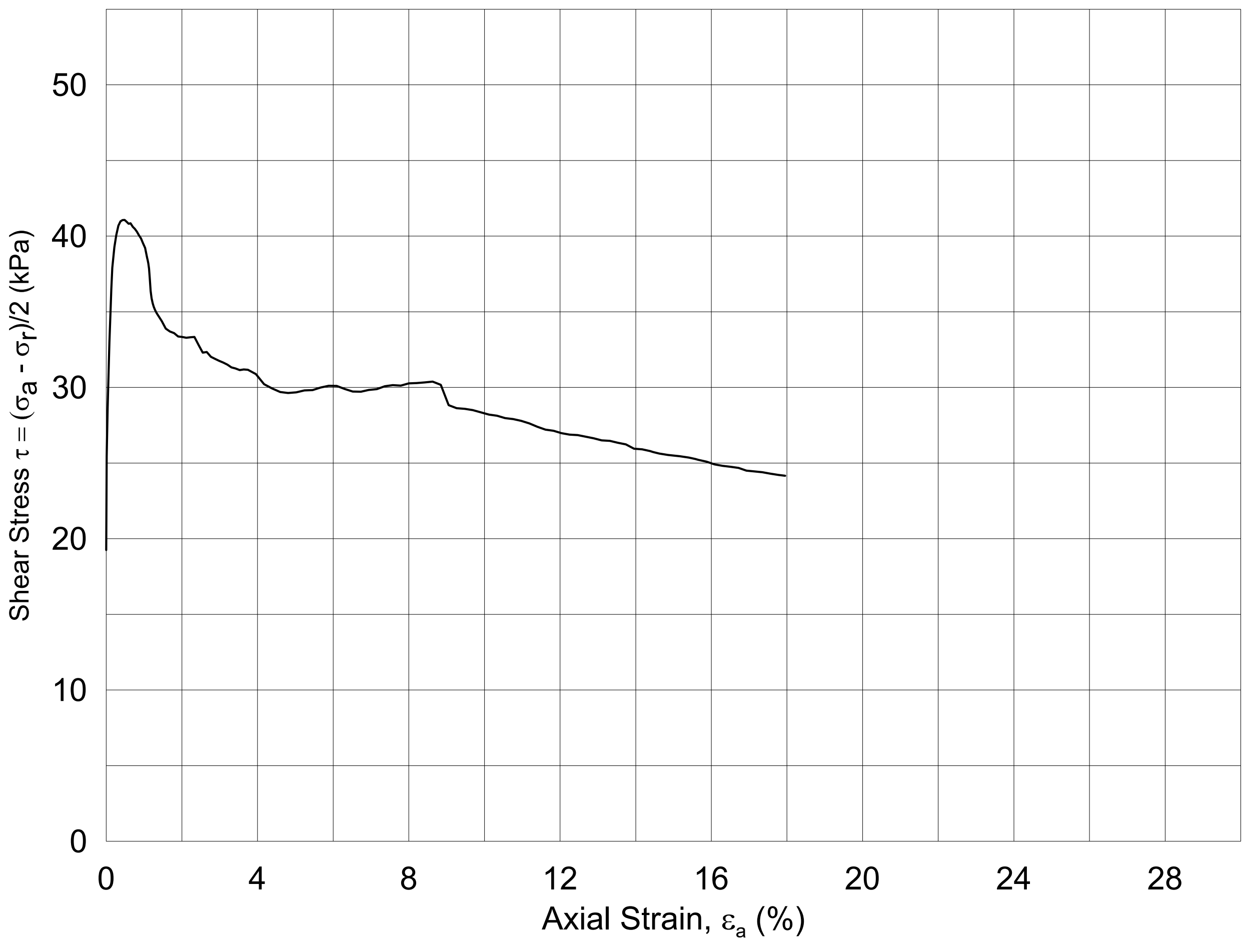
BH-SP8_6-9-A-1_Plot1.grf

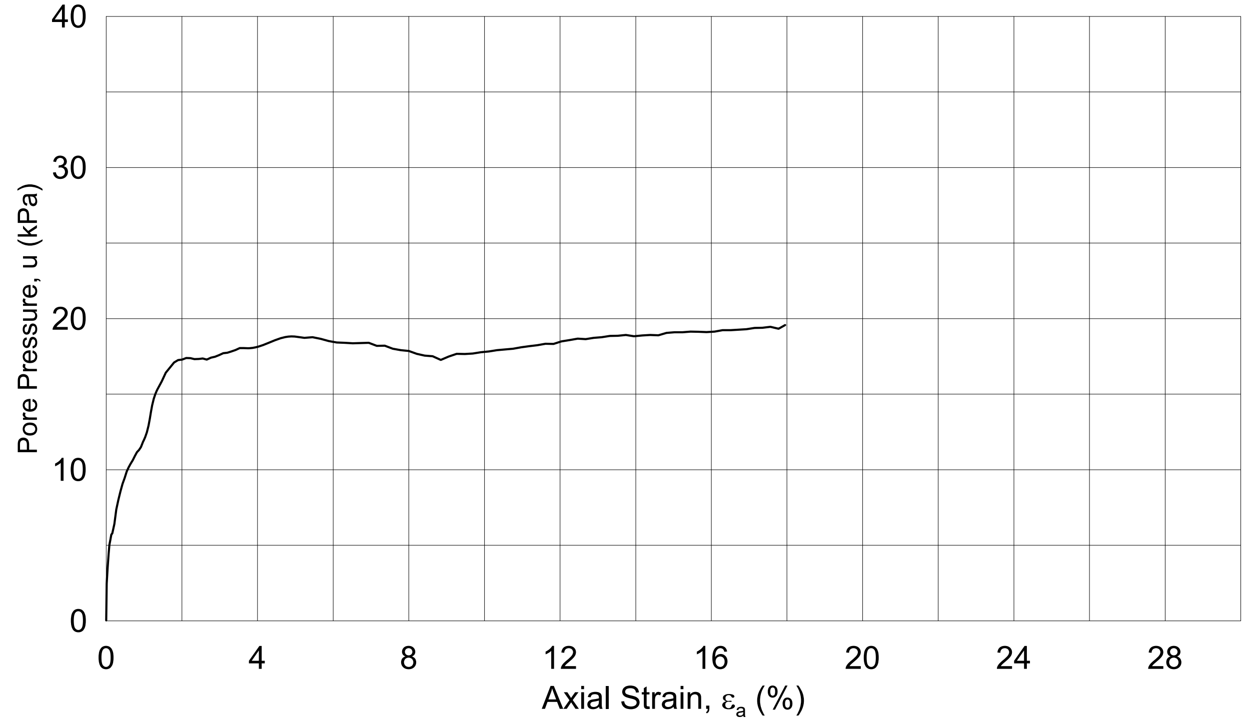


Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site									Document No. 20160154-04-R
Triaxial test: **CAUC**									Figure No. 02
Boring:	**HALB01**	Depth =	**5.30**	m	Consolidation stresses				Date 2018-03-22 / Drawn by/checked MAS / GS
Tube:	**9**	po' =	**77.0**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**29.6**	%	σ_{ac}' =	-	-	**76.9**	
Test:	**1**	w_c =	**29.0**	%	σ_{rc}' =	-	-	**38.5**	

BH-SP8_6-9-A-1_Plot2.grf





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Document No. 20160154-04-R

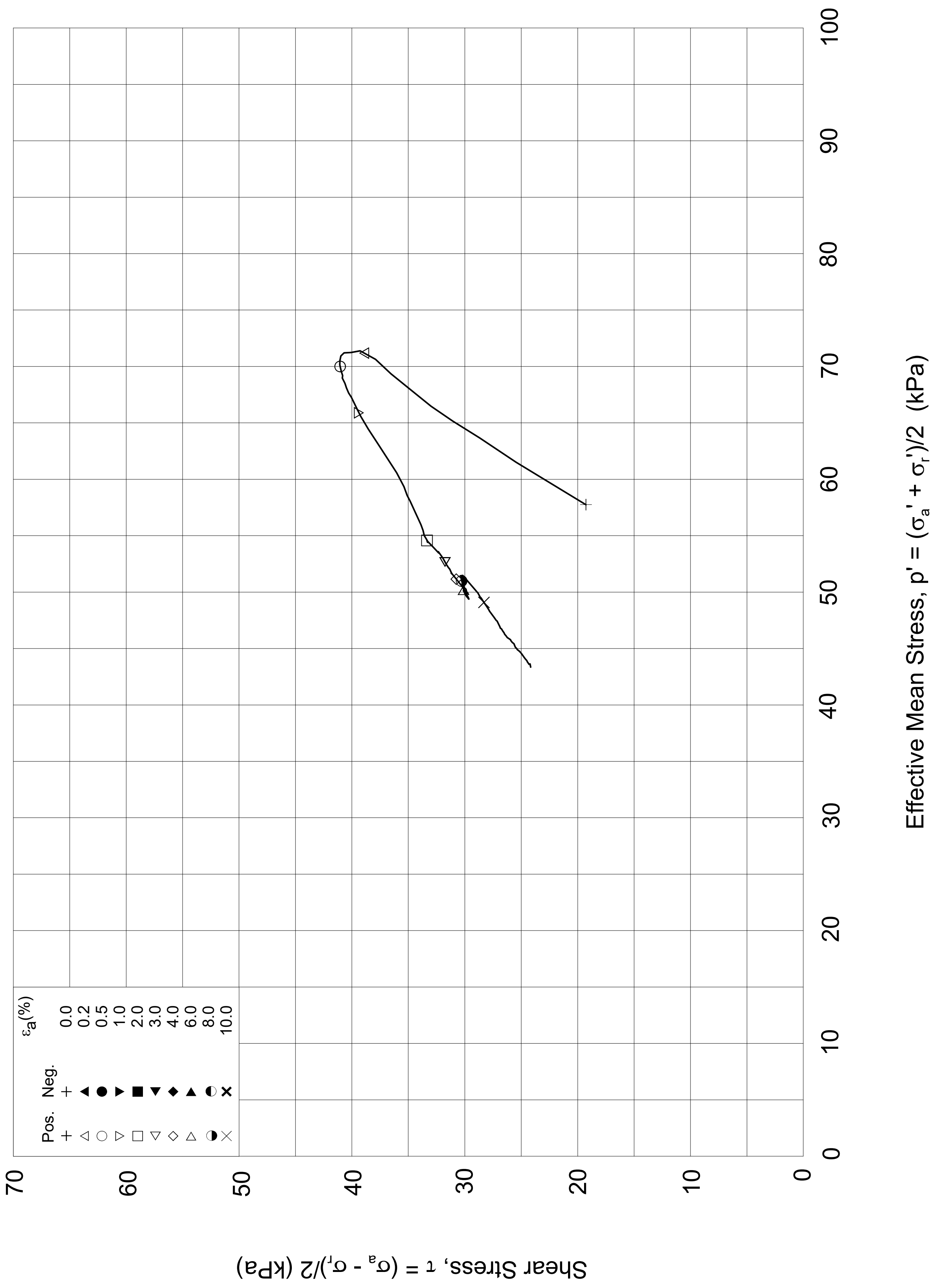
Triaxial test: **CAUC**

Figure No. 03

Boring:	**HALB01**	Depth =	**5.30**	m	Consolidation stresses				Date 2018-03-22	Drawn by/checked MAS / XXX
Tube:	**9**	po' =	**77.0**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i =	**30.5**	%	σ_{ac}' =	-	-	**77.0**		
Test:	**2**	w_c =	**30.4**	%	σ_{rc}' =	-	-	**38.5**		

NGTS

BH-SP8_6-9-A-2_Plot1.grf



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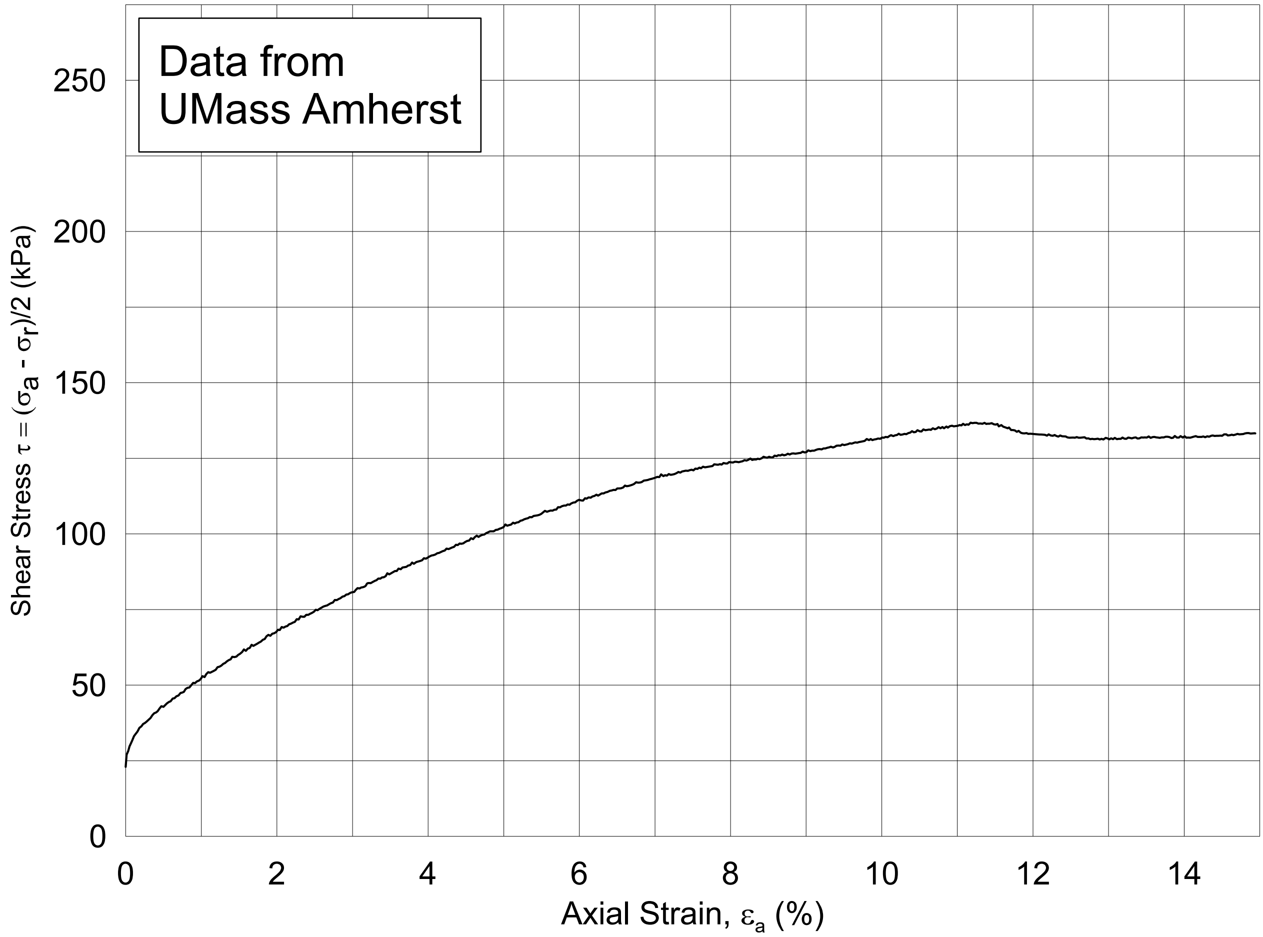
Document No.	20160154-04-R			
Figure No.	04			
Date	2018-03-22	Drawn by/checked	MAS / XXX	

Triaxial test: **CAUC**

Boring:	**BH06**	Depth =	**5.30**	m	Consolidation stresses			
Tube:	**9**	po' =	**77.0**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**30.5**	%	σ_{ac}' =	-	-	**77.0**
Test:	**2**	w_c =	**30.4**	%	σ_{rc}' =	-	-	**38.5**

BH-SP8_6-9-A-2.Plot2.grf



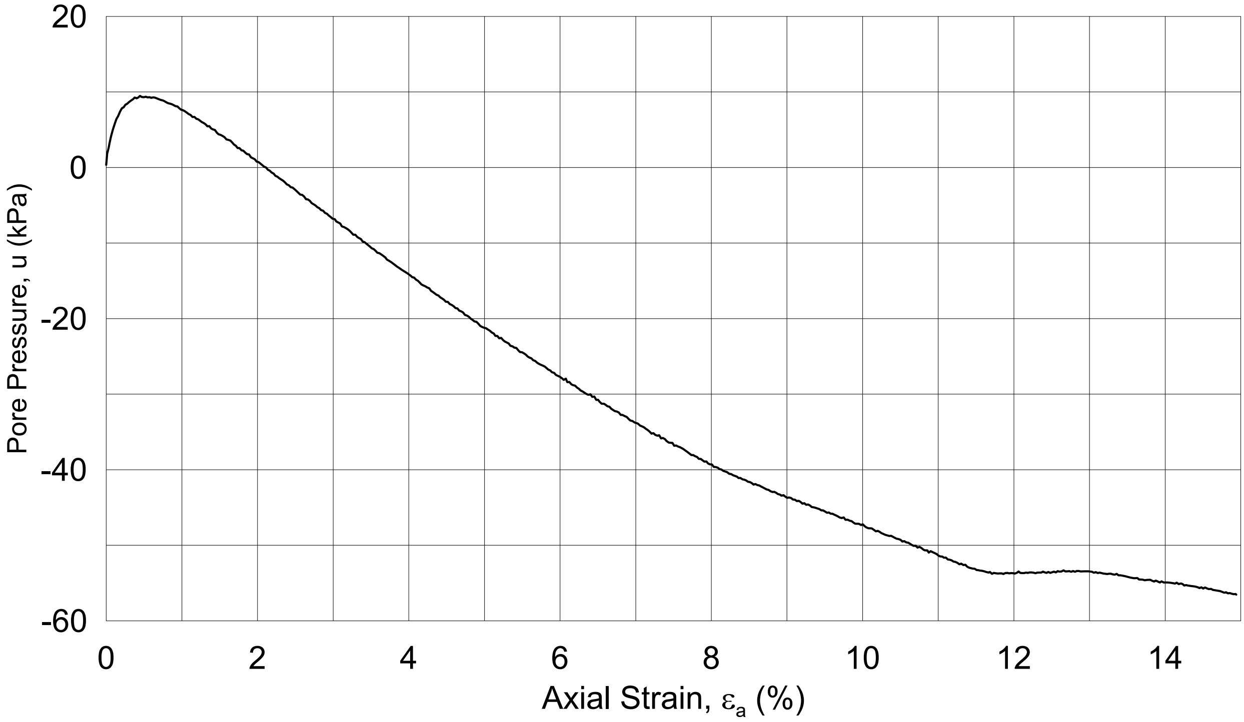


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Figure No. 05

Date 2018-03-22

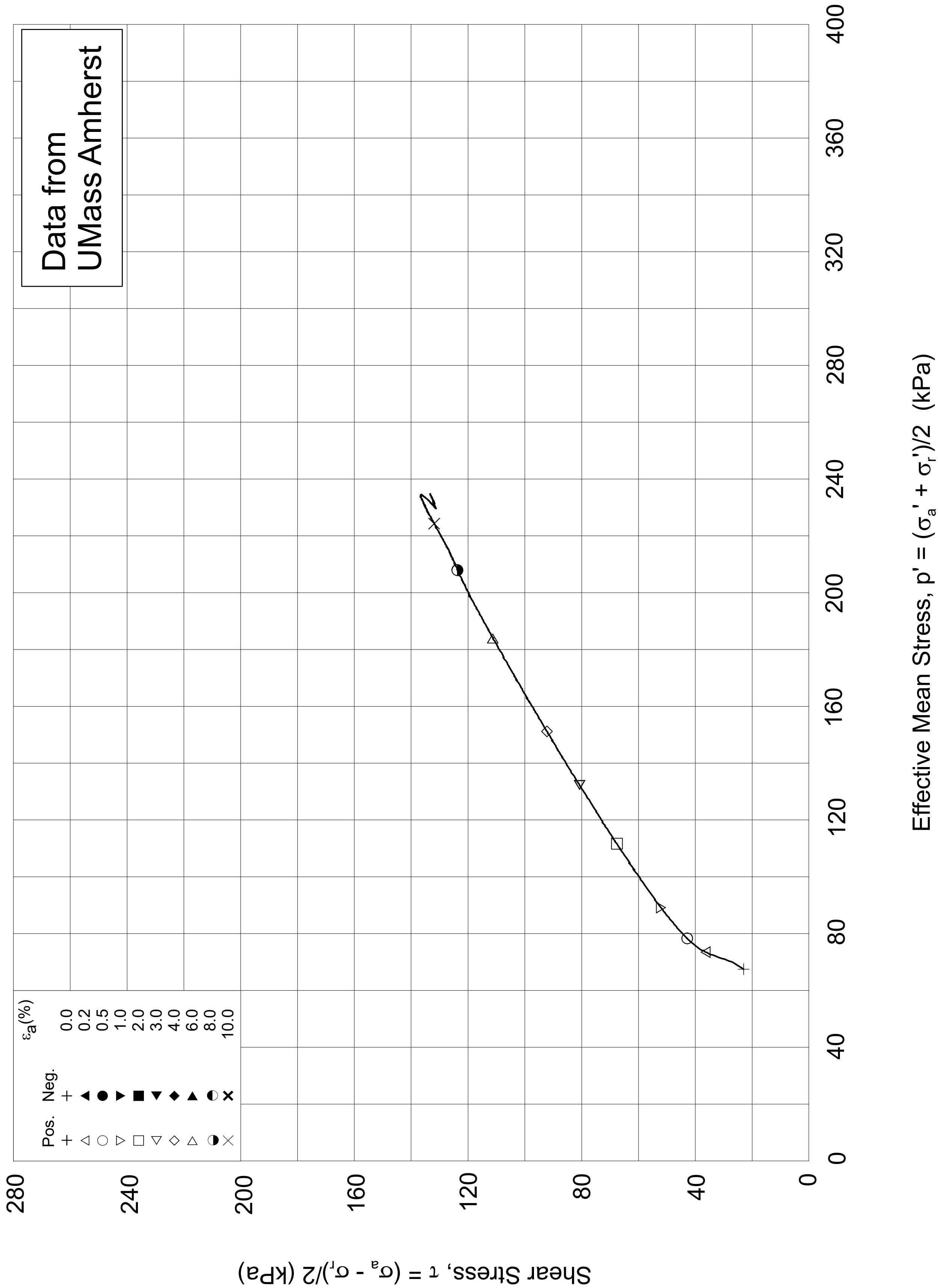
Drawn by/checked OyB / -

Triaxial test: **CAUC**

Boring:	**HALB01**	Depth =	**7.60**	m		Consolidation stresses			
Tube:	**11**	po'	=	**87.5**	kPa	(kPa)	max.	min.	final
Part:	**C**	w_i	=	**23.2**	%	σ_{ac}' =	-	-	**89.0**
Test:	**1**	w_c	=	-	%	σ_{rc}' =	-	-	**44.9**

NGTS

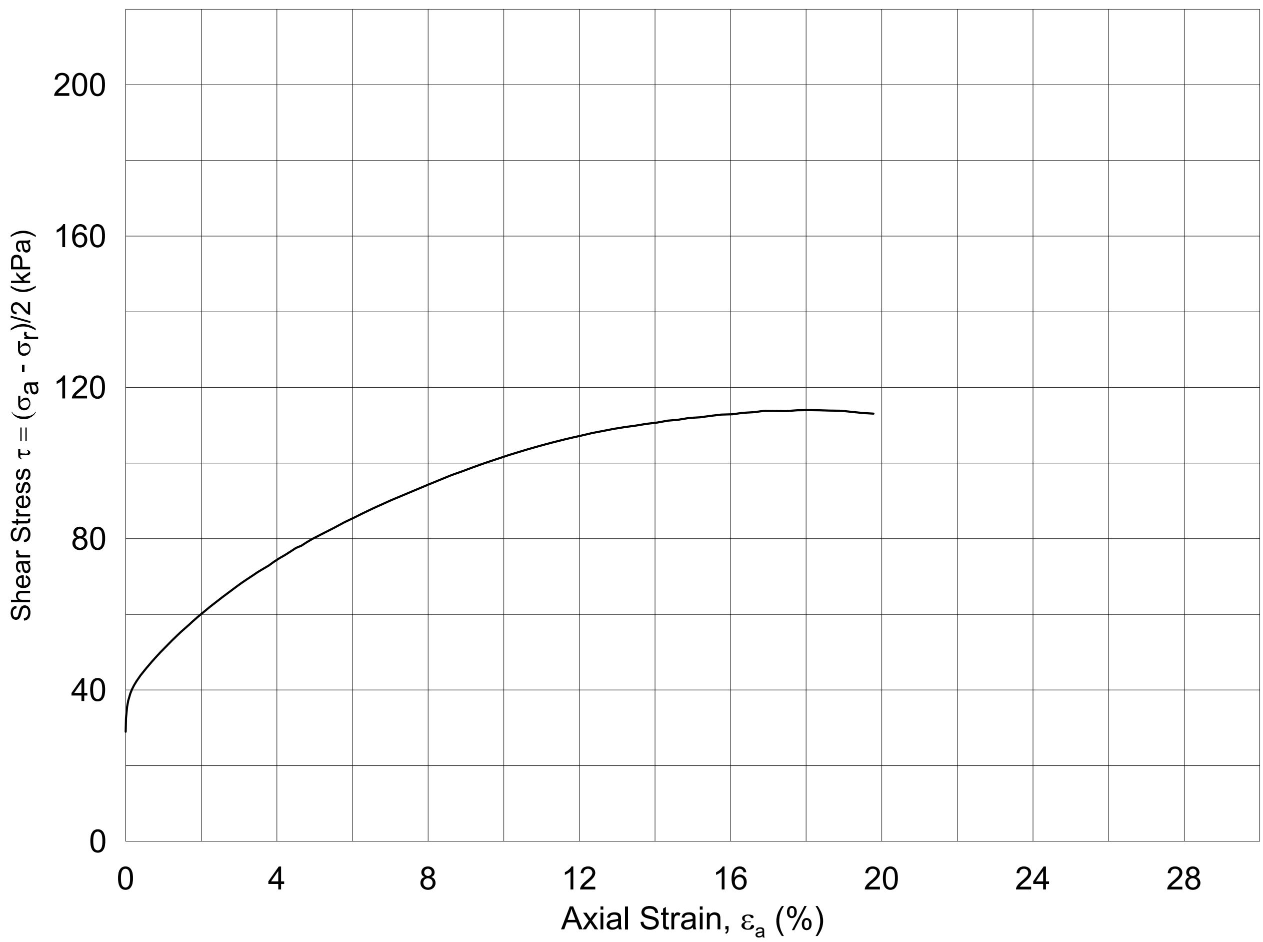
BH15-13-A-1.Plot1.grf

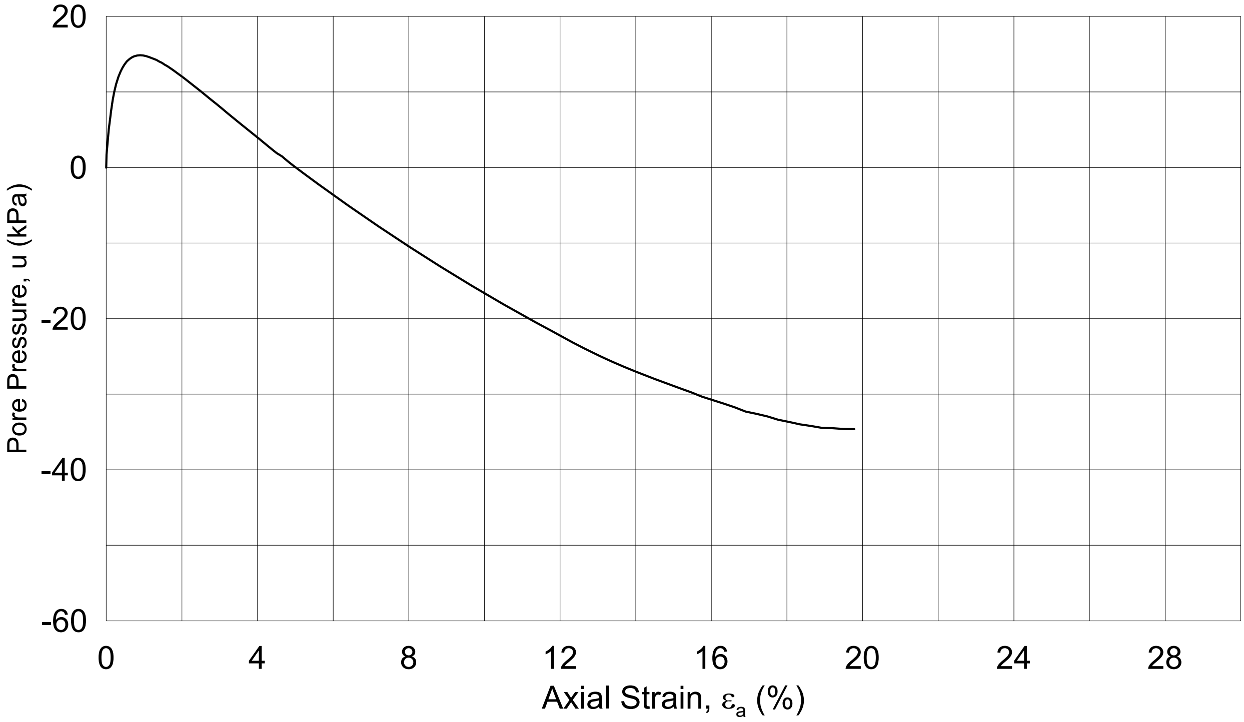


Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site									Document No. 20160154-04-R
Triaxial test: **CAUC**									Figure No. 06
Boring:	**HALB01**	Depth =	**7.60**	m	Consolidation stresses				Date 2018-03-22 / Drawn by/checked OyB / -
Tube:	**11**	po' =	**87.5**	kPa	(kPa)	max.	min.	final	
Part:	**C**	w_i =	**23.2**	%	σ_{ac}' =	-	-	**89.0**	NGTS
Test:	**1**	w_c =	**-**	%	σ_{rc}' =	-	-	**44.9**	

BH15-13-A-1.Plot2.grf





Dato/rev.: 2014-12-23/01

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Triaxial test: **CAUC**									
Boring:	**HALB01**	Depth =	**8.60**	m	Consolidation stresses				
Tube:	**12**	po' =	**105.0**	kPa	(kPa)	max.	min.	final	
Part:	**B**	w_i =	**28.6**	%	σ_{ac}' =	-	-	**115.9**	
Test:	**4**	w_c =	**28.0**	%	σ_{rc}' =	-	-	**58.0**	

Document No. 20160154-04-R

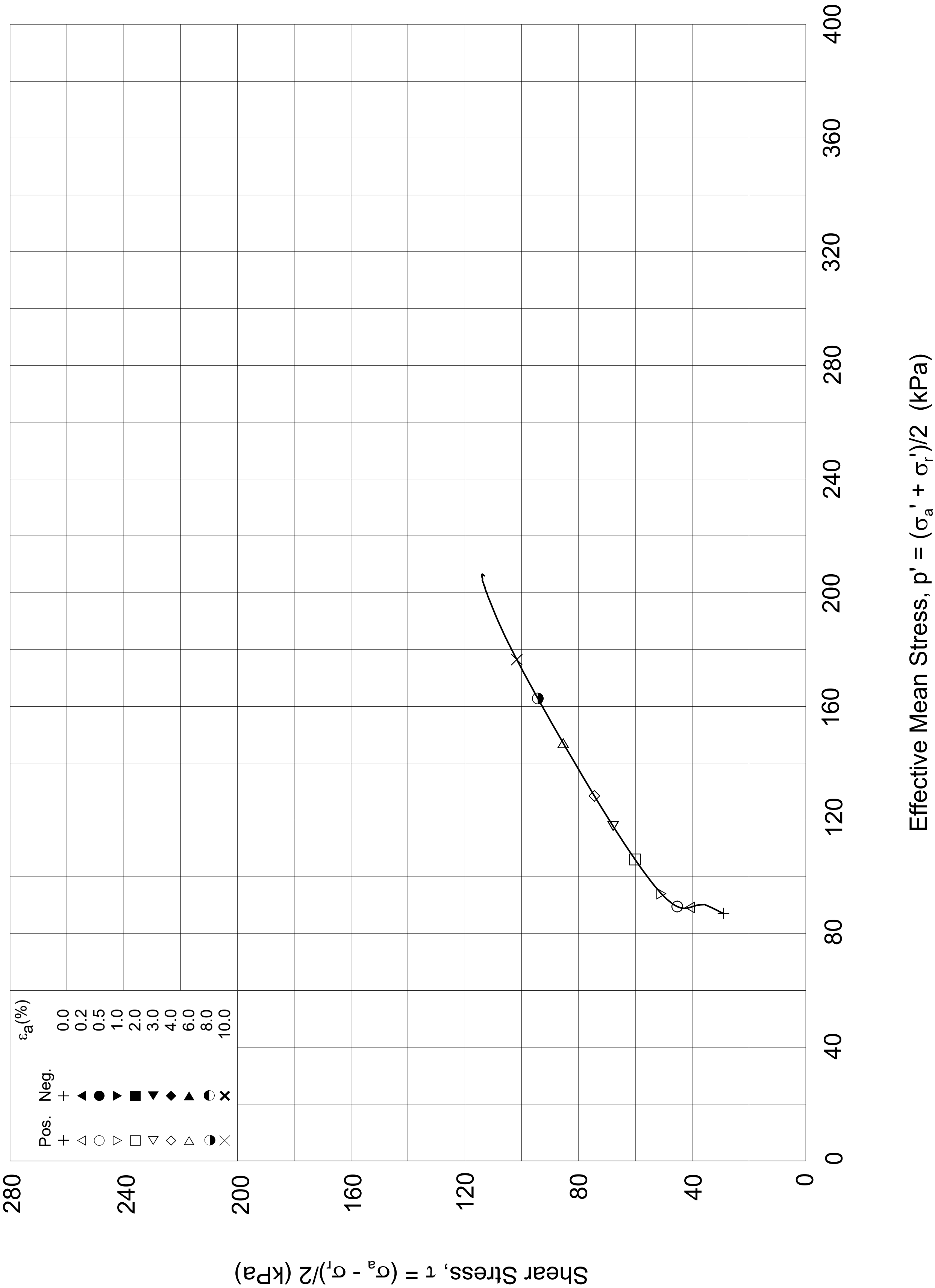
Figure No. 07

Date 2018-03-22

Drawn by/checked MAS / GS

NGTS

BH-SP8_6-12-B-4.Plot1.grf

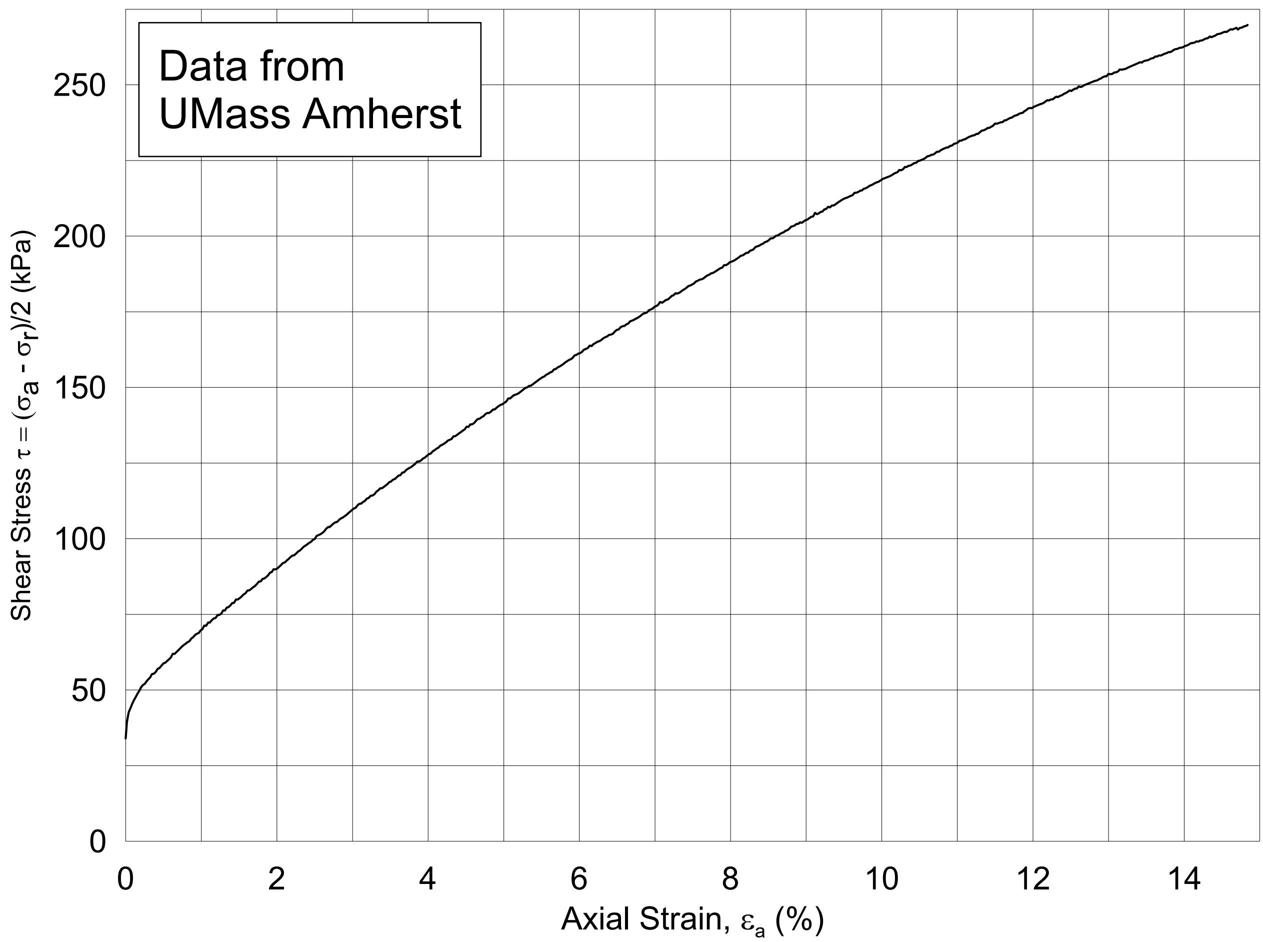


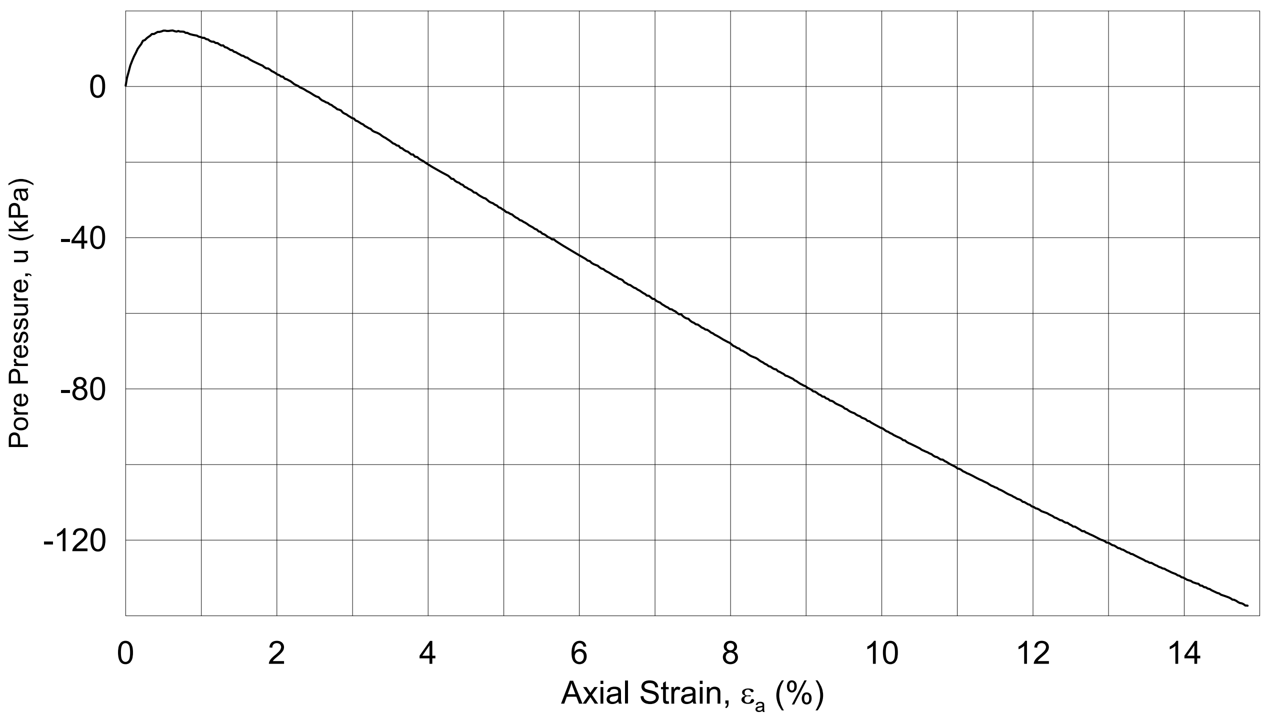
Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site									Document No. 20160154-04-R	
Triaxial test: **CAUC**									Figure No. 08	
Boring:	**HALB01**	Depth =	**8.60**	m	Consolidation stresses				Date 2018-03-22	Drawn by/checked MAS / GS
Tube:	**12**	po' =	**105.0**	kPa	(kPa)	max.	min.	final		
Part:	**B**	w_i =	**28.6**	%	σ_{ac}' =	-	-	**115.9**		
Test:	**4**	w_c =	**28.0**	%	σ_{rc}' =	-	-	**58.0**		

NGTS

BH-SP8_6-12-B-4.Plot2.grf

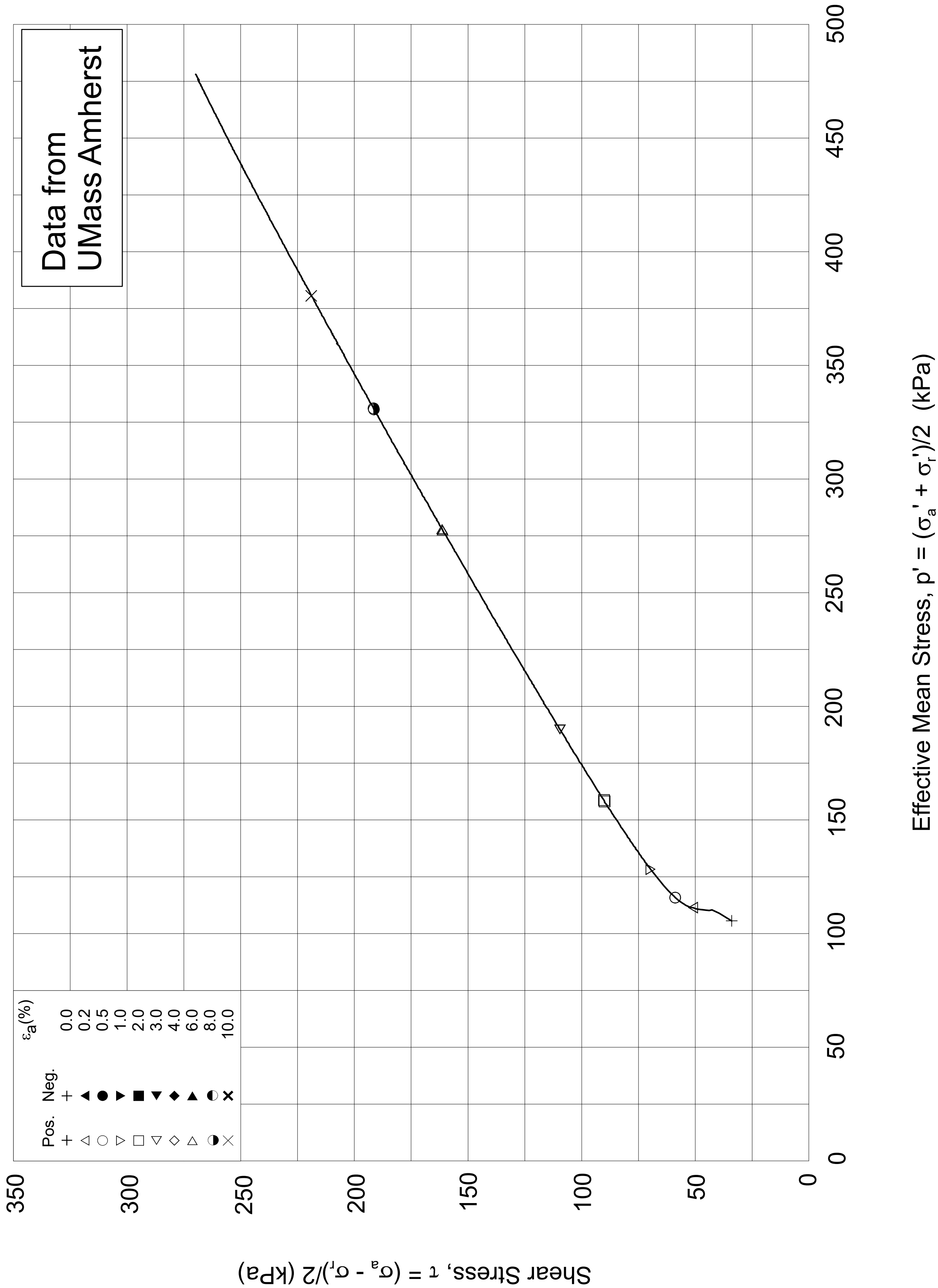




Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site													Document No. 20160154-04-R	
Triaxial test: **CAUC**													Figure No. 09	
Boring:	**HALB01**	Depth =		**12.60**	m	Consolidation stresses							Date 2018-03-22	Drawn by/checked OyB / -
Tube:	**14**	po'	=	**136.5**	kPa	(kPa)		max.		min.		final	NGTS	
Part:	**B**	w_i	=	**22.6**	%	σ_{ac}' =		-		-		**139.7**		
Test:	**1**	w_c	=	**-**	%	σ_{rc}' =		-		-		**71.8**		

BH15-13-A-1.Plot1.grf



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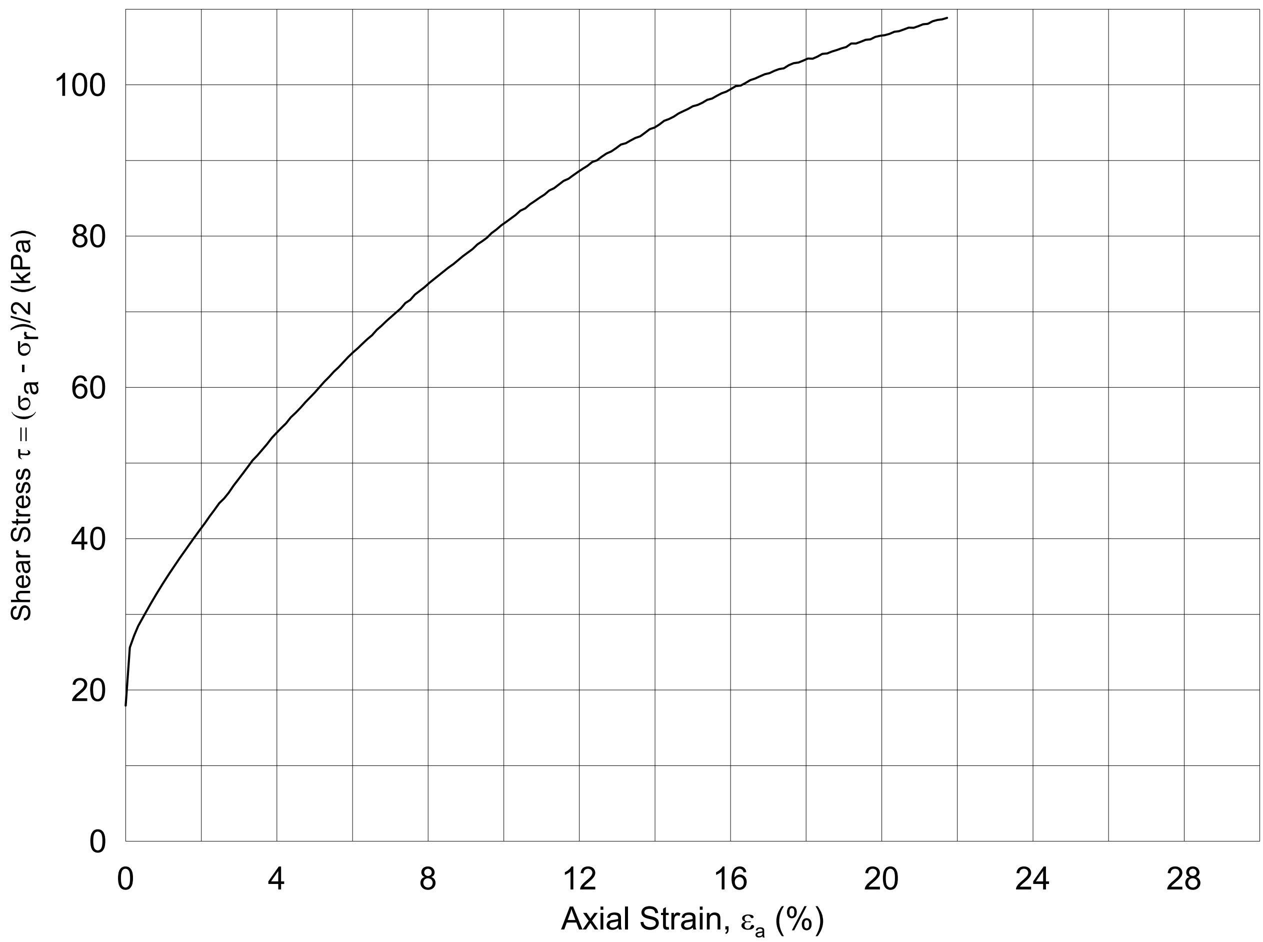
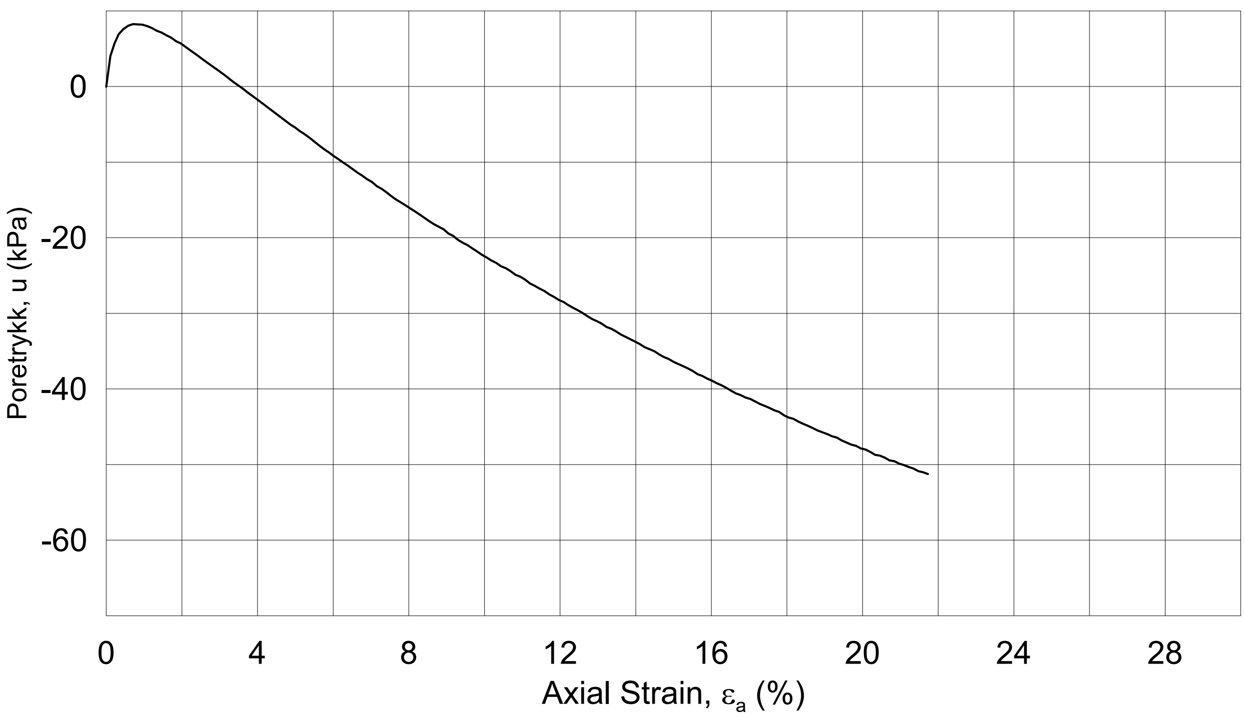
NGTS - Halden Research Site										Document No. 20160154-04-R
Triaxial test: **CAUC**										Figure No. 10
Boring:	**HALB01**	Depth =	**12.60**	m	Consolidation stresses					Date 2018-03-22 / Drawn by/checked OyB / -
Tube:	**14**	po' =	**136.5**	kPa	(kPa)		max.	min.	final	
Part:	**B**	w_i =	**22.6**	%	σ_{ac}' =		-	-	**139.7**	NGTS
Test:	**1**	w_c =	**-**	%	σ_{rc}' =		-	-	**71.8**	

BH15-13-A-1.Plot2.grf





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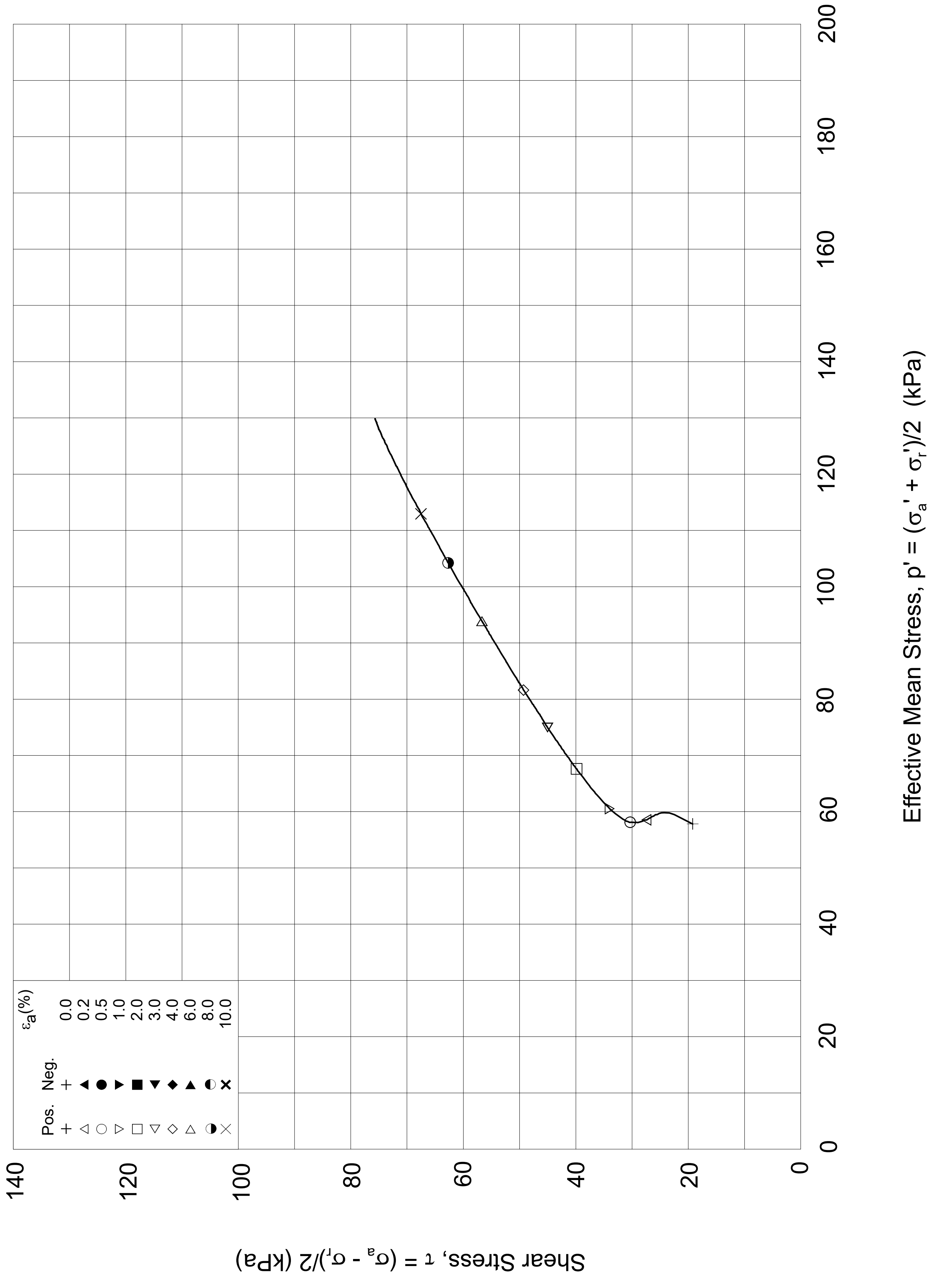
Triaxial test: **CAUC**

Figure No. 11

Boring:	**HALB03**	Depth =	**5.32**	m	Consolidation stresses				Date 2018-03-22	Drawn by/checked ThV / GS
Tube:	**3**	po' =	**0.0**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i =	**30.0**	%	σ_{ac}' =	-	-	**72.3**		
Test:	**1**	w_c =	**29.6**	%	σ_{rc}' =	-	-	**36.3**		

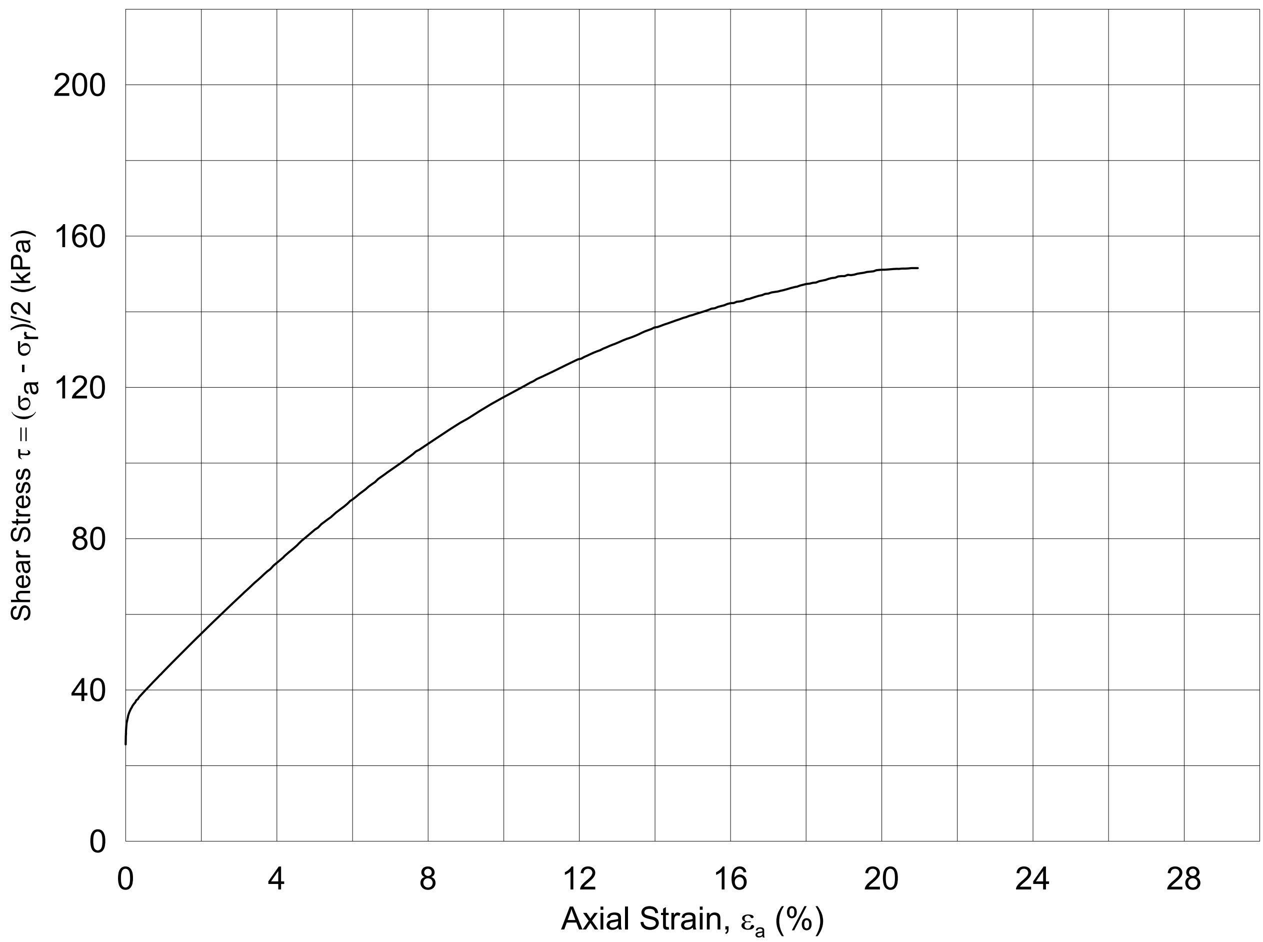
BH14-3-A-1.Plot1.grf

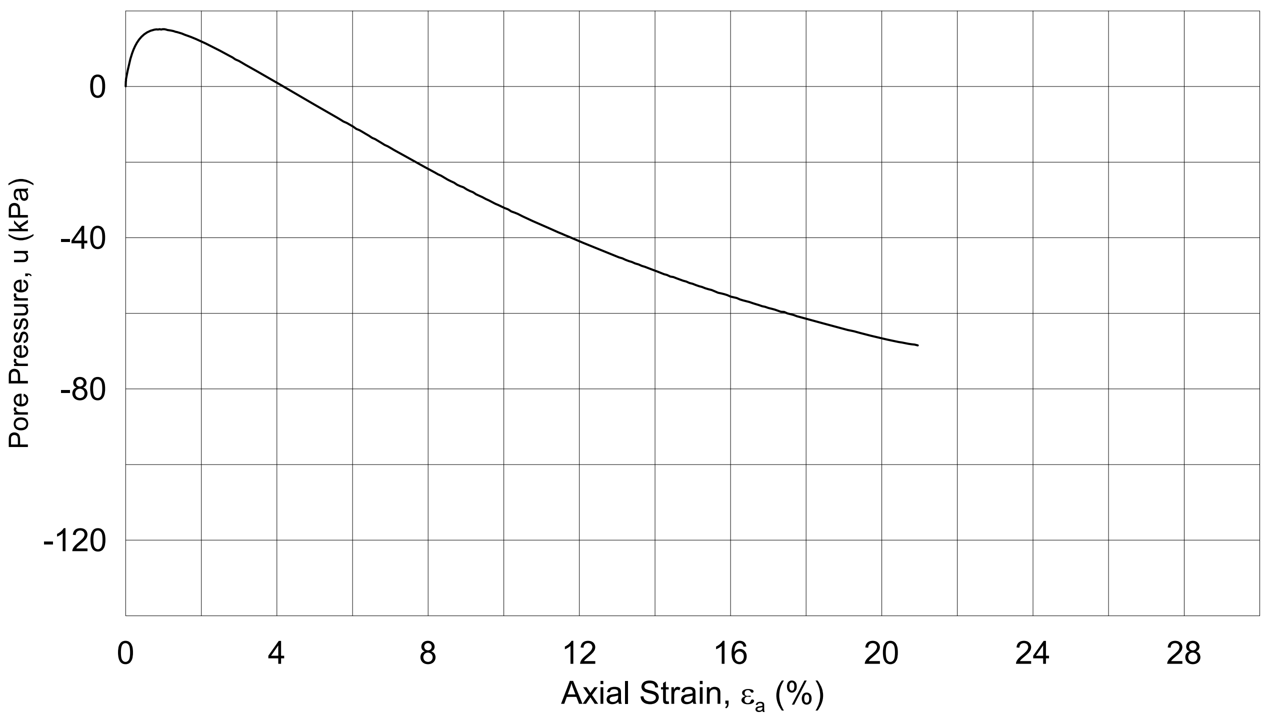


Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site									Document No. 20160154-04-R
Triaxial test: **CAUC**									Figure No. 12
Boring: **HALB03**	Depth =	**5.32**	m	Consolidation stresses					Date 2018-03-22 / Drawn by/checked ThV / GS
Tube: **3**	po' =	**0.0**	kPa	(kPa)	max.	min.	final		
Part: **A**	w_i =	**30.0**	%	σ_{ac}' =	-	-	**72.3**		NGTS
Test: **1**	w_c =	**29.6**	%	σ_{rc}' =	-	-	**36.3**		

BH14-3-A-1.Plot2.grf





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Document No. 20160154-04-R

Figure No. 13

Date 2018-03-22

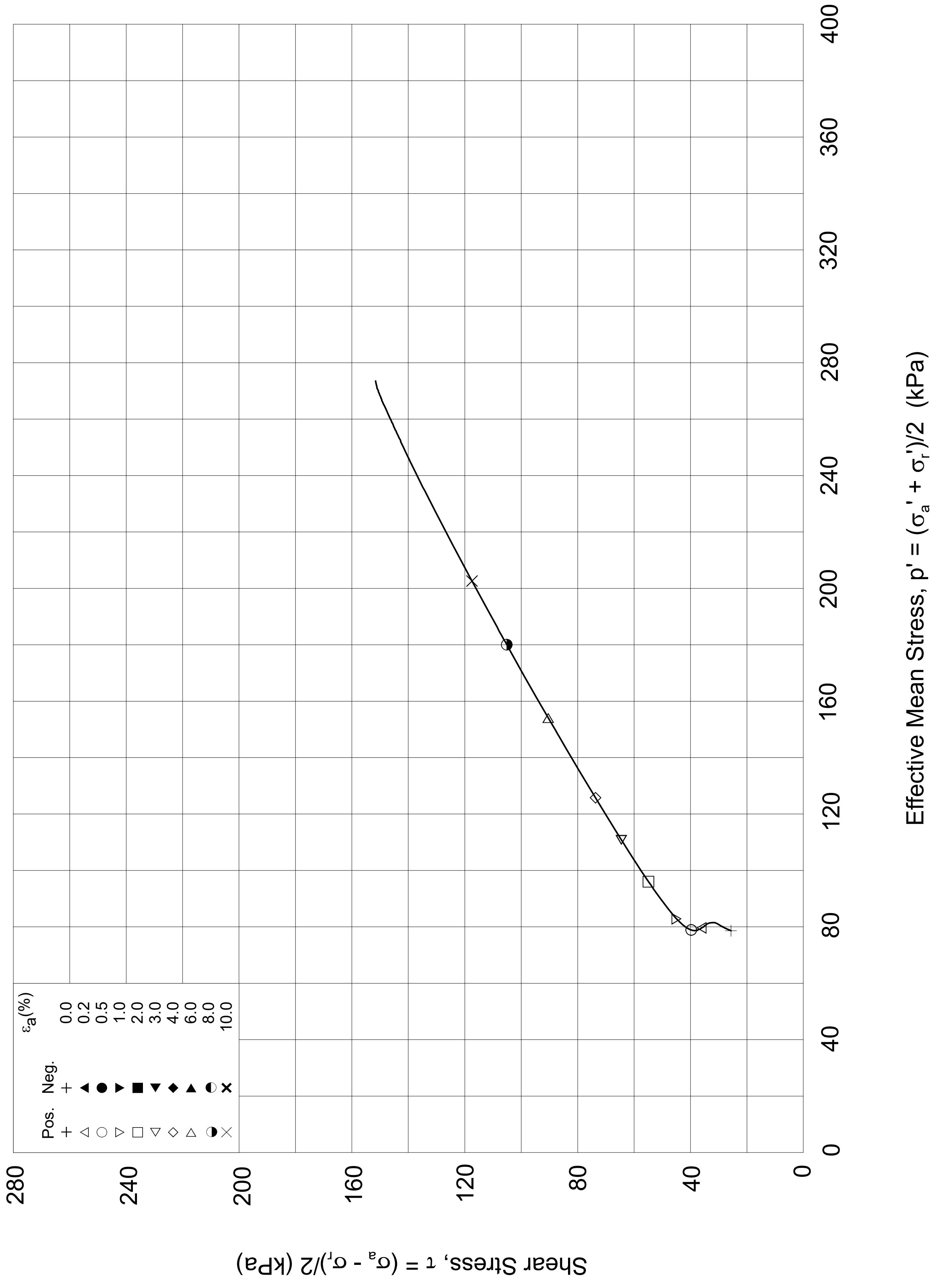
Drawn by/checked ThV / GS

Triaxial test: **CAUC**

Boring:	**HALB03**	Depth =	**8.46**	m	Consolidation stresses			
Tube:	**6**	po' =	**105.0**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**28.3**	%	σ_{ac}' =	-	-	**104.9**
Test:	**1**	w_c =	**27.4**	%	σ_{rc}' =	-	-	**53.0**

NGTS

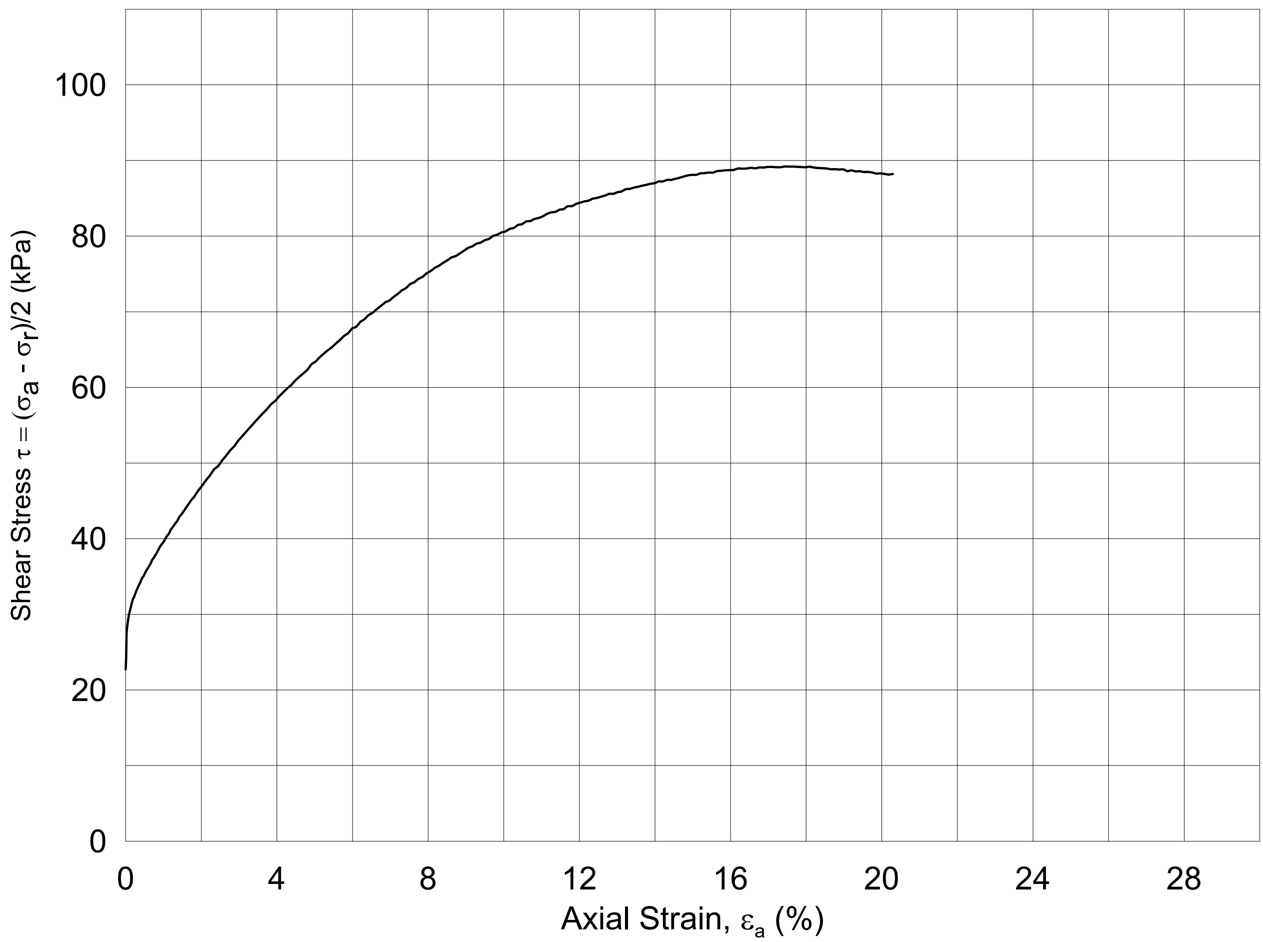
BH14-6-A-1.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site								Document No. 20160154-04-R
Triaxial test: **CAUC**								Figure No. 14
Boring: **HALB03**	Depth =	**8.46**	m	Consolidation stresses				Date 2018-03-22 / Drawn by/checked ThV / GS
Tube: **6**	po' =	**105.0**	kPa	(kPa)	max.	min.	final	
Part: **A**	w_i =	**28.3**	%	σ_{ac}' =	-	-	**104.9**	NGTS
Test: **1**	w_c =	**27.4**	%	σ_{rc}' =	-	-	**53.0**	

BH14-6-A-1.Plot2.grf



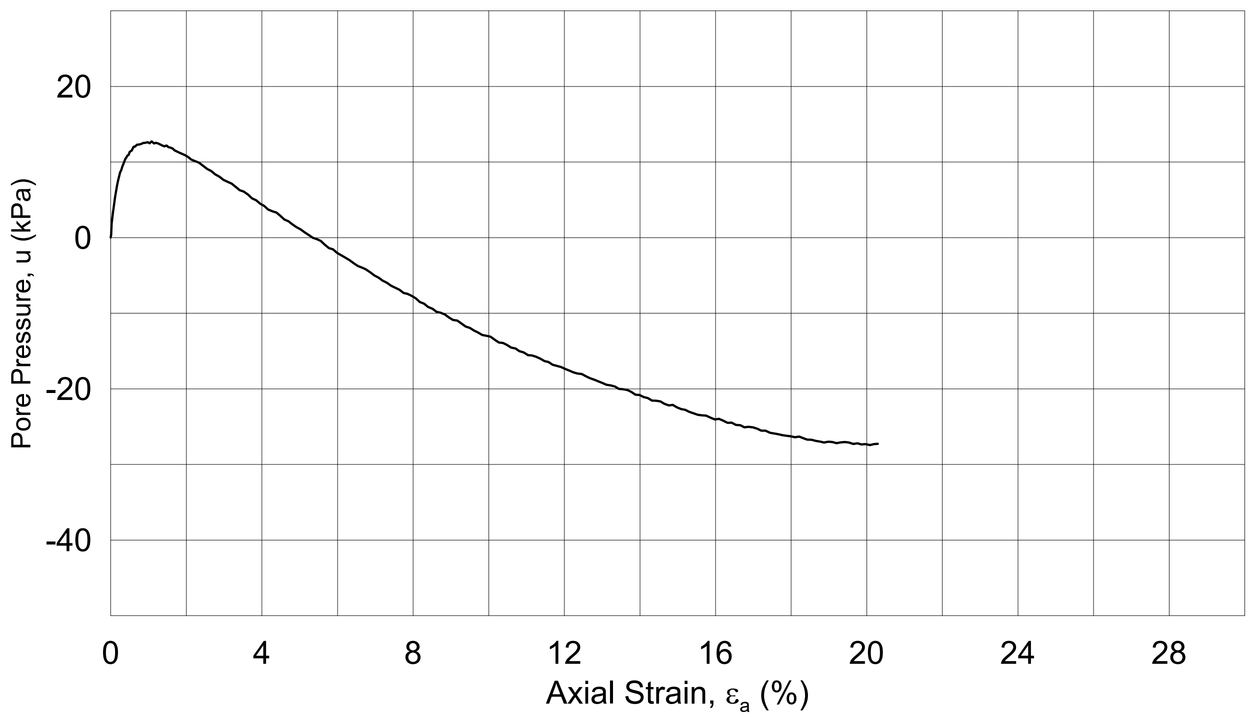


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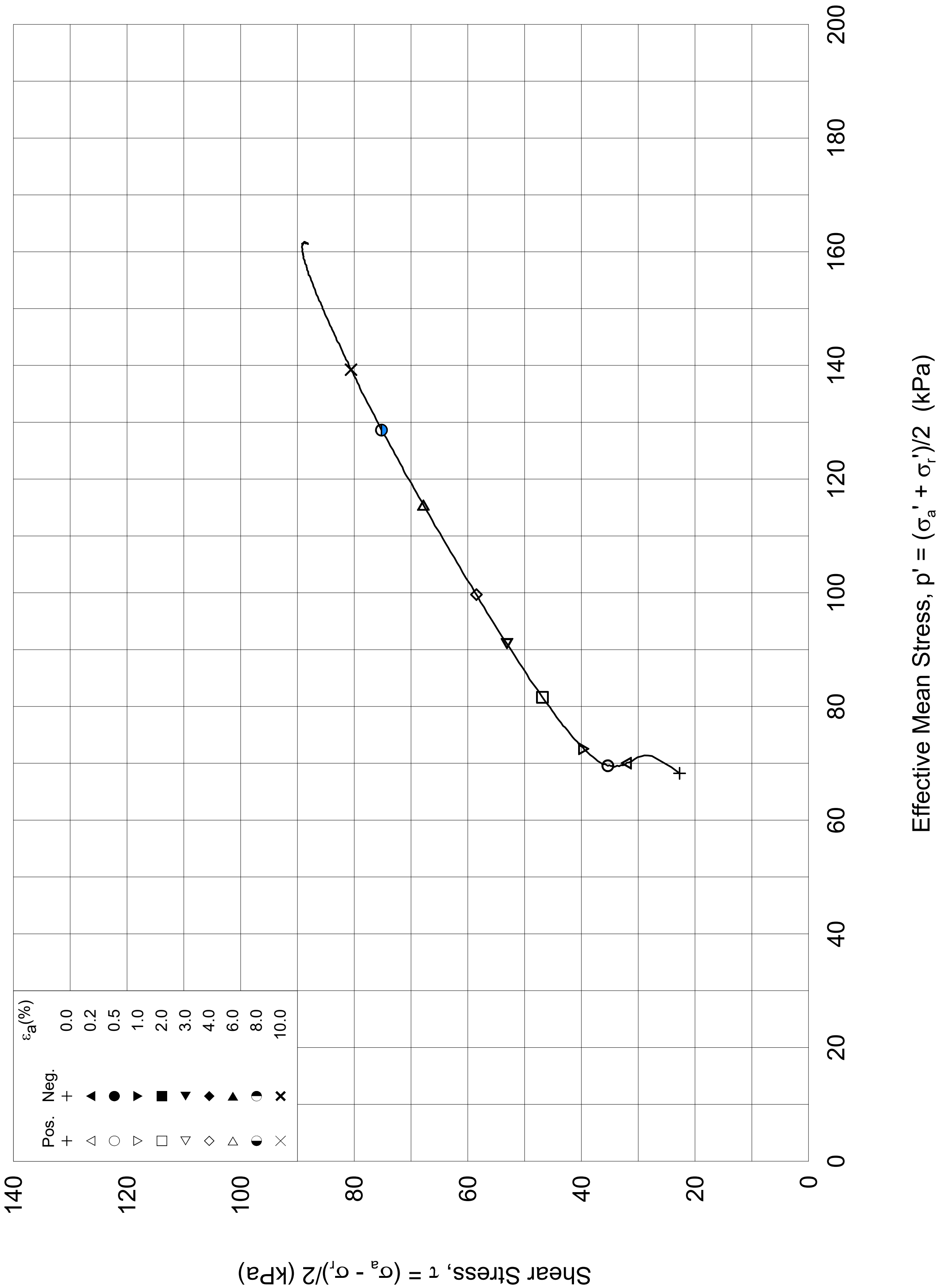
Figure No. 15

Triaxial test: **CAUC**

Boring:	**HALB06**	Depth =	**8.32**	m	Consolidation stresses				Date 2018-06-22
Tube:	**3**	po' =	**91.0**	kPa	(kPa)	max.	min.	final	Drawn by/checked ThV / GS
Part:	**A**	w_i =	**30.7**	%	σ_{ac}' =	-	-	**90.9**	
Test:	**1**	w_c =	**29.7**	%	σ_{rc}' =	-	-	**45.5**	

NGTS

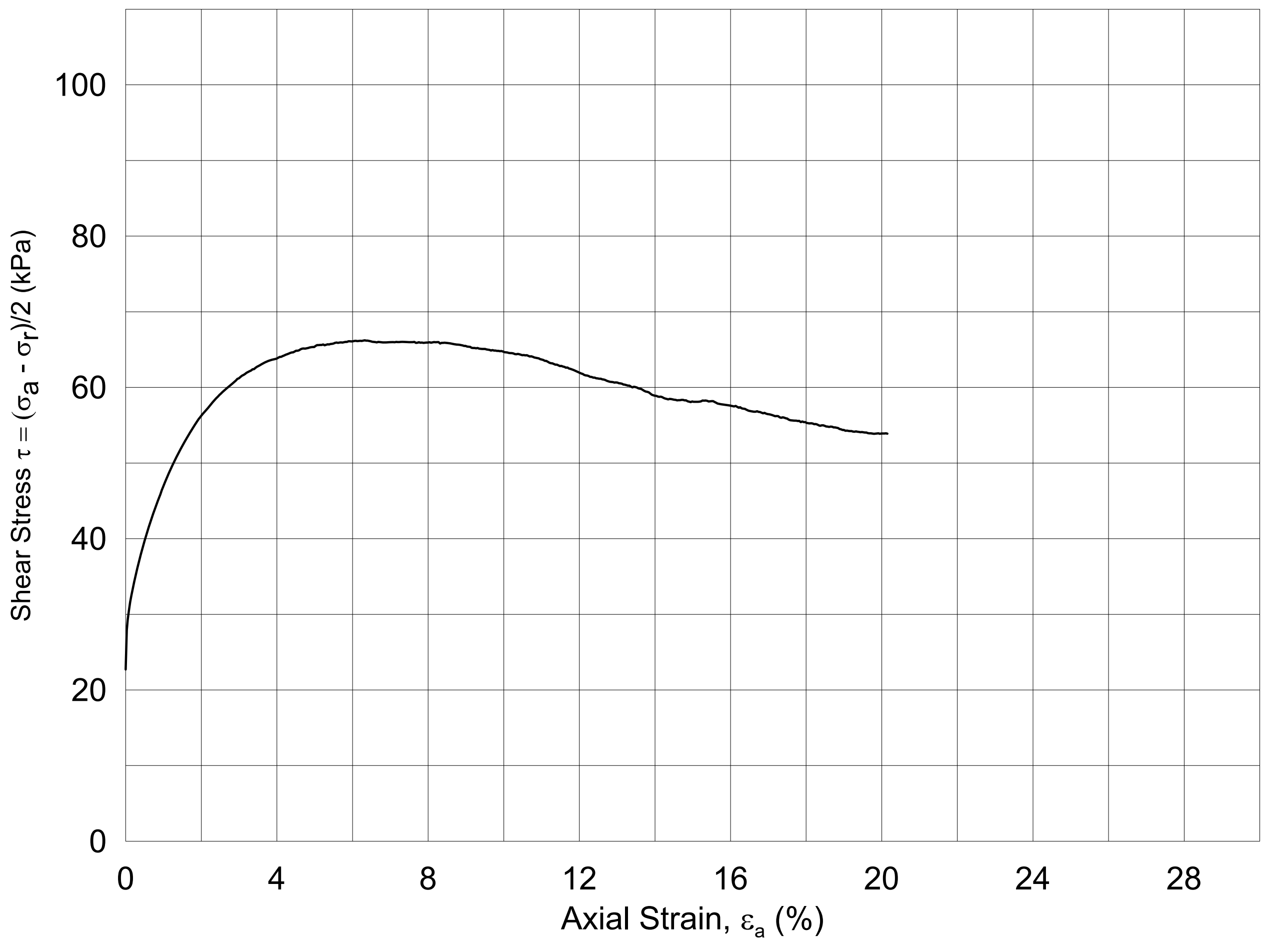
HALB06-3-A-1.Plot1.grf

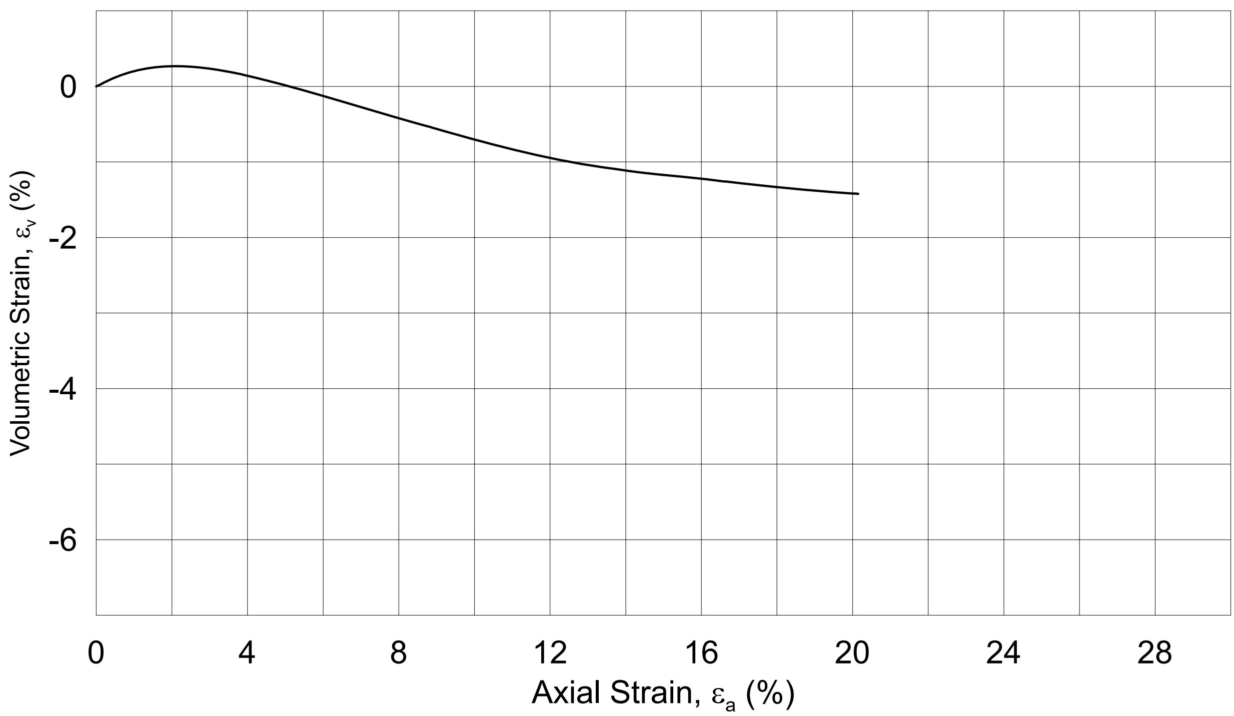


Dato/rev.: 2014-12-23/01

NGTS - Halden Silt Site					Document No. 20160154-01-R
Triaxial test: **CAUC**					Figure No. 16
Boring: **HALB06**	Depth = **8.32** m	Consolidation stresses			Date 2018-06-22 / Drawn by/checked ThV / GS
Tube: **3**	po' = **91.0** kPa	(kPa) max.	min.	final	
Part: **A**	w_i = **30.7** %	σ_{ac}' = -	-	**90.9**	NGTS
Test: **1**	w_c = **29.7** %	σ_{rc}' = -	-	**45.5**	

HALB06-3-A-1.Plot2.grf

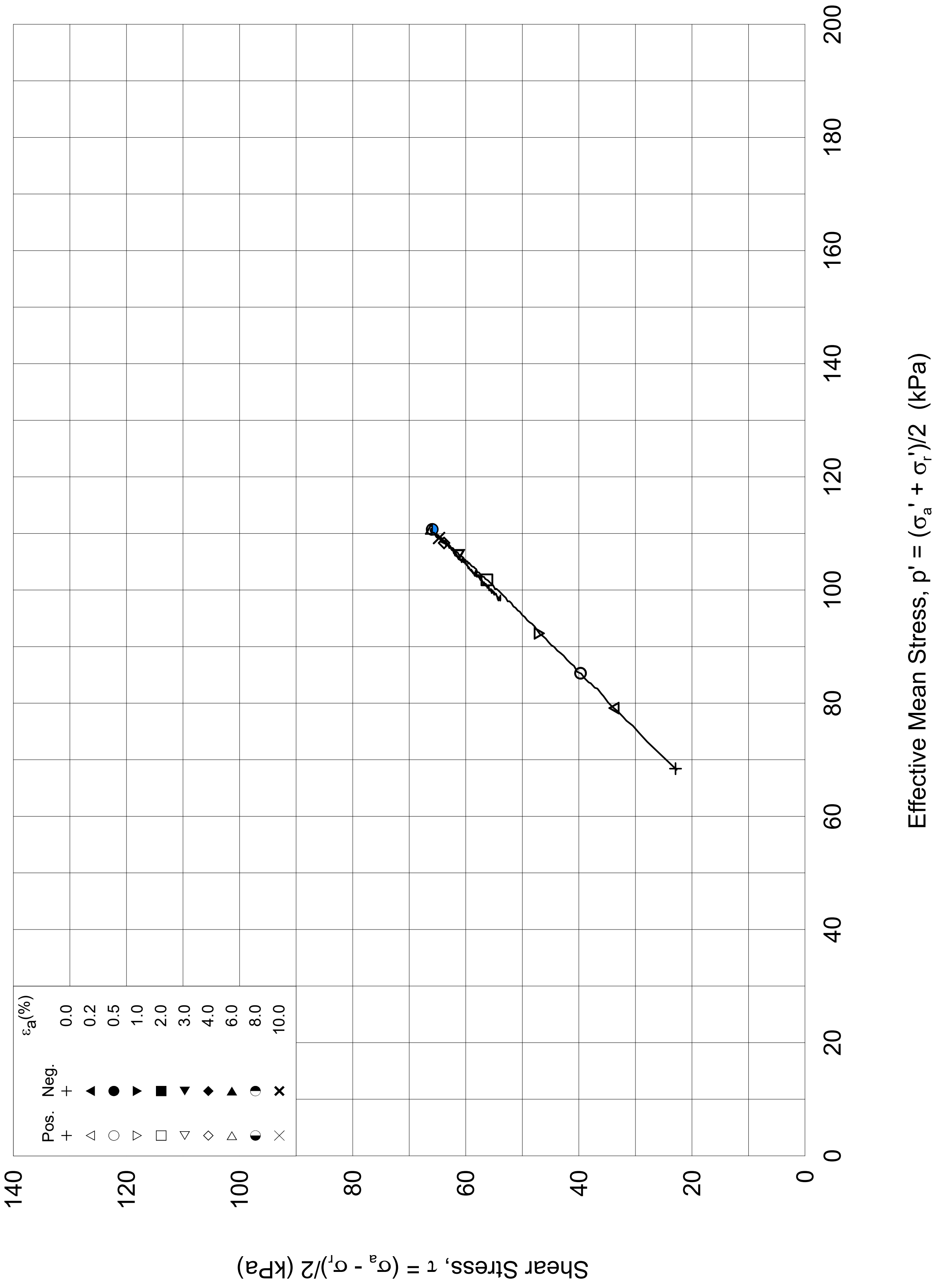




Dato/rev.: 2014-12-23/01

NGTS - Halden Silt Site				Document No. 20160154-01-R
Triaxial test: **CADC**				Figure No. 17
Boring: **HALB06**	Depth = **8.47** m	Consolidation stresses		Date 2018-06-22 / Drawn by/checked ThV / GS
Tube: **3**	po' = **91.0** kPa	(kPa)	max. / min. / final	
Part: **B**	w_i = **29.5** %	σ_{ac}' =	- / - / **91.0**	NGTS
Test: **1**	w_c = **28.3** %	σ_{rc}' =	- / - / **45.5**	

HALB06-3-B-1.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Silt Site

Document No. 20160154-01-R

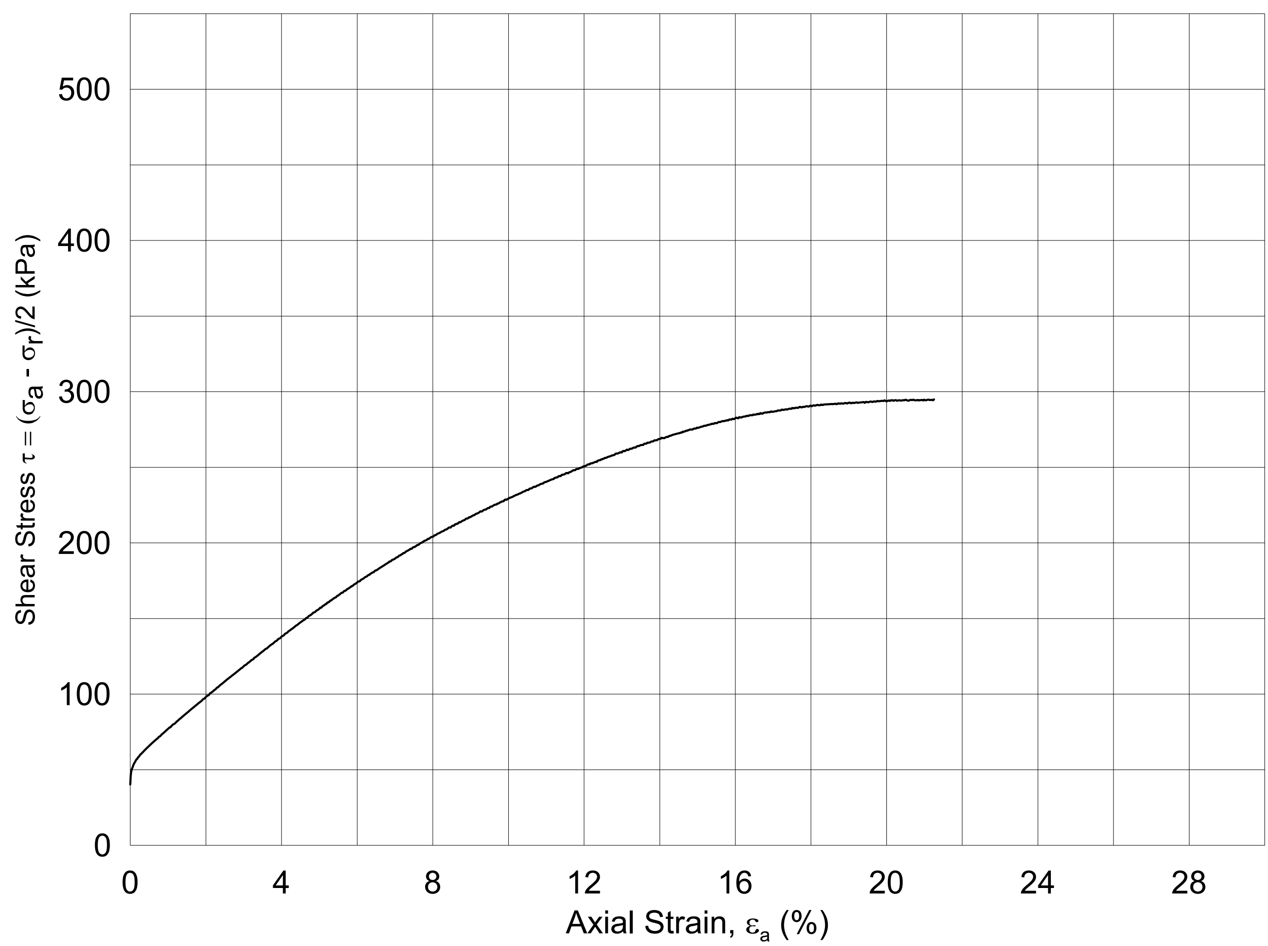
Triaxial test: **CADC**

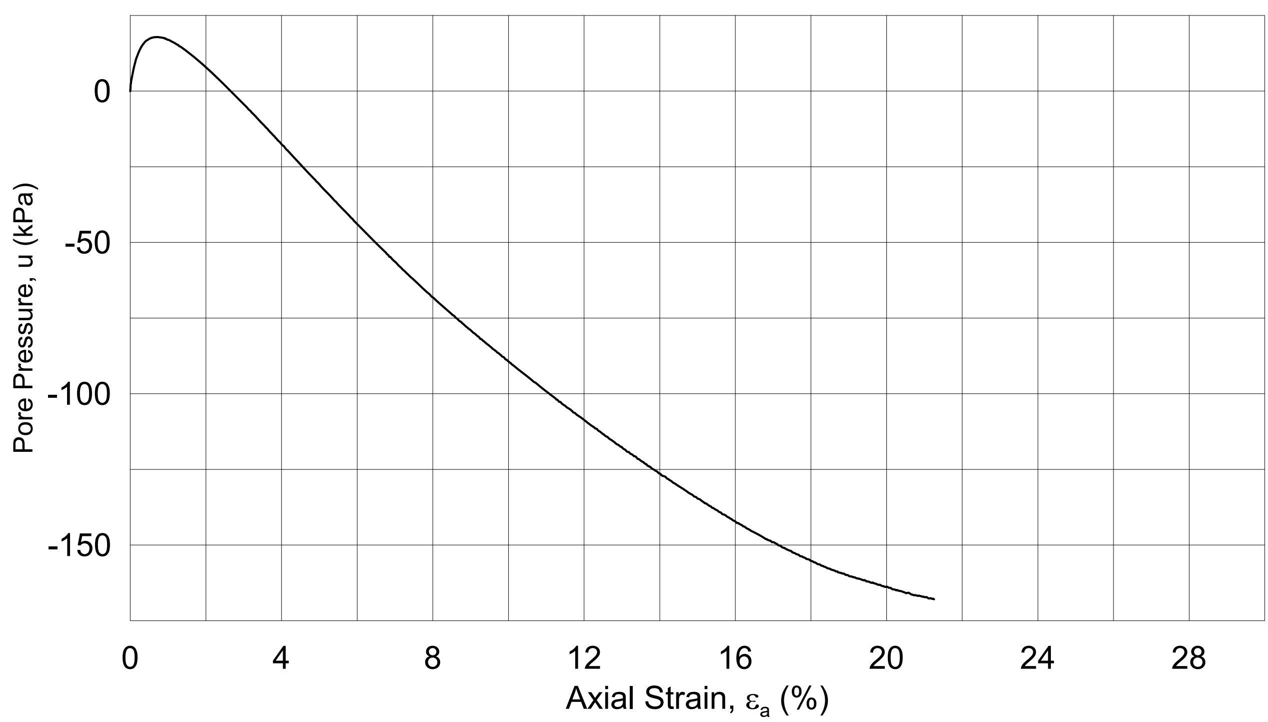
Figure No. 18

Boring:	**HALB06**	Depth =	**8.47**	m	Consolidation stresses				Date 2018-06-22
Tube:	**3**	po' =	**91.0**	kPa	(kPa)	max.	min.	final	Drawn by/checked ThV / GS
Part:	**B**	w_i =	**29.5**	%	σ_{ac}' =	-	-	**91.0**	
Test:	**1**	w_c =	**28.3**	%	σ_{rc}' =	-	-	**45.5**	

NGTS

HALB06-3-B-1.Plot2.grf

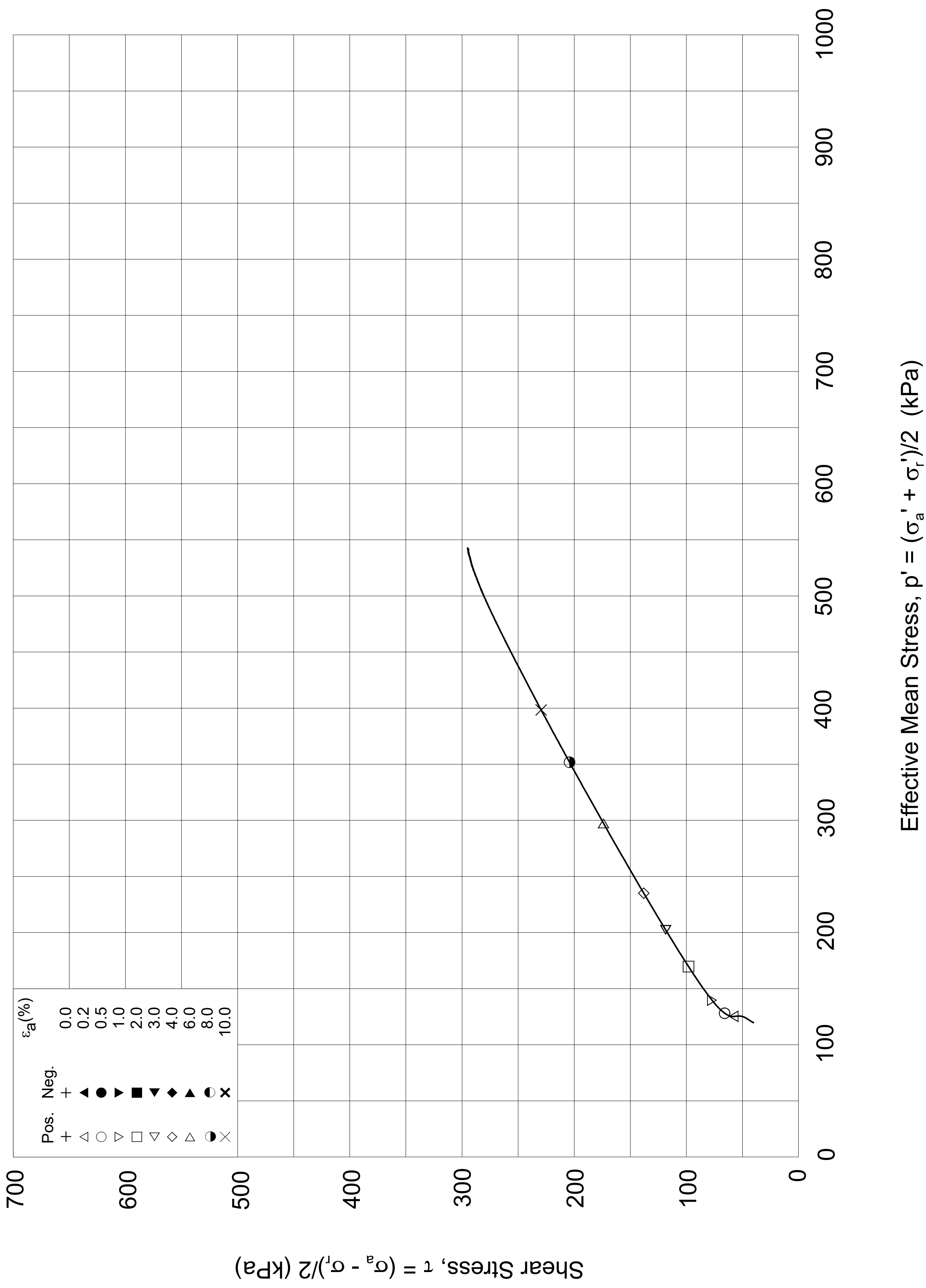




Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site							Document No. 20160154-04-R
Triaxial test: **CAUC**							Figure No. 19
Boring: **HALB03**	Depth = **14.42** m	Consolidation stresses				Date 2018-03-22	Drawn by/checked ThV / GS
Tube: **12**	po' = **159.0** kPa	(kPa)	max.	min.	final		
Part: **A**	w_i = **23.4** %	σ_{ac}' =	-	-	**160.4**	NGTS	
Test: **1**	w_c = **22.1** %	σ_{rc}' =	-	-	**79.4**		

BH14-12-A-1.Plot1.grf



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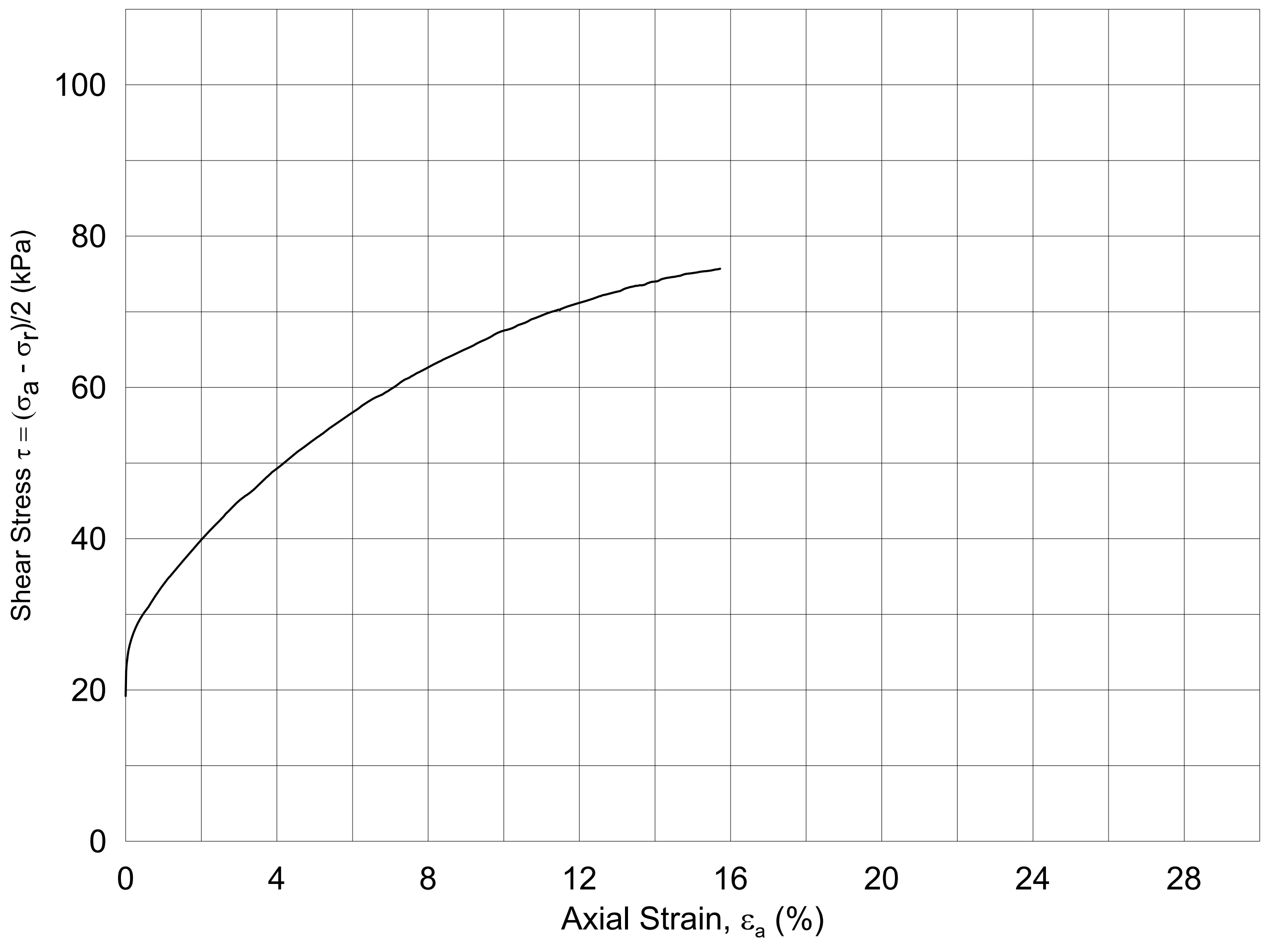
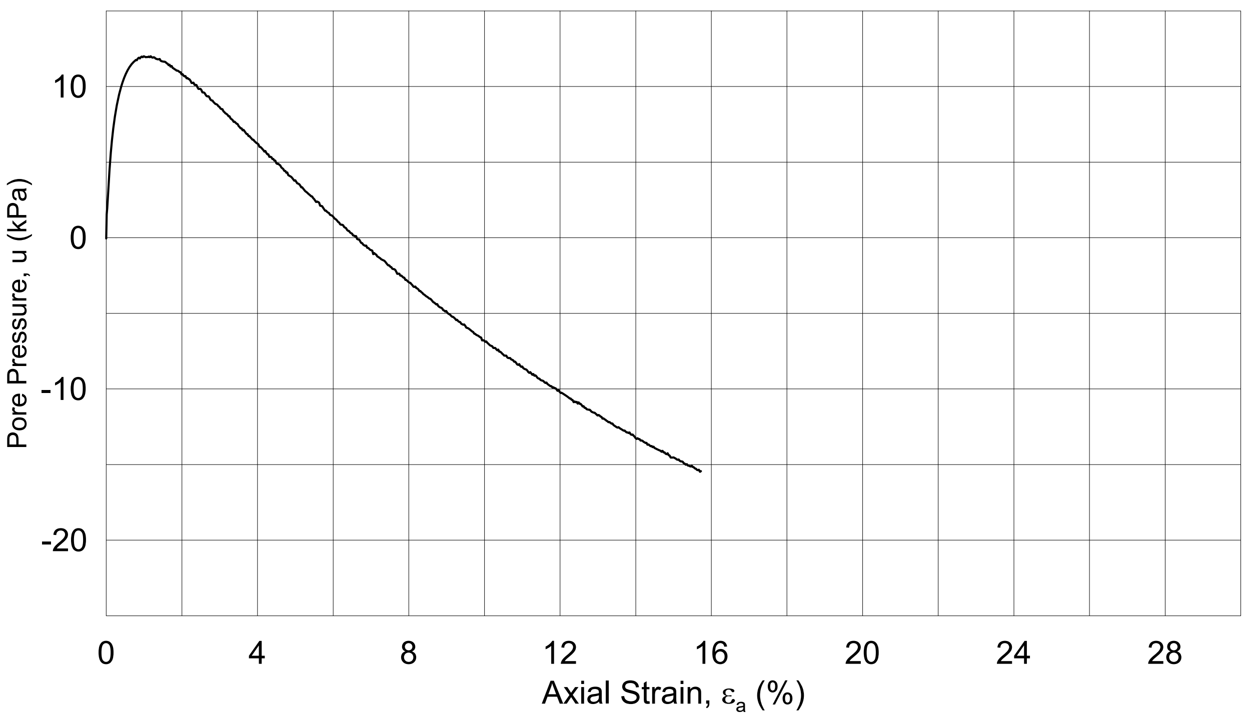
Triaxial test: **CAUC**							Document No. 20160154-04-R	
							Figure No. 20	
Boring: **HALB03**	Depth =	**14.42**	m	Consolidation stresses			Date 2018-03-22	Drawn by/checked ThV / GS
Tube: **12**	po' =	**159.0**	kPa	(kPa)	max.	min.	final	
Part: **A**	w_i =	**23.4**	%	σ_{ac}' =	-	-	**160.4**	
Test: **1**	w_c =	**22.1**	%	σ_{rc}' =	-	-	**79.4**	

NGTS

BH14-12-A-1.Plot2.grf





Dato/rev.: 2014-12-23/01

BH15-3-A-1.Plot1.grf

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Document No. 20160154-04-R

Triaxial test: **CAUC**

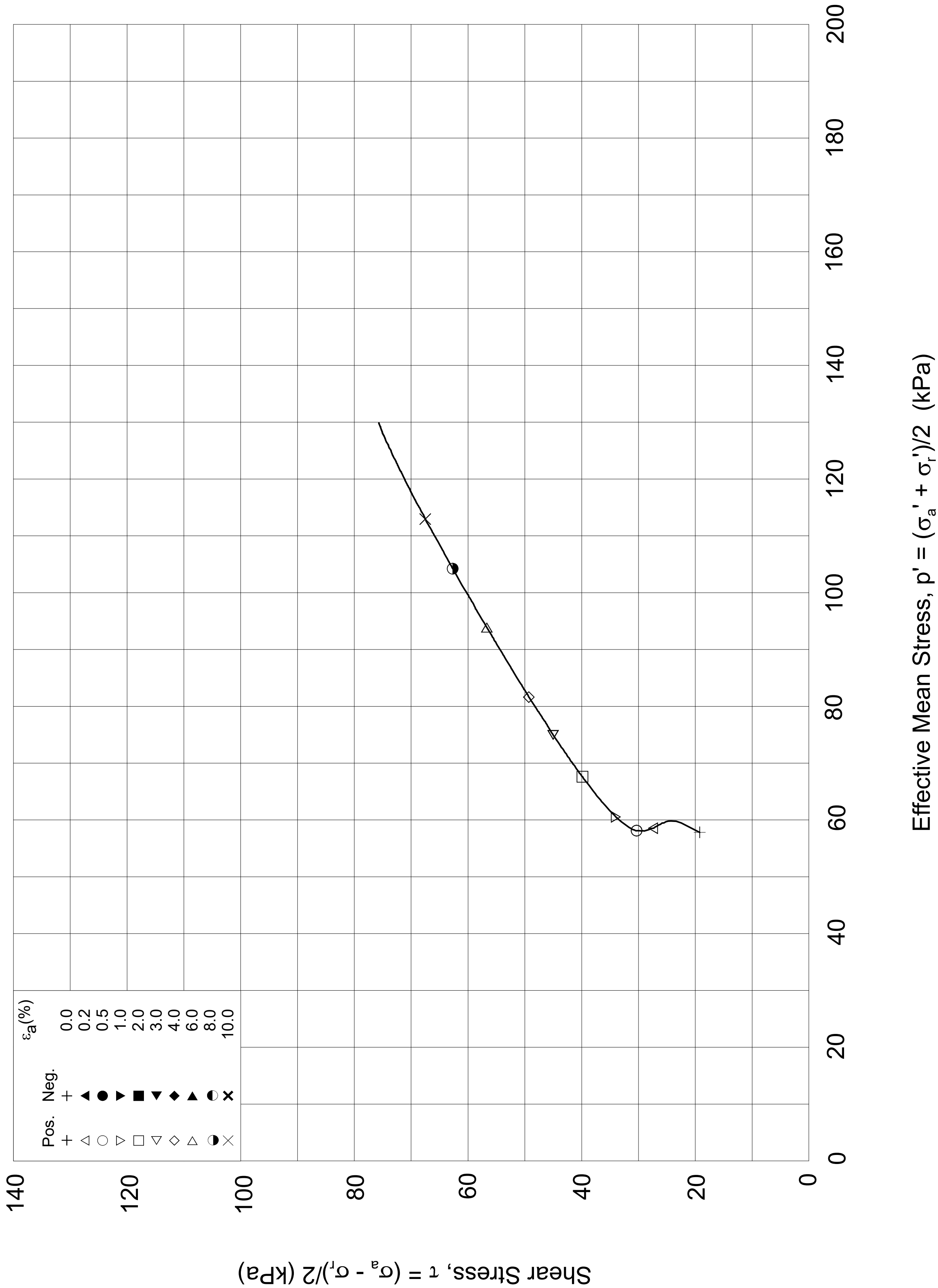
Figure No. 21

Date 2018-03-22

Drawn by/checked ThV / GS

Boring:	**HALB04**	Depth =	**5.28**	m	Consolidation stresses					
Tube:	**3**	po' =	**77.0**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i =	**31.9**	%	σ_{ac}' =	-	-	**76.9**		
Test:	**1**	w_c =	**30.8**	%	σ_{rc}' =	-	-	**38.5**		

NGTS



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site

Triaxial test: **CAUC**									
Boring:	**HALB04**	Depth =	**5.28**	m	Consolidation stresses				
Tube:	**3**	po' =	**77.0**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**31.9**	%	σ_{ac}' =	-	-	**76.9**	
Test:	**1**	w_c =	**30.8**	%	σ_{rc}' =	-	-	**38.5**	

Document No. 20160154-04-R

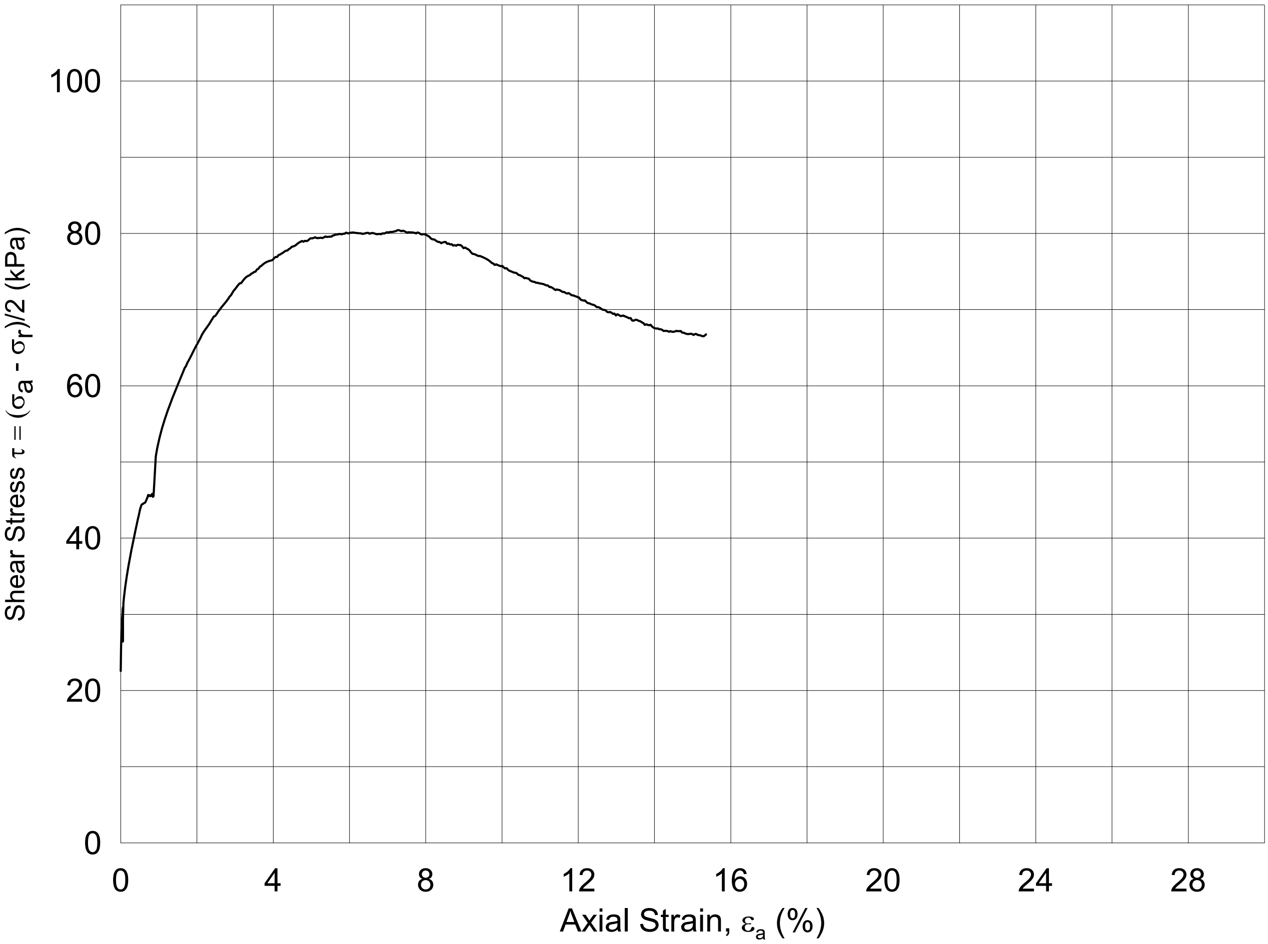
Figure No. 22

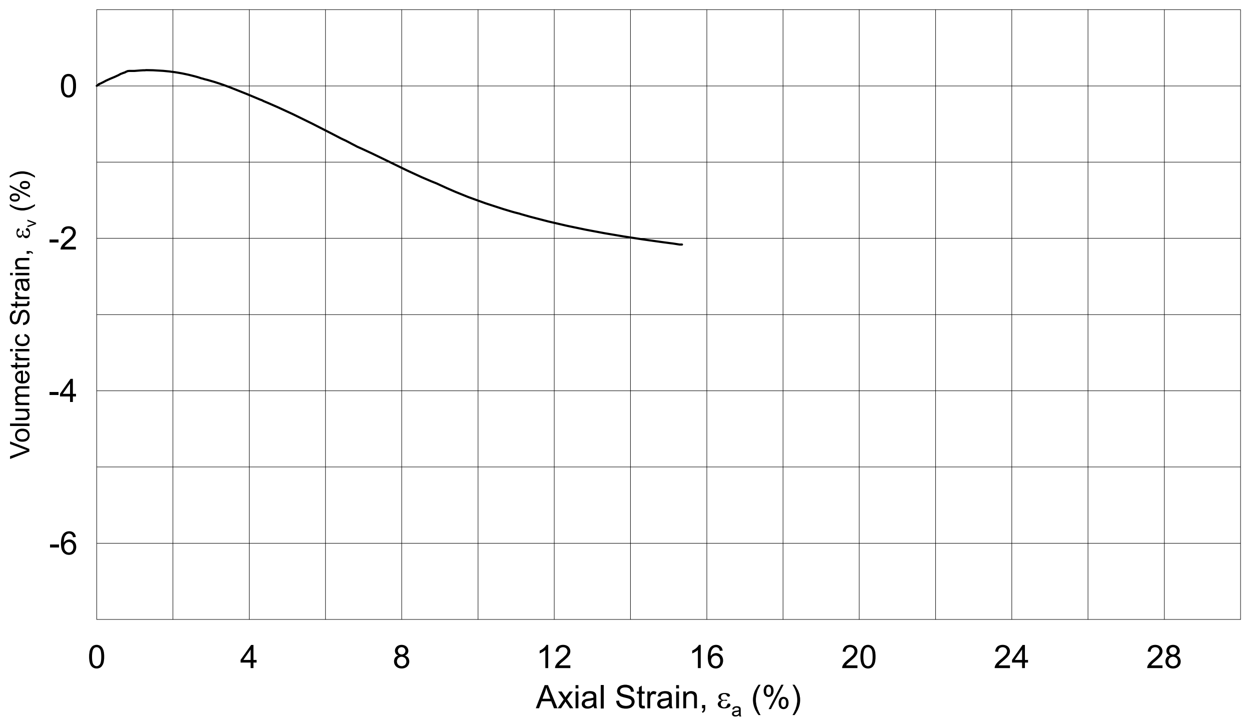
Date 2018-03-22

Drawn by/checked ThV / GS

NGTS

BH15-3-A-1.Plot2.grf





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Document No. 20160154-04-R

Figure No. 23

Triaxial test: **CAD**

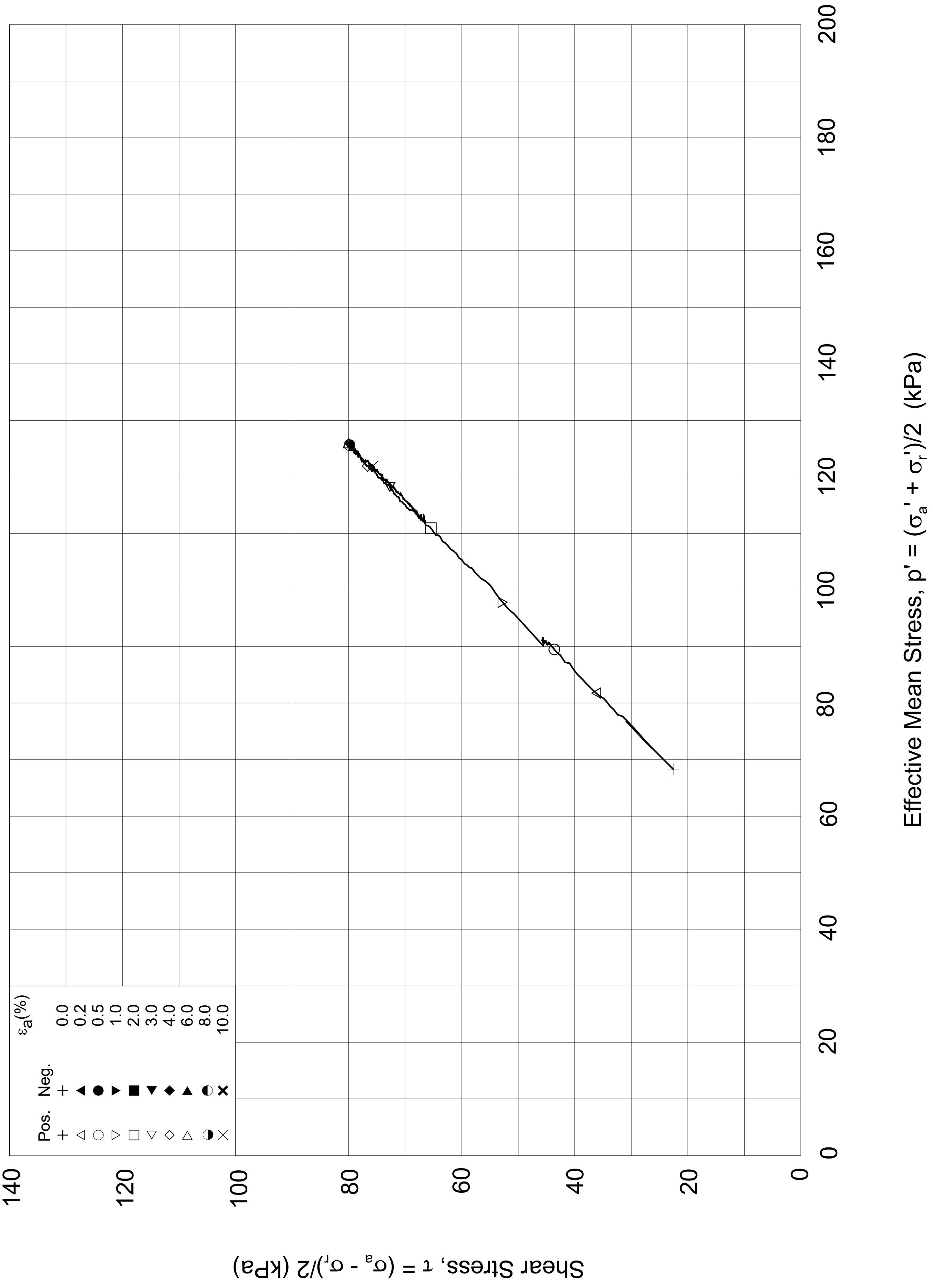
Date 2018-04-06

Drawn by/checked PCa / GS

Boring:	**HALB04**	Depth =	**8.02**	m	Consolidation stresses			
Tube:	**6**	po' =	**91.0**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**27.1**	%	σ_{ac}' =	-	-	**90.8**
Test:	**1**	w_c =	**25.4**	%	σ_{rc}' =	-	-	**45.5**

NGTS

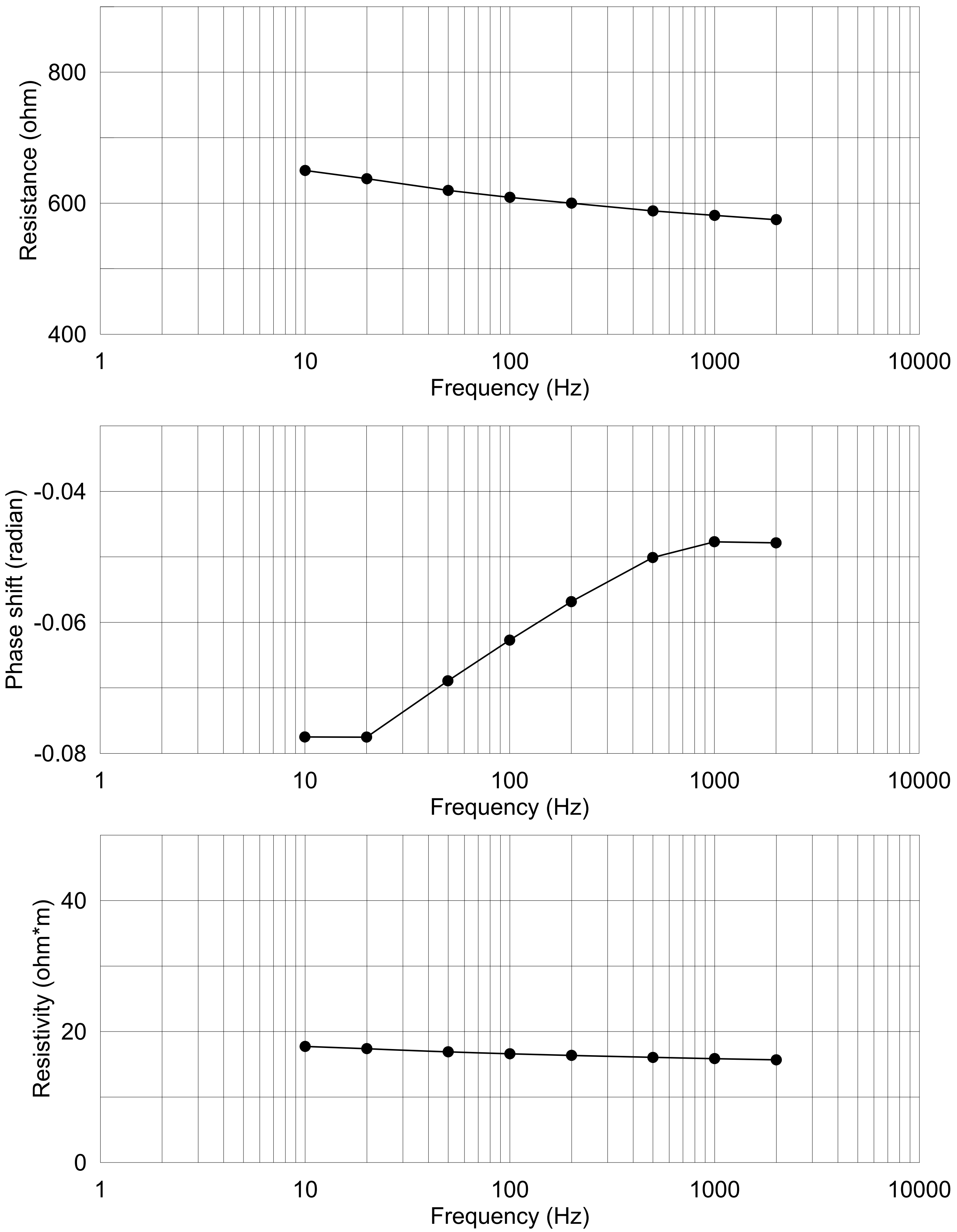
HALB04-6-CAD-1.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site						Document No. 20160154-04-R
Triaxial test: **CAD**						Figure No. 24
Boring: **HALB04**	Depth = **8.02** m	Consolidation stresses				Date 2018-04-06
Tube: **6**	po' = **91.0** kPa	(kPa)	max.	min.	final	Drawn by/checked PCa / GS
Part: **A**	w_i = **27.1** %	σ_{ac}' =	-	-	**90.8**	NGTS
Test: **1**	w_c = **25.4** %	σ_{rc}' =	-	-	**45.5**	

HALB04-6-CAD-1.Plot2.grf



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Document No. 20160154-04-R

Figure No. 25

Date 2018-04-06

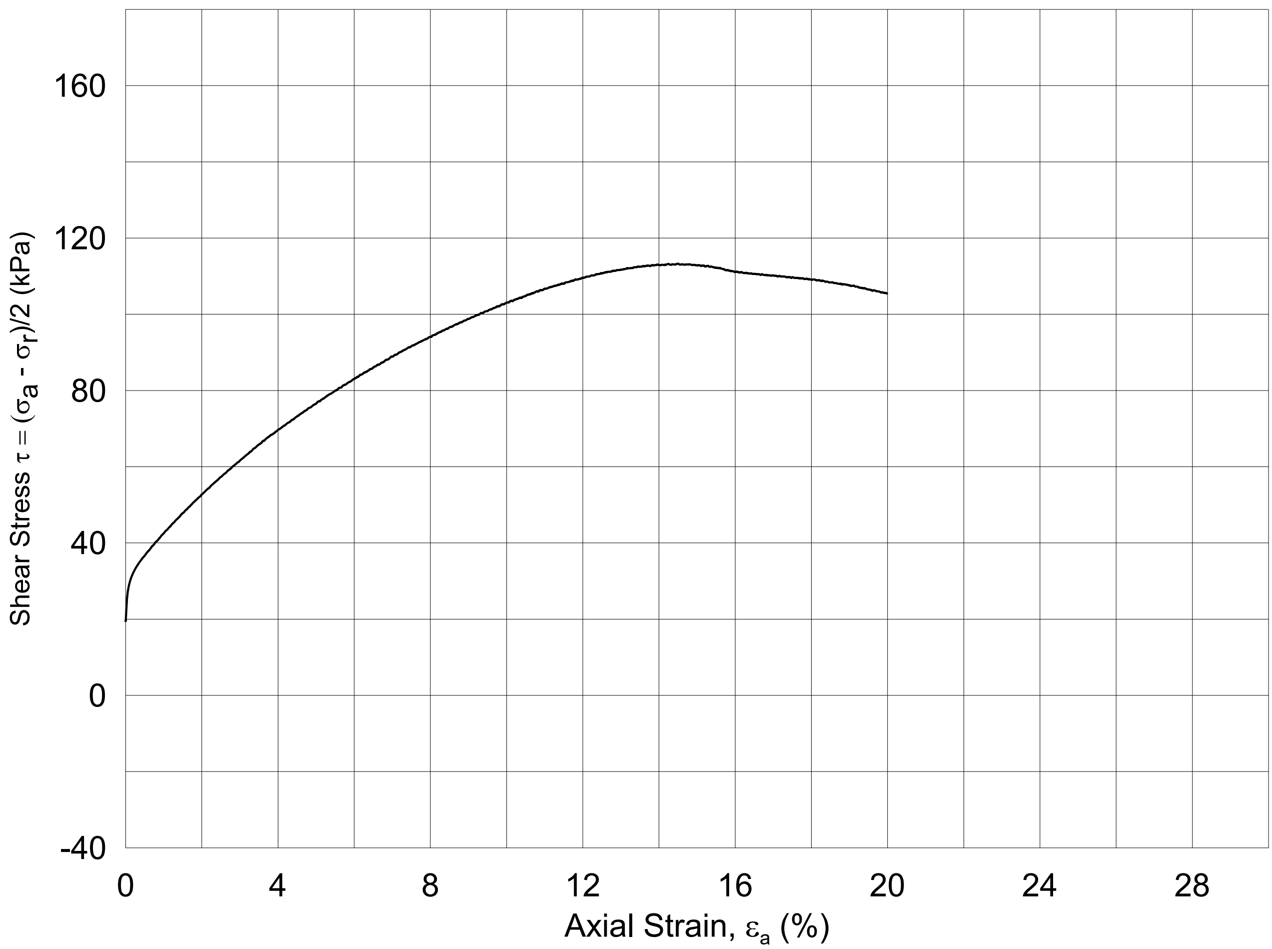
Drawn by/checked PCa / GS

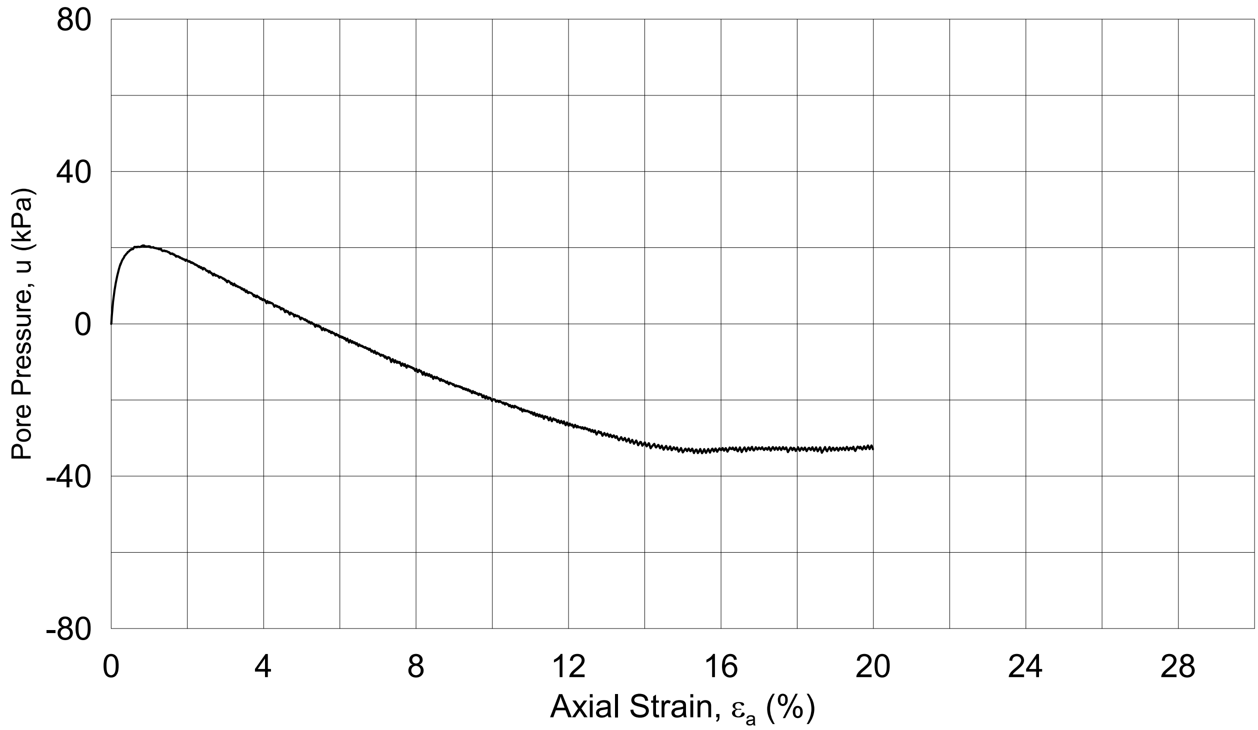
Triaxial test: **CAD**

Resistivity test results

Boring:	**HALB04**	Depth =		**8.02**	m	Consolidation stresses					
Tube:	**6**	po'	=	**91.0**	kPa	(kPa)		max.	min.	final	
Part:	**A**	w_i	=	**27.1**	%	σ_{ac}' =		-	-	**90.8**	
Test:	**1**	w_c	=	**25.4**	%	σ_{rc}' =		-	-	**45.5**	

BH15-12-0-0.Plot1.grf





Dato/rev.: 2014-12-23/01

BH_WFS1_B05A_P23Q1_K0CAUC_22.89.Plot1.grf

NGTS - Halden Research Site

Document No. 20170329-04-R

Figure No. 26

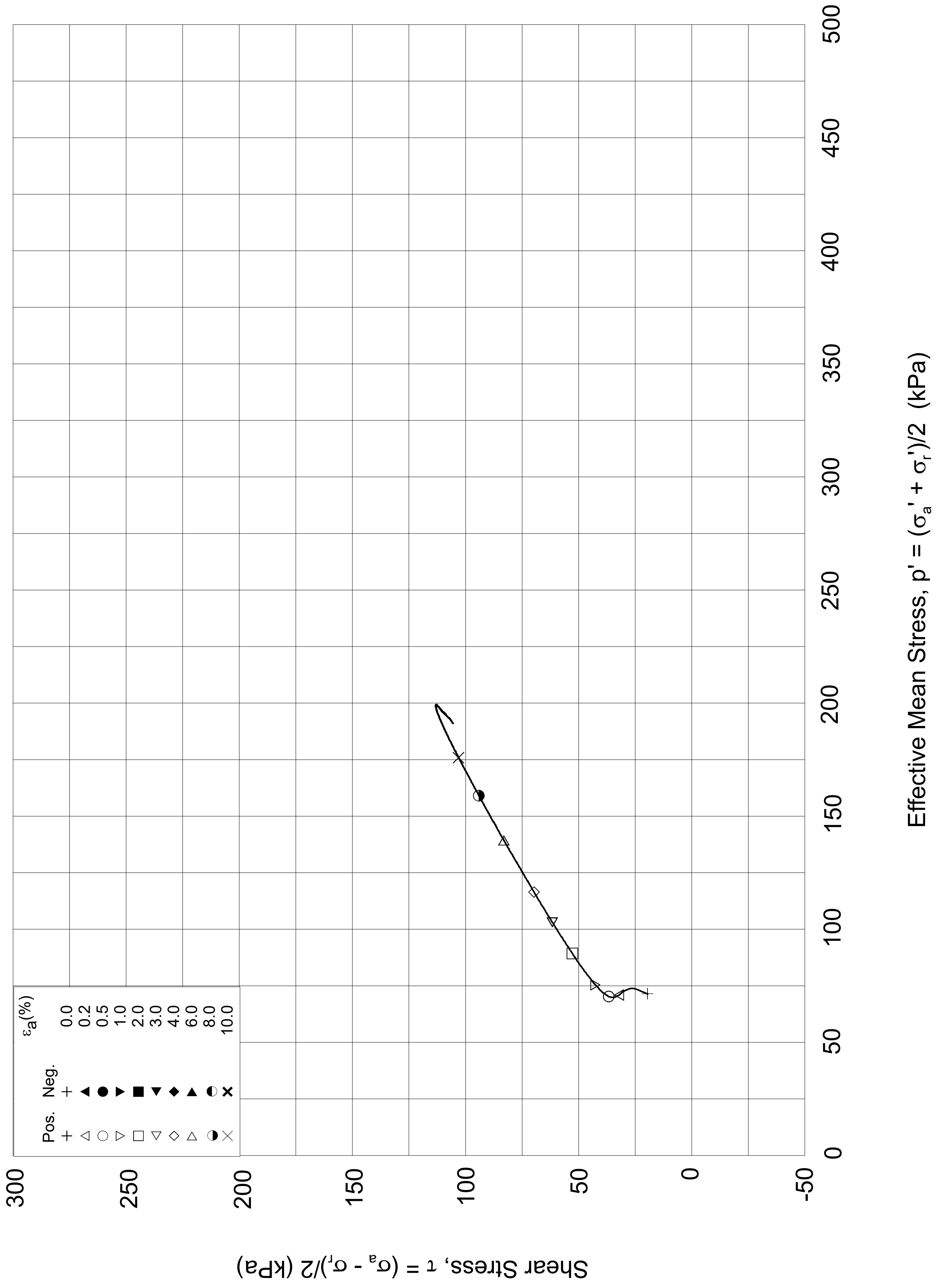
Date 2018-04-06

Drawn by/checked PCa / YuS

Triaxial test: **K0CAUC**

Boring:	**HALB04**	Depth =	**8.02**	m	Consolidation stresses			
Tube:	**6**	po' =	**91.0**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**28.0**	%	σ_{ac}' =	-	-	**90.8**
Test:	**2**	w_c =	**27.6**	%	σ_{rc}' =	-	-	**51.0**

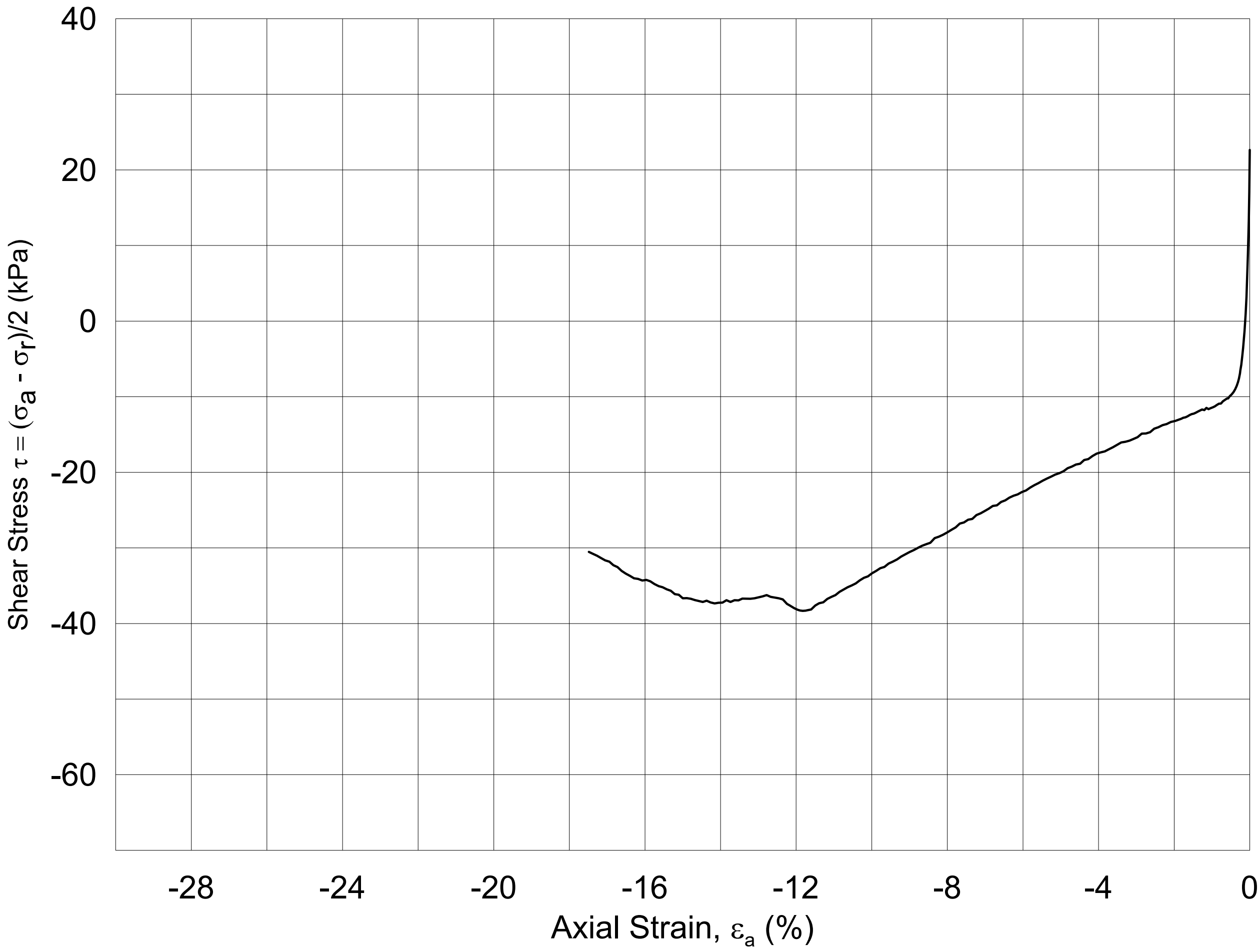
NGTS

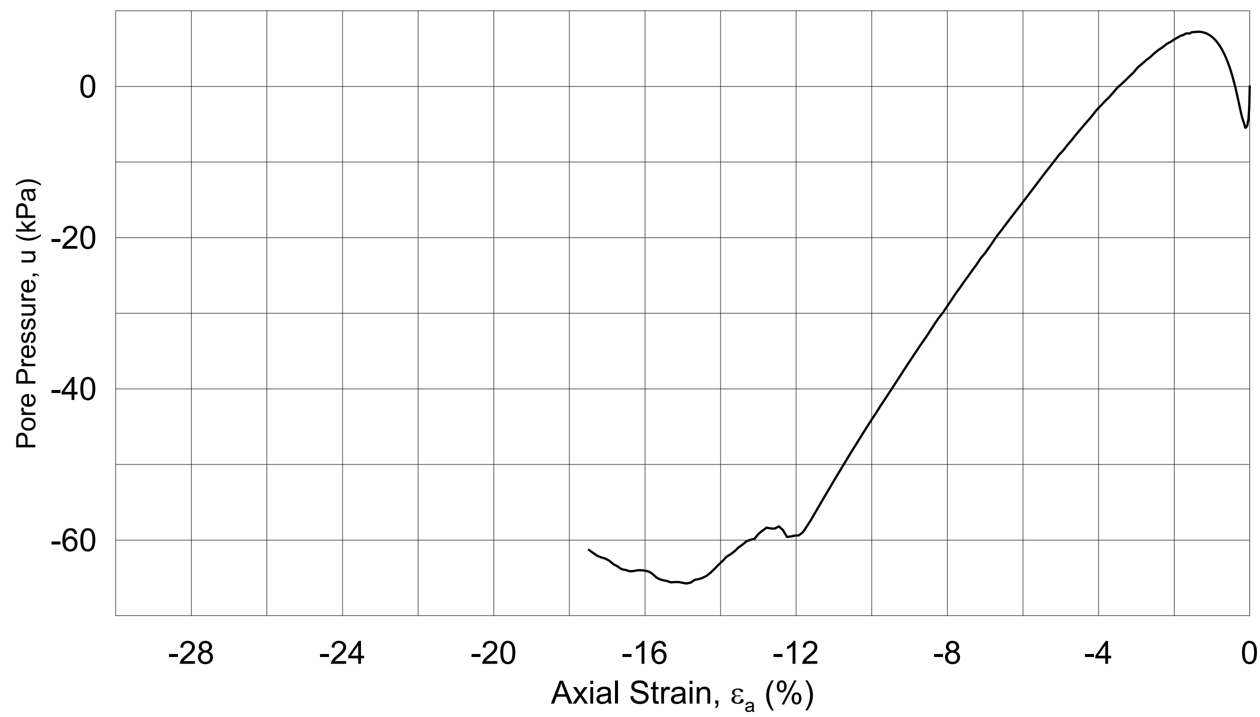


Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site									Document No. 20170329-04-R
Triaxial test: **K0CAUC**									Figure No. 27
Boring:	**HALB04**	Depth =	**8.02**	m	Consolidation stresses				Date 2018-04-06 / Drawn by/checked PCa / YuS
Tube:	**6**	po' =	**91.0**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**28.0**	%	σ_{ac}' =	-	-	**90.8**	NGTS
Test:	**2**	w_c =	**27.6**	%	σ_{rc}' =	-	-	**51.0**	

BH_WFS1_B05A_P23Q1_K0CAUC_22.89.Plot1.grf





Dato/rev.: 2014-12-23/01

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Document No. 20160154-01-R

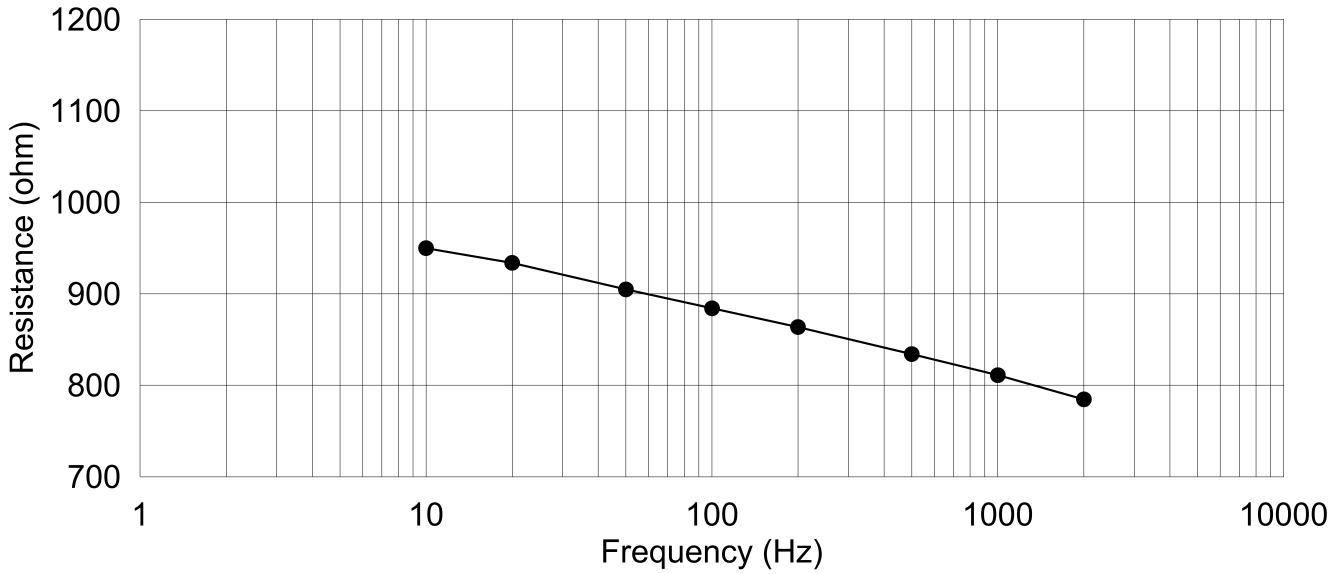
Figure No. 28

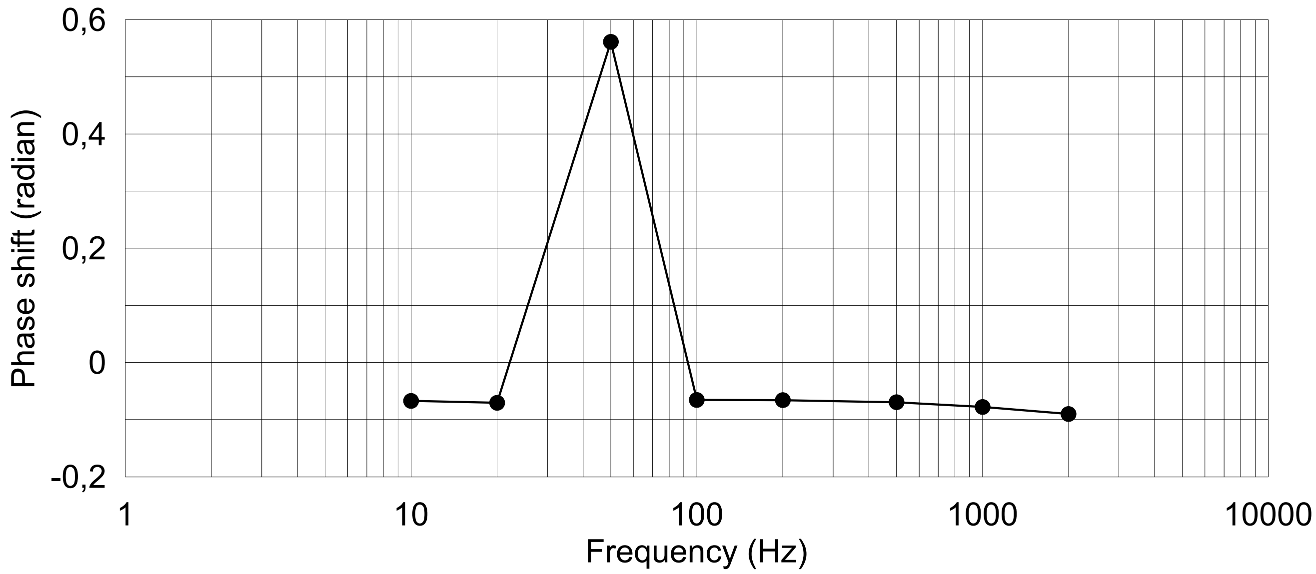
Triaxial test: **CAUE**

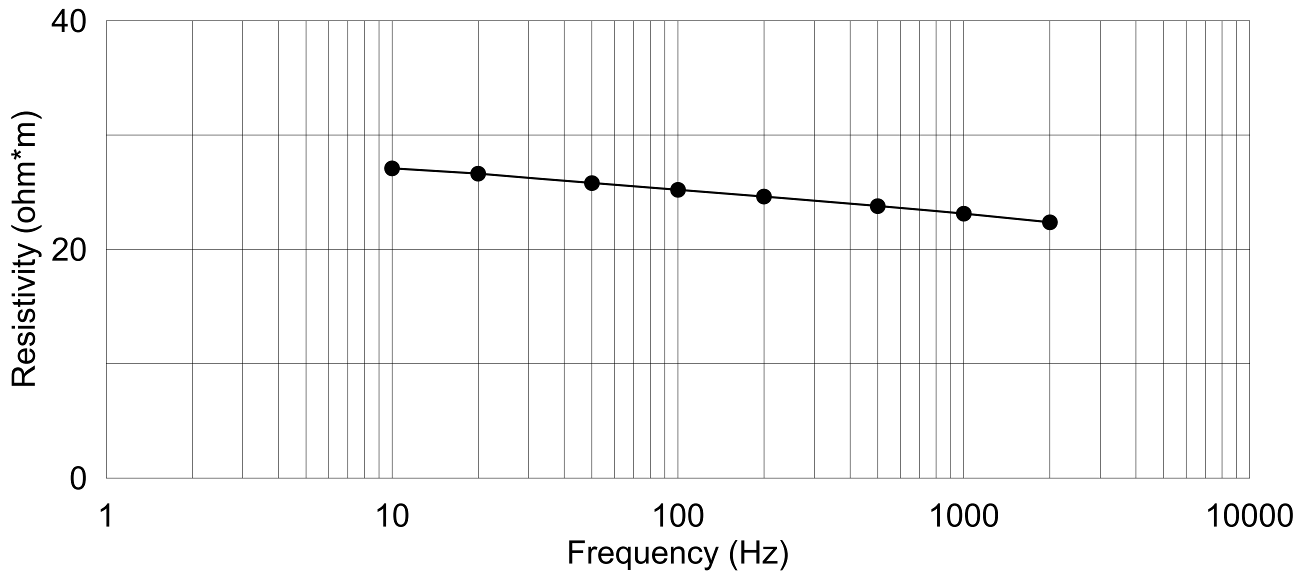
Boring:	**HALB06**	Depth =		**8.65**	m	Consolidation stresses				Date: 2018-07-02	Drawn by/checked: YSu / PCa
Tube:	**3**	po'	=	**91.0**	kPa	(kPa)	max.	min.	final		
Part:	**C**	w_i	=	**28.7**	%	σ_{ac}' =	-	-	**91.0**		
Test:	**1**	w_c	=	**28.0**	%	σ_{rc}' =	-	-	**45.5**		

NGTS

HALB06-3-C-1.Plot1.grf







Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Triaxial test: **CAUE**

Resistivity test results

Figure No. 29.1

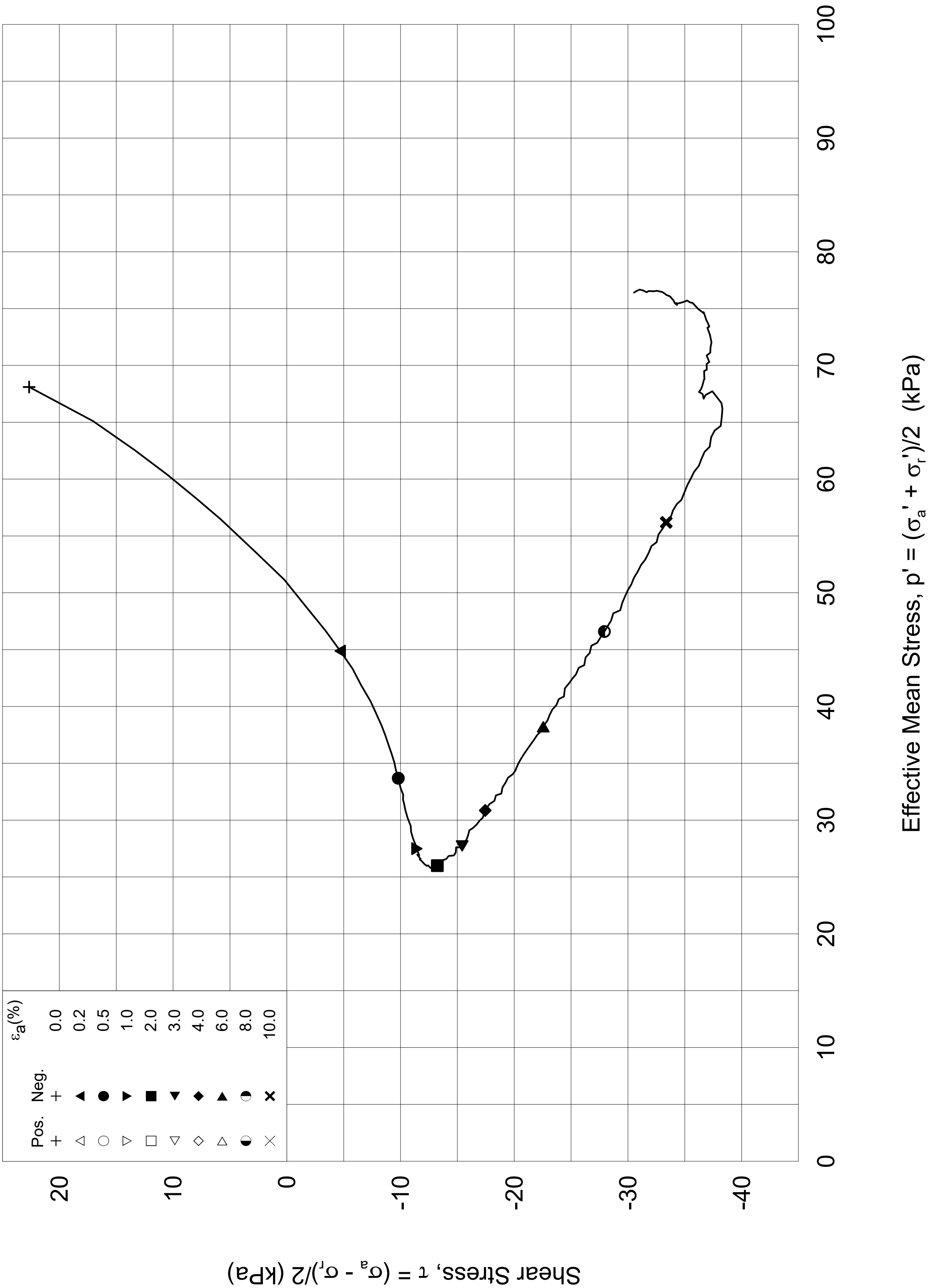
Boring: **HALB06**	Depth = **8.65** m		Consolidation stresses			
Tube: **3**	po' = **91.0** kPa	(kPa)	max.	min.	final	
Part: **C**	w_i = **28.7** %	σ_{ac}' =	-	-	**91.0**	
Test: **1**	w_c = **28.0** %	σ_{rc}' =	-	-	**45.5**	

Date 2018-09-12

Drawn by/checked APP / MAS

NGTS

BH15-12-0-0.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Silt Site

Document No. 20160154-01-R

Figure No. 29

Triaxial test: **CAUE**

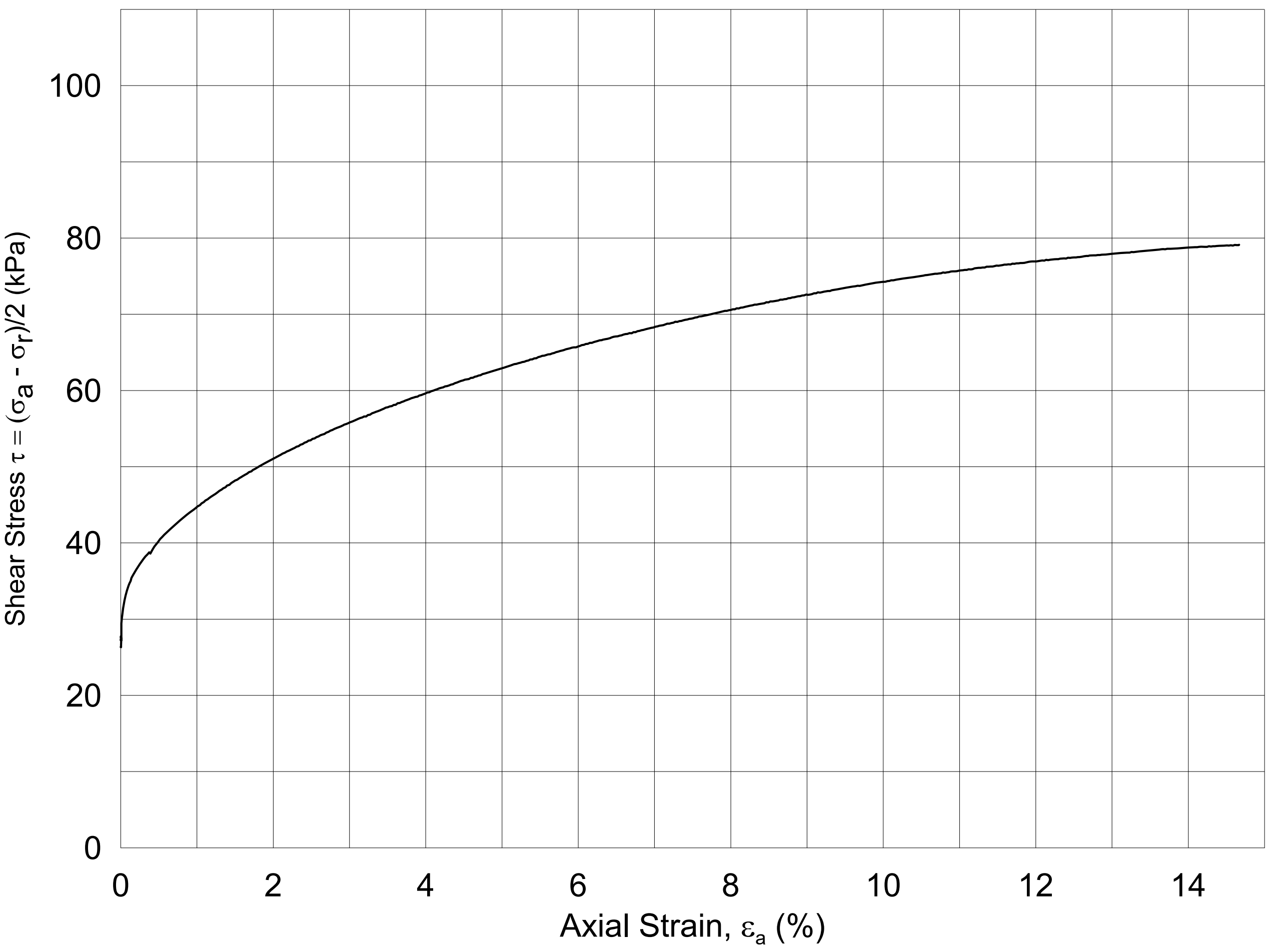
Date 2018-07-02

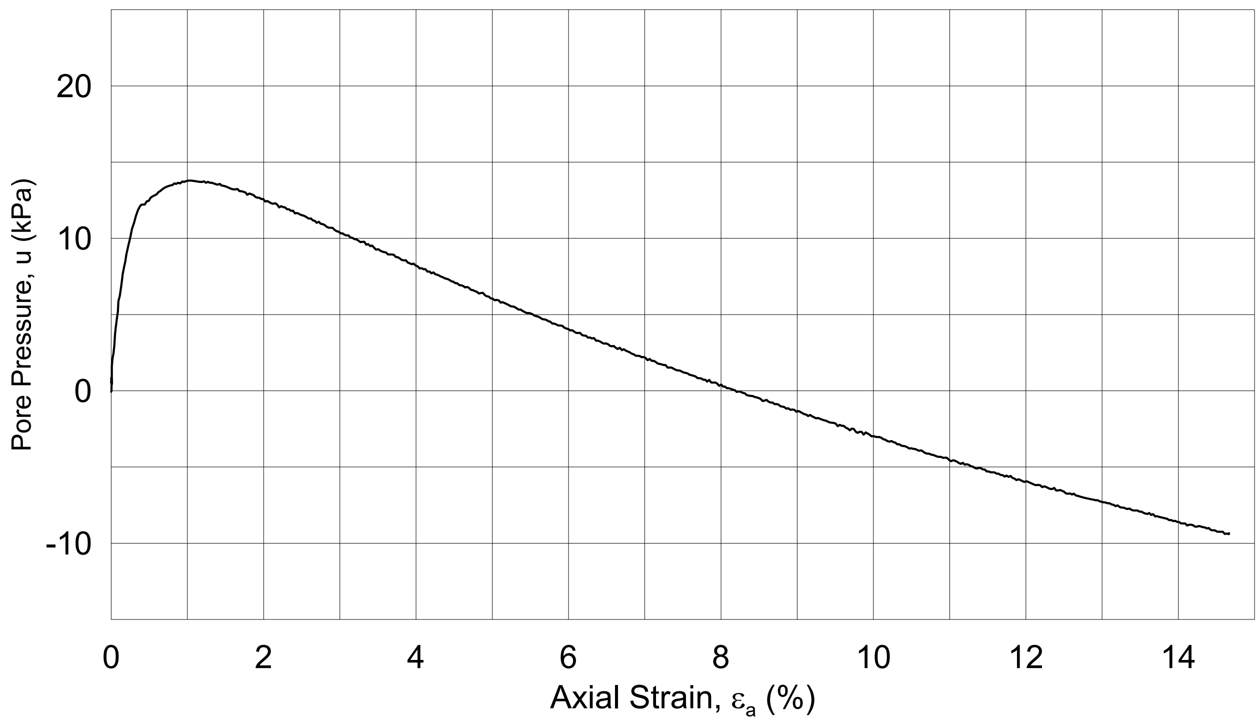
Drawn by/checked YSu / PCa

Boring:	**HALB06**	Depth =	**8.65**	m		Consolidation stresses			
Tube:	**3**	po' =	**91.0**	kPa		(kPa)	max.	min.	final
Part:	**C**	w_i =	**28.7**	%		σ_{ac}' =	-	-	**91.0**
Test:	**1**	w_c =	**28.0**	%		σ_{rc}' =	-	-	**45.5**

NGTS

HALB06-3-C-1.Plot2.grf

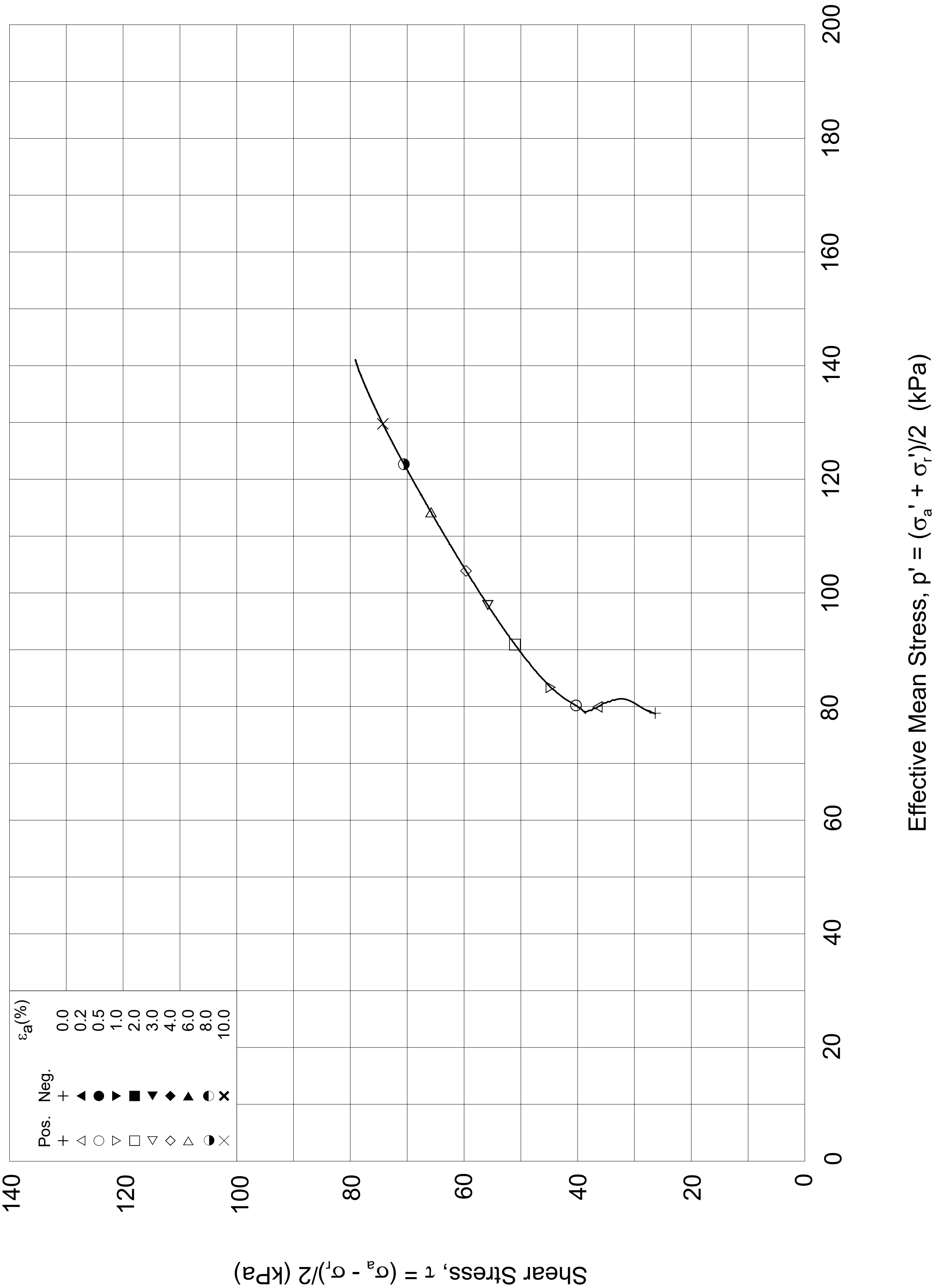




Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site										Document No. 20160154-04-R
Triaxial test: **CAUC**										Figure No. 30
Boring:	**HALB04**	Depth =	**8.36**	m	Consolidation stresses					Date 2018-04-06; Drawn by/checked MAS / GS
Tube:	**5.5**	po' =	**105.0**	kPa	(kPa)	max.	min.	final		NGTS
Part:	**A**	w_i =	**30.1**	%	σ_{ac}' =	-	-	**105.0**		
Test:	**1**	w_c =	**29.2**	%	σ_{rc}' =	-	-	**52.4**		

BH15-5.5-A-1.Plot1.grf



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Triaxial test: **CAUC**

Figure No. 31

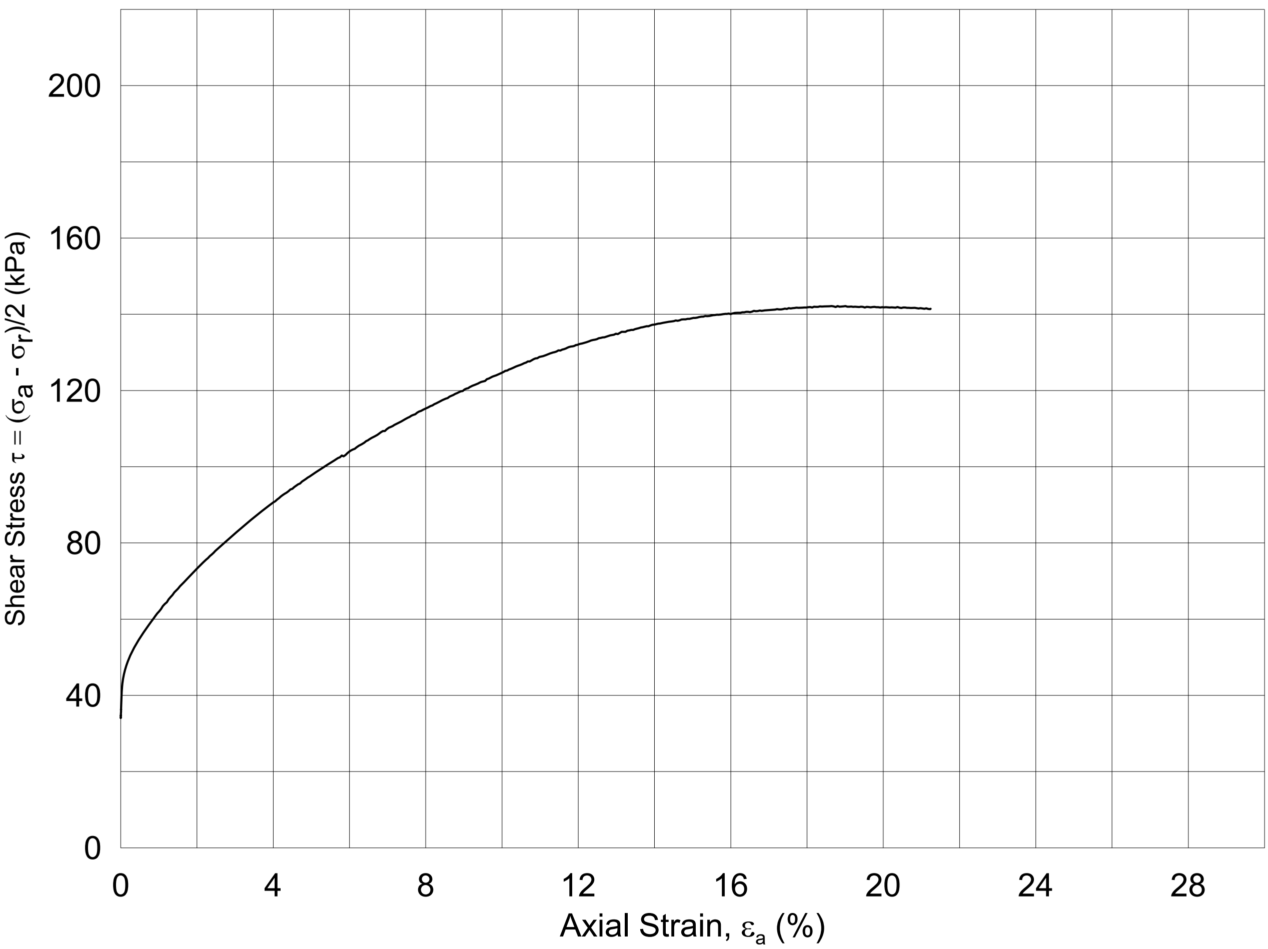
Date 2018-04-06

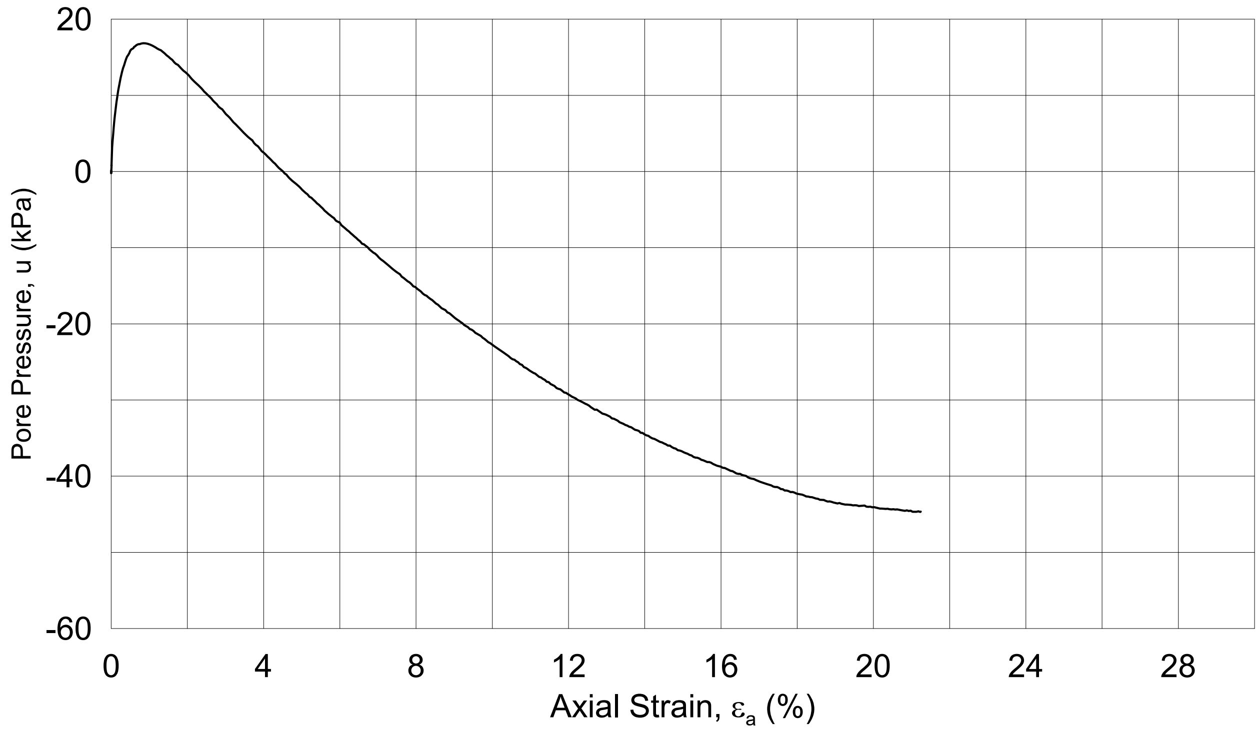
Drawn by/checked MAS / GS

Boring:	**BH15**	Depth =	**8.36**	m	Consolidation stresses				
Tube:	**5.5**	po' =	**105.0**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**30.1**	%	σ_{ac}' =	-	-	**105.0**	
Test:	**1**	w_c =	**29.2**	%	σ_{rc}' =	-	-	**52.4**	

NGTS

BH15-5.5-A-1.Plot2.grf





Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Triaxial test: **CAUC + Resistivity**

Figure No. 32

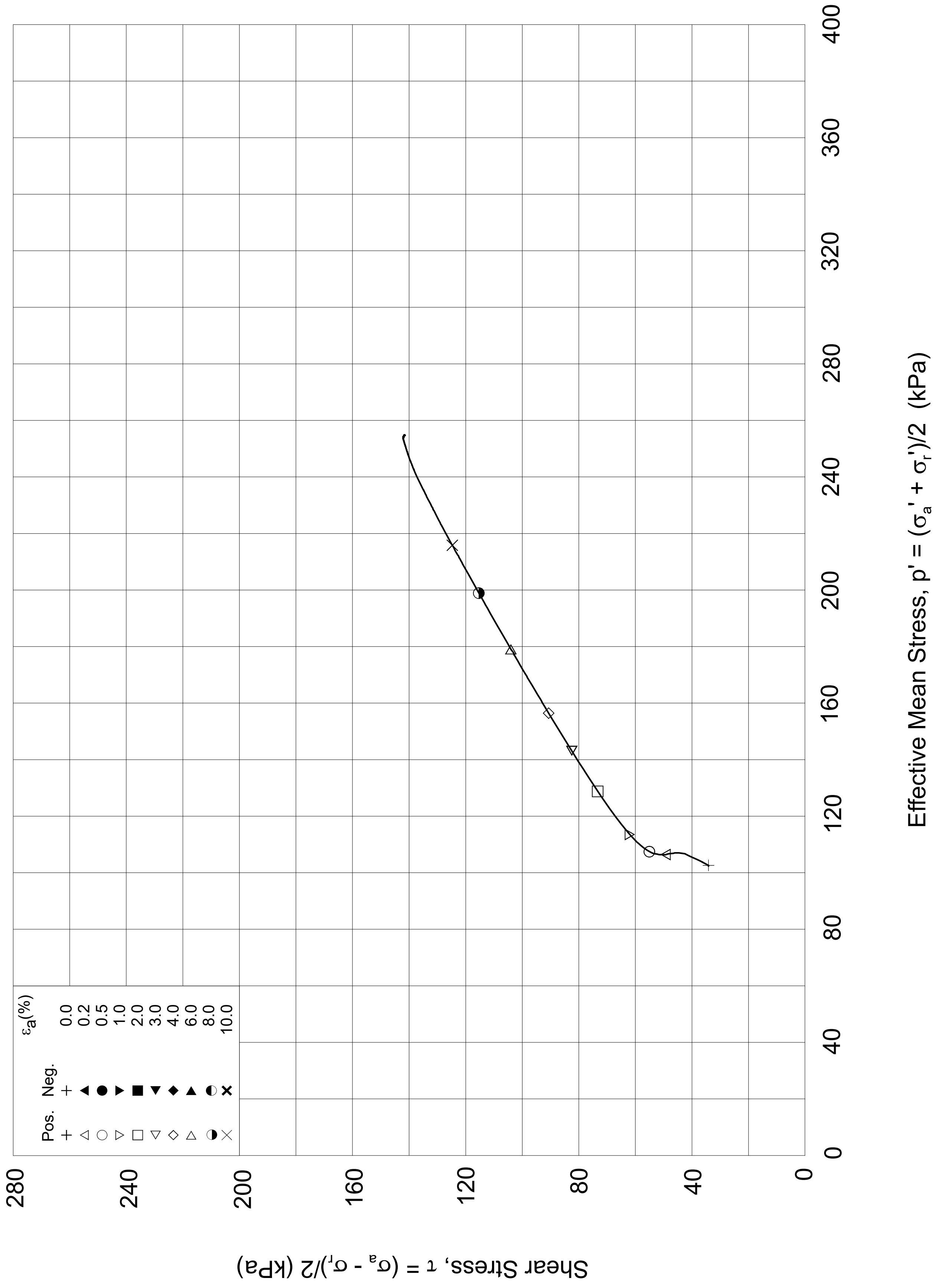
Date 2018-04-06

Drawn by/checked YSu / GS

Boring:	**HALB04**	Depth =	**12.58**	m	Consolidation stresses			
Tube:	**12**	po' =	**136.5**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**26.6**	%	σ_{ac}' =	-	-	**136.5**
Test:	**1**	w_c =	**25.9**	%	σ_{rc}' =	-	-	**68.3**

NGTS

BH15-12-0-0.Plot1.grf



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Document No. 20160154-04-R

Figure No. 33

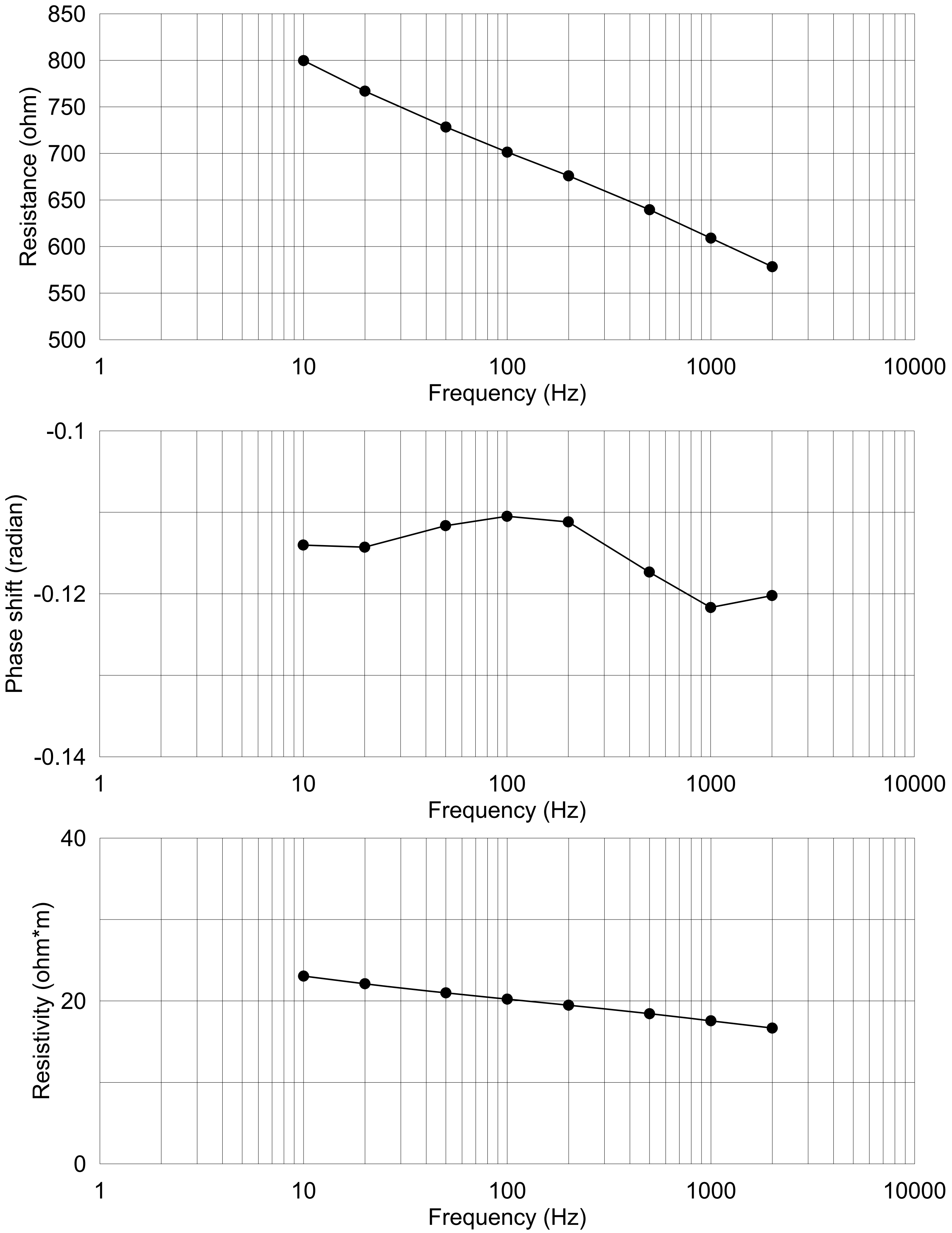
Triaxial test: **CAUC + Resistivity**

Date 2018-04-06

Drawn by/checked YSu / GS

Boring:	**HALB04**	Depth =		**12.58**	m	Consolidation stresses			
Tube:	**12**	po'	=	**136.5**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i	=	**26.6**	%	σ_{ac}' =	-	-	**136.5**
Test:	**1**	w_c	=	**25.9**	%	σ_{rc}' =	-	-	**68.3**

BH15-12-0-0.Plot2.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site

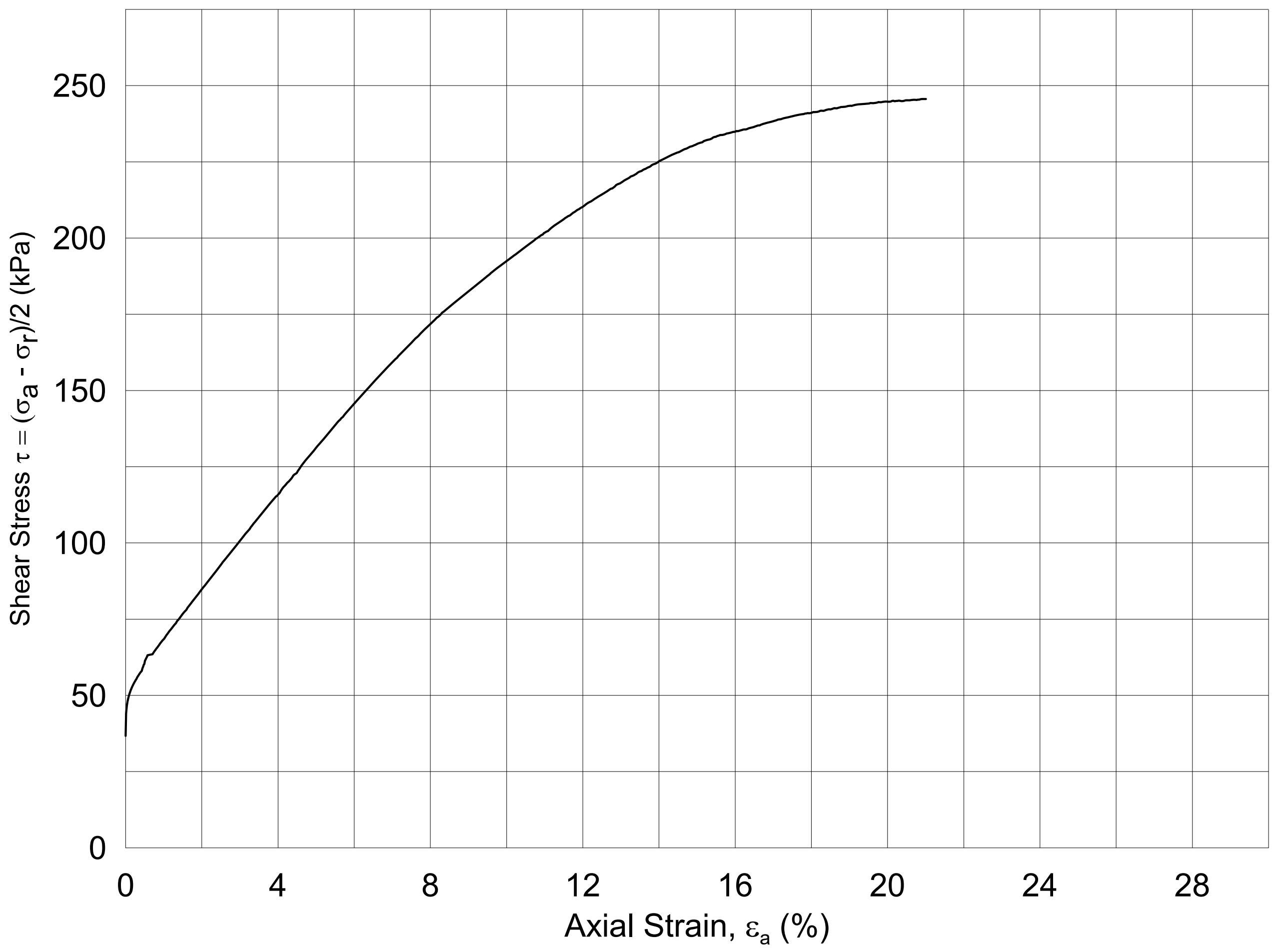
Document No. 20160154-04-R

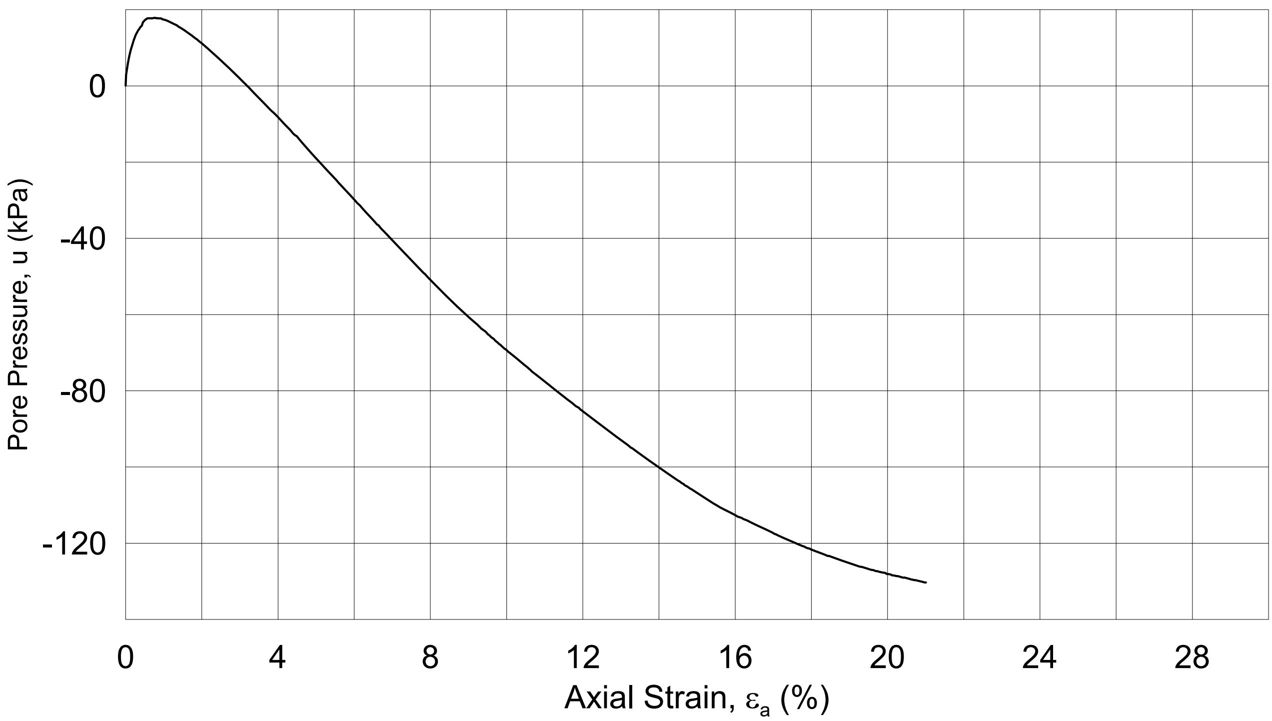
Triaxial test: **CAUC + Resistivity**

Figure No. 34

Boring:	**HALB04**	Depth =	**12.58**	m	Consolidation stresses				Date 2018-04-06	Drawn by/checked YSu / GS
Tube:	**12**	po' =	**136.5**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i =	**26.6**	%	σ_{ac}' =	-	-	**136.5**	NGTS	
Test:	**1**	w_c =	**25.9**	%	σ_{rc}' =	-	-	**68.3**		

BH15-12-0-0.Plot1.grf

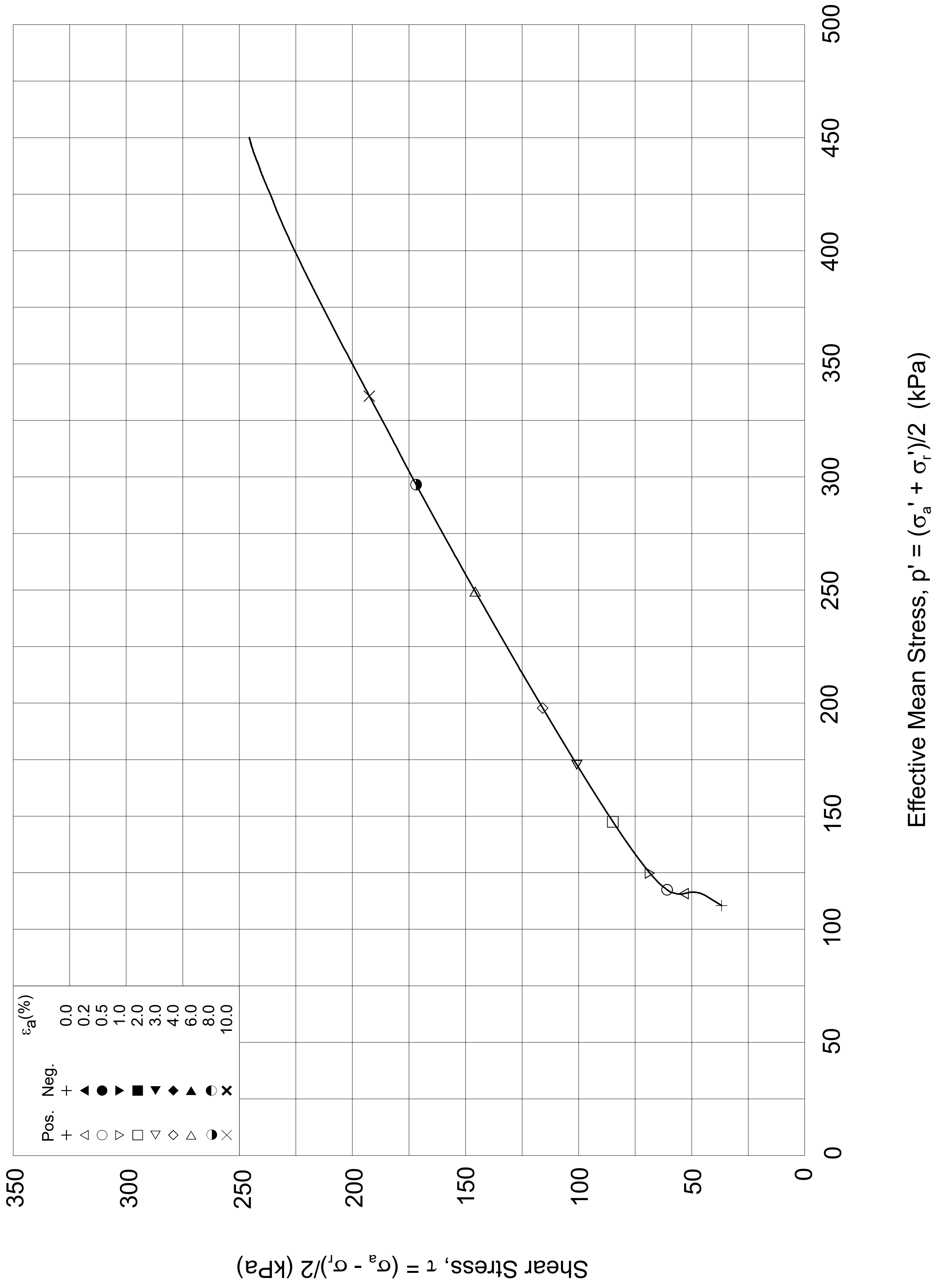




Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site										Document No. 20160154-04-R
Triaxial test: **CAUC**										Figure No. 35
Boring:	**HALB04**	Depth	=	**13.55**	m	Consolidation stresses				Date 2018-04-06 / Drawn by/checked MAS / GS
Tube:	**2_Mini**	po'	=	**147.5**	kPa	(kPa)	max.	min.	final	NGTS
Part:	**A**	w_i	=	**25.2**	%	σ_{ac}' =	-	-	**147.3**	
Test:	**1**	w_c	=	**24.8**	%	σ_{rc}' =	-	-	**73.8**	

BH15-2_Mini-A-1.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 36

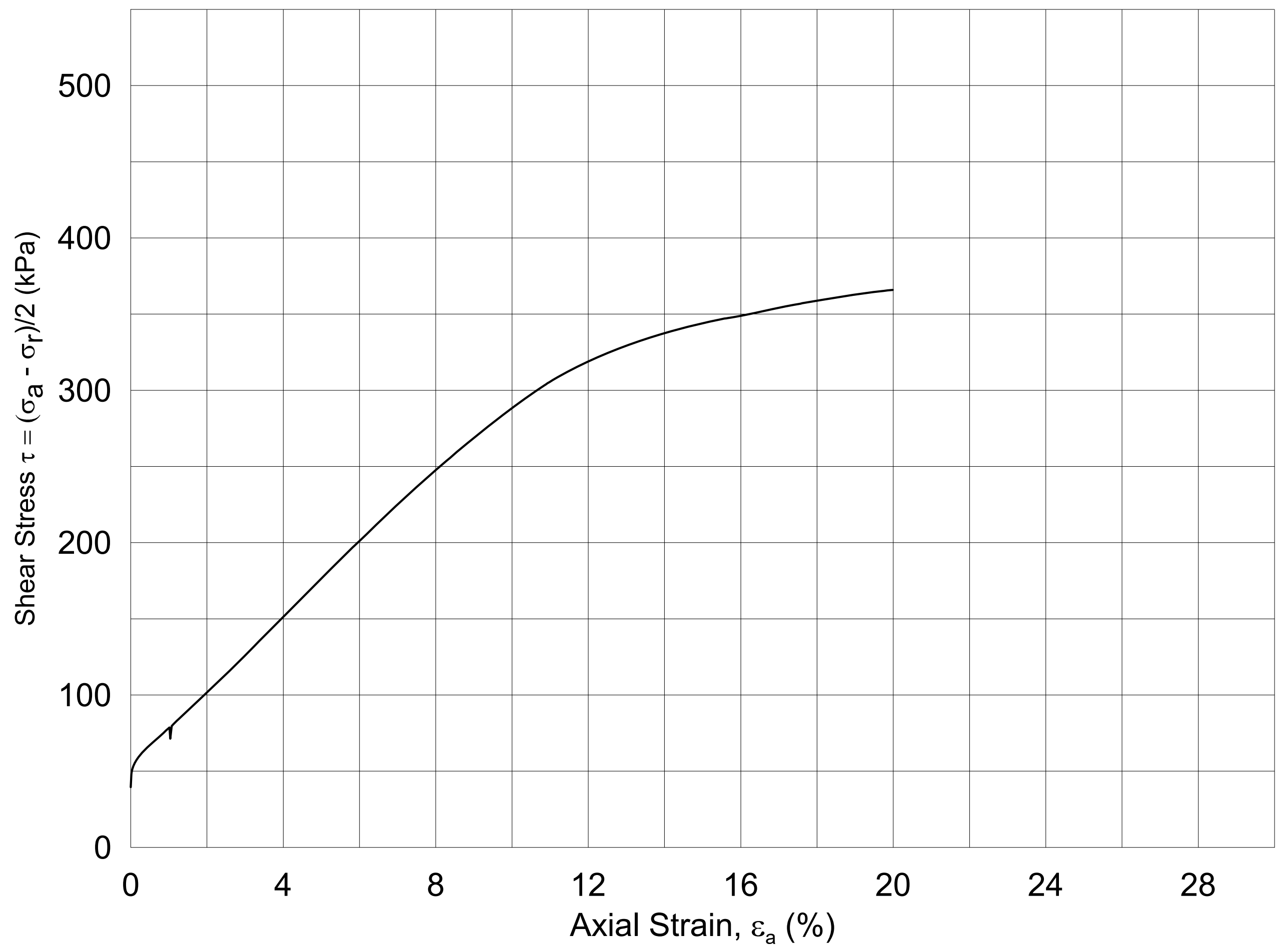
Triaxial test: **CAUC**

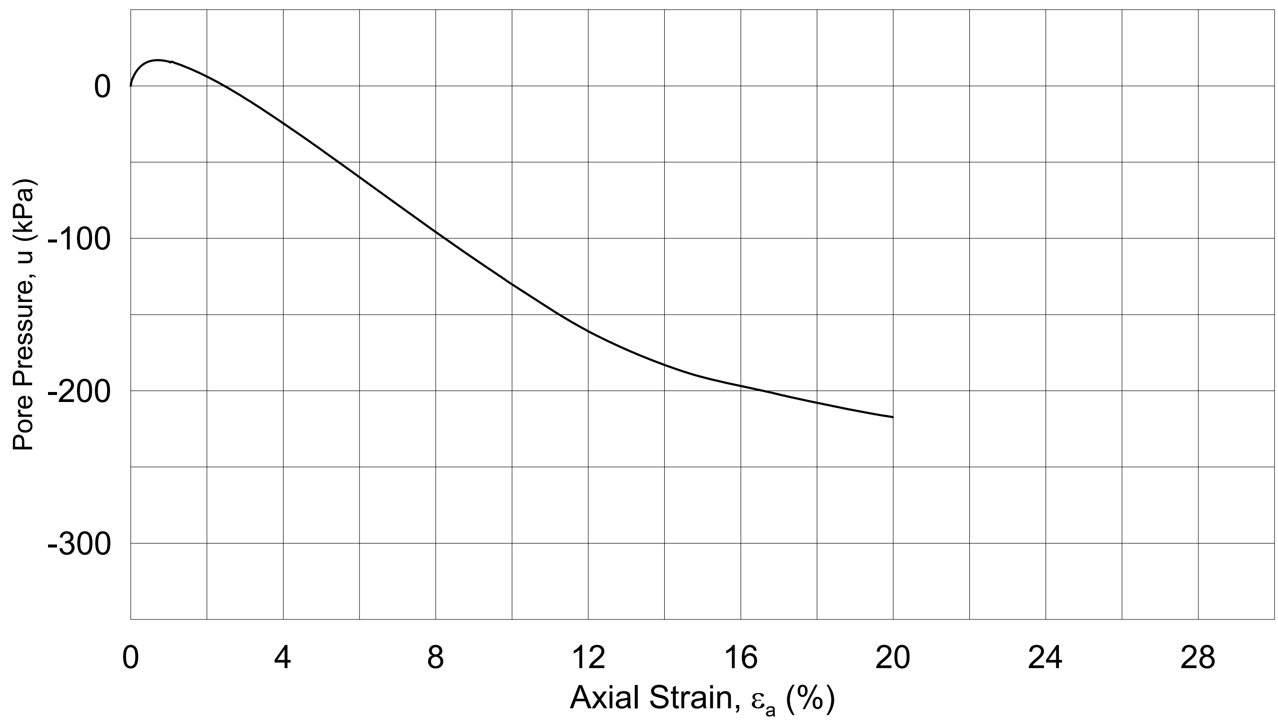
Date 2018-04-06

Drawn by/checked MAS / GS

Boring:	**HALB04**	Depth =	**13.55**	m	Consolidation stresses				
Tube:	**2_Mini**	po' =	**147.5**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**25.2**	%	σ_{ac}' =	-	-	**147.3**	
Test:	**1**	w_c =	**24.8**	%	σ_{rc}' =	-	-	**73.8**	

BH15-2_Mini-A-1.Plot2.grf





NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 37

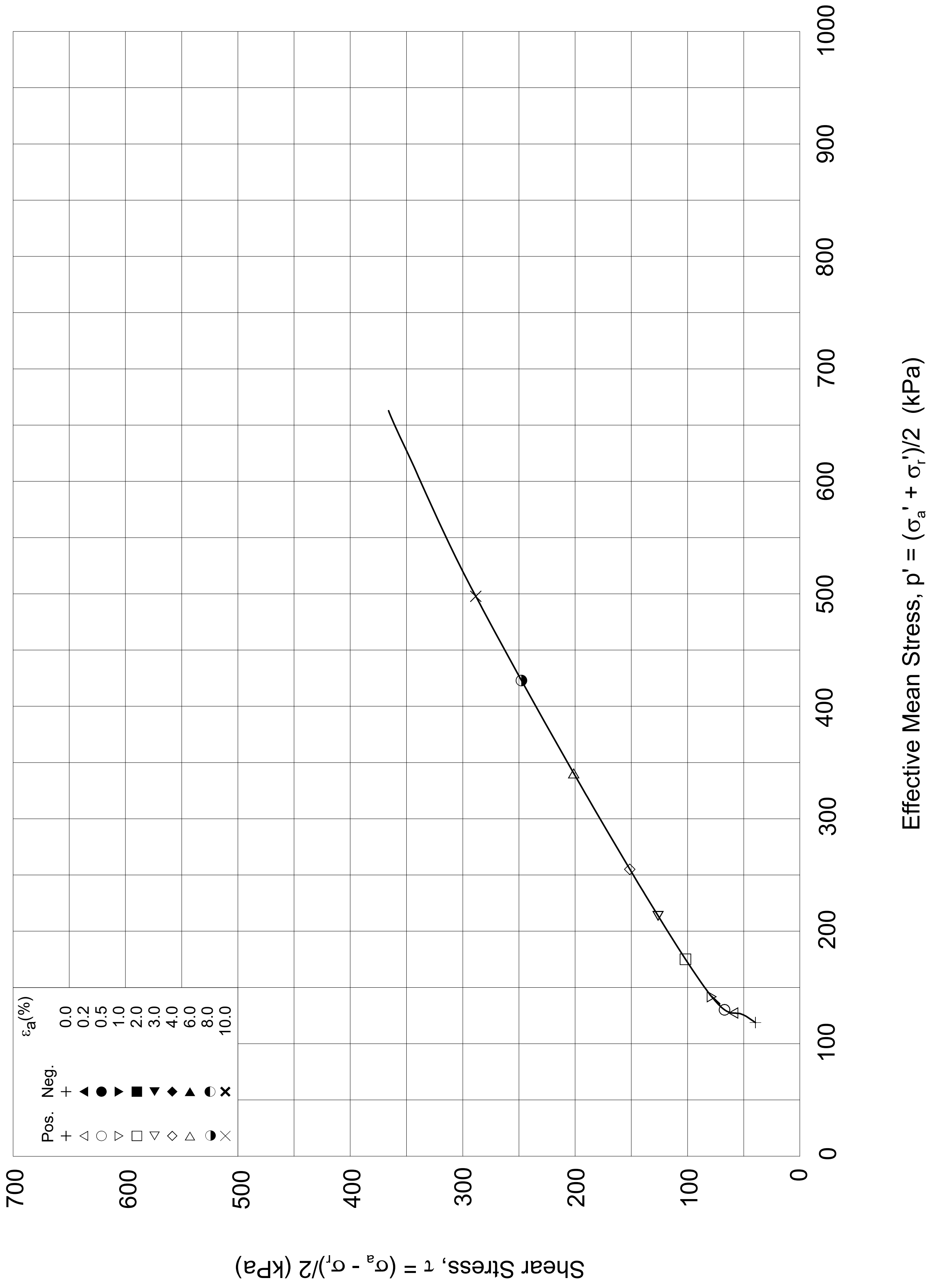
Date 2018-04-06

Drawn by/checked MAS / GS

Triaxial test: **CAUC**

Boring:	**HALB04**	Depth =		**14.60**	m	Consolidation stresses			
Tube:	**13**	po'	=	**158.5**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i	=	**23.2**	%	σ_{ac}' =	-	-	**158.4**
Test:	**1**	w_c	=	**21.7**	%	σ_{rc}' =	-	-	**79.3**

BH15-13-A-1.Plot1.grf



Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site

Document No. 20160154-04-R

Figure No. 38

Triaxial test: **CAUC**

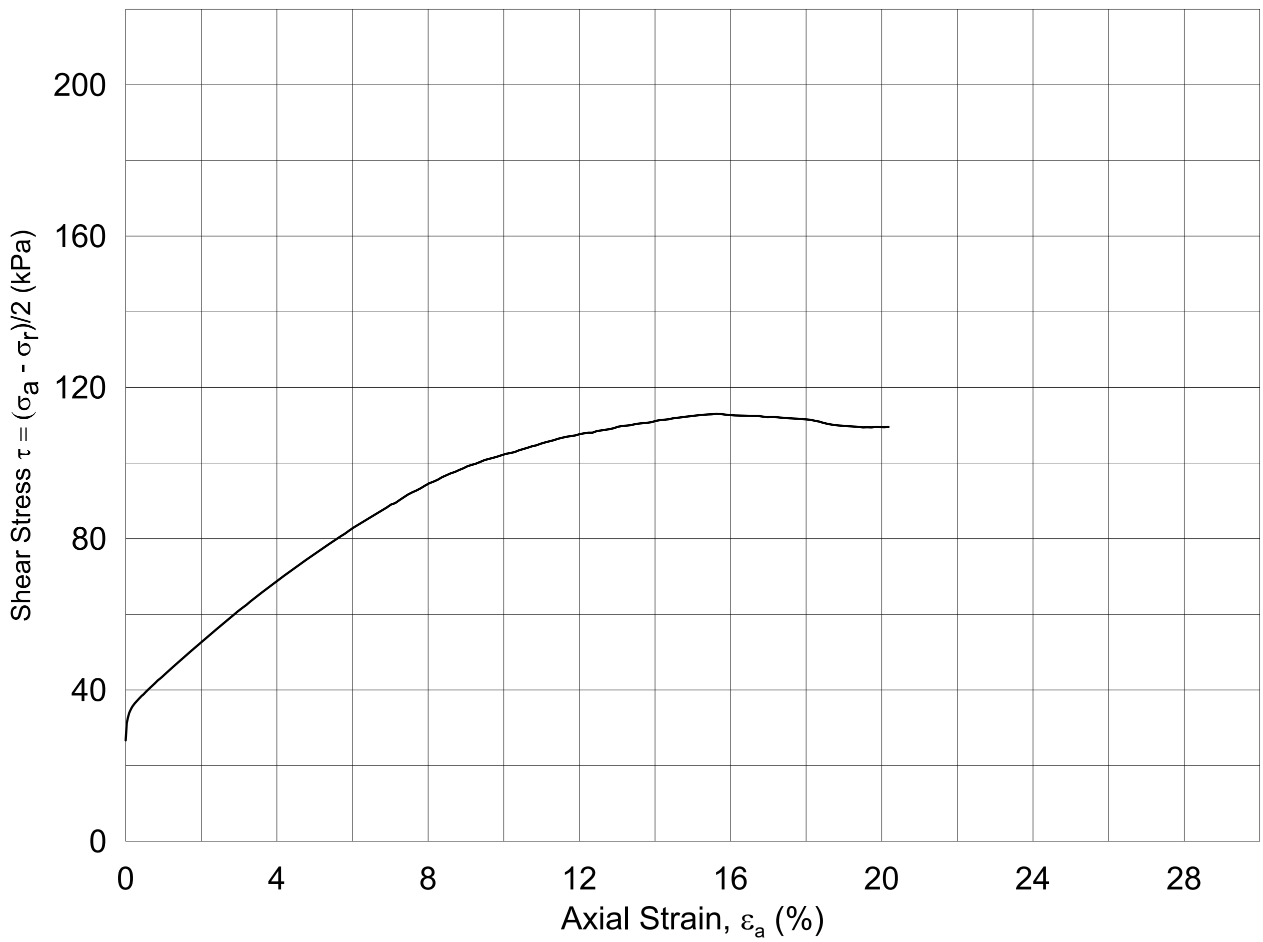
Boring: **HALB04**	Depth =	**14.60**	m	Consolidation stresses		
Tube: **13**	po' =	**158.5**	kPa	(kPa) max.	min.	final
Part: **A**	w_i =	**23.2**	%	σ_{ac}' = -	-	**158.4**
Test: **1**	w_c =	**21.7**	%	σ_{rc}' = -	-	**79.3**

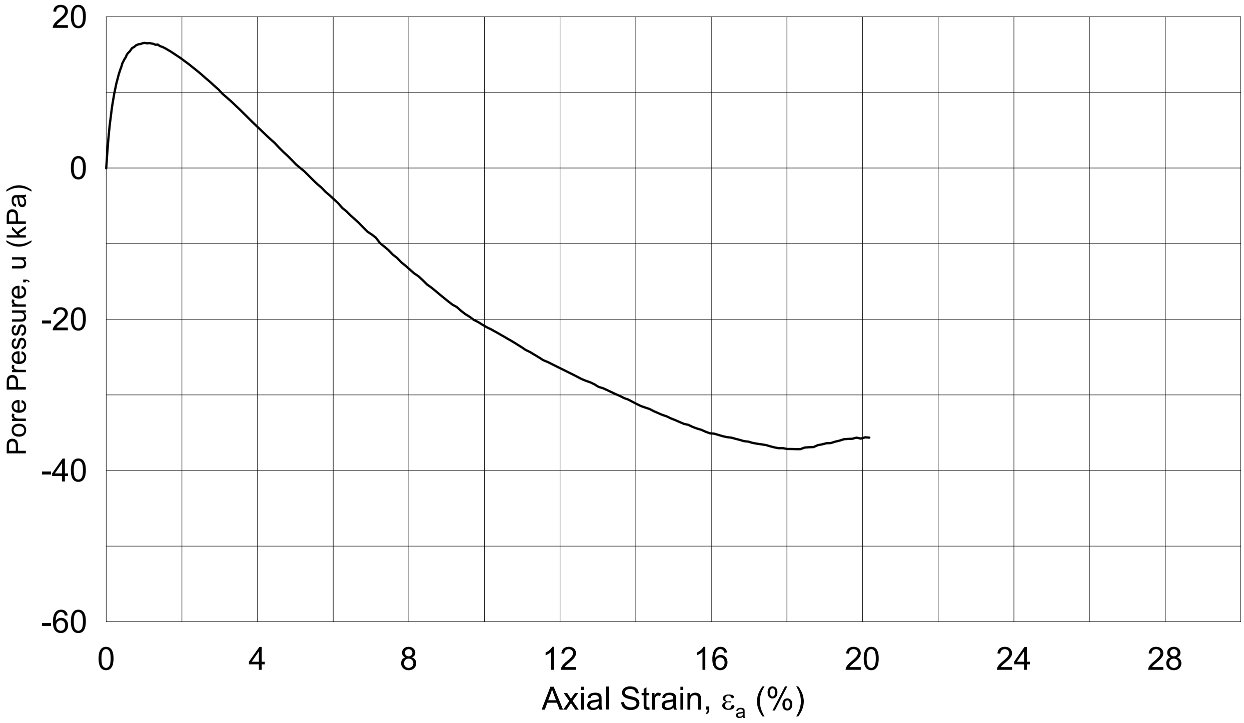
Date 2018-04-06

Drawn by/checked MAS / GS

NGTS

BH15-13-A-1.Plot2.grf





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Document No. 20160154-01-R

Figure No. 39

Triaxial test: **CAUC**

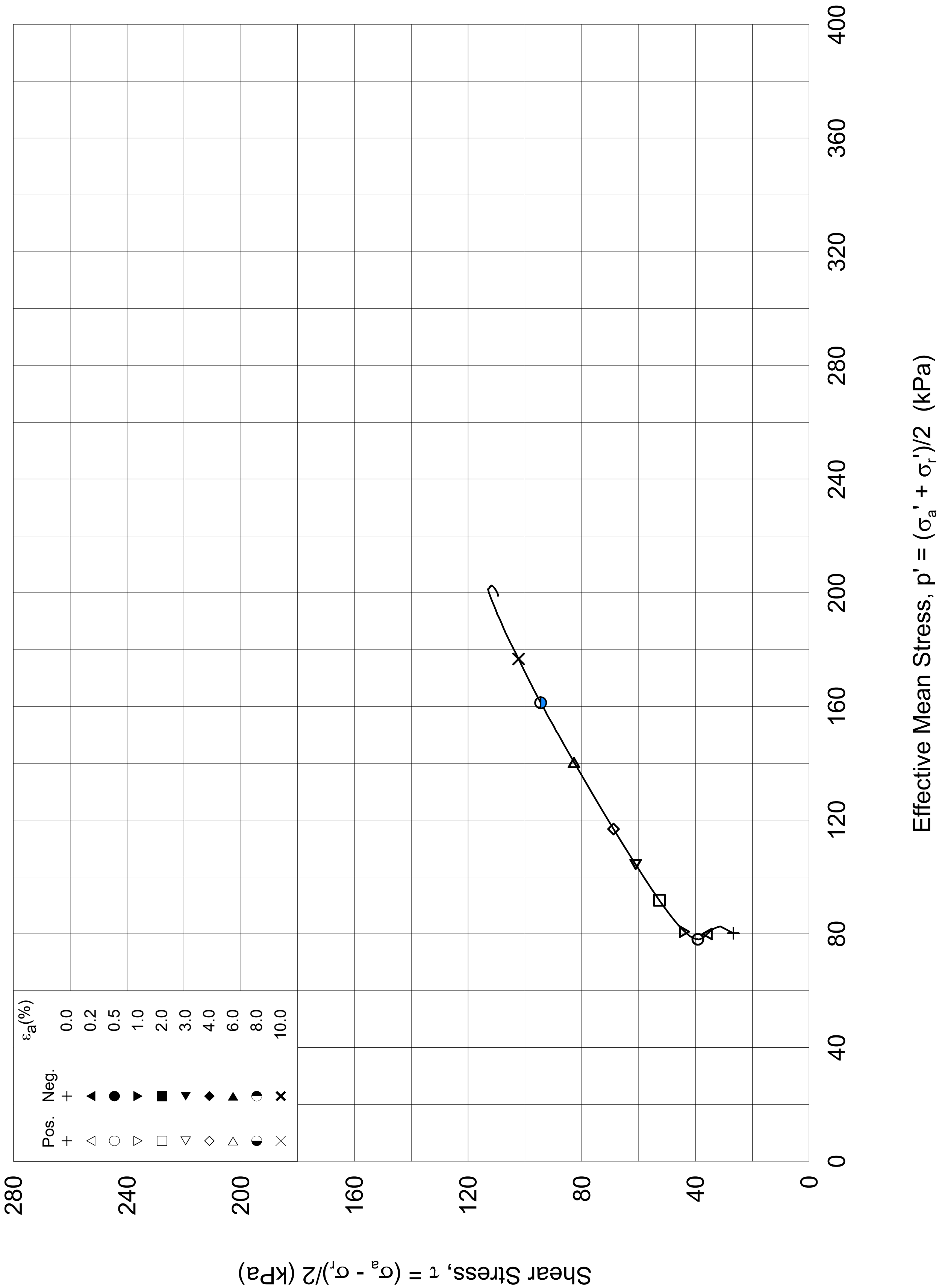
Date 2018-06-22

Drawn by/checked ThV / GS

Boring:	**HALB06**	Depth =	**9.93**	m			Consolidation stresses				
Tube:	**4**	po'	=	**107.0**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i	=	**29.4**	%	σ_{ac}' =	-	-	**107.0**		
Test:	**1**	w_c	=	**28.5**	%	σ_{rc}' =	-	-	**53.5**		

NGTS

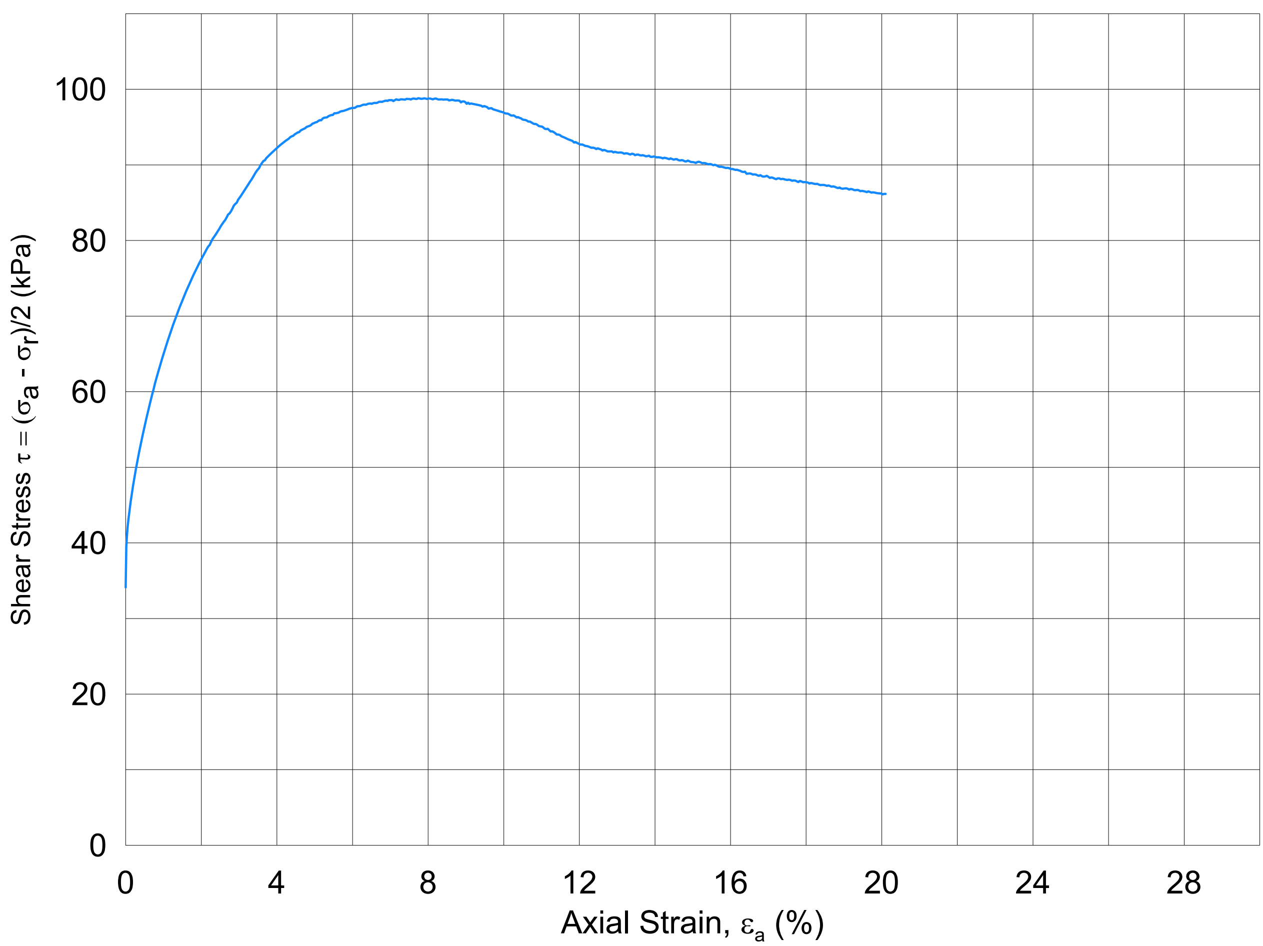
HALB06-4-A-1.Plot1.grf

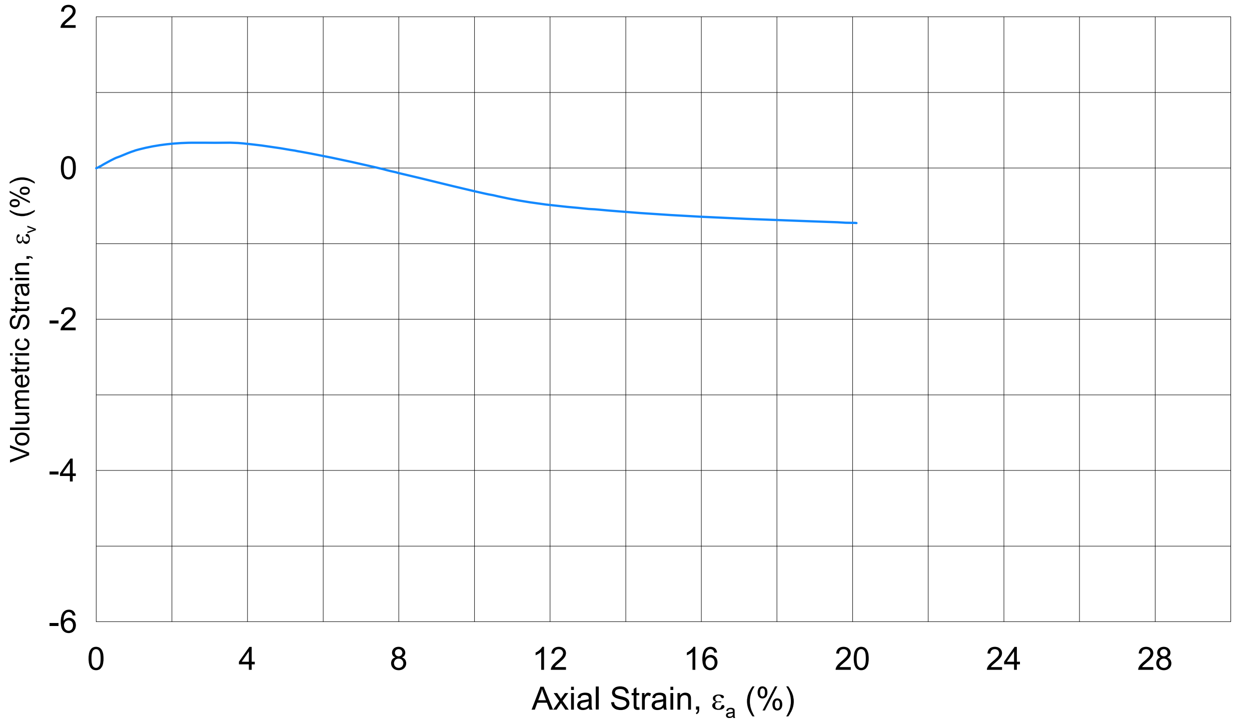


Dato/rev.: 2014-12-23/01

NGTS - Halden Silt Site										Document No. 20160154-01-R
Triaxial test: **CAUC**										Figure No. 40
Boring:	**HALB06**	Depth =	**9.93**	m	Consolidation stresses					Date 2018-06-22 / Drawn by/checked ThV / GS
Tube:	**4**	po' =	**107.0**	kPa	(kPa)	max.	min.	final		
Part:	**A**	w_i =	**29.4**	%	σ_{ac}' =	-	-	**107.0**		NGTS
Test:	**1**	w_c =	**28.5**	%	σ_{rc}' =	-	-	**53.5**		

HALB06-4-A-1.Plot2.grf





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Document No. 20160154-01-R

Figure No. 41

Triaxial test: **CADC**

Date 2018-07-06

Drawn by/checked MAS / PCa

Boring:	**HALB06**	Depth =	**12.95**	m	Consolidation stresses					
Tube:	**6**	po' =	**137.0**	kPa	(kPa)	max.	min.	final		
Part:	**B**	w_i =	**27.9**	%	σ_{ac}' =	-	-	**136.9**		
Test:	**1**	w_c =	**27.1**	%	σ_{rc}' =	-	-	**68.5**		

NGTS

HALB06-6-B-1.Plot1.grf

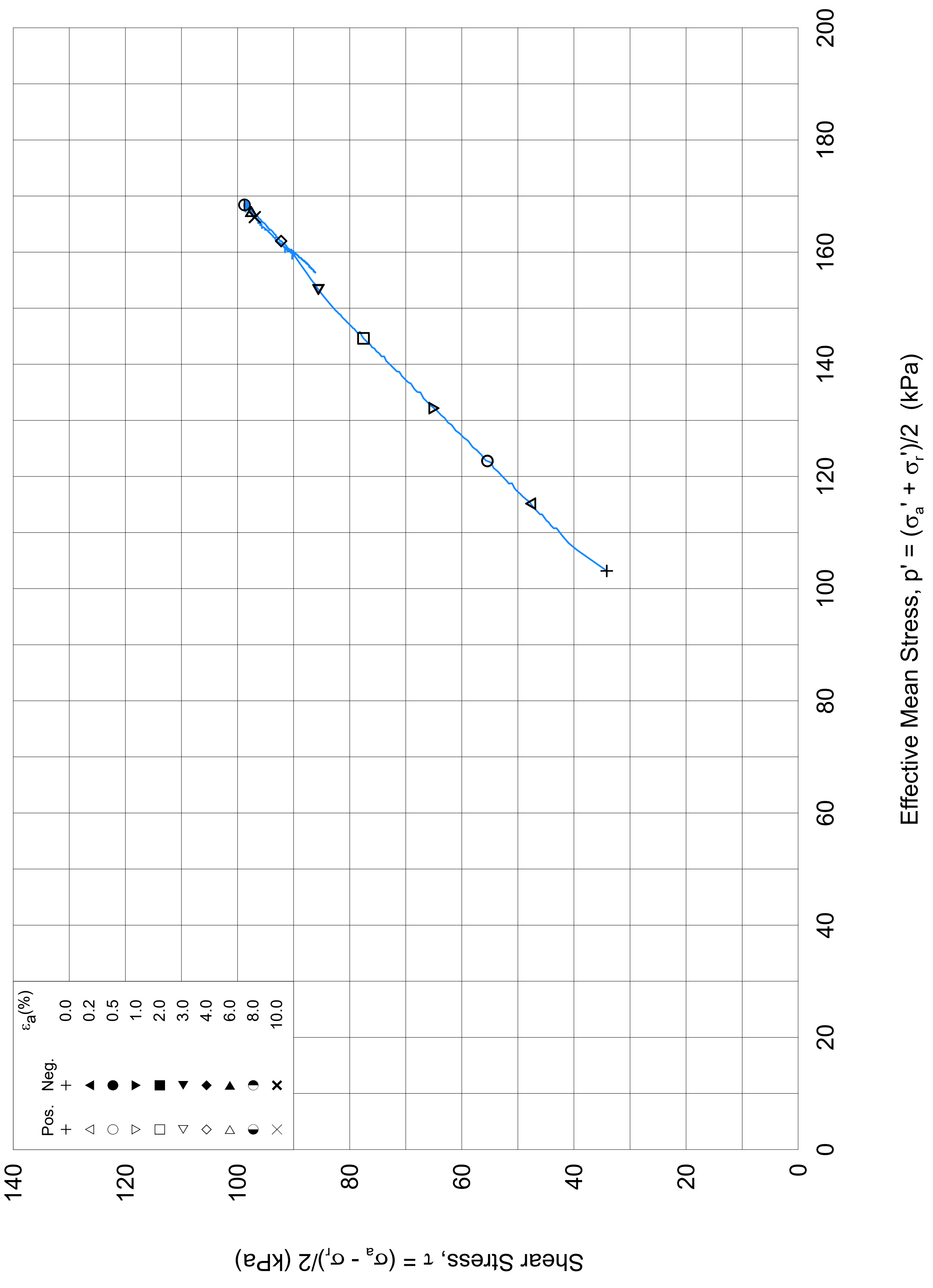

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Figure No. 42

Triaxial test: **CADC**

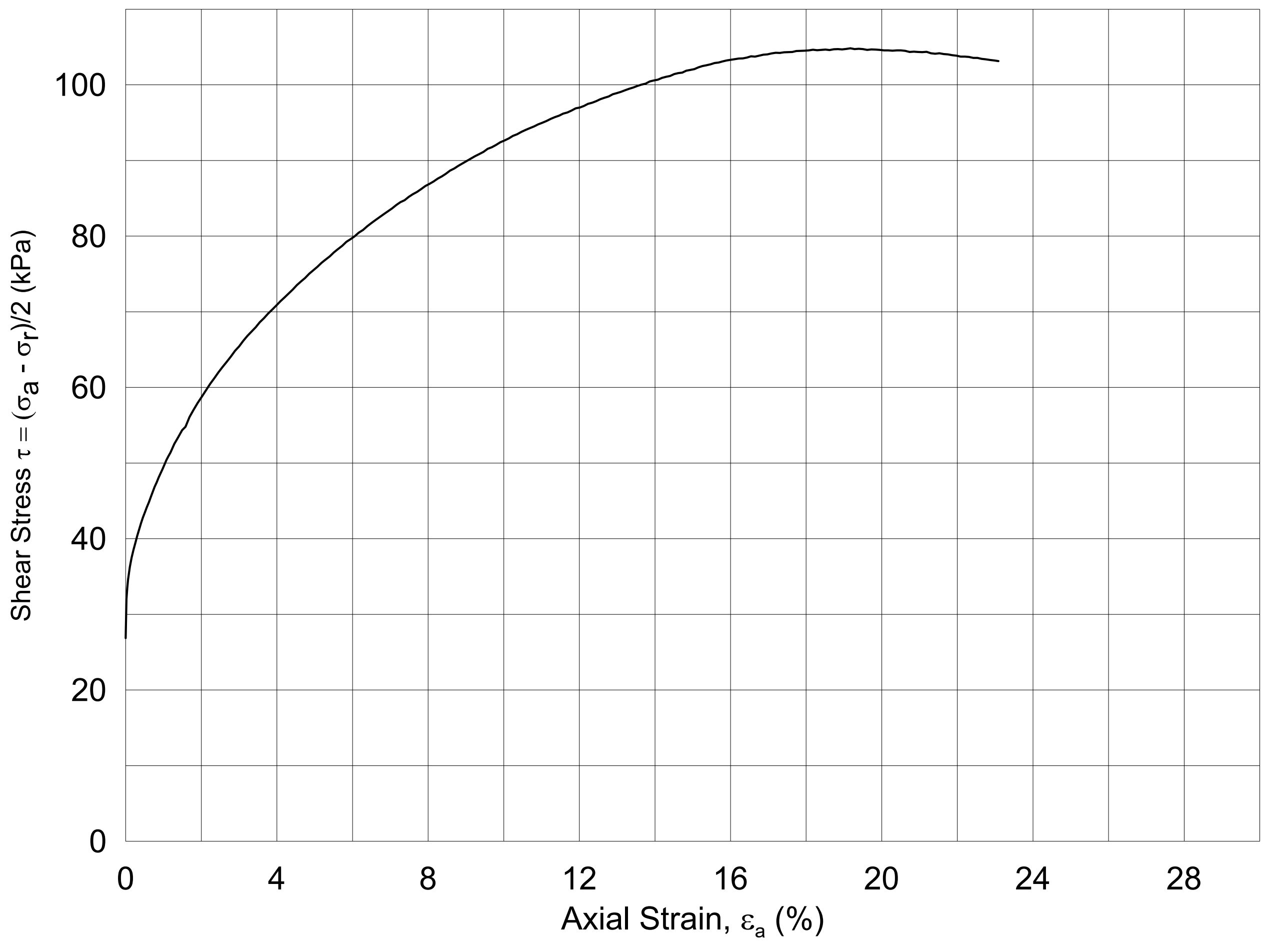
Boring:	**HALB06**	Depth =	**12.95**	m	Consolidation stresses			
Tube:	**6**	po' =	**137.0**	kPa	(kPa)	max.	min.	final
Part:	**B**	w_i =	**27.9**	%	σ_{ac}' =	-	-	**136.9**
Test:	**1**	w_c =	**27.1**	%	σ_{rc}' =	-	-	**68.5**

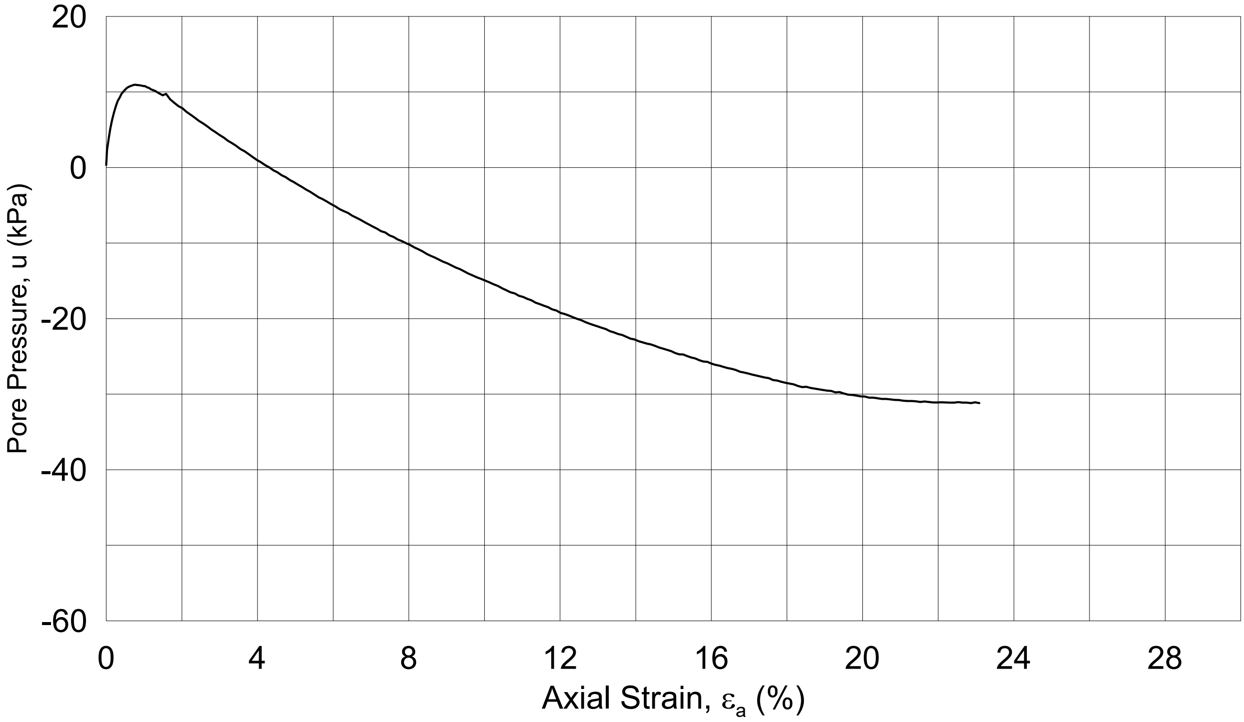
Date 2018-07-31

Drawn by/checked MAS / PCa

NGTS

HALB06-6-B-1.Plot2.grf





Dato/rev.: 2014-12-23/01

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Figure No. 43

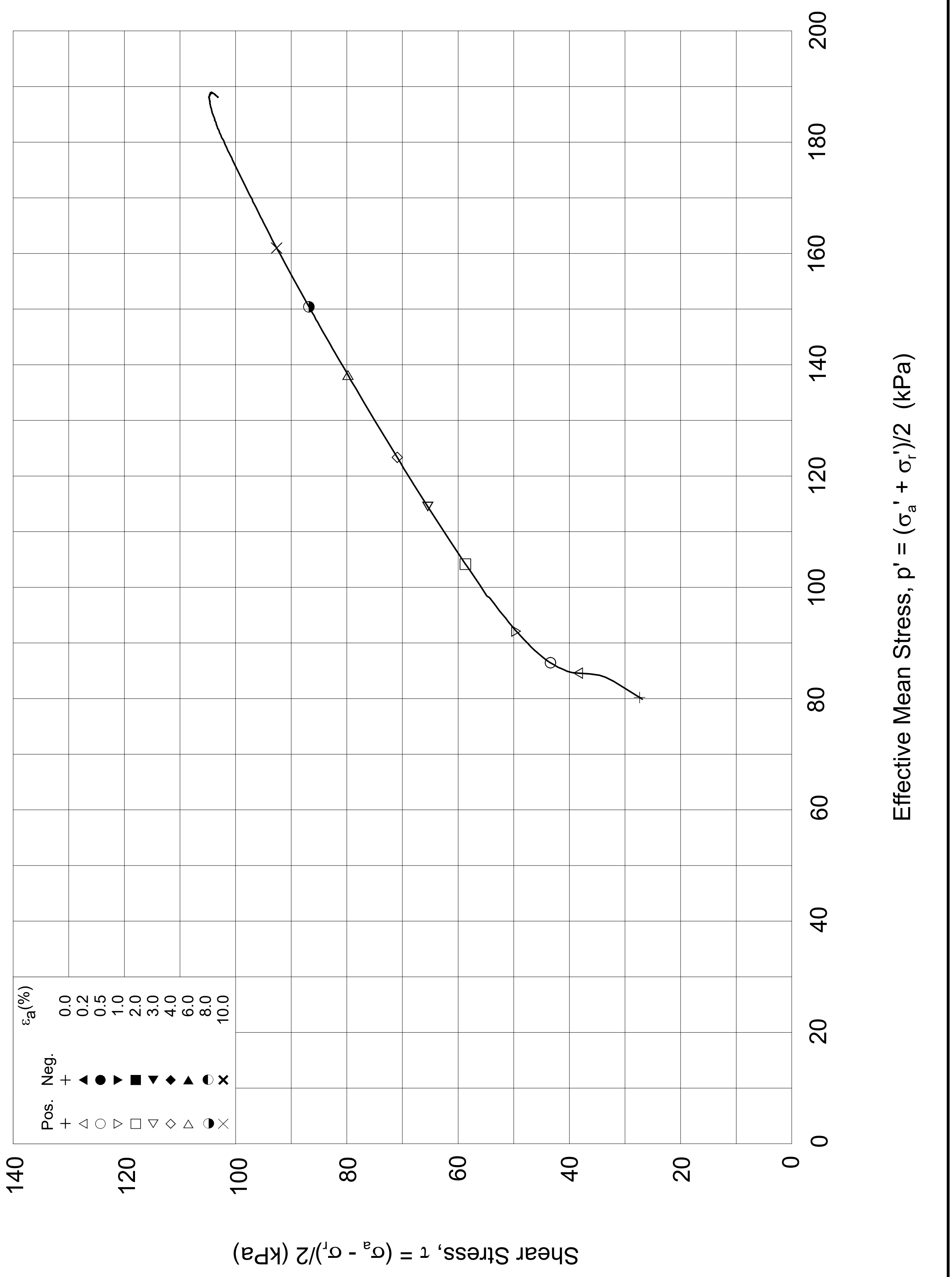
Date 2018-04-27

Drawn by/checked PCa / GS

Triaxial test: **CAUC**

Boring:	**HALB05**	Depth =	**9.45**	m	Consolidation stresses			
Tube:	**1**	po' =	**106.7**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**30.4**	%	σ_{ac}' =	-	-	**106.4**
Test:	**1**	w_c =	**30.3**	%	σ_{rc}' =	-	-	**53.4**

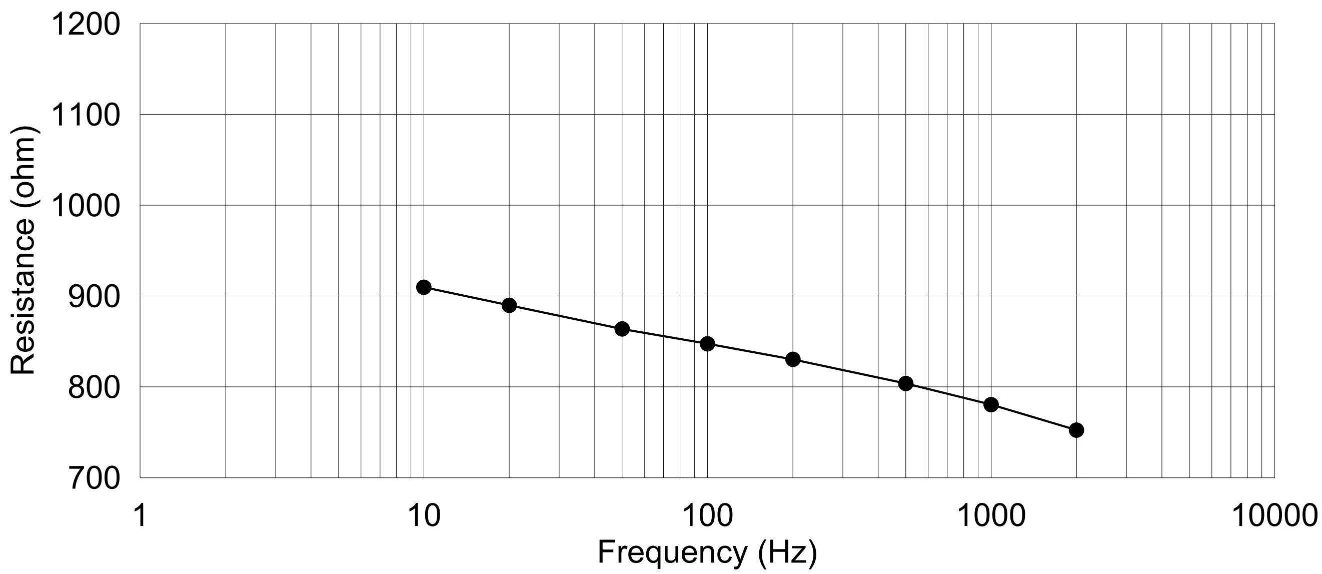
HALB05-1-A-1.Plot1.grf

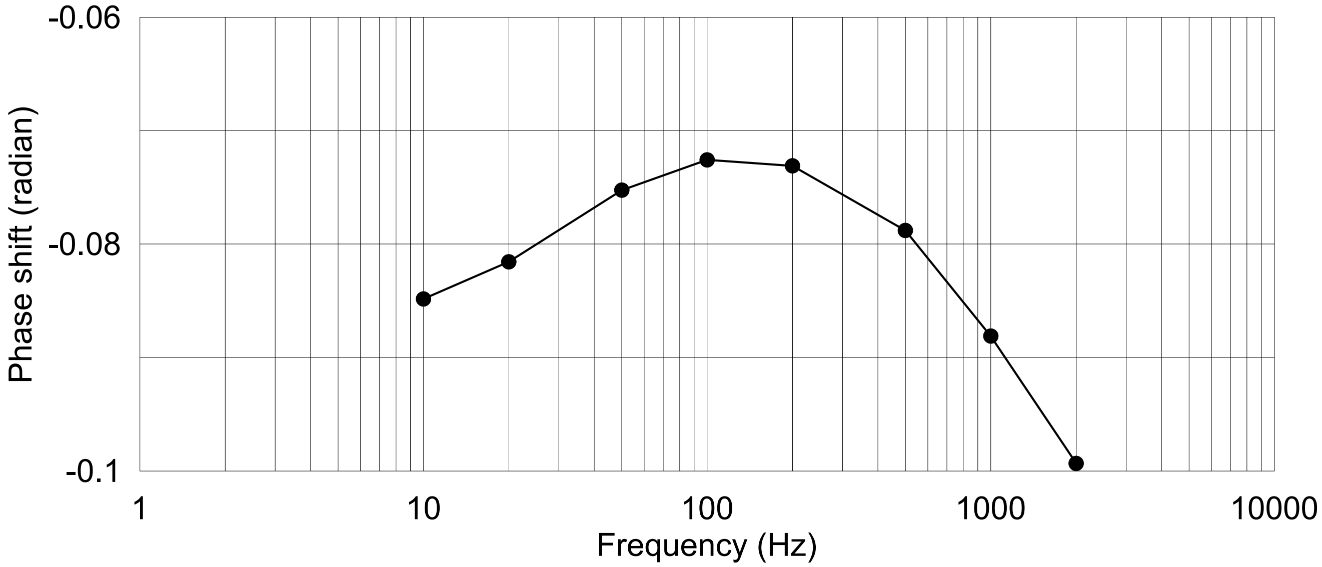


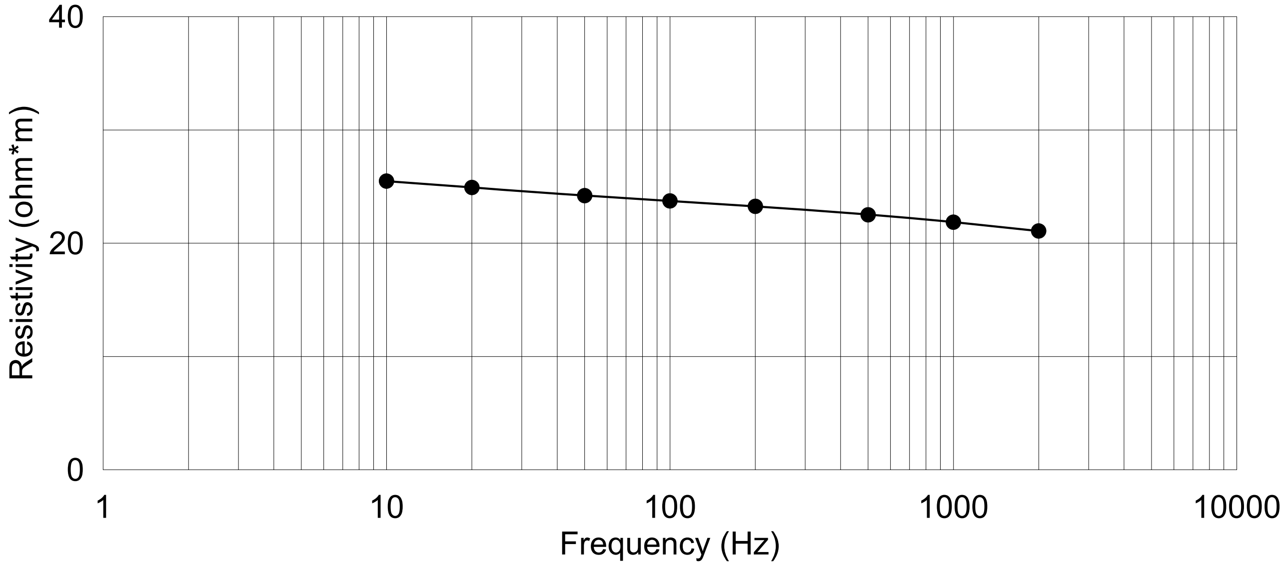
Dato/rev.: 2014-12-23/01

NGTS - Halden Research Site								Document No. 20160154-04-R
Triaxial test: **CAUC**								Figure No. 44
Boring: **HALB05**	Depth = **9.45** m		Consolidation stresses					Date 2018-04-27 / Drawn by/checked PCa / GS
Tube: **1**	po' = **106.7** kPa		(kPa)	max.	min.	final		
Part: **A**	w_i = **30.4** %		σ_{ac}' =	-	-	**106.4**		NGTS
Test: **1**	w_c = **30.3** %		σ_{rc}' =	-	-	**53.4**		

HALB05-1-A-1.Plot2.grf







Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Triaxial test: **CAUC**

Resistivity test results

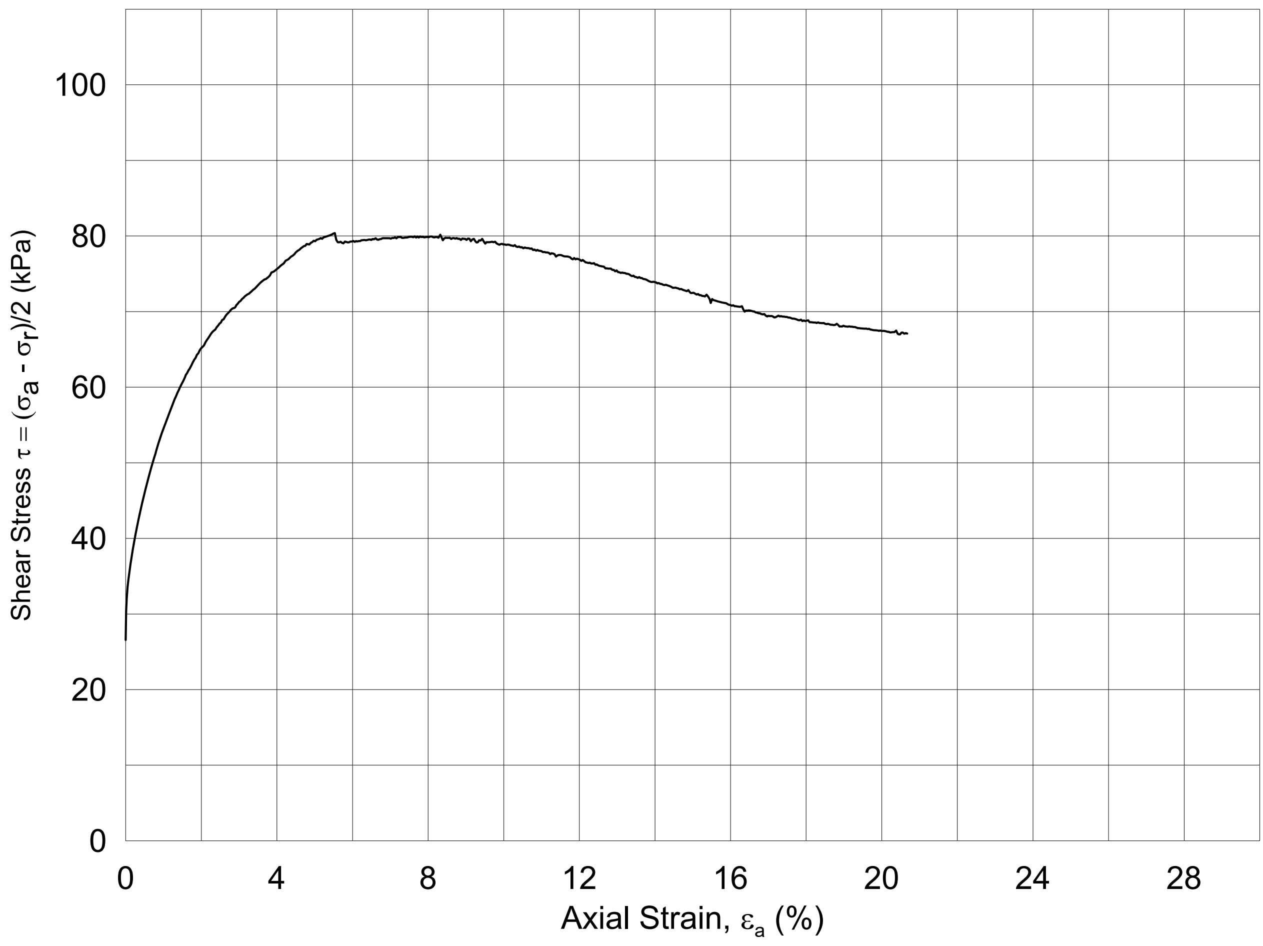
Figure No. 45

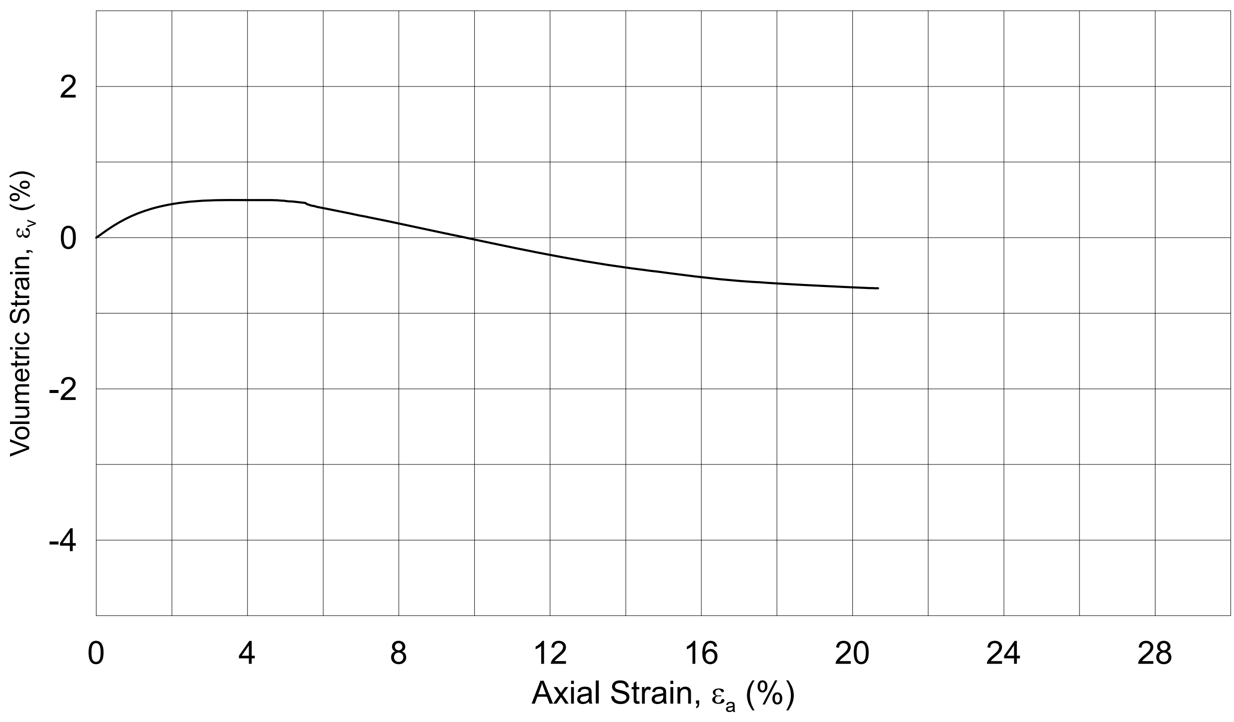
Date 2018-06-05

Drawn by/checked PCa / GS

Boring:	**HALB05**	Depth =	**9.45**	m	Consolidation stresses			
Tube:	**1**	po' =	**106.7**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**30.4**	%	σ_{ac}' =	-	-	**106.4**
Test:	**1**	w_c =	**30.3**	%	σ_{rc}' =	-	-	**53.4**

BH15-12-0-0.Plot1.grf





Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Triaxial test: **CADC**

Figure No. 46

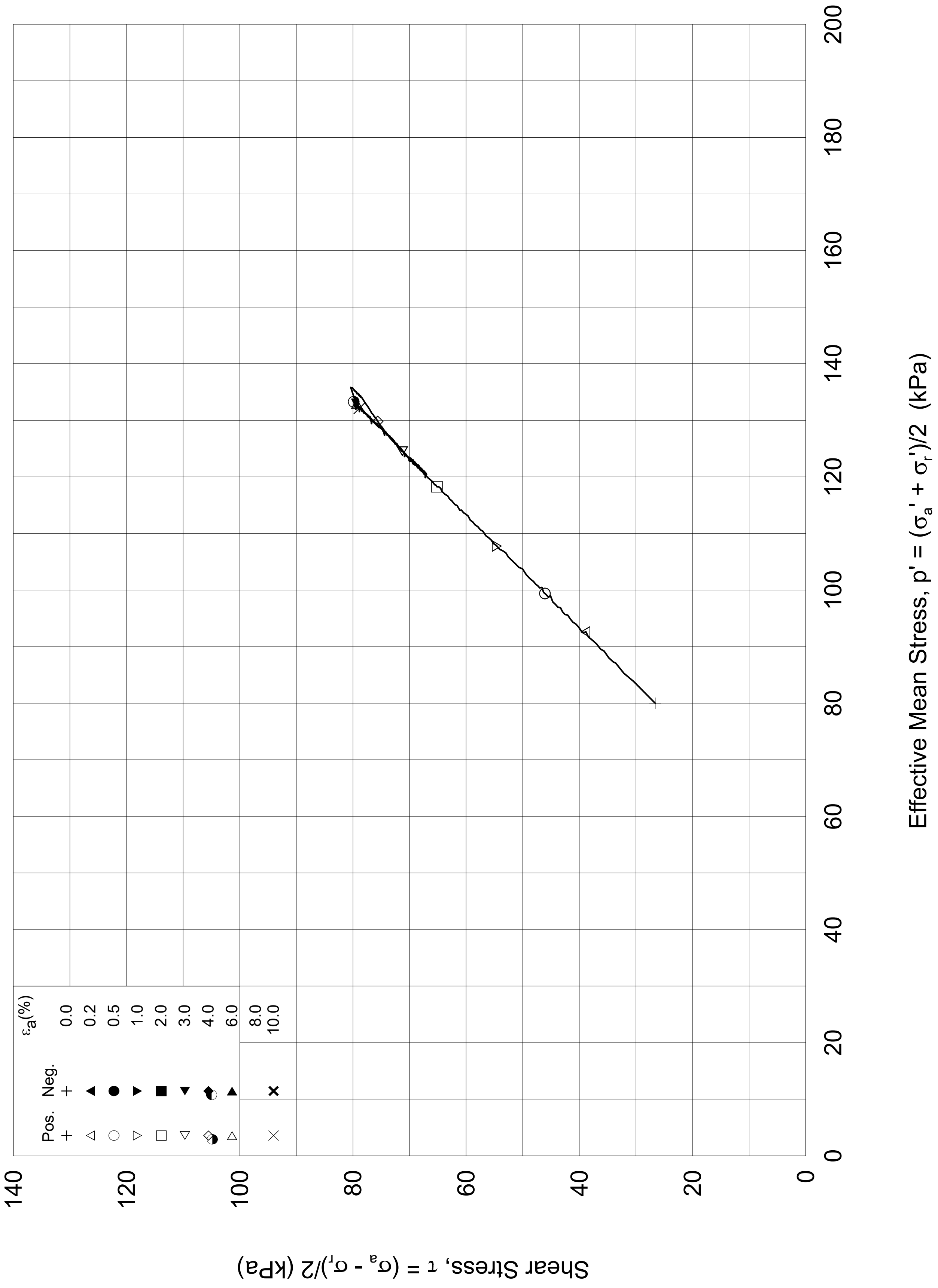
Date 2018-06-05

Drawn by/checked ThV / PCa

Boring:	**HALB05**	Depth =		**9.60**	m	Consolidation stresses					
Tube:	**1**	po'	=	**106.7**	kPa	(kPa)		max.	min.	final	
Part:	**B**	w_i	=	**30.2**	%	σ_{ac}' =		-	-	**106.7**	
Test:	**1**	w_c	=	**26.7**	%	σ_{rc}' =		-	-	**53.4**	

NGTS

HALB05-1-B-1.Plot1.grf



Dato/rev.: 2014-12-23/01

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Triaxial test: **CADC**								
Boring:	**HALB05**	Depth =	**9.60**	m	Consolidation stresses			
Tube:	**1**	po' =	**106.7**	kPa	(kPa)	max.	min.	final
Part:	**B**	w_i =	**30.2**	%	σ_{ac}' =	-	-	**106.7**
Test:	**1**	w_c =	**26.7**	%	σ_{rc}' =	-	-	**53.4**

Document No. 20160154-04-R

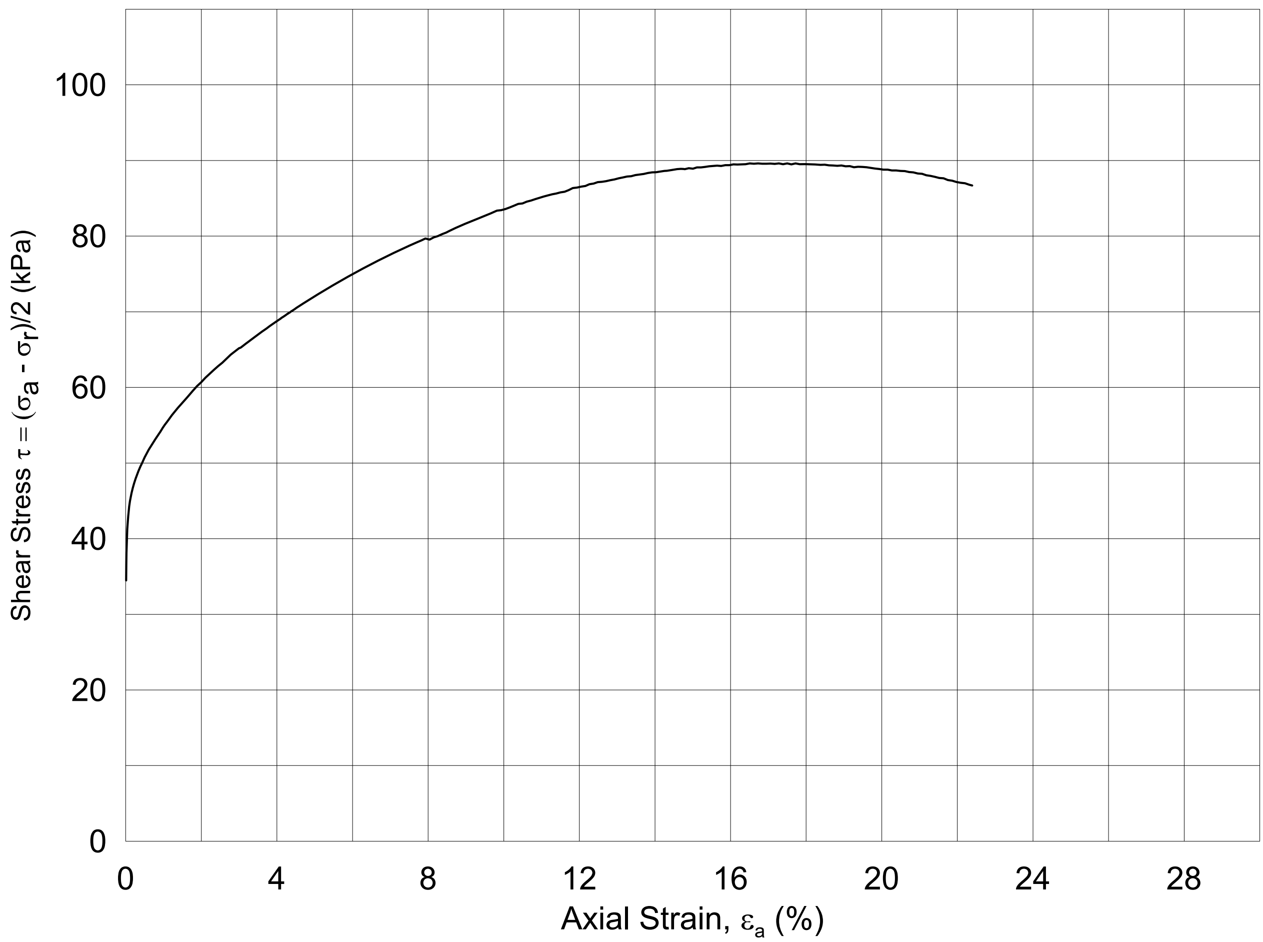
Figure No. 47

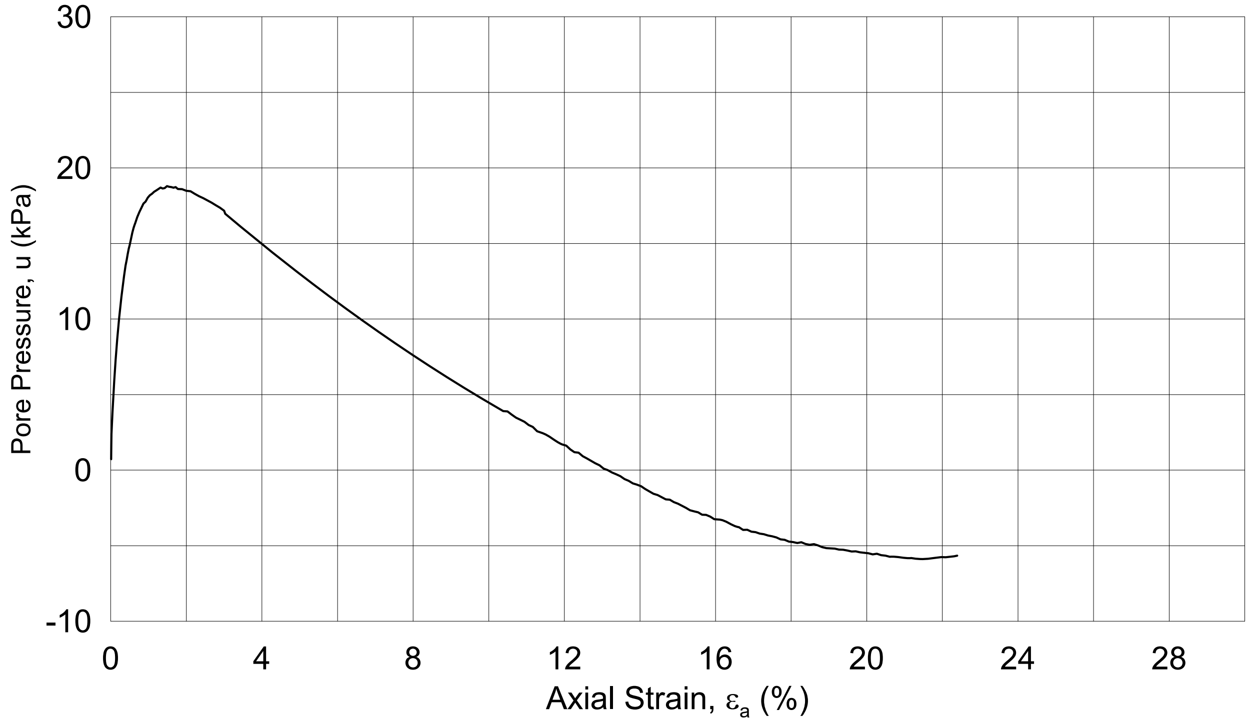
Date 2018-06-05

Drawn by/checked ThV / PCa

NGTS

HALB05-1-B-1.Plot2.grf





Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Figure No. 48

Triaxial test: **CAUC**

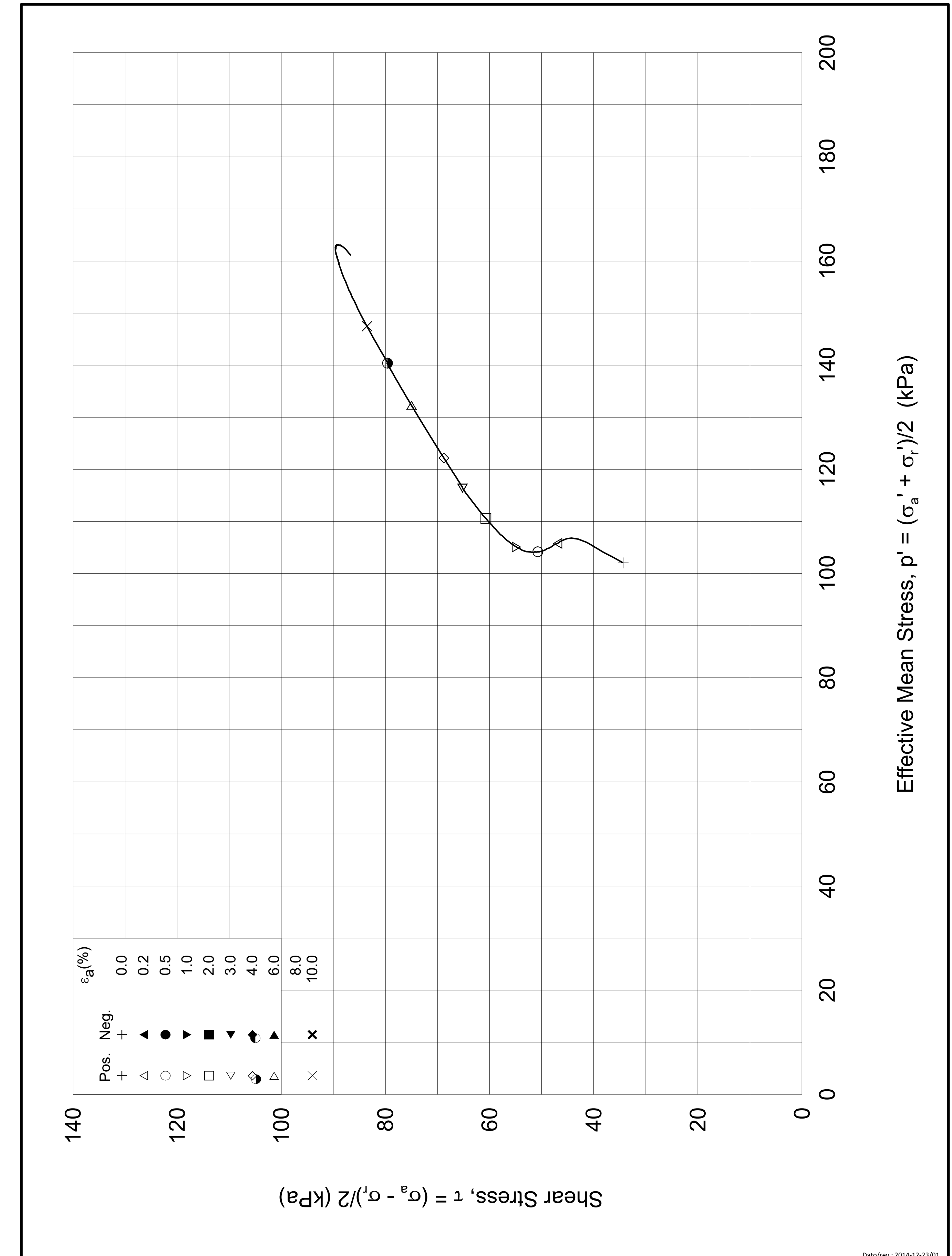
Boring:	**HALB05**	Depth =	**12.50**	m	Consolidation stresses				
Tube:	**2**	po' =	**136.5**	kPa	(kPa)	max.	min.	final	
Part:	**A**	w_i =	**30.3**	%	σ_{ac}' =	-	-	**136.6**	
Test:	**1**	w_c =	**28.6**	%	σ_{rc}' =	-	-	**68.3**	

Date: 2018-06-05

Drawn by/checked: PCa / MAS

NGTS

HALB05-2-A-1.Plot1.grf



Dato/rev.: 2014-12-23/01

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Triaxial test: **CAUC**

Document No. 20160154-04-R

Figure No. 49

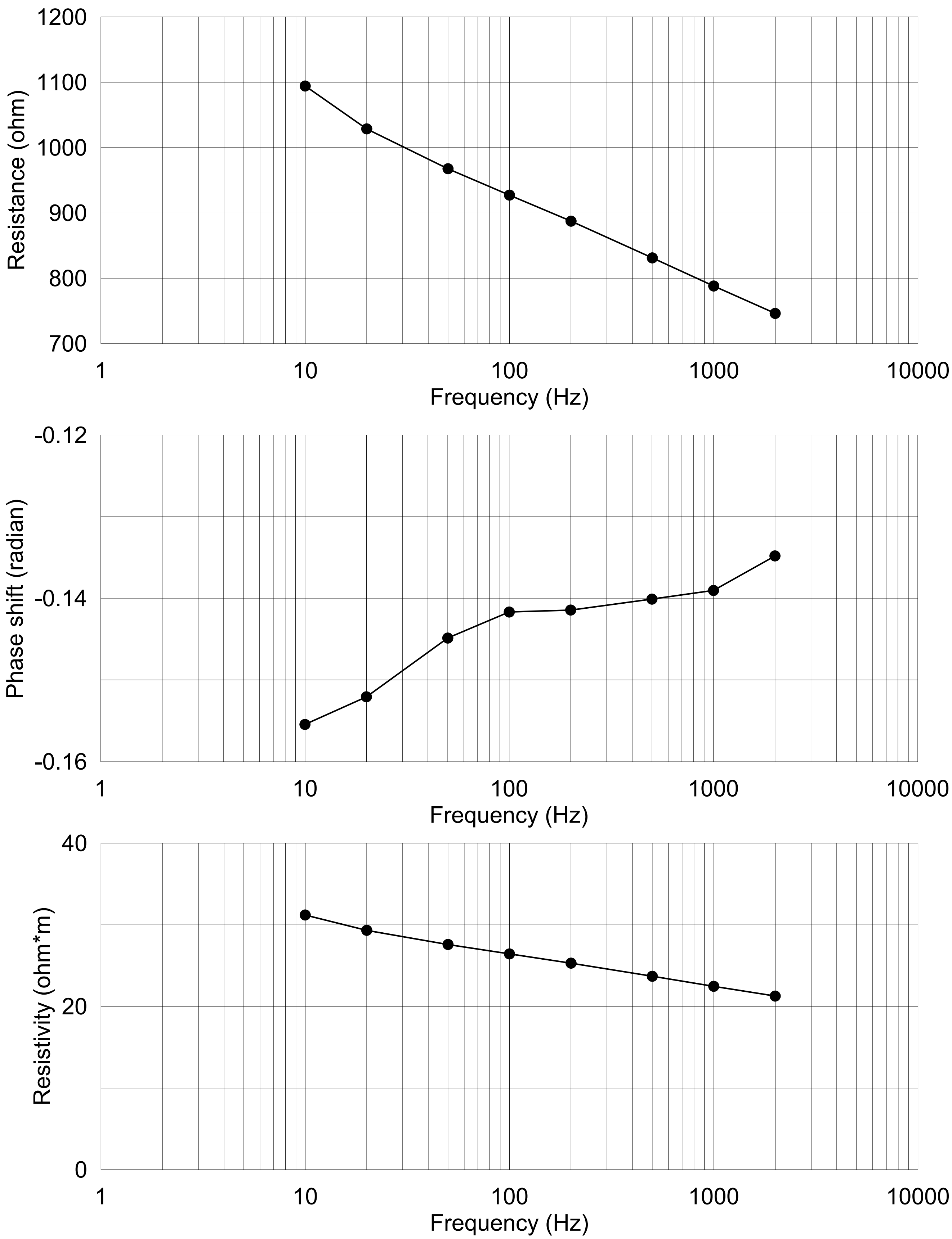
Date 2018-06-05

Drawn by/checked PCa / MAS

Boring:	**HALB05**	Depth =	**12.50**	m	Consolidation stresses			
Tube:	**2**	po' =	**136.5**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**30.3**	%	σ_{ac}' =	-	-	**136.6**
Test:	**1**	w_c =	**28.6**	%	σ_{rc}' =	-	-	**68.3**

NGTS

HALB05-2-A-1.Plot2.grf



Dato/rev.: 2014-12-23/01

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Document No. 20160154-04-R

Triaxial test: **CAUC**

Resistivity test results

Figure No. 50

Date 2018-06-05

Drawn by/checked PCa / MAS

Boring:	**HALB05**	Depth =	**12.50**	m	Consolidation stresses			
Tube:	**2**	po' =	**136.5**	kPa	(kPa)	max.	min.	final
Part:	**A**	w_i =	**30.3**	%	σ_{ac}' =	-	-	**136.6**
Test:	**1**	w_c =	**28.6**	%	σ_{rc}' =	-	-	**68.3**

BH15-12-0-0.Plot1.grf

Appendix Q

SMALL STRAIN SHEAR MODULUS (GMAX) AND SUCTION

Table 1: Summary of shear wave velocity measurements on consolidated specimens.

Boring No.	Tube part test	Depth m	Type of test	Area cm^2	Time after consolidation min	I_p %	Clay cont. %	Fines cont. %	Vs at σ'_{vc} m/s	G_{max} at σ'_{vc} MPa	σ'_{vc} kPa	s_{uD} kPa	G_{max}/σ'_{vc} -	G_{max}/s_{uD} -	Comment
HALB01	9-A-1	5,3	CAUC		580	10,3	7,5	75,0	115	25,9	76,9	-	337	-	
HALB01	11-B-1	7,5	DSS	35	1276	9,1	8,4	86	118	27,5	105	29,5	262	932	
HALB01	11-B-2	7,55	DSS-rem	35	4051	9,1	8,4	86	179	63,9	105	27,7	609	2307	
HALB01	12-B-4	8,6	CAUC		NA	8,2	7,2	83,0	139	37,8	115,9	-	326	-	
HALB01	13-B-1	10,5	DSS	35	1231	8,4	7,8	85	142	39,2	135	36,9	290	1062	
HALB03	3-A-1	5,32	CAUC		NA	-	7,5	57,0	114	25,6	72,3	-	354	-	
HALB03	5-0-1	7,54	DSS	20	1194	8,1	8,5	89	151	43,2	105	34,3	411	1259	Unusual Vs unconfined
HALB03	6-A-1	8,46	CAUC		NA	9,0	9,5	99,0	133	33,9	104,9	-	323	-	
HALB03	8-0-1	10,25	DSS	20	1245	6,0	10,5	84	163	51,5	135	36,9	381	1396	
HALB03	12-A-1	14,42	CAUC		NA	6,5	8,4	73,0	158	51,7	160,4	-	322	-	
HALB04	3-A-1	5,28	CAUC		1980	6,7	7,5	75,0	120	28,2	76,9	-	367	-	multiple Freq
HALB04	5-0-1	7,03	DSS	20	1144	8,1	7,0	86	164	51,6	105,0	36,3	491	1421	
HALB04	5-0-2	7,03	DSS	35	1432	8,1	7,0	86	158	48	105,0	36,2	457	1326	
HALB04	6-A-1	8,02	CADC		1440	10,0	8,0	82,0	136	36,8	90,8	-	405	-	
HALB04	5.5-A-1	8,36	CAUC		NA	10,0	8,0	82,0	128	32,1	105	-	306	-	
HALB04	8-0-1	10,07	DSS	20	1074	9,2	10,5	84	183	65,8	135,0	47,5	487	1385	
HALB04	8-0-2	10,07	DSS	35	1209	9,2	10,5	84	170	56,8	135,0	48,9	421	1162	
HALB04	12-A-1	12,58	CAUC		1625	6,5	8,0	81,0	147	42,6	136,5	-	312	-	
HALB04	2-A-1	13,55	CAUC		1400	6,7	8,0	87,0	157	49,7	147,7	-	336	-	Mini block. Multiple Freq
HALB04	13-0-1	14,48	DSS	20	1176	5,0	7,0	81	160	53,1	158	39,2	336	1355	
HALB04	13-0-2	14,48	DSS	35	1050	5,0	7,0	81	171	60,5	158	50,3	383	1203	
HALB04	13-A-1	14,6	CAUC		1620	5,0	7,0	81,0	159	52,7	158,4	-	333	-	multiple Freq
HALB05	1-A-1	9,45	CAUC		5040	-	9,3	88,1	135	35	106,4	-	329	-	
HALB05	2-A-1	12,5	CAUC		1440	6,5	8,0	81,0	148	44,1	136,6	-	323	-	
HALB06	3-C-1	8,65	CAUE	40	3378	9,0	9,5	99,0	130	32,6	91,0	-	358	-	Fq = 3,5 kHz

CLIENT: NGI

PROJECT: NGTS Halden
2018-09-12

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LEGEND

DSS = Direct Simple Shear, static test
CAUC = Consolidated Anisotropic Undrained test in Compression
CADC = Consolidated Anisotropic Drained test in Compression

Table 2: Summary of bender elememt test results on unconfined specimens.

					H_i	D_i	A_i	W_i	f	t_{peak}	$t_{1st\ cross}$	σ'_{vc}	V_s peak to peak	V_s 1st cross over	ρ_{soil}	G_{max} peak to peak	G_{max} 1st Cross over		
Boring	Tube	Part	Test	Depth	Initial specimen height	Initial specimen diameter	Initial specimen area	Initial specimen weight	Freq.	Peak to peak travel time	1st cross over travel time	Effective stress if consolidated	Shear wave velocity Peak to Peak	Shear wave velocity 1st Cross over	Density of soil	Initial shear modulus	Initial shear modulus	Comment	INTACT/ REMOULDED
				m	cm	cm	cm^2	g	kHz	ms	ms	kPa	m/s	m/s	g/cm^3	MPa	MPa		
HALB03	3			5,18	5,200	5,418	23,052	226,06	1	0,7191	0,7021	0,0	51,7	52,9	1,89	**5,0**	**5,3**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	2	0,6876	0,6391	0,0	54,1	58,2	1,89	**5,5**	**6,4**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	3	0,6604	0,5875	0,0	56,3	63,3	1,89	**6,0**	**7,6**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	4	0,6434	0,5619	0,0	57,8	66,2	1,89	**6,3**	**8,3**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	5	0,6331	0,5344	0,0	58,7	69,7	1,89	**6,5**	**9,2**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	6	0,6263	0,5037	0,0	59,4	73,9	1,89	**6,7**	**10,3**	intact	INTACT
HALB03	3			5,18	5,200	5,418	23,052	226,06	7	0,6161	0,4765	0,0	60,4	78,2	1,89	**6,9**	**11,5**	intact	INTACT
HALB03	3			5,42	2,663	6,453	32,708	189,33	0,4	1,6710	NA	-	8,8	NA	2,17	**0,2**	**NA**	Very low signal. Uncertain.	REMOULDED
HALB03	6			8,43	5,400	5,379	22,728	242,34	1	0,8680	0,8000	0,0	45,1	49,0	1,97	**4,0**	**4,7**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	2	0,8033	0,6178	0,0	48,7	63,5	1,97	**4,7**	**8,0**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	3	0,7666	0,5274	0,0	51,1	74,4	1,97	**5,2**	**10,9**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	4	0,7915	0,4614	0,0	49,5	85,1	1,97	**4,8**	**14,3**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	5	0,7795	0,4406	0,0	50,2	89,2	1,97	**5,0**	**15,7**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	6	0,7642	0,4442	0,0	51,3	88,4	1,97	**5,2**	**15,4**	intact	INTACT
HALB03	6			8,43	5,400	5,379	22,728	242,34	7	0,7574	0,4253	0,0	51,7	92,4	1,97	**5,3**	**16,9**	intact	INTACT
HALB03	6			8,43	3,167	6,453	32,708	221,83	0,4	1,5340	NA	-	12,8	NA	2,14	**0,4**	**NA**		REMOULDED
HALB03	12			14,40	5,100	5,443	23,269	244,23	1	0,8766	0,8426	0,0	41,2	42,9	2,06	**3,5**	**3,8**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	2	0,8723	0,7318	0,0	41,4	49,4	2,06	**3,5**	**5,0**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	3	0,8732	0,6845	0,0	41,4	52,8	2,06	**3,5**	**5,7**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	4	0,8766	0,5683	0,0	41,2	63,7	2,06	**3,5**	**8,4**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	5	0,8698	0,5803	0,0	41,5	62,4	2,06	**3,6**	**8,0**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	6	0,8510	0,7233	0,0	42,5	50,0	2,06	**3,7**	**5,1**	intact	INTACT
HALB03	12			14,40	5,100	5,443	23,269	244,23	7	0,8476	0,4884	0,0	42,6	74,2	2,06	**3,7**	**11,3**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	1	0,9446	0,8595	-	47,0	51,7	1,97	**4,4**	**5,3**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	1,4	0,9063	0,8042	-	49,0	55,3	1,97	**4,7**	**6,0**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	2	0,8638	0,7574	-	51,5	58,7	1,97	**5,2**	**6,8**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	2,5	0,8468	0,7063	-	52,5	63,0	1,97	**5,4**	**7,8**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	3	0,8297	0,6723	-	53,5	66,2	1,97	**5,6**	**8,6**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	4	0,8085	0,6723	-	55,0	66,2	1,97	**5,9**	**8,6**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	4,5	0,7914	0,5993	-	56,1	74,3	1,97	**6,2**	**10,8**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	5	0,7744	0,6178	-	57,4	72,1	1,97	**6,5**	**10,2**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	6	0,6314	0,6314	-	70,4	70,4	1,97	**9,8**	**9,8**	intact	INTACT
HALB03	8	1	1	10,30	5,920	5,418	23,052	268,36	7	0,6672	0,6672	-	66,6	66,6	1,97	**8,7**	**8,7**	intact	INTACT
HALB04	5,5	C		8,30	7,100	7,200	40,715	553,94	1	0,8723	0,8723	-	64,6	64,6	1,92	**8,0**	**8,0**	intact	INTACT
HALB04	5,5	C		8,30	7,100	7,200	40,715	553,94	2	0,7702	0,7234	-	73,2	78,0	1,92	**10,3**	**11,6**	intact	INTACT
HALB04	5,5			8,37	3,059	6,453	32,705	205,80	0,5	1,6310	NA	-	11,4	NA	2,06	**0,3**	**NA**		REMOULDED
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	0,6	1,6420	1,4800	-	33,4	37,0	1,92	**2,1**	**2,6**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	1	1,5140	1,3650	-	36,2	40,1	1,92	**2,5**	**3,1**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	1,5	1,4380	1,3190	-	38,0	41,5	1,92	**2,8**	**3,3**	intact-tested within 3 hrs of opening-CRS	INTACT

Table 2: Summary of bender elememt test results on unconfined specimens.

Boring	Tube	Part	Test	Depth	H_i Initial specimen height	D_i Initial specimen diameter	A_i Initial specimen area	W_i Initial specimen weight	f Freq.	t_{peak} Peak to peak travel time	$t_{1st\ cross}$ 1st cross over travel time	σ'_{vc} Effective stress if consolidated	V_s peak to peak Shear wave velocity Peak to Peak	V_s 1st cross over Shear wave velocity 1st Cross over	ρ_{soil} Density of soil	G_{max} peak to peak Initial shear modulus	G_{max} 1st Cross over Initial shear modulus	Comment	INTACT/ REMOULDED
				m	cm	cm	cm^2	g	kHz	ms	ms	kPa	m/s	m/s	g/cm^3	MPa	MPa		
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	2	1,4000	1,2760	-	39,0	42,9	1,92	**2,9**	**3,5**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	2,5	1,3740	1,1230	-	39,8	48,7	1,92	**3,0**	**4,6**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	3	1,3610	1,1360	-	40,1	48,1	1,92	**3,1**	**4,4**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	0,3	1,2760	1,5310	-	43,0	35,8	1,92	**3,6**	**2,5**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3	B1	1	5,27	6,950	7,035	38,866	519,28	0,5	1,3950	1,4120	-	39,3	38,8	1,92	**3,0**	**2,9**	intact-tested within 3 hrs of opening-CRS	INTACT
HALB04	3			5,28	3,218	6,453	32,705	218,80	0,5	1,8250	NA	-	11,1	NA	2,08	**0,3**	**NA**		REMOULDED
HALB04	13			14,60	6,650	5,634	24,931	329,02	1	1,4290	1,3610	-	36,2	38,0	1,98	**2,6**	**2,9**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	1	1,3950	1,2930	-	37,1	40,0	1,98	**2,7**	**3,2**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	0,5	1,3950	1,3610	-	37,1	38,1	1,98	**2,7**	**2,9**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	1,5	1,3140	1,2890	-	39,3	40,1	1,98	**3,1**	**3,2**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	2	1,3060	1,2460	-	39,6	41,5	1,98	**3,1**	**3,4**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	2,5	1,2890	1,1140	-	40,1	46,4	1,98	**3,2**	**4,3**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	3	1,2760	1,2210	-	40,5	42,3	1,98	**3,2**	**3,5**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	3,5	1,2680	1,1270	-	40,7	45,8	1,98	**3,3**	**4,2**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	4	1,2550	1,1870	-	41,1	43,5	1,98	**3,4**	**3,8**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	0,8	1,2340	1,2250	-	42,0	42,3	1,98	**3,5**	**3,6**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	0,3	1,8550	1,4120	-	27,9	36,7	1,98	**1,5**	**2,7**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	6,650	5,634	24,931	329,02	4,5	1,2460	1,2290	-	41,4	42,0	1,98	**3,4**	**3,5**	NB - Trimmed to 54mm! intact-tested within 3 hrs of opening	INTACT
HALB04	13			14,60	3,017	6,453	32,705	218,70	0,3	1,7100	NA	-	10,6	NA	2,22	**0,3**	**NA**	Difficult interpretation	REMOULDED
HALB03	5			7,63	6,070	5,475	23,542	274,11	0,3	2,0590	1,9230	-	22,3	23,9	1,92	**1,0**	**1,1**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	0,5	2,0760	1,9910	-	22,1	23,1	1,92	**0,9**	**1,0**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	1	2,0760	1,8890	-	22,1	24,3	1,92	**0,9**	**1,1**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	1,5	1,9570	1,8380	-	23,4	24,9	1,92	**1,1**	**1,2**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	2	1,9310	1,8210	-	23,7	25,2	1,92	**1,1**	**1,2**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	2,5	1,8970	1,7950	-	24,1	25,5	1,92	**1,1**	**1,2**	intact-tested within 3 hrs of opening	INTACT
HALB03	5			7,63	6,070	5,475	23,542	274,11	3	1,8720	1,8120	-	24,5	25,3	1,92	**1,1**	**1,2**	intact-tested within 3 hrs of opening	INTACT
												-							
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	1	1,2380	1,1190	-	45,4	50,2	2,00	**4,1**	**5,0**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	0,5	1,2510	1,1820	-	44,9	47,5	2,00	**4,0**	**4,5**	intact-tested within 3 hrs of opening	INTACT

Table 2: Summary of bender elememt test results on unconfined specimens.

					H_i	D_i	A_i	W_i	f	t_{peak}	$t_{1st\ cross}$	σ'_{vc}	V_s peak to peak	V_s 1st cross over	ρ_{soil}	G_{max} peak to peak	G_{max} 1st Cross over		
Boring	Tube	Part	Test	Depth	Initial specimen height	Initial specimen diameter	Initial specimen area	Initial specimen weight	Freq.	Peak to peak travel time	1st cross over travel time	Effective stress if consolidated	Shear wave velocity Peak to Peak	Shear wave velocity 1st Cross over	Density of soil	Initial shear modulus	Initial shear modulus	Comment	INTACT/ REMOULDED
				m	cm	cm	cm^2	g	kHz	ms	ms	kPa	m/s	m/s	g/cm^3	MPa	MPa		
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	1,5	1,0300	1,0420	-	54,6	53,9	2,00	**6,0**	**5,8**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	2	1,0630	1,0040	-	52,9	56,0	2,00	**5,6**	**6,3**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	2,5	1,0340	0,9659	-	54,4	58,2	2,00	**5,9**	**6,8**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	3	1,0170	0,9276	-	55,3	60,6	2,00	**6,1**	**7,3**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	7,100	7,098	39,573	561,60	0,7	1,0850	1,0760	-	51,8	52,2	2,00	**5,4**	**5,5**	intact-tested within 3 hrs of opening	INTACT
HALB04	2-mini			13,53	3,140	6,453	32,705	226,03	NA	NA	NA	-	NA	NA	2,20	NA	**NA**	Too low signal. Interpretation not possible. A numer of frequency psd dat are saved	REMOULDED
HALB04	8			10,07	4,700	7,108	39,680	377,00	1	0,5617	0,5234	-	57,4	61,6	2,02	**6,7**	**7,7**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	1,2	0,5063	0,4808	-	63,7	67,1	2,02	**8,2**	**9,1**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	0,7	0,4630	0,4978	-	69,7	64,8	2,02	**9,8**	**8,5**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	1,5	0,4765	0,4510	-	67,7	71,6	2,02	**9,3**	**10,4**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	2	0,4382	0,3957	-	73,7	81,7	2,02	**11,0**	**13,5**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	2,5	0,4297	0,3695	-	75,2	87,6	2,02	**11,4**	**15,5**	intact-tested within 3 hrs of opening	INTACT
HALB04	8			10,07	4,700	7,108	39,680	377,00	3	0,4212	0,3319	-	76,7	97,6	2,02	**11,9**	**19,3**	intact-tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	0,5	1,1057	1,2410	-	49,9	44,5	1,92	**4,8**	**3,8**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	1			-							
HALB04	5			7,03	7,000	7,130	39,929	537,11	1,3	1,0068	0,9768	-	54,8	56,5	1,92	**5,8**	**6,1**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	1,5	1,1234	0,9821	-	49,1	56,2	1,92	**4,6**	**6,1**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	2	1,1103	1,0639	-	49,7	51,9	1,92	**4,7**	**5,2**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	2,5	1,1075	1,0369	-	49,8	53,2	1,92	**4,8**	**5,4**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	3	1,0830	1,0285	-	51,0	53,7	1,92	**5,0**	**5,5**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	3,5	1,0722	1,0286	-	51,5	53,7	1,92	**5,1**	**5,5**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	4	1,0669	0,9660	-	51,7	57,2	1,92	**5,1**	**6,3**	Tested within 3 hrs of opening	INTACT
HALB04	5			7,03	7,000	7,130	39,929	537,11	4,5			-							INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	1	1,0680	1,0170	-	54,0	56,8	1,99	**5,8**	**6,4**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	0,5	0,9270	1,0970	-	62,3	52,6	1,99	**7,7**	**5,5**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	0,8	1,0120	1,0380	-	57,0	55,6	1,99	**6,5**	**6,2**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	1,2	1,0380	0,9190	-	55,6	62,8	1,99	**6,2**	**7,9**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	1,5	0,9870	0,8760	-	58,5	65,9	1,99	**6,8**	**8,7**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	2	0,9740	0,8680	-	59,3	66,6	1,99	**7,0**	**8,8**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	2,5	0,9610	0,8590	-	60,1	67,3	1,99	**7,2**	**9,0**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	3	0,9530	0,7820	-	60,6	73,9	1,99	**7,3**	**10,9**	INTACT	INTACT
HALB04	12			12,61	7,250	7,137	40,000	577,81	1,4	0,9310	0,8680	-	62,0	66,6	1,99	**7,7**	**8,8**	INTACT	INTACT
HALB04	6			8,02	6,324	NA	NA	NA	1	1,0490	NA	-	49,0	NA	2,00	**4,8**	**NA**	INTACT	INTACT
HALB04	6			8,02	2,297	NA	NA	NA	1,5	0,8230	NA	-	13,3	NA	2,00	**0,4**	**NA**	REMOULDED	REMOULDED

Table 2: Summary of bender elememt test results on unconfined specimens.

					H_i	D_i	A_i	W_i	f	t_{peak}	$t_{1st\ cross}$	σ'_{vc}	V_s peak to peak	V_s 1st cross over	ρ_{soil}	G_{max} peak to peak	G_{max} 1st Cross over		
Boring	Tube	Part	Test	Depth	Initial specimen height	Initial specimen diameter	Initial specimen area	Initial specimen weight	Freq.	Peak to peak travel time	1st cross over travel time	Effective stress if consolidated	Shear wave velocity Peak to Peak	Shear wave velocity 1st Cross over	Density of soil	Initial shear modulus	Initial shear modulus	Comment	INTACT/ REMOULDED
				m	cm	cm	cm^2	g	kHz	ms	ms	kPa	m/s	m/s	g/cm^3	MPa	MPa		
HALB05	1			9,73	5,027	7,120	39,815	393,90	0,4	1,5440	NA	-	24,8	NA	1,97	**1,2**	**NA**	INTACT	INTACT
HALB05	1			9,73	3,035	6,453	32,708	224,33	NA	NA	NA	-	NA	NA	2,26	NA	**NA**	Too low signal. Interpretation not possible. A numer of frequency psd dat are saved	REMOULDED
HALB05	2			12,80	6,103	7,100	39,592	474,71	1	1,4550	NA	-	33,8	NA	1,96	**2,2**	**NA**	Difficult interpretation	INTACT
HALB05	2			12,80	3,058	6,453	32,705	196,50	NA	NA	NA	-	NA	NA	1,96	NA	**NA**	Too low signal. Interpretation not possible. A numer of frequency psd dat are saved	REMOULDED
HALB06	3			8,23	5,035	7,210	40,828	397,70	0,7	1,2040	NA	-	41,82	NA	1,93	**3,38**	**NA**	psdata saved for several frequencies	INTACT
HALB06	3			8,23	3,160	NA	NA	NA	0,5	2,1760	NA	-	14,52	NA	1,93	**0,41**	**NA**	Measurement uncertain. Very low Signal. Bad signal. psdata saved for several frequencies	REMOULDED
HALB06	4			10,02	5,017	7,268	41,488	400,17	0,7	1,0190	NA	-	49,23	NA	1,92	**4,66**	**NA**	psdata saved for several frequencies	INTACT
HALB06	4			10,02	3,000	NA	NA	NA	2,5	0,7440	NA	-	40,32	NA	1,92	**3,13**	**NA**	Measurement very uncertain. Extremely low signal. Bad signal. psdata saved for several frequencies	REMOULDED
HALB06	6			13,02	5,226	7,200	40,715	424,84	0,9	0,9640	NA	-	54,21	NA	2,00	**5,87**	**NA**	psdata saved for several frequencies	INTACT
HALB06	6			13,02	3,267	NA	NA	NA	0,3	2,4660	NA	-	13,25	NA	2,00	**0,35**	**NA**	Measurement uncertain. Low Signal. Bad signal. psdata saved for several frequencies	REMOULDED

Table 3: Summary of suction tests on unconfined specimens.

Sample type (Block or tube)	Boring	Tube/block	Part	Test	Depth	Date	Time	Operator	Probe Nr	Recorded suction	Time to equilibrium	Comment
-	-	-	-	-	m	-	hh:mm:ss	-	-	kPa	Min	-
Block	HALB04	6	NA	NA	8,02	09.03.2018	14:50:00	Pca	SP6	0	5	Zero suction measured. Test is repeated
Block	HALB04	6	NA	NA	8,02	09.03.2018	15:00:00	Pca	SP6	0	5	Zero suction measured, as for previous test
Tube	HALB03	3	NA	NA	5,42	10.04.2018	14:00:00	Pca	SP6	0	5	Zero suction measured.
Block	HALB04	5,5	NA	NA	8,37	11.04.2018	10:05:00	Pca	SP6	-114	65	Sample appears very dry
Tube	HALB05	1	NA	NA	9,73	25.04.2017	15:47:00	Pca	SP6	0	5	Zero suction measured. Test is repeated
Tube	HALB05	1	NA	NA	9,73	25.04.2017	16:00:00	Pca	SP6	0	0	Zero suction measured, as for previous test
Tube	HALB05	2	NA	NA	12,80	2018.05.03	10:19:00	Pca	SP6	0	0	Zero suction measured.
Tube	HALB06	3	na	Na	8,23	14.06.2018	10:59:00	Pca	SP6	-0,4	10	No suction
Tube	HALB06	4	na	Na	10,02	15.06.2018	11:00:00	Pca	SP6	-0,3	10	No suction

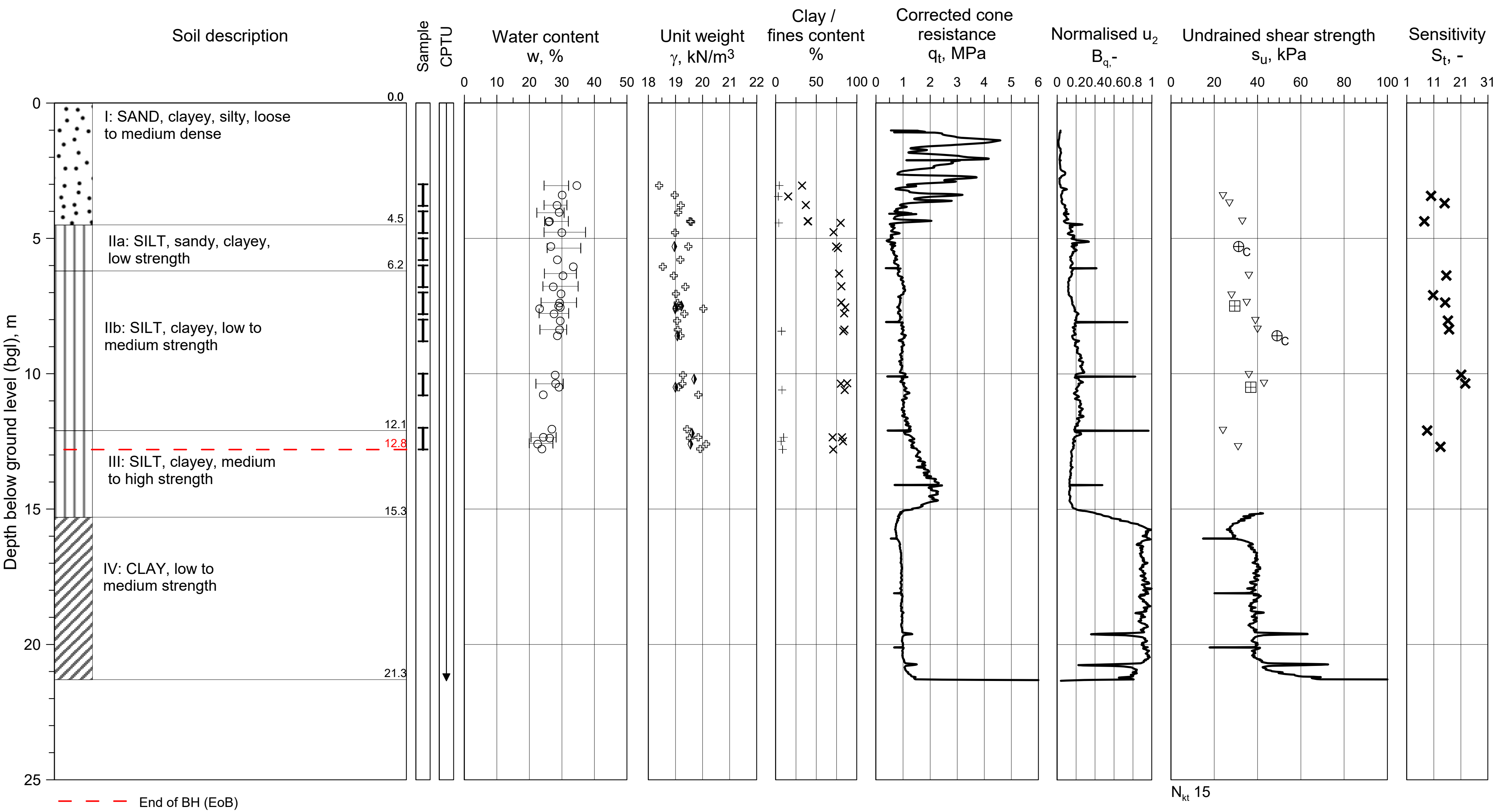
CLIENT: NGI

PROJECT: NGTS Halden
2018-09-12

Document No.: 20160154-04-R

Appendix R

BOREHOLE LOGS



End of BH (EoB)

Pocket Penetrometer	Water content
Fall cone	Unit weight, γ
	γ (Based on water content)
Vane (Field)	Sensitivity, fall cone
UU test	Sensitivity, vane
CAUC/CIUC	Clay content
CAUE/CIUE	Fines content
DSS test	Plasticity index, Ip

Coordinate system EUREF89 UTM Zone 32N CM9⁰E

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB01, BH72

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB01	635291.230	6555905.691	28.45
HALC05	635291.230	6555904.691	28.45

Document No. 20160154-04-R

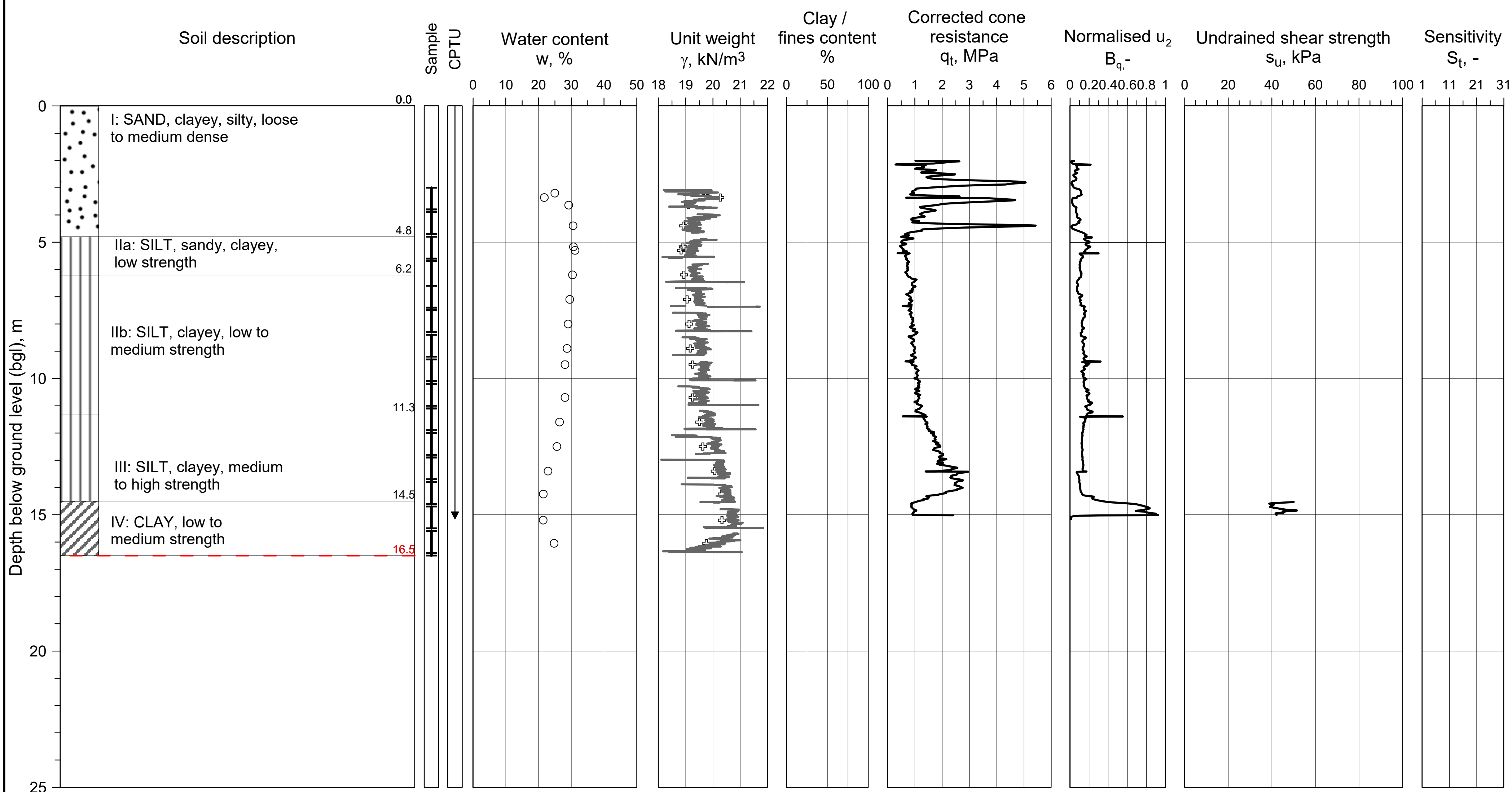
Figure No. 01

Date 2018-04-07

Drawn by OyB/RCa

NGTS

P:\2016\01\20160154\Fieldwork\Halden\Interp-CPT-R-S-DIS\R_Fig_01_NGTS HALB01 log.grf



Note: q_t is used for interpretation of CPTU.

- End of BH (EoB)
- □ Pocket Penetrometer
- ▽ Fall cone
- Vane (Field)
- ◇ UU test
- $⊕_C$ CAUC/CIUC
- $⊕_E$ CAUE/CIUE
- ⊞ DSS test
- ○ Water content
- Unit weight, γ
- γ (Based on water content)
- Sensitivity, fall cone
- ▷ Sensitivity, vane
- \+ Clay content
- × Fines content
- Plasticity index, I_p

Coordinate system EUREF89 UTM Zone 32N CM9⁰E

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB02, BH54C

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB02	635291.057	6555910.153	28.69
HALC06	635289.801	6555911.174	28.78

Document No. 20160154-04-R

Figure No. 02

Date 2018-04-07

Drawn by OyB/RCa

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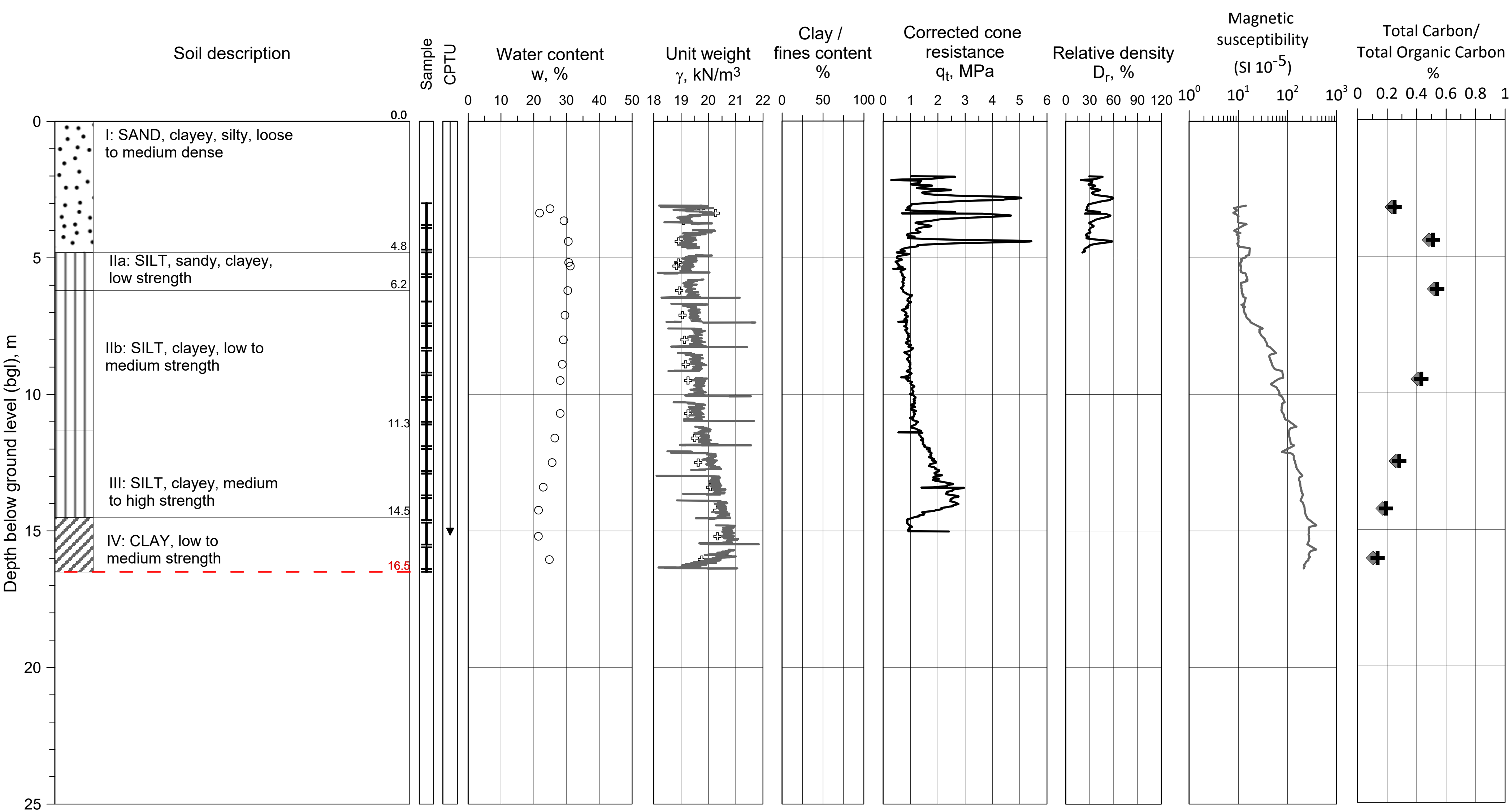
P:\2016\01\20160154\Fieldwork\Halden\Interp-CPT-R-S-DIS\R_Fig_03_NGTS HALB02 log ADDITIONAL.grf



Note: q_t is used for interpretation of CPTU.

- End of BH (EoB)
- Pocket Penetrometer
- Fall cone
- Vane (Field)
- UU test
- CAUC/CIUC
- CAUE/CIUE
- DSS test
- Water content
- Unit weight, γ
- γ (Based on water content)
- Sensitivity, fall cone
- Sensitivity, vane
- Clay content
- Fines content
- Plasticity index, I_p

Coordinate system EUREF89 UTM Zone 32N CM9^{0}E

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB02, BH54C

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB02	635291.057	6555910.153	28.69
HALC06	635289.801	6555911.174	28.78

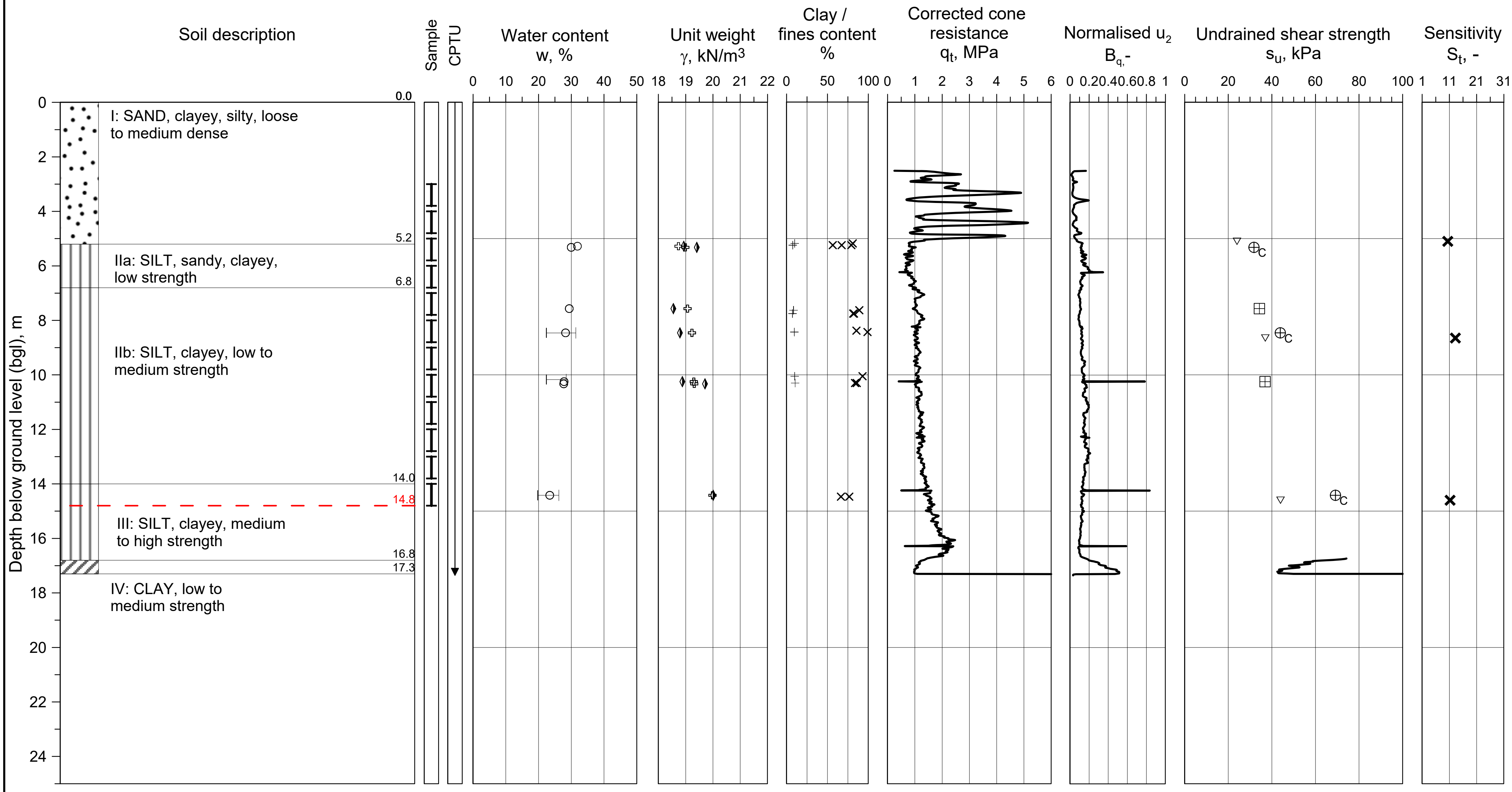
Document No. 20160154-04-R

Figure No. 03

Date 2018-04-07

Drawn by OyB/RCa

NGTS



Note: q_t is used for interpretation of CPTU.

End of BH (EoB)

- □ Pocket Penetrometer
- ▽ Fall cone
- Vane (Field)
- ◇ UU test
- $\oplus_C$ CAUC/CIUC
- $\oplus_E$ CAUE/CIUE
- ⊞ DSS test
- ○ Water content
- Unit weight, γ
- γ (Based on water content)
- ✕ Sensitivity, fall cone
- ▷ Sensitivity, vane
- + Clay content
- × Fines content
- Plasticity index, I_p

Coordinate system EUREF89 UTM Zone 32N CM9⁰E

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB03, BH54C

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB03	635279.230	6555899.500	28.45
HALC11	635280.768	6555901.501	28.48

Document No. 20160154-04-R

Figure No. 04

Date 2018-04-07

Drawn by OyB/RCa

NGTS

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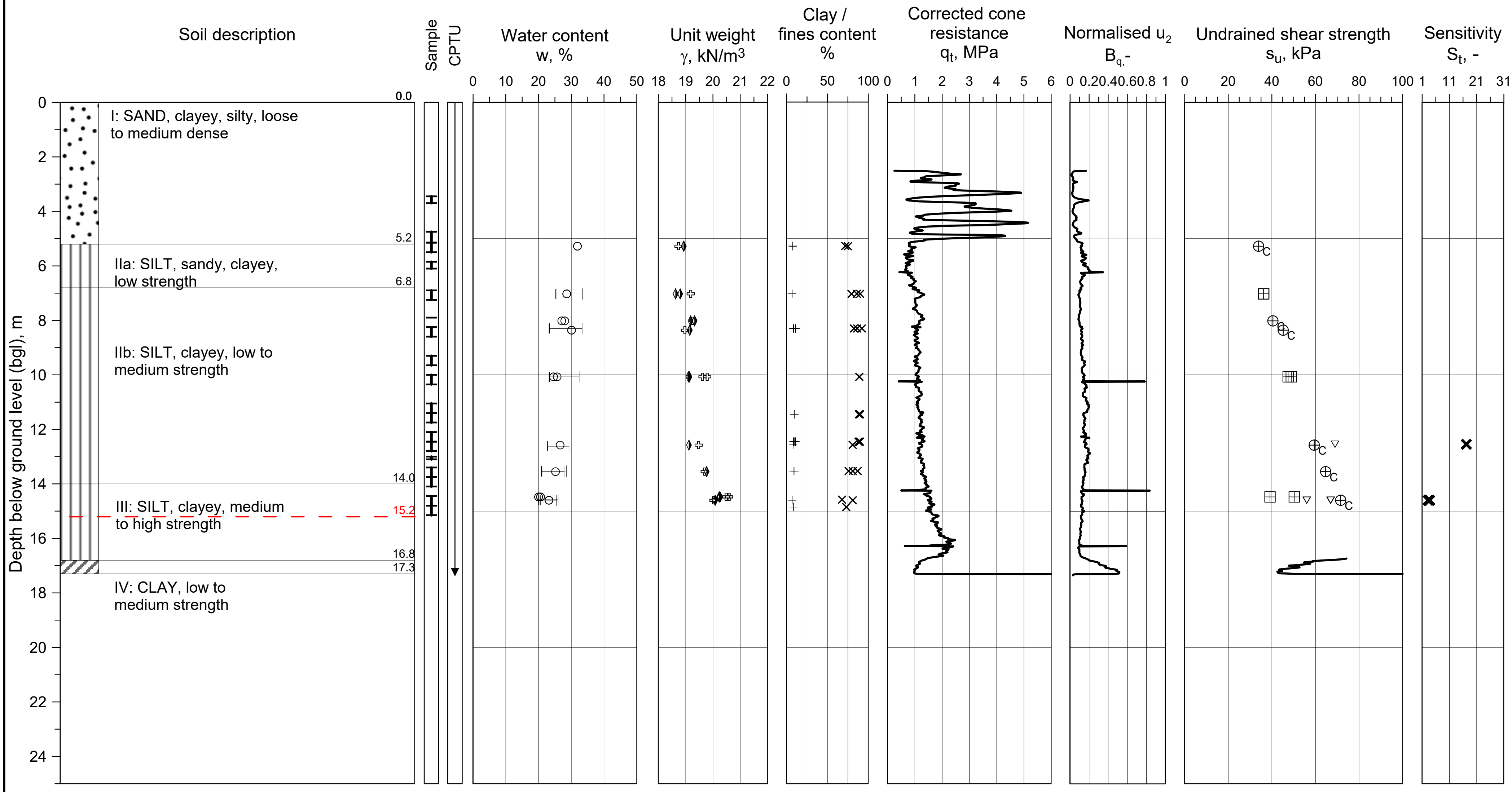

Note: q_t is used for interpretation of CPTU.

- - - End of BH (EoB)

□ Pocket Penetrometer	○ Water content
▽ Fall cone	◊ Unit weight, γ
	✥ γ (Based on water content)
✲ Vane (Field)	✖ Sensitivity, fall cone
◇ UU test	▷ Sensitivity, vane
⊕C CAUC/CIUC	+ Clay content
⊕E CAUE/CIUE	× Fines content
⊞ DSS test	├─┤ Plasticity index, I_p

Coordinate system EUREF89 UTM Zone 32N CM9⁰E

Date/rev.: 2017-06-19/00

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Document No. 20160154-04-R

Borehole log and classification test results HALB04, BHSB

Figure No. 05

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB04	635276.449	6555898.627	28.55
HALC11	635280.768	6555901.501	28.48

Date 2018-04-07

Drawn by OyB/RCa

NGTS

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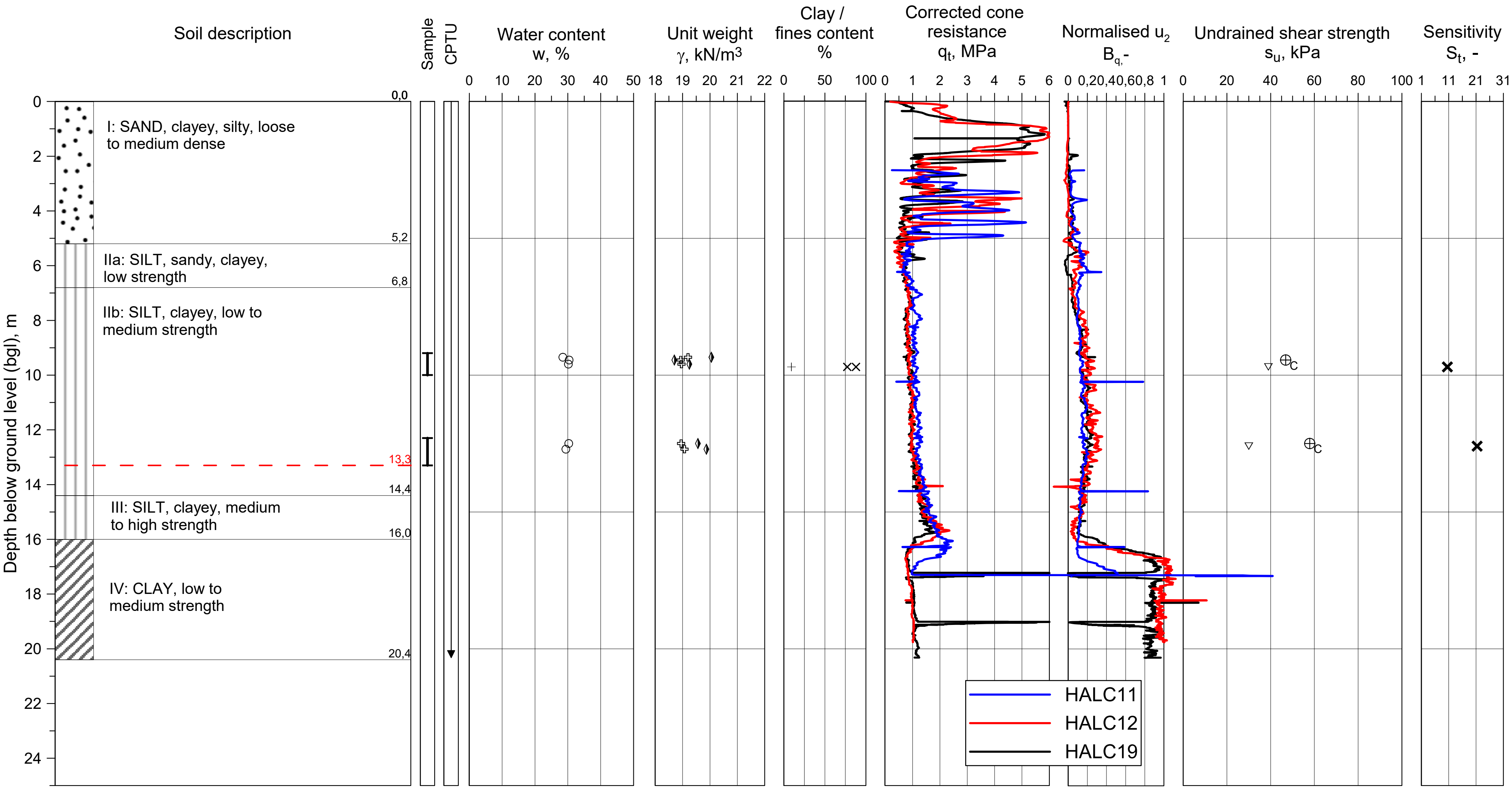

End of BH (EoB)

Note: q_t is used for interpretation of CPTU.

□	Pocket Penetrometer
△	Fall cone
	Vane (Field)
✲	UU test
◇	CAUC/CIUC
⊕C	CAUE/CIUE
⊕E	DSS test
⊞	
○	Water content
⧫	Unit weight, γ
	γ (Based on water content)
✙	Sensitivity, fall cone
✖	Sensitivity, vane
▷	Clay content
+	Fines content
×	Plasticity index, I_p

Coordinate system EUREF89 UTM Zone 32N CM9ºE

P:\2016\01\20160154\Fieldwork\Halden\Interp-CPT-R-S-DIS\R_Fig_06_NGTS HALB05 log.grf

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB05, BHGPS

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB05	635277,213	6555901,013	28,44
HALC11	635280,768	6555901,501	28,48
HALC12	635275,730	6555901,045	28,60
HALC19	635277,123	6555902,412	28,54

Document No. 20160154-04-R

Figure No. 06

Date 2018-09-13

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NGTS

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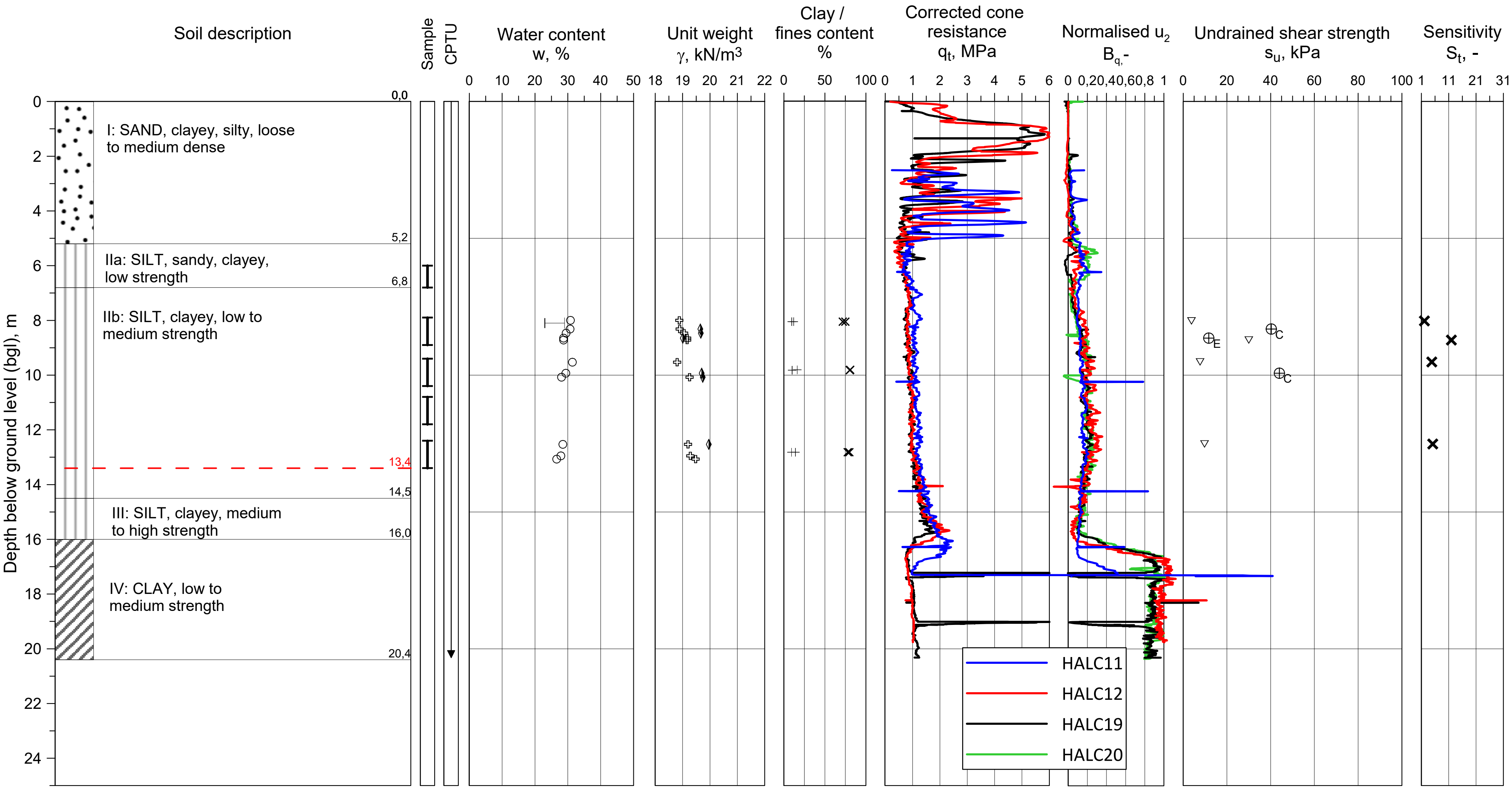

- - End of BH (EoB)

Note: q_t is used for interpretation of CPTU.

□	Pocket Penetrometer	○	Water content
△	Fall cone	⧫	Unit weight, γ
			γ (Based on water content)
	Vane (Field)	✙	Sensitivity, fall cone
✲	UU test	✖	Sensitivity, vane
◇	CAUC/CIUC	▷	Clay content
	CAUE/CIUE		Fines content
⊕C	DSS test	+	Plasticity index, I_p
⊕E		×	
⊞		├─┤	

Coordinate system EUREF89 UTM Zone 32N CM9⁰E

Date/rev.: 2017-06-19/00

NGTS - Halden Research Site

Borehole log and classification test results HALB06, BHGPS

Borehole	Easting (m)	Northing (m)	Elevation (m)
HALB06	635278,730	6555901,045	28,46
HALC11	635280,768	6555901,501	28,48
HALC12	635275,730	6555901,045	28,60
HALC19	635277,123	6555902,412	28,54
HALC20	635278,730	6555902,545	28,54

Document No. 20160154-04-R

Figure No. 07

Date 2018-09-13

Drawn by APP

NGTS

Appendix S

MULTI-SENSOR CORE LOGGING (MSCL), TOTAL CARBON,
TOTAL ORGANIC CARBON AND MINERALOGY

Contents

S1 List of analysed cores

Core	NGI - NGTS Halden						NGU		
	Name outside		Name inside						
Nr.	Sample No.	Depth (m)	OLD ID	**NGTS ID**	No.	Date	Corenr.	Length (cm)	Corename at NGU
1	T11	3.0-3.8	SP8-7-BH	**HALB02**	1	19.10.2015	1	79,5	NGI-Halden20150030-SP8-7-BH-01
2	T16	3.9-4.7	SP8-7-BH	**HALB02**	3	19.10.2015	2	79,5	NGI-Halden20150030-SP8-7-BH-03
3	C84	4.8-5.6	SP8-7-BH	**HALB02**	4	19.10.2015	3	79,5	NGI-Halden20150030-SP8-7-BH-04
4	F110	5.7-6.5	SP8-7-BH	**HALB02**	6	19.10.2015	4	79,5	NGI-Halden20150030-SP8-7-BH-06
5	T12	6.6-7.4	SP8-7-BH	**HALB02**	7	19.10.2015	5	79,5	NGI-Halden20150030-SP8-7-BH-07
6	153	7.5-8.3	SP8-7-BH	**HALB02**	9	19.10.2015	6	79,5	NGI-Halden20150030-SP8-7-BH-09
7	2080	8.4-9.2	SP8-7-BH	**HALB02**	10	19.10.2015	7	79,5	NGI-Halden20150030-SP8-7-BH-10
8	T4	9.3-10.1	SP8-7-BH	**HALB02**	11	19.10.2015	8	79,5	NGI-Halden20150030-SP8-7-BH-11
9	1	10.2-11.0	SP8-7-BH	**HALB02**	13	20.10.2015	9	79,5	NGI-Halden20150030-SP8-7-BH-13
10	80	11.1-11.9	SP8-7-BH	**HALB02**	15	20.10.2015	10	79,5	NGI-Halden20150030-SP8-7-BH-15
11	X1	12.0-12.8	SP8-7-BH	**HALB02**	17	20.10.2015	11	79,5	NGI-Halden20150030-SP8-7-BH-17
12	766	12.9-13.7	SP8-7-BH	**HALB02**	19	20.10.2015	12	79,5	NGI-Halden20150030-SP8-7-BH-19
13	X4	13.8-14.6	SP8-7-BH	**HALB02**	21	20.10.2015	13	79,5	NGI-Halden20150030-SP8-7-BH-21
14	X5	14.7-15.5	SP8-7-BH	**HALB02**	22	20.10.2015	14	79,5	NGI-Halden20150030-SP8-7-BH-22
15	X6	15.6-16.4	SP8-7-BH	**HALB02**	23	20.10.2015	15	79,5	NGI-Halden20150030-SP8-7-BH-23

S2 X-ray images of whole cores (Folder: 020 XRI processed)

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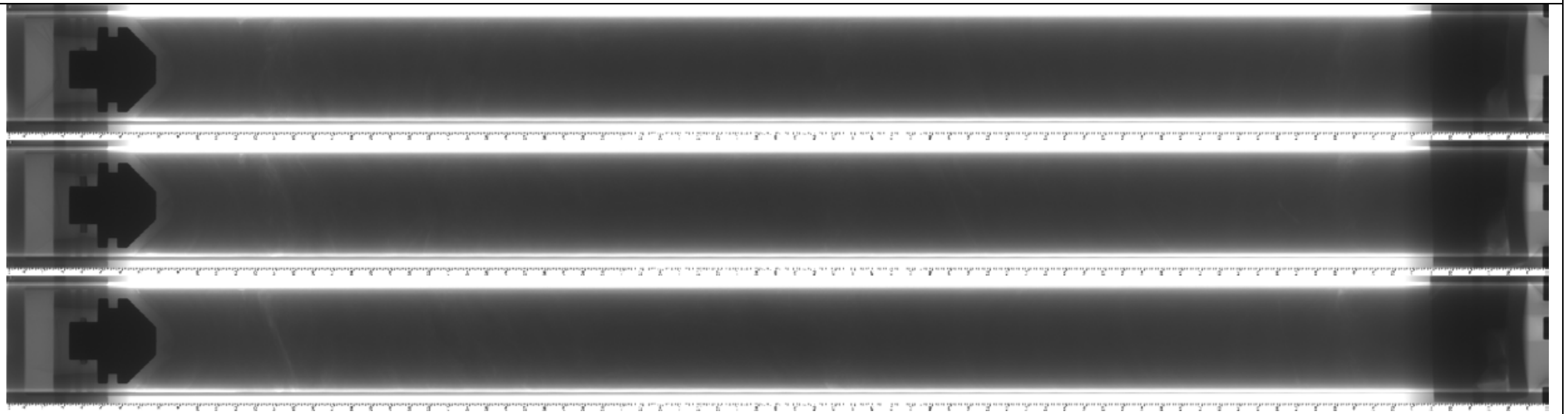
00	
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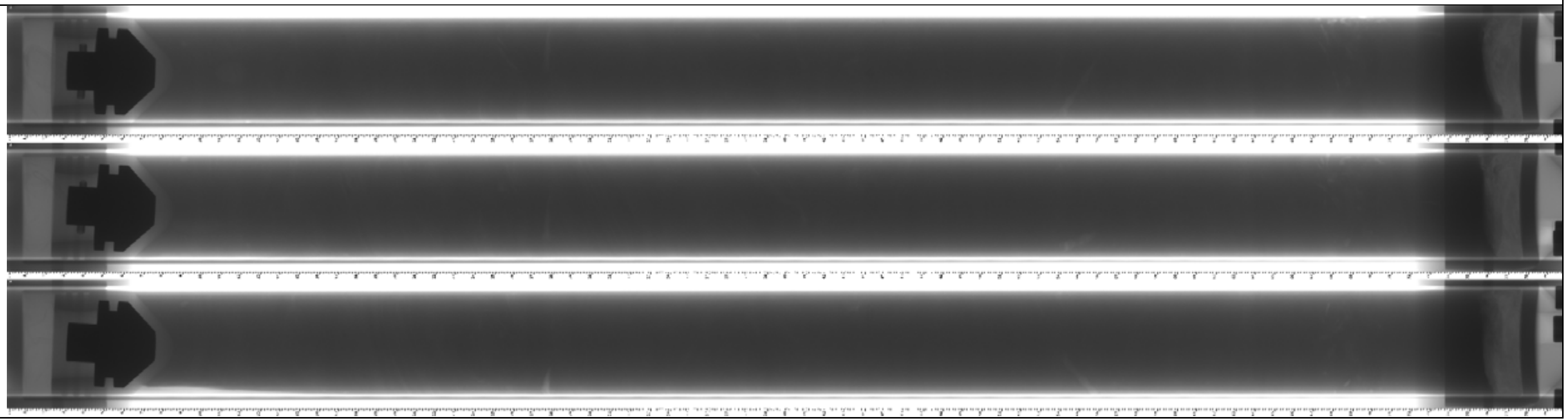
00	
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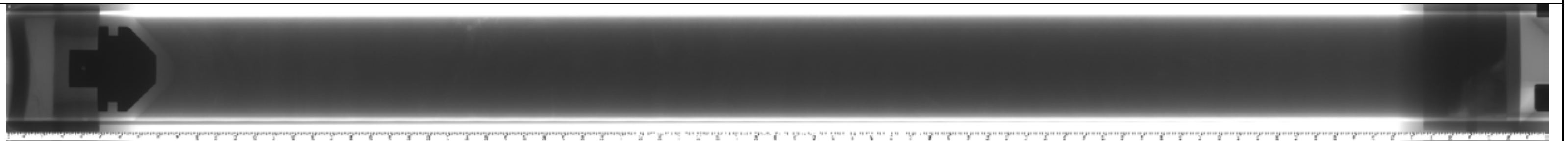
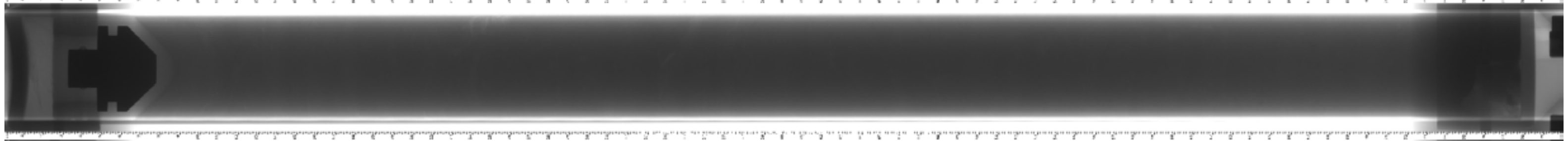
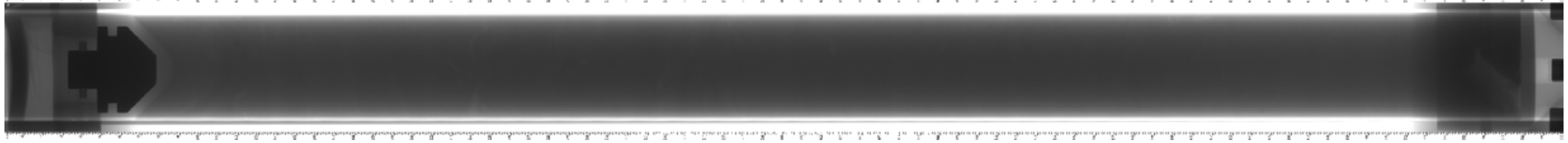
00	
45	
90	

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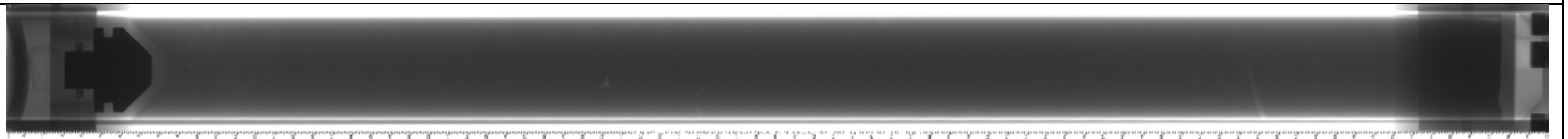
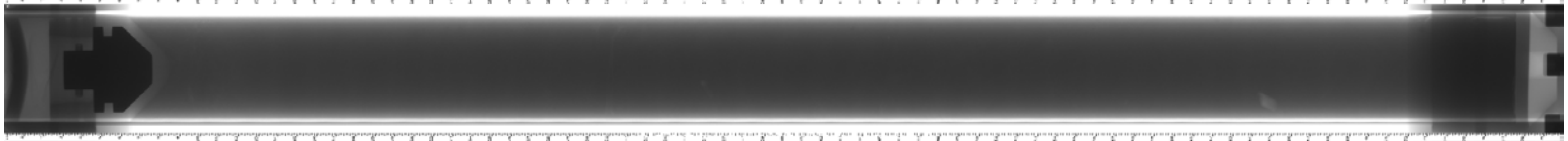
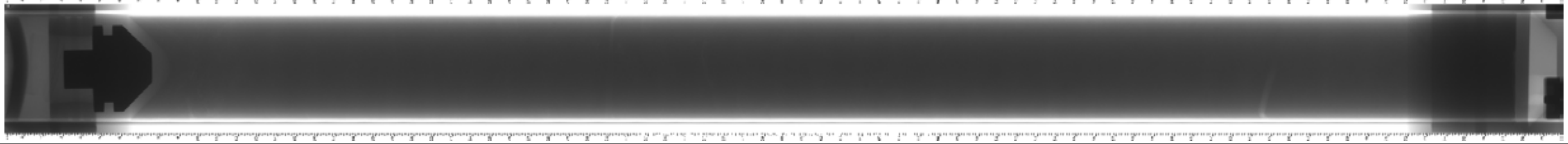
00	
45	
90	

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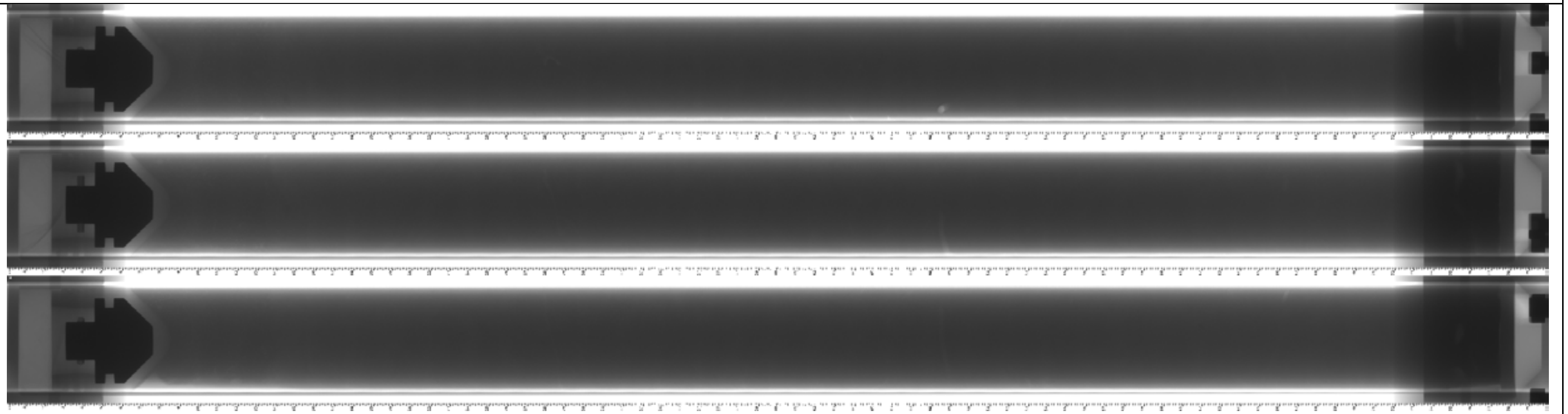
00	
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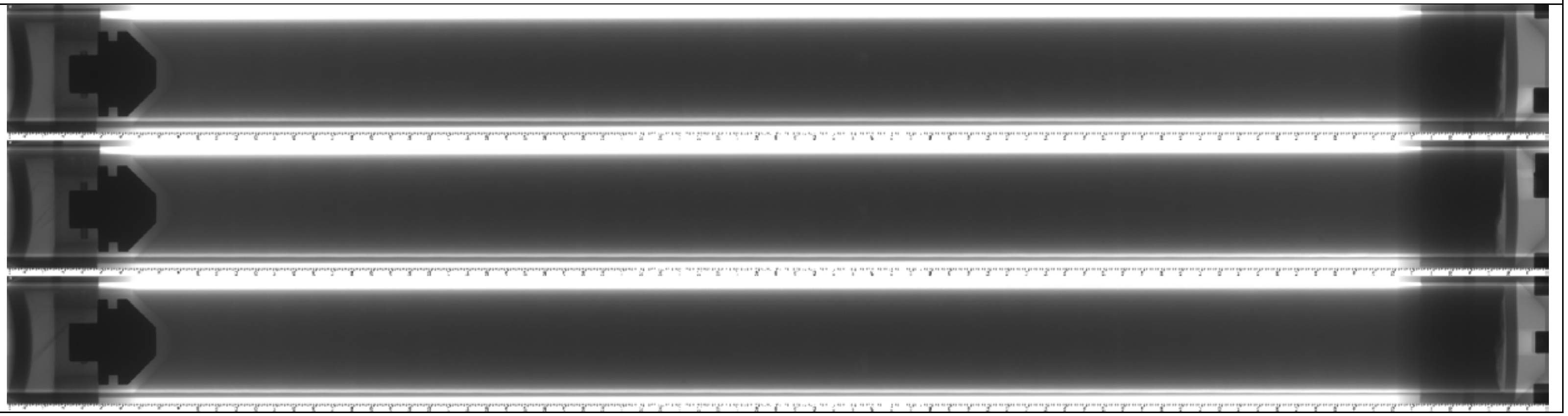
00	
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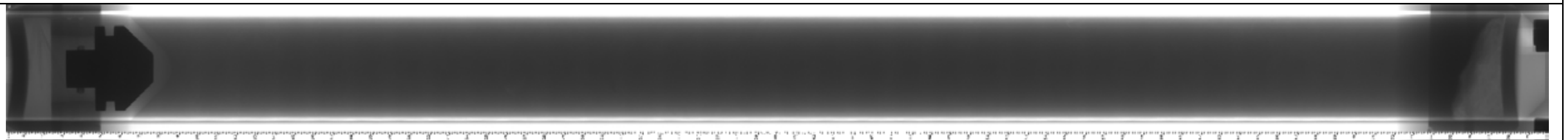

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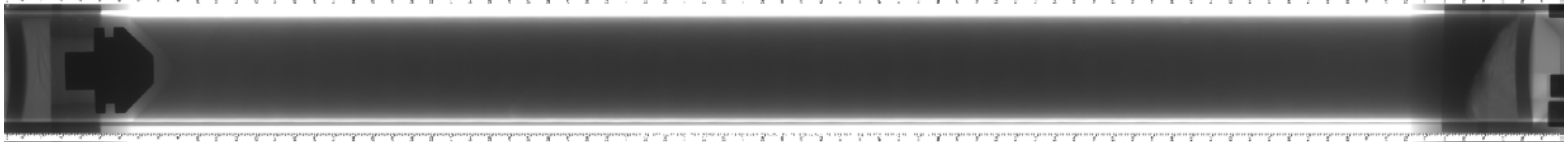

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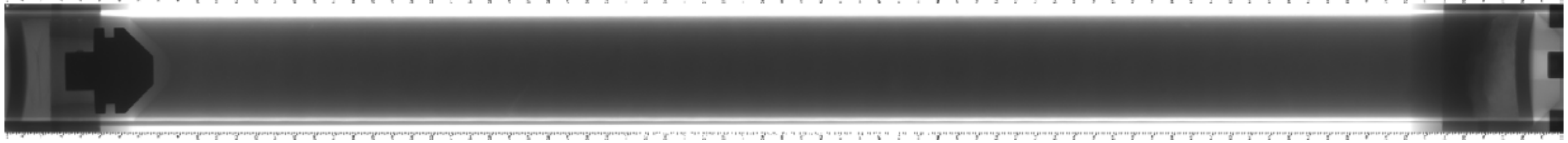

NGI-Halden20150030-SP8-7-BH-11

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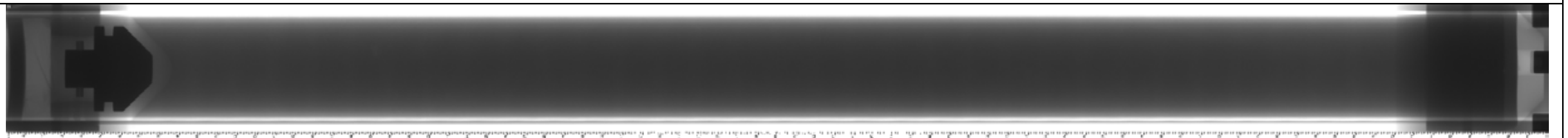

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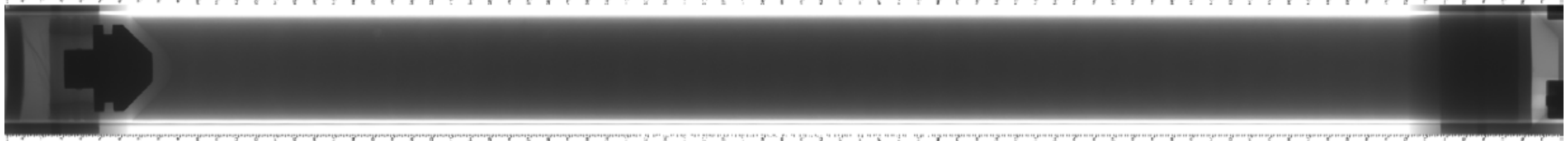

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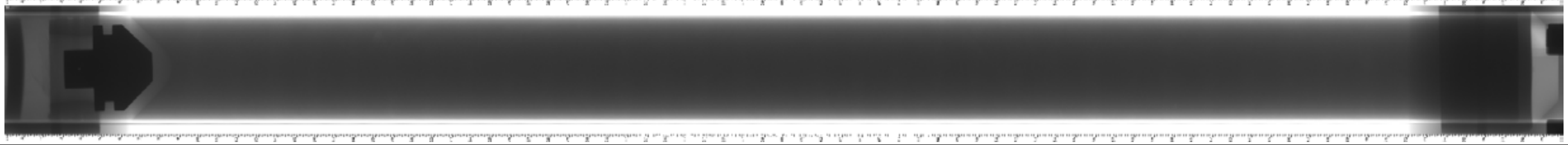

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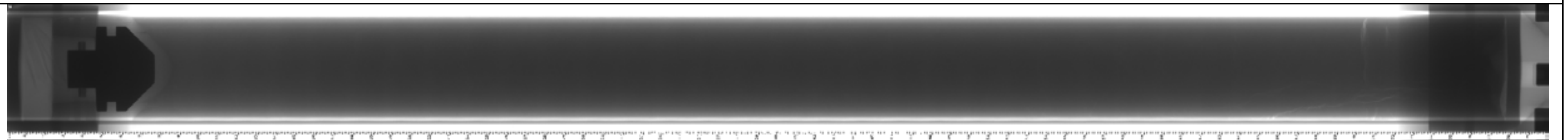
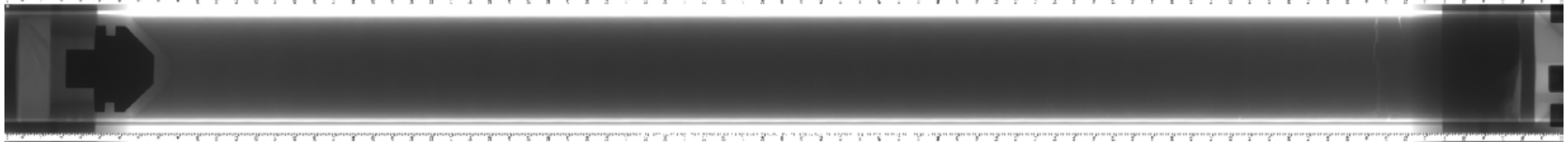
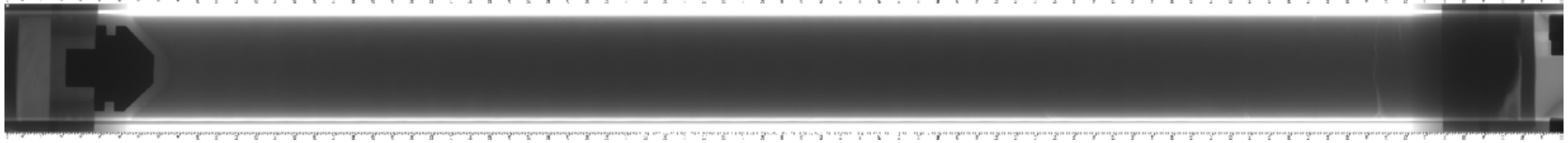
00	
45	
90	

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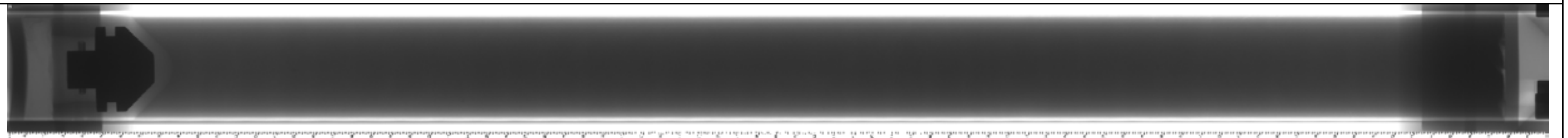
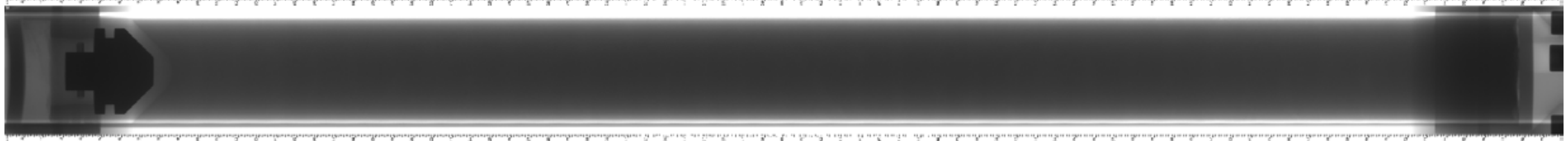
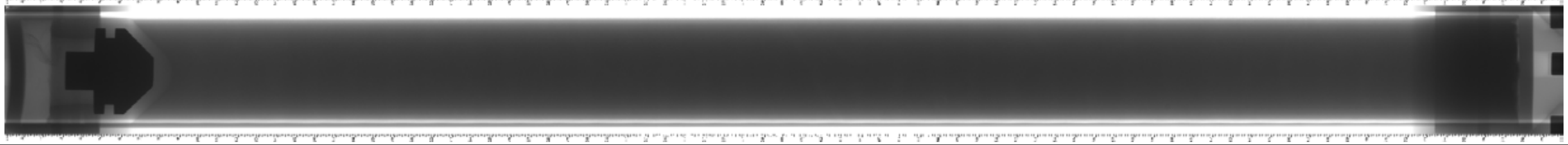
00	
45	
90	

NGI-Halden20150030-SP8-7-BH-17

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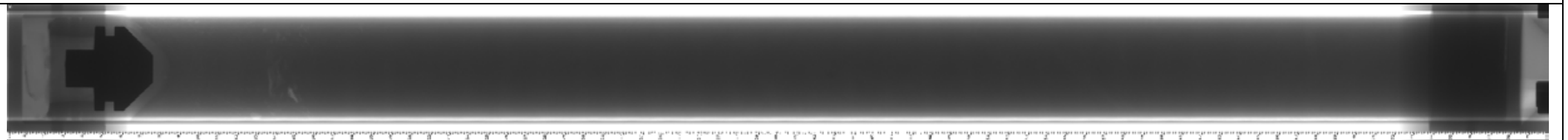

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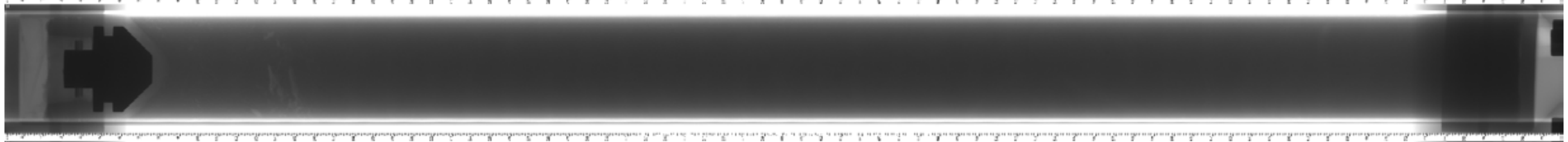

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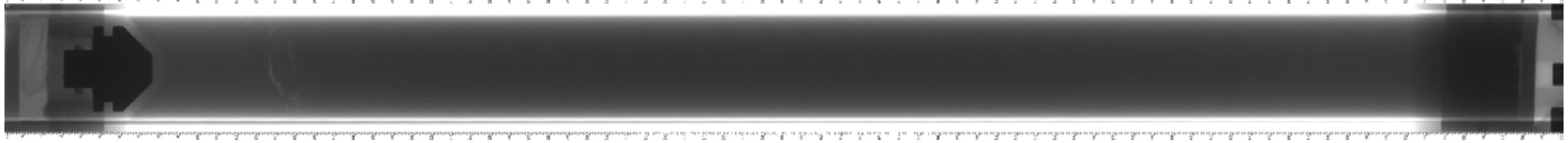

NGI-Halden20150030-SP8-7-BH-19

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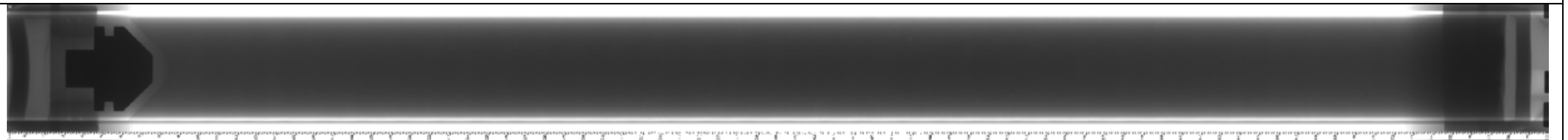

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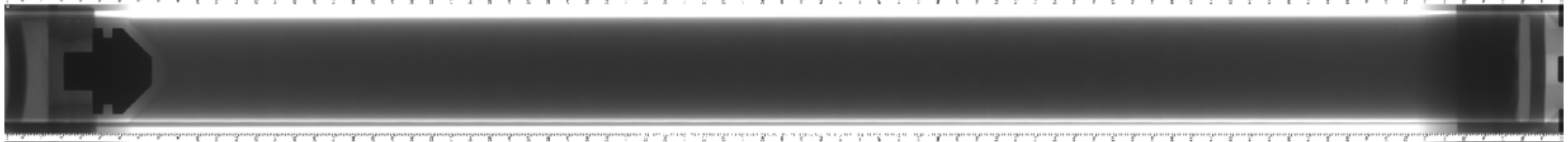

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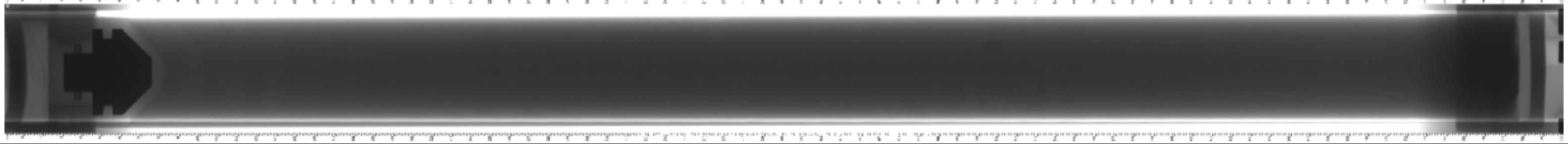

NGI-Halden20150030-SP8-7-BH-21

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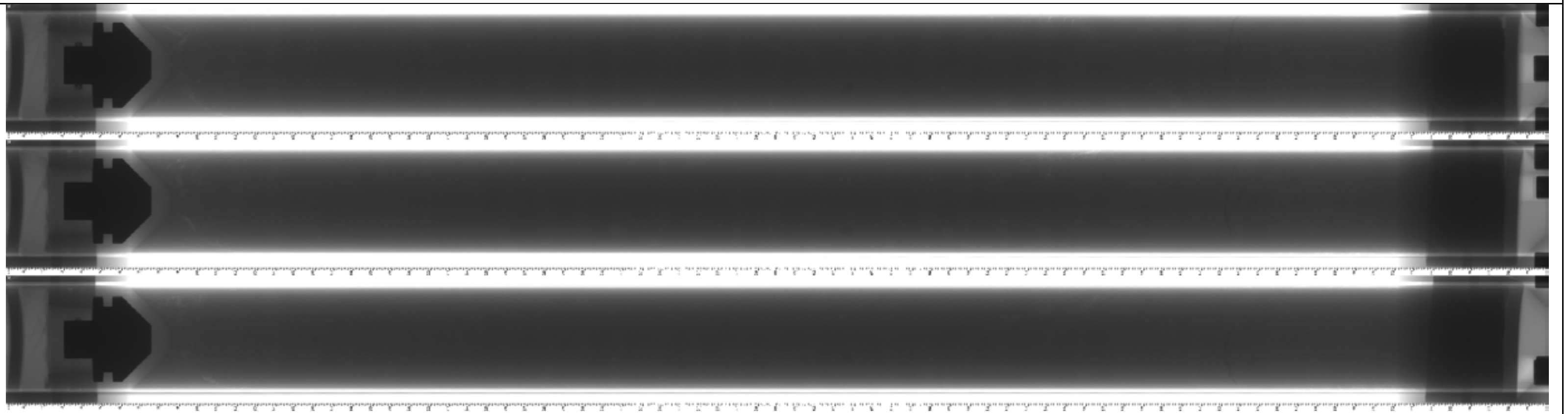
45

90



NGI-Halden20150030-SP8-7-BH-22

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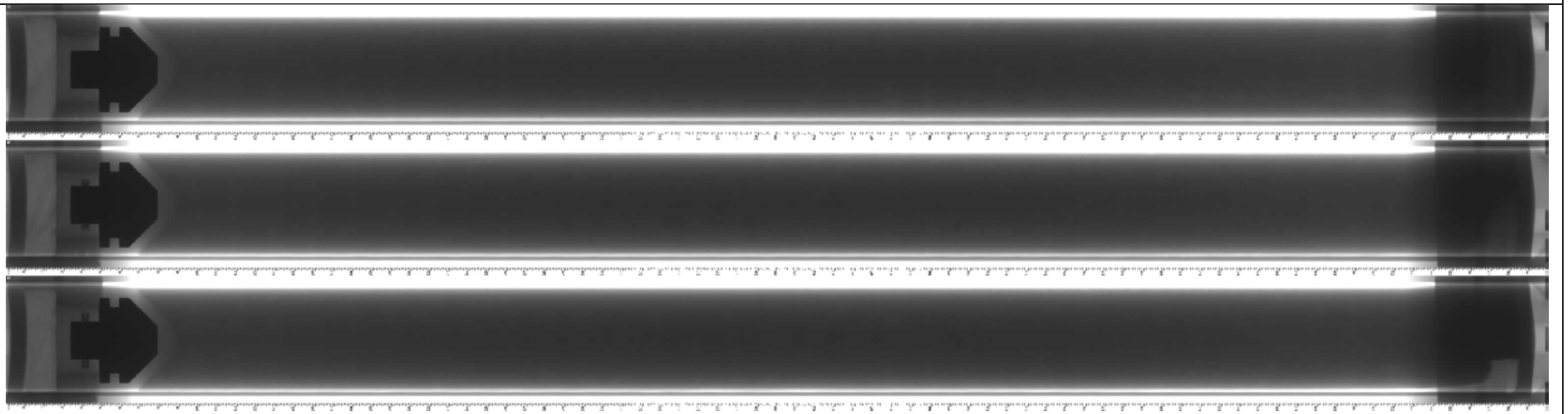
45

90



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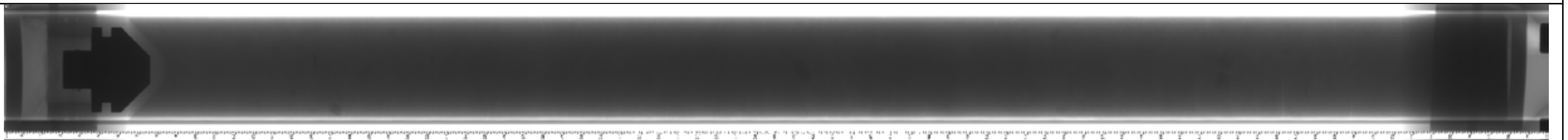
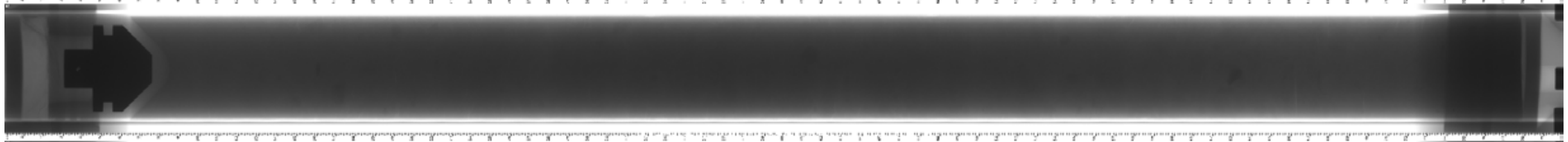
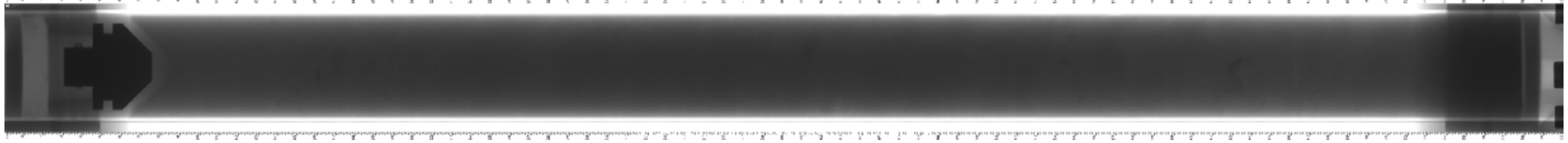
00	
45	
90	

S3 Core surface images (Folder: 041_Images_processed)

NGI-Halden20150030-SP8-7-BH-01	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-03	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-04	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-06	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-07	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-09	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-10	
40 ms	

NGI-Halden20150030-SP8-7-BH-11	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-13	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-15	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-17	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-19	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-21	
20 ms	
40 ms	

NGI-Halden20150030-SP8-7-BH-22

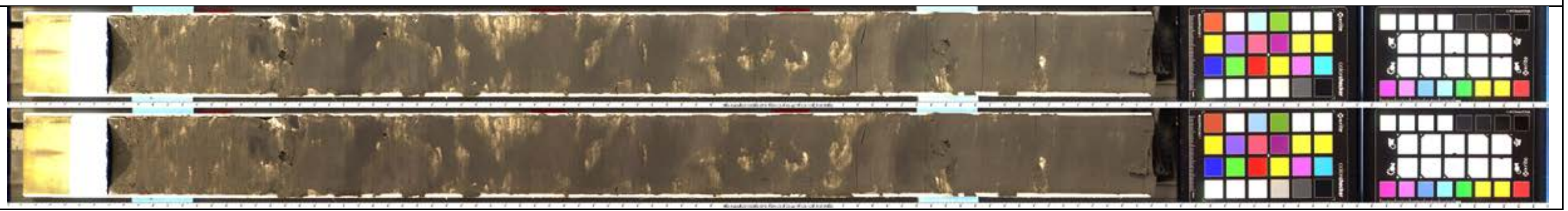
20 ms

40 ms

NGI-Halden20150030-SP8-7-BH-23

20 ms

40 ms



S4 Multisensor Core Logging

S4.1 General

Multisensor Core Logging and X-Ray Imaging were performed by Norwegian Geotechnical Society (NGU). Details on methodology and results are provided in the following.

NGI_Halden - Core logging at NGU
Analysekontrakt 2015.0231

Trondheim, 01.12.2015

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Material

15 sediment cores with a total core length of 12m (Table 1) were logged at the NGU core logging facilities 03.11. – 27.10.2015. The plastic tubes containing the sediment have an outer diameter of 5.8 cm and single wall thickness of 0.165cm. All cores contained a piston on top of the sediment and were sealed at top and bottom with plastic caps. The bottom caps were secured with a pipe clamps. Prior core logging the piston inside the core was replaced by a Styrofoam plug to preserve the sediment surface. To avoid interference of the metal pipe clamp with magnetic susceptibility (MS) measurements of sample material, all pipe clamps were removed and the cap surfaces cleaned from visible rust contamination. The cores were stored horizontally for at least one day in the core logging facilities to allow for thermal equilibration with the laboratory temperature.

Table 1: Core identification, individual length and measurements applied

Core no.	Length (cm)	Core name	XRI	Gamma/MS	Colour image
1	79.5	NGI-Halden20150030-SP8-7-BH-01	x	x	x
2	79.5	NGI-Halden20150030-SP8-7-BH-03	x	x	x
3	79.5	NGI-Halden20150030-SP8-7-BH-04	x	x	x
4	79.5	NGI-Halden20150030-SP8-7-BH-06	x	x	x
5	79.5	NGI-Halden20150030-SP8-7-BH-07	x	x	x
6	79.5	NGI-Halden20150030-SP8-7-BH-09	x	x	x
7	79.5	NGI-Halden20150030-SP8-7-BH-10	x	x	x
8	79.5	NGI-Halden20150030-SP8-7-BH-11	x	x	x
9	79.5	NGI-Halden20150030-SP8-7-BH-13	x	x	x
10	79.5	NGI-Halden20150030-SP8-7-BH-15	x	x	x
11	79.5	NGI-Halden20150030-SP8-7-BH-17	x	x	x
12	79.5	NGI-Halden20150030-SP8-7-BH-19	x	x	x
13	79.5	NGI-Halden20150030-SP8-7-BH-21	x	x	x
14	79.5	NGI-Halden20150030-SP8-7-BH-22	x	x	x
15	79.5	NGI-Halden20150030-SP8-7-BH-23	x	x	x

Methods

X-ray inspection

X-ray images of whole cores were taken with the Geotek MSCL-XCT (Geotek Ltd., UK). The Geotek MSCL-XCT is equipped with a Thermo Kevex PSX10-65W X-ray source (Thermo Fisher Scientific Inc., USA) and a Varian PAXScan 2520V (Varian Medical Systems, Inc., USA) with a 1920 x 1536 pixel array as X-ray detector. The micro-focal X-ray source was used with a voltage of 120 kV and a current of 100µA. The 1x1 0.5pF G4 10 fps detector-CCD-mode was used for highest resolution. 20 images per frame were taken and averaged to an image slice. Each image is then reproduced from adjacent image slices which were stitched with an overlap of 50% to the final product.
After loading the core repeated runs produced three 16bit greyscale images with 0, 45, and 90 degree axial orientation. X-ray imagines primarily reflect density changes where denser material attenuate more of the X-ray travelling through the sample resulting in darker areas of the image.

MultiSensorCoreLogging (MSCL)

Whole Core measurements

Whole core Gamma density, i.e. wet bulk density (WBD) and magnetic susceptibility (MS) were measured using the Standard MSCL-S core logger (GeoTek Ltd., UK) at 0.5 cm resolution with 5sec exposure/measurement time. During a measurement the section of a core is moved past the array of stationary sensors, and data is collected from all sensors when the core paused at a measurement point.

Gamma density

To measure sediment density based on emitted gamma ray attenuation a ^{137}Cs radioactive source and a NaI (TI) detector are used. Prior WBD measurements appropriate calibration measurements were conducted that facilitates the basis for counts per second to g/ccm conversion. Calibration is provided by the measurement of a defined aluminium body. The aluminium body is mounted in a water filled plastic tube similar to the sediment cores. Repetition of measurements and application of extended measurement time allow for a statistically reasonable calibration data set. Results of the calibration measurements are the basis for all data conversion facilitated by the GeoTek software. To measure the gamma density a 0.5 cm beam of gamma rays with a intensity (I_0) passes through the core. The intensity of the gamma rays is altered by several processes; predominantly by Compton scattering (Zolitschka et al. 2001 and refs therein). The intensity of gamma rays detected after passing the core depends on the source intensity, the sediment thickness, sediment bulk density and the mass absorption or Compton attenuation coefficient of the sediment core (Zolitschka et al. 2001). Details about Compton scattering and its effect on gamma density measurements are described elsewhere (e.g. Davidson et al. 1963; Ellis & Singer 2007; Evans & Cotterell 1970). Wet bulk density yields information on sediment properties such as grain size and mineralogy (St-Onge et al. 2007) but may also reflect compaction (i.e. water content) and some texture features like layering. Density data has been processed to remove data from core sections at top and bottom where air or water fills the liner. Some cores, cf. NGI-Halden20150030-SP8-7-BH-04 (third core section from top in Fig1.), still show unrealistic density variations at the bottom. These variation are likely artefacts from the core caps.

Loop Sensor magnetic susceptibility

Magnetic susceptibility measurements for whole cores were taken with a Bartington MS2C loop sensor (Dearing 1994) with 100mm coil diameter. The MS2C loop sensor measurement represents data integrated over a distance equivalent to the sensor diameter which is symmetrically located before and behind the sensor along the core axis (see also Nowaczyk 2002). For calibration of the MS2C sensor a certified sample piece with known magnetic susceptibility were measured. Since the sample material is continuously moved through the sensor zeroing of the MS2C is only possible before a core. To correct any magnetic susceptibility drift blank measurements with empty core pieces before and after a sediment core were measured and linear drift correction applied to the results. The blank measurements furthermore allowed for sediment air interface correction. It corrects the core start and core end effects from loop sensor integration thus providing a recalculation of MS measurements in the effected transition zones. The raw magnetic susceptibility data is processed to corrected volume specific magnetic susceptibility, which takes into account the relative effect of size of the core and the size of the loop sensor being used.

Although attention has been paid during mechanical cleaning of cores and end caps, increased MS results at some core starts and ends may indicate impurities, for example small remaining metal or rust fragments from the pipe clamps at the core caps (Fig.1.) or incomplete sediment filling due to removed piston on top. The MS data at sediment boundaries (near section ends) have been back-folded to correct for MS2C loop sensor integration over the sediment air interface. The back-folding produces corrected MS values which correspond to virtual measurements, where the air filled end of the core is replaced by a mirror image of the sediment filled part and may not reflect the true MS variations in the sediment. The user is therefore advised to carefully interpret the MS_folded data near the sediment boundaries. In case of doubt the user should also check the MS_unfolded data and reject critical MS core boundary data. The MS_unfolded data is corrected volume specific magnetic susceptibility before backfolding (Fig. 1).

Fractional Porosity

Fractional porosity has been calculated from Gamma density with fluid density of 1g/ccm for fresh pore water and an assumed mineral grain density of 2.65 g/ccm. Fractional porosity can be used to assess the water content of the sediment. A more detailed description of fractional porosity is provided e.g. in Zolitschka et al. (2001) and refs. therein.

Split Core measurements

After lengthwise core opening and surface cleaning colour images were taken (Table 1).

Imaging

Core surface images were taken with the GeoScan colour line-scan camera. The camera is equipped with a 105mm, 1:2.8D DC Macro lens and three detectors using three 2048 pixel charge-coupled device CCD arrays for red, green and blue light. Prior imaging the CCD detectors were calibrated. Polarised light from two white LED banks is reflected from the core surface and passes through the lens that is equipped with a polarizing filter to reduce glare effects. The core surface was continuously imaged with 50 µm down and cross core resolution. Two runs with 20 ms and 40 ms exposure time produced two images per core. Each image comes with an X-rite color reference card for basic color control. A ruler attached to the processed image files facilitates depth information.

References

Davidson J.M., Biggar J.W., & Nielsen D.R. 1963. Gamma-radiation attenuation for measuring bulk density and transient water flow in porous materials. *Journal of Geophysical Research 68*, 4777–4783.

Dearing J.A. 1994. Environmental Magnetic Susceptibility: Using the Bartington MS2 System. Chi Publishing. 104 pp.

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Evans H.B. & Cotterell C.H. 1970. Gamma-ray attenuation density scanner. *Peterson, MNA, Edgar, NT, et al., Init. Repts. DSDP 2*, 442–54.

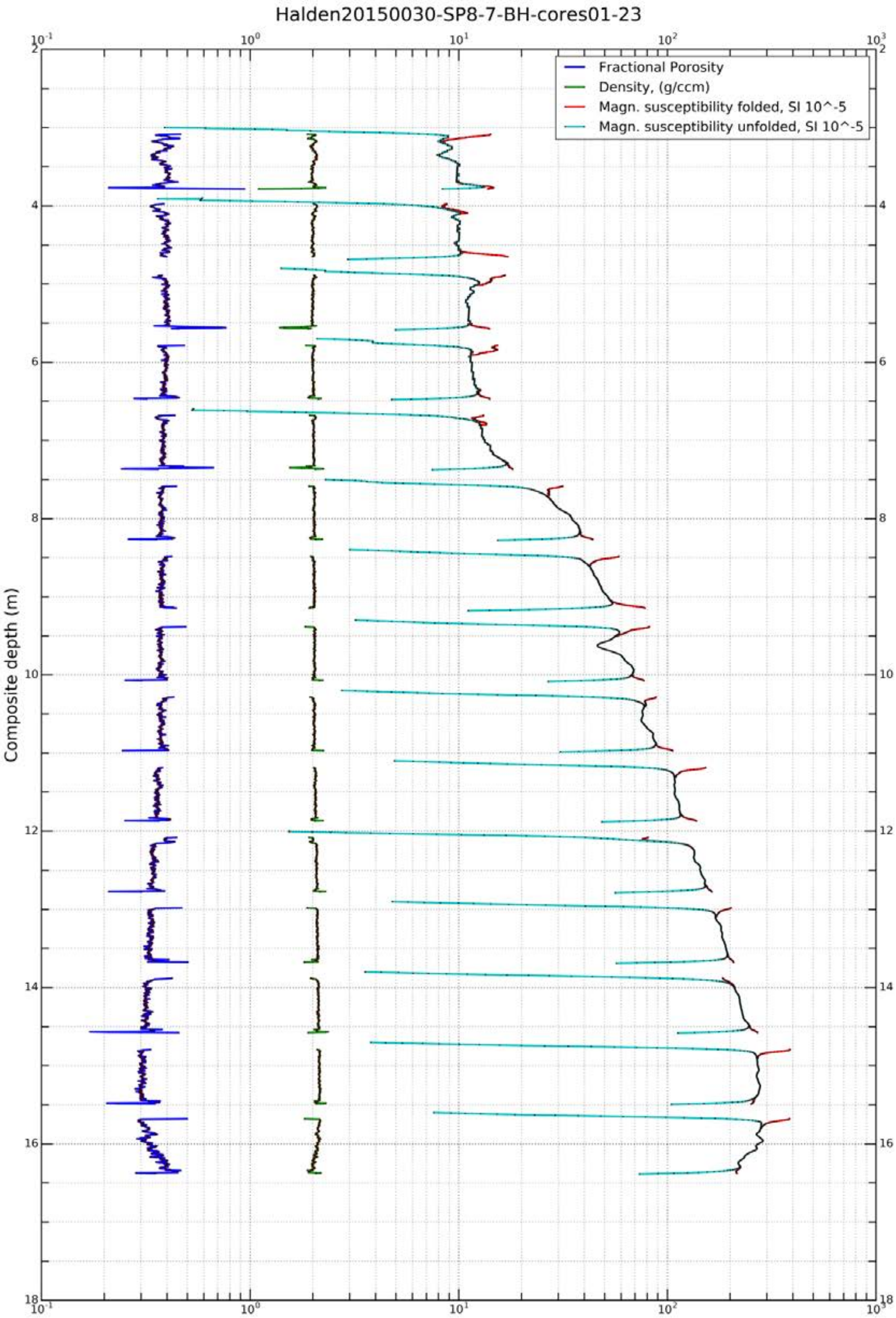
Nowaczyk N. 2002. Logging of magnetic susceptibility. *Tracking environmental change using lake sediments* 155–170.

St-Onge G., Mulder T., Francus P., & Long B. 2007. Chapter Two Continuous Physical Properties of Cored Marine Sediments. *Developments in Marine Geology*. Elsevier. pp. 63–98.

Zolitschka B., Mingram J., Van Der Gaast S., Jansen J.F., & Naumann R. 2001. Sediment logging techniques. *Tracking environmental change using lake sediments*. Springer. pp. 137–153.

Appendix

Fig.1: Semi logarithmic plot of whole core measurements based on depth information provided by NGI. Depth adjustments might be necessary.



Depth = 3,0 – 3,8 m

core no.: SP8-1			name: L'Heureux + Hansen.			date: 24.11.15
core depth (cm)	**sketch**	**colour**	**grain size**	**texture**	**structure**	**remarks**	**samples**
...0							WC
10							
20						✱ litt me-org våt sandig si – si sa.	SP8-1-020 (26,86g) ✓
30							
40						"for" el. ren f.sand (litt grovere enn do. og du.) ✱ ✱	SP8-1-036 (31.08g) ✓
50						✱ svak lysere lag (biow)	
60						våt som øverste lag	
70							SP8-1-064 (23.83g) ✓
80		↑ brun grå generelt				generelt homogen svakt mottled	
100							
...0							

Depth= 3,9 - 4,7 m

core no.: SP8 - 2	name: L'Heureux + Hansen	date: 24/11 - 15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							wc
10							
2...0						— svale slire av leire (del av grave spor?)	
30							
4...0						homogent / svalof mottled siltig-mfs	
50							sp8-2-050 (36,37 g) ÷ 1,25g ✓
6.0							
70							
8...0		↑ brun grå generelt				↑ 78,5 cm nedent på kappe	
10.0							
...0							

Depth = 4,8-5,6 m

core no.: SP8-3	name: L'Heureux + Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							WC
10							
20						svakt lagdelt ↑	
							sp8-3-025 kul
30						= litt rel. grovere lomme	sp8-3-034 kul
							Sp8-3-035 (34.44g) ✓
40							
50						homogent si-mfs	SP8-3-050 (22,56g) ✓
60							
70							
80							
		brunlig grå					
...0							
...0							

Depth = 5,7-6,5 m

core no.: SP8-4 | name: L'Heureux Hansen | date: 24/11-15

sketch	colour	grain size	texture	structure	remarks	samples

core depth (cm)

...0

forstyrret? 10 — Litt grovere? lag?

2.0

30 — kulbit

4.0 — kulbit — SP8-4-036 kul

homogent / generelt (svakt mottled)

50 — SP8-4-050 (38,53g) — wc ✓

6.0

skjellbit 65,5 cm — SP8-4-066 ~~skjell~~ pinne

70

8.0

90

...0

...0

Depth = 6,6 - 7,4 m

core no.: sp8 – 5	name: L'Heureux-Hamm	date: 24/11 – 15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
10						siltig sand (forstyrret ??)	
20						silt dom (lidt m/s)	
30						homogen mottled brunlig grå	
40						kul	
50							sp8-5-050 (38,12g) wc ✓
60							
70							
80							
...0							
...0							

Depth = 7,5-8,3 m

core no.: SP8-6	name: L'Heureux Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
2...0							
4...0						silt m. lidt m/s. meget homogent (mottled) brunlig grå	SP8-6-050 WC (30,14g) ✓
6...0							
8...0							
...0							
...0							

Depth = 8.4 – 9,2 m

core no.: sp8 – 7	name: L'Heureux-Hansen			date: 24/11 – 15		
sketch	colour	grain size	texture	structure	remarks	samples
					litt organisk	w.c. (43,58 g) sp8-7

core depth (cm)

...0
10
2.0
30
4.0
50
6.0
70
8.0
...0
...0

Depth = 9.3 - 10,1 m

core no.: Sp8 - 8	name: L'Heureux + Hansen	date: 24/11 -15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
						- gruskorn	
2...0							Sp8-8-019 (46,87g) wc ✓
anomali magsusc. 4...0						homogen silt (m litt mfs) brunlig grå mottled	
6...0							
8...0							
...0							
...0							

Depth = 10.2 - 11.0 m

core no.: Sp8 - 9	name: L'Heureux + Hansen	date: 24/11 - 15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
10							
2...0							
30						homogen silt (mottled)	
4...0							
50							Sp8-9-050 wg (31,65g) ✓
6...0							
70							
8...0							
...0							
...0							

Depth = 11.1 - 11,9 m

core no.: Sp8 - 10	name: L'Heureux + Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
...0						homogen -litten fast silt brunlig grå noe mottled	
4..0							
50							Sp8-10-050 (16,76 g) WC ✓
6..0							
70							
8..0							
...0							
...0							

Depth = 12-12.8 m

core no.: Sp8-11	name: L'Heureux Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
						blød	
						tydelig signaturer på x-ray - hvite flekker	fastere
2...0							
						homogen!	
4...0						silt (evt. m litt leire) brunlig grå	
							Sp8-11-050 (36,97g) WC ✓
6...0							
8...0							
...0							
...0							

Depth: 12.9 – 13.7 m

core no.: Sp8-12	name: L'Heureux Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
						mikroskjell bit*	
2...0							
						homogen mottled silt (m. litt leire) brunlig grå	
4...0							
						org mat, svart	
							Sp8-12-050 wc 46.82 g
						skjell bit	Sp8-12-053 skjell
6...0						← microskjellbiter	
8...0							
...0							
...0							

Depth: 13.8 – 14.6 m

core no.: Sp8 – 13	name: L'Heureux Hansen	date: 24/11 – 15					
core depth (cm)	**sketch**	**colour**	**grain size**	**texture**	**structure**	**remarks**	**samples**
...0							
2...0						liten klast	
						homogen silt m litt leire (mottled)	
4...0						liten skjell bit	Sp8-13-04 / wc (36,28 g) ✓
6...0						← skjell!!	Sp8-13-064 / skjell
8...0							
...0							
...0							

Depth : 14.7-15.5 m

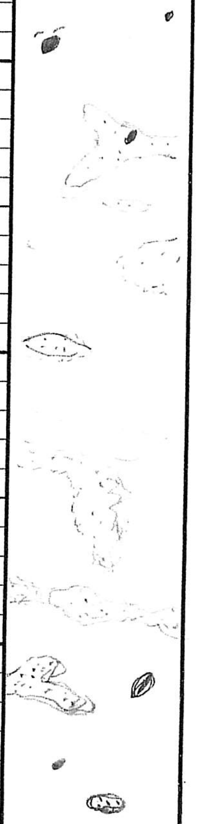
core no.: sp8-14	name: L'Heureux Hansen	date: 24/11-15

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
0							
10							
20						homogen silt m litt mfS (enkelt sa korn) brunlig grå	
30							
40							
50						← mikroskjellfragment ← liten klast 5mm	sp8-14-a50 wc 31/12 ✓
60							
70						evt litt mer sand	
80							
...0							
...0							

Depth : 15.6 – 16.4 m

core no.: Sp8-15	name: L'Heureux Hansen				date: 24/11-15	

core depth (cm)	sketch	colour	grain size	texture	structure	remarks	samples
...0							
10						litt grovere homogent	
2.0						← 1cm klast m. litt skjellrest.	
						m. tydelig bioturbasjon	
30							
4.0							
50						svakt lysere lag	sp8-15-045 wc (37,00g)
						gravespor m. mfs. + si	
6.0							
		←	grovere sandsynligvis herfra			1cm klast	sp8-15-063 skjell
70						skjellbit muligvis herfra.	
						Leirholdig silt	
8.0							
...0							
...0							



S5 Total Carbon/Total Organic Carbon

S5.1 General

Total carbon (TC) and Total organic carbon (TOC) tests were performed by Norwegian Geotechnical Society (NGU). Details on methodology and results are provided in the following.

NORGES GEOLOGISKE UNDERSØKELSE - NGU -

7491 TRONDHEIM
Tlf.: 73 90 40 00
E-post: lab@ngu.no

Totalt karbon / Totalt svovel / Totalt organisk karbon
GEOLOGISK MATERIALE
Analysekontrakt nr. 2015.0367

NORSK AKKREDITERING TEST 020

INSTRUMENT: **Leco SC-632**

METODER: **BESTEMMELSER AV TOTALT KARBON (TC) / TOTALT SVOVEL (TS) / TOTALT ORGANISK KARBON (TOC)**
Forbrenningsanalyser i henhold til metodebeskrivelser i NGU-SD 2.14, NGU-SD 2.15 og NGU-SD 2.16.

I) TOTALT KARBON (TC)

Nedre bestemmelsesgrense [% C]: **0.06**

Analyseusikkerhet

Måleområde	Usikkerhet
0.06 - 0.4 %	± 0.06 %
> 0.4 %	± 15 % rel.

II) TOTALT SVOVEL (TS)

Nedre bestemmelsesgrense [% S]: **0.02**

Analyseusikkerhet

Måleområde	Usikkerhet
0.02 - 3.0 %	± 30 % rel.
> 3.0 %	± 20 % rel.

III) TOTALT ORGANISK KARBON (TOC)

Nedre bestemmelsesgrense [% TOC]: **0.1**

Analyseusikkerhet

Måleområde	Usikkerhet
0.1 - 3.0 %	± 25 % rel.
> 3.0 %	± 20 % rel.

Oppgitte usikkerheter har dekningsfaktor 2 (2 standardavvik), noe som tilsvarer et konfidensintervall på 95 %.

PRESISJON : Det analyseres rutinemessig kontrollprøver som føres i kontrolldiagram (X-diagram). Disse kan forevises om ønskelig.

ANTALL PRØVER: 7

ANMERKNINGER: **Ingen.**

Gjengivelse av analysedata skal skje på en slik måte at meningsinnholdet i rapporten ikke endres.

Ferdig analysert	14/ Jan/ 2016	Anne Nordtømme
	Dato	OPERATØR

NORGES GEOLOGISKE UNDERSØKELSE
- NGU -
7491 TRONDHEIM
Tlf.: 73 90 40 00
E-post: lab@ngu.no

Totalt karbon / Totalt svovel / Totalt organisk karbon
GEOLOGISK MATERIALE
Analysekontrakt nr. 2015.0367

NORSK AKKREDITERING TEST 020

Prøve ID	Karbon [%]	TOC [%]	Total depth	
SP8-1-20	0.251	0.232	3.2	Unit I
SP8-2-50	0.511	0.484	4.4	Unit I
SP8-4-50	0.539	0.519	6.2	Unit II
SP8-8-19	0.432	0.408	9.49	Unit II
SP8-11-50	0.282	0.259	12.5	Unit III
SP8-13-44	0.193	0.170	14.24	Unit III
SP8-15-45	0.136	0.105	16.05	Unit IV

S6 Mineralogy

S6.1 General

Mineralogical analyses by x-ray diffraction (XRD) were performed on selected soil samples. Samples are prepared and XRD scans produced according to the standard techniques used by Norwegian Geotechnical Society (NGU). Details on methodology and results are provided in the following.

NORGES GEOLOGISKE UNDERSØKELSE
- NGU -

7491 TRONDHEIM
Tlf.: 73 90 40 00
Telefaks: 73 92 16 20

XRD-analyses
Geological material
Analyses contract 2015.0367

Instrument:	Bruker D8 Advance med Cu X-ray tube and Lynxeye XE detector.
Method description:	NGU-SD 4.1: XRD-analysis
Purpose:	Mineral identification and quantification
Project number:	21003
Customer:	Jean-Sebastien L'Heureux (Norges Geotekniske Institutt)
XRD scan:	Cu Kα, 40 kV/40 mA, scan 3-75°2θ; step size = 0.02 °2θ; time/step = 1 s; soller slits 2,5 ° fixed divergence + antiscatter slits 0,6 mm; Ni-filter; knife edge; rotation 1/30
Sample type:	sediment
Number of samples:	3
LLD:	Lower limit of determination is dependent on mineral, but normally between 1-2 wt%.
Uncertainty:	Depending on sample material, Rietveld modelling has an uncertainty of at least 2-3 wt%.
Quality control:	Control samples are run routinely (2θ-value/d-value). These can be presented upon request.
Comments:	See also comments on page 3. Raw data of scans can be delivered upon request.

Analyses completed	18/12/2015	Jasmin Schönenberger
	Date	Operator/Data interpretation

NORGES GEOLOGISKE UNDERSØKELSE
7491 TRONDHEIM
Tlf.: 73 90 40 00
Telefaks: 73 92 16 20

XRD-analyses
Geological material
Analyses contract 2015.0367

sample-ID	qtz [wt%]	K-fsp [wt%]	plag [wt%]	ill/musc [wt%]	chl [wt%]	amph [wt%]	py [wt%]	GOF	Rwp
SP8-4-50	41	12	30	8	3	6	traces	1.58	16.95
SP8-8-19	40	13	29	8	4	6	traces	1.58	16.83
SP8-13-44	44	12	30	7	2	5	traces	1.58	16.96

NORGES GEOLOGISKE UNDERSØKELSE - NGU -
7491 TRONDHEIM
Tlf.: 73 90 40 00
Telefaks: 73 92 16 20

COMMENTS ON XRD ANALYSES

Mineral identification was carried out with automatic and/or manual peak search/match function in Bruker's Diffrac.EVA V3.1 software. For supplementary search, ICDD's PDF 4 Minerals database was used. Mineral quantification was performed using Rietveld modelling with software TOPAS 5.

Abbreviations:

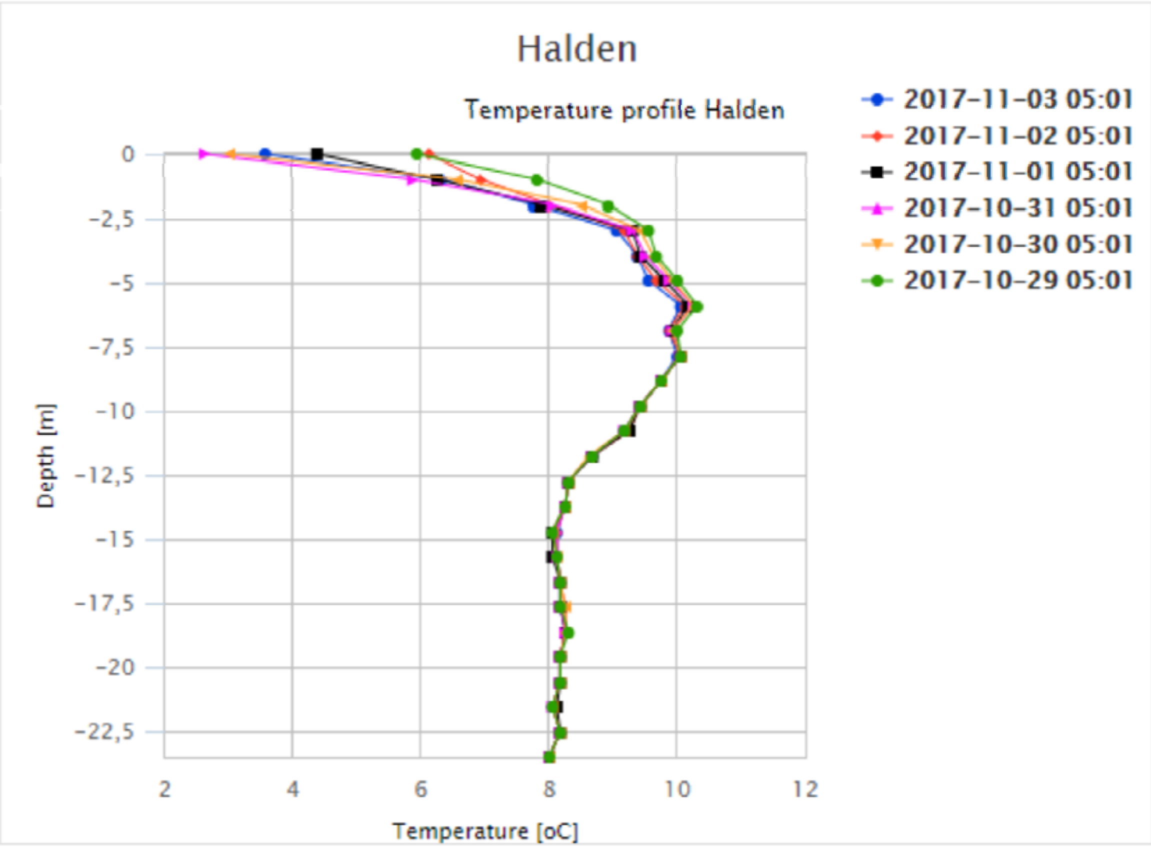
GOF/Rwp	GOF stands for "goodness of fit" and serves -along with Rwp - as an indication of the performance of Rietveld modelling.
	[*rule of thumb:* GOF < 1.5: excellent refinement; GOF < 2: reliable refinement]
Rwp	weighted profile factor

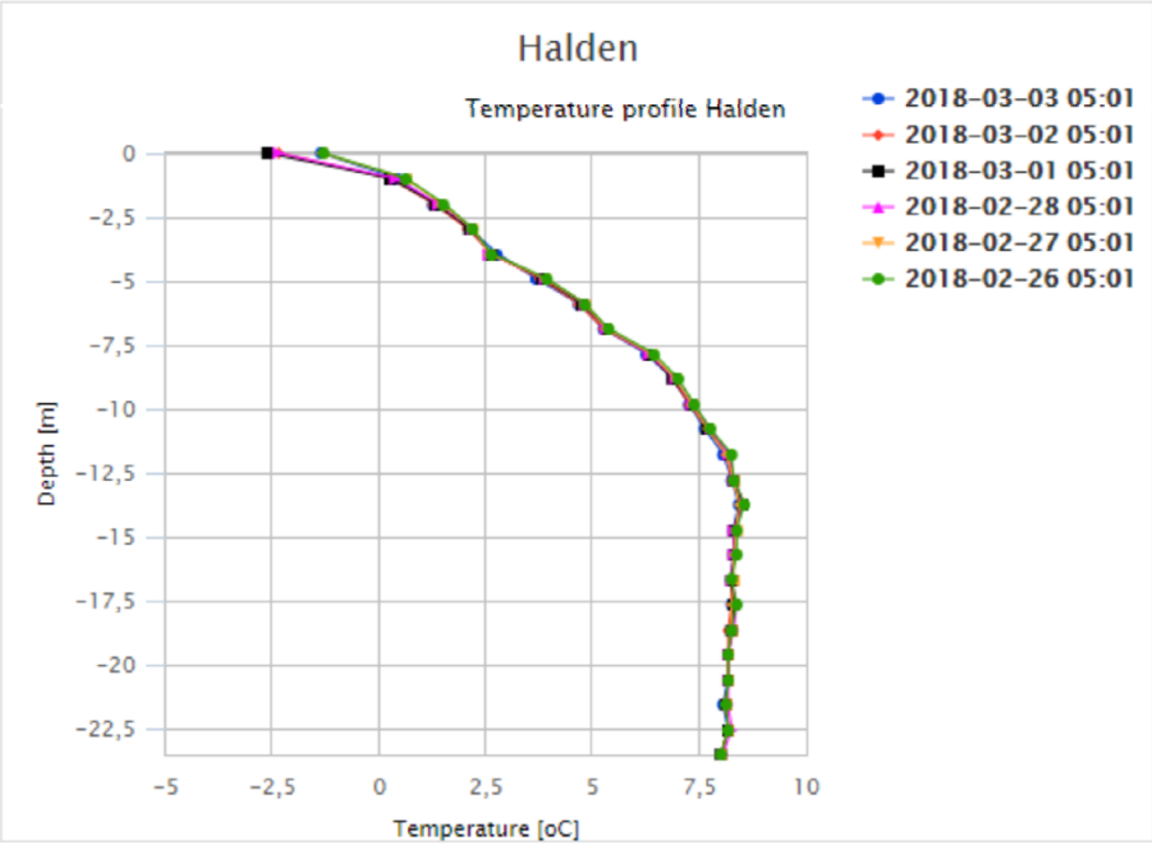
qtz	quartz
K-fsp	alkali-feldspar
plag	plagioclase
ill/musc	illite/muscovite
chl	chlorite
amph	amphibole
py	pyrite

Appendix T

THERMISTOR STRING RESULTS

Sensor No.	Position	Depth below ground level	Comment
(-)	(-)	(m)	(-)
1	-	-	Above ground
2	-	-	Above ground
3	1	0	Ground level
4	2	0.25	
5	3	0.5	
6	5	0.75	
7	6	1	
8	7	1.5	
9	8	2	
10	9	2.5	
11	10	3	
12	11	3.5	
13	12	4	
14	13	4.5	
15	14	5.5	
16	15	6.5	
17	16	7.5	
18	17	8.5	
19	18	9.5	
20	19	10.5	
21	20	11.5	
22	21	13.5	
23	22	15.5	
24	23	17.5	
25	24	19.5	
26	25	21.5	
27	26	23.5	20cm above bedrock
28	27	*25.5*	Not used (coiled on pipe)
29	28	*27.5*	Not used (coiled on pipe)
30	29	*29.5*	Not used (coiled on pipe)

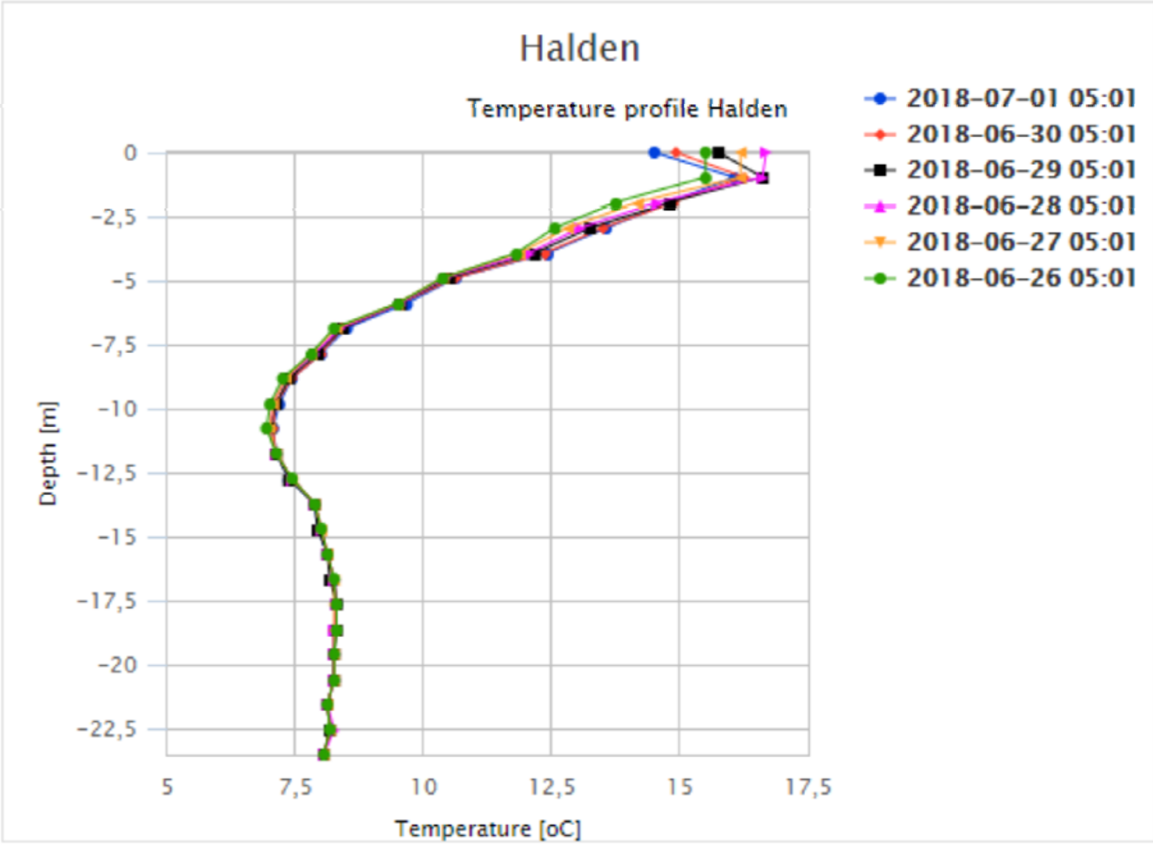


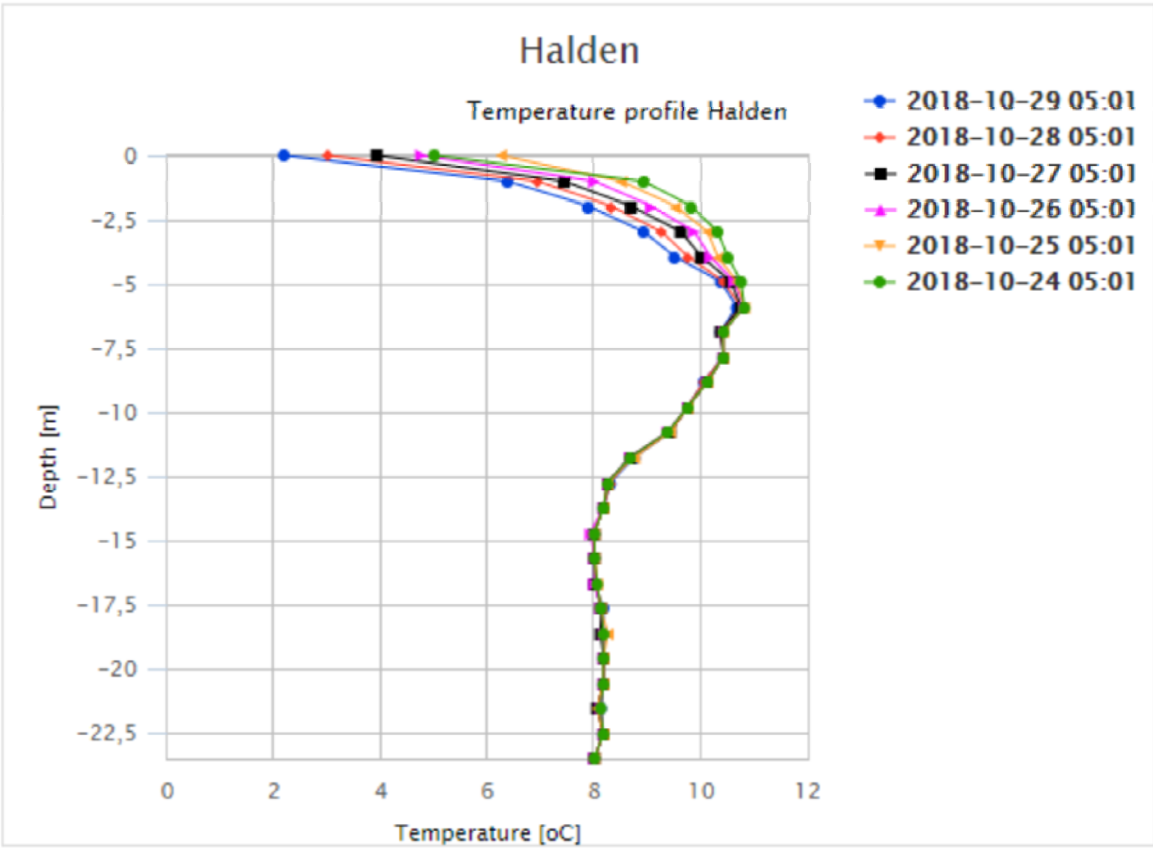


Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Thermistor string Halden	Figure No. 01	
	Date 2020-01-06	Drawn by APP
	NGTS	

P:\2016\01\20160154\Fieldwork\Halden\THS\HALTH01.grf





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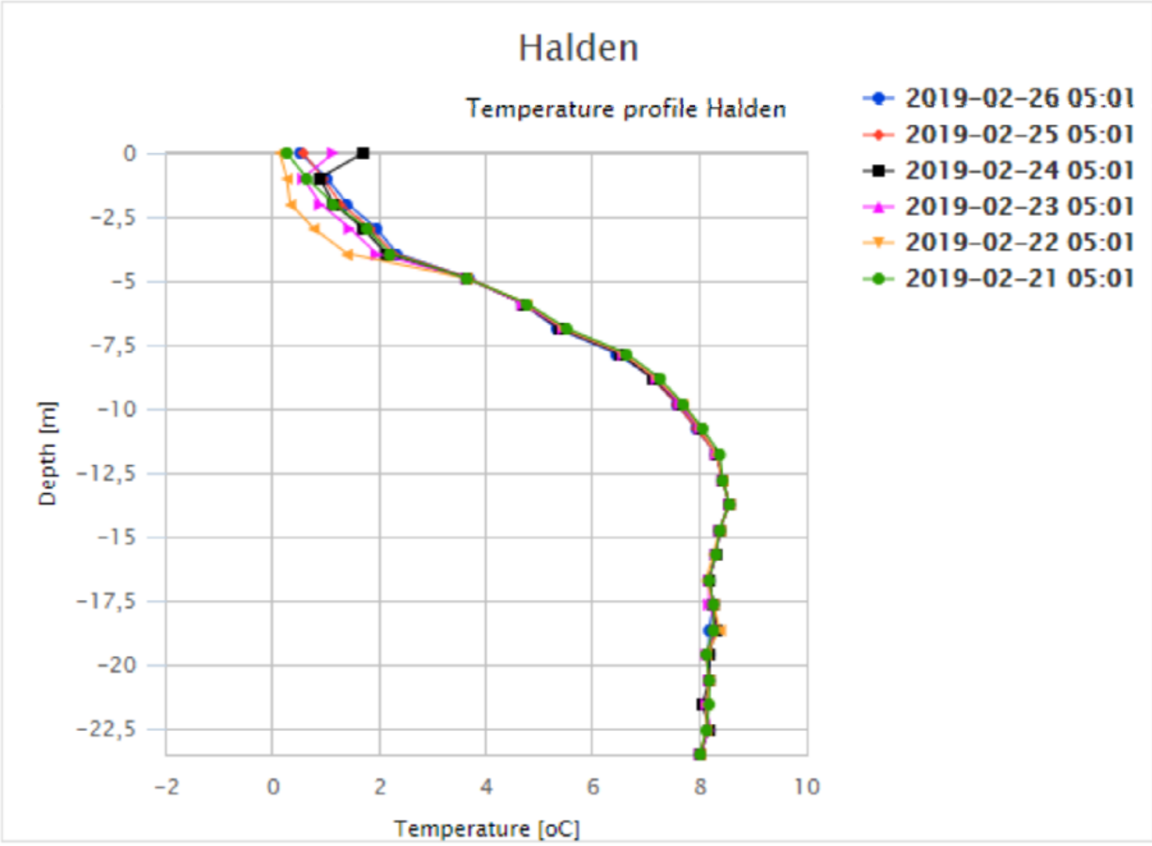
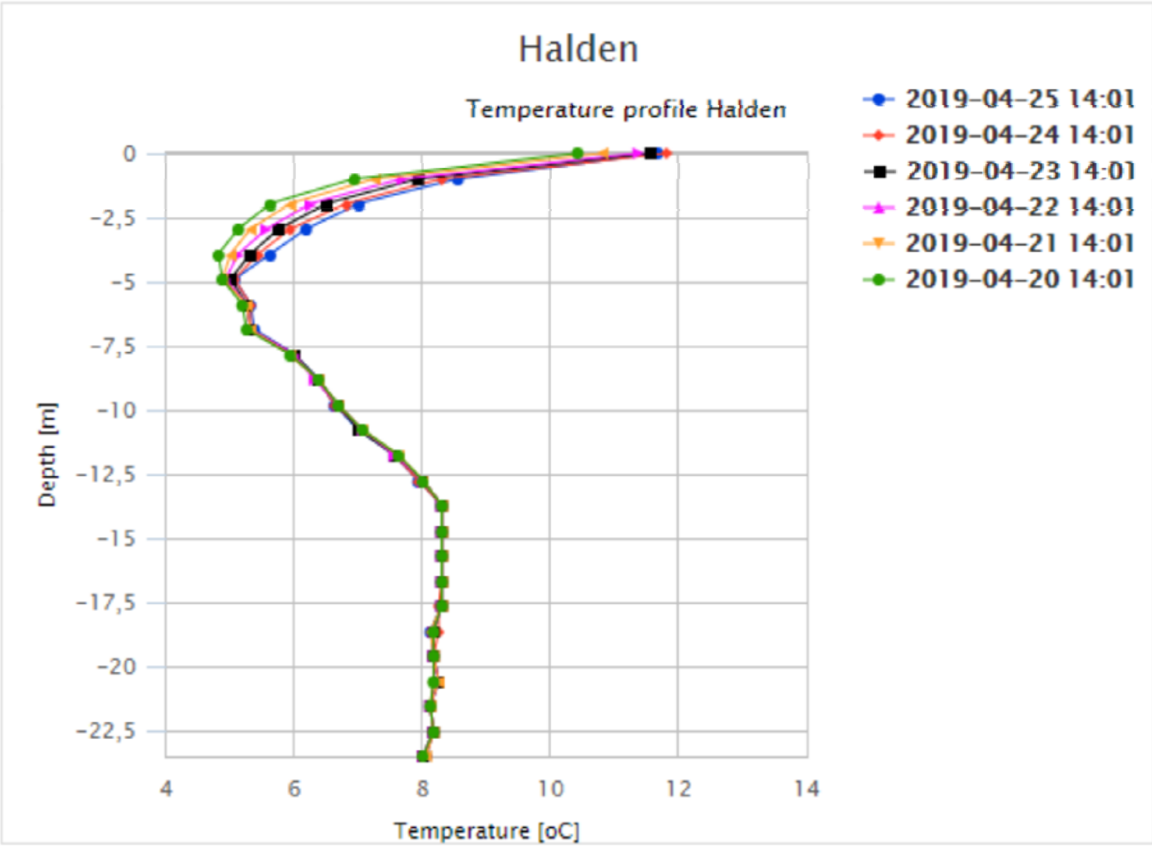
Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R	
Thermistor string Halden	Figure No. 02	
	Date 2020-01-06	Drawn by APP
	NGTS	





Date/Rev.: 2015-01-21/01

NGTS - Halden Research Site	Document No. 20160154-04-R
Thermistor string Halden	Figure No. 03
	Date 2020-01-06 / Drawn by APP

NGTS

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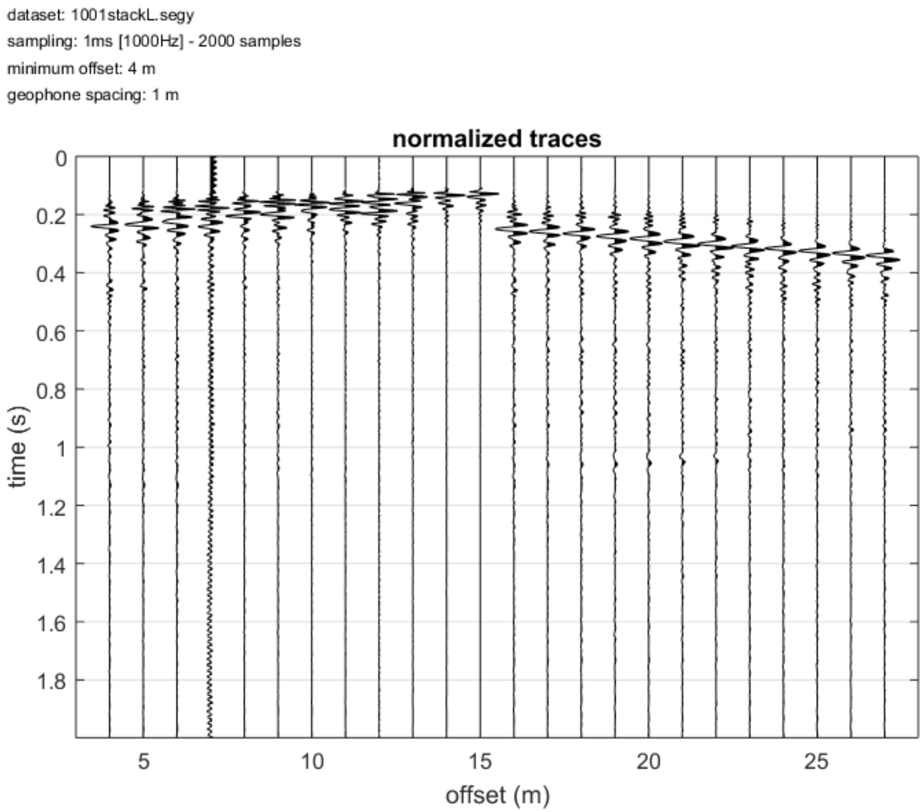
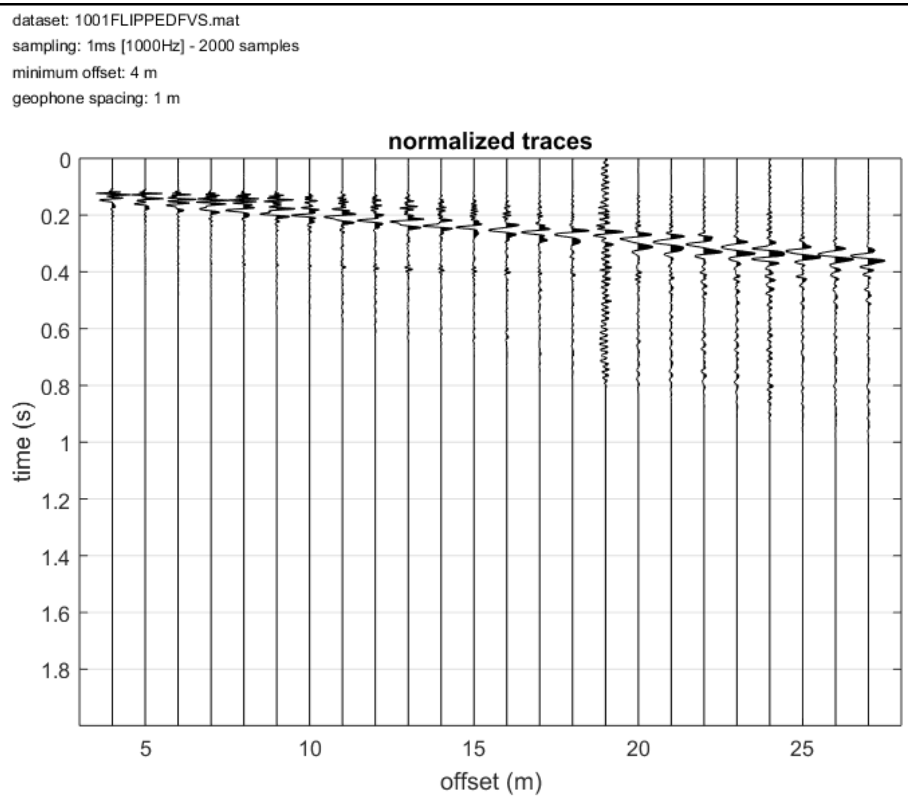
Appendix U

MASW RESULTS



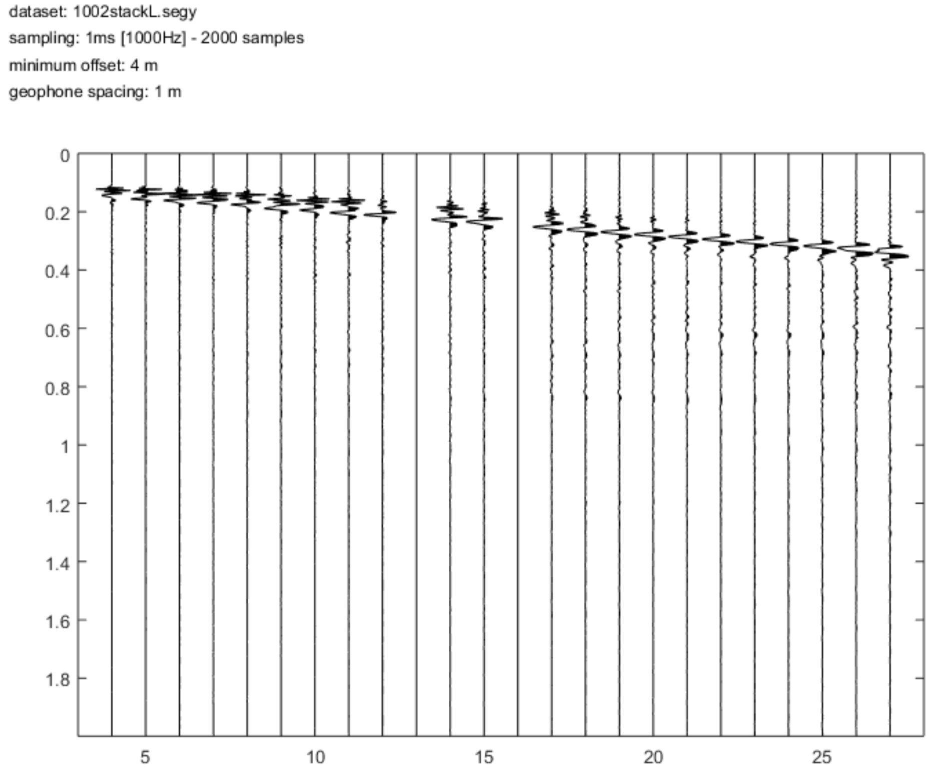


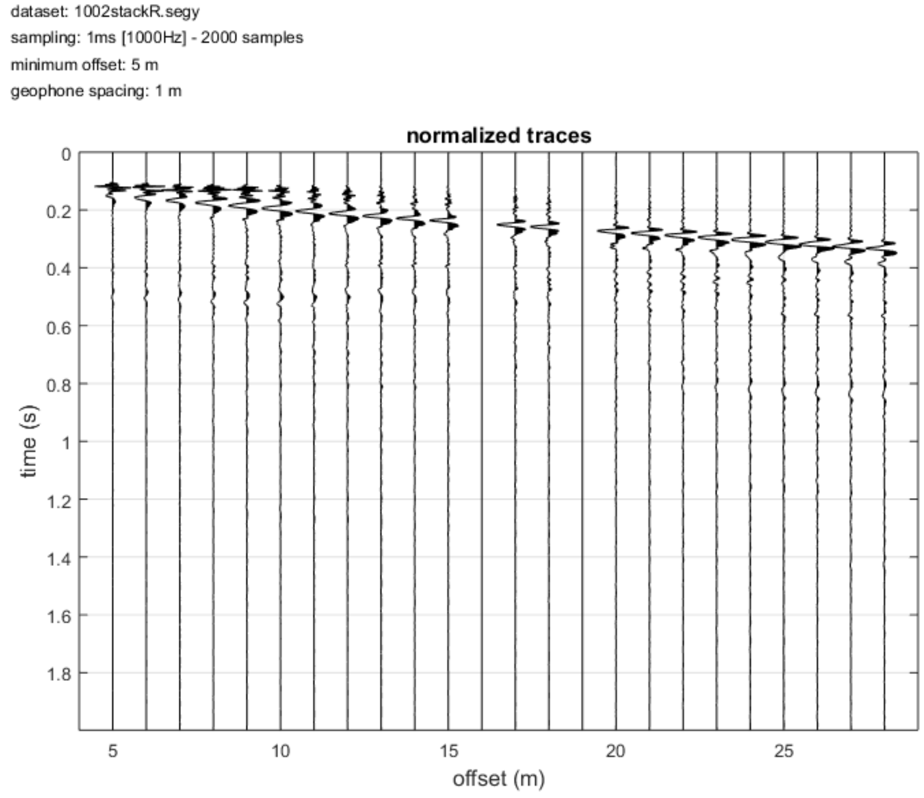
Norwegian GeoTest Sites - Halden

MASW profile HALM01, left side shot gather.
The left figure shows the shot gather are recorded in the field. The 1-12 geophone cable was unfortunately inverted. The right figure shows the shot gather after data handling with the corrected acquisition geometry.

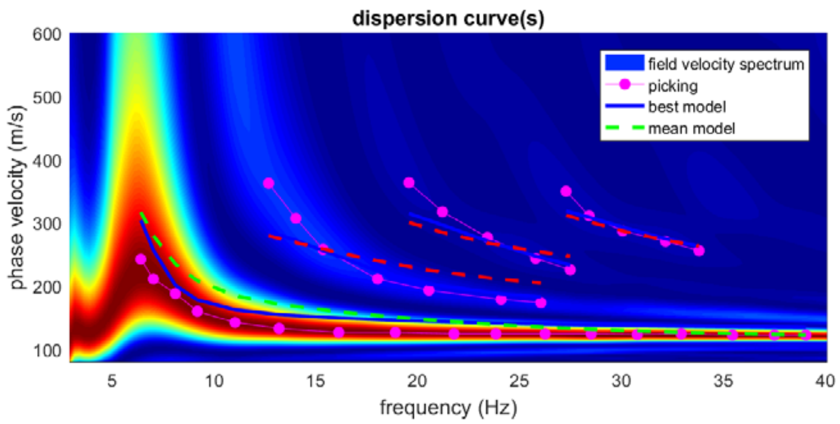
Document no. 20160154-04-R	
Figure no. U1	
Date 2018-04-23	Drawn by SaB

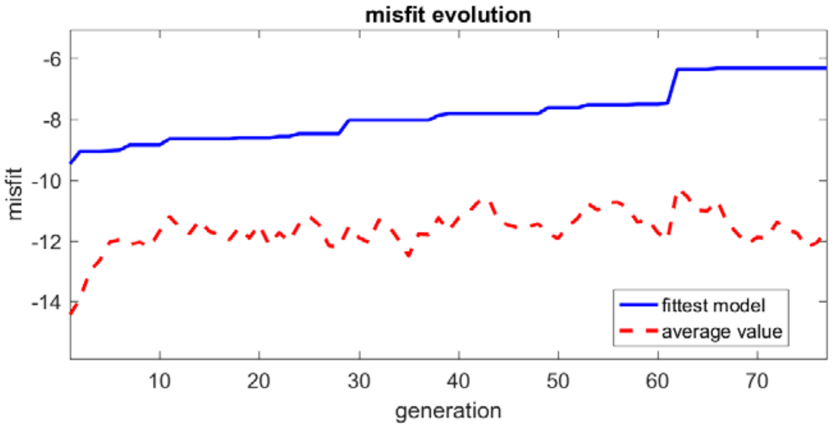
NGTS

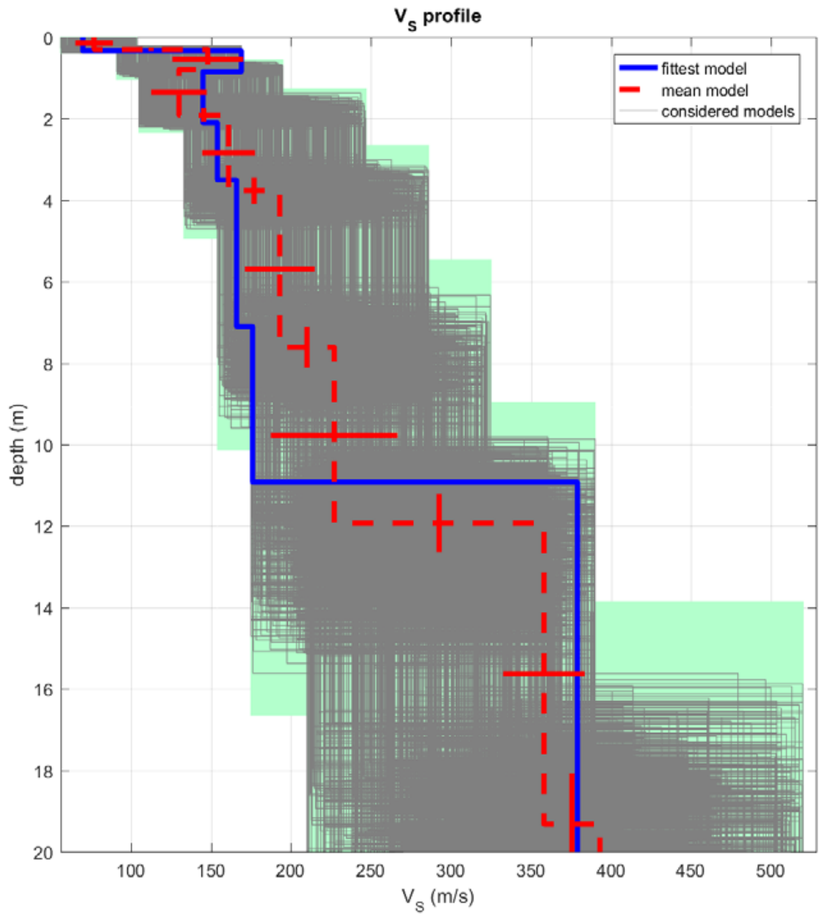




Norwegian GeoTest Sites - Halden	Document no. 20160154-04-R	
MASW profile HALM02 (left and right shot gathers). Unlike for HALM01 (Figure U1), the acquisition geometry was correct and did not necessitate data handling. Geophones #10 and #13 were noisy and therefore muted.	Figure no. U2	
	Date 2018-04-23	Drawn by SaB
	NGTS	







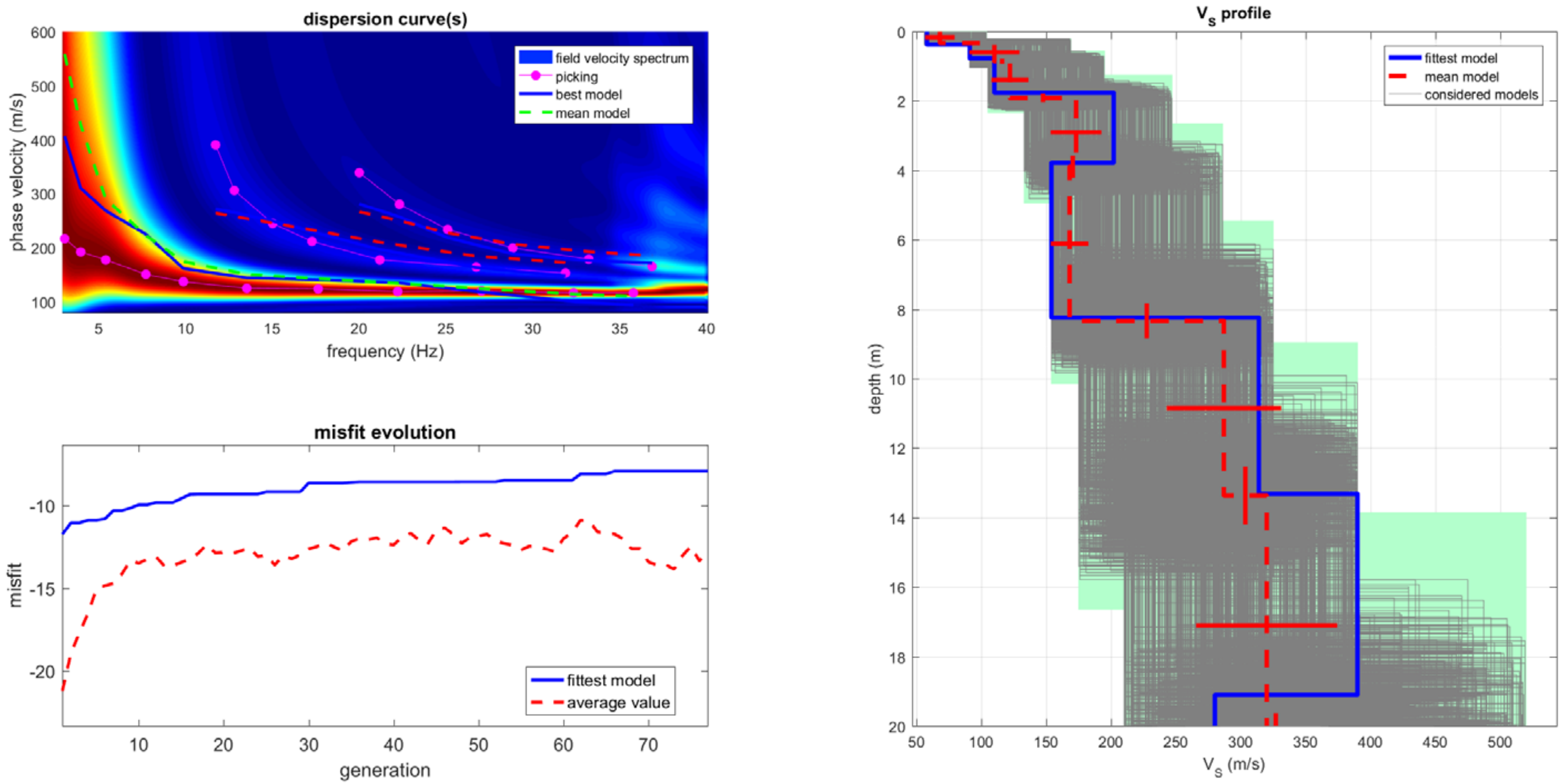
dataset: 1002stackL-CLEAN.sgy

dispersion curve: 1002Lc.cdp

Vs30 (best model): 253 m/s

Vs30 (mean model): 267 m/s

Norwegian GeoTest Sites - Halden	Document no. 20160154-04-R	
Dispersion curve of HALM02 (stacked, left side of array) and inversion results. Top Left: the pink dots are picks for the fundamental mode, the 1st higher mode, the 2nd higher mode, and the 3rd higher mode picks. The blue curve is the data fit after inversion. Right: Best fitting velocity structure.	Figure no. U3	
	Date 2018-04-23	Drawn by SaB
	NGTS	



www.winmasw.com

dataset: 1001FLIPPEDFVS.mat

dispersion curve: 1001L.cdp

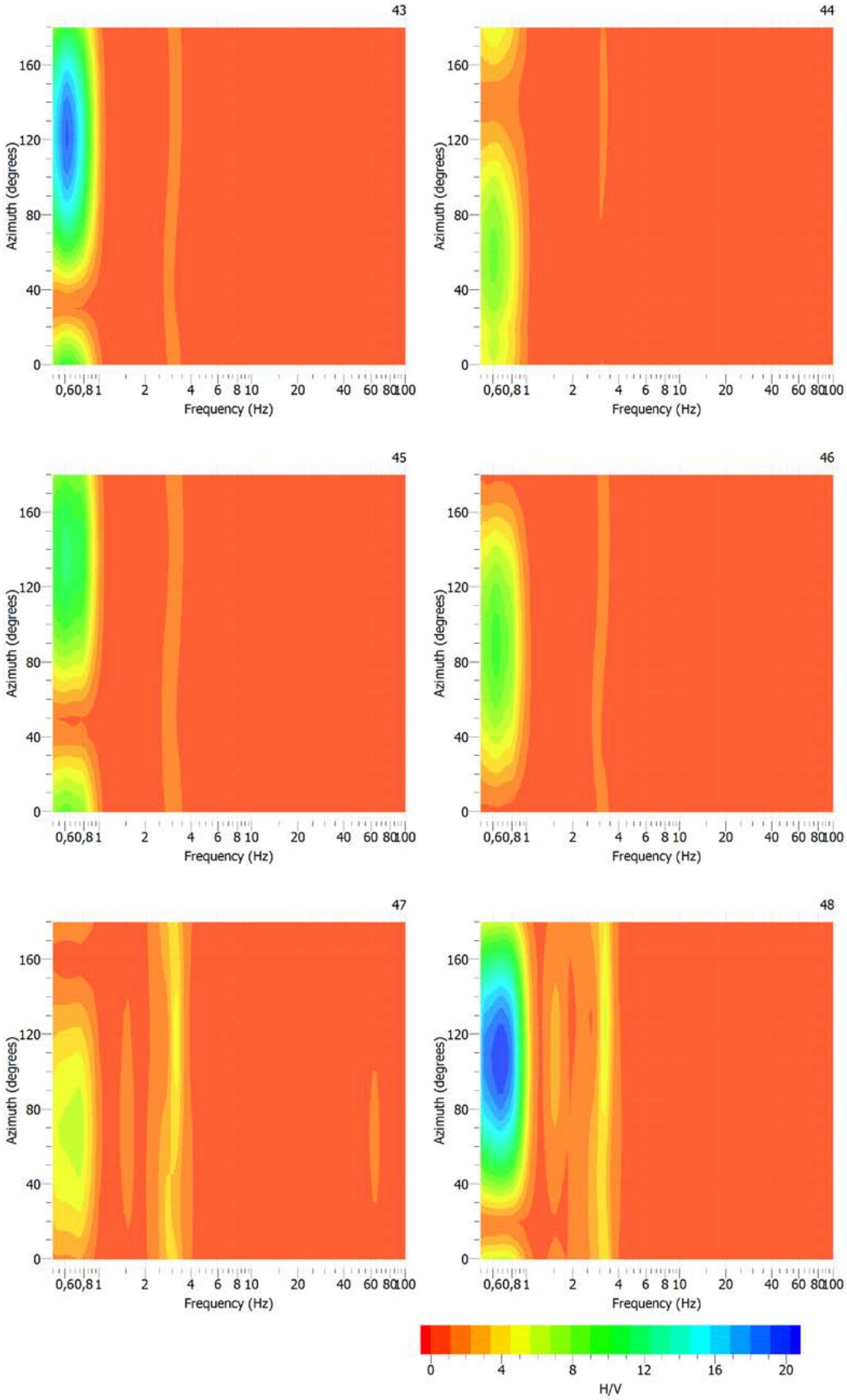
Vs30 (best model): 233 m/s

Vs30 (mean model): 241 m/s

Norwegian GeoTest Sites - Halden	Document no. 20160154-04-R	
Dispersion curve of HALM01 (one shot, right side of array) and inversion results. Top Left: the pink dots are picks for the fundamental mode, the 1st higher mode, the 2nd higher mode, and the 3rd higher mode picks. The blue curve is the data fit after inversion. Right: Best fitting velocity structure.	Figure no. U3	
	Date 2018-04-24	Drawn by SaB
	NGTS	

Appendix V

PASSIVE SEISMIC RESULTS



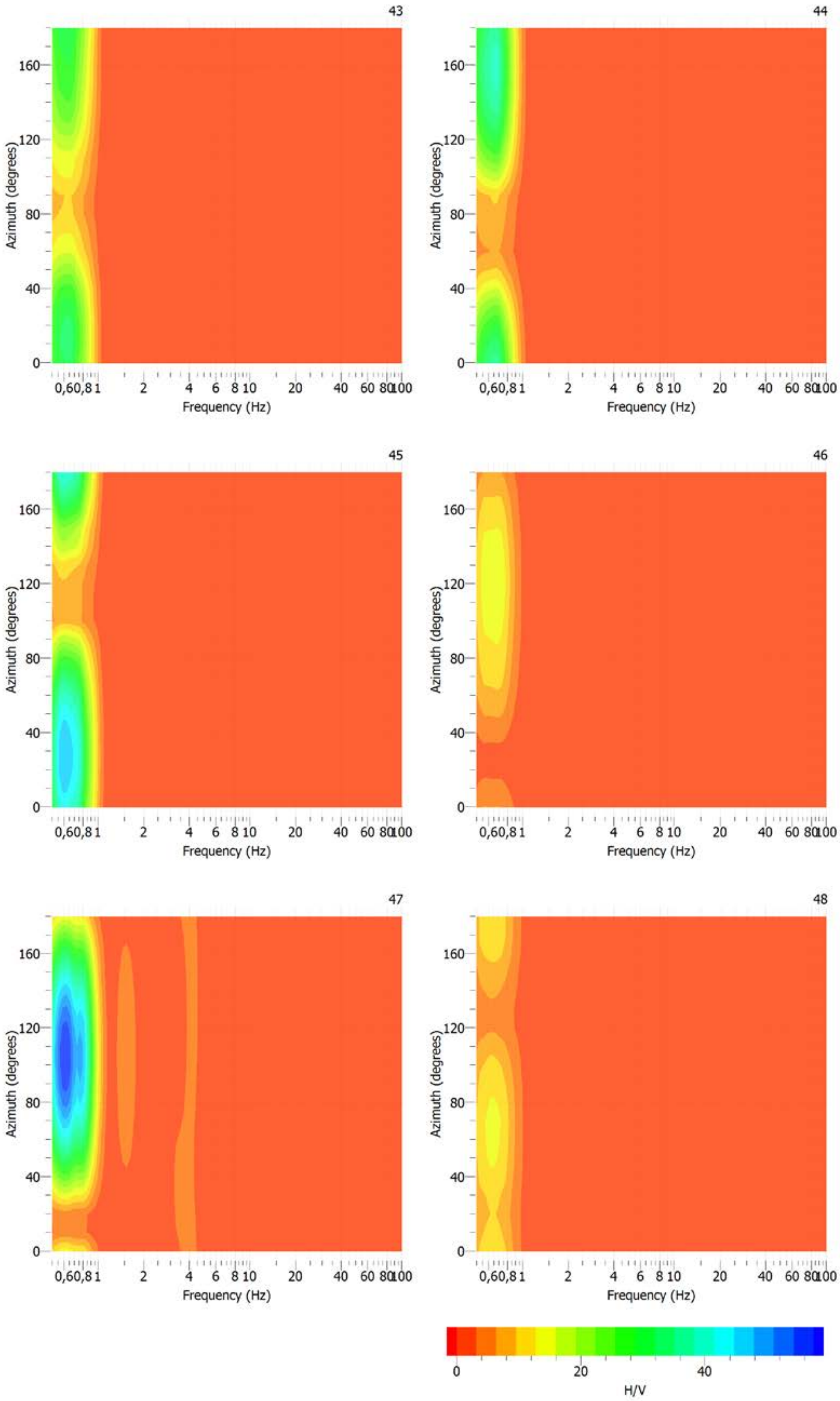
Norwegian GeoTest Sites - Halden

Passive seismic array.
H/V spectral ratio of the 6 stations recorded at site HALPS01.
The spectral ratio presents a clear peak at 3,2Hz.

Document no.	
20160154-04-R	
Figure no. V1	
Date 2018-04-23	Drawn by SaB

NGTS

document1



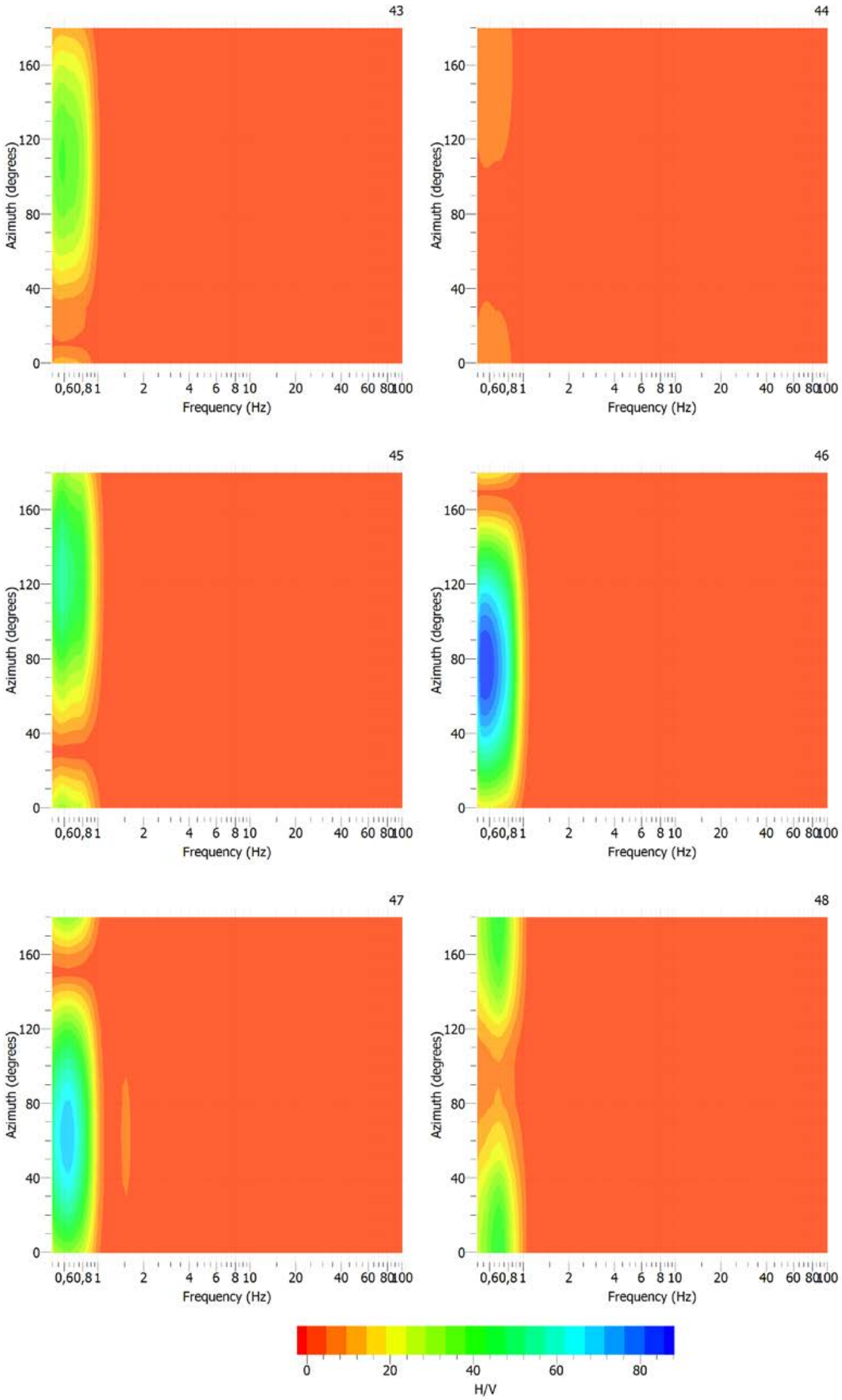
Norwegian GeoTest Sites - Halden

Passive seismic array.
H/V spectral ratio of the 6 stations recorded at site HALPS02.
The spectral ratio does not show any fundamental frequency.

Document no.	
20160154-04-R	
Figure no.	
V2	
Date	Drawn by
2018-04-23	SaB

NGTS

document1



Norwegian GeoTest Sites - Halden

Passive seismic array.
H/V spectral ratio of the 6 stations recorded at site HALPS03.
The spectral ratio does not show any fundamental frequency.

Document no.	
20160154-04-R	
Figure no.	
V3	
Date	Drawn by
2018-04-23	SaB

NGTS

Appendix W

FROZEN HEAVE TESTS

Experimental study on the influence factors of frost heave soil

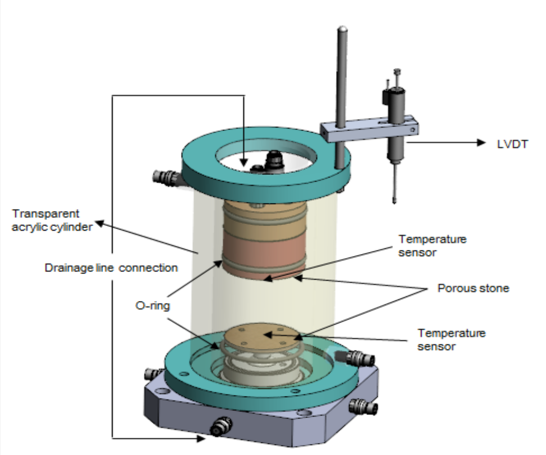
10 September 2018

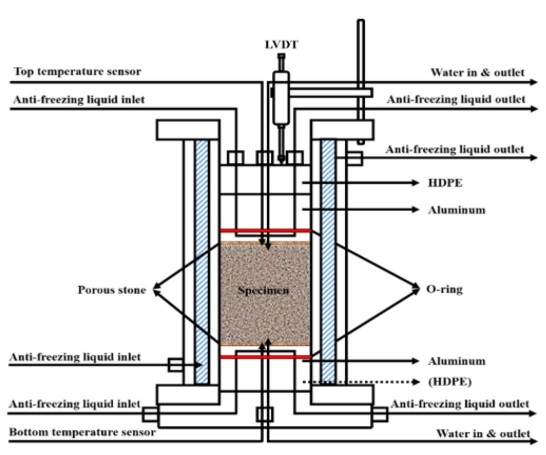
Yunsup Shin (NGI)

Hyunwoo Jin, Jangguen Lee (KICT)

Laboratory Testing System

- **KICT transparent temperature-controllable cell**





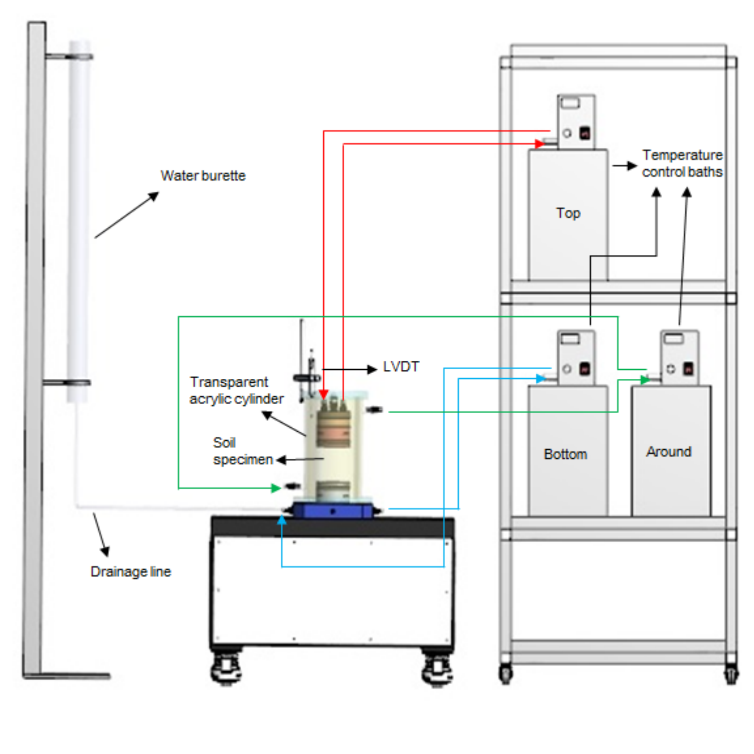
Mold material	Acrylic
Freezing Direction	Bottom → Top Top → Bottom
Drainage condition	Open system Closed system
Advantage	Temperature-controllable cell → w/o freezing chamber transparent cell → observable frost heave with naked eyes

NGI

Laboratory Testing System

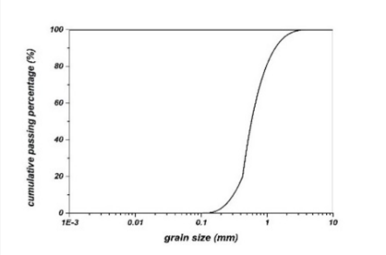
KICT frost heave testing system

- **Frost heave test apparatus**



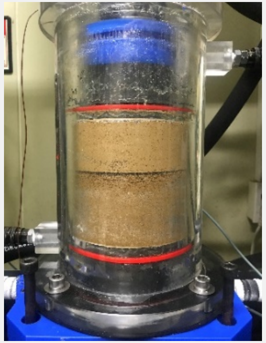
Step 1. system verification

Non-frost susceptible soil & undrained condition



Step 2. frost heave test

Frost susceptible soils & side friction

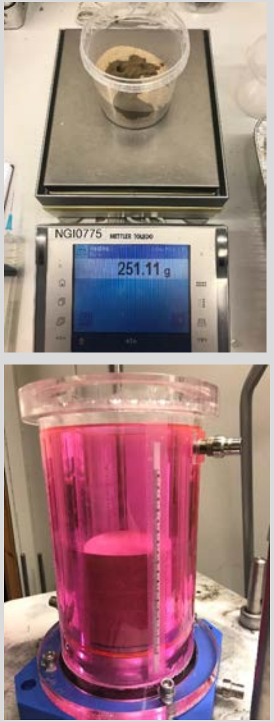


+

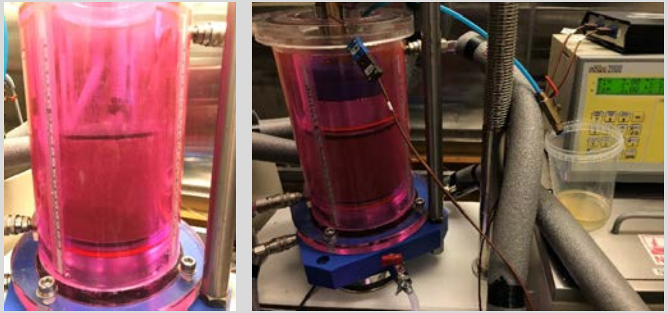
Laboratory Testing System

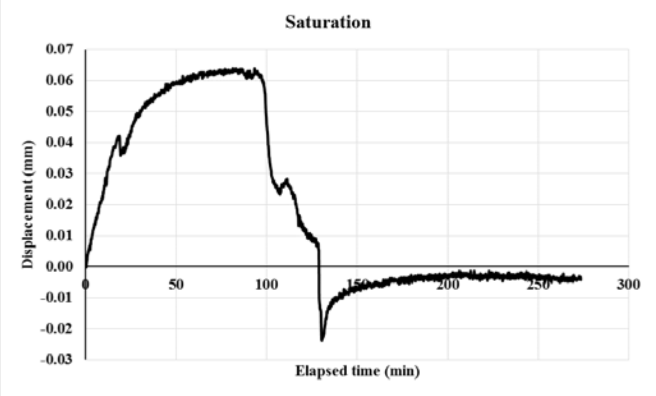
- **Test Procedure**

Soil preparation

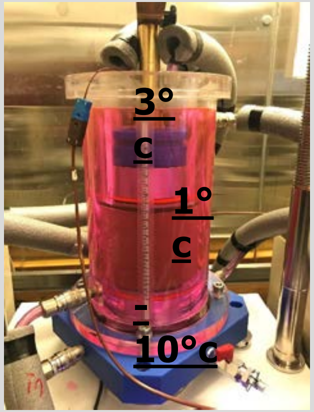


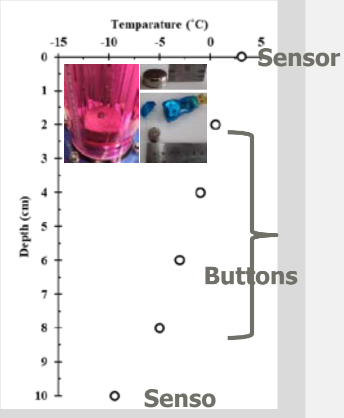
Saturation step

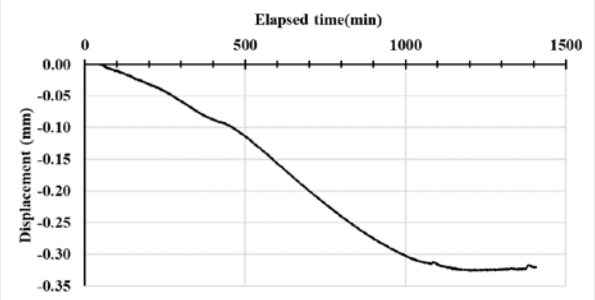




Freezing step

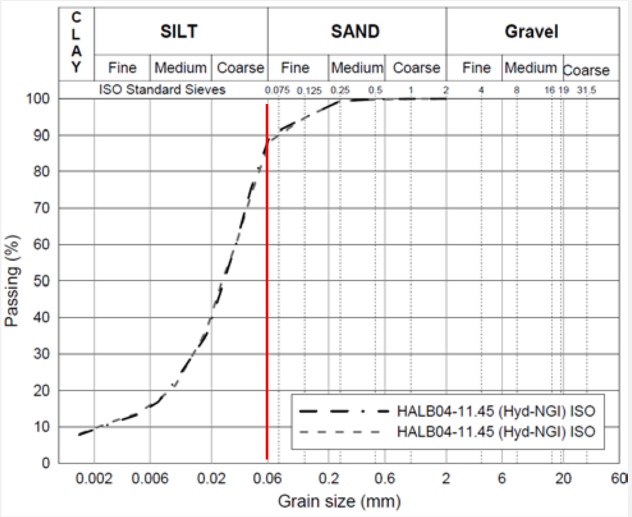






Frost heave tests

- Test soil grain size distribution



Soil	D_{10}	D_{30}	D_{60}	Uniformity coefficient, C_u	Coefficient of curvature, C_c	Specific gravity, G_s	USCS
Halden soil	0.002	0.01	0.032	16	1.56	2.65	SC

NGI

Frost heave tests

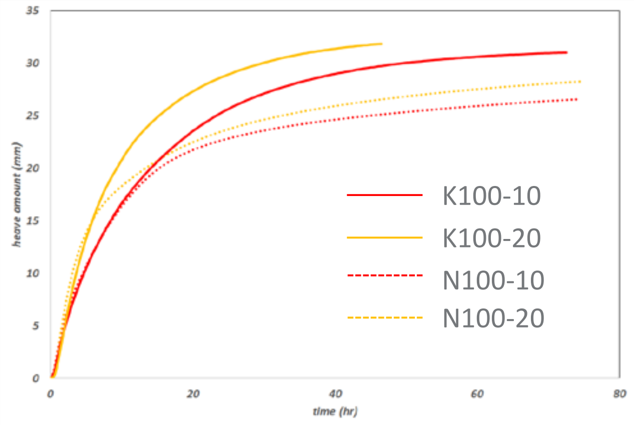
- Test programs

Soil	Specific gravity, G_s	No.	O-ring	Dry unit weight, (kN/m^3)
Artificial soil 1	2.63	A-1	O	16.25
Halden Soil (NGI and KICT)	2.56	K100-10	X	14.51
		K50-5	X	13.84
		K30-3	X	14.84
		K100-20	X	14.91
		K50-10	X	14.30
		K30-6	X	14.91
		N100-10	X	13.55
		N100-20	X	13.43

NGI

Frost heave tests: Test results (Halden soil)

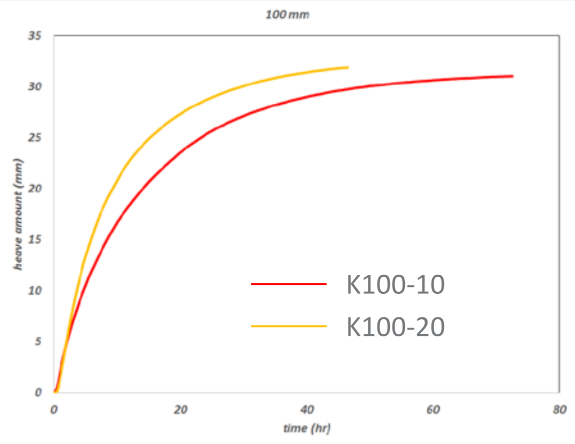
- **Halden soil, Silt (SC)**
- **KICT and NGI test result comparison**

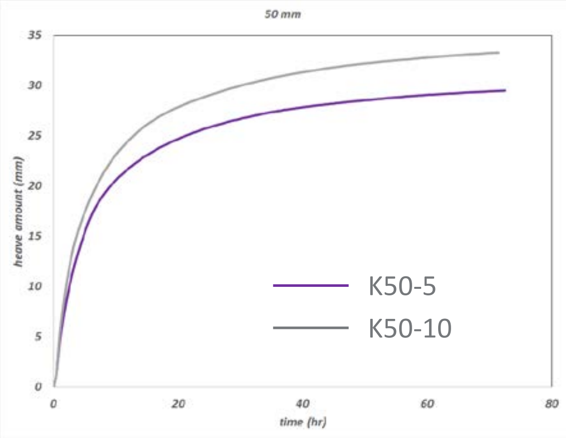


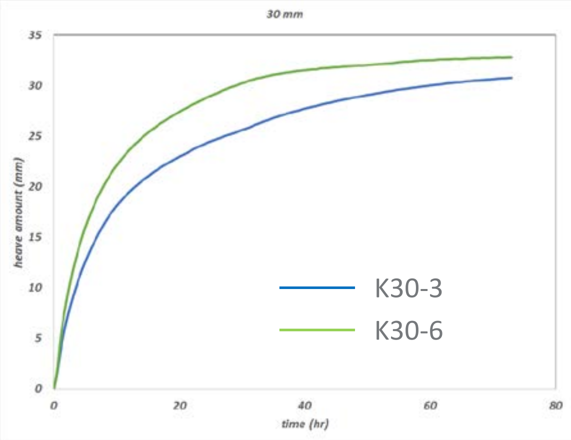
Test Com.	No	Dry unit weight, (kN/m³)	Height mm	Bottom °C	Top °C	Gradient °C/mm	Con. °C	Heave amount (mm)			Heave rate (mm/day)		
								total	Pore water	Water intake	ASTM (8hr)	KICT (14hr)	SP (hr)
KICT	K100-10	14.51	99.59	-9.1	2.7	0.118	3.0 ℃	31.01	3.02	27.99	43.55	34.23	-
KICT	K100-20	14.72	98.15	-20.8	2.8	0.240		31.85	3.34	28.51	55.35	41.57	-
NGI	N100-10	13.55	105.26	-9.4	3.2	0.119		26.62	3.67	22.95	43.34	33.20	-
NGI	N100-20	13.43	107.60	-20.9	3.1	0.223		28.29	4.11	24.18	51.23	34.87	-

Frost heave tests: Test results (Halden soil)

- **Temperature gradient and sample height**



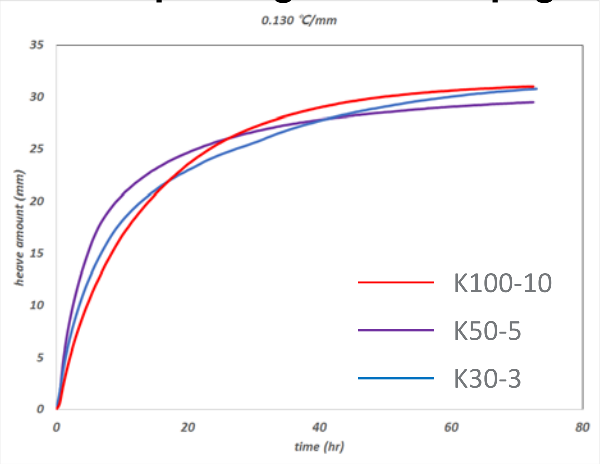


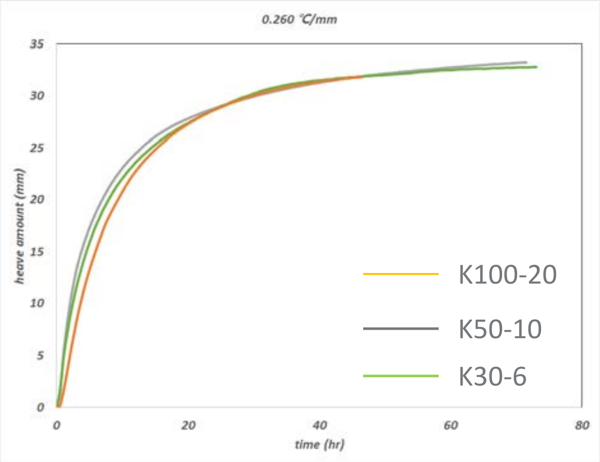


No	rd, (kN/m^3)	Height mm	Botto m °C	Top °C	Gradient °C/mm	Con. °C	Heave amount (mm)			Heave rate (mm/day)		
							total	Pore water	Water intake	ASTM (8hr)	KICT (14hr)	SP (hr)
K100-10	14.51	99.59	-9.1	2.7	0.118	3.0 °C	31.01	3.02	27.99	43.55	34.23	-
K100-20	14.72	98.15	-20.8	2.8	0.240		31.85	3.34	28.51	55.35	41.57	-
K50-5	13.84	52.20	-4.6	1.5	0.117	1.5 °C	29.50	1.64	27.86	57.32	38.84	-
K50-10	14.30	50.54	-10.6	1.6	0.241		33.26	1.76	31.50	63.84	43.94	-
K30-3	14.84	29.22	-3.3	0.7	0.137	0.9 °C	30.79	0.92	29.87	48.99	35.24	-
N30-6	14.91	29.10	-6.7	0.7	0.261		32.83	1.00	31.83	60.50	42.56	-

Frost heave tests: Test results, Halden soil

- **Sample height and Temp. gradient**

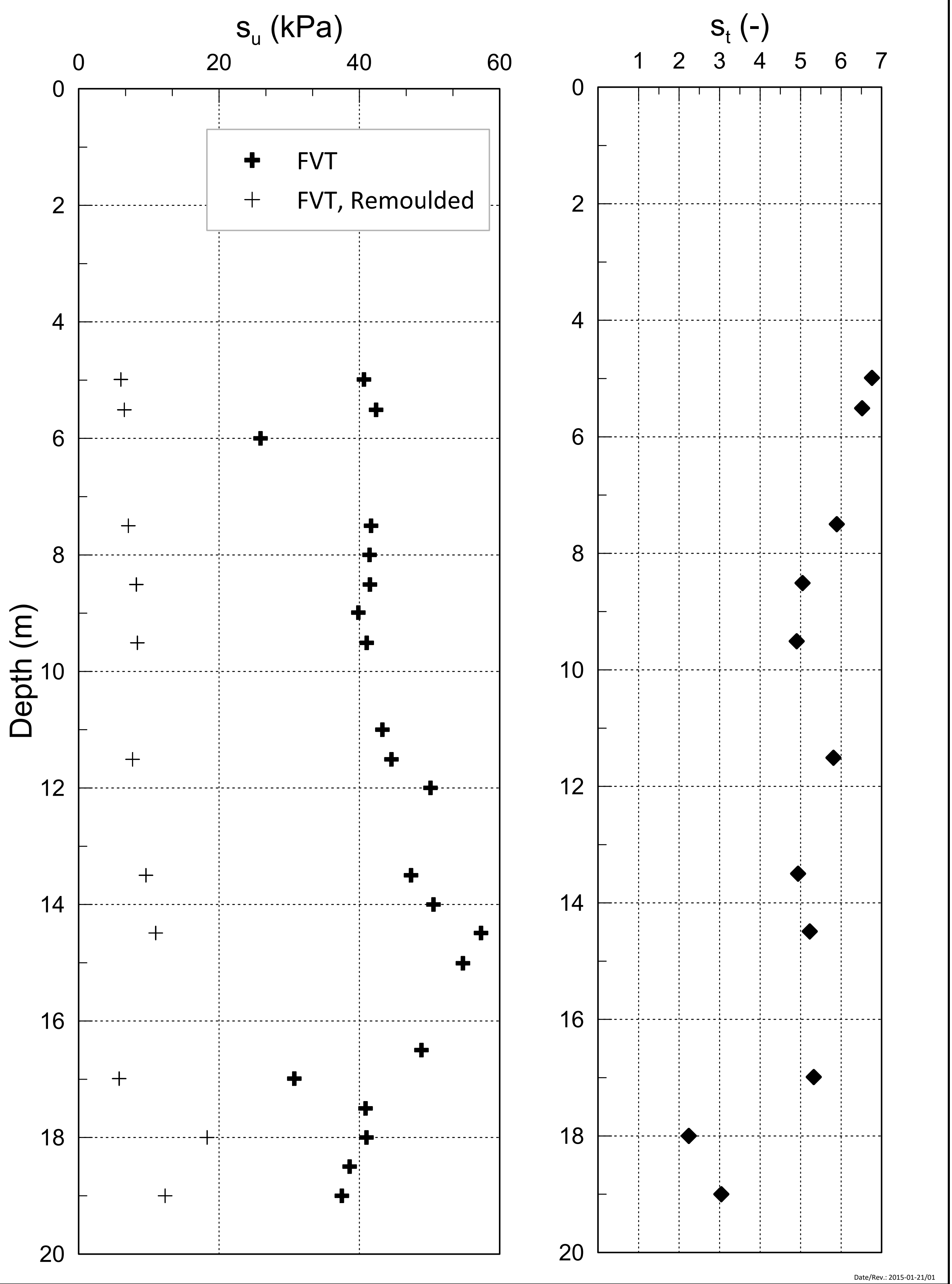




No	rd, (kN/m^3)	Height mm	Bottom °C	Top °C	Gradient °C/mm	Con. °C	Heave amount (mm)			Heave rate (mm/day)		
							total	Pore water	Water intake	ASTM (8hr)	KICT (14hr)	SP (hr)
K100-10	14.51	99.59	-9.1	2.7	0.118	3.0 ℃	31.01	3.02	27.99	43.55	34.23	-
K50-5	13.84	52.20	-4.6	1.5	0.117	1.5 ℃	29.50	1.64	27.86	57.32	38.84	
K30-3	14.84	29.22	-3.3	0.7	0.137	3.0 ℃	30.79	0.92	29.87	48.99	35.24	-
K100-20	14.72	98.15	-20.8	2.8	0.240	3.0 ℃	31.85	3.34	28.51	55.35	41.57	-
K50-10	14.30	50.54	-10.6	1.6	0.241	1.5 ℃	33.26	1.76	31.50	63.84	43.94	-
N30-6	14.91	29.10	-6.7	0.7	0.261	0.9 ℃	32.83	1.00	31.83	60.50	42.56	-

Appendix X

FIELD VANE TESTS



NGTS - Halden Research Site

Undrained shear strength and sensitivity from field vane tests

HALV01
Rate of shearing = 0.1 °/s

Document No.
20160154-04-R

Figure No.
01

Date
2019-05-16

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APP/OyB

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Kartblad/*Map*	**Felt, blokknr./*Field, Block No.*** -
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